

Geography of a Process plant

Geography is the science or the study of earth and its life; a description of land, sea, air and the distribution of plant and animal life including people and cities.

We will study the steam circuit in a typical process plant, describe the various loops within the steam system and study how the different parts of the steam plant relate to each other.

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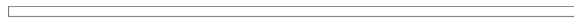
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Typical steam circuit

Steam runs in a closed circuit. Steam starts from the boiler, is utilised by the process and returns back via the condensate line.

Generation. Heat is applied to water in the boiler. We convert water to gas, steam. The resultant expansion, pressurizes the system. Steam is forced out of the boiler by its own pressure. It moves into the second stage

Distribution. Steam is carried by piping to various equipment that heat or process material. Again, the steam is carried along because of pressure changes within the system. Steam has now arrived at its point of use.

Utilisation. Heat from the steam is now put to work. Special devices absorb heat from steam to do different types of jobs. As the steam gives up its heat through heat transfer or use, it condenses or changes its state - this time from a gas back into a liquid. This is called condensate. As condensate can lead to various problems in the steam system, it is drained via steam traps almost immediately.

Condensate Return. Condensate is that is already treated before entering the steam circuit. If this is returned to the boiler, it can replace an equal quantity of cold make-up water. This is not only energy-wise but also helps save fuel.

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Generation - the boiler house and its controls

The boiler

Our journey starts at the boiler house. Our boiler has to be safe, efficient, its pressure and temperature must be well controlled. Also, it has to be economical to run.

REFER We explain boilers in full in the "Boilogy" section.

Boiler Feedtanks

One of the most important factors in keeping your boiler on-line is to keep enough water in it. Otherwise the boiler will shutdown on a low water condition. This is especially true with firetube boilers that are fired automatically. That is why it is so important to size a feedwater system so that it has the capability of maintaining the proper water level in your boiler.

A properly sized feedwater system will have a tank adequately sized to feed your boiler and pumps selected to deliver that water at the correct rate and pressure. Typical FWT size is 2.5 to 3 times of generation.

Furnace

Space in a boiler where a burner burns oil, gas or pulverized (finely ground) coal.

Burners mix air with fuel to provide oxygen in the combustion process. A burner sends heat into the boiler tubes and it is set to maintain the correct pressure in the boiler. If the boiler pressure falls because of growing steam demand, the burner switches on to produce more steam from the boiler. As long as the amount of steam being produced in the boiler is as great as that leaving the boiler, the boiler will remain pressurised. This maintains correct pressure. If correct pressure is maintained, correct temperature is also maintained as they are interlinked.

REFER Combustion, stack losses etc are covered in Chemistry.

Boiler mountings - for maximum safety

These are provided for the safe working of boilers. A feed check valve, a main steam stop valve, a safety valve, water level indicator, a fusible plug are some of the mountings. They are mounted on the boiler shell and are a must for every boiler.

- Feed check valve
- Main steam stop valve
- Mobrey - water level indicator
- Safety Valve
- Gauge glass
- Feed pumps
- Fusible plug
- MSSV

Boiler auxiliaries - for high efficiency and economical running

These are used to improve the efficiency of the boiler. An economiser, super heater and air pre-heater are the main accessories. These are not a must for any boiler but are highly desirable.

- Economisers
- Super-heaters
- Air pre-heaters

Boiler controls - for regulating boiler parameters

We must have an excellent control on pressure and temperature as well as other parameters in the boiler.

- Combustion control
- Air control
- Feedwater level control
- Blowdown control
- Furnace Pressure control
- Steam temperature control
- Cold end temperature control
- Soot blower control

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Distribution – piping steam to the plant

The boiler has one or two main steam pipes – called steam mains. These branch outwards to smaller pipes which distribute steam to various processes.

Boilers generate pressurised steam, as it occupies less space. So, more steam can be produced by a smaller high pressure boiler and transferred to the point of use using small bore pipework. Steam pressure is then reduced at the point of use.

The steam flows through the pipes losing heat via radiation. As steam condenses to water, the pressure drops, suctioning the steam forward. This pressure drop creates the flow of steam through the pipes.

Condensate and Air in the distribution system

Knowing that it is virtually impossible to keep air, oxygen and carbon dioxide from getting into a system, lets deal with getting them out of a system. These gases become free when the steam condenses.

We must drain condensate out of our distribution system because it can

- reduce heat transfer , and
- cause water hammer

We also should evacuate air and other non-condensable gases because they

- can reduce heat transfer by reducing steam temperature and insulating the system
- foster destructive corrosion

For this, we use a device called a steam trap, which is simply an automatic valve that opens for condensate , air and CO₂ and closes for steam. For economic reasons , the steam trap should do its work for long periods with minimum attention.

REFER Water hammer, corrosion due to gases, etc. are fully explained in Chemistry.



Piping details and steam traps will be taken up in detail in Training Level 2.

Once the steam has been employed in the process, the resulting condensate needs to be drained from the plant and returned to the boiler house. This loop is called the condensate loop and is talked about later in this Module.

