

- **Reviewing Key Safety Measures for Mobile Home HVAC Work**  
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**Understanding PPE Guidelines for Mobile Home Furnace Repair** **Following OSHA Standards During Mobile Home AC Installations** **Noting Electrical Hazard Precautions in Mobile Home HVAC Projects** **Planning Lockout Procedures for Mobile Home Heating Maintenance** **Checking for Proper Ventilation in Mobile Home HVAC Crawl Spaces** **Confirming Compliance with HUD Requirements for Mobile Home Ducts** **Conducting On Site Safety Assessments Before Mobile Home AC Repairs** **Checking Gas Line Integrity in Mobile Home Heating Systems** **Identifying Combustion Clearance Issues in Mobile Home Furnaces** **Monitoring Air Quality Factors During Mobile Home HVAC Upkeep** **Coordinating Exit Strategies for Emergencies in Mobile Home HVAC Work**
- **Identifying Warning Signs of Outdated Components**  
**Identifying Warning Signs of Outdated Components** **Converting Older Units to High Efficiency Models** **Examining Duct Layout for Better Distribution** **Adjusting Equipment Size to Fit Modern Needs** **Evaluating Newer Options to Replace Electric Heaters** **Implementing Airflow Balancing Techniques** **Overcoming Physical Constraints in Legacy Structures** **Transitioning to Improved Refrigerants for Compliance** **Strengthening Insulation to Enhance Performance** **Matching Compatibility of Controls and Existing Wiring** **Coordinating Expert Consultations for Complex Projects** **Planning Timelines for Effective System Upgrades**
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# Upkeep

## Importance of Safety in Mobile Home HVAC Work

Monitoring air quality factors during mobile home HVAC upkeep is a crucial task that ensures the health and comfort of occupants. Mobile homes, like traditional houses, are subject to various air quality issues that can significantly affect indoor environments. Understanding these common air quality factors can help in maintaining a safe living space.

One significant factor is particulate matter, which includes dust, pollen, and smoke. These tiny particles can easily infiltrate mobile homes due to their often less robust construction compared to traditional homes. Regularly replacing HVAC filters and using high-efficiency particulate air (HEPA) filters can help capture these particles effectively, improving indoor air quality.

Volatile organic compounds (VOCs) are another critical concern in mobile homes. Outdoor compressor units should be shielded from debris and weather exposure **mobile home hvac systems** energy. VOCs are emitted from many household products such as paints, varnishes, cleaning supplies, and even furnishings. These compounds can cause headaches, dizziness, or more severe long-term health problems if not managed properly. Ensuring proper ventilation and using low-VOC or VOC-free products during maintenance tasks can mitigate this issue.

Humidity levels also play a vital role in indoor air quality within mobile homes. Excessive humidity can lead to mold growth, which poses serious health risks including respiratory problems and allergic reactions. On the other hand, very low humidity can cause discomfort and exacerbate certain health conditions like asthma. It's essential to maintain balanced humidity levels through dehumidifiers or humidifiers as needed during HVAC maintenance checks.

Carbon monoxide is another dangerous factor that must be monitored diligently. This colorless and odorless gas can be fatal if it accumulates indoors due to faulty gas appliances or inadequate ventilation systems often found in mobile homes with older HVAC setups. Installing carbon monoxide detectors and ensuring proper servicing of gas-powered appliances are critical safety measures.

Lastly, allergens such as pet dander or dust mites are common in many households but may be particularly problematic in the confined spaces of a mobile home where circulation might be limited. Regular cleaning routines along with efficient air filtration provided by well-maintained HVAC systems will help reduce these allergens significantly.

In conclusion, understanding common air quality factors such as particulate matter, VOCs, humidity levels, carbon monoxide presence, and allergens is essential for maintaining optimal indoor environments in mobile homes during HVAC upkeep. By addressing these factors proactively through routine maintenance and adopting appropriate technologies or practices where necessary-residents ensure not only their comfort but also their overall well-being inside their unique living spaces.

The impact of HVAC systems on indoor air quality is a critical topic, especially when examining the specific context of mobile homes. These environments often present unique challenges due to their compact spaces and specific construction materials. Understanding how HVAC systems influence air quality in these settings is vital for ensuring the health and comfort of inhabitants.

Mobile homes, like any other residential structures, rely heavily on HVAC systems for temperature regulation and ventilation. However, due to their smaller size and sometimes more limited insulation options, maintaining optimal indoor air quality can be more challenging compared to traditional homes. The efficiency of an HVAC system in managing air quality factors such as humidity levels, particulate matter, and volatile organic compounds (VOCs) becomes particularly crucial.

Monitoring these air quality factors during routine HVAC upkeep is essential. Regular maintenance checks can help identify potential issues that could compromise indoor air quality. For instance, clogged filters or ducts can lead to the accumulation of dust and allergens, while poorly maintained units might fail to adequately ventilate harmful VOCs released from building materials or household products.

Moreover, proper monitoring allows for adjustments that optimize the performance of HVAC systems in mobile homes. This includes calibrating thermostats for efficient energy use without sacrificing ventilation needs or introducing advanced filtration technologies that can capture finer particles known to affect respiratory health.

In conclusion, the interplay between HVAC systems and indoor air quality in mobile homes underscores the necessity for diligent monitoring and upkeep. As these systems play a pivotal role in both climate control and pollutant management within confined spaces, ensuring their optimal function through regular maintenance not only enhances living conditions but also safeguards the health of occupants.

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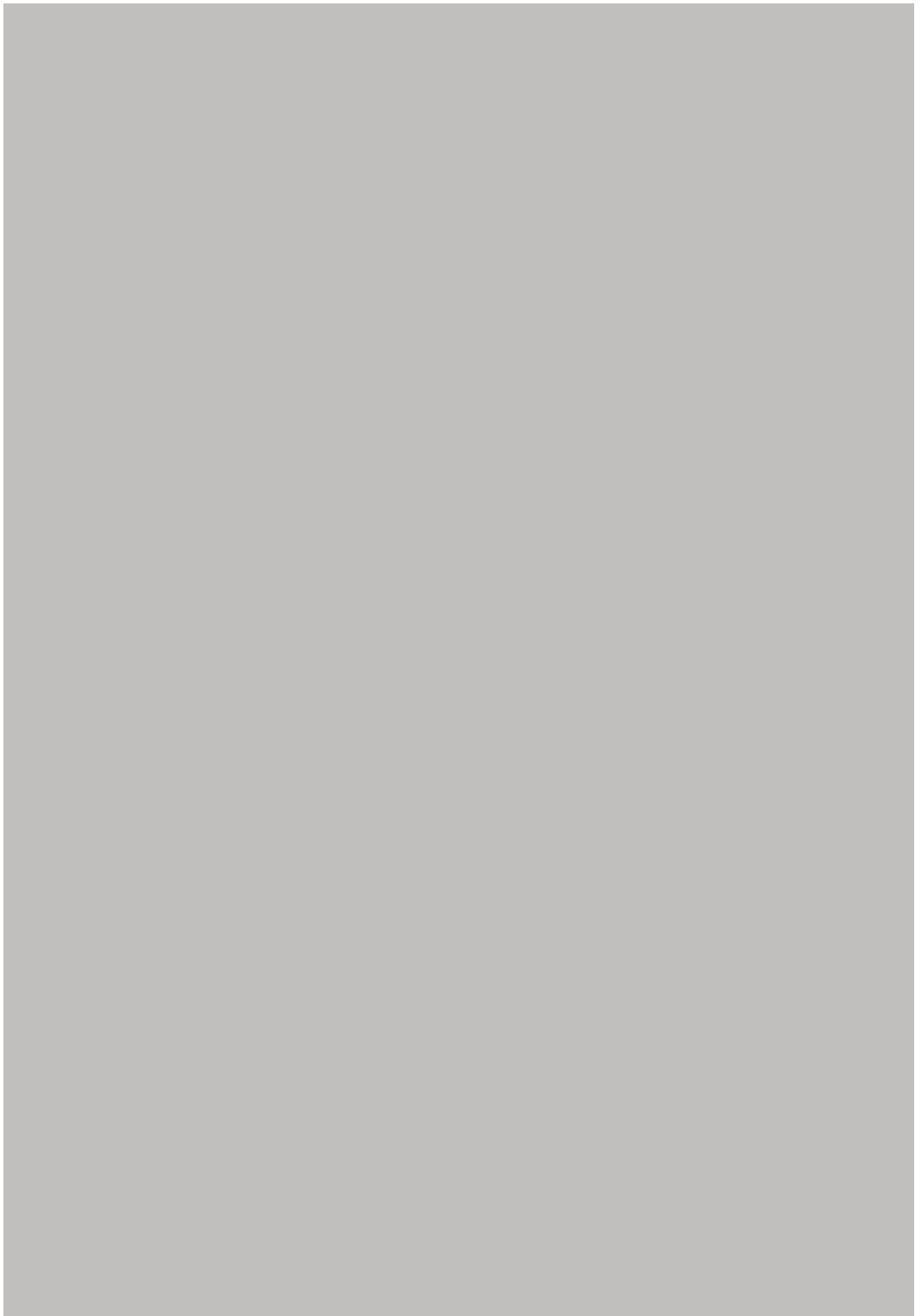
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Mobile Home Hvac Repair





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# Essential Safety Gear and Equipment for Technicians

Mobile homes, like any other dwelling, require a well-functioning HVAC (heating, ventilation, and air conditioning) system to ensure a comfortable and healthy indoor environment. The air quality within these compact living spaces significantly depends on key components of the HVAC system. Understanding and monitoring these components during routine upkeep can lead to improved air quality, enhanced comfort, and increased efficiency.

Firstly, the air filter is a critical component affecting indoor air quality in mobile homes. It traps dust, pollen, pet dander, and other airborne particles that would otherwise circulate throughout the home. A clogged or dirty filter not only hinders airflow but also reduces the efficiency of the HVAC system. Regularly replacing or cleaning air filters is essential for maintaining optimal airflow and preventing pollutants from accumulating indoors.

Another vital component is the ductwork system. In mobile homes, space constraints often result in shorter duct systems compared to traditional houses. However, this does not negate their importance in distributing heated or cooled air evenly throughout the home. Ducts that are poorly sealed or insulated can leak conditioned air into unconditioned spaces such as attics or crawlspaces, leading to energy loss and potential contamination by dust or mold spores. Regular inspection of ductwork for leaks or blockages ensures efficient operation and prevents pollutants from entering living areas.

The HVAC unit itself plays a significant role in influencing indoor air quality. Units that are improperly sized for the space they serve may cycle on and off too frequently (short cycling), which affects humidity control and can lead to excess moisture buildup—a breeding ground for mold growth. Additionally, older units may emit volatile organic compounds (VOCs) if their internal components are deteriorating. Ensuring that HVAC units are appropriately sized and maintained helps maintain ideal humidity levels and minimizes harmful emissions.

Ventilation is another crucial factor impacting air quality within mobile homes. Insufficient ventilation can lead to a buildup of carbon dioxide and other indoor pollutants such as volatile organic compounds from household cleaners or off-gassing furniture materials. Installing energy-efficient mechanical ventilators can aid in exchanging stale indoor air with fresh outdoor air without sacrificing energy efficiency.

Lastly, thermostats might seem trivial but play an essential role in regulating temperature settings that indirectly affect indoor air quality by dictating how hard your HVAC system works at maintaining desired conditions inside your home environment efficiently while minimizing stress on its machinery over time due largely because they determine when heating/cooling cycles begin/end based upon pre-set preferences established by users themselves

beforehand via inputs made directly onto touchscreen interfaces now commonly found among newer models today which offer greater precision than ever before possible thus providing homeowners greater control over their environments than previously imaginable even just ten years ago!

In conclusion: Maintaining good indoor climate control within your own personal abode doesn't have to be a daunting task requiring specialized technical knowledge; rather it involves simple measures taken consistently over time such as regularly changing out old worn-out filters checking seals around doors/windows ensuring vents remain unobstructed etcetera all aimed ultimately towards achieving healthier cleaner safer places wherein we live work play rest relax recharge ourselves away from our busy frenetic world beyond our doorstep day after day week after week month after month year round regardless of external weather conditions prevailing outside at any given moment during the course of natural seasonal cycles experienced globally across planet Earth itself!





