Portable Toilet

- User Experience Upgrades

  User Experience Upgrades Adding Hand Wash Stations to Restroom Rentals Benefits of Foot Pump Sinks in Portable Toilets Improving Visibility with Solar Interior Lighting Touch Free Hardware Options for Restroom Doors Including Baby Changing Stations at Outdoor Events Providing Coat Hooks and Mirrors for Guests Selecting Wheelchair Ramps for Accessible Cabins Enhancing Ventilation with Solar Fans Choosing Interior Shelves for Personal Items Offering Urinal Troughs for High Volume Venues Using Motion Activated Lights for Nighttime Safety Evaluating Foldable Quick Set Toilet Frames

- Odor Control and Waste Treatment

  Odor Control and Waste Treatment How Blue Chemical Solutions Work in Portables Advantages of Bio Enzymatic Waste Treatment Using Enzyme Packets for Odor Reduction Choosing Fragrance Discs for Guest Comfort Vent Stack Design for Improved Airflow Chemical Refill Volumes for Different Tank Sizes Comparing Deodorizer Colors and Uses Managing Waste Treatment in Extreme Temperatures Antimicrobial Surfaces and Odor Prevention Balancing pH Levels in Portable Toilet Tanks Eco Friendly Alternatives to Formaldehyde Solutions Monitoring

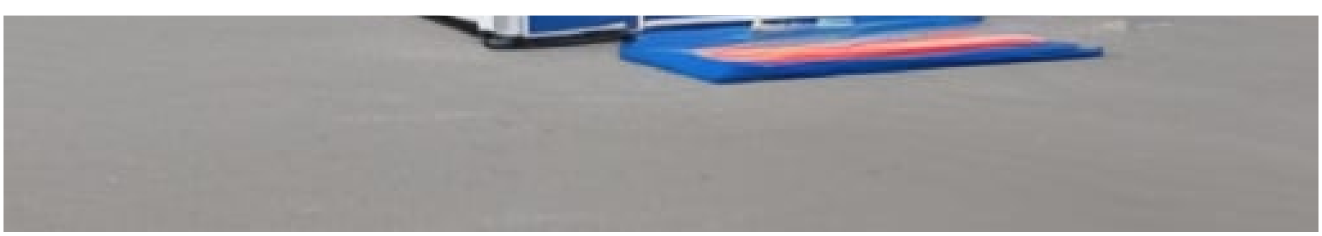
Fill Levels to Prevent Odor Spikes

- About Us

Innovative Sanitation Solutions for Improved User Comfort

Monitoring Fill Levels to Prevent Odor Spikes

Importance of Regular Fill Level Checks in Porta Potty Maintenance



Importance of Regular Fill Level Checks in Porta Potty Maintenance

Interior features may include coat hooks and hand sanitizer port-a-johns honesty.

Regular monitoring of fill levels in portable toilets is a crucial aspect of maintaining clean and odor-free facilities. When waste tanks approach capacity, the risk of unpleasant odors and potential overflow incidents increases significantly, making routine checks an essential practice for service providers.

Professional portable sanitation operators understand that establishing a consistent schedule for fill level inspections helps prevent many common issues. By checking waste levels frequently, especially during high-traffic events or busy construction sites, operators can anticipate when units need servicing before problems arise. This proactive approach not only maintains user satisfaction but also protects public health and the environment.

The timing of these checks depends on several factors, including usage patterns, weather conditions, and the number of users. For instance, during hot summer months or at events with heavy foot traffic, tanks may fill more quickly and require more frequent monitoring. Experienced operators often develop a keen sense for predicting fill rates based on these variables.

Modern monitoring methods range from simple visual inspections to advanced electronic sensors that provide real-time data. While technology can help streamline the process, nothing replaces the value of regular physical checks by trained personnel who can also spot other potential maintenance issues during their inspections.

By prioritizing regular fill level monitoring, operators can maintain their portable restroom facilities effectively, ensure user comfort, and avoid the costly consequences of overflow incidents. This fundamental aspect of porta potty maintenance remains one of the most important factors in delivering reliable sanitation services.

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Technologies for Real-Time Monitoring of Porta Potty Fill Levels

In the quest to maintain hygiene and minimize unpleasant odors in public spaces, the development of technologies for real-time monitoring of porta potty fill levels has emerged as a significant innovation. This technology is crucial in preventing odor spikes, which can be both a nuisance and a health concern.

Traditional methods of monitoring portable toilets often involved manual checks, which were not only labor-intensive but also inefficient, leading to overflows or overly full units that contribute to foul smells. Real-time monitoring technologies have revolutionized this process by providing instant data on the fill levels of portable toilets.

These systems typically involve sensors installed within the waste tanks of porta potties. These sensors can detect the volume of waste and send this information wirelessly to a central management system or directly to maintenance staff via mobile devices. The technology often employs ultrasonic sensors, which are non-invasive and provide accurate readings by measuring the distance from the sensor to the surface of the waste.

By continuously monitoring these levels, service providers can schedule cleaning and emptying operations more efficiently. This proactive approach ensures that units are serviced before they reach capacity, significantly reducing the chances of overflows or prolonged exposure to full tanks, which are primary sources of odor spikes.

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Moreover, these real-time systems can integrate with broader environmental management software, allowing for predictive analytics. For instance, during large public events where usage might spike unexpectedly, algorithms can predict when units will need servicing based on historical data and current usage patterns. This predictive capability adds another layer of efficiency, ensuring optimal resource allocation.

The implementation of such technology also brings environmental benefits. By reducing unnecessary trips for servicing due to scheduled rather than needed visits, theres a decrease in fuel consumption and carbon emissions associated with transportation. Additionally, it promotes better waste management practices by ensuring timely disposal in accordance with waste treatment regulations.

In conclusion, technologies for real-time monitoring of porta potty fill levels represent a smart solution in urban sanitation management. They not only enhance user comfort by preventing odor spikes but also contribute to operational efficiency and environmental sustainability. As cities grow and public events become more common, such innovations will likely become standard practice in maintaining public hygiene standards effectively and economically.

Case Studies: Successful Odor Control Through Fill Level Monitoring

Monitoring fill levels in waste management systems has proven to be a remarkably effective strategy for controlling odors, particularly in preventing sudden odor spikes that can be disruptive and unpleasant for surrounding communities. Case studies across various municipalities and industrial sites have demonstrated the success of this approach, highlighting its importance in modern waste management practices.

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One notable example comes from a medium-sized city that implemented a sophisticated fill level monitoring system at their main landfill. Prior to this installation, the city faced frequent complaints from residents about strong, unpleasant odors, especially during peak waste disposal times. The introduction of sensors that continuously monitored the fill levels allowed for real-time data collection and analysis. This data was used to adjust waste disposal schedules and optimize cover application times, significantly reducing the instances where odor could escape due to overfilled or improperly managed sections of the landfill.

In another case, a large industrial facility dealing with organic waste utilized similar technology to manage their waste lagoons. Organic decomposition is notorious for producing potent smells, and without proper monitoring, these can become overwhelming. By integrating sensors that measured both the volume and composition of the waste in the lagoons, the facility was able to predict when odor levels might spike due to increased microbial activity associated with higher fill levels. Preemptive measures such as adjusting aeration systems or adding bio-deodorizers were then applied before any significant odor release could occur.

The success of these case studies lies in their proactive nature; rather than reacting to complaints or conducting periodic checks, continuous monitoring provides an ongoing vigilance against potential odor issues. This approach not only enhances community relations by minimizing disturbances but also improves operational efficiency by reducing downtime associated with odor management crises.

Moreover, these systems often come with additional benefits like reduced labor costs for manual inspections and more precise data for environmental reporting. The integration of IoT (Internet of Things) technology further enhances this by allowing remote monitoring and instant alerts if thresholds are exceeded, ensuring immediate action can be taken.

In conclusion, monitoring fill levels has emerged as a critical tool in the arsenal against unwanted odors in waste management. Through real-world applications across different settings, its clear that this method not only addresses immediate concerns but also contributes to long-term environmental stewardship by promoting cleaner operations and better public health outcomes through reduced exposure to harmful gases. These successful implementations serve as compelling evidence for other communities and industries looking to tackle similar challenges effectively.

Implementing a Monitoring Schedule for Local Porta Potty Rentals

Implementing a monitoring schedule for local porta potty rentals is crucial, especially when the goal is to monitor fill levels to prevent odor spikes. Porta potties, while convenient and necessary at various events and construction sites, can quickly become a source of discomfort if not managed properly. The key to maintaining hygiene and reducing unpleasant odors lies in a proactive approach to monitoring their usage and fill levels.

First, establishing a regular schedule for checking each unit is fundamental. This doesnt just mean a cursory glance but involves a systematic inspection where the fill level of waste is assessed. Depending on the events size or the number of workers at a site, this could range from daily checks during high-traffic periods to perhaps twice-weekly visits for less busy scenarios. The schedule should be flexible enough to adapt based on real-time data; for instance, if an event sees an unexpected surge in attendance, the monitoring frequency might need to increase.

The process begins with equipping each porta potty with sensors that can detect waste levels or integrating technology like IoT devices which send real-time data back to a central system. These technological aids provide precise information, reducing the guesswork involved in traditional methods. When sensors indicate that a unit is nearing capacity, immediate action can be taken - either by scheduling an earlier service or by temporarily redirecting users to less full units.

Moreover, training staff or volunteers who perform these checks is vital. They need to understand not only how to read sensor data but also how environmental factors like heat can exacerbate odor issues even before units are full. Training should cover basic maintenance tasks like ensuring vents are clear and adding deodorizers as needed.

Communication plays a significant role too. Clear signage at each porta potty informing users about the last service date or next scheduled check can manage expectations and encourage responsible use. Additionally, having a direct line of communication for users to report any urgent issues directly contributes to maintaining standards.

Finally, documenting all checks and services creates a historical record which is invaluable for refining future schedules. Patterns might emerge showing that certain times of day or specific events require more frequent attention than initially thought.

In conclusion, implementing a monitoring schedule tailored around fill levels helps in preempting odor spikes by ensuring timely servicing of porta potties. This proactive strategy not only enhances user experience by keeping facilities clean but also upholds public health standards at local events and work sites alike. Through technology integration, staff training, effective communication, and diligent record-keeping, we can maintain cleanliness and reduce nuisances associated with portable sanitation solutions.

Meet us at Facebook

Social signals:

How to reach us:

About Fresh water

Fresh water or freshwater is any kind of naturally taking place fluid or icy water including reduced focus of dissolved salts and various other complete dissolved solids. The term omits seawater and brackish water, yet it does consist of non-salty mineral-rich waters, such as chalybeate springtimes. Fresh water may include frozen and meltwater in ice sheets, ice caps, glaciers, snowfields and icebergs, all-natural rainfalls such as rainfall, snowfall, hail/sleet and graupel, and surface runoffs that create inland bodies of water such as wetlands, ponds, lakes, rivers, streams, in addition to groundwater contained in aquifers, subterranean rivers and lakes. Water is critical to the survival of all living microorganisms. Many organisms can flourish on salt water, however the great bulk of vascular plants and most pests, amphibians, reptiles, animals and birds require fresh water to make it through. Fresh water is the water source that is of one of the most and instant usage to people. Fresh water is not always safe and clean water, that is, water secure to consume by people. Much of the earth's fresh water (on the surface and groundwater) is to a significant degree improper for human consumption without treatment. Fresh water can conveniently come to be polluted by human activities or as a result of naturally happening processes, such as erosion. Fresh water composes much less than 3% of the world's water resources, and simply 1% of that is easily available. Around 70% of the world's freshwater reserves are iced up in Antarctica. Just 3% of it is extracted for human intake. Agriculture makes use of about two thirds of all fresh water drawn out from the environment. Fresh water is a renewable and variable, but limited natural resource. Fresh water is restored with the procedure of the all-natural water cycle, in which water from seas, lakes, forests, land, rivers and reservoirs evaporates, creates clouds, and returns inland as precipitation. Locally, however, if even more fresh water is consumed through human activities than is naturally brought back, this may cause minimized fresh water accessibility (or water shortage) from surface area and below ground resources and can create serious damage to bordering and linked settings. Water air pollution likewise reduces the accessibility of fresh water. Where offered water resources are limited, people have established technologies like desalination and wastewater reusing to stretch the readily available supply further. Nevertheless, provided the high price (both resources and running costs) and - especially for desalination - energy requirements, those continue to be mostly specific niche applications. A non-sustainable option is utilizing so-called "fossil water" from underground aquifers. As a few of those aquifers developed hundreds of thousands or perhaps countless years ago when neighborhood climates were wetter (e. g. from one of the Eco-friendly Sahara periods) and are not significantly restored under present weather problems - at the very least compared to drawdown, these aquifers develop essentially non-renewable sources comparable to peat or lignite, which are additionally constantly developed in the current era but orders of magnitude slower than they are mined.

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About Wastewater

Wastewater (or waste water) is water produced after using freshwater, raw water, drinking water or saline water in a range of intentional applications or processes.:â€‹â€‹ 1 â€‹ One more meaning of wastewater is "Made use of water from any kind of mix of domestic, commercial, commercial or agricultural activities, surface area runoff/ tornado water, and any drain inflow or drain seepage".:â€‹â€‹ 175 â€‹ In daily use, wastewater is typically a basic synonym for sewage (also called domestic wastewater or community wastewater), which is wastewater that is created by a community of individuals. As a common term, wastewater may also explain water having pollutants accumulated in other setups, such as: Industrial wastewater: waterborne waste generated from a variety of industrial processes, such as producing operations, mineral extraction, power generation, or water and wastewater treatment. Cooling water, is launched with possible thermal contamination after usage to condense vapor or reduce machinery temperature levels by transmission or evaporation. Leachate: precipitation including toxins liquified while percolating through ores, resources, items, or strong waste. Return flow: the circulation of water bring put on hold soil, pesticide deposits, or dissolved minerals and nutrients from irrigated cropland. Surface drainage: the flow of water occurring on the ground surface area when excess rainwater, stormwater, meltwater, or various other sources, can no more sufficiently rapidly penetrate the dirt. Urban overflow, including water utilized for exterior cleansing task and landscape irrigation in largely inhabited locations produced by urbanization. Agricultural wastewater: pet husbandry wastewater generated from confined animal procedures.

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About Water

For other uses, see Water (disambiguation). "H2O" redirects here. For other uses, see H2O (disambiguation).

Water

The water molecule has this basic geometric structure

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The water molecule has this basic geometric structure

Hydrogen, H

Ball-and-stick model of a water molecule

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Ball-and-stick model of a water molecule

Space filling model of a water molecule

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Space filling model of a water molecule

Oxygen, O

A drop of water falling towards water in a glass

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A drop of water falling towards water in a glass

NamesPreferred IUPAC name

Water

Systematic IUPAC name

Oxidane (not in common use)[3]

Other names

- Hydrogen oxide
- Hydrogen hydroxide (H_2O or HOH)
- Hydroxylic acid
- Dihydrogen monoxide (DHMO) (parody name[1])
- Dihydrogen oxide
- Hydric acid
- Hydrohydroxic acid
- Hydroxic acid
- Hydroxoic acid
- Hydrol[2]
- □-Oxidodihydrogen
- □-Hydroxylhydrogen(0)
- Aqua
- Neutral liquid
- Oxygen dihydride (may be considered incorrect)

Identifiers

- 7732-18-5 Image not found or type unknown check

CAS Number

- Interactive image

3D model (JSmol)

Beilstein Reference 3587155

- CHEBI:15377 Image not found or type unknown check

ChEBI

- ChEMBL1098659 Image not found or type unknown check

ChEMBL

- 937 Image not found or type unknown check

ChemSpider

- DB09145

DrugBank

ECHA InfoCard100.028.902 Image not found or type unknown Edit this at Wikidata

- 231-791-2

EC Number

Gmelin Reference 117

- C00001

KEGG

- 962

PubChem CID

- ZC0110000

RTECS number

- 059QF0KO0R Image not found or type unknown check

UNII

- DTXSID6026296 Image not found or type unknown Edit this at Wikidata

CompTox Dashboard (EPA)

InChI

InChI=1S/H2O/h1H2 Image not found or type unknown check

Key: XLYOFNOQVPJJNP-UHFFFAOYSA-N Image not found or type unknown check

SMILES

O

Properties

Chemical formula

H

$_2$OMolar mass18.01528(33) g/molAppearanceAlmost colorless or white crystalline solid, almost colorless liquid, with a hint of blue, colorless gas[4]OdorOdorless

- Liquid (1 atm, VSMOW):
- 0.999 842 83(84) g/mL at 0 °C[5]
- 0.999 974 95(84) g/mL at 3.983 035(670) °C (temperature of maximum density, often 4 °C)[5]
- 0.997 047 02(83) g/mL at 25 °C[5]
- 0.961 887 91(96) g/mL at 95 °C[6]
- Solid:
- 0.9167 g/mL at 0 °C[7]

Density

Melting point0.00 °C (32.00 °F; 273.15 K) [b]Boiling point99.98 °C (211.96 °F; 373.13 K)[17][b]
SolubilityPoorly soluble in haloalkanes, aliphatic and aromatic hydrocarbons, ethers.[8]
Improved solubility in carboxylates, alcohols, ketones, amines.
Miscible with methanol, ethanol, propanol, isopropanol, acetone, glycerol, 1,4-dioxane, tetrahydrofuran, sulfolane, acetaldehyde, dimethylformamide, dimethoxyethane, dimethyl sulfoxide, acetonitrile.
Partially miscible with diethyl ether, methyl ethyl ketone, dichloromethane, ethyl acetate, bromine.Vapor pressure3.1690 kilopascals or 0.031276 atm at 25 °C[9]Acidity (pK_a)13.995[10][11][a]Basicity (pK_b)13.995Conjugate acidHydronium H_3O^+ (pK_a = 0)Conjugate baseHydroxide OH^- (pK_b = 0)Thermal conductivity0.6065 W/(m·K)[14]

Refractive index (n_D)

1.3330 (20 °C)[15]Viscosity0.890 mPa·s (0.890 cP)[16]Structure

Crystal structure

Hexagonal

Point group

C_{2v}

Molecular shape

Bent

Dipole moment

1.8546 D[18]Thermochemistry

Heat capacity (*C*)

75.385â€¯±â€¯0.05 J/(mol·K)[17]

Std molar
entropy ($S^{\text{â¦µ}}_{298}$)

69.95â€¯±â€¯0.03 J/(mol·K)[17]

Std enthalpy of
formation ($\text{}_{f}H^{\text{â¦µ}}_{298}$)

−285.83â€¯±â€¯0.04 kJ/mol[8][17]

Gibbs free energy ($\text{}_{f}G^{\text{â¦µ}}$)

−237.24 kJ/mol[8]Hazards**Occupational safety and health** (OHS/OSH):

Main hazards

Drowning

Avalanche (as snow)

Water intoxication**NFPA 704** (fire diamond)

NFPA 704 four-colored diamond

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Flash pointNon-flammableRelated compounds

- Hydrogen sulfide
- Hydrogen selenide
- Hydrogen telluride
- Hydrogen polonide
- Hydrogen peroxide

Other anions

- Acetone
- Ethanol
- Methanol
- Hydrogen fluoride
- Ammonia

Related solvents

Supplementary data pageWater (data page)

Except where otherwise noted, data are given for materials in their standard state (at 25 °C [77 °F], 100 kPa).

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Infobox references

Water is an inorganic compound with the chemical formula H_2O. It is a transparent, tasteless, odorless,[c] and nearly colorless chemical substance. It is the main constituent of Earth's hydrosphere and the fluids of all known living organisms (in which it acts as a solvent[20]). It is vital for all known forms of life, despite not providing food energy or organic micronutrients. Its chemical formula,

H_2O, indicates that each of its molecules contains one oxygen and two hydrogen atoms, connected by covalent bonds. The hydrogen atoms are attached to the oxygen atom at an angle of 104.45°.[21] In liquid form,

H_2O is also called "water" at standard temperature and pressure.

Because Earth's environment is relatively close to water's triple point, water exists on Earth as a solid, a liquid, and a gas.[22] It forms precipitation in the form of rain and aerosols in the form of fog. Clouds consist of suspended droplets of water and ice, its solid state. When finely divided, crystalline ice may precipitate in the form of snow. The gaseous state of water is steam or water vapor.

Water covers about 71.0% of the Earth's surface, with seas and oceans making up most of the water volume (about 96.5%).[23] Small portions of water occur as groundwater

(1.7%), in the glaciers and the ice caps of Antarctica and Greenland (1.7%), and in the air as vapor, clouds (consisting of ice and liquid water suspended in air), and precipitation (0.001%).[24][25] Water moves continually through the water cycle of evaporation, transpiration (evapotranspiration), condensation, precipitation, and runoff, usually reaching the sea.

Water plays an important role in the world economy. Approximately 70% of the fresh water used by humans goes to agriculture.[26] Fishing in salt and fresh water bodies has been, and continues to be, a major source of food for many parts of the world, providing 6.5% of global protein.[27] Much of the long-distance trade of commodities (such as oil, natural gas, and manufactured products) is transported by boats through seas, rivers, lakes, and canals. Large quantities of water, ice, and steam are used for cooling and heating in industry and homes. Water is an excellent solvent for a wide variety of substances, both mineral and organic; as such, it is widely used in industrial processes and in cooking and washing. Water, ice, and snow are also central to many sports and other forms of entertainment, such as swimming, pleasure boating, boat racing, surfing, sport fishing, diving, ice skating, snowboarding, and skiing.

Etymology

[edit]

The word *water* comes from Old English ***wæter***, from Proto-Germanic **watar* (source also of Old Saxon *watar*, Old Frisian *wetir*, Dutch *water*, Old High German *wazzar*, German *Wasser*, *vatn*, Gothic ð…ðŒºð (*wato*)), from Proto-Indo-European **wod-or*, suffixed form of root **wed-* ('water'; 'wet').[28] Also cognate, through the Indo-European root, with Greek Ï (*ýdor*; from Ancient Greek á½• (*hýdÅ•r*), whence English 'hydro-'), Russian Ð²Ð¾Ð´Ð°Ì (*vodá*), Irish *uisce*, and Albanian *ujë*.

History

[edit]

Main articles: Origin of water on Earth § History of water on Earth, and Properties of water § History

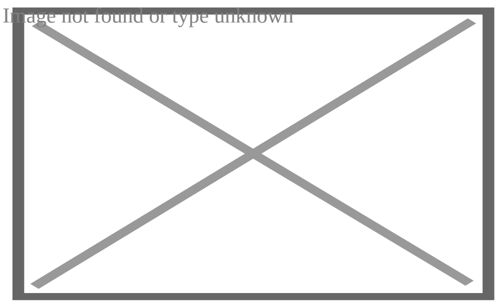
On Earth

[edit]

This section is an excerpt from Origin of water on Earth § History of water on Earth.[edit]

One factor in estimating when water appeared on Earth is that water is continually being lost to space. H_2O molecules in the atmosphere are broken up by photolysis, and the resulting free hydrogen atoms can sometimes escape Earth's gravitational pull. When the Earth was younger and less massive, water would have been lost to space more easily.[29] Lighter elements like hydrogen and helium are expected to leak from the atmosphere continually, but isotopic ratios of heavier noble gases in the modern atmosphere suggest that even the heavier elements in the early atmosphere were subject to significant losses.[30] In particular, xenon is useful for calculations of water loss over time. Not only is it a noble gas (and therefore is not removed from the atmosphere through chemical reactions with other elements), but comparisons between the abundances of its nine stable isotopes in the modern atmosphere reveal that the Earth lost at least one ocean of water, a volume of water approximately equal to modern ocean volume, early in its history. This is likely to have occurred between the Hadean and Archean eons in cataclysmic events such as the moon forming impact.[31]

Any water on Earth during the latter part of its accretion would have been disrupted by the Moon-forming impact (~4.5 billion years ago), which likely vaporized much of Earth's crust and upper mantle and created a rock-vapor atmosphere around the young planet.[32][33] The rock vapor would have condensed within two thousand years, leaving behind hot volatiles which probably resulted in a majority carbon dioxide atmosphere with hydrogen and water vapor. Afterward, liquid water oceans may have existed despite the surface temperature of 230 °C (446 °F) due to the increased atmospheric pressure of the CO_2 atmosphere.[34] As the cooling continued, most CO_2 was removed from the atmosphere by subduction and dissolution in ocean water, but levels oscillated wildly as new surface and mantle cycles appeared.[35]



This pillow basalt on the seafloor near Hawaii was formed when magma extruded underwater. Other, much older pillow basalt formations provide evidence for large bodies of water long ago in Earth's history.

