Saving energy when creating electricity

Helium leak detection in the power plant

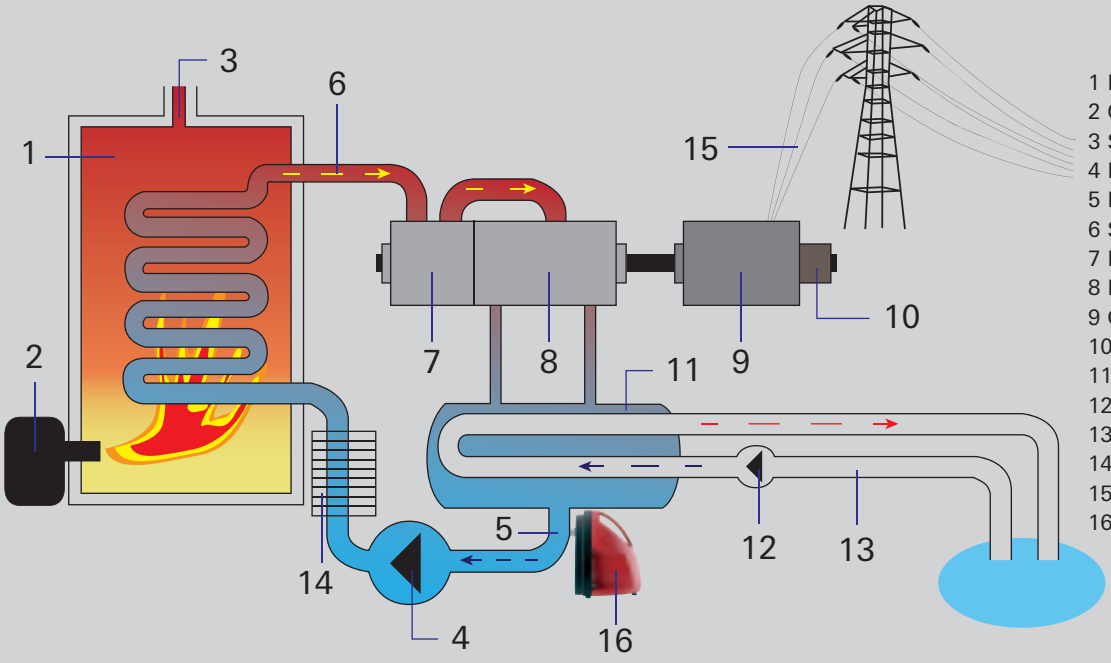
We hardly think twice when we turn on the lights, use our coffee maker or boot up the computer. Electricity rules our everyday lives. Without it, most of our modern devices wouldn't work. Most of the time we're not even aware of just how much we depend on electricity. Only during power outages do we catch a glimpse of how all-encompassing this dependency really is.

To cover our daily demand for energy we get electricity from various sources, one of them being thermal power plants.

In many power plants, electricity is generated using water vapor, which is converted into electrical energy in generators. Larger power plants putting out several hundred megawatts (MW) can power entire large cities. Various fuels such as lignite and hard coal, crude oil and natural gas can be used. The basic principle, however, is usually the same: The burning of the fuel creates heat that is used to heat water. The process creates high-pressure water vapor. This water vapor, in turn, drives turbines that are linked to current generators. Electricity is created in the generator and fed into the high-voltage power lines. Thus, it can be transported across vast distances.

Improving efficiency with complex technologies

In order to improve the efficiency of the power plant, the steam is sent through an arrangement of various high- and low-pressure turbines. The goal is to utilize the energy bound in the steam as thermodynamically efficient as possible. In modern power plants, the steam is also routed out of the turbines to pre-heat the steam boiler water feed. These efficiency improvement measures result in a highly complex steam line system.



The condenser is the interface between the closed water-steam-circuit, the steam turbine and the cooling circuit. The water vapor condenses on pipes filled with coolant water, and is then available for steam generation again.

Impact of leaks in power plants

Once the steam has passed through the final turbine stage it arrives in the condenser. In the condenser, the steam is cooled and condenses to water. The condensed water is pumped back into the piping of the steam generator and is again available for use. A circuit is created.

In order for the condenser to run optimally it must only contain steam. Any other gas that infiltrates the steam circuit through leakages, e.g. the ambient air, significantly reduces the efficiency of the condenser, and thus the efficiency of the entire power plant. In order to remove all foreign gases from the condenser, it is evacuated when the plant is started and during its operation. It is extremely important to prevent leakages anywhere in the complex steam circuit in order to maintain the vacuum in the system.

Each and every leakage in the system reduces the overall efficiency of the power plant. As a rule of thumb, one can say that improving the vacuum by 1 hPa (mbar) will increase the net efficiency by approx. 0.04%.

Power plant operators are therefore very eager to prevent leakages in their systems. In a power plant, leak detection is performed in all vacuum-containing parts in the condensation area of the main turbines and the feed water turbines. Some of these are e.g.: Condensing chamber, turbine housing (sealing joints), blow-out disks, labyrinth seals of the turbine shaft, low pressure pre-heater and start-up flash tank.

Advantages of leak detection with helium:

- Fast leak detection due to relatively short reaction times
- Selective measurement - no malfunction signals due to other gases or water vapor
- Easy localization of leaks thanks to high detection sensitivity
- Reproducible- and documentable results

The Neurath power plant in North Rhine-Westphalia is a brown coal fueled power plant with a gross output of approx. 4400 MW. This makes it the second-largest lignite-fired power plant in Europe. The coal supply is ensured by a rail connection to the North-South-Rail of the opencast mines of the Rhineland industrial lignite mining area, particularly the Garzweiler mine.

Pfeiffer Vacuum has the optimal solution for leak detection in power plants

At the Neurath location, technical services have decided to use the helium leak detector MiniTest 300 by Pfeiffer Vacuum. This leak detector is operable at high inlet pressures of up to 200 hPa (mbar). Additional pressure reduction is not necessary, so the device can be connected to vacuum-containing components directly. The MiniTest's sensitivity of $5 \cdot 10^{-8}$ Pa m^3/s is more than sufficient to detect leakages in the vacuum-containing components of the power plant. The biggest advantage over conventional leak detectors is the insensitivity towards water vapor. This makes an additional external pump normally used to create a condensate trap unnecessary.

At only 5 kg, the MiniTest 300 is extremely lightweight and easy to transport from one site of operation to the next. It is installed directly onto a standard KF 25 connection. The wireless remote control allows operation of the device from distances of up to 100 m.

The MiniTest 300 was flanged directly to the vacuum system. Leak detection can be carried out in a radius of up to 100 m with the wireless remote control.

Checking the leak rate on a low-pressure pre-heater with the MiniTest 300. Measured values are indicated on the wireless remote control.

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Pfeiffer Vacuum GmbH
Headquarters · Germany
T +49 6441 802-0
info@pfeiffer-vacuum.de

www.pfeiffer-vacuum.com