# **Proper Procedures for Handling Refrigerants and Chemicals**

Maintaining optimal air quality in mobile homes is a critical concern that often goes overlooked until noticeable issues arise. This oversight can lead to discomfort and health problems for the inhabitants. Routine maintenance practices are essential to ensure that the HVAC systems in these homes function efficiently and contribute positively to indoor air quality.

Mobile homes, by their very design, have unique challenges when it comes to air circulation and ventilation. Their compact size can exacerbate the accumulation of dust, allergens, and pollutants if not properly managed. Therefore, regular monitoring of air quality factors becomes an indispensable part of HVAC upkeep. This proactive approach helps identify potential issues before they escalate into costly repairs or health hazards.

One key aspect of routine maintenance is the frequent inspection and replacement of HVAC filters. Filters play a crucial role in trapping dust, pollen, mold spores, and other airborne particles that could compromise air quality. Over time, these filters can become clogged and inefficient, leading to poor performance of the HVAC system and reduced air quality inside the home. By adhering to a schedule for filter replacement-typically every three months or more frequently if necessary-homeowners can significantly enhance their indoor environment.

In addition to filter maintenance, ensuring proper ventilation is another vital component of maintaining good air quality. Ventilation involves both bringing fresh outdoor air into the home and exhausting stale indoor air outside. For mobile homes with limited space for natural airflow, mechanical ventilation systems might be necessary to aid this process. Regularly checking vents for obstructions and ensuring fans are operational will support adequate ventilation.

Furthermore, monitoring humidity levels within the home is crucial since excessive moisture can lead to mold growth-a serious threat to both structural integrity and health. Portable dehumidifiers or integrated solutions within HVAC systems help manage indoor humidity effectively. Routine checks on seals around windows and doors also prevent unwanted moisture ingress which could compromise both comfort and safety.

Finally, professional inspections should not be underestimated as part of routine maintenance practices. Engaging certified HVAC technicians annually ensures that all components are functioning correctly and any minor issues are addressed promptly before becoming major problems.

In conclusion, routine maintenance practices tailored specifically for mobile home HVAC systems play a pivotal role in safeguarding indoor air quality. By diligently monitoring key factors such as filtration efficiency, ventilation effectiveness, humidity control, and system integrity through professional assessments, homeowners can create a healthier living environment while prolonging the lifespan of their equipment. Adopting these practices not only enhances comfort but also contributes significantly towards promoting overall well-being for those residing within these uniquely challenging spaces.

# Electrical Safety Protocols for Mobile Home HVAC Work

Maintaining good air quality in mobile homes is crucial for the health and comfort of their occupants. As these compact living spaces often rely heavily on HVAC systems to regulate temperature and circulate air, ensuring the cleanliness and efficiency of these systems is paramount. Monitoring air quality during HVAC upkeep involves employing a variety of tools and techniques designed to detect, assess, and address potential contaminants that can affect indoor environments.

One fundamental tool in monitoring air quality is the use of air quality sensors. These devices are capable of detecting particulate matter, volatile organic compounds (VOCs), carbon monoxide, carbon dioxide, and other pollutants. By strategically placing sensors throughout a mobile home, maintenance personnel can gather data on pollutant levels in real-time. This information aids in identifying areas where contaminants accumulate, thus allowing for targeted cleaning or repairs within the HVAC system to mitigate these issues.

Another essential technique involves regular inspections and filter replacements within the HVAC system itself. Filters play a critical role in trapping dust, pollen, mold spores, and other airborne particles. Over time, however, they can become clogged or less effective at capturing pollutants. Routine checks ensure that filters are replaced as needed to maintain optimal performance. Moreover, inspecting ductwork for leaks or blockages ensures that airflow remains unobstructed and reduces the risk of pollutants being recirculated throughout the home.

Implementing proper ventilation strategies also contributes significantly to maintaining good air quality during HVAC upkeep. Mobile homes may benefit from mechanical ventilation systems that introduce fresh outdoor air while expelling stale indoor air. This exchange helps dilute concentrations of indoor pollutants and improves overall air circulation within the space.

In addition to these tools and techniques, it's important for those responsible for HVAC maintenance to stay informed about advancements in technology related to air quality monitoring. Innovations such as smart thermostats equipped with built-in sensors provide homeowners with continuous feedback on their indoor environment's status while offering suggestions for improving conditions if necessary.

Regularly educating occupants about ways they can contribute to better indoor air quality is equally vital. Encouraging practices such as minimizing smoking indoors, using eco-friendly cleaning products, and maintaining adequate humidity levels can complement professional HVAC maintenance efforts.

In conclusion, effective monitoring of air quality during mobile home HVAC upkeep requires a comprehensive approach involving advanced tools like sensors alongside routine inspections and strategic interventions such as efficient ventilation practices. By employing these methods consistently over time-while staying abreast of technological advancements-individuals responsible for maintaining mobile homes' heating-and-cooling systems have an opportunity not only improve residents' immediate comfort but also safeguard long-term health outcomes associated with cleaner breathable environments indoors.

# **Best Practices for Ensuring Structural Integrity During Installation and Maintenance**



Addressing common air quality issues found during maintenance is a critical aspect of ensuring optimal living conditions, especially in mobile homes where space constraints and design features can exacerbate indoor air quality problems. Mobile homes often rely on HVAC systems to regulate temperature and maintain air circulation. However, without regular upkeep and monitoring of these systems, the air quality within these confined spaces can deteriorate, leading to health issues for residents.

One of the most prevalent air quality issues encountered during HVAC maintenance in mobile homes is the accumulation of dust and debris. Over time, filters become clogged with particles, reducing their efficiency and allowing contaminants to circulate throughout the home. Regularly replacing or cleaning filters is essential for trapping dust, pollen, and other airborne pollutants that can trigger allergies or respiratory problems.

Another significant concern is the presence of mold and mildew. Due to limited ventilation options in many mobile homes, moisture can accumulate quickly, particularly in areas like bathrooms or kitchens where humidity levels are naturally higher. Mold not only affects air quality but also poses severe health risks if left unchecked. During HVAC maintenance, it's crucial to inspect ductwork for signs of mold growth and ensure that any sources of excess moisture are addressed promptly.

Volatile organic compounds (VOCs) present another challenge when maintaining air quality in mobile homes. These compounds can emanate from various household products such as paints, cleaning supplies, or even building materials used in the construction of the home itself. To mitigate VOC exposure, it's essential to use products with low VOC emissions whenever possible and ensure adequate ventilation during their application.

Carbon monoxide (CO) detection should also be a priority during HVAC maintenance checks. Mobile homes may have gas appliances that could emit CO if not properly ventilated or maintained. Ensuring that all appliances are functioning correctly and installing CO detectors can prevent potential poisoning incidents.

Lastly, pet dander is a common issue for pet owners living in mobile homes with limited space for their furry companions to roam freely without affecting indoor air quality. Regular cleaning routines combined with efficient filtration systems can help manage dander levels effectively.

In conclusion, maintaining good indoor air quality in mobile homes involves proactive monitoring and addressing several factors during HVAC upkeep: replacing filters regularly;

checking for mold; minimizing VOC exposure; ensuring proper appliance function; managing pet dander-all contribute significantly towards healthier living environments within these unique housing structures. By prioritizing these aspects during routine maintenance checks on HVAC systems specifically tailored for mobile homes' needs-residents stand better chances at enjoying cleaner breathable environments which ultimately promote overall well-being long-term while residing comfortably inside them year-round regardless season/weather outside!

The benefits of regular HVAC maintenance, particularly for mobile homes, extend beyond mere comfort to significantly enhance air quality. As the world becomes increasingly conscious of environmental and health issues, ensuring clean indoor air has never been more crucial. Mobile homes, which often face unique challenges due to their compact spaces and varying climates, require diligent attention to their heating, ventilation, and air conditioning (HVAC) systems.

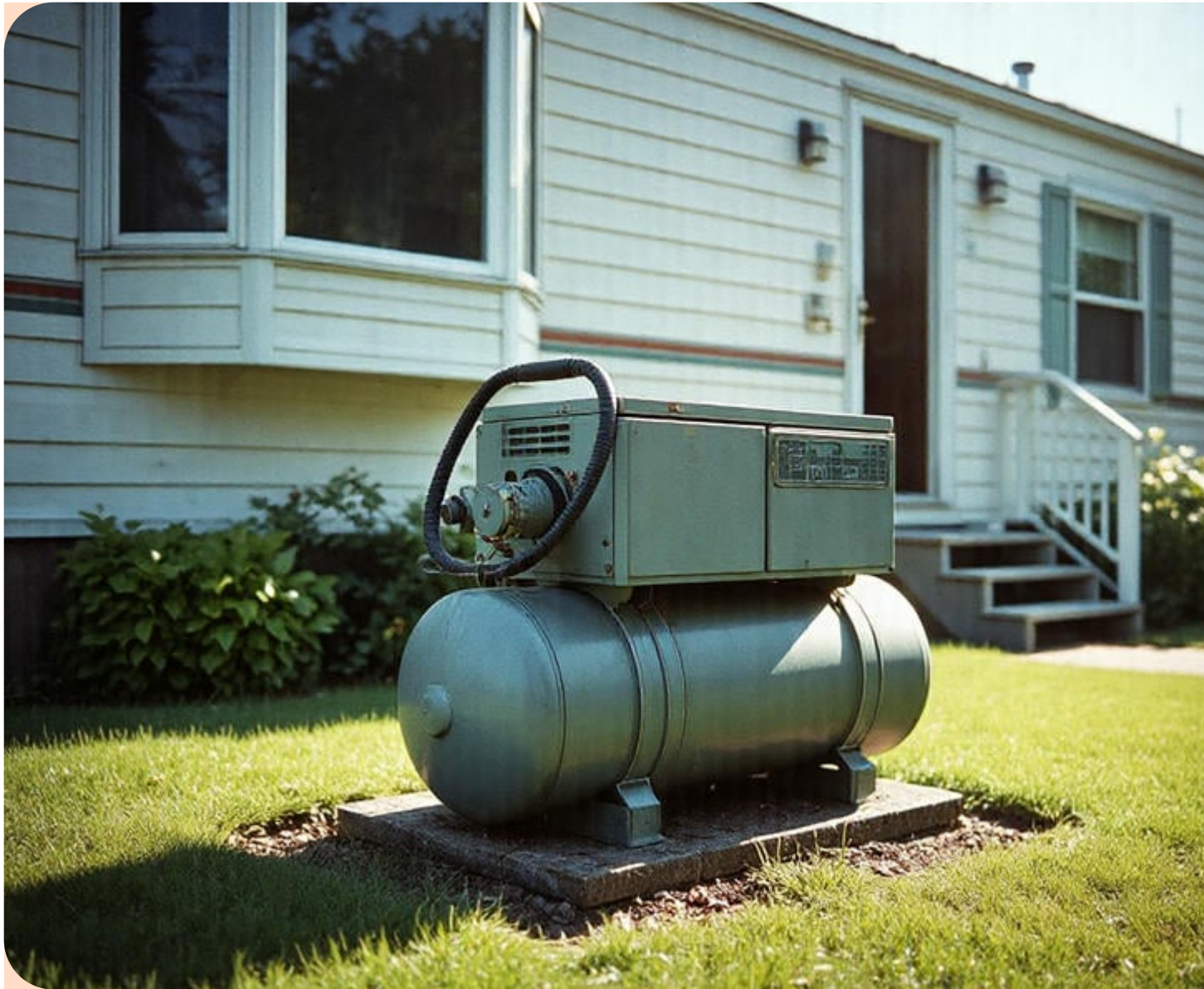
One primary benefit of regular HVAC maintenance is the reduction of airborne pollutants. Over time, dust, pet dander, mold spores, and other allergens can accumulate in an HVAC system. Without routine cleaning and filter replacement, these particles are continuously circulated throughout the living space. By adhering to a consistent maintenance schedule-such as changing filters every three months and having bi-annual professional inspections-homeowners can ensure that their systems operate efficiently without constantly recirculating contaminants.

Furthermore, well-maintained HVAC systems help regulate humidity levels within mobile homes. Excessive humidity can lead to mold growth, which not only damages property but also poses significant health risks. Conversely, too little humidity may cause respiratory discomfort or exacerbate conditions like asthma. Regular checks allow for early detection of issues such as leaks or malfunctioning components that might affect humidity control.