Geological evidence also helps constrain the time frame for liquid water existing on Earth. A sample of pillow basalt (a type of rock formed during an underwater eruption) was recovered from the Isua Greenstone Belt and provides evidence that water existed on Earth 3.8 billion years ago.[36] In the Nuvvuagittuq Greenstone Belt, Quebec, Canada, rocks dated at 3.8 billion years old by one study[37] and 4.28 billion years old by another[38] show evidence of the presence of water at these ages.[36] If oceans existed earlier than this, any geological evidence has yet to be discovered (which may be because such potential evidence has been destroyed by geological processes like crustal recycling). More recently, in August 2020, researchers reported that sufficient water to fill the oceans may have always been on the Earth since the beginning of the planet's formation.[39][40][41]

Unlike rocks, minerals called zircons are highly resistant to weathering and geological processes and so are used to understand conditions on the very early Earth.

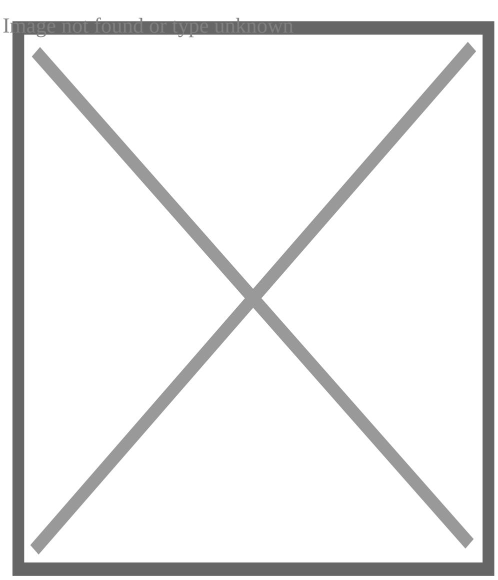
Mineralogical evidence from zircons has shown that liquid water and an atmosphere must have existed 4.404 ± 0.008 billion years ago, very soon after the formation of Earth.[42][43][44][45] This presents somewhat of a paradox, as the cool early Earth hypothesis suggests temperatures were cold enough to freeze water between about 4.4 billion and 4.0 billion years ago.[46] Other studies of zircons found in Australian Hadean rock point to the existence of plate tectonics as early as 4 billion years ago.[47] If true, that implies that rather than a hot, molten surface and an atmosphere full of carbon dioxide, early Earth's surface was much as it is today (in terms of thermal insulation). The action of plate tectonics traps vast amounts of CO_2, thereby reducing greenhouse effects, leading to a much cooler surface temperature and the formation of solid rock and liquid water.[48]

Properties

[edit]

Main article: Properties of water

See also: Water (data page) and Water model



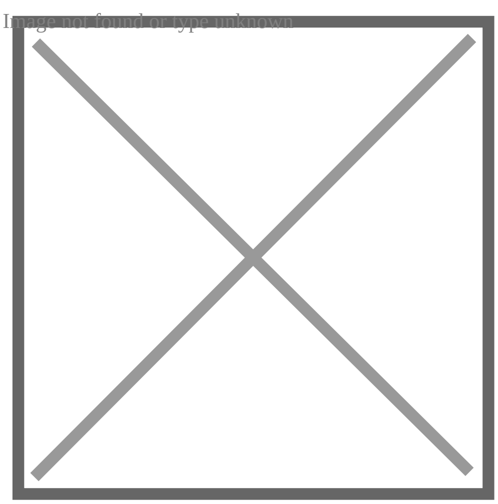
A water molecule consists of two hydrogen atoms and one oxygen atom.

Water (

H_2O) is a polar inorganic compound. At room temperature it is a tasteless and odorless liquid, nearly colorless with a hint of blue. The simplest hydrogen chalcogenide, it is by far the most studied chemical compound and is sometimes described as the "universal solvent" for its ability to dissolve more substances than any other liquid,[49][50] though it is poor at dissolving nonpolar substances.[51] This allows it to be the "solvent of life":[52] indeed, water as found in nature almost always includes various dissolved substances, and special steps are required to obtain chemically pure water. Water is the only common substance to exist as a solid, liquid, and gas in normal terrestrial conditions.[53]

States

[edit]



The three common states of matter

Along with *oxidane*, *water* is one of the two official names for the chemical compound H_2O;[54] it is also the liquid phase of H_2O.[55] The other two common states of matter of water are the solid phase, ice, and the gaseous phase, water vapor or steam. The addition or removal of heat can cause phase transitions: freezing (water to ice), melting (ice to water), vaporization (water to vapor), condensation (vapor to water), sublimation (ice to vapor) and deposition (vapor to ice).[56]

Density

[edit]

See also: Frost weathering

Water is one of only a few common naturally occurring substances which, for some temperature ranges, become less dense as they cool, and the only known naturally occurring substance which does so while liquid. In addition it is unusual as it becomes significantly less dense as it freezes, though it is not unique in that respect.[d]

At 1 atm pressure, it reaches its maximum density of 999.972 kg/m^3 (62.4262 lb/cu ft) at 3.98 °C (39.16 °F).[58][59]

Below that temperature, but above the freezing point of 0 °C (32 °F), it expands becoming less dense until it reaches freezing point, reaching a density in its liquid phase of 999.8 kg/m^3 (62.4155 lb/cu ft).

Once it freezes and becomes ice, it expands by about 9%, with a density of 917 kg/m^3 (57.25 lb/cu ft).[60][61] This expansion can exert enormous pressure, bursting pipes and cracking rocks.[62] As a solid, it displays the usual behavior of contracting and becoming more dense as it cools. These unusual thermal properties have important consequences for life on earth.

In a lake or ocean, water at 4 °C (39 °F) sinks to the bottom, and ice forms on the surface, floating on the liquid water. This ice insulates the water below, preventing it from freezing solid. Without this protection, most aquatic organisms residing in lakes would perish during the winter.[63] In addition, this anomalous behavior is an important part of the thermohaline circulation which distributes heat around the planet's oceans.

Magnetism

[edit]

Water is a diamagnetic material.[64] Though interaction is weak, with superconducting magnets it can attain a notable interaction.[64]

Phase transitions

[edit]

At a pressure of one atmosphere (atm), ice melts or water freezes (solidifies) at 0 °C (32 °F) and water boils or vapor condenses at 100 °C (212 °F). However, even below the boiling point, water can change to vapor at its surface by evaporation (vaporization throughout the liquid is known as boiling). Sublimation and deposition also occur on surfaces.[56] For example, frost is deposited on cold surfaces while snowflakes form by deposition on an aerosol particle or ice nucleus.[65] In the process of freeze-drying, a food is frozen and then stored at low pressure so the ice on its surface sublimates.[66]

The melting and boiling points depend on pressure. A good approximation for the rate of change of the melting temperature with pressure is given by the Clausius–Clapeyron relation:

$$\frac{dT}{dP}=\frac{T\left(v_{\text{L}}-v_{\text{S}}\right)}{L_{\text{f}}}$$

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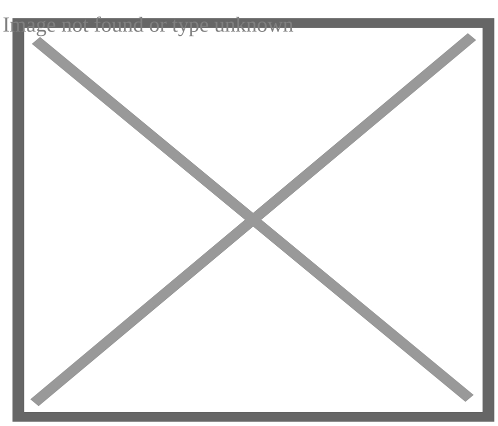
where v_{L} and v_{S} are the molar volumes of the liquid and solid phases, and L_{f} is the molar latent heat of melting. In most substances, the volume increases when melting occurs, so the melting temperature increases with pressure. However, because ice is less dense than water, the melting temperature decreases.[57] In glaciers, pressure melting can occur under sufficiently thick volumes of ice, resulting in subglacial lakes.[67][68]

The Clausius-Clapeyron relation also applies to the boiling point, but with the liquid/gas transition the vapor phase has a much lower density than the liquid phase, so the boiling point increases with pressure.[69] Water can remain in a liquid state at high temperatures in the deep ocean or underground. For example, temperatures exceed 205 °C (401 °F) in Old Faithful, a geyser in Yellowstone National Park.[70] In hydrothermal vents, the temperature can exceed 400 °C (752 °F).[71]

At sea level, the boiling point of water is 100 °C (212 °F). As atmospheric pressure decreases with altitude, the boiling point decreases by 1 °C every 274 meters. High-altitude cooking takes longer than sea-level cooking. For example, at 1,524 metres (5,000 ft), cooking time must be increased by a fourth to achieve the desired result.[72] Conversely, a pressure cooker can be used to decrease cooking times by raising the boiling temperature.[73] In a vacuum, water will boil at room temperature.[74]

Triple and critical points

[edit]



Phase diagram of water

On a pressure/temperature phase diagram (see figure), there are curves separating solid from vapor, vapor from liquid, and liquid from solid. These meet at a single point called the triple point, where all three phases can coexist. The triple point is at a temperature of 273.16 K (0.01 °C; 32.02 °F) and a pressure of 611.657 pascals (0.00604 atm; 0.0887 psi);[75] it is the lowest pressure at which liquid water can exist. Until 2019, the triple point was used to define the Kelvin temperature scale.[76][77]

The water/vapor phase curve terminates at 647.096 K (373.946 °C; 705.103 °F) and 22.064 megapascals (3,200.1 psi; 217.75 atm).[78] This is known as the critical point. At higher temperatures and pressures the liquid and vapor phases form a continuous phase called a supercritical fluid. It can be gradually compressed or expanded between gas-like and liquid-like densities; its properties (which are quite different from those of ambient water) are sensitive to density. For example, for suitable pressures and temperatures it can mix freely with nonpolar compounds, including most organic compounds. This makes it useful in a variety of applications including high-temperature electrochemistry and as an ecologically benign solvent or catalyst in chemical reactions involving organic compounds. In Earth's mantle, it acts as a solvent during mineral formation, dissolution and deposition.[79][80]

Phases of ice and water

[edit]

Main article: Ice

The normal form of ice on the surface of Earth is ice I_h, a phase that forms crystals with hexagonal symmetry. Another with cubic crystalline symmetry, ice I_c, can occur in the upper atmosphere.[81] As the pressure increases, ice forms other crystal structures. As of 2024, twenty have been experimentally confirmed and several more are predicted theoretically.[82] The eighteenth form of ice, ice XVIII, a face-centred-cubic, superionic ice phase, was discovered when a droplet of water was subject to a shock wave that raised the water's pressure to millions of atmospheres and its temperature to thousands of degrees, resulting in a structure of rigid oxygen atoms in which hydrogen atoms flowed freely.[83][84] When sandwiched between layers of graphene, ice forms a square lattice.[85]

The details of the chemical nature of liquid water are not well understood; some theories suggest that its unusual behavior is due to the existence of two liquid states.[59][86][87][88]

Taste and odor

[edit]

Pure water is usually described as tasteless and odorless, although humans have specific sensors that can feel the presence of water in their mouths,[89][90] and frogs are known to be able to smell it.[91] However, water from ordinary sources (including mineral water) usually has many dissolved substances that may give it varying tastes and odors. Humans and other animals have developed senses that enable them to evaluate the potability of water to avoid water that is too salty or putrid.[92]

Color and appearance

[edit]

Main article: Color of water

See also: Electromagnetic absorption by water

Pure water is visibly blue due to absorption of light in the region c. 600–800 nm.[93] The color can be easily observed in a glass of tap-water placed against a pure white background, in daylight. The principal absorption bands responsible for the color are overtones of the O–H stretching vibrations. The apparent intensity of the color increases with the depth of the water column, following Beer's law. This also applies, for example, with a swimming pool when the light source is sunlight reflected from the pool's white tiles.

In nature, the color may also be modified from blue to green due to the presence of suspended solids or algae.

In industry, near-infrared spectroscopy is used with aqueous solutions as the greater intensity of the lower overtones of water means that glass cuvettes with short path-length may be employed. To observe the fundamental stretching absorption spectrum of water or of an aqueous solution in the region around 3,500 cm^{-1} (2.85 μm)[94] a path length of about 25 μm is needed. Also, the cuvette must be both transparent around 3500 cm^{-1} and insoluble in water; calcium fluoride is one material that is in common use for the cuvette windows with aqueous solutions.

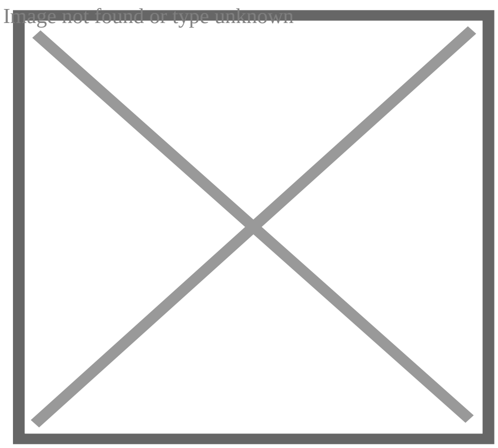
The Raman-active fundamental vibrations may be observed with, for example, a 1 cm sample cell.

Aquatic plants, algae, and other photosynthetic organisms can live in water up to hundreds of meters deep, because sunlight can reach them. Practically no sunlight reaches the parts of the oceans below 1,000 metres (3,300 ft) of depth.

The refractive index of liquid water (1.333 at 20 °C (68 °F)) is much higher than that of air (1.0), similar to those of alkanes and ethanol, but lower than those of glycerol (1.473), benzene (1.501), carbon disulfide (1.627), and common types of glass (1.4 to 1.6). The refraction index of ice (1.31) is lower than that of liquid water.

Molecular polarity

[edit]



Tetrahedral structure of water

In a water molecule, the hydrogen atoms form a 104.5° angle with the oxygen atom. The hydrogen atoms are close to two corners of a tetrahedron centered on the oxygen. At the other two corners are *lone pairs* of valence electrons that do not participate in the bonding. In a perfect tetrahedron, the atoms would form a 109.5° angle, but the repulsion between the lone pairs is greater than the repulsion between the hydrogen atoms.[95][96] The O–H bond length is about 0.096 nm.[97]

Other substances have a tetrahedral molecular structure, for example methane (CH_4) and hydrogen sulfide (H_2S). However, oxygen is more electronegative than most other elements, so the oxygen atom has a negative partial charge while the hydrogen atoms are partially positively charged. Along with the bent structure, this gives the molecule an electrical dipole moment and it is classified as a polar molecule.[98]

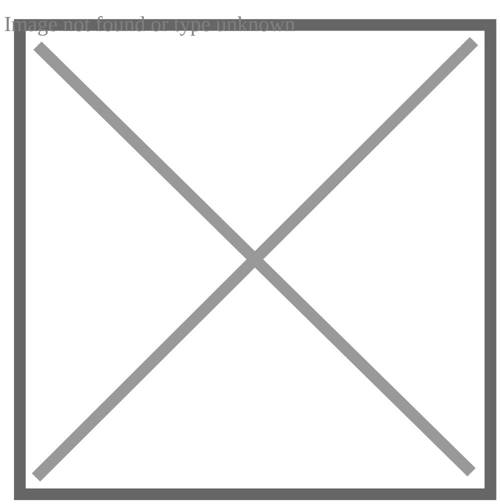
Water is a good polar solvent, dissolving many salts and hydrophilic organic molecules such as sugars and simple alcohols such as ethanol. Water also dissolves many gases, such as oxygen and carbon dioxide—the latter giving the fizz of carbonated beverages, sparkling wines and beers. In addition, many substances in living organisms, such as proteins, DNA and polysaccharides, are dissolved in water. The interactions between water and the subunits of these biomacromolecules shape protein folding, DNA base pairing, and other phenomena crucial to life (hydrophobic effect).

Many organic substances (such as fats and oils and alkanes) are hydrophobic, that is, insoluble in water. Many inorganic substances are insoluble too, including most metal oxides, sulfides, and silicates.

Hydrogen bonding

[edit]

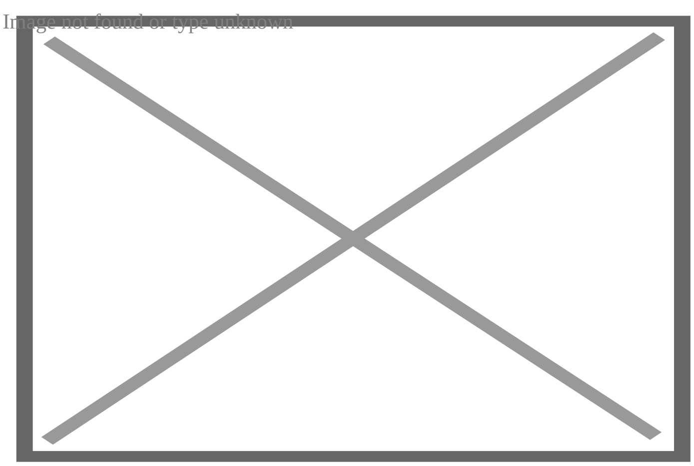
See also: Chemical bonding of water



Model of hydrogen bonds (1) between molecules of water

Because of its polarity, a molecule of water in the liquid or solid state can form up to four hydrogen bonds with neighboring molecules. Hydrogen bonds are about ten times as strong as the Van der Waals force that attracts molecules to each other in most liquids. This is the reason why the melting and boiling points of water are much higher than those of other analogous compounds like hydrogen sulfide. They also explain its exceptionally high specific heat capacity (about 4.2 J/(g·K)), heat of fusion (about 333 J/g), heat of vaporization (2257 J/g), and thermal conductivity (between 0.561 and 0.679 W/(m·K)). These properties make water more effective at moderating Earth's climate, by storing heat and transporting it between the oceans and the atmosphere. The hydrogen bonds of water are around 23 kJ/mol (compared to a covalent O–H bond at 492 kJ/mol). Of this, it is estimated that 90% is attributable to electrostatics, while the remaining 10% is partially covalent.[99]

These bonds are the cause of water's high surface tension[100] and capillary forces. The capillary action refers to the tendency of water to move up a narrow tube against the force of gravity. This property is relied upon by all vascular plants, such as trees.[*citation needed*]



Specific heat capacity of water[101]

Self-ionization

[edit]

Main article: Self-ionization of water

Water is a weak solution of hydronium hydroxide—there is an equilibrium $2H_2O$ â‡Œ $H_3O^+ + OH^-$, in combination with solvation of the resulting hydronium and hydroxide ions.

Electrical conductivity and electrolysis

[edit]

Pure water has a low electrical conductivity, which increases with the dissolution of a small amount of ionic material such as common salt.

Liquid water can be split into the elements hydrogen and oxygen by passing an electric current through it—a process called electrolysis. The decomposition requires more energy input than the heat released by the inverse process (285.8 kJ/mol, or 15.9 MJ/kg).[102]

Mechanical properties

[edit]

Liquid water can be assumed to be incompressible for most purposes: its compressibility ranges from 4.4 to 5.1 × 10^{-10} Pa^{-1} in ordinary conditions.[103] Even in oceans at 4 km depth, where the pressure is 400 atm, water suffers only a 1.8% decrease in volume.[104]

The viscosity of water is about 10^{-3} Pa·s or 0.01 poise at 20 °C (68 °F), and the speed of sound in liquid water ranges between 1,400 and 1,540 metres per second (4,600 and 5,100 ft/s) depending on temperature. Sound travels long distances in water with little attenuation, especially at low frequencies (roughly 0.03 dB/km for 1 kHz), a property that is exploited by cetaceans and humans for communication and environment sensing (sonar).[105]

Reactivity

[edit]

Metallic elements which are more electropositive than hydrogen, particularly the alkali metals and alkaline earth metals such as lithium, sodium, calcium, potassium and caesium displace hydrogen from water, forming hydroxides and releasing hydrogen. At high temperatures, carbon reacts with steam to form carbon monoxide and hydrogen.[*citation*

On Earth

[edit]

Main articles: Hydrology and Water distribution on Earth

Hydrology is the study of the movement, distribution, and quality of water throughout the Earth. The study of the distribution of water is hydrography. The study of the distribution and movement of groundwater is hydrogeology, of glaciers is glaciology, of inland waters is limnology and distribution of oceans is oceanography. Ecological processes with hydrology are in the focus of ecohydrology.

The collective mass of water found on, under, and over the surface of a planet is called the hydrosphere. Earth's approximate water volume (the total water supply of the world) is 1.386 billion cubic kilometres (333 million cubic miles).[24]

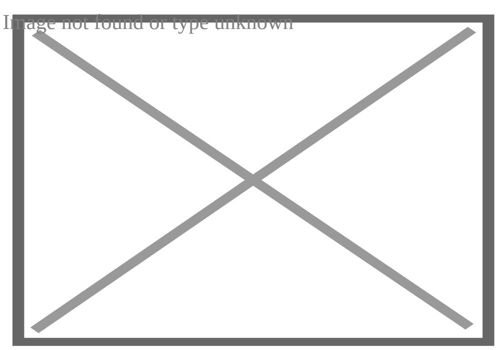
Liquid water is found in bodies of water, such as an ocean, sea, lake, river, stream, canal, pond, or puddle. The majority of water on Earth is seawater. Water is also present in the atmosphere in solid, liquid, and vapor states. It also exists as groundwater in aquifers.

Water is important in many geological processes. Groundwater is present in most rocks, and the pressure of this groundwater affects patterns of faulting. Water in the mantle is responsible for the melt that produces volcanoes at subduction zones. On the surface of the Earth, water is important in both chemical and physical weathering processes. Water, and to a lesser but still significant extent, ice, are also responsible for a large amount of sediment transport that occurs on the surface of the earth. Deposition of transported sediment forms many types of sedimentary rocks, which make up the geologic record of Earth history.

Water cycle

[edit]

Main article: Water cycle



Water cycle

The water cycle (known scientifically as the hydrologic cycle) is the continuous exchange of water within the hydrosphere, between the atmosphere, soil water, surface water, groundwater, and plants.

Water moves perpetually through each of these regions in the *water cycle* consisting of the following transfer processes:

- evaporation from oceans and other water bodies into the air and transpiration from land plants and animals into the air.
- precipitation, from water vapor condensing from the air and falling to the earth or ocean.
- runoff from the land usually reaching the sea.

Most water vapors found mostly in the ocean returns to it, but winds carry water vapor over land at the same rate as runoff into the sea, about 47 Tt per year while evaporation and transpiration happening in land masses also contribute another 72 Tt per year. Precipitation, at a rate of 119 Tt per year over land, has several forms: most commonly rain, snow, and hail, with some contribution from fog and dew.[106] Dew is small drops of water that are condensed when a high density of water vapor meets a cool surface. Dew usually forms in the morning when the temperature is the lowest, just before sunrise and when the temperature of the earth's surface starts to increase.[107] Condensed water in the air may also refract sunlight to produce rainbows.

Water runoff often collects over watersheds flowing into rivers. Through erosion, runoff shapes the environment creating river valleys and deltas which provide rich soil and level ground for the establishment of population centers. A flood occurs when an area of land, usually low-lying, is covered with water which occurs when a river overflows its banks or a storm surge happens. On the other hand, drought is an extended period of months or years when a region notes a deficiency in its water supply. This occurs when a region receives consistently below average precipitation either due to its topography or due to its location in terms of latitude.