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Utilisation – steam and the process

Steam is generated, distributed and now it reaches the point of use. At the point of use, steam gives up its energy to the process, ie, a heat transfer takes place. Steam could be utilised for example, by any of the following processes:

- Jacketed vessels
- Heat exchanger
- Autoclave
- Heater battery
- Process tank heating

Pressure reduction

We control steam to the process on start-up and also during normal working. Why?

- On startup, a gradually increasing flow of steam will be needed to deliver slow heat build-up in the plant. As the process reaches the desired temperature, the flow must be reduced.

- More important, steam is usually generated at high pressure, and the pressure may have to be reduced at the point of use, either because of the pressure limitations of the plant, or the temperature limitations of the process.

We therefore need a way to control the flow of steam. A PRV is a special Pressure Reducing Valve which functions as a safety device to keep the low pressure header from gaining more low pressure steam than it can distribute. A variety of pressure control options exist, from the simplest to the more complicated and accurate pressure reducers.

1. Pilot operated:
Ex: Spirax DP 17 / DP 143
2. Self-acting diaphragm-type:
It is comparatively a low cost valve, and is easy to maintain. It is a mechanical device and can be easily looked after by the normal maintenance crew.
Ex: Steamline Samson 41-23
3. Pneumatically actuated valves: Compressed air is applied to a diaphragm in the "actuator" to open or close the valve. The process has a sensor which is relaying process conditions to the controller. Depending on the set values, the controller compares the process condition with the set value and sends a corrective signal to the actuator, which adjusts the valve setting.

The CV is an electro-mechanical device and is highly specialized. Its accuracy is very high, but it is expensive. It needs trained personnel for maintenance.
Ex: Samson 241-1, Arca



Distribution end: On the steam mains and distribution lines, we reduce pressure using a simple direct-acting pressure reducing valve or a pilot operated valve. (1 or 2 above)

Utilisation end: This is the process end, which is a more critical area, and here control valves are used to control the flow of steam. (3 or 4 above)

The need to drain the heat transfer unit

When steam comes in contact with condensate cooled below the temperature of steam, it can produce another kind of water hammer known as thermal shock. Steam occupies a much greater volume than condensate, and when it collapses suddenly, it can send shock waves throughout the system. This form of water hammer can damage equipment, and it signals that condensate is not being drained from the system. Obviously, condensate in the heat transfer unit takes up space and reduces the physical size and capacity of the equipment. Removing it quickly keeps the unit full of steam.

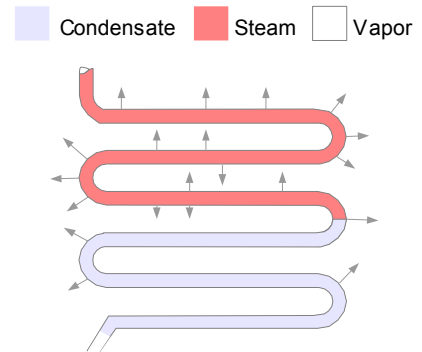


Fig. Coil half-full of condensate can't work at full capacity.

As steam condenses, it forms a film of water on the inside of the heat exchanger. Non-condensable gases do not change into liquid and flow away by gravity. Instead, they accumulate as a thin film on the surface of the heat exchanger - along with dirt and scale. All are potential barriers to heat transfer.

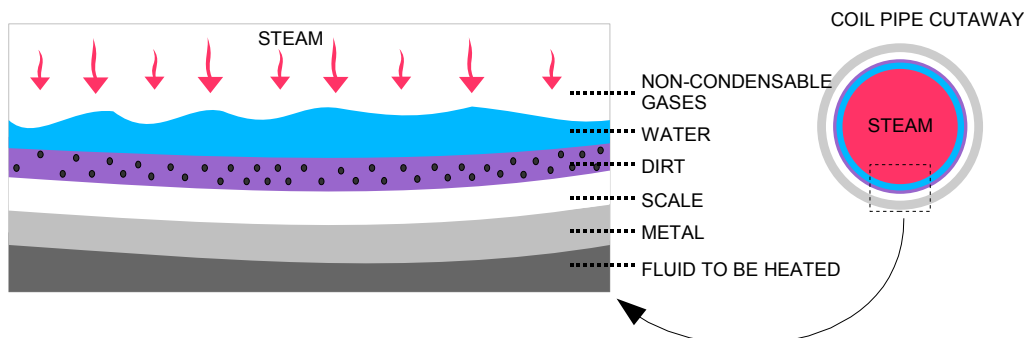


Fig. Potential barriers to heat transfer: steam heat and temperature must penetrate these potential barriers to do their work.

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The need for Steam traps

All steam pipes and heat exchangers are drained by steam traps placed at strategic locations. The job of the steam trap is to get condensate, air and CO₂ out of the system as quickly as they accumulate.

- Condensate does not transmit heat effectively. A film of condensate inside plant will reduce the efficiency with which heat is transferred. Condensate also causes water hammer.
- Dissolved air causes corrosion.

In addition, for overall efficiency and economy, the trap must also provide.

