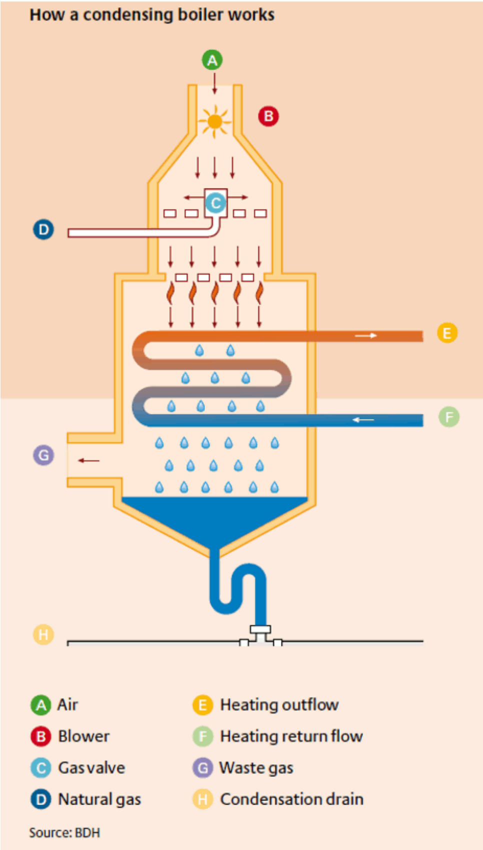
Part-financed by the European Union (European Regional Development Fund and European Neighbourhood and Partnership Instrument)

HEATING SYSTEMS

Susanne Simpson
Kiel
2013

1. Condensing Boiler



Compared to conventional boiler systems the condensing technique offers energy processing at highest level.

Burning fossil fuel produces water vapour which in conventional systems is lead outside through an exhaust pipe. The energy content in the water vapour is wasted.

Using condensing technique the exhaust is cooled down to condensate. Water returning from the radiators (low temperature) runs through a heat exchanging device which is mounted into the exhaust pipe. Reaching a certain temperature lower than either 57°Celsius for gas or 48° Celsius for fuel oil starts the condensation process. The dissipation of energy also heats the advance pipe.

The system works best in low temperature circulation systems, which require sufficient area for heat transmission e.g. on wall, ceiling, floor or sufficient sized radiators using 55° C at most.

As the return temperature in the system is low, constant heat transmission all over the building is necessary and a hydraulic alignment mandatory.

Pro´s

High efficiency on using fossil fuel

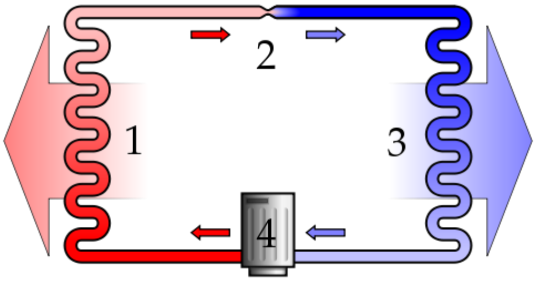
Low investment costs allows for low temperature systems

Can also be used producing high system temperature if necessary

Con´s

Low efficiency in high temperature systems

2. Heatpumps



A simple stylized diagram of a heat pump's vapor-compression refrigeration cycle: 1) condenser, 2) expansion valve, 3) evaporator, 4) compressor.
Source: Wikipedia.org

Mechanical heat pumps exploit the physical properties of a volatile evaporating and condensing fluid known as a refrigerant. The heat pump compresses the refrigerant to make it hotter on the side to be warmed, and releases the pressure at the side where heat is absorbed.

The working fluid, in its gaseous state, is pressurized and circulated through the system by a compressor. On the discharge side of the compressor, the now hot and highly pressurized vapor is cooled in a heat exchanger, called a condenser, until it condenses into a high pressure, moderate temperature liquid. The condensed refrigerant then passes through a pressure-lowering device also called a metering device. This may be an expansion valve, capillary tube, or possibly a work-extracting device such as a turbine. The low pressure liquid refrigerant then enters another heat exchanger, the evaporator, in which the fluid absorbs heat and boils. The refrigerant then returns to the compressor and the cycle is repeated.

It is essential that the refrigerant reaches a sufficiently high temperature, when compressed, to release heat through the "hot" heat exchanger (the condenser). Similarly, the fluid must reach a sufficiently low temperature when allowed to expand, or else heat cannot flow from the ambient cold region into the fluid in the cold heat exchanger (the evaporator). In particular, the pressure difference must be great enough for the fluid to condense at the hot side and still evaporate in the lower pressure region at the cold side. The greater the temperature difference, the greater the required pressure difference, and consequently the more energy needed to compress the fluid. Thus, as with all heat pumps, the Coefficient of Performance (amount of thermal energy moved per unit of input work required) decreases with increasing temperature difference.