Water resources

[edit]

Main article: Water resources

Water resources are natural resources of water that are potentially useful for humans,[108] for example as a source of drinking water supply or irrigation water. Water occurs as both "stocks" and "flows". Water can be stored as lakes, water vapor, groundwater or aquifers, and ice and snow. Of the total volume of global freshwater, an estimated 69 percent is stored in glaciers and permanent snow cover; 30 percent is in groundwater; and the remaining 1 percent in lakes, rivers, the atmosphere, and biota.[109] The length of time water remains in storage is highly variable: some aquifers consist of water stored over thousands of years but lake volumes may fluctuate on a seasonal basis, decreasing during dry periods and increasing during wet ones. A substantial fraction of the water supply for some regions consists of water extracted from water stored in stocks, and when withdrawals exceed recharge, stocks decrease. By some estimates, as much as 30 percent of total water used for irrigation comes from unsustainable withdrawals of groundwater, causing groundwater depletion.[110]

Seawater and tides

[edit]

Main articles: Seawater and Tides

Seawater contains about 3.5% sodium chloride on average, plus smaller amounts of other substances. The physical properties of seawater differ from fresh water in some important respects. It freezes at a lower temperature (about -1.9 °C (28.6 °F)) and its density increases with decreasing temperature to the freezing point, instead of reaching maximum density at a temperature above freezing. The salinity of water in major seas varies from about 0.7% in the Baltic Sea to 4.0% in the Red Sea. (The Dead Sea, known for its ultra-high salinity levels of between 30 and 40%, is really a salt lake.)

Tides are the cyclic rising and falling of local sea levels caused by the tidal forces of the Moon and the Sun acting on the oceans. Tides cause changes in the depth of the marine and estuarine water bodies and produce oscillating currents known as tidal streams. The changing tide produced at a given location is the result of the changing positions of the Moon and Sun relative to the Earth coupled with the effects of Earth rotation and the local bathymetry. The strip of seashore that is submerged at high tide and exposed at low tide, the intertidal zone, is an important ecological product of ocean tides.

The Bay of Fundy at high tide and low tide

High tide

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  High tide

Low tide

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  Low tide

Effects on life

[edit]

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Overview of photosynthesis (green) and respiration (red)

From a biological standpoint, water has many distinct properties that are critical for the proliferation of life. It carries out this role by allowing organic compounds to react in ways that ultimately allow replication. All known forms of life depend on water. Water is vital both as a solvent in which many of the body's solutes dissolve and as an essential part of many metabolic processes within the body. Metabolism is the sum total of anabolism and catabolism. In anabolism, water is removed from molecules (through energy requiring enzymatic chemical reactions) to grow larger molecules (e.g., starches, triglycerides, and proteins for storage of fuels and information). In catabolism, water is used to break bonds to generate smaller molecules (e.g., glucose, fatty acids, and amino acids to be used for fuels for energy use or other purposes). Without water, these particular metabolic processes could not exist.

Water is fundamental to both photosynthesis and respiration. Photosynthetic cells use the sun's energy to split off water's hydrogen from oxygen.[111] In the presence of sunlight, hydrogen is combined with CO_2 (absorbed from air or water) to form glucose and release oxygen.[112] All living cells use such fuels and oxidize the hydrogen and carbon to capture the sun's energy and reform water and CO_2 in the process (cellular respiration).

Water is also central to acid-base neutrality and enzyme function. An acid, a hydrogen ion (H^+, that is, a proton) donor, can be neutralized by a base, a proton acceptor such as a hydroxide ion (OH^-) to form water. Water is considered to be neutral, with a pH (the negative log of the hydrogen ion concentration) of 7 in an ideal state. Acids have pH values less than 7 while bases have values greater than 7.

Aquatic life forms

[edit]

Further information: Hydrobiology, Marine life, and Aquatic plant

Earth's surface waters are filled with life. The earliest life forms appeared in water; nearly all fish live exclusively in water, and there are many types of marine mammals, such as dolphins and whales. Some kinds of animals, such as amphibians, spend portions of their lives in water and portions on land. Plants such as kelp and algae grow in the water and are the basis for some underwater ecosystems. Plankton is generally the foundation of the ocean food chain.

Aquatic vertebrates must obtain oxygen to survive, and they do so in various ways. Fish have gills instead of lungs, although some species of fish, such as the lungfish, have both. Marine mammals, such as dolphins, whales, otters, and seals need to surface periodically to breathe air. Some amphibians are able to absorb oxygen through their skin. Invertebrates exhibit a wide range of modifications to survive in poorly oxygenated waters including breathing tubes (see insect and mollusc siphons) and gills (*Carcinus*). However, as invertebrate life evolved in an aquatic habitat most have little or no specialization for respiration in water.

Some of the biodiversity of a coral reef

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  Some of the biodiversity

  of a coral reef

  Some marine diatoms â€“ a key phytoplankton group

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Some marine diatoms –
a key phytoplankton
group

Squat lobster and Alvinocarididae shrimp at the Von Damm hydrothermal field survive b

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Squat lobster and
Alvinocarididae shrimp at
the Von Damm
hydrothermal field survive
by altered water
chemistry.

Effects on human civilization

[edit]

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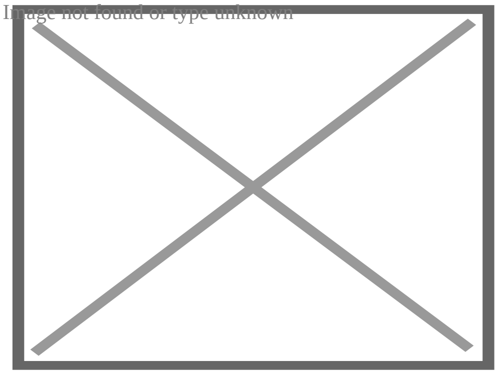
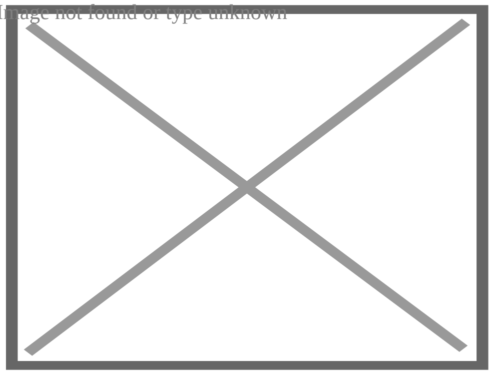


Water fountain

Civilization has historically flourished around rivers and major waterways; Mesopotamia, one of the so-called cradles of civilization, was situated between the major rivers Tigris and Euphrates; the ancient society of the Egyptians depended entirely upon the Nile. The early Indus Valley civilization (c. 3300 BCE – c. 1300 BCE) developed along the Indus River and tributaries that flowed out of the Himalayas. Rome was also founded on the banks of the Italian river Tiber. Large metropolises like Rotterdam, London, Montreal, Paris, New York City, Buenos Aires, Shanghai, Tokyo, Chicago, and Hong Kong owe their success in part to their easy accessibility via water and the resultant expansion of trade. Islands with safe water ports, like Singapore, have flourished for the same reason. In places such as North Africa and the Middle East, where water is more scarce, access to clean drinking water was and is a major factor in human development.

Health and pollution

[edit]



An environmental science program – a student from Iowa State University sampling water

Water fit for human consumption is called drinking water or potable water. Water that is not potable may be made potable by filtration or distillation, or by a range of other methods. More than 660 million people do not have access to safe drinking water.[113][114]

Water that is not fit for drinking but is not harmful to humans when used for swimming or bathing is called by various names other than potable or drinking water, and is sometimes called safe water, or "safe for bathing". Chlorine is a skin and mucous membrane irritant that is used to make water safe for bathing or drinking. Its use is highly technical and is usually monitored by government regulations (typically 1 part per million (ppm) for drinking water, and 1–2 ppm of chlorine not yet reacted with impurities for bathing water). Water for bathing may be maintained in satisfactory microbiological condition using chemical disinfectants such as chlorine or ozone or by the use of ultraviolet light.

Water reclamation is the process of converting wastewater (most commonly sewage, also called municipal wastewater) into water that can be reused for other purposes. There are 2.3 billion people who reside in nations with water scarcities, which means that each individual receives less than 1,700 cubic metres (60,000 cu ft) of water annually. 380 billion cubic metres (13×10^{12} cu ft) of municipal wastewater are produced globally each year.[115][116][117]

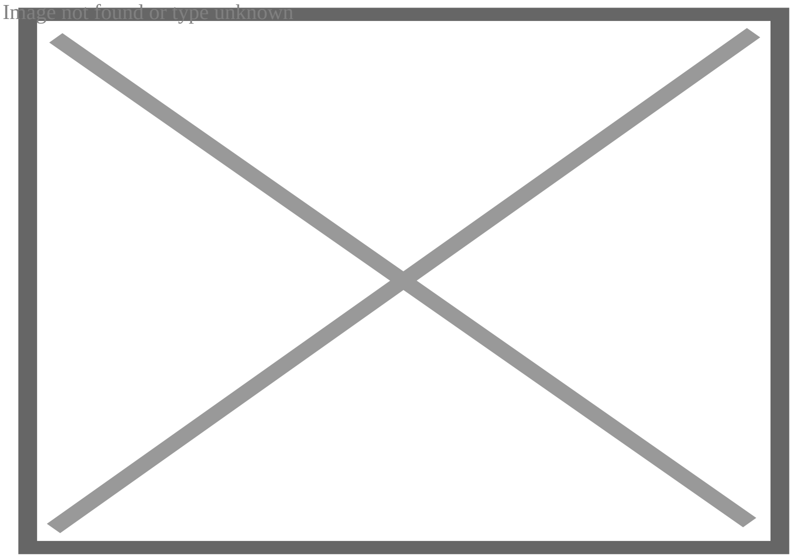
Freshwater is a renewable resource, recirculated by the natural hydrologic cycle, but pressures over access to it result from the naturally uneven distribution in space and time, growing economic demands by agriculture and industry, and rising populations. Currently, nearly a billion people around the world lack access to safe, affordable water. In 2000, the United Nations established the Millennium Development Goals for water to halve by 2015 the proportion of people worldwide without access to safe water and sanitation. Progress toward that goal was uneven, and in 2015 the UN committed to the Sustainable Development Goals of achieving universal access to safe and affordable water and sanitation by 2030. Poor water quality and bad sanitation are deadly; some five million deaths a year are caused by water-related diseases. The World Health Organization estimates that safe water could prevent 1.4 million child deaths from diarrhea each year.[118]

In developing countries, 90% of all municipal wastewater still goes untreated into local rivers and streams.[119] Some 50 countries, with roughly a third of the world's population, also suffer from medium or high water scarcity and 17 of these extract more water annually than is recharged through their natural water cycles.[120] The strain not only affects surface freshwater bodies like rivers and lakes, but it also degrades groundwater resources.

Human uses

[edit]

Further information: Water supply



Total water withdrawals for agricultural, industrial and municipal purposes per capita, measured in cubic metres (m^3) per year in 2010[121]

Agriculture

[edit]

The most substantial human use of water is for agriculture, including irrigated agriculture, which accounts for as much as 80 to 90 percent of total human water consumption.[122] In the United States, 42% of freshwater withdrawn for use is for irrigation, but the vast majority of water "consumed" (used and not returned to the environment) goes to agriculture.[123]

Access to fresh water is often taken for granted, especially in developed countries that have built sophisticated water systems for collecting, purifying, and delivering water, and removing wastewater. But growing economic, demographic, and climatic pressures are increasing concerns about water issues, leading to increasing competition for fixed water resources, giving rise to the concept of peak water.[124] As populations and economies continue to grow, consumption of water-thirsty meat expands, and new demands rise for biofuels or new water-intensive industries, new water challenges are likely.[125]

An assessment of water management in agriculture was conducted in 2007 by the International Water Management Institute in Sri Lanka to see if the world had sufficient water to provide food for its growing population.[126] It assessed the current availability of water for agriculture on a global scale and mapped out locations suffering from water scarcity. It found that a fifth of the world's people, more than 1.2 billion, live in areas of physical water scarcity, where there is not enough water to meet all demands. A further 1.6 billion people live in areas experiencing economic water scarcity, where the lack of investment in water or insufficient human capacity make it impossible for authorities to satisfy the demand for water. The report found that it would be possible to produce the food required in the future, but that continuation of today's food production and environmental trends would lead to crises in many parts of the world. To avoid a global water crisis, farmers will have to strive to increase productivity to meet growing demands for food, while industries and cities find ways to use water more efficiently.[127]

Water scarcity is also caused by production of water intensive products. For example, cotton: 1 kg of cotton—equivalent of a pair of jeans—requires 10.9 cubic metres (380 cu ft) water to produce. While cotton accounts for 2.4% of world water use, the water is consumed in regions that are already at a risk of water shortage. Significant environmental damage has been caused: for example, the diversion of water by the former Soviet Union from the Amu Darya and Syr Darya rivers to produce cotton was largely responsible for the disappearance of the Aral Sea.[128]

Water requirement per tonne of food product

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Water
requirement per
tonne of food
product

◦

Water distribution
in subsurface drip
irrigation
Irrigation of field crops

◦

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Irrigation of field
crops

As a scientific standard

[edit]

On 7 April 1795, the gram was defined in France to be equal to "the absolute weight of a volume of pure water equal to a cube of one-hundredth of a meter, and at the temperature of melting ice".[129] For practical purposes though, a metallic reference standard was required, one thousand times more massive, the kilogram. Work was therefore commissioned to determine precisely the mass of one liter of water. In spite of the fact that the decreed definition of the gram specified water at 0 °C (32 °F)—a highly reproducible *temperature*—the scientists chose to redefine the standard and to perform their measurements at the temperature of highest water *density*, which was measured at the time as 4 °C (39 °F).[130]

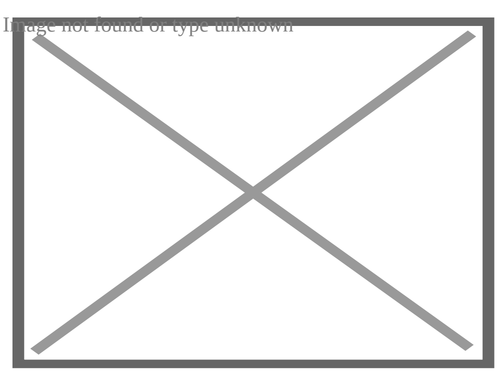
The Kelvin temperature scale of the SI system was based on the triple point of water, defined as exactly 273.16 K (0.01 °C; 32.02 °F), but as of May 2019 is based on the Boltzmann constant instead. The scale is an absolute temperature scale with the same increment as the Celsius temperature scale, which was originally defined according to the boiling point (set to 100 °C (212 °F)) and melting point (set to 0 °C (32 °F)) of water.

Natural water consists mainly of the isotopes hydrogen-1 and oxygen-16, but there is also a small quantity of heavier isotopes oxygen-18, oxygen-17, and hydrogen-2 (deuterium). The percentage of the heavier isotopes is very small, but it still affects the properties of water. Water from rivers and lakes tends to contain less heavy isotopes than seawater. Therefore, standard water is defined in the Vienna Standard Mean Ocean Water specification.

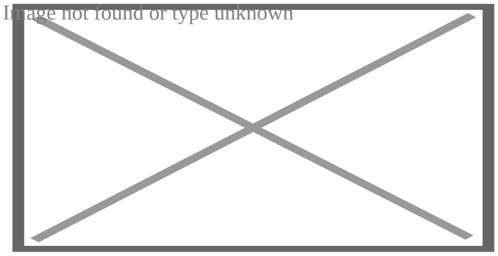
For drinking

[edit]

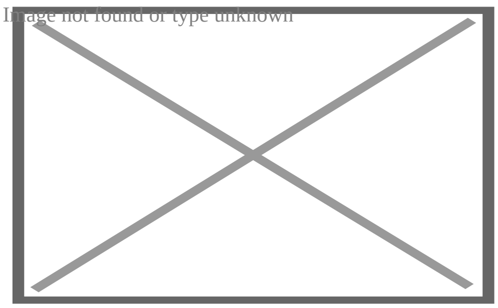
Main article: Drinking water



A young girl drinking bottled water



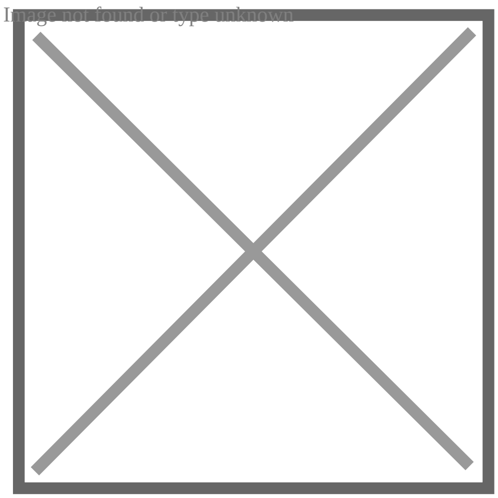
Water availability: the fraction of the population using improved water sources by country



Roadside fresh water outlet from glacier, Nubra

The human body contains from 55% to 78% water, depending on body size.[131][*user-generated*
To function properly, the body requires between one and seven litres (0.22 and 1.54 imp gal; 0.26 and 1.85 US gal)[*citation needed*] of water per day to avoid dehydration; the precise amount depends on the level of activity, temperature, humidity, and other factors. Most of this is ingested through foods or beverages other than drinking straight water. It is not clear how much water intake is needed by healthy people, though the British Dietetic Association advises that 2.5 liters of total water daily is the minimum to maintain proper hydration, including 1.8 liters (6 to 7 glasses) obtained directly from beverages.[132] Medical literature favors a lower consumption, typically 1 liter of water for an average male, excluding extra requirements due to fluid loss from exercise or warm weather.[133]

Healthy kidneys can excrete 0.8 to 1 liter of water per hour, but stress such as exercise can reduce this amount. People can drink far more water than necessary while exercising, putting them at risk of water intoxication (hyperhydration), which can be fatal.[134][135] The popular claim that "a person should consume eight glasses of water per day" seems to have no real basis in science.[136] Studies have shown that extra water intake, especially up to 500 millilitres (18 imp fl oz; 17 US fl oz) at mealtime, was associated with weight loss.[137][138][139][140][141][142] Adequate fluid intake is helpful in preventing constipation.[143]



Hazard symbol for non-potable water

An original recommendation for water intake in 1945 by the Food and Nutrition Board of the U.S. National Research Council read: "An ordinary standard for diverse persons is 1 milliliter for each calorie of food. Most of this quantity is contained in prepared foods."[144] The latest dietary reference intake report by the U.S. National Research Council in general recommended, based on the median total water intake from US survey data (including food sources): 3.7 litres (0.81 imp gal; 0.98 US gal) for men and 2.7 litres (0.59 imp gal; 0.71 US gal) of water total for women, noting that water contained in food provided approximately 19% of total water intake in the survey.[145]

Specifically, pregnant and breastfeeding women need additional fluids to stay hydrated. The US Institute of Medicine recommends that, on average, men consume 3 litres (0.66 imp gal; 0.79 US gal) and women 2.2 litres (0.48 imp gal; 0.58 US gal); pregnant women should increase intake to 2.4 litres (0.53 imp gal; 0.63 US gal) and breastfeeding women should get 3 liters (12 cups), since an especially large amount of fluid is lost during nursing.[146] Also noted is that normally, about 20% of water intake comes from food, while the rest comes from drinking water and beverages (caffeinated included). Water is excreted from the body in multiple forms; through urine and feces, through sweating, and by exhalation of water vapor in the breath. With physical exertion and heat exposure, water loss will increase and daily fluid needs may increase as well.

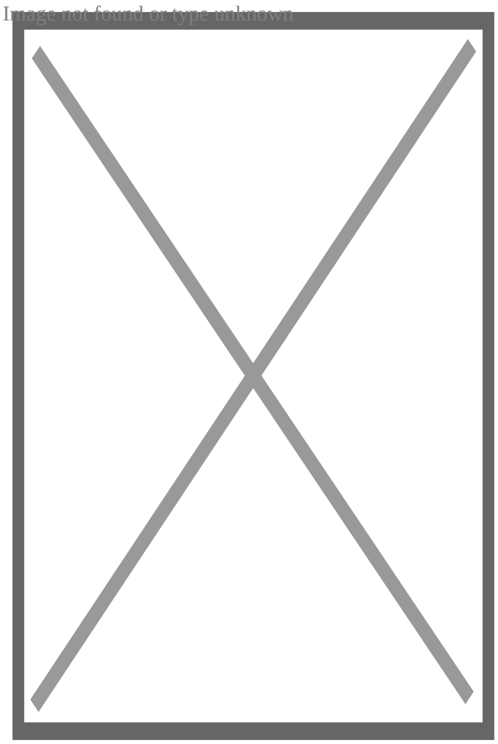
Humans require water with few impurities. Common impurities include metal salts and oxides, including copper, iron, calcium and lead,[147][*full citation needed*] and harmful bacteria, such as *Vibrio*. Some solutes are acceptable and even desirable for taste enhancement and to provide needed electrolytes.[148]

The single largest (by volume) freshwater resource suitable for drinking is Lake Baikal in Siberia.[149]

Washing

[edit]

This section is an excerpt from Washing.[edit]



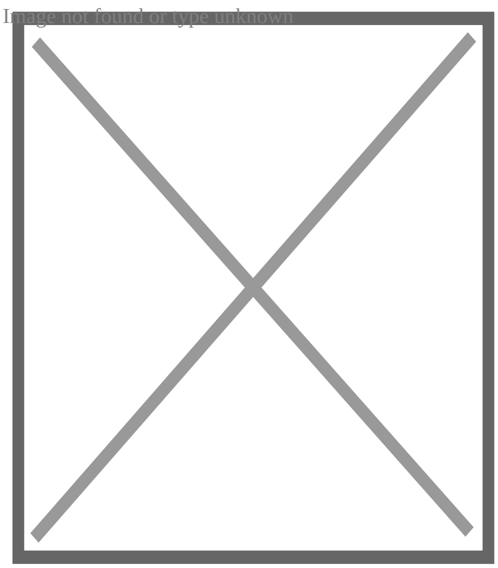
A woman washes her hands with soap and water.

Washing is a method of cleaning, usually with water and soap or detergent. Regularly washing and then rinsing both body and clothing is an essential part of good hygiene and health.[150][151][152]

Often people use soaps and detergents to assist in the emulsification of oils and dirt particles so they can be washed away. The soap can be applied directly, or with the aid of a washcloth or assisted with sponges or similar cleaning tools.

In social contexts, washing refers to the act of bathing, or washing different parts of the body, such as hands, hair, or faces. Excessive washing may damage the hair, causing dandruff, or cause rough skin/skin lesions.[153][154] Some washing of the body is done ritually in religions like Christianity and Judaism, as an act of purification.

Washing can also refer to washing objects. For example, washing of clothing or other cloth items, like bedsheets, or washing dishes or cookwear. Keeping objects clean, especially if they interact with food or the skin, can help with sanitation. Other kinds of washing focus on maintaining cleanliness and durability of objects that get dirty, such washing one's car, by lathering the exterior with car soap, or washing tools used in a dirty process.



A private home washing machine

Transportation

[edit]

These paragraphs are an excerpt from Maritime transport.[edit]

Maritime transport (or ocean transport) or more generally waterborne transport, is the transport of people (passengers) or goods (cargo) via waterways. Freight transport by watercraft has been widely used throughout recorded history, as it provides a higher-capacity mode of transportation for passengers and cargo than land transport, the latter typically being more costly per unit payload due to it being affected by terrain conditions and road/rail infrastructures. The advent of aviation during the 20th century has diminished the importance of sea travel for passengers, though it is still popular for short trips and pleasure cruises. Transport by watercraft is much cheaper than transport by aircraft or land vehicles (both road and rail),[155] but is significantly slower for longer journeys and heavily dependent on adequate port facilities. Maritime transport accounts for roughly 80% of international trade, according to UNCTAD in 2020.