- Minimal steam loss. Unattended steam leaks can be very costly.
- Long life and dependable service. Rapid wear of parts quickly brings a trap to the point of unavailability. An efficient trap saves money by minimizing trap testing, repair, cleaning, downtime and associated losses.
- Corrosion resistance. Working trap parts should be corrosion-resistant in order to combat the damaging effects of acidic or oxygen-laden condensate.
- Air venting. Air can be present in steam at any time and especially on start-up. Air must be vented for efficient heat transfer and to prevent system binding.
- CO₂ venting. Venting CO₂ at steam temperature will prevent the formation of carbonic acid. Therefore, the steam trap must function at or near steam temperature since CO₂ dissolves in condensate that has cooled below steam temperature.
- Operation against back pressure. Pressurized return lines can occur both design and unintentionally. A steam trap should be able to operate against the actual back pressure in its return system.
- Freedom from dirt problems. Dirt is an ever-present concern since traps are located at low points in the steam system. Condensate picks up dirt and scale in the piping, and solids may carry over from the boiler. Even particles passing through strainer screens are corrosive and, therefore, the steam trap must be able to operate in the presence of dirt.

A trap delivering anything less than all these desirable operating /design features will reduce the efficiency of the system and increase costs. When a trap delivers all these features the system can achieve.

- Fast heat-up of heat transfer equipment.
- Maximum equipment temperature for enhanced steam heat transfer.
- Maximum equipment capacity.
- Maximum fuel economy.
- Reduced labour per unit of output.
- Minimum maintenance and a long trouble-free service life.

Sometimes an application may demand a trap without these design features, but in the vast majority of applications the trap which meets all the requirements will deliver the best results.

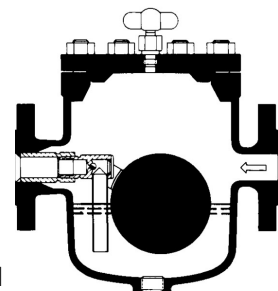
Types of traps

There are three primary categories of steam traps:

1. Mechanical: This trap is made up of mechanical apparatus that are driven by the density of the condensate to operate a float or a bucket.

Float traps

In the float steam trap a valve is connected to a float in such a way that a valve opens when the float rises. As condensate enters the trap, a float is raised and the float lever mechanism opens the main valve to allow condensate to drain. When the condensate flow reduces the float falls and closes the main valve, thus preventing the escape of steam. The valve is positioned so that when the float is at rest the valve is seated in the outlet of the trap, i.e., it is closed.



2. Thermodynamic: In addition to downstream flash steam assist, this type of trap operates on the difference in velocity or kinetic energy between steam and condensate passing through a fixed or modulating orifice. These are mostly used for mainline applications. They are comparatively cheap. This is a blast discharge trap, not a continuous discharge type. There is a build-up of condensate which is then discharged at one go. The float inside this trap is mechanically coupled to a valve.



Thermodynamic traps contain a disc which opens to condensate and closes to steam. This trap is reliable, effective and has a long life. The float is made of pressed SS on Titanium and the body is generally CS or cast iron. There are 10 times as many TD traps compared to float traps.

4. Thermostatic: This type of trap operates on the principle of expanding liquids and metals used to drive a valve into or back it away from a seat. There are two basic designs for the thermostatic steam trap, a bimetallic and a balanced pressure design. Both designs use the difference in temperature between live steam and condensate or air to control the release of condensate and air from the steam line.



These are mostly used for process applications. These traps are used in 10% of total applications. They are reliable but expensive, so only used in critical applications.

Which trap is preferred depends on the application. A steam trap prime missions is to remove condensate and air preventing escape of live steam from the distribution system. The steam trap must adapt to the application. A disc thermodynamic steam trap should never be used together with a modulating heat exchanger - and a floating ball steam trap is overkill for draining steam pipes.

Parameter	TD	Float
Reliability	1	5
Duty	inter mittent	continuous
Cost	1	4
Life	1-2 yrs.	3-5 yrs.
Sizes	1/2" - 3/4"	1/2"-3"

In most cases, when start-up occurs, we bypass the trap. The cost of traps rise exponentially with increasing pipe size. This way , when the normal load comes on and condensate reduces, we can function with a much smaller trap.



Keeping cost in mind, we can also decide to use cheaper (and efficient) traps for non- critical applications like the steam lines, and more expensive ones for critical areas like process.

Practically, we need to install traps every 30 M in a stream line. But, if we are using cheaper traps, we can even reduce this distance to 25 M for increased reliability of trapping and replace as & when required.

Good design practice

In terms of configuration, this should include, among other things, the following: proper slope, the elimination of pockets, proper trapping of condensate when pockets do occur, strategic location of steam traps and a configuration that integrates flexibility to keep the system piping itself within allowable stress ranges during expansion and contraction cycles.

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Condensate return

Condensate is the by-product of heat transfer in a steam system. It forms in the distribution system due to unavoidable radiation. It also forms in heating and process equipment as a result of desirable heat transfer from the steam to the substance heated. Once the steam has condensed and given up its valuable latent heat, the hot condensate must be removed immediately.

Often, the condensate which forms will drain easily out of the plant through a steam trap. The condensate enters the condensate drainage system. If it is contaminated, it will probably be drained.