Source: Wikipedia.org_28.3.2013

Pro´s

High COP/ year (coefficient of performance) possible

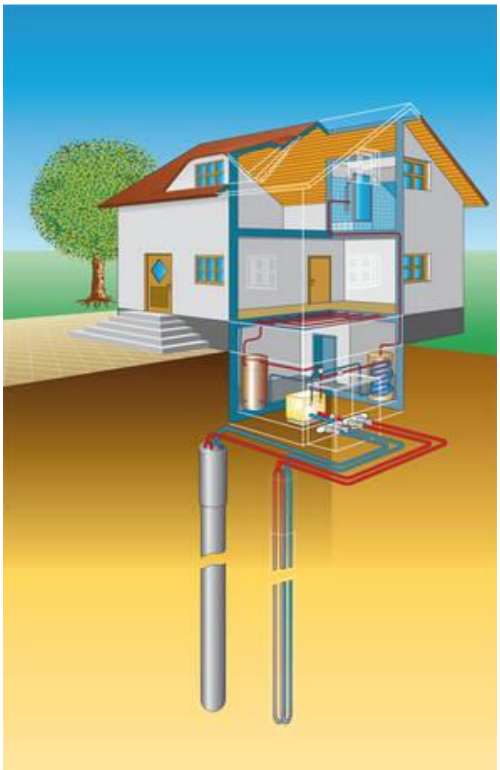
Low runnung cost if well planned carbon- neutral when using power from renewable sources

Con´s

Only cost efficient using low temperature systems

High investment costs

2.1 Brine-Water Heatpump



Brine-water heat pump with vertical probe system
Source: BDH

This type of heat pump uses the earth's heat (geothermal energy) as a source of heat. For this purpose, the soil is dug up to 200 meters depth in order to use average ground temperatures of 10 °C. This heat is extracted from the ground and routed to the respective heating system.

Brine-water heat pumps achieve high performance coefficients between 3.8 and 5.0. They are available in various designs, e.g., as a simple basic unit or as a compact unit with integrated domestic hot water tank.
Its cooling function can also be used in summer to control the room temperature. Brine-water heat pumps use an antifreeze liquid (often called brine) to tap the heat source, which circulates in plastic pipes and is laid in the ground to extract the heat from the surroundings.

While digging up the soil, a distinction is made between two types of construction methods which depend on external conditions: If the site is large, it is possible to lay a so-called ground collector. Ground collectors are polyethylene pipes that are laid at depths of 1.2 to 1.5 m in the garden. The distance between the pipes must be 0.5 to 0.8 meters. About 25 m2 of surface area is enough for one kilowatt heating output. After laying the collectors, the ground is closed again.

If this option is not possible for lack of space, bore-hole heat exchangers can be used. Polyethylene U-pipes are called bore-hole heat exchangers which go several hundred meters into the ground. Bore-hole heat exchangers can also be used for cooling.

Source: By courtesy of BDH Köln_ 28.3.2013 (Bundesverband für Effizienz und erneuerbarer Energien_ http://www.bdh-koeln.de)