Maritime transport can be realized over any distance as long as there are connecting bodies of water that are navigable to boats, ships or barges such as oceans, lakes, rivers and canals. Shipping may be for commerce, recreation, or military purposes, and is an important aspect of logistics in human societies since early shipbuilding and river engineering were developed, leading to canal ages in various civilizations. While extensive inland shipping is less critical today, the major waterways of the world including many canals are still very important and are integral parts of worldwide economies. Particularly, especially any material can be moved by water; however, water transport becomes impractical when material delivery is time-critical such as various types of perishable produce. Still, water transport is highly cost effective with regular schedulable cargoes, such as trans-oceanic shipping of consumer products – and especially for heavy loads or bulk cargos, such as coal, coke, ores or grains. Arguably, the Industrial Revolution had its first impacts where cheap water transport by canal, navigations, or shipping by all types of watercraft on natural waterways supported cost-effective bulk transport.
Containerization revolutionized maritime transport starting in the 1970s. "General cargo" includes goods packaged in boxes, cases, pallets, and barrels. When a cargo is carried in more than one mode, it is intermodal or co-modal.

Chemical uses

[edit]

Water is widely used in chemical reactions as a solvent or reactant and less commonly as a solute or catalyst. In inorganic reactions, water is a common solvent, dissolving many ionic compounds, as well as other polar compounds such as ammonia and compounds closely related to water. In organic reactions, it is not usually used as a reaction solvent, because it does not dissolve the reactants well and is amphoteric (acidic *and* basic) and nucleophilic. Nevertheless, these properties are sometimes desirable. Also, acceleration of Diels-Alder reactions by water has been observed. Supercritical water has recently been a topic of research. Oxygen-saturated supercritical water combusts organic pollutants efficiently.

Heat exchange

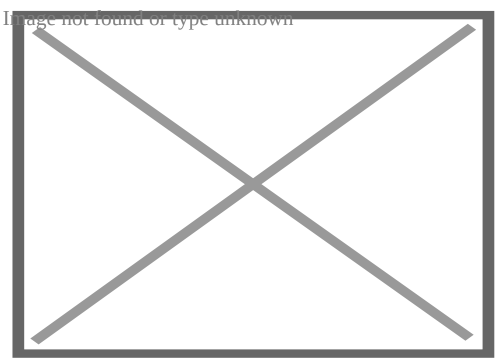
[edit]

Water and steam are a common fluid used for heat exchange, due to its availability and high heat capacity, both for cooling and heating. Cool water may even be naturally available from a lake or the sea. It is especially effective to transport heat through vaporization and condensation of water because of its large latent heat of vaporization. A disadvantage is that metals commonly found in industries such as steel and copper are oxidized faster by untreated water and steam. In almost all thermal power stations, water is used as the working fluid (used in a closed-loop between boiler, steam turbine, and condenser), and the coolant (used to exchange the waste heat to a water body or carry it away by evaporation in a cooling tower). In the United States, cooling power plants is the largest use of water.[156]

In the nuclear power industry, water can also be used as a neutron moderator. In most nuclear reactors, water is both a coolant and a moderator. This provides something of a passive safety measure, as removing the water from the reactor also slows the nuclear reaction down. However other methods are favored for stopping a reaction and it is preferred to keep the nuclear core covered with water so as to ensure adequate cooling.

Fire considerations

[edit]



Water is used for fighting wildfires.

Water has a high heat of vaporization and is relatively inert, which makes it a good fire extinguishing fluid. The evaporation of water carries heat away from the fire. It is dangerous to use water on fires involving oils and organic solvents because many organic materials float on water and the water tends to spread the burning liquid.

Use of water in fire fighting should also take into account the hazards of a steam explosion, which may occur when water is used on very hot fires in confined spaces, and of a hydrogen explosion, when substances which react with water, such as certain metals or hot carbon such as coal, charcoal, or coke graphite, decompose the water, producing water gas.

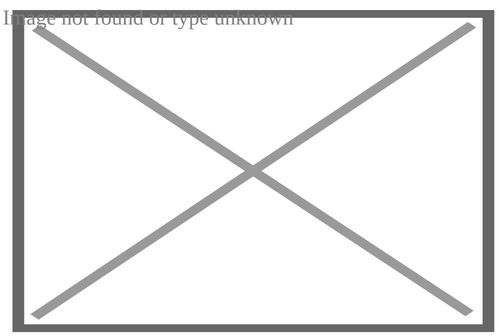
The power of such explosions was seen in the Chernobyl disaster, although the water involved in this case did not come from fire-fighting but from the reactor's own water cooling system. A steam explosion occurred when the extreme overheating of the core caused water to flash into steam. A hydrogen explosion may have occurred as a result of a reaction between steam and hot zirconium.

Some metallic oxides, most notably those of alkali metals and alkaline earth metals, produce so much heat in reaction with water that a fire hazard can develop. The alkaline earth oxide quicklime, also known as calcium oxide, is a mass-produced substance that is often transported in paper bags. If these are soaked through, they may ignite as their contents react with water.[157]

Recreation

[edit]

Main article: Water sport (recreation)



San Andrés island, Colombia

Humans use water for many recreational purposes, as well as for exercising and for sports. Some of these include swimming, waterskiing, boating, surfing and diving. In addition, some sports, like ice hockey and ice skating, are played on ice. Lakesides, beaches and water parks are popular places for people to go to relax and enjoy recreation. Many find the sound and appearance of flowing water to be calming, and fountains and other flowing water structures are popular decorations. Some keep fish and other flora and fauna inside aquariums or ponds for show, fun, and companionship. Humans also use water for snow sports such as skiing, sledding, snowmobiling or snowboarding, which require the water to be at a low temperature either as ice or crystallized into snow.

Water industry

[edit]

The water industry provides drinking water and wastewater services (including sewage treatment) to households and industry. Water supply facilities include water wells, cisterns for rainwater harvesting, water supply networks, and water purification facilities, water tanks, water towers, water pipes including old aqueducts. Atmospheric water generators are in development.

Drinking water is often collected at springs, extracted from artificial borings (wells) in the ground, or pumped from lakes and rivers. Building more wells in adequate places is thus a possible way to produce more water, assuming the aquifers can supply an adequate flow. Other water sources include rainwater collection. Water may require purification for human consumption. This may involve the removal of undissolved substances, dissolved substances and harmful microbes. Popular methods are filtering with sand which only removes undissolved material, while chlorination and boiling kill harmful microbes. Distillation does all three functions. More advanced techniques exist, such as reverse osmosis. Desalination of abundant seawater is a more expensive solution used in coastal arid climates.

The distribution of drinking water is done through municipal water systems, tanker delivery or as bottled water. Governments in many countries have programs to distribute water to the needy at no charge.

Reducing usage by using drinking (potable) water only for human consumption is another option. In some cities such as Hong Kong, seawater is extensively used for flushing toilets citywide to conserve freshwater resources.

Polluting water may be the biggest single misuse of water; to the extent that a pollutant limits other uses of the water, it becomes a waste of the resource, regardless of benefits to the polluter. Like other types of pollution, this does not enter standard accounting of market costs, being conceived as externalities for which the market cannot account. Thus other people pay the price of water pollution, while the private firms' profits are not redistributed to the local population, victims of this pollution. Pharmaceuticals consumed by humans often end up in the waterways and can have detrimental effects on aquatic life if they bioaccumulate and if they are not biodegradable.

Municipal and industrial wastewater are typically treated at wastewater treatment plants. Mitigation of polluted surface runoff is addressed through a variety of prevention and treatment techniques.

A water-carrier in India, 1882. In many places where running water is not available, water

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A water-carrier in India, 1882. In many places where running water is not available, water has to be transported by people.

A manual water pump in China

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  A manual water pump in
  China

Water purification facility

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  Water purification facility

Reverse osmosis (RO) desalination plant in Barcelona, Spain

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  Reverse osmosis (RO)
  desalination plant in
  Barcelona, Spain

Industrial applications

[edit]

Many industrial processes rely on reactions using chemicals dissolved in water, suspension of solids in water slurries or using water to dissolve and extract substances, or to wash products or process equipment. Processes such as mining, chemical pulping, pulp bleaching, paper manufacturing, textile production, dyeing, printing, and cooling of power plants use large amounts of water, requiring a dedicated water source, and often cause significant water pollution.

Water is used in power generation. Hydroelectricity is electricity obtained from hydropower. Hydroelectric power comes from water driving a water turbine connected to a generator. Hydroelectricity is a low-cost, non-polluting, renewable energy source. The energy is supplied by the motion of water. Typically a dam is constructed on a river, creating an artificial lake behind it. Water flowing out of the lake is forced through turbines that turn generators.

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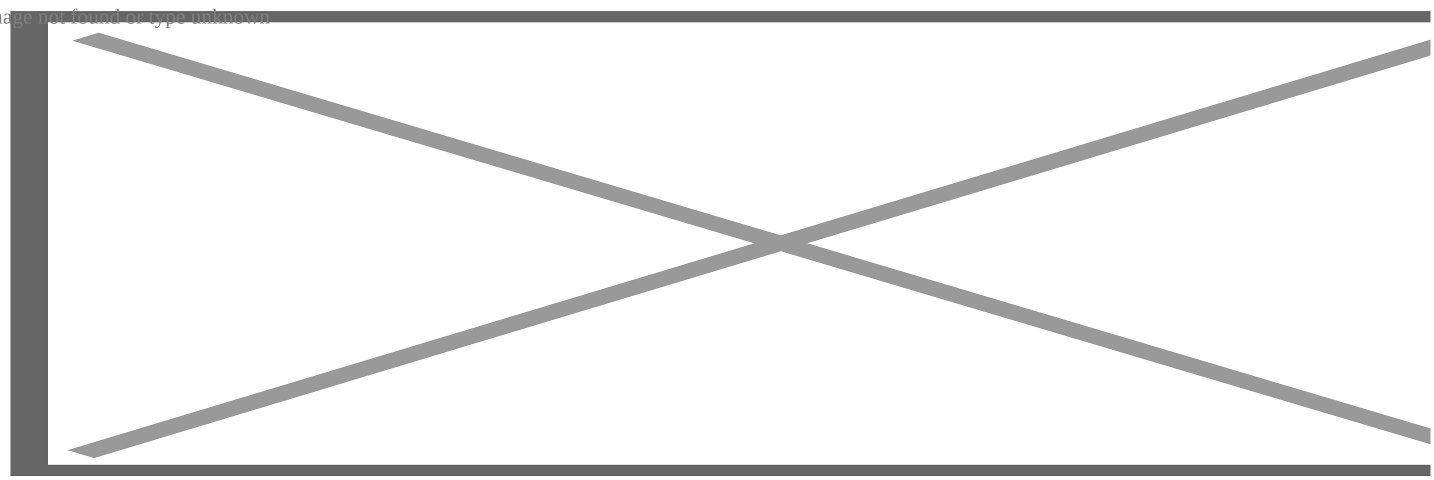


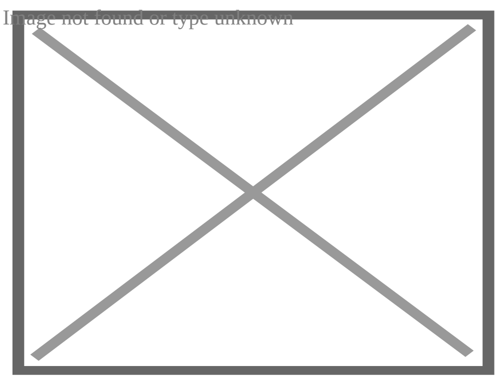
Three Gorges Dam is the largest hydro-electric power station in the world.

Pressurized water is used in water blasting and water jet cutters. High pressure water guns are used for precise cutting. It works very well, is relatively safe, and is not harmful to the environment. It is also used in the cooling of machinery to prevent overheating, or prevent saw blades from overheating.

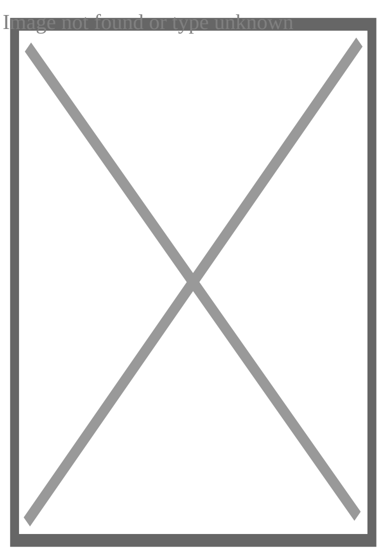
Water is also used in many industrial processes and machines, such as the steam turbine and heat exchanger, in addition to its use as a chemical solvent. Discharge of untreated water from industrial uses is pollution. Pollution includes discharged solutes (chemical pollution) and discharged coolant water (thermal pollution). Industry requires pure water for many applications and uses a variety of purification techniques both in water supply and discharge.

Food processing

[edit]



Water can be used to cook foods such as noodles.



Sterile water for injection

Boiling, steaming, and simmering are popular cooking methods that often require immersing food in water or its gaseous state, steam.[158] Water is also used for dishwashing. Water also plays many critical roles within the field of food science.

Solutes such as salts and sugars found in water affect the physical properties of water. The boiling and freezing points of water are affected by solutes, as well as air pressure, which is in turn affected by altitude. Water boils at lower temperatures with the lower air pressure that occurs at higher elevations. One mole of sucrose (sugar) per kilogram of water raises the boiling point of water by 0.51 °C (0.918 °F), and one mole of salt per kg raises the boiling point by 1.02 °C (1.836 °F); similarly, increasing the number of dissolved particles lowers water's freezing point.[159]

Solutes in water also affect water activity that affects many chemical reactions and the growth of microbes in food.[160] Water activity can be described as a ratio of the vapor pressure of water in a solution to the vapor pressure of pure water.[159] Solutes in water lower water activity—this is important to know because most bacterial growth ceases at low levels of water activity.[160] Not only does microbial growth affect the safety of food, but also the preservation and shelf life of food.

Water hardness is also a critical factor in food processing and may be altered or treated by using a chemical ion exchange system. It can dramatically affect the quality of a product, as well as playing a role in sanitation. Water hardness is classified based on concentration of calcium carbonate the water contains. Water is classified as soft if it contains less than 100 mg/L (UK)[161] or less than 60 mg/L (US).[162]

According to a report published by the Water Footprint organization in 2010, a single kilogram of beef requires 15 thousand litres (3.3×10^3 imp gal; 4.0×10^3 US gal) of water; however, the authors also make clear that this is a global average and circumstantial factors determine the amount of water used in beef production.[163]

Medical use

[edit]

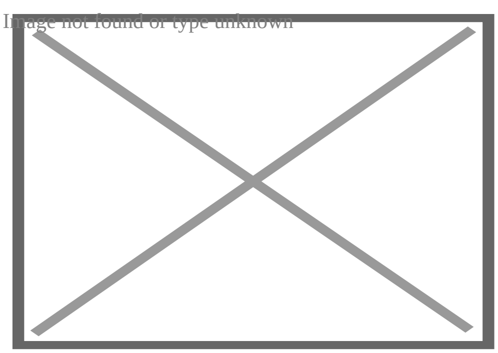
Water for injection is on the World Health Organization's list of essential medicines.[164]

Distribution in nature

[edit]

In the universe

[edit]



Band 5 ALMA receiver is an instrument specifically designed to detect water in the universe.[165]

Much of the universe's water is produced as a byproduct of star formation. The formation of stars is accompanied by a strong outward wind of gas and dust. When this outflow of material eventually impacts the surrounding gas, the shock waves that are created compress and heat the gas. The water observed is quickly produced in this warm dense gas.[166]

On 22 July 2011, a report described the discovery of a gigantic cloud of water vapor containing "140 trillion times more water than all of Earth's oceans combined" around a quasar located 12 billion light years from Earth. According to the researchers, the "discovery shows that water has been prevalent in the universe for nearly its entire existence".[167][168]

Water has been detected in interstellar clouds within the Milky Way.[169] Water probably exists in abundance in other galaxies, too, because its components, hydrogen, and oxygen, are among the most abundant elements in the universe. Based on models of the formation and evolution of the Solar System and that of other star systems, most other planetary systems are likely to have similar ingredients.

Water vapor

[edit]

Water is present as vapor in:

- Atmosphere of the Sun: in detectable trace amounts[170]
- Atmosphere of Mercury: 3.4%, and large amounts of water in Mercury's exosphere[171]
- Atmosphere of Venus: 0.002%[172]
- Earth's atmosphere: ≈0.40% over full atmosphere, typically 1–4% at surface
- Atmosphere of the Moon: in trace amounts[173]
- Atmosphere of Mars: 0.03%[174]
- Atmosphere of Ceres[175]
- Atmosphere of Jupiter: 0.0004%[176] – in ices only; and that of its moon Europa[177]
- Atmosphere of Saturn – in ices only; Enceladus: 91%[178] and Dione (exosphere)[*citation ne*
- Atmosphere of Uranus – in trace amounts below 50 bar
- Atmosphere of Neptune – found in the deeper layers[179]

- Extrasolar planet atmospheres: including those of HD 189733 b[180] and HD 209458 b,[181] Tau Boötis b,[182] HAT-P-11b,[183][184] XO-1b, WASP-12b, WASP-17b, and WASP-19b.[185]
- Stellar atmospheres: not limited to cooler stars and even detected in giant hot stars such as Betelgeuse, Mu Cephei, Antares and Arcturus.[184][186]
- Circumstellar disks: including those of more than half of T Tauri stars such as AA Tauri[184] as well as TW Hydrae,[187][188] IRC +10216[189] and APM 08279+5255,[167][168] VY Canis Majoris and S Persei.[186]

Liquid water

[edit]

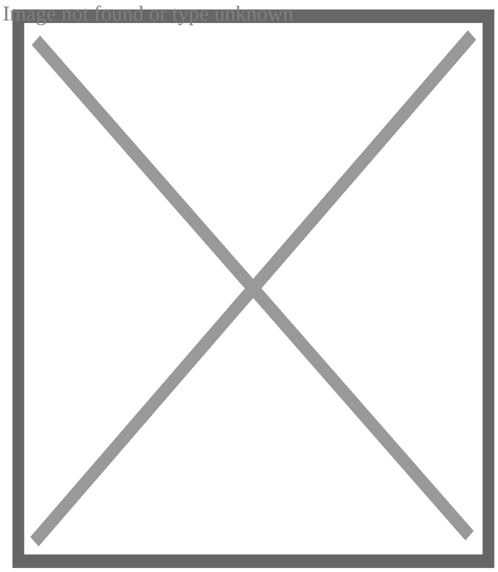
Further information: List of largest lakes and seas in the Solar System and Extraterrestrial liquid water

Liquid water is present on Earth, covering 71% of its surface.[23] Liquid water is also occasionally present in small amounts on Mars.[190] Scientists believe liquid water is present in the Saturnian moons of Enceladus, as a 10-kilometre thick ocean approximately 30–40 kilometers below Enceladus' south polar surface,[191][192] and Titan, as a subsurface layer, possibly mixed with ammonia.[193] Jupiter's moon Europa has surface characteristics which suggest a subsurface liquid water ocean.[194] Liquid water may also exist on Jupiter's moon Ganymede as a layer sandwiched between high pressure ice and rock.[195]

Water ice

[edit]

Water is present as ice on:

- 

  Water ice in the Korolev crater on Mars

  Mars: under the regolith and at the poles.[196][197]
- Earth–Moon system: mainly as ice sheets on Earth and in Lunar craters and volcanic rocks[198] NASA reported the detection of water molecules by NASA's Moon Mineralogy Mapper aboard the Indian Space Research Organization's Chandrayaan-1 spacecraft in September 2009.[199]
- Ceres[200][201][202]
- Jupiter's moons: Europa's surface and also that of Ganymede[203] and Callisto[204][205]
- Saturn: in the planet's ring system[206] and on the surface and mantle of Titan[207] and Enceladus[208]
- Pluto–Charon system[206]
- Comets[209][210] and other related Kuiper belt and Oort cloud objects[211]

And is also likely present on:

- Mercury's poles[212]
- Tethys[213]

Exotic forms

[edit]

Water and other volatiles probably comprise much of the internal structures of Uranus and Neptune and the water in the deeper layers may be in the form of ionic water in which the molecules break down into a soup of hydrogen and oxygen ions, and deeper still as superionic water in which the oxygen crystallizes, but the hydrogen ions float about freely within the oxygen lattice.[214]

Water and planetary habitability

[edit]

Further information: Water distribution on Earth and Planetary habitability

The existence of liquid water, and to a lesser extent its gaseous and solid forms, on Earth are vital to the existence of life on Earth as we know it. The Earth is located in the habitable zone of the Solar System; if it were slightly closer to or farther from the Sun (about 5%, or about 8 million kilometers), the conditions which allow the three forms to be present simultaneously would be far less likely to exist.[215][216]

Earth's gravity allows it to hold an atmosphere. Water vapor and carbon dioxide in the atmosphere provide a temperature buffer (greenhouse effect) which helps maintain a relatively steady surface temperature. If Earth were smaller, a thinner atmosphere would allow temperature extremes, thus preventing the accumulation of water except in polar ice caps (as on Mars).[*citation needed*]

The surface temperature of Earth has been relatively constant through geologic time despite varying levels of incoming solar radiation (insolation), indicating that a dynamic process governs Earth's temperature via a combination of greenhouse gases and surface or atmospheric albedo. This proposal is known as the Gaia hypothesis.[*citation nee*

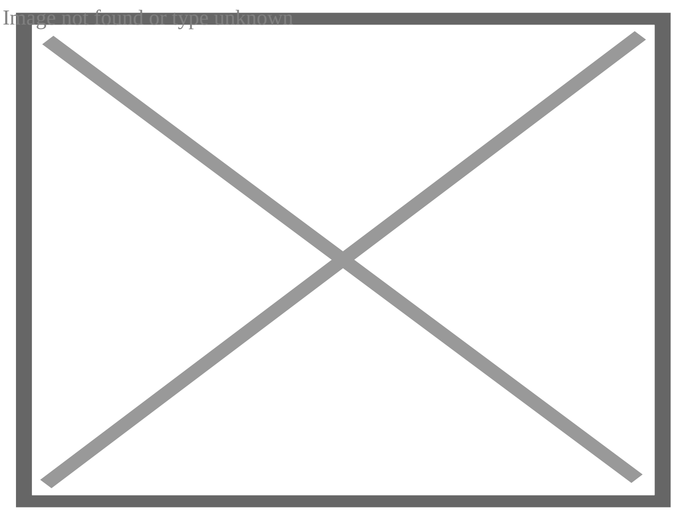
The state of water on a planet depends on ambient pressure, which is determined by the planet's gravity. If a planet is sufficiently massive, the water on it may be solid even at high temperatures, because of the high pressure caused by gravity, as it was observed on exoplanets Gliese 436 b[217] and GJ 1214 b.[218]

Law, politics, and crisis

[edit]

Main articles: Water law, Water right, and Water scarcity

This section needs to be **updated**. Please help update this article to reflect recent events or newly available information. *(June 2022)*



An estimate of the proportion of people in developing countries with access to potable water 1970–2000

Water politics is politics affected by water and water resources. Water, particularly fresh water, is a strategic resource across the world and an important element in many political conflicts. It causes health impacts and damage to biodiversity.

Access to safe drinking water has improved over the last decades in almost every part of the world, but approximately one billion people still lack access to safe water and over 2.5 billion lack access to adequate sanitation.[219] However, some observers have estimated that by 2025 more than half of the world population will be facing water-based vulnerability.[220] A report, issued in November 2009, suggests that by 2030, in some developing regions of the world, water demand will exceed supply by 50%.[221]

1.6 billion people have gained access to a safe water source since 1990.[222] The proportion of people in developing countries with access to safe water is calculated to have improved from 30% in 1970[223] to 71% in 1990, 79% in 2000, and 84% in 2004.[219]

A 2006 United Nations report stated that "there is enough water for everyone", but that access to it is hampered by mismanagement and corruption.[224] In addition, global initiatives to improve the efficiency of aid delivery, such as the Paris Declaration on Aid Effectiveness, have not been taken up by water sector donors as effectively as they have in education and health, potentially leaving multiple donors working on overlapping projects and recipient governments without empowerment to act.[225]

The authors of the 2007 Comprehensive Assessment of Water Management in Agriculture cited poor governance as one reason for some forms of water scarcity. Water governance is the set of formal and informal processes through which decisions related to water management are made. Good water governance is primarily about knowing what processes work best in a particular physical and socioeconomic context. Mistakes have sometimes been made by trying to apply 'blueprints' that work in the developed world to developing world locations and contexts. The Mekong river is one example; a review by the International Water Management Institute of policies in six countries that rely on the Mekong river for water found that thorough and transparent cost-benefit analyses and environmental impact assessments were rarely undertaken.