Although the available heat in a kg of condensate is small as compared to a kg of steam, condensate is still valuable hot water and should be returned to the boiler.

If not, the valuable heat energy it contains can be retained by returning it to the boiler feedtank. This also saves on water and water treatment costs.

Sometimes a vacuum may form inside the steam using plant. This hinders condensate drainage, but proper drainage from the steam space maintains the effectiveness of the plant. The condensate may then have to be pumped out.

Steam powered mechanical pumps are used for this purpose. These, or electric powered pumps, are used to lift the condensate back to the boiler feedtank. Steam and the condensate system represents a continuous loop.



Fig. Steamline CRPS50

Once the condensate reaches the feedtank, it becomes available to the boiler for recycling.

Steam consumption

Now almost all clients are very energy conscious and it is common for customers to monitor the steam consumption of their plant. Steam flowmeters measure the steam consumption, and are used to allocate costs to individual departments or items of plant.

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Pipeline accessories

The steam pipeline has many accessories, all designed for special purposes and needs.

- Stop Valves
- Bypass valves
- Non-return Valves (NRV) and Disc Check Valves (DCV)
- Control Valves (CV)
- Pressure Reducing Valves (PRV)
- Strainers
- Moisture Separators (Msep)
- Traps
- Pressure gauges (PG)
- Pressure sensors
- Temperature gauges (TG)
- Temperature sensors
- Vacuum Breakers (VB)
- Safety Valves (SV)

Stop Valves

These are basic valves that shut off or supply steam, water or air supply to the downstream end. These come in three basic types:

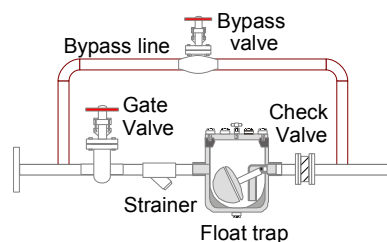
- Ball
- Gate
- Globe

Our PRS for example has two stop valves one at the inlet and the other at the outlet.

Bypass Valve

These valves are the normal stop valves, but installed in a bypass line, which can be used to bypass a piece of equipment, or a section of pipe during routine maintenance, when new fittings are to be put online, or removed. They are usually Globe valves.

For example, if the trap needs maintenance, the stop valve before trap is shut, the bypass opened, and the trap taken out.



Non-return Valves (NRV) and Disc Check Valves (DCV)

These are used to ensure flow in a certain direction only. Take a look at this NRV on the steamline pump inlet.



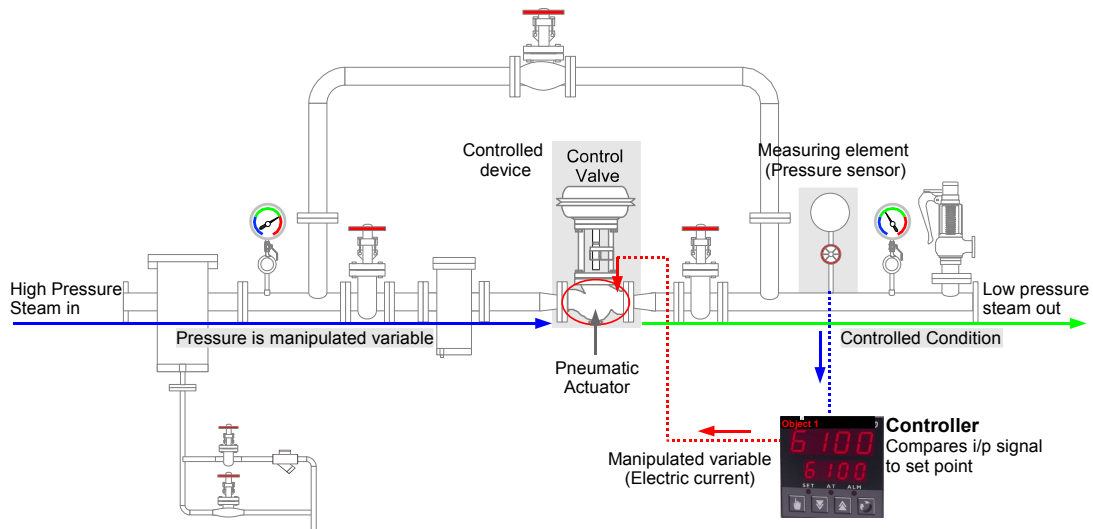
Control Valves (CV)

These are valves that provide automatic controls in a process plant, especially in the critical process areas. Their job could be any, or all the following:

- Safety - The plant or process must be safe to operate. Dangerous and complex plants or processes need automatic controls for safety.

- Stability - The plant or processes should work steadily, predictably and repeatably, without fluctuations or unplanned shutdowns.
- Accuracy - This is a primary requirement in processes to prevent spoilage, increase quality and production rates, and maintain comfort.
- Economy, speed, and reliability are other desirable benefits.

There is normally a **Sensor**, that senses the process **Parameter to be Controlled**, sends it to a **Controller**, which matches it with a predetermined **Set Point**, and **Actuates** the **Control Valve** to make the required adjustments.