Energy efficiency is another critical aspect tied to regular maintenance. An efficient system not only reduces energy consumption—a boon for both the environment and utility bills—but also ensures that air exchange processes are optimized for better air quality. When an HVAC system runs smoothly without obstruction or strain from blockages or worn-out parts, it effectively filters out pollutants while maintaining optimal temperature levels.

Moreover, consistent upkeep can prolong the lifespan of the system itself. Mobile homeowners often invest substantially in their living spaces; hence ensuring longevity of essential components like the HVAC system is financially prudent. With longer-lasting equipment comes sustained air quality benefits—since newer models tend to include advanced filtration technologies designed specifically with health standards in mind.

In conclusion, monitoring air quality factors during mobile home HVAC upkeep is indispensable for cultivating a healthy indoor environment. Regular maintenance offers a proactive approach not only in safeguarding against potential mechanical failures but also in promoting superior air quality through cleaner airflow and improved efficiency. As we continue navigating through environmental challenges and prioritize our well-being indoors more than ever before—it becomes evident that taking care of our HVAC systems is not just about comfort; it's fundamentally about health preservation and enhancing our overall living experience within our homes.

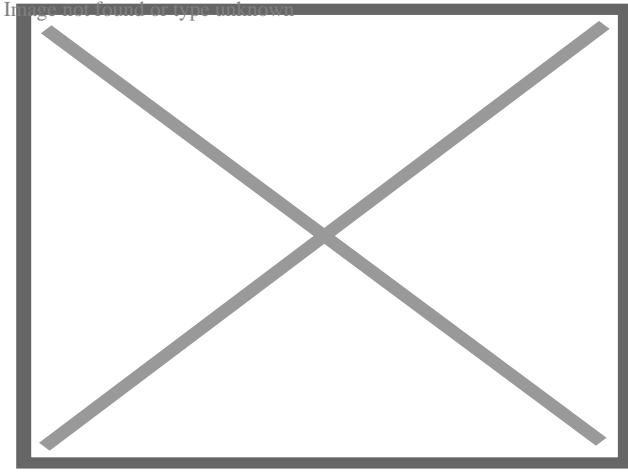


## About Manufactured housing



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A modern "triple wide" home

**Manufactured housing** (commonly known as mobile homes in the United States) is a type of prefabricated housing that is largely assembled in factories and then transported to sites of use. The definition of the term in the United States is regulated by federal law (Code of Federal Regulations, 24 CFR 3280): "Manufactured homes are built as dwelling units of at least 320 square feet (30 m<sup>2</sup>) in size with a permanent chassis to assure the initial and continued transportability of the home."<sup>[1]</sup> The requirement to have a wheeled chassis permanently attached differentiates "manufactured housing" from other types of prefabricated homes, such as modular homes.

## United States

[edit]

## Definition

[edit]

According to the Manufactured Housing Institute's National Communities Council (MHINCC), *manufactured homes*<sup>[2]</sup>

are homes built entirely in the factory under a federal building code administered by the U.S. Department of Housing and Urban Development (HUD). The Federal Manufactured Home Construction and Safety Standards (commonly known as the HUD Code) went into effect June 15, 1976. Manufactured homes may be single- or multi-section and are transported to the site and installed.

The MHINCC distinguishes among several types of *factory-built housing*: manufactured homes, modular homes, panelized homes, pre-cut homes, and mobile homes.

From the same source, *mobile home* "is the term used for manufactured homes produced prior to June 15, 1976, when the HUD Code went into effect."<sup>[2]</sup> Despite the formal definition, *mobile home* and *trailer* are still common terms in the United States for this type of housing.

## History

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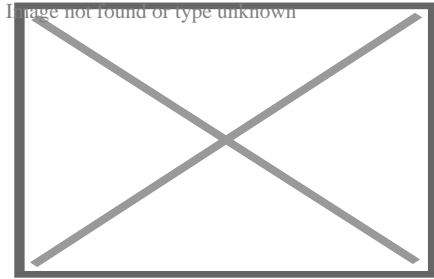
The original focus of this form of housing was its ability to relocate easily. Units were initially marketed primarily to people whose lifestyle required mobility. However, beginning in the 1950s, these homes began to be marketed primarily as an inexpensive form of housing designed to be set up and left in a location for long periods of time, or even permanently installed with a masonry foundation. Previously, units had been eight feet or less in width, but in 1956, the 10-foot (3.0 m) wide home was introduced. This helped solidify the line between mobile and house/travel trailers, since the smaller units could be moved simply with an automobile, but the larger, wider units required the services of a professional trucking company. In the 1960s and '70s, the homes became even longer and wider, making the mobility of the units more difficult. Today, when a factory-built home is moved to a location, it is usually kept there permanently. The mobility of the units has decreased considerably.

The factory-built homes of the past developed a negative stereotype because of their lower cost and the tendency for their value to depreciate more quickly than site-built homes. The tendency of these homes to rapidly depreciate in resale value made using them as collateral for loans far riskier than traditional home loans. Loan terms were usually limited to less than the 30-year term typical of the general home-loan market, and interest rates were considerably higher. In other words, these home loans resembled motor vehicle loans far more than traditional home mortgages. They have been consistently linked to lower-income families, which has led to prejudice and zoning restrictions, which include limitations on the number and density of homes permitted on any given site, minimum size requirements, limitations on exterior colors and finishes, and foundation mandates.

Many jurisdictions do not allow the placement of any additional factory-built homes, while others have strongly limited or forbidden all single-wide models, which tend to depreciate more rapidly than modern double-wide models. The derogatory concept of a "trailer park" is typically older single-wide homes occupying small, rented lots and remaining on wheels, even if the home stays in place for decades.

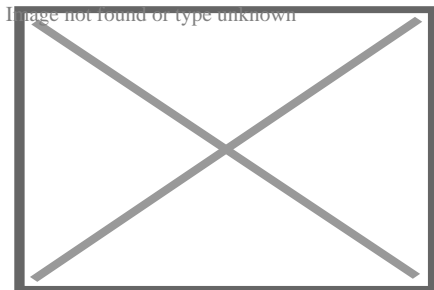
# Modern manufactured homes

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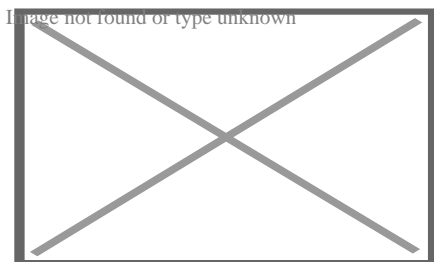


A manufactured house ready to be assembled in Grass Valley, California

Modern homes, especially modular homes, belie this image and can be identical in appearance to site-built homes. Newer homes, particularly double-wides, tend to be built to much higher standards than their predecessors. This has led to a reduction in the rate of value depreciation of many used units.



A manufactured house just before construction of its garage



Stick built garage being added to a new manufactured house

Although great strides have been made in terms of quality, manufactured homes do still struggle with construction problems. Author Wes Johnson has pointed out that the HUD code which governs manufactured homes desperately needs to be updated, quality control at manufacturing facilities are often lax, and set-up issues often compromise even a well-made manufactured home. Johnson states buyers need to be exceptionally cautious if they are entertaining the idea of purchasing any manufactured home by carefully checking it for defects before signing the contract and supervising the set-up

process closely. These homes in the modern age are built to be beautiful and last longer than the typical old trailers.<sup>[citation needed]</sup>

When FEMA studied the destruction wrought by Hurricane Andrew in Dade County Florida, they concluded that modular and masonry homes fared best compared to other construction.<sup>[3]</sup>

## High-performance manufactured housing

[edit]

While manufactured homes are considered to be affordable housing, older models can be some of the most expensive in the nation to heat due to energy inefficiency.<sup>[4]</sup> *High-performance manufactured housing* uses less energy and therefore increases life-cycle affordability by decreasing operating costs. High-performance housing is not only energy efficient, but also attractive, functional, water-efficient, resilient to wind, seismic forces, and moisture penetration, and has healthy indoor environmental quality. Achieving high-performance involves integrated, whole building design, involving many components, not one single technology. High-performance manufactured housing should also include energy efficient appliances, such as Energy Star qualified appliances.<sup>[4]</sup> Energy Star requires ample insulation: 2x6 walls: R21, roof: R40, floor: R33.

## Difference from modular homes

[edit]

Both types of homes - manufactured and modular - are commonly referred to as factory-built housing, but they are not identical. Modular homes are built to International Residential Code (IRC) code. Modular homes can be transported on flatbed trucks rather than being towed, and can lack axles and an automotive-type frame. However, some modular houses are towed behind a semi-truck or toter on a frame similar to that of a trailer. The house is usually in two pieces and is hauled by two separate trucks. Each frame has five or more axles, depending on the size of the house. Once the house has reached its location, the axles and the tongue of the frame are then removed, and the house is set on a concrete foundation by a large crane. Some modern modular homes, once fully assembled, are indistinguishable from site-built homes. In addition, modular homes:



- must conform to the same local, state and regional building codes as homes built on-site;
- are treated the same by banks as homes built on-site. They are easily refinanced, for example;
- must be structurally approved by inspectors;
- can be of any size, although the block sections from which they are assembled are uniformly sized;<sup>[5][6]</sup>

## Difference from IRC codes homes (site built)

[edit]

Manufactured homes have several standard requirements that are more stringent than International Residential Code homes.

### Fire Protection

A National Fire Protection Association (NFPA) study from July 2011 shows that occurrence of fires is lower in manufactured housing and the injury rate is lower in manufactured housing. The justification behind the superior fire safety is due to the following higher standard requirements:

- The HUD standard requires a flame spread of 25 or less in water heater and furnace compartments.
- The HUD standard requires a flame spread of 50 or less on the wall behind the range.
- The HUD standard requires a flame spread of 75 or less on the ceilings.
- The HUD standard requires a flame spread of 25 or less to protect the bottoms and side of kitchen cabinets around the range.
- The HUD standard requires additional protection of cabinets above the range.
- The HUD standard requires trim larger than 6" to meet flame spread requirements.
- The HUD standard requires smoke detectors in the general living area.
- The HUD standard requires 2 exterior doors.
- The HUD standard requires bedroom doors to be within 35 feet of an exterior door.

## Bay Area

[edit]

The San Francisco Bay Area, located in Northern California, is known for its high real estate prices, making manufactured housing an increasingly popular alternative to traditional real estate.<sup>[7]</sup> It is mainly the value of the land that makes real estate in this area so expensive. As of May 2011, the median price of a home in Santa Clara was \$498,000,<sup>[8]</sup> while the most expensive manufactured home with all the premium features was only \$249,000.<sup>[9]</sup> This drastic price difference is due to the fact that manufactured homes are typically placed in communities where individuals do not own the land, but instead pay a monthly site fee. This enables a consumer, who could otherwise not afford to live in the Bay Area, the opportunity to own a new home in this location. There are various communities of manufactured homes in the Bay Area, the largest being Casa de Amigos, located in Sunnyvale, California.

## Bulk material storage

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**Bulk material storage**  
Construction starts with the frame

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**Construction starts with  
the frame**  
Interior wall assemblies are attached

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**Interior wall assemblies  
are attached**  
Exterior wall assemblies are set in place

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**Exterior wall  
assemblies are set in  
place**

Roof assembly is set atop the house

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Roof assembly is set  
atop the house  
Drywall completed

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Drywall completed  
House is ready for delivery to site

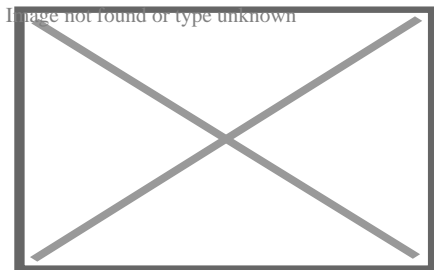
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House is ready for  
delivery to site

## Australia

[edit]



An Australian modern prefabricated house

In Australia these homes are commonly known as **transportable homes**, **relocatable homes** or **prefabricated homes** (not to be confused with the American meaning of the term). They are not as common as in the US, but the industry is expected to grow as this method of construction becomes more accepted.

Manufactured home parks refer to housing estates where the house owner rents the land instead of owning it. This is quite common in Queensland in both the form of tourist parks and over fifty estates. The term transportable homes tends to be used to refer to houses that are built on land that is owned by the house owner.<sup>[*citation needed*]</sup>

Typically the homes are built in regional areas where the cost of organizing tradespeople and materials is higher than in the cities. In particular prefabricated homes have been popular in mining towns or other towns experiencing demand for new housing in excess of what can be handled by local builders. This method of construction is governed by state construction legislation and is subject to local council approval and homeowners' warranty or home warranty insurance.