They also discovered that Cambodia's draft water law was much more complex than it needed to be.[226]

In 2004, the UK charity WaterAid reported that a child dies every 15 seconds from easily preventable water-related diseases, which are often tied to a lack of adequate sanitation.[227][228]

Since 2003, the UN World Water Development Report, produced by the UNESCO World Water Assessment Programme, has provided decision-makers with tools for developing sustainable water policies.[229] The 2023 report states that two billion people (26% of the population) do not have access to drinking water and 3.6 billion (46%) lack access to safely managed sanitation.[230] People in urban areas (2.4 billion) will face water scarcity by 2050.[229] Water scarcity has been described as endemic, due to overconsumption and pollution.[231] The report states that 10% of the world's population lives in countries with high or critical water stress. Yet over the past 40 years, water consumption has increased by around 1% per year, and is expected to grow at the same rate until 2050. Since 2000, flooding in the tropics has quadrupled, while flooding in northern mid-latitudes has increased by a factor of 2.5.[232] The cost of these floods between 2000 and 2019 was 100,000 deaths and $650 million.[229]

Organizations concerned with water protection include the International Water Association (IWA), WaterAid, Water 1st, and the American Water Resources Association. The International Water Management Institute undertakes projects with the aim of using effective water management to reduce poverty. Water related conventions are United Nations Convention to Combat Desertification (UNCCD), International Convention for the Prevention of Pollution from Ships, United Nations Convention on the Law of the Sea and Ramsar Convention. World Day for Water takes place on 22 March[233] and World Oceans Day on 8 June.[234]

In culture

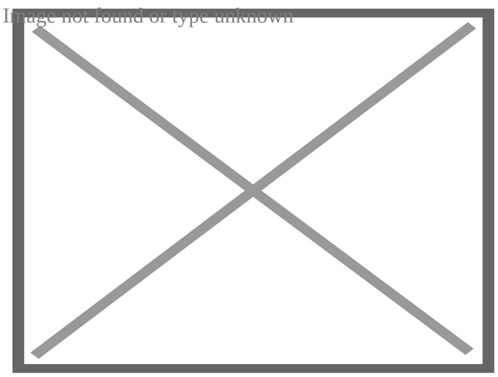
[edit]

Religion

[edit]

Main article: Water and religion

See also: Sacred waters



People come to Inda Abba Hadera spring (Inda Sillasie, Ethiopia) to wash in holy water.

Water is considered a purifier in most religions. Faiths that incorporate ritual washing (ablution) include Christianity,[235] Hinduism, Islam, Judaism, the Rastafari movement, Shinto, Taoism, and Wicca. Immersion (or aspersion or affusion) of a person in water is a central Sacrament of Christianity (where it is called baptism); it is also a part of the practice of other religions, including Islam (*Ghusl*), Judaism (*mikvah*) and Sikhism (*Amrit Sanskar*). In addition, a ritual bath in pure water is performed for the dead in many religions including Islam and Judaism. In Islam, the five daily prayers can be done in most cases after washing certain parts of the body using clean water (*wudu*), unless water is unavailable (see *Tayammum*). In Shinto, water is used in almost all rituals to cleanse a person or an area (e.g., in the ritual of *misogi*).

In Christianity, holy water is water that has been sanctified by a priest for the purpose of baptism, the blessing of persons, places, and objects, or as a means of repelling evil.[236][237]

In Zoroastrianism, water (*Ä•b*) is respected as the source of life.[238]

Philosophy

[edit]

Icosahedron as a part of Spinoza monument in Amsterdam.

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Icosahedron as a part of Spinoza monument in Amsterdam

The Ancient Greek philosopher Empedocles saw water as one of the four classical elements (along with fire, earth, and air), and regarded it as an ylem, or basic substance of the universe. Thales, whom Aristotle portrayed as an astronomer and an engineer, theorized that the earth, which is denser than water, emerged from the water. Thales, a monist, believed further that all things are made from water. Plato believed that the shape of water is an icosahedron – flowing easily compared to the cube-shaped earth.[239]

The theory of the four bodily humors associated water with phlegm, as being cold and moist. The classical element of water was also one of the five elements in traditional Chinese philosophy (along with earth, fire, wood, and metal).

Some traditional and popular Asian philosophical systems take water as a role-model. James Legge's 1891 translation of the *Dao De Jing* states, "The highest excellence is like (that of) water. The excellence of water appears in its benefiting all things, and in its occupying, without striving (to the contrary), the low place which all men dislike. Hence (its way) is near to (that of) the Tao" and "There is nothing in the world more soft and weak than water, and yet for attacking things that are firm and strong there is nothing that can take precedence of it—for there is nothing (so effectual) for which it can be changed."[240] *Guanzi* in the "Shui di" æº´åœ° chapter further elaborates on the symbolism of water, proclaiming that "man is water" and attributing natural qualities of the people of different Chinese regions to the character of local water resources.[241]

Folklore

[edit]

"Living water" features in Germanic and Slavic folktales as a means of bringing the dead back to life. Note the Grimm fairy-tale ("The Water of Life") and the Russian dichotomy of living [ru] and dead water [ru]. The Fountain of Youth represents a related concept of magical waters allegedly preventing aging.

Art and activism

[edit]

In the significant modernist novel *Ulysses* (1922) by Irish writer James Joyce, the chapter "Ithaca" takes the form of a catechism of 309 questions and answers, one of which is known as the "water hymn".[242]:â€‰91â€‰According to Richard E. Madtes, the hymn is not merely a "monotonous string of facts", rather, its phrases, like their subject, "ebb and flow, heave and swell, gather and break, until they subside into the calm quiescence of the concluding 'pestilential fens, faded flowerwater, stagnant pools in the waning moon.'"[242]:â€‰79â€‰The hymn is considered one of the most remarkable passages in Ithaca, and according to literary critic Hugh Kenner, achieves "the improbable feat of raising to poetry all the clutter of footling information that has accumulated in schoolbooks."[242]:â€‰91â€‰The literary motif of water represents the novel's theme of "everlasting, everchanging life," and the hymn represents the culmination of the motif in the novel.[242]:â€‰91â€‰The following is the hymn quoted in full.[243]

> What in water did Bloom, waterlover, drawer of water, watercarrier returning to the range, admire?
> Its universality: its democratic equality and constancy to its nature in seeking its own level: its vastness in the ocean of Mercator’s projection: its unplumbed profundity in the Sundam trench of the Pacific exceeding 8,000 fathoms: the restlessness of its waves and surface particles visiting in turn all points of its seaboard: the independence of its units: the variability of states of sea: its hydrostatic quiescence in calm: its hydrokinetic turgidity in neap and spring tides: its subsidence after devastation: its sterility in the circumpolar icecaps, arctic and antarctic: its climatic and commercial significance: its preponderance of 3 to 1 over the dry land of the globe: its indisputable hegemony extending in square leagues over all the region below the subequatorial tropic of Capricorn: the multisecular stability of its primeval basin: its luteofulvous bed: its capacity to dissolve and hold in solution all soluble substances including millions of tons of the most precious metals: its

slow erosions of peninsulas and downwardtending promontories: its alluvial deposits: its weight and volume and density: its imperturbability in lagoons and highland tarns: its gradation of colours in the torrid and temperate and frigid zones: its vehicular ramifications in continental lakecontained streams and confluent oceanflowing rivers with their tributaries and transoceanic currents: gulfstream, north and south equatorial courses: its violence in seaquakes, waterspouts, artesian wells, eruptions, torrents, eddies, freshets, spates, groundswells, watersheds, waterpartings, geysers, cataracts, whirlpools, maelstroms, inundations, deluges, cloudbursts: its vast circumterrestrial ahorizontal curve: its secrecy in springs, and latent humidity, revealed by rhabdomantic or hygrometric instruments and exemplified by the well by the hole in the wall at Ashtown gate, saturation of air, distillation of dew: the simplicity of its composition, two constituent parts of hydrogen with one constituent part of oxygen: its healing virtues: its buoyancy in the waters of the Dead Sea: its persevering penetrativeness in runnels, gullies, inadequate dams, leaks on shipboard: its properties for cleansing, quenching thirst and fire, nourishing vegetation: its infallibility as paradigm and paragon: its metamorphoses as vapour, mist, cloud, rain, sleet, snow, hail: its strength in rigid hydrants: its variety of forms in loughs and bays and gulfs and bights and guts and lagoons and atolls and archipelagos and sounds and fjords and minches and tidal estuaries and arms of sea: its solidity in glaciers, icebergs, icefloes: its docility in working hydraulic millwheels, turbines, dynamos, electric power stations, bleachworks, tanneries, scutchmills: its utility in canals, rivers, if navigable, floating and graving docks: its potentiality derivable from harnessed tides or watercourses falling from level to level: its submarine fauna and flora (anacoustic, photophobe) numerically, if not literally, the inhabitants of the globe: its ubiquity as constituting 90% of the human body: the noxiousness of its effluvia in lacustrine marshes, pestilential fens, faded flowerwater, stagnant pools in the waning moon.

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The vast "water hymn" in James Joyce's novel *Ulysses* is occasioned when the protagonist Leopold Bloom fills a kettle with water from a kitchen faucet.[243]

Painter and activist Fredericka Foster curated *The Value of Water*, at the Cathedral of St. John the Divine in New York City,[244] which anchored a year-long initiative by the Cathedral on our dependence on water.[245][246] The largest exhibition to ever appear at the Cathedral,[247] it featured over forty artists, including Jenny Holzer, Robert Longo, Mark Rothko, William Kentridge, April Gornik, Kiki Smith, Pat Steir, Alice Dalton Brown, Teresita Fernandez and Bill Viola.[248][249] Foster created Think About Water,[250][*full citation needed*] an ecological collective of artists who use water as their subject or medium. Members include Basia Irland,[251][*full citation needed*] Aviva Rahmani, Betsy Damon, Diane Burko, Leila Daw, Stacy Levy, Charlotte Coté,[252] Meridel Rubenstein, and Anna Macleod.

To mark the 10th anniversary of access to water and sanitation being declared a human right by the UN, the charity WaterAid commissioned ten visual artists to show the impact of clean water on people's lives.[253][254]

Dihydrogen monoxide parody

[edit]

Main article: Dihydrogen monoxide parody

'Dihydrogen monoxide' is a technically correct but rarely used chemical name of water. This name has been used in a series of hoaxes and pranks that mock scientific illiteracy. This began in 1983, when an April Fools' Day article appeared in a newspaper in Durand, Michigan. The false story consisted of safety concerns about the substance.[255]

Music

[edit]

The word "Water" has been used by many Florida based rappers as a sort of catchphrase or adlib. Rappers who have done this include BLP Kosher and Ski Mask the Slump God.[256] To go even further some rappers have made whole songs dedicated to the water in Florida, such as the 2023 Danny Towers song "Florida Water".[257] Others have made whole songs dedicated to water as a whole, such as XXXTentacion, and Ski Mask the Slump God with their hit song "H2O".

See also

[edit]

- icon Image not found or type unknown Oceans portal
- icon Image not found or type unknown Renewable energy portal
- icon Image not found or type unknown Water portal
- icon Image not found or type unknown Weather portal

- Outline of water – Overview of and topical guide to water

- Water (data page) – Chemical data page for water is a collection of the chemical and physical properties of water.
- Aquaphobia – Persistent and abnormal fear of water
- Blue roof – Roof of a building that is designed to provide temporary water storage
- Catchwater – Runoff catching or channeling device
- Human right to water and sanitation
- Hydroelectricity – Electricity generated by hydropower
- List of waterfalls
- Marine current power – Extraction of power from ocean currents
- Marine energy – Energy available from oceans
- Mpemba effect – Natural phenomenon that hot water freezes faster than cold
- Oral rehydration therapy – Type of fluid replacement used to prevent and treat dehydration
- Osmotic power – Energy available from the difference in the salt concentration between seawater and river water
- Oxyhydrogen – Explosive mixture of hydrogen and oxygen gases
- Properties of water – Physical and chemical properties of pure water
- Rainwater tank – Container for collecting and storing rainwater
- Thirst – Craving for potable fluids experienced by animals
- Tidal power – Technology to convert the energy from tides into useful forms of power
- Water pinch analysis – systematic technique for reducing water consumption and wastewater generation
- Wave power – Transport of energy by wind waves, and the capture of that energy to do useful work
- Water filter – Device that removes impurities in water
- Water heat recycling – Use of a heat exchanger to recover energy and reuse heat from drain water

- Water recycling shower – Showers that use a basin and a pump to re-use the showering water
- Water-sensitive urban design – Integrated approach to urban water cycle

Notes

[edit]

1. **^** A commonly quoted value of 15.7 used mainly in organic chemistry for the pK_a of water is incorrect.[12][13]
2. ^ ***a b*** Vienna Standard Mean Ocean Water (VSMOW), used for calibration, melts at 273.150089(10) K (0.000089(10) °C, and boils at 373.1339 K (99.9839 °C). Other isotopic compositions melt or boil at slightly different temperatures.
3. **^** see the taste and odor section
4. **^** Other substances with this property include bismuth, silicon, germanium and gallium.[57]

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Water

Overviews	- Outline - Data - Model - Properties	Water droplet Image not found or type unknown Water droplet

States

- Liquid
- Ice
- Vapor
- Steam
    - superheated

Forms

- Deuterium-depleted
- Semiheavy
- Heavy
- Tritiated
- Doubly labeled water
- Hydronium

On Earth

- Cycle
- Distribution
- Hydrosphere
    - Hydrology
    - Hydrobiology
- Origin
- Pollution
- Resources
    - management
    - policy
- Supply

Extraterrestrial

- Extraterrestrial liquid water
  - Asteroidal water
  - Planetary oceanography
  - Ocean world
  - Hycean planet
  - List of Candidates
- Specific
  - Europa
  - Mars
  - Moon
  - Enceladus

Physical parameters

- Stratification
  - Ocean stratification
  - Lake stratification
- Ocean temperature

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Food chemistry

- Additives
- Carbohydrates
- Coloring
- Enzymes
- Essential fatty acids
- Flavors
- Fortification
- Lipids
- "Minerals" (Chemical elements)
- Proteins
- Vitamins
- Water

Natural resources

Air	Pollution / quality	◦ Ambient standards (US) ◦ Index ◦ Indoor ◦ Law ◦ Clean Air Act (US) ◦ Ozone depletion
	Emissions	◦ Airshed ◦ Trading ◦ Deforestation (REDD)

Energy	◦ Bio
	◦ Law
	◦ Resources
	◦ Fossil fuels (gas, peak coal, peak gas, peak oil)
	◦ Geothermal
	◦ Hydro
	◦ Nuclear
	◦ Solar
	    ◦ sunlight
	    ◦ shade
	◦ Wind

Land

- Agricultural
  - arable
    - peak farmland
- Degradation
- Field
- Landscape
  - cityscape
  - seascape
  - soundscape
  - viewshed
- Law
  - property
- Management
  - habitat conservation
- Minerals
  - gemstone
  - industrial
  - ore
    - metal
  - mining
    - law
    - sand
  - peak
    - copper
    - phosphorus
  - rights
- Soil
  - conservation
  - fertility
  - health

Life

- Biodiversity
- Bioprospecting
  - biopiracy
- Biosphere
- Bushfood
- Bushmeat
- Fisheries
  - climate change
  - law
  - management
- Forests
  - genetic resources
  - law
  - management
  - non-timber products
- Game
  - law
- Marine conservation
- Meadow
- Pasture
- Plants
  - FAO Plant Treaty
  - food
  - genetic resources
  - gene banks
  - herbal medicines
  - UPOV Convention
  - wood
- Rangeland
- Seed bank

Water	Types / location	- Aquifer
		  - storage and recovery
		- Drinking
		- Fresh
		- Groundwater
		  - pollution
		  - recharge
		  - remediation
		- Hydrosphere
		- Ice
		  - bergs
		  - glacial
		  - polar
		- Irrigation
		  - *huerta*
		- Marine
		- Rain
		  - harvesting
		- Stormwater
		- Surface water
		- Sewage
		  - reclaimed water
		- Watershed

		- Desalination - Floods - Law - Leaching - Sanitation

- Commons
  - enclosure
  - global
  - land
  - tragedy of
- Economics
  - ecological
  - land
- Ecosystem services
- Exploitation
  - overexploitation
  - Earth Overshoot Day
- Management
  - adaptive
- Natural capital
  - accounting
  - good
- Natural heritage
- Nature reserve
  - remnant natural area
- Systems ecology
- Urban ecology
- Wilderness

Related

Resource

- Common-pool
- Conflict (perpetuation)
- Curse
- Depletion
- Extraction

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Molecules detected in outer space

Diatomic

- Aluminium monochloride
- Aluminium monofluoride
- Aluminium(II) oxide
- Argonium
- Carbon cation
- Carbon monophosphide
- Carbon monosulfide
- Carbon monoxide
- Cyano radical
- Diatomic carbon
- Fluoromethylidynium
- Helium hydride ion
- Hydrogen chloride
- Hydrogen fluoride
- Hydrogen (molecular)
- Hydroxyl radical
- Imidogen
- Iron(II) oxide
- Magnesium monohydride
- Methylidyne radical
- Nitric oxide
- Nitrogen (molecular)
- Oxygen (molecular)
- Phosphorus monoxide
- Phosphorus mononitride
- Potassium chloride
- Silicon carbide
- Silicon monoxide
- Silicon monosulfide

Deuterated molecules	◦ Ammonia ◦ Ammonium ion ◦ Formaldehyde ◦ Formyl radical ◦ Heavy water ◦ Hydrogen cyanide ◦ Hydrogen deuteride ◦ Hydrogen isocyanide ◦ N_2D^+ ◦ Propyne ◦ Trihydrogen cation
Unconfirmed	◦ Anthracene ◦ Dihydroxyacetone ◦ Glycine ◦ Graphene ◦ H_2NCO^+ ◦ Hemolithin ◦ Linear C_5 ◦ Methoxyethane ◦ Naphthalene cation ◦ Phosphine ◦ Pyrene ◦ Silylidyne

Related	◦ Abiogenesis ◦ Astrobiology ◦ Astrochemistry ◦ Atomic and molecular astrophysics ◦ Chemical formula ◦ Circumstellar dust ◦ Circumstellar envelope ◦ Cosmic dust ◦ Cosmic ray ◦ Cosmochemistry ◦ Diffuse interstellar band ◦ Earliest known life forms ◦ Extraterrestrial life ◦ Extraterrestrial liquid water ◦ Forbidden mechanism ◦ Homochirality ◦ Intergalactic dust ◦ Interplanetary medium ◦ Interstellar medium ◦ Iron–sulfur world theory ◦ Kerogen ◦ Molecules in stars ◦ Nexus for Exoplanet System Science ◦ Organic compound ◦ Outer space ◦ PAH world hypothesis ◦ Photodissociation region ◦ Polycyclic aromatic hydrocarbon (PAH) ◦ Pseudo-panspermia ◦ RNA world hypothesis

- Image not found or type unknown **Category:Astrochemistry**
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About toilet

A toilet is a piece of hygienic hardware that collects human waste (urine and feces) and sometimes bathroom tissue, normally for disposal. Flush bathrooms use water, while completely dry or non-flush toilets do not. They can be developed for a resting placement prominent in Europe and The United States And Canada with a bathroom seat, with additional considerations for those with disabilities, or for a bowing stance much more preferred in Asia, called a squat toilet. In metropolitan areas, flush commodes are typically attached to a drain system; in isolated areas, to a septic system. The waste is called blackwater and the consolidated effluent, including various other sources, is sewer. Dry toilets are linked to a pit, removable container, composting chamber, or various other storage space and therapy tool, including urine diversion with a urine-diverting commode. "Toilet" or "toilets" is likewise extensively utilized for areas including only one or even more commodes and hand-basins. Lavatory is an older word for commode. The modern technology made use of for modern-day commodes differs. Commodes are typically made of ceramic (porcelain), concrete, plastic, or timber. More recent toilet technologies include double flushing, reduced flushing, bathroom seat warming, self-cleaning, female urinals and waterless rest rooms. Japan is known for its commode innovation. Aircraft bathrooms are specially developed to operate airborne. The need to preserve rectal hygiene post-defecation is widely identified and toilet paper (frequently held by a bathroom roll owner), which may additionally be used to clean the vulva after urination, is widely used (in addition to bidets). Secretive homes, depending upon the area and style, the bathroom may exist in the very same restroom as the sink, bath tub, and shower. One more option is to have one room for body cleaning (additionally called "washroom") and a different one for the bathroom and handwashing sink (toilet area). Public toilets (restrooms) include several toilets (and generally single urinals or trough rest rooms) which are offered for use by the general public. Products like rest room blocks and commode obstructs help maintain the scent and tidiness of toilets. Toilet seat covers are often made use of. Portable bathrooms (regularly chemical "porta johns") may be generated for large and momentary gatherings. Historically, cleanliness has been a worry from the earliest stages of human negotiations. Nevertheless, many inadequate houses in developing countries use extremely basic, and frequently unclean, bathrooms --- and almost one billion individuals have no accessibility to a commode in all; they need to freely excrete and pee. These issues can result in the spread of diseases transferred using the fecal-oral route, or the transmission of waterborne diseases such as cholera and dysentery. For that reason, the United Nations Sustainable Growth Goal 6 wishes to "achieve access to adequate and equitable cleanliness and health for all and finish open defecation".

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About sustainability

Sustainability is a social objective for individuals to co-exist in the world over a long period of time. Definitions of this term are contested and have actually differed with literary works, context, and time. Sustainability usually has 3 measurements (or columns): environmental, economic, and social. Lots of definitions highlight the ecological measurement. This can consist of attending to crucial ecological problems, including climate change and biodiversity loss. The idea of sustainability can assist choices at the international, nationwide, business, and private levels. A related idea is that of lasting growth, and the terms are usually used to suggest the very same point. UNESCO identifies the two such as this: "Sustainability is commonly taken a lasting goal (i. e. a more lasting world), while sustainable development describes the many processes and paths to attain it. " Information around the economic dimension of sustainability are questionable. Scholars have reviewed this under the idea of weak and strong sustainability. For instance, there will certainly constantly be stress in between the ideas of "well-being and success for all" and ecological conservation, so trade-offs are necessary. It would be desirable to locate manner ins which different economic development from damaging the environment. This indicates making use of less resources each of result also while growing the economy. This decoupling decreases the ecological impact of economic growth, such as contamination. Doing this is tough. Some experts say there is no proof that such a decoupling is happening at the required scale. It is challenging to determine sustainability as the concept is intricate, contextual, and dynamic. Indicators have actually been developed to cover the atmosphere, culture, or the economy however there is no set meaning of sustainability indicators. The metrics are developing and consist of signs, standards and audits. They include sustainability criteria and certification systems like Fairtrade and Organic. They also include indices and accounting systems such as company sustainability coverage and Triple Profits accounting. It is essential to attend to lots of barriers to sustainability to accomplish a sustainability change or sustainability transformation.:â€‹â€‹ 34 â€‹ Some obstacles develop from nature and its intricacy while others are extrinsic to the concept of sustainability. For example, they can arise from the dominant institutional frameworks in nations. Worldwide issues of sustainability are tough to deal with as they need worldwide solutions. The United Nations writes, "Today, there are almost 140 creating countries in the world looking for ways of meeting their growth requires, but with the enhancing risk of climate adjustment, concrete efforts should be made to make certain growth today does not adversely influence future generations" UN Sustainability. Existing global organizations such as the UN and WTO are seen as ineffective in implementing existing worldwide regulations. One factor for this is the absence of appropriate approving mechanisms.:â€‹â€‹ 135-- 145 â€‹ Federal governments are not the only resources of action for sustainability. For instance, business groups have attempted to incorporate eco-friendly concerns with financial task, seeking sustainable service. Spiritual leaders have actually emphasized the demand for caring for nature and ecological stability. People can likewise live more sustainably. Some individuals have actually slammed the idea of sustainability.One point of objection is that the concept is obscure and only a buzzword. Another is that sustainability might be a difficult goal. Some experts have actually explained that "no country is delivering what its citizens need without oversteping the biophysical global limits".:â€‹â€‹ 11 â€‹

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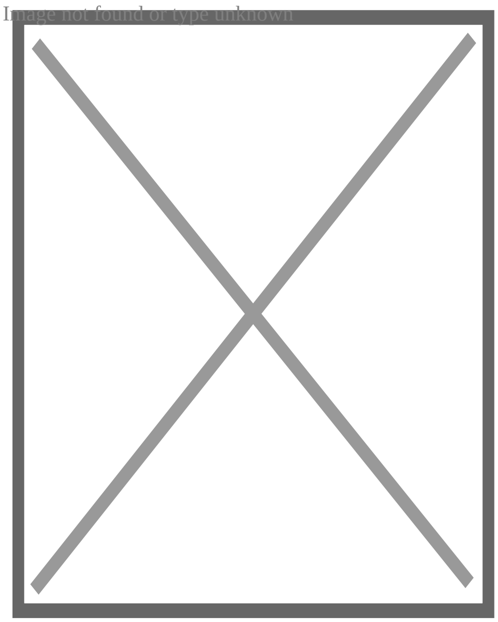
About Ventilative cooling



A sash window with two sashes that can be adjusted to control airflows and temperatures

Ventilative cooling is the use of natural or mechanical ventilation to cool indoor spaces.[1] The use of outside air reduces the cooling load and the energy consumption of these systems, while maintaining high quality indoor conditions; passive ventilative cooling may eliminate energy consumption. Ventilative cooling strategies are applied in a wide range of buildings and may even be critical to realize renovated or new high efficient buildings and zero-energy buildings (ZEBs).[2] Ventilation is present in buildings mainly for air quality reasons. It can be used additionally to remove both excess heat gains, as well as increase the velocity of the air and thereby widen the thermal comfort range.[3] Ventilative cooling is assessed by long-term evaluation indices.[4] Ventilative cooling is dependent on the availability of appropriate external conditions and on the thermal physical characteristics of the building.