Pressure Reducing Valves (PRV)

These are specialized Control valves that provide steam at the correct pressure for the process.

REFER PRS Product Pack

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Strainers

These keep steam clean, and free of dirt, and grit by straining them out of the system.

Ref: Chemistry / Quality of steam/ Clean, clean steam

Moisture Separators (Msep)

This eliminates wet steam from the process which is the cause of corrosion and decreased efficiencies.

Ref: Chemistry / Quality of steam/ Dry steam

Traps

No matter how much we try, the twin enemies of our steam system – air and condensate – will be present in our system in some degree. Steam traps are used to drain condensate and air from steam lines and heat transfer units, and are a must on every equipment to prevent air and water related problems.

Pressure Gauges (PG)

We use a simple Bourdon tube type pressure gauge. It is a tube, one end sealed and the other is open from which the gas or liquid enters. This causes a distortion in the tube proportional to the pressure of the process.

Our dial is normally 150 mm in diameter and, is marked to indicate the normal working pressure and the maximum permissible working pressure / design pressure.

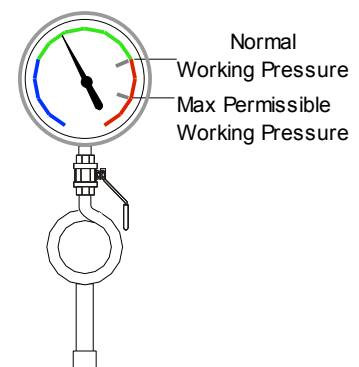


Fig. Pressure gauge

Pressure gauges are connected to the steam space in the PRS and usually have a ring type siphon tube which fills with condensed steam and protects the dial mechanism from high temperatures.

All Steamline PRS's, for example are fitted with two pressure gauges. The inlet PG helps the boiler operator to visually monitor the inlet pressure, to check if the steam is being supplied at the correct pressure. The outlet PG is used by him for setting and monitoring the outlet pressure by looking at the gauge, if required. We also fit a pressure gauge to our flash vessels to see at what pressure flash steam is being generated.

Pressure sensors

These sense the process parameter – Pressure, and return a signal to a Controller.

Temperature Gauges (TG)

The TG helps the Utilities staff to visually monitor the temperatures, either of steam or process.

Temperature sensors

These sense the process parameter – Temperature, and output a signal to a Controller.

Sight glass

Through a sight glass, we can see the water levels, water flow and also the colour of the process, if need be. Traps sometimes have a sight glass mounted to check correct working. Also, if a valve or strainer is blocked flow will be affected and that too can be checked visually.

Vacuum Breakers (VB)

Steam, when it condenses, ie, cools, becomes water and shrinks tremendously in volume. What happens? Around it we have suddenly an almost perfect vacuum. This cannot be allowed to occur, otherwise, our plant and expensive machinery may get damaged.

Steam condenses when heat is lost to the atmosphere for example, on the distribution lines while working, or , more regularly when a machine in the process is switched off.

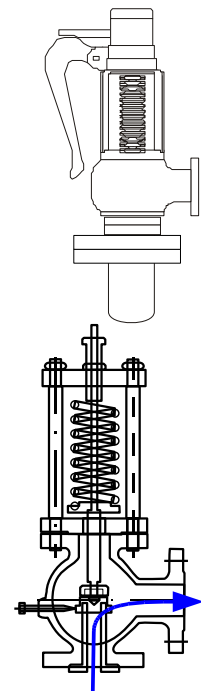
We therefore insatll a device called a vacuum breaker on the steam inlet of expensive machinery, before it enters the process. It is a valve, that basically allows air in as soon as a vacuum starts to

Safety Valves (SV)

The safety valve is fitted to protect the process that the PRS is supplying steam to. The SV protects from over pressure and in the worst case, an explosion.

A safety valve must meet the following criteria:

- The total discharge capacity of the safety valve must be at least equal to the flow through the PRS at the set pressure of PRV. This way, the safety valve capacity will always be higher than the actual maximum flow through the PRS.
- The full rated discharge capacity of the safety valve(s) must be achieved within 110% of the PRS set pressure.
- There must be an adequate margin between the normal operating pressure of the PRS and the set pressure of the safety valve, otherwise the safety valve will keep blowing. Typically 10% above set pressure.

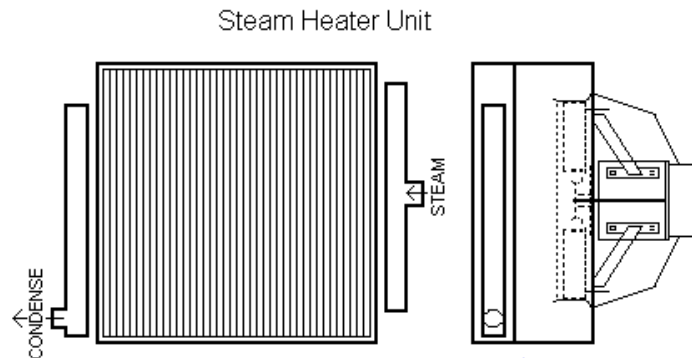


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Typical steam using equipment

Space Heaters / Hot rooms / Air Steam heater / Radiators

Steam heaters or steam coils are heat exchangers in which one medium is steam being condensed while the other medium is a gas (air) being heated when forced through the heat exchanger with a fan. The inlet air may be ducted or simply gathered from the room in which the steam heating unit is positioned. The actual heat exchanger is constructed as a matrix of tubes and corrugated or flat fins (aluminium, copper or other materials) with as high thermal conductivity as feasible for the given application.



