Processes for degassing

The service life of pipes, boiler systems, pumps and fittings in thermal hot-water and steam-boiler systems is determined to a great extent by the quality of the boiler water.
Water contains different amounts of oxygen (O_2) and carbon dioxide (CO_2) depending on the pressure and temperature. Both gases cause specific types of damage to metallic boiler materials: Oxygen has an oxidising effect, and carbon dioxide (carbonic acid) is aggressive.

Oxidation / Corrosion

The O_2 corrosion leads to partial, wheel-shaped depressions. Over time, these depressions become pits with edges that generally grow together. The oxidised material then often fills the depressions and holes.

The CO_2 corrosion on the other hand attacks the surface evenly.

Both forms of corrosion can considerably endanger the operating safety of a boiler system, depending on the pressure and temperature levels.

Degassing

Specific degassing methods are therefore used to remove the two gases, oxygen and carbon dioxide, from the water or to reduce them to below the respective required residual concentrations (guaranteed value to be complied with).

Requirements for the feedwater and boiler water quality in the steam generator can be found in DIN EN 12953-10 and DIN EN 12952-12.

The technical removal of troublesome, gaseous contents is generally referred to as „degassing". Deacidification is the technical removal of free, aggressive CO_2 since it is tied to an increase in the pH value of the water.

Degassing processes

Common degassing processes are:

- **Thermal degassing:**
  - **Pressure degassing**
  - **Vacuum degassing**
- **Membrane degassing**
- **Chemical degassing**

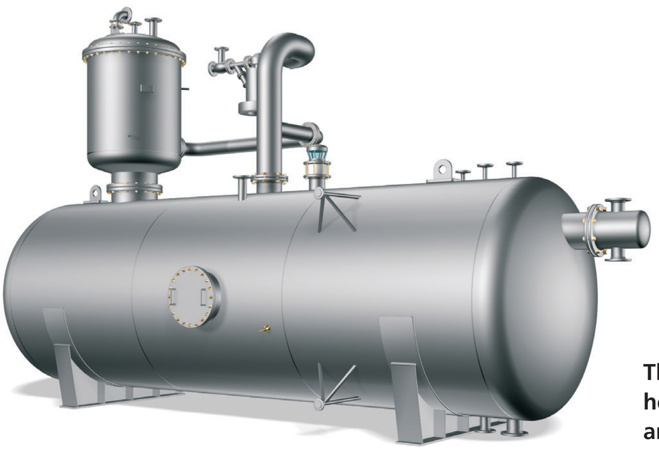
Thermal degassing

Thermal degassing of feedwater to separate out the dissolved and corrosive gases contained within requires that the water be boiling. In this state, the solubility of gases in liquids lies near zero. Fine distribution via cascading percolation plates has a supportive function. Degassing can occur in over- or underpressure.

Pressure degassing

The mixture of condensate and fresh water is fed into the degassing dome at the top. Heating up to the boiling temperature occurs with heating steam, which flows into the degassing unit at the bottom and flows upward against the current. The gases driven out as a result are lead away with the exhaust vapours via the exhaust vapour outlet in the degassing dome. The degassed water is collected in the feedwater tank.

Thermal degassing is an excellent way of removing dissolved gases from the water, particularly from the boiler feedwater. Germs are removed from the water at the same time.



Thermal degassing systems for heating stations, power stations and other steam-boiler systems

Thermal degassing often works at temperatures just over 100 °C and operating pressures of around 0.2 to 0.3 bar. Thus an oxygen content of less than 0.02 mg O_2/l and a carbon dioxide content of less than 1 mg CO_2/l are possible in the feedwater.

Vacuum degassing

With vacuum degassing, water can also be degassed below 100 °C by boiling. Creating a corresponding negative pressure (partial vacuum) in the degassing unit enables the boiling point to be reached as early as in the 30-80 °C range. This degassing process is suitable when no hot steam is available for operating thermal pressure degassing.

Here degassing takes place in a percolator with a spraying unit, packing and supply section. The gases are removed via a vacuum pump with the resulting water vapour. It is preferable to use an exhaust vapour condenser to enable the vacuum pump's intake volume flow to be kept low. The residual oxygen content of 0.02 mg/l can also be achieved here.