## Construction process


[edit]

A manufactured home is built entirely inside a huge, climate-controlled factory by a team of craftsmen. The first step in the process is the flooring, which is built in sections, each attached to a permanent chassis with its own wheels and secured for transport upon the home's completion. Depending on the size of the house and the floorplan's layout, there may be two, three or even four sections. The flooring sections have heating, electrical and plumbing connections pre-installed before they are finished with laminate, tile or hardwood. Next, the walls are constructed on a flat level surface with insulation and interior Sheetrock before being lifted by crane into position and secured to the floor sections. The interior ceilings and roof struts are next, vapor sealed and secured to each section's wall frame before being shingled. Then, the exterior siding is added, along with the installation of doors and windows. Finally, interior finishing, such as sealing the drywall, is completed, along with fixture installation and finishing the electrical and plumbing connections. The exposed portions of each section, where they will eventually be joined together, are wrapped in plastic to protect them for transport.

With all the building site prep work completed, the building will be delivered by trucks towing the individual sections on their permanent chassis. The sections will be joined together securely, and all final plumbing and electrical connections are made before a decorative skirt or facade is applied to the bottom exterior of the house, hiding the chassis and finishing off the look of the home.

## See also

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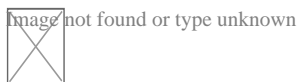
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- Modular home
- Prefabrication
- Prefabricated home
- Reefer container housing units
- British post-war temporary prefab houses
- HUD USER
- Regulatory Barriers Clearinghouse
- Lustron house

- Cardinal Industries, Inc.
- Dymaxion house
- Excel Homes
- All American Homes
- All Parks Alliance for Change

## References

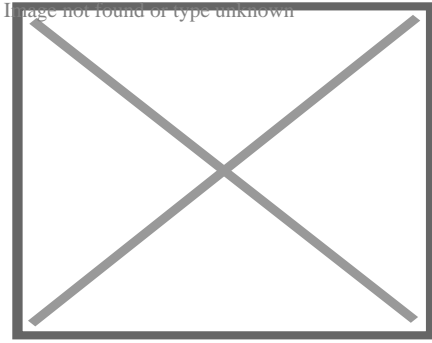
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1. ^ *"HUD.gov / U.S. Department of Housing and Urban Development (HUD)". portal.hud.gov. Archived from the original on 2017-05-14. Retrieved 2020-03-24.*
2. ^ **a b** "What is a Manufactured Home?" Manufactured Housing Institute's National Communities Council, accessed 6 July 2011 Archived 23 March 2012 at the Wayback Machine
3. ^ *"FIA 22, Mitigation Assessment Team Report: Hurricane Andrew in Florida (1993) - FEMA.gov". www.fema.gov.*
4. ^ **a b** Environmental and Energy Study Institute. "Issue Brief: High-Performance Manufactured Housing". eesi.org. Retrieved August 2, 2011.
5. ^ <https://homenation.com/mobile-vs-modular/> Modular home vs Manufactured home
6. ^ Kit Homes Guide
7. ^ *"2011 Coldwell Banker U.S. Home Listing Report". Coldwell Banker. Retrieved 6 July 2011.*
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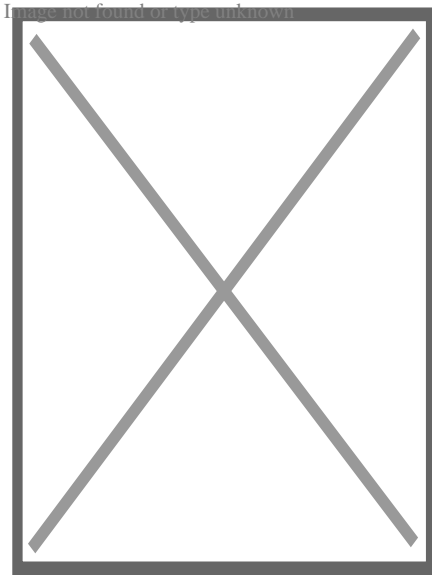


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**About Heat exchanger**



Tubular heat exchanger

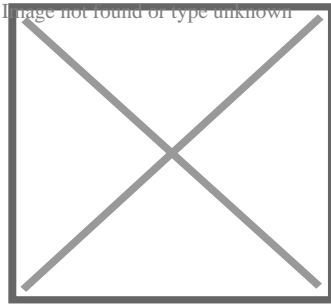


Partial view into inlet plenum of shell and tube heat exchanger of a refrigerant based chiller for providing air-conditioning to a building

A **heat exchanger** is a system used to transfer heat between a source and a working fluid. Heat exchangers are used in both cooling and heating processes.<sup>[1]</sup> The fluids may be separated by a solid wall to prevent mixing or they may be in direct contact.<sup>[2]</sup> They are widely used in space heating, refrigeration, air conditioning, power stations, chemical plants, petrochemical plants, petroleum refineries, natural-gas processing, and sewage treatment. The classic example of a heat exchanger is found in an internal combustion engine in which a circulating fluid known as engine coolant flows through radiator coils and air flows past the coils, which cools the coolant and heats the incoming air. Another example is the heat sink, which is a passive heat exchanger that transfers the heat generated by an electronic or a mechanical device to a fluid medium, often air or a liquid coolant.<sup>[3]</sup>

### Flow arrangement

[edit]



Countercurrent (A) and parallel (B) flows

There are three primary classifications of heat exchangers according to their flow arrangement. In *parallel-flow* heat exchangers, the two fluids enter the exchanger at the same end, and travel in parallel to one another to the other side. In *counter-flow* heat exchangers the fluids enter the exchanger from opposite ends. The counter current design is the most efficient, in that it can transfer the most heat from the heat (transfer) medium per unit mass due to the fact that the average temperature difference along any unit length is *higher*. See countercurrent exchange. In a *cross-flow* heat exchanger, the fluids travel roughly perpendicular to one another through the exchanger.

Fig. 1: Shell and tube heat

○

Image not found or type unknown

Fig. 1: Shell and tube heat exchanger, single pass (1–1 parallel flow)

Fig. 2: Shell and tube heat

○

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Fig. 2: Shell and tube heat exchanger, 2-pass tube side (1–2 crossflow)

For efficiency, heat exchangers are designed to maximize the surface area of the wall between the two fluids, while minimizing resistance to fluid flow through the exchanger. The exchanger's performance can also be affected by the addition of fins or corrugations in one or both directions, which increase surface area and may channel fluid flow or induce turbulence.

The driving temperature across the heat transfer surface varies with position, but an appropriate mean temperature can be defined. In most simple systems this is the "log mean temperature difference" (LMTD). Sometimes direct knowledge of the LMTD is not available and the NTU method is used.

## Types

[edit]

Double pipe heat exchangers are the simplest exchangers used in industries. On one hand, these heat exchangers are cheap for both design and maintenance, making them a good choice for small industries. On the other hand, their low efficiency coupled with the high space occupied in large scales, has led modern industries to use more efficient heat exchangers like shell and tube or plate. However, since double pipe heat exchangers are simple, they are used to teach heat exchanger design basics to students as the fundamental rules for all heat exchangers are the same.

### 1. Double-pipe heat exchanger

When one fluid flows through the smaller pipe, the other flows through the annular gap between the two pipes. These flows may be parallel or counter-flows in a double pipe heat exchanger.

(a) Parallel flow, where both hot and cold liquids enter the heat exchanger from the same side, flow in the same direction and exit at the same end. This configuration is preferable when the two fluids are intended to reach exactly the same temperature, as it reduces thermal stress and produces a more uniform rate of heat transfer.

(b) Counter-flow, where hot and cold fluids enter opposite sides of the heat exchanger, flow in opposite directions, and exit at opposite ends. This configuration is preferable when the objective is to maximize heat transfer between the fluids, as it creates a larger temperature differential when used under otherwise similar conditions.<sup>[citation needed]</sup>

Fig. 3: Shell and tube heat

o

Image not found or type unknown

Fig. 3: Shell and tube heat exchanger, 2-pass shell side, 2-pass tube side (2-2 countercurrent)



The figure above illustrates the parallel and counter-flow flow directions of the fluid exchanger.

## 2. Shell-and-tube heat exchanger

In a shell-and-tube heat exchanger, two fluids at different temperatures flow through the heat exchanger. One of the fluids flows through the tube side and the other fluid flows outside the tubes, but inside the shell (shell side).

Baffles are used to support the tubes, direct the fluid flow to the tubes in an approximately natural manner, and maximize the turbulence of the shell fluid. There are many various kinds of baffles, and the choice of baffle form, spacing, and geometry depends on the allowable flow rate of the drop in shell-side force, the need for tube support, and the flow-induced vibrations. There are several variations of shell-and-tube exchangers available; the differences lie in the arrangement of flow configurations and details of construction.

In application to cool air with shell-and-tube technology (such as intercooler / charge air cooler for combustion engines), fins can be added on the tubes to increase heat transfer area on air side and create a tubes & fins configuration.

## 3. Plate Heat Exchanger

A plate heat exchanger contains an amount of thin shaped heat transfer plates bundled together. The gasket arrangement of each pair of plates provides two separate channel system. Each pair of plates form a channel where the fluid can flow through. The pairs are attached by welding and bolting methods. The following shows the components in the heat exchanger.

In single channels the configuration of the gaskets enables flow through. Thus, this allows the main and secondary media in counter-current flow. A gasket plate heat exchanger has a heat region from corrugated plates. The gasket function as seal between plates and they are located between frame and pressure plates. Fluid flows in a counter current direction throughout the heat exchanger. An efficient thermal performance is produced. Plates are produced in different depths, sizes and corrugated shapes. There are different types of plates available including plate and frame, plate and shell and spiral plate heat exchangers. The distribution area guarantees the flow of fluid to the whole heat transfer surface. This helps to prevent stagnant area that can cause accumulation of unwanted material on solid surfaces. High flow turbulence between plates results in a greater transfer of heat and a decrease in pressure.

4. Condensers and Boilers Heat exchangers using a two-phase heat transfer system are condensers, boilers and evaporators. Condensers are instruments that take and cool hot gas or vapor to the point of condensation and transform the gas into a liquid

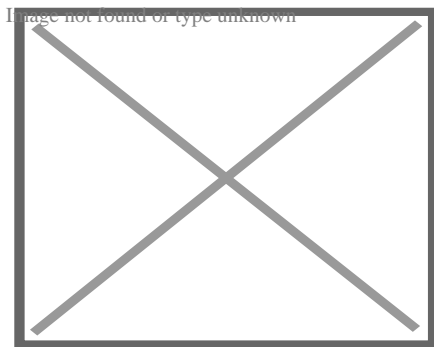
form. The point at which liquid transforms to gas is called vaporization and vice versa is called condensation. Surface condenser is the most common type of condenser where it includes a water supply device. Figure 5 below displays a two-pass surface condenser.

The pressure of steam at the turbine outlet is low where the steam density is very low where the flow rate is very high. To prevent a decrease in pressure in the movement of steam from the turbine to condenser, the condenser unit is placed underneath and connected to the turbine. Inside the tubes the cooling water runs in a parallel way, while steam moves in a vertical downward position from the wide opening at the top and travel through the tube. Furthermore, boilers are categorized as initial application of heat exchangers. The word steam generator was regularly used to describe a boiler unit where a hot liquid stream is the source of heat rather than the combustion products. Depending on the dimensions and configurations the boilers are manufactured. Several boilers are only able to produce hot fluid while on the other hand the others are manufactured for steam production.