Process Air heaters

Process air heating with steam coils is one of industry's toughest jobs. Many steam coils become early victims of mechanical failure and the internal/external corrosion that can be the beginning of the end of efficient heat transfer.

A process air heating solution should deliver the ability to achieve and maintain the temperatures you need to keep production running at optimum speed and efficiency. The coils must have extra-sturdy fins to stand up to high-pressure cleaning and be made out of tough materials as a defense against galvanic action to survive the rigors of high pressures, high temperatures and corrosive conditions.

Driers – Tray and Rotary

Used for drying out products like tobacco and paper with heat.



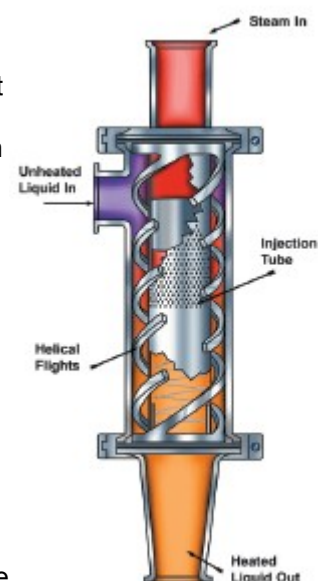
Tanks – Injection, coil, jacketed

Steam Sparger

Steam sparging is common in open tanks or kettles containing liquid products or water. This is simply a pipe mounted inside the tank, generally at the bottom, with small holes drilled at regular positions spaced along the length of the pipe with the end blanked off. The steam exits the pipe through the holes as small bubbles, which will either condense as intended or reach the surface of the liquid.

Steam Injection Heater

Steam injection heating for products is a direct-contact process in which steam is mixed with a pumpable ingredient. Heating occurs when the steam transfers some of its internal energy to the product. Steam gives up all of its latent heat of vaporization while condensing and, depending upon the system pressure, some of its sensible heat. Since the steam directly contacts the product and the condensate becomes incorporated into it, the steam source must be clean. Typical steam injection units are compact, inexpensive and simple to control. An example is provided in the figure.



A direct steam injector draws in cold liquid and mixes it with steam inside the injector, distributing heated liquid to the tank. It discharges a series of steam bubbles into a liquid at a lower temperature. The steam bubbles condense and give up their heat to the surrounding liquid. Heat is transferred by direct contact between the steam and the liquid, consequently

this method is only used when dilution and an increase in liquid mass is acceptable. Therefore, the liquid being heated is usually water.

Steam Jacketed Kettles and vats

A jacket, used to distribute steam over a wide surface area, consists of a thin space formed between two, parallel, metallic surfaces. Steam jackets are typically used to heat bulk products held in tanks and kettles. An example of a steam-jacketed kettle is shown in figure. Condensing steam, held captive within the jacket, transfers heat to the product in the kettle. A layer of insulation over the jacket protects operators and conserves heat.



Used in Food processing

Humidifier

Certain drying and curing processes require humidification of the air surrounding the product to control the drying rate. Culinary steam can be injected directly into a drying chamber or into a ventilation air duct.

Steam-In- place (SIP) Culinary steam is used to achieve high temperatures and moisture levels required to sterilize enclosed surfaces (such as closed tanks, pipes and valves) in food processing equipment.

PHE

The basic plate heat exchanger consists of a series of thin, corrugated plates that are gasketed, welded together (or any combination of these) or brazed together depending on application. The plates are then compressed together in a rigid frame to create an arrangement of parallel flow channels. One fluid travels in the odd numbered channels, the other in the even.

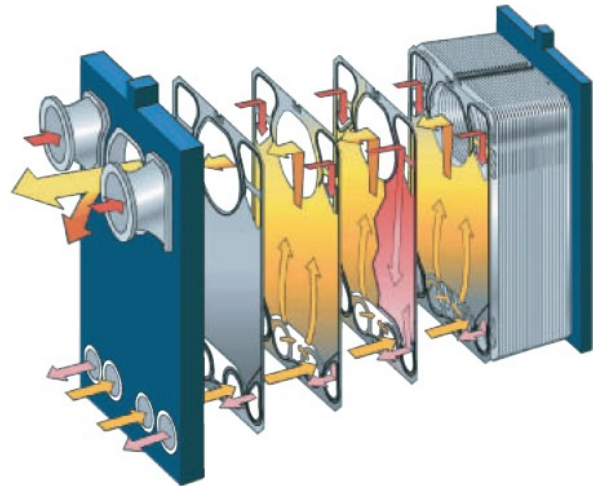


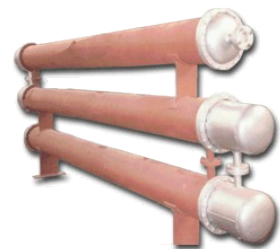
Fig. Inside a Heat Exchanger

Shell & Tube Heat Exchanger

Shell and tube heaters are commonly used to heat a flowing liquid by condensing plant steam or a pumped heat transfer media. A thin-tube wall separates the heating media from the product being heated. In the case of a pumped heat-transfer media (such as hot water), steam is often used to heat the media in a separate heat exchanger.