Background

[edit]

In the last years, overheating in buildings has been a challenge not only during the design stage but also during the operation. The reasons are:[5][6]

- High performance energy standards which reduce heating demand in heating dominated climates. Mainly refer to increase of the insulation levels and restriction on infiltration rates
- The occurrence of higher outdoor temperatures during the cooling season, because of the climate change and the heat island effect not considered at the design phase
- Internal heat gains and occupancy behavior were not calculated with accuracy during the design phase (gap in performance).

In many post-occupancy comfort studies overheating is a frequently reported problem not only during the summer months but also during the transitions periods, also in temperate climates.

Potentials and limitations

[edit]

The effectiveness of ventilative cooling has been investigated by many researchers and has been documented in many post occupancy assessments reports.[7][8][9] The system cooling effectiveness (natural or mechanical ventilation) depends on the air flow rate that can be established, the thermal capacity of the construction and the heat transfer of the elements. During cold periods the cooling power of outdoor air is large. The risk of draughts is also important. During summer and transition months outdoor air cooling power might not be enough to compensate overheating indoors during daytime and application of ventilative cooling will be limited only during the night period. The night ventilation may remove effectively accumulated heat gains (internal and solar) during daytime in the building constructions.[10] For the assessment of the cooling potential of the location simplified methods have been developed.[11][12][13][14] These methods use mainly building characteristics information, comfort range indices and local climate data. In most of the simplified methods the thermal inertia is ignored.

The critical limitations for ventilative cooling are:

- Impact of global warming
- Impact of urban environment
- Outdoor noise levels
- Outdoor air pollution[15]
- Pets and insects
- Security issues
- Locale limitations

Existing regulations

[edit]

Ventilative cooling requirements in regulations are complex. Energy performance calculations in many countries worldwide do not explicitly consider ventilative cooling. The available tools used for energy performance calculations are not suited to model the impact and effectiveness of ventilative cooling, especially through annual and monthly calculations.[16]

Case studies

[edit]

A large number of buildings using ventilative cooling strategies have already been built around the world.[17][18][19] Ventilative cooling can be found not only in traditional, pre-air-condition architecture, but also in temporary European and international low energy buildings. For these buildings passive strategies are priority. When passive strategies are not enough to achieve comfort, active strategies are applied. In most cases for the summer period and the transition months, automatically controlled natural ventilation is used. During the heating season, mechanical ventilation with heat recovery is used for indoor air quality reasons. Most of the buildings present high thermal mass. User behavior is crucial element for successful performance of the method.

Building components and control strategies

[edit]

Building components of ventilative cooling are applied on all three levels of climate-sensitive building design, i.e. site design, architectural design and technical interventions . A grouping of these components follows:[1][20]

- Airflow guiding ventilation components (windows, rooflights, doors, dampers and grills, fans, flaps, louvres, special effect vents)
- Airflow enhancing ventilation building components (chimneys, atria, venturi ventilators, wind catchers, wind towers and scoops, double facades, ventilated walls)
- Passive cooling building components (convective components, evaporative components, phase change components)
- Actuators (chain, linear, rotary)
- Sensors (temperature, humidity, air flow, radiation, CO_2, rain, wind)

Control strategies in ventilative cooling solutions have to control the magnitude and the direction, of air flows in space and time.[1] Effective control strategies ensure high indoor comfort levels and minimum energy consumption. Strategies in a lot of cases include temperature and CO_2 monitoring.[21] In many buildings in which occupants had learned how to operate the systems, energy use reduction was achieved. Main control parameters are operative (air and radiant) temperature (both peak, actual or average), occupancy, carbon dioxide concentration and humidity levels.[21] Automation is more effective than personal control.[1] Manual control or manual override of automatic control are very important as it affects user acceptance and appreciation of the indoor climate positively (also cost).[22] The third option is that operation of facades is left to personal control of the inhabitants, but the building automation system gives active feedback and specific advises.

Existing methods and tools

[edit]

Building design is characterized by different detailed design levels. In order to support the decision-making process towards ventilative cooling solutions, airflow models with different resolution are used. Depending on the detail resolution required, airflow models can be grouped into two categories:[1]

- Early stage modelling tools, which include empirical models, monozone model, bidimensional airflow network models;and
- Detailed modelling tools, which include airflow network models, coupled BES-AFN models, zonal models, Computational Fluid Dynamic, coupled CFD-BES-AFN models.

Existing literature includes reviews of available methods for airflow modelling.[9][23][24][25][26][27][28]

IEA EBC Annex 62

[edit]

Annex 62 'ventilative cooling' was a research project of the Energy in Buildings and Communities Programme (EBC) of the International Energy Agency (IEA), with a four-year working phase (2014–2018).[29] The main goal was to make ventilative cooling an attractive and energy efficient cooling solution to avoid overheating of both new and renovated buildings. The results from the Annex facilitate better possibilities for prediction and estimation of heat removal and overheating risk – for both design purposes and for energy performance calculation. The documented performance of ventilative cooling systems through analysis of case studies aimed to promote the use of this technology in future high performance and conventional buildings.[30] To fulfill the main goal the Annex had the following targets for the research and development work:

- To develop and evaluate suitable design methods and tools for prediction of cooling need, ventilative cooling performance and risk of overheating in buildings.
- To develop guidelines for an energy-efficient reduction of the risk of overheating by ventilative cooling solutions and for design and operation of ventilative cooling in both residential and commercial buildings.
- To develop guidelines for integration of ventilative cooling in energy performance calculation methods and regulations including specification and verification of key performance indicators.
- To develop instructions for improvement of the ventilative cooling capacity of existing systems and for development of new ventilative cooling solutions including their control strategies.
- To demonstrate the performance of ventilative cooling solutions through analysis and evaluation of well-documented case studies.

The Annex 62 research work was divided in three subtasks.

- **Subtask A** "Methods and Tools" analyses, developed and evaluated suitable design methods and tools for prediction of cooling need, ventilative cooling performance and risk of overheating in buildings. The subtask also gave guidelines for integration of ventilative cooling in energy performance calculation methods and regulation including specification and verification of key performance indicators.

- **Subtask B** "Solutions" investigated the cooling performance of existing mechanical, natural and hybrid ventilation systems and technologies and typical comfort control solutions as a starting point for extending the boundaries for their use. Based upon these investigations the subtask also developed recommendations for new kinds of flexible and reliable ventilative cooling solutions that create comfort under a wide range of climatic conditions.
- **Subtask C** "Case studies" demonstrated the performance of ventilative cooling through analysis and evaluation of well-documented case studies.

See also

[edit]

- Air conditioning
- Architectural engineering
- Glossary of HVAC
- Green building
- Heating, Ventilation and Air-Conditioning
- Indoor air quality
- Infiltration (HVAC)
- International Energy Agency Energy in Buildings and Communities Programme
- Mechanical engineering
- Mixed Mode Ventilation
- Passive cooling
- Room air distribution
- Sick building syndrome
- Sustainable refurbishment
- Thermal comfort
- Thermal mass

- Venticool
- Ventilation (architecture)

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About Sewage

Sewage (or domestic sewer, residential wastewater, community wastewater) is a type of wastewater that is created by a neighborhood of individuals. It is typically transferred through a drain system.:â€‹â€‹ 175 â€‹ Sewer includes wastewater released from residences and from industrial, institutional and public centers that exist in the locality.:â€‹â€‹ 10 â€‹ Sub-types of sewer are greywater (from sinks, bath tubs, showers, dishwashing machines, and clothing washers) and blackwater (the water utilized to purge toilets, incorporated with the human waste that it flushes away). Sewer additionally has soaps and detergents. Food waste might be present from dishwashing, and food quantities may be increased where garbage disposal systems are made use of. In regions where toilet tissue is made use of instead of bidets, that paper is additionally included in the sewage. Sewage consists of macro-pollutants and micro-pollutants, and might additionally integrate some community strong waste and contaminants from industrial wastewater. Sewage typically takes a trip from a building's plumbing either right into a drain, which will bring it elsewhere, or right into an onsite sewer facility. Collection of sewer from a number of homes with each other usually happens in either sanitary sewage systems or combined sewers. The former is created to leave out stormwater streams whereas the latter is made to likewise take stormwater. The manufacturing of sewage typically corresponds to the water intake. A variety of factors affect water usage and therefore the sewer flowrates each. These include: Water availability (the reverse of water deficiency), water alternatives, environment (warmer climates may lead to greater water consumption), neighborhood size, financial degree of the neighborhood, degree of automation, metering of house intake, water cost and water pressure.:â€‹â€‹ 20 â€‹. The major parameters in sewage that are determined to examine the sewer toughness or high quality in addition to therapy options consist of: solids, indicators of organic matter, nitrogen, phosphorus, and indications of fecal contamination.:â€‹â€‹ 33 â€‹ These can be thought about to be the primary macro-pollutants in sewage. Sewage includes pathogens which come from fecal matter. The complying with four sorts of pathogens are located in sewage: pathogenic germs, viruses, protozoa (in the kind of cysts or oocysts) and helminths (in the type of eggs). In order to evaluate the organic matter, indirect approaches are typically made use of: primarily the Biochemical Oxygen Need (BOD) and the Chemical Oxygen Need (COD).:â€‹â€‹ 36 â€‹. Administration of sewer includes collection and transport for launch into the setting, after a therapy degree that works with the neighborhood requirements for discharge into water bodies, onto dirt or for reuse applications.:â€â€ 156 â€ Disposal options consist of dilution (self-purification of water bodies, taking advantage of their assimilative capability ideally), aquatic outfalls, land disposal and sewage ranches. All disposal options might run risks of triggering water contamination.

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About health

Health and wellness has a selection of meanings, which have actually been utilized for different objectives with time. As a whole, it describes physical and psychological wellness, particularly that associated with normal performance of the human body, lacking of illness, discomfort (including psychological pain), or injury. Health and wellness can be promoted by urging healthy tasks, such as normal physical exercise and appropriate sleep, and by decreasing or avoiding unhealthy activities or circumstances, such as cigarette smoking or extreme tension. Some aspects affecting wellness are because of specific options, such as whether to take part in a risky behavior, while others are because of structural reasons, such as whether the culture is set up in a way that makes it simpler or more difficult for people to get required health care services. Still, other factors are past both specific and team choices, such as congenital diseases.

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About air conditioning

This article is about cooling of air. For the Curved Air album, see Air Conditioning (album). For a similar device capable of both cooling and heating, see Heat pump.

"a/c" redirects here. For the abbreviation used in banking and book-keeping, see Account (disambiguation). For other uses, see AC.

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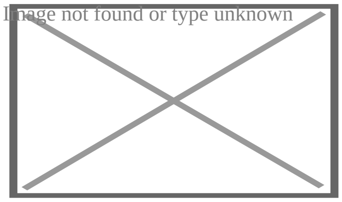

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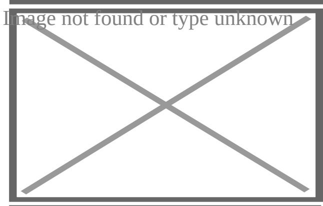

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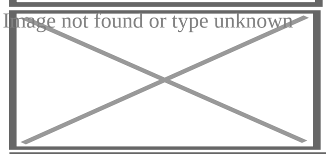

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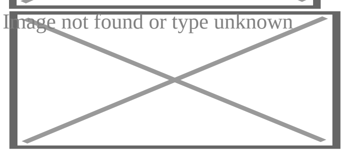

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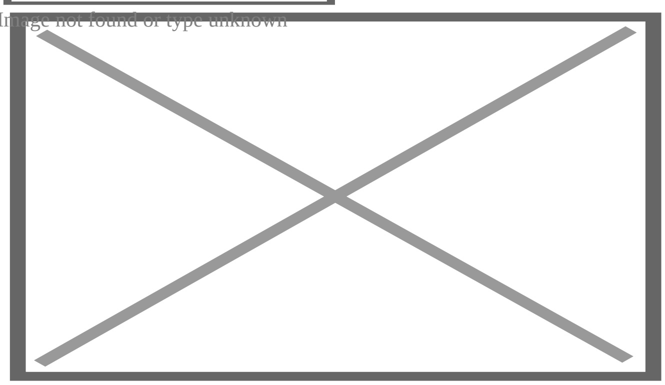


There are various types of air conditioners. Popular examples include: Window-mounted air conditioner (China, 2023); Ceiling-mounted cassette air conditioner (China, 2023); Wall-mounted air conditioner (Japan, 2020); Ceiling-mounted console (Also called ceiling suspended) air conditioner (China,

2023); and portable air conditioner
(Vatican City, 2018).

Air conditioning, often abbreviated as **A/C** (US) or **air con** (UK),[1] is the process of removing heat from an enclosed space to achieve a more comfortable interior temperature, and in some cases, also controlling the humidity of internal air. Air conditioning can be achieved using a mechanical 'air conditioner' or through other methods, such as passive cooling and ventilative cooling.[2][3] Air conditioning is a member of a family of systems and techniques that provide heating, ventilation, and air conditioning (HVAC).[4] Heat pumps are similar in many ways to air conditioners but use a reversing valve, allowing them to both heat and cool an enclosed space.[5]

Air conditioners, which typically use vapor-compression refrigeration, range in size from small units used in vehicles or single rooms to massive units that can cool large buildings.[6] Air source heat pumps, which can be used for heating as well as cooling, are becoming increasingly common in cooler climates.

Air conditioners can reduce mortality rates due to higher temperature.[7] According to the International Energy Agency (IEA) 1.6 billion air conditioning units were used globally in 2016.[8] The United Nations called for the technology to be made more sustainable to mitigate climate change and for the use of alternatives, like passive cooling, evaporative cooling, selective shading, windcatchers, and better thermal insulation.

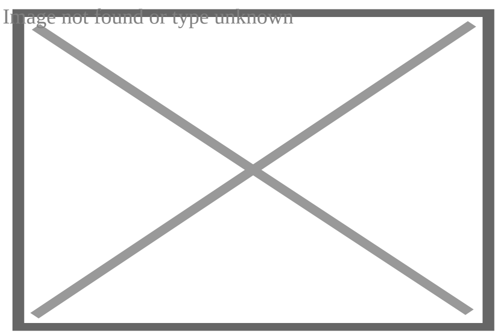
History

[edit]

Air conditioning dates back to prehistory.[9] Double-walled living quarters, with a gap between the two walls to encourage air flow, were found in the ancient city of Hamoukar, in modern Syria.[10] Ancient Egyptian buildings also used a wide variety of passive air-conditioning techniques.[11] These became widespread from the Iberian

Peninsula through North Africa, the Middle East, and Northern India.[12]

Passive techniques remained widespread until the 20th century when they fell out of fashion and were replaced by powered air conditioning. Using information from engineering studies of traditional buildings, passive techniques are being revived and modified for 21st-century architectural designs.[13][12]



An array of air conditioner condenser units outside a commercial office building

Air conditioners allow the building's indoor environment to remain relatively constant, largely independent of changes in external weather conditions and internal heat loads. They also enable deep plan buildings to be created and have allowed people to live comfortably in hotter parts of the world.[14]

Development

[edit]

Preceding discoveries

[edit]

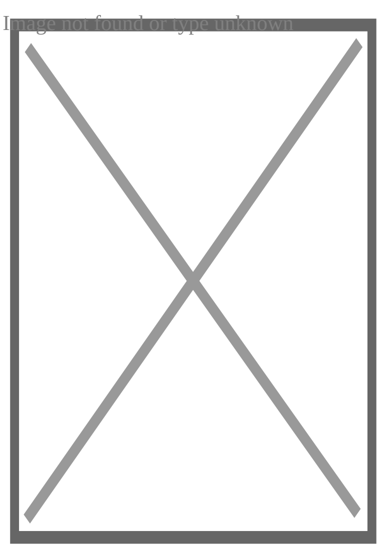
In 1558, Giambattista della Porta described a method of chilling ice to temperatures far below its freezing point by mixing it with potassium nitrate (then called "nitre") in his popular science book *Natural Magic*.[15][16][17] In 1620, Cornelis Drebbel demonstrated "Turning Summer into Winter" for James I of England, chilling part of the Great Hall of Westminster Abbey with an apparatus of troughs and vats.[18] Drebbel's contemporary Francis Bacon, like della Porta a believer in science communication, may not have been present at the demonstration, but in a book published later the same year, he described it as "experiment of artificial freezing" and said that "Nitre (or rather its spirit) is very cold, and hence nitre or salt when added to snow or ice intensifies the cold of the latter, the nitre by adding to its cold, but the salt by supplying activity to the cold of the snow."[15]

In 1758, Benjamin Franklin and John Hadley, a chemistry professor at the University of Cambridge, conducted experiments applying the principle of evaporation as a means to cool an object rapidly. Franklin and Hadley confirmed that the evaporation of highly volatile liquids (such as alcohol and ether) could be used to drive down the temperature of an object past the freezing point of water. They experimented with the bulb of a mercury-in-glass thermometer as their object. They used a bellows to speed up the evaporation. They lowered the temperature of the thermometer bulb down to −14 °C (7 °F) while the ambient temperature was 18 °C (64 °F). Franklin noted that soon after they passed the freezing point of water 0 °C (32 °F), a thin film of ice formed on the surface of the thermometer's bulb and that the ice mass was about 6 mm (1⁄4 in) thick when they stopped the experiment upon reaching −14 °C (7 °F). Franklin concluded: "From this experiment, one may see the possibility of freezing a man to death on a warm summer's day."[19]

The 19th century included many developments in compression technology. In 1820, English scientist and inventor Michael Faraday discovered that compressing and liquefying ammonia could chill air when the liquefied ammonia was allowed to evaporate.[20] In 1842, Florida physician John Gorrie used compressor technology to create ice, which he used to cool air for his patients in his hospital in Apalachicola, Florida. He hoped to eventually use his ice-making machine to regulate the temperature of buildings.[20][21] He envisioned centralized air conditioning that could cool entire cities. Gorrie was granted a patent in 1851,[22] but following the death of his main backer, he was not able to realize his invention.[23] In 1851, James Harrison created the first mechanical ice-making machine in Geelong, Australia, and was granted a patent for an ether vapor-compression refrigeration system in 1855 that produced three tons of ice per day.[24] In 1860, Harrison established a second ice company. He later entered the debate over competing against the American advantage of ice-refrigerated beef sales to the United Kingdom.[24]

First devices

[edit]



Willis Carrier, who is credited with building the first modern electrical air conditioning unit

Electricity made the development of effective units possible. In 1901, American inventor Willis H. Carrier built what is considered the first modern electrical air conditioning unit.[

25][26][27][28] In 1902, he installed his first air-conditioning system in the Sackett-Wilhelms Lithographing & Publishing Company in Brooklyn, New York.[29] His invention controlled both the temperature and humidity, which helped maintain consistent paper dimensions and ink alignment at the printing plant. Later, together with six other employees, Carrier formed The Carrier Air Conditioning Company of America, a business that in 2020, employed 53,000 people and was valued at $18.6 billion.[30][31]

In 1906, Stuart W. Cramer of Charlotte, North Carolina, was exploring ways to add moisture to the air in his textile mill. Cramer coined the term "air conditioning" in a patent claim which he filed that year, where he suggested that air conditioning was analogous to "water conditioning", then a well-known process for making textiles easier to process.[32] He combined moisture with ventilation to "condition" and change the air in the factories, thus controlling the humidity that is necessary in textile plants. Willis Carrier adopted the term and incorporated it into the name of his company.[33]

Domestic air conditioning soon took off. In 1914, the first domestic air conditioning was installed in Minneapolis in the home of Charles Gilbert Gates. It is, however, possible that the considerable device (c. 2.1 m × 1.8 m × 6.1 m; 7 ft × 6 ft × 20 ft) was never used, as the house remained uninhabited[20] (Gates had already died in October 1913.)