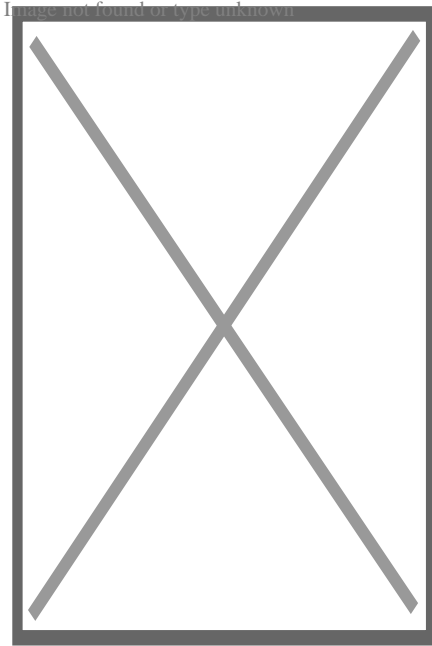
## Shell and tube

[edit]

Main article: Shell and tube heat exchanger



A shell and tube heat exchanger



Shell and tube heat exchanger

Shell and tube heat exchangers consist of a series of tubes which contain fluid that must be either heated or cooled. A second fluid runs over the tubes that are being heated or cooled so that it can either provide the heat or absorb the heat required. A set of tubes is called the tube bundle and can be made up of several types of tubes: plain, longitudinally finned, etc. Shell and tube heat exchangers are typically used for high-pressure applications (with pressures greater than 30 bar and temperatures greater than 260 °C).[4] This is because the shell and tube heat exchangers are robust due to their shape.

Several thermal design features must be considered when designing the tubes in the shell and tube heat exchangers: There can be many variations on the shell and tube design. Typically, the ends of each tube are connected to plenums (sometimes called water boxes) through holes in tubesheets. The tubes may be straight or bent in the shape of a U, called U-tubes.

- Tube diameter: Using a small tube diameter makes the heat exchanger both economical and compact. However, it is more likely for the heat exchanger to foul up faster and the small size makes mechanical cleaning of the fouling difficult. To prevail over the fouling and cleaning problems, larger tube diameters can be used. Thus to determine the tube diameter, the available space, cost and fouling nature of the fluids must be considered.
- Tube thickness: The thickness of the wall of the tubes is usually determined to ensure:
  - There is enough room for corrosion
  - That flow-induced vibration has resistance
  - Axial strength

- Availability of spare parts
- Hoop strength (to withstand internal tube pressure)
- Buckling strength (to withstand overpressure in the shell)
- Tube length: heat exchangers are usually cheaper when they have a smaller shell diameter and a long tube length. Thus, typically there is an aim to make the heat exchanger as long as physically possible whilst not exceeding production capabilities. However, there are many limitations for this, including space available at the installation site and the need to ensure tubes are available in lengths that are twice the required length (so they can be withdrawn and replaced). Also, long, thin tubes are difficult to take out and replace.
- Tube pitch: when designing the tubes, it is practical to ensure that the tube pitch (i.e., the centre-centre distance of adjoining tubes) is not less than 1.25 times the tubes' outside diameter. A larger tube pitch leads to a larger overall shell diameter, which leads to a more expensive heat exchanger.
- Tube corrugation: this type of tubes, mainly used for the inner tubes, increases the turbulence of the fluids and the effect is very important in the heat transfer giving a better performance.
- Tube Layout: refers to how tubes are positioned within the shell. There are four main types of tube layout, which are, triangular ( $30^\circ$ ), rotated triangular ( $60^\circ$ ), square ( $90^\circ$ ) and rotated square ( $45^\circ$ ). The triangular patterns are employed to give greater heat transfer as they force the fluid to flow in a more turbulent fashion around the piping. Square patterns are employed where high fouling is experienced and cleaning is more regular.
- Baffle Design: baffles are used in shell and tube heat exchangers to direct fluid across the tube bundle. They run perpendicularly to the shell and hold the bundle, preventing the tubes from sagging over a long length. They can also prevent the tubes from vibrating. The most common type of baffle is the segmental baffle. The semicircular segmental baffles are oriented at  $180^\circ$  to the adjacent baffles forcing the fluid to flow upward and downwards between the tube bundle. Baffle spacing is of large thermodynamic concern when designing shell and tube heat exchangers. Baffles must be spaced with consideration for the conversion of pressure drop and heat transfer. For thermo economic optimization it is suggested that the baffles be spaced no closer than 20% of the shell's inner diameter. Having baffles spaced too closely causes a greater pressure drop because of flow redirection. Consequently, having the baffles spaced too far apart means that there may be cooler spots in the corners between baffles. It is also important to ensure the baffles are spaced close enough that the tubes do not sag. The other main type of baffle is the disc and doughnut baffle, which consists of two concentric baffles. An outer, wider baffle looks like a doughnut, whilst the inner baffle is shaped like a disk. This type of baffle forces the fluid to pass around each side of the disk then through the doughnut baffle generating a different type of fluid flow.

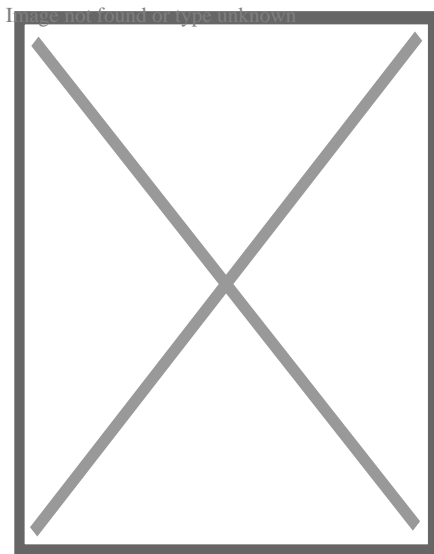
- Tubes & fins Design: in application to cool air with shell-and-tube technology (such as intercooler / charge air cooler for combustion engines), the difference in heat transfer between air and cold fluid can be such that there is a need to increase heat transfer area on air side. For this function fins can be added on the tubes to increase heat transfer area on air side and create a tubes & fins configuration.

Fixed tube liquid-cooled heat exchangers especially suitable for marine and harsh applications can be assembled with brass shells, copper tubes, brass baffles, and forged brass integral end hubs.<sup>[citation needed]</sup> (See: *Copper in heat exchangers*).

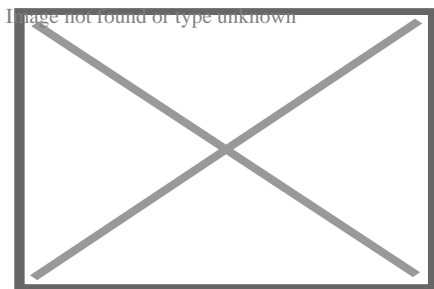
## Plate

[edit]

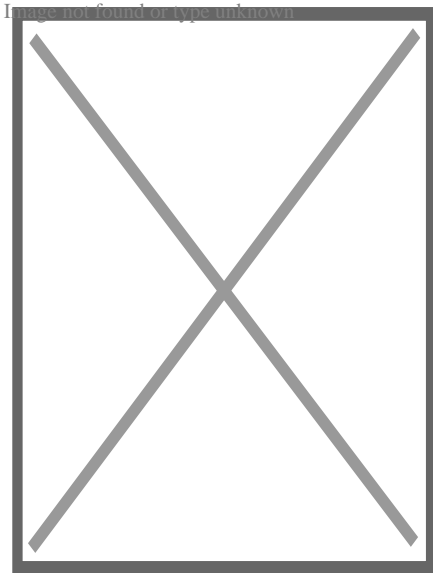
Main article: Plate heat exchanger



Conceptual diagram of a plate and frame heat exchanger



A single plate heat exchanger



An interchangeable plate heat exchanger directly applied to the system of a swimming pool

Another type of heat exchanger is the plate heat exchanger. These exchangers are composed of many thin, slightly separated plates that have very large surface areas and small fluid flow passages for heat transfer. Advances in gasket and brazing technology have made the plate-type heat exchanger increasingly practical. In HVAC applications, large heat exchangers of this type are called *plate-and-frame*; when used in open loops, these heat exchangers are normally of the gasket type to allow periodic disassembly, cleaning, and inspection. There are many types of permanently bonded plate heat exchangers, such as dip-brazed, vacuum-brazed, and welded plate varieties, and they are often specified for closed-loop applications such as refrigeration. Plate heat exchangers also differ in the types of plates that are used, and in the configurations of those plates. Some plates may be stamped with "chevron", dimpled, or other patterns, where others may have machined fins and/or grooves.

When compared to shell and tube exchangers, the stacked-plate arrangement typically has lower volume and cost. Another difference between the two is that plate exchangers typically serve low to medium pressure fluids, compared to medium and high pressures of shell and tube. A third and important difference is that plate exchangers employ more countercurrent flow rather than cross current flow, which allows lower approach temperature differences, high temperature changes, and increased efficiencies.

## Plate and shell

[edit]

A third type of heat exchanger is a plate and shell heat exchanger, which combines plate heat exchanger with shell and tube heat exchanger technologies. The heart of the heat exchanger contains a fully welded circular plate pack made by pressing and cutting round plates and welding them together. Nozzles carry flow in and out of the platepack (the 'Plate side' flowpath). The fully welded platepack is assembled into an outer shell that creates a second flowpath ( the 'Shell side'). Plate and shell technology offers high heat transfer, high pressure, high operating temperature, compact size, low fouling and close approach temperature. In particular, it does completely without gaskets, which provides security against leakage at high pressures and temperatures.

## Adiabatic wheel

[edit]

A fourth type of heat exchanger uses an intermediate fluid or solid store to hold heat, which is then moved to the other side of the heat exchanger to be released. Two examples of this are adiabatic wheels, which consist of a large wheel with fine threads rotating through the hot and cold fluids, and fluid heat exchangers.

## Plate fin

[edit]

Main article: Plate fin heat exchanger

This type of heat exchanger uses "sandwiched" passages containing fins to increase the effectiveness of the unit. The designs include crossflow and counterflow coupled with various fin configurations such as straight fins, offset fins and wavy fins.

Plate and fin heat exchangers are usually made of aluminum alloys, which provide high heat transfer efficiency. The material enables the system to operate at a lower temperature difference and reduce the weight of the equipment. Plate and fin heat exchangers are mostly used for low temperature services such as natural gas, helium and oxygen liquefaction plants, air separation plants and transport industries such as motor and aircraft engines.

Advantages of plate and fin heat exchangers:

- High heat transfer efficiency especially in gas treatment
- Larger heat transfer area

- Approximately 5 times lighter in weight than that of shell and tube heat exchanger. [citation]
- Able to withstand high pressure

Disadvantages of plate and fin heat exchangers:

- Might cause clogging as the pathways are very narrow
- Difficult to clean the pathways
- Aluminium alloys are susceptible to Mercury Liquid Embrittlement Failure

## Finned tube

[edit]

The usage of fins in a tube-based heat exchanger is common when one of the working fluids is a low-pressure gas, and is typical for heat exchangers that operate using ambient air, such as automotive radiators and HVAC air condensers. Fins dramatically increase the surface area with which heat can be exchanged, which improves the efficiency of conducting heat to a fluid with very low thermal conductivity, such as air. The fins are typically made from aluminium or copper since they must conduct heat from the tube along the length of the fins, which are usually very thin.

The main construction types of finned tube exchangers are:

- A stack of evenly-spaced metal plates act as the fins and the tubes are pressed through pre-cut holes in the fins, good thermal contact usually being achieved by deformation of the fins around the tube. This is typical construction for HVAC air coils and large refrigeration condensers.
- Fins are spiral-wound onto individual tubes as a continuous strip, the tubes can then be assembled in banks, bent in a serpentine pattern, or wound into large spirals.
- Zig-zag metal strips are sandwiched between flat rectangular tubes, often being soldered or brazed together for good thermal and mechanical strength. This is common in low-pressure heat exchangers such as water-cooling radiators. Regular flat tubes will expand and deform if exposed to high pressures but flat microchannel tubes allow this construction to be used for high pressures.<sup>[5]</sup>

Stacked-fin or spiral-wound construction can be used for the tubes inside shell-and-tube heat exchangers when high efficiency thermal transfer to a gas is required.

In electronics cooling, heat sinks, particularly those using heat pipes, can have a stacked-fin construction.



# Pillow plate

[edit]

A pillow plate heat exchanger is commonly used in the dairy industry for cooling milk in large direct-expansion stainless steel bulk tanks. Nearly the entire surface area of a tank can be integrated with this heat exchanger, without gaps that would occur between pipes welded to the exterior of the tank. Pillow plates can also be constructed as flat plates that are stacked inside a tank. The relatively flat surface of the plates allows easy cleaning, especially in sterile applications.

The pillow plate can be constructed using either a thin sheet of metal welded to the thicker surface of a tank or vessel, or two thin sheets welded together. The surface of the plate is welded with a regular pattern of dots or a serpentine pattern of weld lines. After welding the enclosed space is pressurised with sufficient force to cause the thin metal to bulge out around the welds, providing a space for heat exchanger liquids to flow, and creating a characteristic appearance of a swelled pillow formed out of metal.