Fixed Tube-Sheet Exchangers

These are the most economical and are used more often than any other type. The tubes sheets are welded to the shell. The tubes can be examined and replaced easily. Expansion joints are used where there is a possibility of excessive stresses due to differential expansion during operation.



U-Tube Heat Exchangers

The tube Bundle, in this case, consists of a stationary tube sheets, "U" tubes (or hair pin tubes). The tube bundle can be removed from the shell for inspection and cleaning from outside. The design is particularly recommended for high pressure, high temperature applications. The disadvantages of this design are that the tubes cannot be mechanically cleaned from inside, and also that the tubes can not be replaced except for a few outer bands. Variations of this design are used as Tank Suction Heaters and also in Kettle type re-boilers / evaporators etc.



Evaporators

In the field of thermal separation / concentration technology, evaporation plants are widely used for concentration of liquids in the form of solutions, suspensions, and emulsions.

The major requirement in the field of evaporation technology is to maintain the quality of the liquid during evaporation and to avoid damage to the product. This may require the liquid to be exposed to the lowest possible boiling temperature for the shortest period of time.

This and numerous other requirements and limitations have resulted in a wide variation of designs available today. In almost all evaporators the heating medium is steam, which heats a product on the other side of a heat transfer surface.

- Typical evaporator applications
- Product concentration
- Dryer feed pre-concentration
- Volume reduction
- Water / solvent recovery
- Crystallization

Plate Evaporators

Compact and economically efficient, the plate evaporator /condenser replaces conventional large and expensive falling film units. Its deep channels, large ports and laser welding allow vacuum and low pressure evaporation and condensing for both aqueous and organic systems.

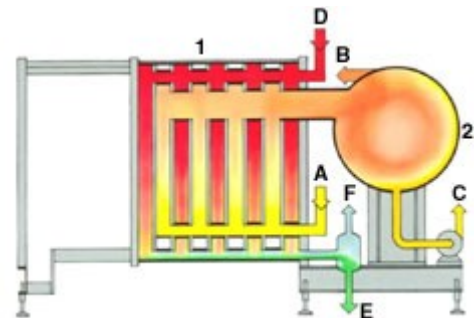


Fig. Plate Evaporators

Framed plates are used as heating surface. These plate assemblies are similar to plate heat exchangers, but are equipped with large passages for the vapor flow. In these units a product plate and a steam plate are connected alternately. The product passage is designed for even distribution of liquid on the plate surfaces and low pressure drop in the vapor phase. Used especially in Dairy and Pharmaceutical industries.



Distillation columns

Distillation is a separation process, separating components in a mixture by making use of the fact that some components vaporize more readily than others. When vapours are produced from a mixture, they contain the components of the original mixture, but in proportions which are determined by the relative volatilities of these components. The vapour is richer in some components, those that are more volatile, and so a separation occurs.

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In fractional distillation, the vapour is condensed and then re-evaporated when a further separation occurs. It is difficult and sometimes impossible to prepare pure components in this way, but a degree of separation can easily be attained if the volatilities are reasonably different. Where great purity is required, successive distillations may be used.

In traditional distillation, steam or another heat source is indirectly applied through an external reboiler. In contrast, in direct steam distillation, the steam acts as a dilutant, preventing the buildup of undesirable by-products at the bottom of the distillation column.

Used especially in Chemical and Pharmaceutical industries.

Case study: Steam distillation is also the most common method of extracting essential oils. Many old-time distillers favor this method for most oils, and say that none of the newer methods produces better quality oils.



Steam distillation is done in a still. Fresh, or sometimes dried, botanical material is placed in the plant chamber of the still, and pressurized steam is generated in a separate chamber and circulated through the plant material. The heat of the steam forces the tiny intercellular pockets that hold the essential oils to open and release them. The temperature of the steam must be high enough to open the pouches, yet not so high that it destroys the plants or fractures or burns the essential oils.

As they are released, the tiny droplets of essential oil evaporate and, together with the steam molecules, travel through a tube into the still's condensation chamber. As the steam cools, it condenses into water. The essential oil forms a film on the surface of the water. To separate the essential oil from the water, the film is then decanted or skimmed off the top.

Autoclaves and sterilisers

An autoclave is a pressurized device designed to heat aqueous solutions above their boiling point.



The heat generated under pressure is called latent heat and has more penetrative power to squeeze through bacteria and even their dormant, heat-resistant form—the spores. This works just fine on solid objects when we start to talk about hollow objects (needles, tools etc etc) you need to make sure all the air get sucked out or otherwise it will act as an insulation for the bacteria you want to kill.