Pro´s

High COP/ year (coefficient of performance) possible

Best for low temperature systems

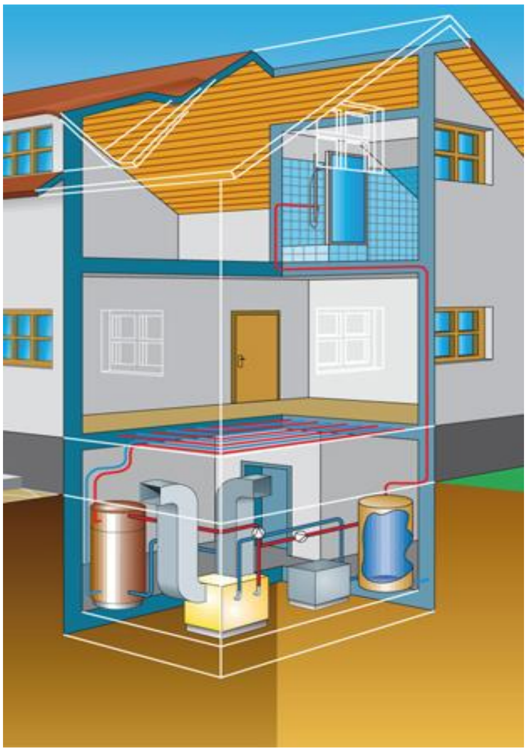
Low running cost if well planned

Con´s

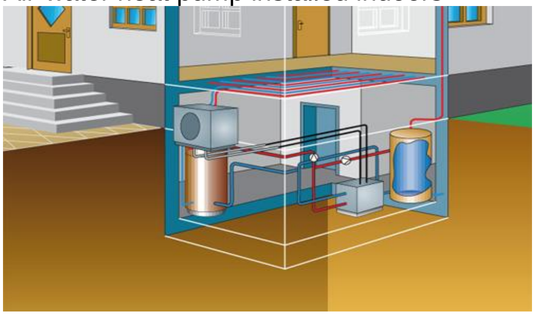
Only cost efficient using low temperature systems

High investment costs

2.2 Air-Water Heatpump



Air-water heat pump installed indoors



Split System
Source: BDH Köln

Pro´s
Cost efficient in highly insulated buildings
Low running cost if well planned
Low investment costs

Con´s
Only cost efficient using low temperature systems

COP/ year (coefficient of performance) lower as with GHP (geothermal heatpumps)

No efficiency with very low external temperatures (if approach is on high temperature the system fails in cost efficiency)

Air-water heat pumps use the ambient air to remove heat from it. They are able to withdraw energy from the external air even when the temperature is -20 °C or less. Air-water heat pumps achieve only annual coefficients of performance from 3.0 to 4.0 because the heat source temperature fluctuates and is often lower than that of the other types of heat pumps during the heating period.

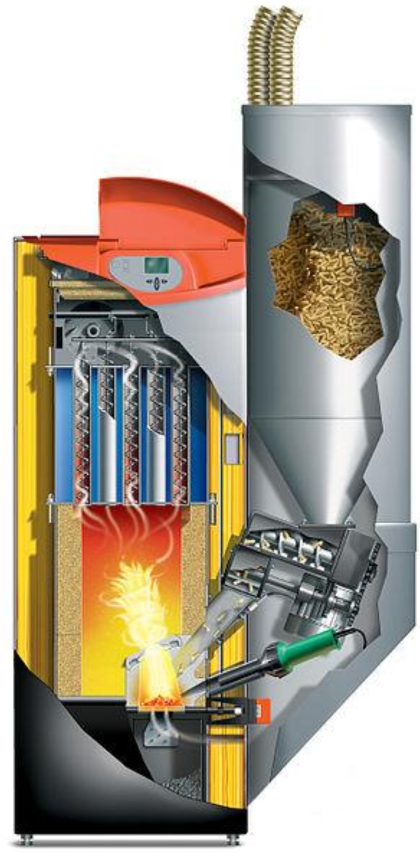
Complex utilisation of heat sources, which is required for brine-water and water-water heat pumps is omitted for this. Some air-water heat pumps also provide a cooling function that can be used in summer.

At low external temperatures COP/ year gets low and the system does not work cost efficient any more. It can reasonable to expand the system by a conventional boiler covering peaks e.g. a condensing boiler.

In general the building has to fulfill highest insulating standards and offer large transmission areas to work with these low system temperatures.

Source: By courtesy of BDH Köln_ 28.3.2013 (Bundesverband für Effizienz und erneuerbarer Energien_ http://www.bdh-koeln.de)

3. Pellet Boiler



Pellet Boiler for Central Heating
Source: Wikipedia

Pro´s

Low carbon emission

Presently low running cost compared to fossil fuels

Best for high temperature systems

Con´s

High investment costs

High maintenance and servicing costs

Price increase due to higher demand possible

Timber- pellet heating systems are suitable from a heat demand of 3.9 kW upwards. From single or double family homes with appr. 30 kW heat consumption to larger units up to a couple hundred kW timber pellet heating can be installed, the latter as a series of burners (energy cascading).

Pellet burners ususally work best at full demand, they can modulate to 1/3 of their maximum output.

Compared to gas- and oil burners pelletburners take a longer prewarming phase. Therefore short periods of activitiy have negative effects in efficiency.

To compensate this effect storage systems usually water tanks, are equipped. This way burning periods are optimised and pollution reduced.

Timber pellet burner are recommendable for high temperature heating systems.

Carbon emissions are low but in comparision to the pollution from fossil fuels higher in nitric oxide, sulphur dioxide and particulate matter.

A raising demand in the market might lead to shortage of raw material accompanied by escalation of cost.

Source: Wikipedia.org_28.3.2013