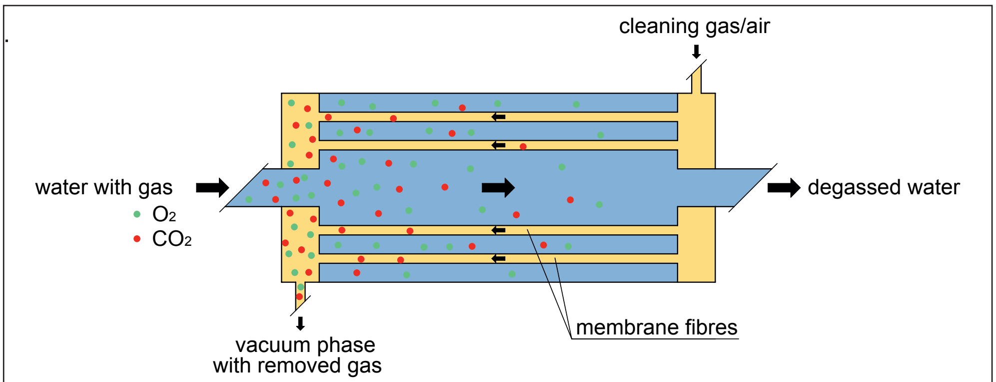
Vacuum degassing is used for treating supplementary water for heating systems.

Membrane degassing

Membrane degassing enables dissolved carbon dioxide (CO_2) to be removed from the water in pure stripping air mode down to values of < 2 mg/l (ppm) or, in combination with a vacuum pump, down to values of < 1 mg/l (ppm). Using industrial nitrogen as the stripping medium and in combination with a vacuum pump enables oxygen to be reduced to residual values of < 1 µg/l (ppb).

Creating a corresponding partial pressure gradient as the driving force (stripping with air/gas and/or creating a vacuum) causes the gases to diffuse out of the liquid and into the gas-bearing membrane fibres through microporous, hydrophobic (water-impermeable) hollow-fibre membrane modules, and to be transported away with the stripping gas.

The individual hollow-fibre membranes are combined in modules (known as membrane contactors). Initially, the liquid flows via the contactor's inlet nozzles into a distributor pipe and is directed along the hollow fibres by a deflection barrier so that the gases can penetrate into the hollow fibres. The degassed liquid then leaves the contactor via a manifold and the subsequent outlet nozzle. In the counter-current, the stripping gas is directed through the hollow fibres via two separate nozzles on the inside. Depending on what is required in terms of gas outlet concentration and treatment volume, individual contactors are connected either in series or, in the case of a high volume flow, also in parallel.



Functional principle of membrane degassing

Membrane degassing is used to support desalination processes. In the case of demineralization with ion exchangers, membrane degassing allows the load to be relieved on the anion exchanger, resulting in a significant reduction in the need for regeneration chemicals (mainly sodium hydroxide). This makes membrane degassing a good alternative to the CO_2 percolator, but with the advantages of requiring much less space and energy (e.g. no pressure increase required).

In addition, membrane degassing is useful between EDI (electro deionisation) and reverse osmosis. Firstly, free carbon dioxide passes the membranes of the reverse osmosis system, and secondly the shift in the lime-carbonic acid equilibrium releases additional carbon dioxide. This places a great load on the downstream EDI, which often results in a deterioration of the diluate conductivity. Here, membrane degassing is an ideal addition between reverse osmosis and EDI, as it reliably removes CO_2 from the reverse osmosis permeate and causes only a low pressure loss during throughflow. Stable operation of the EDI which is vulnerable to CO_2 is thus guaranteed.

Chemical degassing

Chemical degassing or subsequent degassing occurs through the addition of chemicals. These chemicals are dissolved in the dilution water (the quality depends on the operating conditions of the steam generator) and are suitable for removing or converting the oxygen contained in the water. The reaction times differ between the various chemicals that can be used. In general, the greater the water temperature the shorter the reaction time.

Some of these chemicals have almost no side effects apart from a minimal increase in harmless salts, while other chemicals form free acids that decrease the alkalinity. Another group form steam-volatile alkaline substances during heating, which are effective beyond the boiler to the steam and condensate network.

The addition of the chemical solution for removing remaining oxygen occurs together with any required corrective chemicals for stabilising the remaining hardness and alkalisation. Dosing is done by means of suitable dosing equipment.

Due to the heavy use of chemicals, chemical degassing is of interest only at low boiler pressures and a low system performance. In medium-sized and large systems, chemical degassing is used only when it is necessary to achieve residual oxygen contents of < 10 µg/l.

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