Their chambers are usually made of SS316 grade stainless steel chamber, and conform to pressure vessel codes. They have to produce sterile loads repeatedly. They must be very easy to clean and reliable.

Autoclaves are widely used in medicine and metallurgy.



Sterilisation is the elimination of all transmissible agents (such as bacteria, prions and viruses) from a surface, a piece of equipment, food or biological culture medium. This is different from disinfection, where only organisms that can cause disease are removed by a disinfectant.

In general, any instrument that enters an already sterile part of the body (such as the blood, or beneath the skin) should be sterilized. This includes equipment like scalpels, hypodermic needles and artificial pacemakers. This is also essential in the manufacture of many sterile pharmaceuticals.

CSG Clean Steam Generators / PSG Pure steam generators

They are basically heat exchangers in which steam is used to convert ultra-pure water to ultra-pure steam. Used in Pharma, Food industries.



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Steam jacketed molding presses

Used in the following industries: Tyre, Rubber, Chocolate, Fibre glass thermocole packaging.

Vapour absorption chillers

The absorption chiller is a machine to produce chilled water by using heat such as steam, hot water, gas, oil. The chilled water is then used for airconditioning plants.

Absorption chillers use heat instead of mechanical energy to provide cooling. A thermal compressor consists of an absorber, a generator, a pump, and a throttling device, and replaces the mechanical vapor compressor.

Chilled water is produced by the principle that liquid, which evaporates easily, absorbs heat from surrounding when it evaporates. In the chiller, refrigerant vapor from the evaporator is absorbed by a solution mixture in the absorber. This solution is then pumped to the generator. There the refrigerant re-vaporizes using a waste steam heat source. The refrigerant-depleted solution then returns to the absorber via a throttling device.



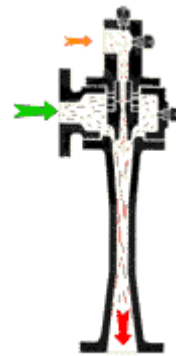
Pure water is used as refrigerant and lithium bromide solution is used as absorbent.

Ejectors

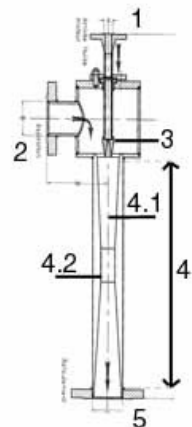
Ejector is the generic name of a jet appliance capable of aspirating different products: gases, liquids and solids (powders, granulates or sludge) and takes different names according to its functions: jet vacuum pump, thermocompressor, gas scrubber, eductor, etc. The operating theory is the same for every type of ejector.

Jet vacuum pump (our main application for the ejector)

Static operating apparatus capable of obtaining a vacuum within a capacity. The vacuum corresponds to the suction pressure of the steam or gas needed by process requirements. The suction pressure is obtained by means of thermodynamic and fluid mechanics laws: A high energy potential motive fluid is relieved through a converging and diverging nozzle and accelerated to velocities that are often supersonic. At the outlet of the nozzle, the potential energy of the motive fluid is transformed into kinetic energy.



At the inlet of the diffuser, the motive fluid gives off part of its kinetic energy to the aspirated fluid so that the mixture of the two fluids goes through inverse transformation in which the velocity is converted into pressure at the diffuser discharge.



1. Motive fluid inlet
2. Vacuum - suction
3. Nozzle
4. Diffuser
- 4.1. Converging mixing cone
- 4.2. Diffuser neck
5. Discharge

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Turbines

A steam turbine is a mechanical device that extracts thermal energy from pressurized steam, and converts it into useful mechanical work. It is operated by highly pressurized steam directed against vanes on a rotor.

It has completely replaced the reciprocating piston steam engine primarily because of its greater thermal efficiency and higher power-to-weight ratio. Also, because the turbine generates rotary motion, it is particularly suited to be used to drive an electrical generator - it doesn't require a linkage mechanism to convert reciprocating to rotary motion.

Pic. Turbine rotors on which high-pressure steam is directed



Steam turbines are made in a variety of sizes ranging from small 1 hp (0.75 kW) units used as mechanical drives for pumps, compressors and other shaft driven equipment, to 2,000,000 hp (1,500,000 kW) turbines used to generate electricity.

There are several classifications for modern steam turbines.

Noncondensing or backpressure turbines are most widely used for process steam applications. The exhaust pressure is controlled by a regulating valve to suit the needs of the process steam pressure. These are commonly found at refineries, pulp and paper plants, and desalination facilities where large amounts of low pressure process steam is available.

Condensing turbines are most commonly found in electrical power plants. These turbines exhaust steam in a partially saturated state, typically of a quality greater than 90%, at a pressure well below atmospheric to a condenser.

Extracting type turbines are common in all applications. In an extracting type turbine, steam is released from various stages of the turbine, and used for industrial process needs or sent to boiler feed water heaters to improve overall cycle efficiency. Extraction flows may be controlled with a valve, or left uncontrolled. Induction turbines introduce low pressure steam at an intermediate stage to produce additional power.

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