# Waste heat recovery units

[edit]



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A waste heat recovery unit (WHRU) is a heat exchanger that recovers heat from a hot gas stream while transferring it to a working medium, typically water or oils. The hot gas stream can be the exhaust gas from a gas turbine or a diesel engine or a waste gas from industry or refinery.

Large systems with high volume and temperature gas streams, typical in industry, can benefit from steam Rankine cycle (SRC) in a waste heat recovery unit, but these cycles are too expensive for small systems. The recovery of heat from low temperature systems requires different working fluids than steam.

An organic Rankine cycle (ORC) waste heat recovery unit can be more efficient at low temperature range using refrigerants that boil at lower temperatures than water. Typical organic refrigerants are ammonia, pentafluoropropane (R-245fa and R-245ca), and

toluene.

The refrigerant is boiled by the heat source in the evaporator to produce super-heated vapor. This fluid is expanded in the turbine to convert thermal energy to kinetic energy, that is converted to electricity in the electrical generator. This energy transfer process decreases the temperature of the refrigerant that, in turn, condenses. The cycle is closed and completed using a pump to send the fluid back to the evaporator.

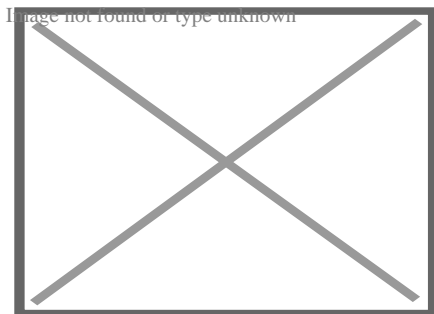
## Dynamic scraped surface

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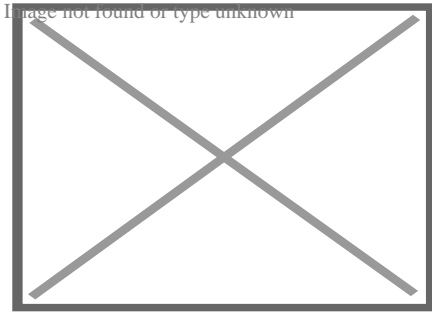
Another type of heat exchanger is called "(dynamic) scraped surface heat exchanger". This is mainly used for heating or cooling with high-viscosity products, crystallization processes, evaporation and high-fouling applications. Long running times are achieved due to the continuous scraping of the surface, thus avoiding fouling and achieving a sustainable heat transfer rate during the process.

## Phase-change

[edit]



Typical kettle reboiler used for industrial distillation towers



Typical water-cooled surface condenser

In addition to heating up or cooling down fluids in just a single phase, heat exchangers can be used either to heat a liquid to evaporate (or boil) it or used as condensers to cool a vapor and condense it to a liquid. In chemical plants and refineries, reboilers used to heat incoming feed for distillation towers are often heat exchangers.[<sup>6</sup>][<sup>7</sup>]

Distillation set-ups typically use condensers to condense distillate vapors back into liquid.

Power plants that use steam-driven turbines commonly use heat exchangers to boil water into steam. Heat exchangers or similar units for producing steam from water are often called boilers or steam generators.

In the nuclear power plants called pressurized water reactors, special large heat exchangers pass heat from the primary (reactor plant) system to the secondary (steam plant) system, producing steam from water in the process. These are called steam generators. All fossil-fueled and nuclear power plants using steam-driven turbines have surface condensers to convert the exhaust steam from the turbines into condensate (water) for re-use.[<sup>8</sup>][<sup>9</sup>]

To conserve energy and cooling capacity in chemical and other plants, regenerative heat exchangers can transfer heat from a stream that must be cooled to another stream that must be heated, such as distillate cooling and reboiler feed pre-heating.

This term can also refer to heat exchangers that contain a material within their structure that has a change of phase. This is usually a solid to liquid phase due to the small volume difference between these states. This change of phase effectively acts as a buffer because it occurs at a constant temperature but still allows for the heat exchanger to accept additional heat. One example where this has been investigated is for use in high power aircraft electronics.

Heat exchangers functioning in multiphase flow regimes may be subject to the Ledinegg instability.

# Direct contact

[edit]

Direct contact heat exchangers involve heat transfer between hot and cold streams of two phases in the absence of a separating wall.<sup>[10]</sup> Thus such heat exchangers can be classified as:

- Gas – liquid
- Immiscible liquid – liquid
- Solid-liquid or solid – gas

Most direct contact heat exchangers fall under the Gas – Liquid category, where heat is transferred between a gas and liquid in the form of drops, films or sprays.<sup>[4]</sup>

Such types of heat exchangers are used predominantly in air conditioning, humidification, industrial hot water heating, water cooling and condensing plants.<sup>[11]</sup>

Phases <sup>[12]</sup>	Continuous phase	Driving force	Change of phase	Examples
Gas – Liquid	Gas	Gravity	No	Spray columns, packed columns
			Yes	Cooling towers, falling droplet evaporators
		Forced Liquid flow	No	Spray coolers/quenchers
			Yes	Spray condensers/evaporation, jet condensers
	Liquid	Gravity	No	Bubble columns, perforated tray columns
			Yes	Bubble column condensers
		Forced Gas flow	No	Gas spargers
			Yes	Direct contact evaporators, submerged combustion

# Microchannel

[edit]

Microchannel heat exchangers are multi-pass parallel flow heat exchangers consisting of three main elements: manifolds (inlet and outlet), multi-port tubes with the hydraulic diameters smaller than 1mm, and fins. All the elements usually brazed together using controllable atmosphere brazing process. Microchannel heat exchangers are characterized by high heat transfer ratio, low refrigerant charges, compact size, and lower airside pressure drops compared to finned tube heat exchangers.<sup>[citation needed]</sup> Microchannel heat exchangers are widely used in automotive industry as the car radiators, and as condenser, evaporator, and cooling/heating coils in HVAC industry.

Main article: Micro heat exchanger

**Micro heat exchangers, Micro-scale heat exchangers, or microstructured heat exchangers** are heat exchangers in which (at least one) fluid flows in lateral confinements with typical dimensions below 1 mm. The most typical such confinement are microchannels, which are channels with a hydraulic diameter below 1 mm. Microchannel heat exchangers can be made from metal or ceramics.<sup>[13]</sup> Microchannel heat exchangers can be used for many applications including:

- high-performance aircraft gas turbine engines<sup>[14]</sup>
- heat pumps<sup>[15]</sup>
- Microprocessor and microchip cooling<sup>[16]</sup>
- air conditioning<sup>[17]</sup>

## HVAC and refrigeration air coils

[edit]

One of the widest uses of heat exchangers is for refrigeration and air conditioning. This class of heat exchangers is commonly called *air coils*, or just *coils* due to their often-serpentine internal tubing, or condensers in the case of refrigeration, and are typically of the finned tube type. Liquid-to-air, or air-to-liquid HVAC coils are typically of modified crossflow arrangement. In vehicles, heat coils are often called heater cores.

On the liquid side of these heat exchangers, the common fluids are water, a water-glycol solution, steam, or a refrigerant. For *heating coils*, hot water and steam are the most common, and this heated fluid is supplied by boilers, for example. For *cooling coils*, chilled water and refrigerant are most common. Chilled water is supplied from a chiller that is potentially located very far away, but refrigerant must come from a nearby condensing unit. When a refrigerant is used, the cooling coil is the evaporator, and the heating coil is the condenser in the vapor-compression refrigeration cycle. HVAC coils that use this direct-expansion of refrigerants are commonly called *DX coils*. Some *DX coils* are "microchannel" type.<sup>[5]</sup>

On the air side of HVAC coils a significant difference exists between those used for heating, and those for cooling. Due to psychrometrics, air that is cooled often has moisture condensing out of it, except with extremely dry air flows. Heating some air increases that airflow's capacity to hold water. So heating coils need not consider moisture condensation on their air-side, but cooling coils *must* be adequately designed and selected to handle their particular *latent* (moisture) as well as the *sensible* (cooling) loads. The water that is removed is called *condensate*.

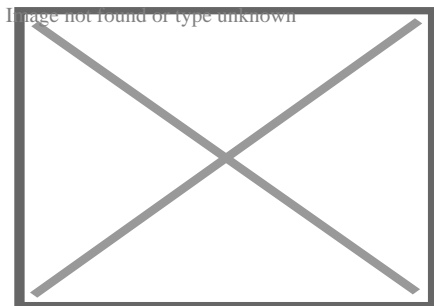
For many climates, water or steam HVAC coils can be exposed to freezing conditions. Because water expands upon freezing, these somewhat expensive and difficult to replace thin-walled heat exchangers can easily be damaged or destroyed by just one freeze. As such, freeze protection of coils is a major concern of HVAC designers, installers, and operators.

The introduction of indentations placed within the heat exchange fins controlled condensation, allowing water molecules to remain in the cooled air.<sup>[18]</sup>

The heat exchangers in direct-combustion furnaces, typical in many residences, are not 'coils'. They are, instead, gas-to-air heat exchangers that are typically made of stamped steel sheet metal. The combustion products pass on one side of these heat exchangers, and air to heat on the other. A *cracked heat exchanger* is therefore a dangerous situation that requires immediate attention because combustion products may enter living space.

## Helical-coil

[edit]



Helical-Coil Heat Exchanger sketch, which consists of a shell, core, and tubes (Scott S. Haraburda design)

Although double-pipe heat exchangers are the simplest to design, the better choice in the following cases would be the helical-coil heat exchanger (HCHE):

- The main advantage of the HCHE, like that for the Spiral heat exchanger (SHE), is its highly efficient use of space, especially when it's limited and not enough

straight pipe can be laid.[<sup>19</sup>]

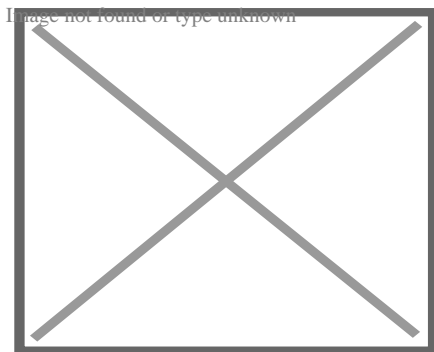
- Under conditions of low flowrates (or laminar flow), such that the typical shell-and-tube exchangers have low heat-transfer coefficients and becoming uneconomical.[<sup>19</sup>]
- When there is low pressure in one of the fluids, usually from accumulated pressure drops in other process equipment.[<sup>19</sup>]
- When one of the fluids has components in multiple phases (solids, liquids, and gases), which tends to create mechanical problems during operations, such as plugging of small-diameter tubes.[<sup>20</sup>] Cleaning of helical coils for these multiple-phase fluids can prove to be more difficult than its shell and tube counterpart; however the helical coil unit would require cleaning less often.

These have been used in the nuclear industry as a method for exchanging heat in a sodium system for large liquid metal fast breeder reactors since the early 1970s, using an HCHE device invented by Charles E. Boardman and John H. Germer.[<sup>21</sup>] There are several simple methods for designing HCHE for all types of manufacturing industries, such as using the Ramachandra K. Patil (et al.) method from India and the Scott S. Haraburda method from the United States.[<sup>19</sup>][<sup>20</sup>]

However, these are based upon assumptions of estimating inside heat transfer coefficient, predicting flow around the outside of the coil, and upon constant heat flux.[<sup>22</sup>]

## Spiral

[edit]



Schematic drawing of a spiral heat exchanger

A modification to the perpendicular flow of the typical HCHE involves the replacement of shell with another coiled tube, allowing the two fluids to flow parallel to one another, and which requires the use of different design calculations.[<sup>23</sup>] These are the Spiral Heat Exchangers (SHE), which may refer to a helical (coiled) tube configuration, more generally, the term refers to a pair of flat surfaces that are coiled to form the two channels in a counter-flow arrangement. Each of the two channels has one long curved

path. A pair of fluid ports are connected tangentially to the outer arms of the spiral, and axial ports are common, but optional.<sup>[24]</sup>

The main advantage of the SHE is its highly efficient use of space. This attribute is often leveraged and partially reallocated to gain other improvements in performance, according to well known tradeoffs in heat exchanger design. (A notable tradeoff is capital cost vs operating cost.) A compact SHE may be used to have a smaller footprint and thus lower all-around capital costs, or an oversized SHE may be used to have less pressure drop, less pumping energy, higher thermal efficiency, and lower energy costs.