In 1931, H.H. Schultz and J.Q. Sherman developed what would become the most common type of individual room air conditioner: one designed to sit on a window ledge. The units went on sale in 1932 at US$10,000 to $50,000 (the equivalent of $200,000 to $1,200,000 in 2024.)[20] A year later, the first air conditioning systems for cars were offered for sale.[34] Chrysler Motors introduced the first practical semi-portable air conditioning unit in 1935,[35] and Packard became the first automobile manufacturer to offer an air conditioning unit in its cars in 1939.[36]

Further development

[edit]

Innovations in the latter half of the 20th century allowed more ubiquitous air conditioner use. In 1945, Robert Sherman of Lynn, Massachusetts, invented a portable, in-window air conditioner that cooled, heated, humidified, dehumidified, and filtered the air.[37] The first inverter air conditioners were released in 1980–1981.[38][39]

In 1954, Ned Cole, a 1939 architecture graduate from the University of Texas at Austin, developed the first experimental "suburb" with inbuilt air conditioning in each house. 22 homes were developed on a flat, treeless track in northwest Austin, Texas, and the community was christened the 'Austin Air-Conditioned Village.' The residents were subjected to a year-long study of the effects of air conditioning led by the nation's premier air conditioning companies, builders, and social scientists. In addition, researchers from UT's Health Service and Psychology Department studied the effects on the "artificially cooled humans." One of the more amusing discoveries was that each family reported being troubled with scorpions, the leading theory being that scorpions sought cool, shady places. Other reported changes in lifestyle were that mothers baked more, families ate heavier foods, and they were more apt to choose hot drinks.[40][41]

Air conditioner adoption tends to increase above around $10,000 annual household income in warmer areas.[42] Global GDP growth explains around 85% of increased air condition adoption by 2050, while the remaining 15% can be explained by climate change.[42]

As of 2016, an estimated 1.6 billion air conditioning units were used worldwide, with over half of them in China and the United States, and with a total cooling capacity of 11,675 gigawatts.[8][43] The International Energy Agency predicted in 2018 that the number of air conditioning units would grow to around 4 billion units by 2050 and that the total cooling capacity would grow to around 23,000 GW, with the biggest increases in India and China.[8] Between 1995 and 2004, the proportion of urban households in China with air conditioners increased from 8% to 70%.[44] As of 2015, nearly 100 million homes, or about 87% of US households, had air conditioning systems.[45] In 2019, it was estimated that 90% of new single-family homes constructed in the US included air conditioning, ranging from 99% in the South to 62% in the West.[46][47]

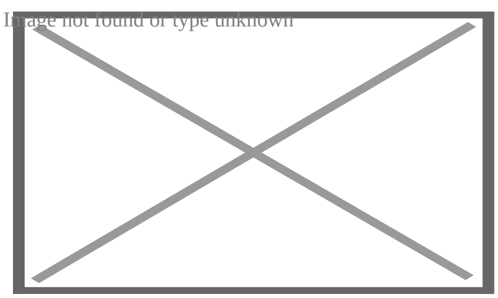
Operation

[edit]

Operating principles

[edit]

Main article: Vapor-compression refrigeration



A simple stylized diagram of the refrigeration cycle: 1) condensing coil, 2) expansion valve, 3) evaporator coil, 4) compressor

Cooling in traditional air conditioner systems is accomplished using the vapor-compression cycle, which uses a refrigerant's forced circulation and phase change between gas and liquid to transfer heat.[48][49] The vapor-compression cycle can occur within a unitary, or packaged piece of equipment, or within a chiller that is connected to terminal cooling equipment (such as a fan coil unit in an air handler) on its evaporator side and heat rejection equipment such as a cooling tower on its condenser side. An air source heat pump shares many components with an air conditioning system, but includes a reversing valve, which allows the unit to be used to heat as well as cool a space.[50]

Air conditioning equipment will reduce the absolute humidity of the air processed by the system if the surface of the evaporator coil is significantly cooler than the dew point of the surrounding air. An air conditioner designed for an occupied space will typically achieve a 30% to 60% relative humidity in the occupied space.[51]

Most modern air-conditioning systems feature a dehumidification cycle during which the compressor runs. At the same time, the fan is slowed to reduce the evaporator temperature and condense more water. A dehumidifier uses the same refrigeration cycle but incorporates both the evaporator and the condenser into the same air path; the air first passes over the evaporator coil, where it is cooled[52] and dehumidified, before passing over the condenser coil, where it is warmed again before it is released back into the room.[*citation needed*]

Free cooling can sometimes be selected when the external air is cooler than the internal air. In this case, the compressor does not need to be used, resulting in high cooling efficiencies for these times. This may also be combined with seasonal thermal energy storage.[53]

Heating

[edit]

Main article: Heat pump

Some air conditioning systems can reverse the refrigeration cycle and act as an air source heat pump, thus heating instead of cooling the indoor environment. They are also commonly referred to as "reverse cycle air conditioners". The heat pump is significantly more energy-efficient than electric resistance heating, because it moves energy from air or groundwater to the heated space and the heat from purchased electrical energy. When the heat pump is in heating mode, the indoor evaporator coil switches roles and becomes the condenser coil, producing heat. The outdoor condenser unit also switches roles to serve as the evaporator and discharges cold air (colder than the ambient outdoor air).

Most air source heat pumps become less efficient in outdoor temperatures lower than 4 °C or 40 °F.[54] This is partly because ice forms on the outdoor unit's heat exchanger coil, which blocks air flow over the coil. To compensate for this, the heat pump system must temporarily switch back into the regular air conditioning mode to switch the outdoor evaporator coil *back* to the condenser coil, to heat up and defrost. Therefore, some heat pump systems will have electric resistance heating in the indoor air path that is activated only in this mode to compensate for the temporary indoor air cooling, which would otherwise be uncomfortable in the winter.

Newer models have improved cold-weather performance, with efficient heating capacity down to -14 °F (-26 °C).[55][54][56] However, there is always a chance that the humidity that condenses on the heat exchanger of the outdoor unit could freeze, even in models that have improved cold-weather performance, requiring a defrosting cycle to be performed.

The icing problem becomes much more severe with lower outdoor temperatures, so heat pumps are sometimes installed in tandem with a more conventional form of heating, such as an electrical heater, a natural gas, heating oil, or wood-burning fireplace or central heating, which is used instead of or in addition to the heat pump during harsher winter temperatures. In this case, the heat pump is used efficiently during milder temperatures, and the system is switched to the conventional heat source when the outdoor temperature is lower.

Performance

[edit]

Main articles: coefficient of performance, Seasonal energy efficiency ratio, and European seasonal energy efficiency ratio

The coefficient of performance (COP) of an air conditioning system is a ratio of useful heating or cooling provided to the work required.[57][58] Higher COPs equate to lower operating costs. The COP usually exceeds 1; however, the exact value is highly dependent on operating conditions, especially absolute temperature and relative temperature between sink and system, and is often graphed or averaged against expected conditions.[59] Air conditioner equipment power in the U.S. is often described in terms of "tons of refrigeration", with each approximately equal to the cooling power of one short ton (2,000 pounds (910 kg) of ice melting in a 24-hour period. The value is equal to 12,000 BTU_{IT} per hour, or 3,517 watts.[60] Residential central air systems are usually from 1 to 5 tons (3.5 to 18 kW) in capacity.[*citation needed*]

The efficiency of air conditioners is often rated by the seasonal energy efficiency ratio (SEER), which is defined by the Air Conditioning, Heating and Refrigeration Institute in its 2008 standard AHRI 210/240, *Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment*.[61] A similar standard is the European seasonal energy efficiency ratio (ESEER).[*citation needed*]

Efficiency is strongly affected by the humidity of the air to be cooled. Dehumidifying the air before attempting to cool it can reduce subsequent cooling costs by as much as 90 percent. Thus, reducing dehumidifying costs can materially affect overall air conditioning costs.[62]

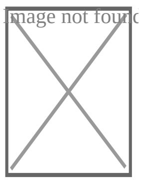
Control system

[edit]

Wireless remote control

[edit]

Main articles: Remote control and Infrared blaster

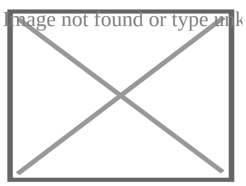


A

wireless

remote

controller

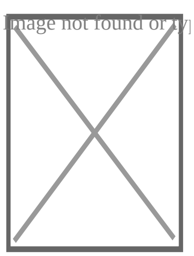


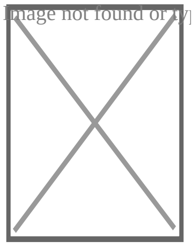
The infrared

transmitting

LED on the

remote





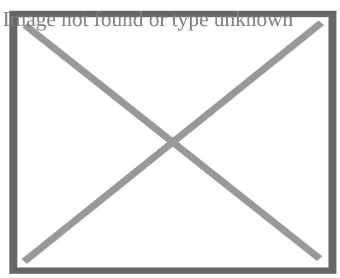
The infrared receiver
on the air conditioner

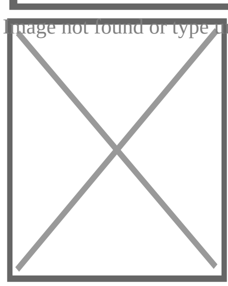
This type of controller uses an infrared LED to relay commands from a remote control to the air conditioner. The output of the infrared LED (like that of any infrared remote) is invisible to the human eye because its wavelength is beyond the range of visible light (940 nm). This system is commonly used on mini-split air conditioners because it is simple and portable. Some window and ducted central air conditioners uses it as well.

Wired controller

[edit]

Main article: Thermostat





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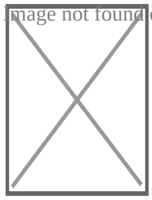

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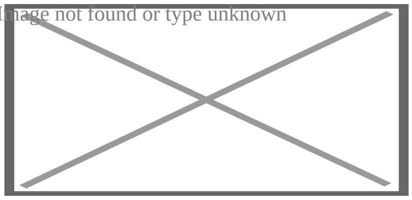


Several wired controllers
(Indonesia, 2024)

A wired controller, also called a "wired thermostat," is a device that controls an air conditioner by switching heating or cooling on or off. It uses different sensors to measure temperatures and actuate control operations. Mechanical thermostats commonly use bimetallic strips, converting a temperature change into mechanical displacement, to actuate control of the air conditioner. Electronic thermostats, instead, use a thermistor or other semiconductor sensor, processing temperature change as electronic signals to control the air conditioner.

These controllers are usually used in hotel rooms because they are permanently installed into a wall and hard-wired directly into the air conditioner unit, eliminating the need for batteries.

Types

[edit]

Types	Typical Capacity*	Air supply	Mounting	Typical application
Mini-split	small – large	Direct	Wall	Residential

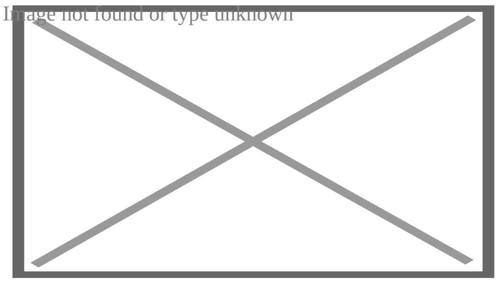
Window	very small – small	Direct	Window	Residential
Portable	very small – small	Direct / Ducted	Floor	Residential, remote areas
Ducted (individual)	small – very large	Ducted	Ceiling	Residential, commercial
Ducted (central)	medium – very large	Ducted	Ceiling	Residential, commercial
Ceiling suspended	medium – large	Direct	Ceiling	Commercial
Cassette	medium – large	Direct / Ducted	Ceiling	Commercial
Floor standing	medium – large	Direct / Ducted	Floor	Commercial
Packaged	very large	Direct / Ducted	Floor	Commercial
Packaged RTU (Rooftop Unit)	very large	Ducted	Rooftop	Commercial

* where the typical capacity is in kilowatt as follows:

- very small: <1.5 kW
- small: 1.5–3.5 kW
- medium: 4.2–7.1 kW
- large: 7.2–14 kW
- very large: >14 kW

Mini-split and multi-split systems

[edit]



Evaporator, indoor unit, or terminal, side of a ductless split-type air conditioner

Ductless systems (often mini-split, though there are now ducted mini-split) typically supply conditioned and heated air to a single or a few rooms of a building, without ducts and in a decentralized manner.[63] Multi-zone or multi-split systems are a common application of ductless systems and allow up to eight rooms (zones or locations) to be conditioned independently from each other, each with its indoor unit and simultaneously from a single outdoor unit.

The first mini-split system was sold in 1961 by Toshiba in Japan, and the first wall-mounted mini-split air conditioner was sold in 1968 in Japan by Mitsubishi Electric, where small home sizes motivated their development. The Mitsubishi model was the first air conditioner with a cross-flow fan.[64][65][66] In 1969, the first mini-split air conditioner was sold in the US.[67] Multi-zone ductless systems were invented by Daikin in 1973, and variable refrigerant flow systems (which can be thought of as larger multi-split systems) were also invented by Daikin in 1982. Both were first sold in Japan.[68] Variable refrigerant flow systems when compared with central plant cooling from an air handler, eliminate the need for large cool air ducts, air handlers, and chillers; instead cool refrigerant is transported through much smaller pipes to the indoor units in the spaces to be conditioned, thus allowing for less space above dropped ceilings and a lower structural impact, while also allowing for more individual and independent temperature control of spaces. The outdoor and indoor units can be spread across the building.[69] Variable refrigerant flow indoor units can also be turned off individually in unused spaces.[*citation needed*] The lower start-up power of VRF's DC inverter compressors and their inherent DC power requirements also allow VRF solar-powered heat pumps to be run using DC-providing solar panels.

Ducted central systems

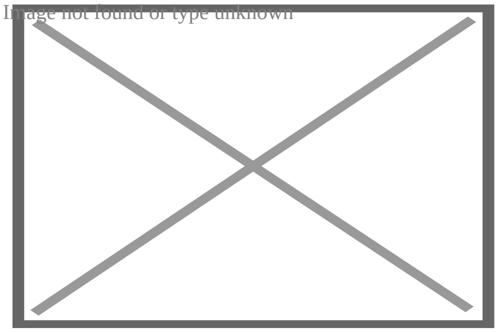
[edit]

Split-system central air conditioners consist of two heat exchangers, an outside unit (the condenser) from which heat is rejected to the environment and an internal heat exchanger (the evaporator, or Fan Coil Unit, FCU) with the piped refrigerant being circulated between the two. The FCU is then connected to the spaces to be cooled by ventilation ducts.[70] Floor standing air conditioners are similar to this type of air conditioner but sit within spaces that need cooling.

Central plant cooling

[edit]

See also: Chiller



Industrial air conditioner cooling towers on top of the shopping mall *Passage* in Linz, Austria

Large central cooling plants may use intermediate coolant such as chilled water pumped into air handlers or fan coil units near or in the spaces to be cooled which then duct or deliver cold air into the spaces to be conditioned, rather than ducting cold air directly to these spaces from the plant, which is not done due to the low density and heat capacity of air, which would require impractically large ducts. The chilled water is cooled by chillers in the plant, which uses a refrigeration cycle to cool water, often transferring its heat to the atmosphere even in liquid-cooled chillers through the use of cooling towers. Chillers may be air- or liquid-cooled.[71][72]

Portable units

[edit]

A portable system has an indoor unit on wheels connected to an outdoor unit via flexible pipes, similar to a permanently fixed installed unit (such as a ductless split air conditioner).

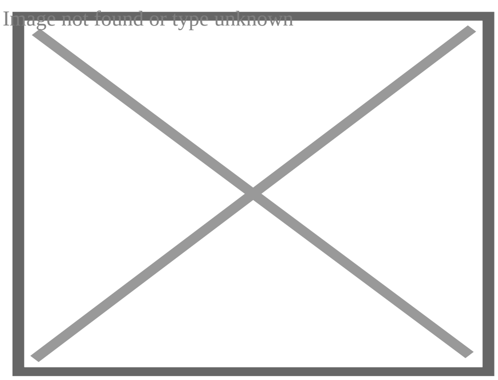
Hose systems, which can be *monoblock* or *air-to-air*, are vented to the outside via air ducts. The *monoblock* type collects the water in a bucket or tray and stops when full. The *air-to-air* type re-evaporates the water, discharges it through the ducted hose, and can run continuously. Many but not all portable units draw indoor air and expel it outdoors through a single duct, negatively impacting their overall cooling efficiency.

Many portable air conditioners come with heat as well as a dehumidification function.[73]

Window unit and packaged terminal

[edit]

Main article: Packaged terminal air conditioner



Through-the-wall PTAC units, University Motor Inn, Philadelphia

The packaged terminal air conditioner (PTAC), through-the-wall, and window air conditioners are similar. These units are installed on a window frame or on a wall opening. The unit usually has an internal partition separating its indoor and outdoor sides, which contain the unit's condenser and evaporator, respectively. PTAC systems may be adapted to provide heating in cold weather, either directly by using an electric strip, gas, or other heaters, or by reversing the refrigerant flow to heat the interior and draw heat from the exterior air, converting the air conditioner into a heat pump. They may be installed in a wall opening with the help of a special sleeve on the wall and a custom grill that is flush with the wall and window air conditioners can also be installed in a window, but without a custom grill.[74]

Packaged air conditioner

[edit]

Packaged air conditioners (also known as self-contained units)[75][76] are central systems that integrate into a single housing all the components of a split central system, and deliver air, possibly through ducts, to the spaces to be cooled. Depending on their construction they may be outdoors or indoors, on roofs (rooftop units),[77][78] draw the air to be conditioned from inside or outside a building and be water or air-cooled. Often, outdoor units are air-cooled while indoor units are liquid-cooled using a cooling tower.[70][79][80][81][82][83]

Types of compressors

[edit]

Compressor types	Common applications	Typical capacity	Efficiency	Durability	Repairability
Reciprocating	Refrigerator, Walk-in freezer, portable air conditioners	small – large	very low (small capacity) medium (large capacity)	very low	medium
Rotary vane	Residential mini splits	small	low	low	easy

Scroll	Commercial and central systems, VRF	medium	medium	medium	easy
Rotary screw	Commercial chiller	medium – large	medium	medium	hard
Centrifugal	Commercial chiller	very large	medium	high	hard
Maglev Centrifugal	Commercial chiller	very large	high	very high	very hard

Reciprocating

[edit]

Main article: Reciprocating compressor

This compressor consists of a crankcase, crankshaft, piston rod, piston, piston ring, cylinder head and valves. [*citation needed*]

Scroll

[edit]

Main article: Scroll compressor

This compressor uses two interleaving scrolls to compress the refrigerant.[84] it consists of one fixed and one orbiting scrolls. This type of compressor is more efficient because it has 70 percent less moving parts than a reciprocating compressor. [*citation needed*

Screw

[edit]

Main article: Rotary-screw compressor

This compressor use two very closely meshing spiral rotors to compress the gas. The gas enters at the suction side and moves through the threads as the screws rotate. The meshing rotors force the gas through the compressor, and the gas exits at the end of the screws. The working area is the inter-lobe volume between the male and female rotors. It is larger at the intake end, and decreases along the length of the rotors until the exhaust port. This change in volume is the compression. [*citation needed*]

Capacity modulation technologies

[edit]

There are several ways to modulate the cooling capacity in refrigeration or air conditioning and heating systems. The most common in air conditioning are: on-off cycling, hot gas bypass, use or not of liquid injection, manifold configurations of multiple compressors, mechanical modulation (also called digital), and inverter technology. [*citation ne*

Hot gas bypass

[edit]

Hot gas bypass involves injecting a quantity of gas from discharge to the suction side. The compressor will keep operating at the same speed, but due to the bypass, the refrigerant mass flow circulating with the system is reduced, and thus the cooling capacity. This naturally causes the compressor to run uselessly during the periods when the bypass is operating. The turn down capacity varies between 0 and 100%.[85]

Manifold configurations

[edit]

Several compressors can be installed in the system to provide the peak cooling capacity. Each compressor can run or not in order to stage the cooling capacity of the unit. The turn down capacity is either 0/33/66 or 100% for a trio configuration and either 0/50 or 100% for a tandem.[*citation needed*]

Mechanically modulated compressor

[edit]

This internal mechanical capacity modulation is based on periodic compression process with a control valve, the two scroll set move apart stopping the compression for a given time period. This method varies refrigerant flow by changing the average time of compression, but not the actual speed of the motor. Despite an excellent turndown ratio – from 10 to 100% of the cooling capacity, mechanically modulated scrolls have high energy consumption as the motor continuously runs.[*citation needed*]

Variable-speed compressor

[edit]

Main article: Inverter compressor

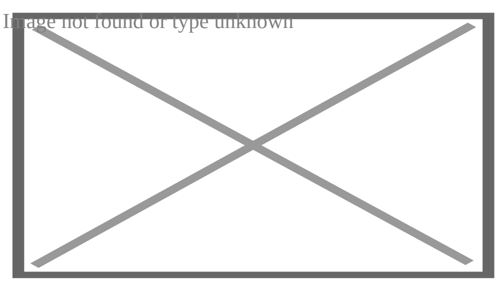
This system uses a variable-frequency drive (also called an Inverter) to control the speed of the compressor. The refrigerant flow rate is changed by the change in the speed of the compressor. The turn down ratio depends on the system configuration and manufacturer. It modulates from 15 or 25% up to 100% at full capacity with a single inverter from 12 to 100% with a hybrid tandem. This method is the most efficient way to modulate an air conditioner's capacity. It is up to 58% more efficient than a fixed speed system.[*citation needed*]

Impact

[edit]

Health effects

[edit]



Rooftop condenser unit fitted on top of an Osaka Municipal Subway 10 series subway carriage. Air conditioning has become increasingly prevalent on public transport vehicles as a form of climate control, and to ensure passenger comfort and drivers' occupational safety and health.

In hot weather, air conditioning can prevent heat stroke, dehydration due to excessive sweating, electrolyte imbalance, kidney failure, and other issues due to hyperthermia.[8][86] Heat waves are the most lethal type of weather phenomenon in the United States.[87][88] A 2020 study found that areas with lower use of air conditioning correlated with higher rates of heat-related mortality and hospitalizations.[89] The August 2003 France heatwave resulted in approximately 15,000 deaths, where 80% of the victims were over 75 years old. In response, the French government required all retirement homes to have at least one air-conditioned room at 25 °C (77 °F) per floor during heatwaves.[8]

Air conditioning (including filtration, humidification, cooling and disinfection) can be used to provide a clean, safe, hypoallergenic atmosphere in hospital operating rooms and other environments where proper atmosphere is critical to patient safety and well-being. It is sometimes recommended for home use by people with allergies, especially mold.[90][91] However, poorly maintained water cooling towers can promote the growth and spread of microorganisms such as *Legionella pneumophila*, the infectious agent responsible for Legionnaires' disease. As long as the cooling tower is kept clean (usually by means of a chlorine treatment), these health hazards can be avoided or reduced. The state of New York has codified requirements for registration, maintenance, and testing of cooling towers to protect against Legionella.[92]

Economic effects

[edit]

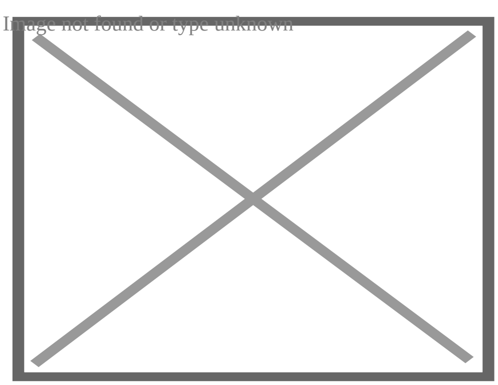
First designed to benefit targeted industries such as the press as well as large factories, the invention quickly spread to public agencies and administrations with studies with claims of increased productivity close to 24% in places equipped with air conditioning.[93]

Air conditioning caused various shifts in demography, notably that of the United States starting from the 1970s. In the US, the birth rate was lower in the spring than during other seasons until the 1970s but this difference then declined since then.[94] As of 2007, the Sun Belt contained 30% of the total US population while it was inhabited by 24% of Americans at the beginning of the 20th century.[95] Moreover, the summer mortality rate in the US, which had been higher in regions subject to a heat wave during the summer, also evened out.[7]

The spread of the use of air conditioning acts as a main driver for the growth of global demand of electricity.[96] According to a 2018 report from the International Energy Agency (IEA), it was revealed that the energy consumption for cooling in the United States, involving 328 million Americans, surpasses the combined energy consumption of 4.4 billion people in Africa, Latin America, the Middle East, and Asia (excluding China).[8] A 2020 survey found that an estimated 88% of all US households use AC, increasing to 93% when solely looking at homes built between 2010 and 2020.[97]

Environmental effects

[edit]



Air conditioner farm in the facade of a building in Singapore

Air conditioning uses a massive amount of energy, leading to more carbon emissions. Space cooling including air conditioning accounted globally for 2021 terawatt-hours of energy usage in 2016 with around 99% in the form of electricity, according to a 2018 report on air-conditioning efficiency by the International Energy Agency.[8] The report predicts an increase of electricity usage due to space cooling to around 6200 TWh by 2050,[8][98] and that with the progress currently seen, greenhouse gas emissions attributable to space cooling will double from 1,135 million tons (2016) to 2,070 million tons.[8] There is some push to increase the energy efficiency of air conditioners. United Nations Environment Programme (UNEP) and the IEA found that if air conditioners could be twice as effective as now, 460 billion tons of GHG could be cut over 40 years.[99] The UNEP and IEA also recommended legislation to decrease the use of hydrofluorocarbons, better building insulation, and more sustainable temperature-controlled food supply chains going forward.[99]

Refrigerants have also caused and continue to cause serious environmental issues, including ozone depletion and climate change, as several countries have not yet ratified the Kigali Amendment to reduce the consumption and production of hydrofluorocarbons.[100] CFCs and HCFCs refrigerants such as R-12 and R-22, respectively, used within air conditioners have caused damage to the ozone layer,[101] and hydrofluorocarbon refrigerants such as R-410A and R-404A, which were designed to replace CFCs and HCFCs, are instead exacerbating climate change.[102] Both issues happen due to the venting of refrigerant to the atmosphere, such as during repairs. HFO refrigerants, used in some if not most new equipment, solve both issues with an ozone damage potential (ODP) of zero and a much lower global warming potential (GWP) in the single or double digits vs. the three or four digits of hydrofluorocarbons.[103]

Hydrofluorocarbons would have raised global temperatures by around 0.3–0.5 °C (0.5–0.9 °F) by 2100 without the Kigali Amendment. With the Kigali Amendment, the increase of global temperatures by 2100 due to hydrofluorocarbons is predicted to be around 0.06 °C (0.1 °F).[104]