## Construction

[edit]

The distance between the sheets in the spiral channels is maintained by using spacer studs that were welded prior to rolling. Once the main spiral pack has been rolled, alternate top and bottom edges are welded and each end closed by a gasketed flat or conical cover bolted to the body. This ensures no mixing of the two fluids occurs. Any leakage is from the periphery cover to the atmosphere, or to a passage that contains the same fluid.<sup>[25]</sup>

## Self cleaning

[edit]

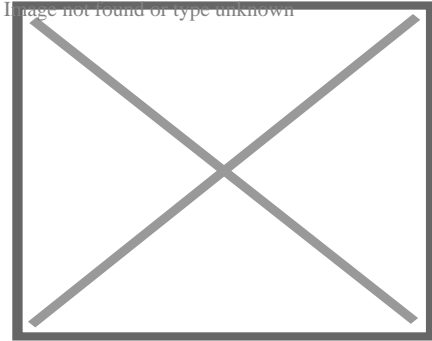
Spiral heat exchangers are often used in the heating of fluids that contain solids and thus tend to foul the inside of the heat exchanger. The low pressure drop lets the SHE handle fouling more easily. The SHE uses a “self cleaning” mechanism, whereby fouled surfaces cause a localized increase in fluid velocity, thus increasing the drag (or fluid friction) on the fouled surface, thus helping to dislodge the blockage and keep the heat exchanger clean. "The internal walls that make up the heat transfer surface are often rather thick, which makes the SHE very robust, and able to last a long time in demanding environments."<sup>[citation needed]</sup> They are also easily cleaned, opening out like an oven where any buildup of foulant can be removed by pressure washing.

Self-cleaning water filters are used to keep the system clean and running without the need to shut down or replace cartridges and bags.



# Flow arrangements

[edit]



A comparison between the operations and effects of a **cocurrent and a countercurrent flow exchange system** is depicted by the upper and lower diagrams respectively. In both it is assumed (and indicated) that red has a higher value (e.g. of temperature) than blue and that the property being transported in the channels therefore flows from red to blue. Channels are contiguous if effective exchange is to occur (i.e. there can be no gap between the channels).

There are three main types of flows in a spiral heat exchanger:

- **Counter-current Flow:** Fluids flow in opposite directions. These are used for liquid-liquid, condensing and gas cooling applications. Units are usually mounted vertically when condensing vapour and mounted horizontally when handling high concentrations of solids.
- **Spiral Flow/Cross Flow:** One fluid is in spiral flow and the other in a cross flow. Spiral flow passages are welded at each side for this type of spiral heat exchanger. This type of flow is suitable for handling low density gas, which passes through the cross flow, avoiding pressure loss. It can be used for liquid-liquid applications if one liquid has a considerably greater flow rate than the other.
- **Distributed Vapour/Spiral flow:** This design is that of a condenser, and is usually mounted vertically. It is designed to cater for the sub-cooling of both condensate and non-condensables. The coolant moves in a spiral and leaves via the top. Hot gases that enter leave as condensate via the bottom outlet.

## Applications

[edit]

The Spiral heat exchanger is good for applications such as pasteurization, digester heating, heat recovery, pre-heating (see: recuperator), and effluent cooling. For sludge treatment, SHEs are generally smaller than other types of heat exchangers.<sup>[citation needed]</sup> These are used to transfer the heat.

## Selection

[edit]

Due to the many variables involved, selecting optimal heat exchangers is challenging. Hand calculations are possible, but many iterations are typically needed. As such, heat exchangers are most often selected via computer programs, either by system designers, who are typically engineers, or by equipment vendors.

To select an appropriate heat exchanger, the system designers (or equipment vendors) would firstly consider the design limitations for each heat exchanger type. Though cost is often the primary criterion, several other selection criteria are important:

- High/low pressure limits
- Thermal performance
- Temperature ranges
- Product mix (liquid/liquid, particulates or high-solids liquid)
- Pressure drops across the exchanger
- Fluid flow capacity
- Cleanability, maintenance and repair
- Materials required for construction
- Ability and ease of future expansion
- Material selection, such as copper, aluminium, carbon steel, stainless steel, nickel alloys, ceramic, polymer, and titanium.<sup>[26]</sup><sup>[27]</sup>

Small-diameter coil technologies are becoming more popular in modern air conditioning and refrigeration systems because they have better rates of heat transfer than conventional sized condenser and evaporator coils with round copper tubes and aluminum or copper fin that have been the standard in the HVAC industry. Small diameter coils can withstand the higher pressures required by the new generation of environmentally friendlier refrigerants. Two small diameter coil technologies are currently available for air conditioning and refrigeration products: copper microgroove<sup>[28]</sup> and brazed aluminum microchannel.<sup>[citation needed]</sup>

Choosing the right heat exchanger (HX) requires some knowledge of the different heat exchanger types, as well as the environment where the unit must operate. Typically in the manufacturing industry, several differing types of heat exchangers are used for just one process or system to derive the final product. For example, a kettle HX for pre-

heating, a double pipe HX for the 'carrier' fluid and a plate and frame HX for final cooling. With sufficient knowledge of heat exchanger types and operating requirements, an appropriate selection can be made to optimise the process.[<sup>29</sup>]

## Monitoring and maintenance

[edit]

Online monitoring of commercial heat exchangers is done by tracking the overall heat transfer coefficient. The overall heat transfer coefficient tends to decline over time due to fouling.

By periodically calculating the overall heat transfer coefficient from exchanger flow rates and temperatures, the owner of the heat exchanger can estimate when cleaning the heat exchanger is economically attractive.

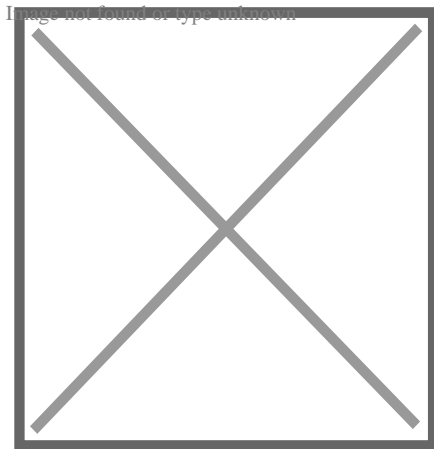
Integrity inspection of plate and tubular heat exchanger can be tested in situ by the conductivity or helium gas methods. These methods confirm the integrity of the plates or tubes to prevent any cross contamination and the condition of the gaskets.

Mechanical integrity monitoring of heat exchanger tubes may be conducted through Nondestructive methods such as eddy current testing.

## Fouling

[edit]

Main article: Fouling



A heat exchanger in a steam power station contaminated with macrofouling

Fouling occurs when impurities deposit on the heat exchange surface. Deposition of these impurities can decrease heat transfer effectiveness significantly over time and are caused by:

- Low wall shear stress
- Low fluid velocities
- High fluid velocities
- Reaction product solid precipitation
- Precipitation of dissolved impurities due to elevated wall temperatures

The rate of heat exchanger fouling is determined by the rate of particle deposition less re-entrainment/suppression. This model was originally proposed in 1959 by Kern and Seaton.

**Crude Oil Exchanger Fouling.** In commercial crude oil refining, crude oil is heated from 21 °C (70 °F) to 343 °C (649 °F) prior to entering the distillation column. A series of shell and tube heat exchangers typically exchange heat between crude oil and other oil streams to heat the crude to 260 °C (500 °F) prior to heating in a furnace. Fouling occurs on the crude side of these exchangers due to asphaltene insolubility. The nature of asphaltene solubility in crude oil was successfully modeled by Wiehe and Kennedy.[<sup>30</sup>] The precipitation of insoluble asphaltenes in crude preheat trains has been successfully modeled as a first order reaction by Ebert and Panchal[<sup>31</sup>] who expanded on the work of Kern and Seaton.

**Cooling Water Fouling.** Cooling water systems are susceptible to fouling. Cooling water typically has a high total dissolved solids content and suspended colloidal solids. Localized precipitation of dissolved solids occurs at the heat exchange surface due to wall temperatures higher than bulk fluid temperature. Low fluid velocities (less than 3 ft/s) allow suspended solids to settle on the heat exchange surface. Cooling water is typically on the tube side of a shell and tube exchanger because it's easy to clean. To prevent fouling, designers typically ensure that cooling water velocity is greater than 0.9 m/s and bulk fluid temperature is maintained less than 60 °C (140 °F). Other approaches to control fouling control combine the "blind" application of biocides and anti-scale chemicals with periodic lab testing.

## Maintenance

[edit]

Plate and frame heat exchangers can be disassembled and cleaned periodically. Tubular heat exchangers can be cleaned by such methods as acid cleaning,

sandblasting, high-pressure water jet, bullet cleaning, or drill rods.

In large-scale cooling water systems for heat exchangers, water treatment such as purification, addition of chemicals, and testing, is used to minimize fouling of the heat exchange equipment. Other water treatment is also used in steam systems for power plants, etc. to minimize fouling and corrosion of the heat exchange and other equipment.

A variety of companies have started using water borne oscillations technology to prevent biofouling. Without the use of chemicals, this type of technology has helped in providing a low-pressure drop in heat exchangers.

## Design and manufacturing regulations

[edit]

The design and manufacturing of heat exchangers has numerous regulations, which vary according to the region in which they will be used.

Design and manufacturing codes include: ASME Boiler and Pressure Vessel Code (US); PD 5500 (UK); BS 1566 (UK);<sup>[32]</sup> EN 13445 (EU); CODAP (French); Pressure Equipment Safety Regulations 2016 (PER) (UK); Pressure Equipment Directive (EU); NOROK (Norwegian); TEMA;<sup>[33]</sup> API 12; and API 560.<sup>[citation needed]</sup>

## In nature

[edit]

# Humans

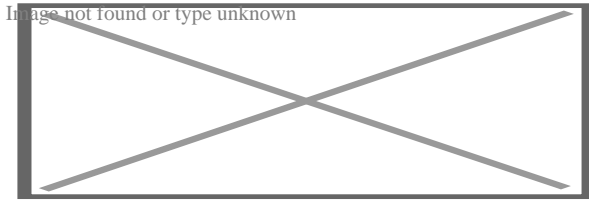
[edit]

The human nasal passages serve as a heat exchanger, with cool air being inhaled and warm air being exhaled. Its effectiveness can be demonstrated by putting the hand in front of the face and exhaling, first through the nose and then through the mouth. Air exhaled through the nose is substantially cooler.<sup>[34]</sup><sup>[35]</sup> This effect can be enhanced with clothing, by, for example, wearing a scarf over the face while breathing in cold weather.

In species that have external testes (such as human), the artery to the testis is surrounded by a mesh of veins called the pampiniform plexus. This cools the blood heading to the testes, while reheating the returning blood.

# Birds, fish, marine mammals

[edit]



Counter-current exchange conservation circuit

Further information: Counter-current exchange in biological systems

"Countercurrent" heat exchangers occur naturally in the circulatory systems of fish, whales and other marine mammals. Arteries to the skin carrying warm blood are intertwined with veins from the skin carrying cold blood, causing the warm arterial blood to exchange heat with the cold venous blood. This reduces the overall heat loss in cold water. Heat exchangers are also present in the tongues of baleen whales as large volumes of water flow through their mouths.<sup>[36]</sup><sup>[37]</sup> Wading birds use a similar system to limit heat losses from their body through their legs into the water.

## Carotid rete

[edit]

Carotid rete is a counter-current heat exchanging organ in some ungulates. The blood ascending the carotid arteries on its way to the brain, flows via a network of vessels where heat is discharged to the veins of cooler blood descending from the nasal passages. The carotid rete allows Thomson's gazelle to maintain its brain almost 3 °C (5.4 °F) cooler than the rest of the body, and therefore aids in tolerating bursts in metabolic heat production such as associated with outrunning cheetahs (during which the body temperature exceeds the maximum temperature at which the brain could function).<sup>[38]</sup> Humans with other primates lack a carotid rete.<sup>[39]</sup>

### In industry

[edit]

Heat exchangers are widely used in industry both for cooling and heating large scale industrial processes. The type and size of heat exchanger used can be tailored to suit a process depending on the type of fluid, its phase, temperature, density, viscosity, pressures, chemical composition and various other thermodynamic properties.

In many industrial processes there is waste of energy or a heat stream that is being exhausted, heat exchangers can be used to recover this heat and put it to use by heating a different stream in the process. This practice saves a lot of money in industry, as the heat supplied to other streams from the heat exchangers would otherwise come from an external source that is more expensive and more harmful to the environment.

Heat exchangers are used in many industries, including:

- Waste water treatment
- Refrigeration
- Wine and beer making
- Petroleum refining
- Nuclear power

In waste water treatment, heat exchangers play a vital role in maintaining optimal temperatures within anaerobic digesters to promote the growth of microbes that remove pollutants. Common types of heat exchangers used in this application are the double pipe heat exchanger as well as the plate and frame heat exchanger.

### **In aircraft**

[edit]

In commercial aircraft heat exchangers are used to take heat from the engine's oil system to heat cold fuel.<sup>[40]</sup> This improves fuel efficiency, as well as reduces the possibility of water entrapped in the fuel freezing in components.<sup>[41]</sup>

### **Current market and forecast**

[edit]

Estimated at US\$17.5 billion in 2021, the global demand of heat exchangers is expected to experience robust growth of about 5% annually over the next years. The market value is expected to reach US\$27 billion by 2030. With an expanding desire for environmentally friendly options and increased development of offices, retail sectors, and public buildings, market expansion is due to grow.<sup>[42]</sup>

## A model of a simple heat exchanger

[edit]

A simple heat exchange [43][44] might be thought of as two straight pipes with fluid flow, which are thermally connected. Let the pipes be of equal length  $L$ , carrying fluids with heat capacity  $c_p$  (per unit mass per unit change in temperature) and let the mass flow rate of the fluids through the pipes, both in the same direction, be  $\dot{m}_i$  (per unit time), where the subscript  $i$  applies to pipe 1 or pipe 2.

Temperature profiles for the pipes are  $T_1(x)$  and  $T_2(x)$  the distance along the pipe. Assume a steady state, so that the temperature profiles are not functions of time. Assume also that the only transfer of heat from a small volume of fluid in one pipe is to the fluid element in the other pipe at the same position, i.e., there is no transfer of heat along a pipe due to temperature differences in that pipe. By Newton's law of cooling the rate of change in energy of a small volume of fluid is proportional to the difference in temperatures between it and the corresponding element in the other pipe:

$$\frac{du_1}{dt} = \gamma (T_2 - T_1)$$

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$$\frac{du_2}{dt} = \gamma (T_1 - T_2)$$

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( this is for parallel flow in the same direction and opposite temperature gradients, but for counter-flow heat exchange countercurrent exchange the sign is opposite in the second equation in front of  $\gamma$  ) where  $\gamma$  is the thermal energy per unit length and  $\gamma$  is the thermal connection constant per unit length between the two pipes. This change in internal energy results in a change in the temperature of the fluid element. The time rate of change for the fluid element being carried along by the flow is:

$$\frac{du_1}{dt} = J_1 \frac{dT_1}{dx}$$

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$$\frac{du_2}{dt} = J_2 \frac{dT_2}{dx}$$

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where  $J_i$  is the "thermal mass flow rate". The differential equations governing the heat exchanger may now be written as:

$$J_1 \frac{\partial T_1}{\partial x} = \gamma (T_2 - T_1)$$

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$$\frac{\partial T_2}{\partial x} = \gamma (T_1 - T_2).$$

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Since the system is in a steady state, there are no partial derivatives of temperature with respect to time, and since there is no heat transfer along the pipe, there are no second derivatives in  $x$  as is found in the heat equation. These two coupled first-order differential equations may be solved to yield:

$$T_1 = A - \frac{Bk_1}{k}, e^{-kx}$$

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$$T_2 = A + \frac{Bk_2}{k}, e^{-kx}$$

Image not found or type unknown

where  $k = \frac{h_1 + h_2}{D} = \gamma \frac{J_2}{J_1}$

$$k = k_1 + k_2$$

(this is for parallel-flow, but for counter-flow the sign in front of  $k_2$  that if  $k_1 = k_2$  the same "thermal mass flow rate" in both opposite directions, the gradient of temperature is constant and the temperatures linear in position  $x$  with a constant difference  $(T_2 - T_1)$  along the exchanger, explaining why the counter current design countercurrent exchange is the most efficient )

and  $A$  and  $B$  are two as yet undetermined constants of integration. Let  $T_1$  and  $T_2$  be the temperatures at  $x=0$  and let  $T_1L$  and  $T_2L$  be the temperatures at the end of the pipe at  $x=L$ . Define the average temperatures in each pipe as:

$$\overline{T_1} = \frac{1}{L} \int_0^L T_1(x) dx$$

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$$\overline{T_2} = \frac{1}{L} \int_0^L T_2(x) dx.$$

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Using the solutions above, these temperatures are:

$$T_1 = A - \frac{Bk_1}{k} e^{-kx} \quad T_2 = A + \frac{Bk_2}{k} e^{-kx}$$

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$$T_1L = A - \frac{Bk_1}{k} e^{-kL} \quad T_2L = A + \frac{Bk_2}{k} e^{-kL}$$

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$$\overline{T_1} = A - \frac{Bk_1}{k^2L} (1 - e^{-kL}) \quad \overline{T_2} = A + \frac{Bk_2}{k^2L} (1 - e^{-kL})$$

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Choosing any two of the temperatures above eliminates the constants of integration, letting us find the other four temperatures. We find the total energy transferred by integrating the expressions for the time rate of change of internal energy per unit length:

$$\frac{dU_1}{dt} = \int_0^L \frac{du_1}{dt} dx = J_1(T_{1L} - T_{10}) = \gamma L \overline{\frac{T_2 - T_1}{\ln \frac{T_2 - T_2}{T_1 - T_1}}}$$

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$$\frac{dU_2}{dt} = \int_0^L \frac{du_2}{dt} dx = J_2(T_{2L} - T_{20}) = \gamma L \overline{\frac{T_2 - T_1}{\ln \frac{T_2 - T_2}{T_1 - T_1}}}$$

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By the conservation of energy, the sum of the two energies is zero. The quantity  $\overline{\frac{T_2 - T_1}{\ln \frac{T_2 - T_2}{T_1 - T_1}}}$  is known as the *Log mean temperature difference*, and is a measure of the effectiveness of the heat exchanger in transferring heat energy.

## See also

[edit]

- Architectural engineering
- Chemical engineering
- Cooling tower
- Copper in heat exchangers
- Heat pipe
- Heat pump
- Heat recovery ventilation
- Jacketed vessel
- Log mean temperature difference (LMTD)
- Marine heat exchangers
- Mechanical engineering
- Micro heat exchanger
- Moving bed heat exchanger
- Packed bed and in particular Packed columns
- Pumpable ice technology
- Reboiler
- Recuperator, or cross plate heat exchanger
- Regenerator
- Run around coil
- Steam generator (nuclear power)
- Surface condenser
- Toroidal expansion joint
- Thermosiphon
- Thermal wheel, or rotary heat exchanger (including enthalpy wheel and desiccant wheel)

- Tube tool
- Waste heat

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## External links

[edit]

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Wikimedia Commons has media related to ***Heat exchangers***.

- o Shell and Tube Heat Exchanger Design Software for Educational Applications (PDF)
- o EU Pressure Equipment Guideline
- o A Thermal Management Concept For More Electric Aircraft Power System Application (PDF)

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- o United States
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Heating, ventilation, and air conditioning

**Fundamental  
concepts**

- Air changes per hour
- 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

## Technology

- 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
- Hydronics
- Ice storage air conditioning
- Kitchen ventilation
- Mixed-mode ventilation
- Microgeneration
- Passive cooling
- Passive daytime radiative cooling
- Passive house
- Passive ventilation
- Radiant heating and cooling
- Radiant cooling
- Radiant heating
- Radon mitigation
- Refrigeration
- Renewable heat
- Room air distribution
- Solar air heat
- Solar combisystem
- Solar cooling



- 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
- Exhaust hood
- Expansion tank
- Fan
- Fan coil unit
- Fan filter unit
- Fan heater
- Fire damper
- Fireplace
- Fireplace insert
- Freeze stat
- Flue
- Freon
- Fume hood
- Furnace
- Gas compressor
- Gas heater
- Gasoline heater
- Grease duct

**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
- Architectural acoustics
- Architectural engineering
- Architectural technologist
- Building services engineering
- Building information modeling (BIM)
- Deep energy retrofit

**Professions,  
trades,  
and services**

- 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)
- ASHRAE Handbook
- Building science
- Fireproofing

**See also**

- Glossary of HVAC terms
- Warm Spaces
- World Refrigeration Day
- Template:Home automation
- Template:Solar energy

**About Durham Supply Inc**

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**Things To Do in Tulsa County**

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**Photo**

## **Streetwalker Tours**

**0 (0)**

### **Photo**

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## **Tulsa Botanic Garden**

**4.7 (1397)**

### **Photo**

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## **Tours of Tulsa**

**4.9 (291)**

### **Photo**

**Tulsa Air and Space Museum & Planetarium**

**4.3 (419)**

**Photo**

Image not found or type unknown

**Tulsa Zoo**

**4.5 (10482)**

**Photo**

Image not found or type unknown

**Center of the Universe**

**4.4 (4471)**

**Driving Directions in Tulsa County**

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**Driving Directions From Best Western Airport to Durham Supply Inc**

**Driving Directions From OYO Hotel Tulsa International Airport to Durham Supply Inc**

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**Driving Directions From Tulsa Botanic Garden to Durham Supply Inc**

**Driving Directions From Gathering Place to Durham Supply Inc**

**Driving Directions From The Blue Dome to Durham Supply Inc**

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**Reviews for Durham Supply Inc**

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## Durham Supply Inc

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**Gerald Clifford Brewster**

**(5)**

We will see, the storm door I bought says on the tag it's 36x80, but it's 34x80. If they return it.....they had no problems returning it. And it was no fault of there's, you measure a mobile home door different than a standard door!

## Durham Supply Inc

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**B Mann**

**(5)**

I was in need of some items for a double wide that I am remodeling and this place is the only place in town that had what I needed ( I didn't even try the other rude place )while I was there I learned the other place that was in Tulsa that also sold mobile home supplies went out of business (no wonder the last time I was in there they were VERY RUDE and high priced) I like the way Dunham does business they answered all my questions and got me the supplies I needed, very friendly, I will be back to purchase the rest of my items when the time comes.

## Durham Supply Inc

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**Dennis Champion**

**(5)**

Durham supply and Royal supply seems to find the most helpful and friendly people to work in their stores, we are based out of Kansas City out here for a few remodels and these guys treated us like we've gone there for years.

## Durham Supply Inc

Image not found or type unknown

**Ty Spears**

**(5)**

Bought a door/storm door combo. Turns out it was the wrong size. They swapped it out, quick and easy no problems. Very helpful in explaining the size differences from standard door sizes.

## Durham Supply Inc

Image not found or type unknown

**Ethel Schiller**



**(5)**

This place is really neat, if they don't have it they can order it from another of their stores and have it there overnight in most cases. Even hard to find items for a trailer! I definitely recommend this place to everyone! O and the prices is awesome too!

Monitoring Air Quality Factors During Mobile Home HVAC Upkeep [View GBP](#)

## Frequently Asked Questions

**What are the key air quality factors to monitor during mobile home HVAC maintenance?**

The key air quality factors to monitor include particulate matter levels, humidity, and volatile organic compounds (VOCs). These elements directly impact indoor air quality and can affect both health and comfort in a mobile home environment.

**How can HVAC upkeep improve air quality in a mobile home?**

Regular HVAC maintenance, such as cleaning or replacing filters, checking for leaks in ductwork, and servicing components like coils and fans, helps ensure efficient operation. This reduces contaminants like dust and allergens while maintaining proper ventilation, thereby improving overall air quality.

**What tools or devices are recommended for monitoring air quality during HVAC upkeep?**

Use digital air quality monitors that measure particulate matter (PM2.5), humidity sensors for moisture levels, and VOC detectors for chemical pollutants. These devices provide real-time data that help identify issues and guide necessary adjustments or repairs during maintenance.

Royal Supply Inc

Phone : +16362969959

City : Oklahoma City

State : OK

Zip : 73149

Address : Unknown Address

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Company Website : <https://royal-durhamsupply.com/locations/oklahoma-city-oklahoma/>

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