Alternatives to continual air conditioning include passive cooling, passive solar cooling, natural ventilation, operating shades to reduce solar gain, using trees, architectural shades, windows (and using window coatings) to reduce solar gain.[*citation needed*]

Social effects

[edit]

Socioeconomic groups with a household income below around $10,000 tend to have a low air conditioning adoption,[42] which worsens heat-related mortality.[7] The lack of cooling can be hazardous, as areas with lower use of air conditioning correlate with higher rates of heat-related mortality and hospitalizations.[89] Premature mortality in NYC is projected to grow between 47% and 95% in 30 years, with lower-income and vulnerable populations most at risk.[89] Studies on the correlation between heat-related mortality and hospitalizations and living in low socioeconomic locations can be traced in Phoenix, Arizona,[105] Hong Kong,[106] China,[106] Japan,[107] and Italy.[108][109] Additionally, costs concerning health care can act as another barrier, as the lack of private health insurance during a 2009 heat wave in Australia, was associated with heat-related hospitalization.[109]

Disparities in socioeconomic status and access to air conditioning are connected by some to institutionalized racism, which leads to the association of specific marginalized communities with lower economic status, poorer health, residing in hotter neighborhoods, engaging in physically demanding labor, and experiencing limited access to cooling technologies such as air conditioning.[109] A study overlooking Chicago, Illinois, Detroit, and Michigan found that black households were half as likely to have central air conditioning units when compared to their white counterparts.[110] Especially in cities, Redlining creates heat islands, increasing temperatures in certain parts of the city.[109] This is due to materials heat-absorbing building materials and pavements and lack of vegetation and shade coverage.[111] There have been initiatives that provide cooling solutions to low-income communities, such as public cooling spaces.[8][111]

Other techniques

[edit]

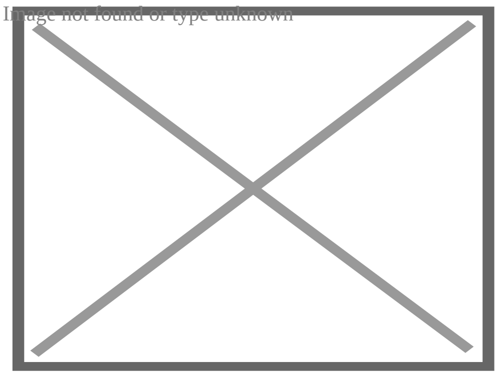
Buildings designed with passive air conditioning are generally less expensive to construct and maintain than buildings with conventional HVAC systems with lower energy demands.[112] While tens of air changes per hour, and cooling of tens of degrees, can be achieved with passive methods, site-specific microclimate must be taken into account, complicating building design.[12]

Many techniques can be used to increase comfort and reduce the temperature in buildings. These include evaporative cooling, selective shading, wind, thermal convection, and heat storage.[113]

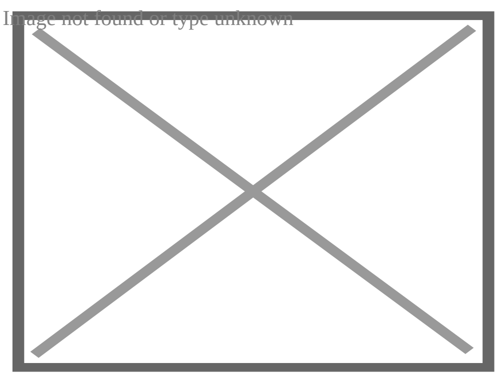
Passive ventilation

[edit]

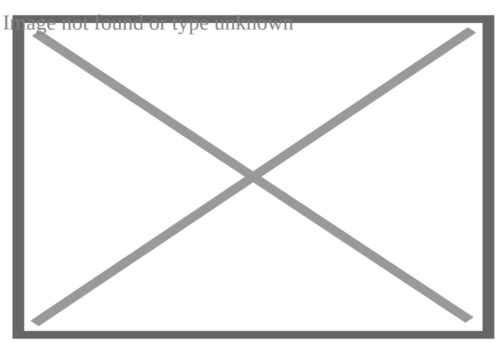
This section is an excerpt from Passive ventilation.[edit]



The ventilation system of a regular earthship



Dogtrot houses are designed to maximise natural ventilation.



A roof turbine ventilator, colloquially known as a 'Whirly Bird', is an application of wind driven ventilation.

Passive ventilation is the process of supplying air to and removing air from an indoor space without using mechanical systems. It refers to the flow of external air to an indoor space as a result of pressure differences arising from natural forces.

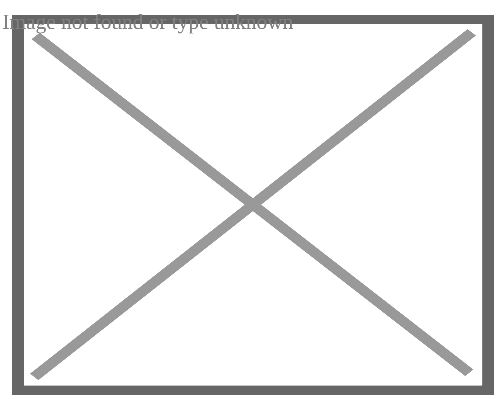
There are two types of natural ventilation occurring in buildings: *wind driven ventilation* and *buoyancy-driven ventilation*. Wind driven ventilation arises from the different pressures

created by wind around a building or structure, and openings being formed on the perimeter which then permit flow through the building. Buoyancy-driven ventilation occurs as a result of the directional buoyancy force that results from temperature differences between the interior and exterior.[114]
Since the internal heat gains which create temperature differences between the interior and exterior are created by natural processes, including the heat from people, and wind effects are variable, naturally ventilated buildings are sometimes called "breathing buildings".

Passive cooling

[edit]

This section is an excerpt from Passive cooling.[edit]

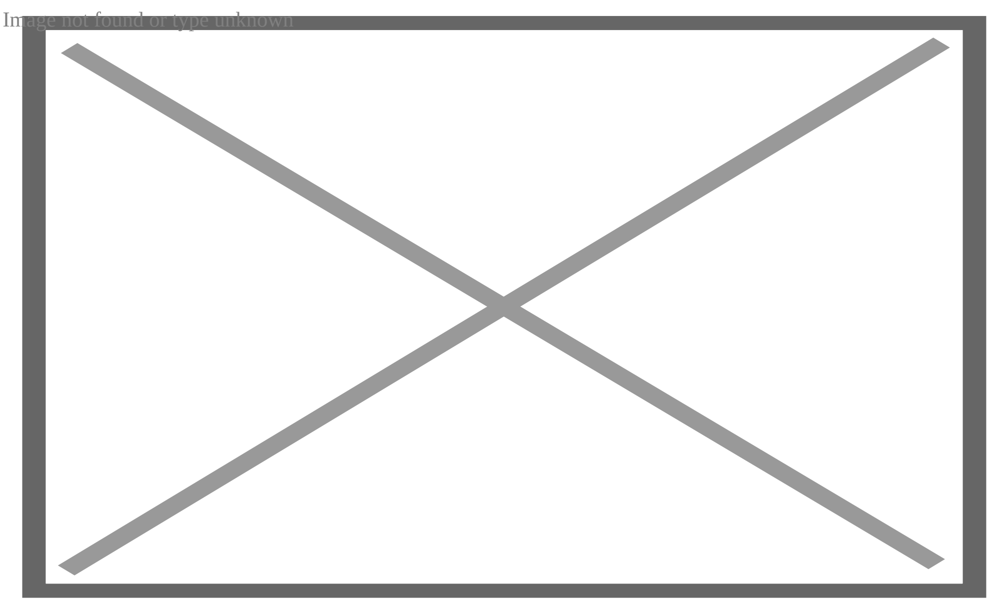


A traditional Iranian solar cooling design using a wind tower

Passive cooling is a building design approach that focuses on heat gain control and heat dissipation in a building in order to improve the indoor thermal comfort with low or no energy consumption.[115][116] This approach works either by preventing heat from entering the interior (heat gain prevention) or by removing heat from the building (natural cooling).[117]

Natural cooling utilizes on-site energy, available from the natural environment, combined with the architectural design of building components (e.g. building envelope), rather than mechanical systems to dissipate heat.[118] Therefore, natural cooling depends not only on the architectural design of the building but on how the site's natural resources are used as heat sinks (i.e. everything that absorbs or dissipates heat). Examples of on-site heat sinks are the upper atmosphere (night sky), the outdoor air (wind), and the earth/soil.

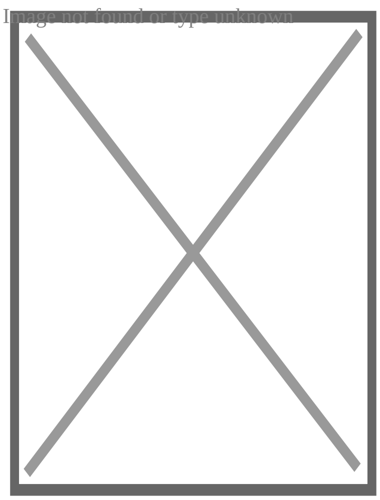
Passive cooling is an important tool for design of buildings for climate change adaptation – reducing dependency on energy-intensive air conditioning in warming environments.[119][120]



A pair of short windcatchers (*malqaf*) used in traditional architecture; wind is forced down on the windward side and leaves on the leeward side (*cross-ventilation*). In the absence of wind, the circulation can be driven with evaporative cooling in the inlet (which is also designed to catch dust). In the center, a *shuksheika* (roof lantern vent), used to shade the qa'a below while allowing hot air rise out of it (*stack effect*).[11]

Daytime radiative cooling

[edit]



Passive daytime radiative cooling (PDRC) surfaces are high in solar reflectance and heat emittance, cooling with zero energy use or pollution.[121]

Passive daytime radiative cooling (PDRC) surfaces reflect incoming solar radiation and heat back into outer space through the infrared window for cooling during the daytime. Daytime radiative cooling became possible with the ability to suppress solar heating using photonic structures, which emerged through a study by Raman et al. (2014).[122] PDRCs can come in a variety of forms, including paint coatings and films, that are designed to be high in solar reflectance and thermal emittance.[121][123]

PDRC applications on building roofs and envelopes have demonstrated significant decreases in energy consumption and costs.[123] In suburban single-family residential areas, PDRC application on roofs can potentially lower energy costs by 26% to 46%.[124] PDRCs are predicted to show a market size of ~$27 billion for indoor space cooling by 2025 and have undergone a surge in research and development since the 2010s.[125][126]

Fans

[edit]

Main article: Ceiling fan

Hand fans have existed since prehistory. Large human-powered fans built into buildings include the punkah.

The 2nd-century Chinese inventor Ding Huan of the Han dynasty invented a rotary fan for air conditioning, with seven wheels 3 m (10 ft) in diameter and manually powered by prisoners.[127]:â€99,â€151,â€233 In 747, Emperor Xuanzong (r. 712–762) of the Tang dynasty (618–907) had the Cool Hall (*Liang Dian* æ¶¼æ®¿) built in the imperial palace, which the *Tang Yulin* describes as having water-powered fan wheels for air conditioning as well as rising jet streams of water from fountains. During the subsequent Song dynasty (960–1279), written sources mentioned the air conditioning rotary fan as even more widely used.[127]:â€134,â€151â€

Thermal buffering

[edit]

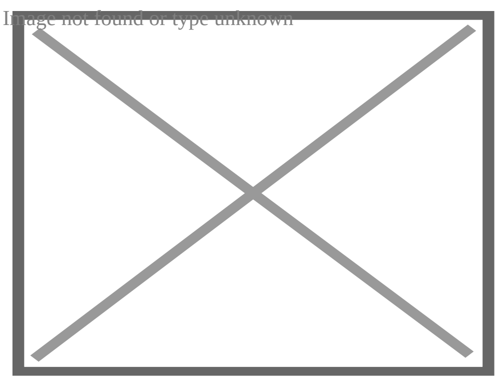
In areas that are cold at night or in winter, heat storage is used. Heat may be stored in earth or masonry; air is drawn past the masonry to heat or cool it.[13]

In areas that are below freezing at night in winter, snow and ice can be collected and stored in ice houses for later use in cooling.[13] This technique is over 3,700 years old in the Middle East.[128] Harvesting outdoor ice during winter and transporting and storing for use in summer was practiced by wealthy Europeans in the early 1600s,[15] and became popular in Europe and the Americas towards the end of the 1600s.[129] This practice was replaced by mechanical compression-cycle icemakers.

Evaporative cooling

[edit]

Main article: Evaporative cooler



An evaporative cooler

In dry, hot climates, the evaporative cooling effect may be used by placing water at the air intake, such that the draft draws air over water and then into the house. For this reason, it is sometimes said that the fountain, in the architecture of hot, arid climates, is like the fireplace in the architecture of cold climates.[11] Evaporative cooling also makes the air more humid, which can be beneficial in a dry desert climate.[130]

Evaporative coolers tend to feel as if they are not working during times of high humidity, when there is not much dry air with which the coolers can work to make the air as cool as possible for dwelling occupants. Unlike other types of air conditioners, evaporative coolers rely on the outside air to be channeled through cooler pads that cool the air before it reaches the inside of a house through its air duct system; this cooled outside air must be allowed to push the warmer air within the house out through an exhaust opening such as an open door or window.[131]

See also

[edit]

- Air conditioning paradox
- Air filter
- Air purifier
- Cleanroom
- Crankcase heater
- Energy recovery ventilation
- Indoor air quality
- Particulates

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Look up ***Cassette air conditioner*** in Wiktionary, the free dictionary.

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Wikiversity has learning resources about ***Refrigeration and air conditioning***

- U.S. patent 808,897 Carrier's original patent
- U.S. patent 1,172,429
- U.S. patent 2,363,294
- *Scientific American*, "Artificial Cold", 28 August 1880, p. 138
- *Scientific American*, "The Presidential Cold Air Machine", 6 August 1881, p. 84

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Heating, ventilation, and air conditioning

Fundamental concepts

- Air changes per hour (ACH)
- Bake-out
- Building envelope
- Convection
- Dilution
- Domestic energy consumption
- Enthalpy
- Fluid dynamics
- Gas compressor
- Heat pump and refrigeration cycle
- Heat transfer
- Humidity
- Infiltration
- Latent heat
- Noise control
- Outgassing
- Particulates
- Psychrometrics
- Sensible heat
- Stack effect
- Thermal comfort
- Thermal destratification
- Thermal mass
- Thermodynamics
- Vapour pressure of water

- Absorption-compression heat pump
- Absorption refrigerator
- Air barrier
- Air conditioning
- Antifreeze
- Automobile air conditioning
- Autonomous building
- Building insulation materials
- Central heating
- Central solar heating
- Chilled beam
- Chilled water
- Constant air volume (CAV)
- Coolant
- Cross ventilation
- Dedicated outdoor air system (DOAS)
- Deep water source cooling
- Demand controlled ventilation (DCV)
- Displacement ventilation
- District cooling
- District heating
- Electric heating
- Energy recovery ventilation (ERV)
- Firestop
- Forced-air
- Forced-air gas
- Free cooling
- Heat recovery ventilation (HRV)
- Hybrid heat

Technology

- Hydronics

- Air conditioner inverter
- Air door
- Air filter
- Air handler
- Air ionizer
- Air-mixing plenum
- Air purifier
- Air source heat pump
- Attic fan
- Automatic balancing valve
- Back boiler
- Barrier pipe
- Blast damper
- Boiler
- Centrifugal fan
- Ceramic heater
- Chiller
- Condensate pump
- Condenser
- Condensing boiler
- Convection heater
- Compressor
- Cooling tower
- Damper
- Dehumidifier
- Duct
- Economizer
- Electrostatic precipitator
- Evaporative cooler
- Evaporator

Measurement and control

- Air flow meter
- Aquastat
- BACnet
- Blower door
- Building automation
- Carbon dioxide sensor
- Clean air delivery rate (CADR)
- Control valve
- Gas detector
- Home energy monitor
- Humidistat
- HVAC control system
- Infrared thermometer
- Intelligent buildings
- LonWorks
- Minimum efficiency reporting value (MERV)
- Normal temperature and pressure (NTP)
- OpenTherm
- Programmable communicating thermostat
- Programmable thermostat
- Psychrometrics
- Room temperature
- Smart thermostat
- Standard temperature and pressure (STP)
- Thermographic camera
- Thermostat
- Thermostatic radiator valve

Professions, trades, and services	○ Architectural acoustics ○ Architectural engineering ○ Architectural technologist ○ Building services engineering ○ Building information modeling (BIM) ○ Deep energy retrofit ○ Duct cleaning ○ Duct leakage testing ○ Environmental engineering ○ Hydronic balancing ○ Kitchen exhaust cleaning ○ Mechanical engineering ○ Mechanical, electrical, and plumbing ○ Mold growth, assessment, and remediation ○ Refrigerant reclamation ○ Testing, adjusting, balancing

Industry organizations	◦ AHRI ◦ AMCA ◦ ASHRAE ◦ ASTM International ◦ BRE ◦ BSRIA ◦ CIBSE ◦ Institute of Refrigeration ◦ IIR ◦ LEED ◦ SMACNA ◦ UMC
Health and safety	◦ Indoor air quality (IAQ) ◦ Passive smoking ◦ Sick building syndrome (SBS) ◦ Volatile organic compound (VOC)
See also	◦ ASHRAE Handbook ◦ Building science ◦ Fireproofing ◦ Glossary of HVAC terms ◦ Warm Spaces ◦ World Refrigeration Day ◦ Template:Fire protection ◦ Template:Home automation ◦ Template:Solar energy

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Home appliances

- Air conditioner
- Air fryer
- Air ioniser
- Air purifier
- Barbecue grill
- Blender
    - Immersion blender
- Bread machine
- Bug zapper
- Coffee percolator
- Clothes dryer
    - combo
- Clothes iron
- Coffeemaker
- Dehumidifier
- Dishwasher
    - drying cabinet
- Domestic robot
- Deep fryer
- Electric blanket
- Electric drill
- Electric kettle
- Electric knife
- Electric water boiler
- Electric heater
- Electric shaver
- Electric toothbrush
- Epilator
- Espresso machine
- Evaporative cooler

See also

- Appliance plug
- Appliance recycling

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Roofs

Roof shapes	- Arched roof - Barrel roof - Board roof - Bochka roof - Bow roof - Butterfly roof - Clerestory - Conical roof - Dome - Flat roof - Gable roof - Gablet roof - Gambrel roof - Half-hipped roof - Hip roof - Onion dome - Mansard roof - Pavilion roof - Rhombic roof - Ridged roof - Saddle roof - Sawtooth roof - Shed roof - Tented roof	Cross-gabled roof Image not found or type unknown

Roof elements

- Air conditioning unit
- Attic
- Catslide
- Chimney
- Collar beam
- Dormer
- Eaves
- Flashing
- Gable
- Green roof
- Gutter
- Hanging beam
- Joist
- Lightning rod
- Loft
- Purlin
- Rafter
- Ridge vent
- Roof batten
- Roof garden
- Roofline
- Roof ridge
- Roof sheeting
- Roof tiles
- Roof truss
- Roof window
- Shingles
- Skylight
- Soffit
- Solar panels

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Electronics

Branches	◦ Analogue electronics ◦ Digital electronics ◦ Electronic engineering ◦ Instrumentation ◦ Microelectronics ◦ Optoelectronics ◦ Power electronics ◦ Printed electronics ◦ Semiconductor ◦ Schematic capture ◦ Thermal management

Advanced topics	◦ 2020s in computing ◦ Atomtronics ◦ Bioelectronics ◦ List of emerging electronics ◦ Failure of electronic components ◦ Flexible electronics ◦ Low-power electronics ◦ Molecular electronics ◦ Nanoelectronics ◦ Organic electronics ◦ Photonics ◦ Piezotronics ◦ Quantum electronics ◦ Spintronics

Electronic equipment	◦ Air conditioner ◦ Central heating ◦ Clothes dryer ◦ Computer/Notebook ◦ Camera ◦ Dishwasher ◦ Freezer ◦ Home robot ◦ Home cinema ◦ Home theater PC ◦ Information technology ◦ Cooker ◦ Microwave oven ◦ Mobile phone ◦ Networking hardware ◦ Portable media player ◦ Radio ◦ Refrigerator ◦ Robotic vacuum cleaner ◦ Tablet ◦ Telephone ◦ Television ◦ Water heater ◦ Video game console ◦ Washing machine

- Audio equipment
- Automotive electronics
- Avionics
- Control system
- Data acquisition
- e-book
- e-health
- Electromagnetic warfare
- Electronics industry
- Embedded system
- Home appliance
- Home automation
- Integrated circuit

Applications

- Home appliance
  - Consumer electronics
  - Major appliance
  - Small appliance
- Marine electronics
- Microwave technology
- Military electronics
- Multimedia
- Nuclear electronics
- Open-source hardware
- Radar and Radio navigation
- Radio electronics
- Terahertz technology
- Wired and Wireless Communications

Authority control databases: National

- Germany
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About hygiene

Hygiene is a set of techniques done to preserve wellness. According to the World Health And Wellness Organization (WHO), "Hygiene describes problems and techniques that help to preserve health and wellness and prevent the spread of diseases." Individual hygiene refers to maintaining the body's sanitation. Health tasks can be organized into the following: home and everyday health, personal hygiene, clinical hygiene, sleep hygiene, and food hygiene. Home and daily health consists of hand cleaning, respiratory health, food hygiene in the house, hygiene in the cooking area, health in the shower room, washing hygiene, and medical hygiene at home. And additionally environmental health in the society to avoid all kinds of bacterias from penetrating right into our homes. Many people equate health with "tidiness", yet health is a broad term. It consists of such individual habit selections as just how often to shower or bathroom, wash hands, trim finger nails, and clean clothes. It additionally consists of interest to keeping surfaces in the home and work environment tidy, including restroom facilities. Adherence to normal hygiene practices is typically considered as a socially responsible and decent habits, while ignoring proper hygiene can be regarded as dirty or unsanitary, and may be taken into consideration socially undesirable or rude, while likewise positioning a danger to public health and wellness.

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About Flush toilet

A flush bathroom (also known as a flushing bathroom, water closet (WC); see additionally toilet names) is a commode that takes care of human waste (i. e., pee and feces) by collecting it in a bowl and then using the force of water to carry it ("flush" it) with a drainpipe to an additional location for therapy, either close by or at a common center. Flush toilets can be made for sitting or bowing (typically regionally separated). A lot of modern sewer therapy systems are likewise created to refine specially developed toilet paper, and there is boosting rate of interest for flushable damp wipes. Porcelain (in some cases with vitreous china) is a prominent material for these bathrooms, although public or institutional ones might be metal or modern-day numerous products of bathrooms. Flush bathrooms are a type of plumbing component, and usually include a bend called a trap (S-, U-, J-, or P-shaped) that triggers water to collect in the bathroom dish --- to hold the waste and work as a seal versus noxious sewer gases. Urban and country flush commodes are connected to a sewage system that communicates wastewater to a sewer therapy plant; rurally, a sewage-disposal tank or composting system is mostly utilized. The opposite of a flush commode is a dry bathroom, which makes use of no water for flushing. Associated tools are urinals, which primarily take care of urine, and bidets, which make use of water to clean the anus, perineum, and vulva after using the bathroom.

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About Royal Porta Johns

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Frequently Asked Questions

How often should fill levels be checked?

Fill levels should be checked at least weekly for regular use, and daily for high-traffic events or construction sites.

What is the maximum safe fill level?

Portable toilets should never exceed 2/3 (about 67%) of tank capacity to prevent odors and spillage risks.

What are early warning signs of approaching maximum fill?

Visible waste reaching halfway up the tank, increased odors, and slower liquid absorption when chemicals are added.

How can I monitor multiple units efficiently?

Use service logs, electronic monitoring systems, or schedule regular route checks with maintenance staff.

Whats the best way to prevent sudden odor spikes?

Maintain proper chemical levels, schedule regular pump-outs before reaching 2/3 capacity, and increase service frequency during hot weather or high-use periods.

Royal Porta Johns

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State : MA

Zip : 02379

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