Here it steams: Thermal feedwater degassing

Steam Loss & Energy Waste | It is common practice to de-gas boiler feedwater by boiling-off the harmful gases, especially dissolved oxygen. However, this process results in a continuous loss of steam - Usually about 0.2 - 0.5 % of the boiler's steam output. **The process presented here can reduce these losses by up to 95 %.**

Feedwater for steam generation boilers must meet certain minimum quality criteria. For shell boilers, the feedwater requirements are based on EN 12953 Part 10 (formerly TRD 611). Gases dissolved in recycled condensate and in fresh make-up water cause damaging corrosion inside boilers and in the steam and condensate network. Dissolved gases can be removed by various means. The most common is Thermal Degassing. Physics (Henry's Law) dictates that the solubility of gases in a liquid reduce as the temperature of the liquid increases. As a result, boiling liquids contain almost zero dissolved gases.

We know this from heating water. When a pot of cold fresh water is heated on a hot plate, small gas bubbles become visible at the bottom. As the temperature rises the bubbles increase in size, detach from the bottom and rise to the surface of the water. The bubbles contain gases which were formerly dissolved in the cold water. They are released from the water by heating (Fig. 1).

Thermal Degassing and Steam Losses

Inside the degassing tank, water is heated by steam injection to above the boiling temperature. This releases dissolved gases. They rise into the head of the degasser dome and flow in countercurrent to the incoming water, to escape from the degasser to atmosphere via the steam exhaust valve. The process can be aided by the exhaust valve being controlled by pressure or temperature, to maintain a positive pressure inside the tank between 0.1 and 0.3 bar, corresponding to 102 - 107 °C. The rising and escaping steam thereby aids the discharge of gases from the degasser dome into the open air.

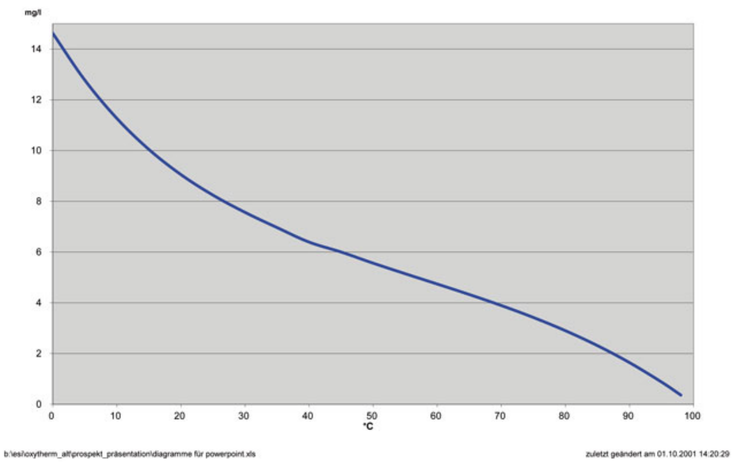

Fig. 1 Dissolved Oxygen versus Temperature

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When a fixed position exhaust valve is used it is set during commissioning. So that even under 'worst case' conditions all gases dissolved in the feed water will be discharged. Published advice recommends setting the exhaust flow at up to 0.5 % of the maximum steam boiler output. It essentially depends on variables such as steam waste, condensate loss and make-up water temperature (deionized).

In practice, the exhaust volume flow is very often set empirically – The real losses are usually unknown. It is only possible to determine the actual losses by means of elaborate measurement techniques. They involve condensing the exhaust vapours and measuring the amount of condensate. Figures from a number of boiler houses suggest losses of 0.15 % to > 3 % of nominal boiler output are common. The steam demand of a typical deaerator can be considerable in relation to the amount of useful steam produced. In situations where the steam demand is low or inconsistent with the degasser running continuously, the absolute losses can be enormous. (Fig. 2).

Fig. 2 Exhaust Vapour Outlet

Regulated Degassing Operation

To reduce the steam loss, vapour condensers are sometimes used. Normally with the make-up water used as the cooling medium. However this only works while there is a requirement for additional cold make-up water. Since this only occurs intermittently, the vapour cannot be condensed or used a lot of the time.

OxySteam has been developed by Centec as a system for regulating the steam used for degassing, which can reduce steam losses by up to 95 %. The process monitors the gas content of the exhaust vapour. The exhaust valve is then controlled via a programmable logic controller (PLC) to only discharge steam when necessary for the effective and efficient control of the degassing process.

Figure 3 shows an extremely simple installation - An in-line oxygen sensor installed upstream from a 'normally-open' shut-off valve in the vapour exhaust from a degasser dome.

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Fig. 3 Installation

Continuously monitoring oxygen levels in the vapour allows the exhaust valve and discharges to atmosphere to be controlled. The exhaust valve opens when the oxygen is above an upper setpoint and closes when the lower setpoint is achieved. This can be combined with opening the exhaust valve when make-up water is fed into the system, because freshwater is the primary contributor of dissolved gases.

The controlled exhaust valve is a 'normally open' type which is positioned downstream from the existing valve. In the event of a malfunction the exhaust valve will open. The system will then automatically return to its original operation.

In addition, the degassing function can be monitored by a second Centec **OxyGuard** sensor directly in the degassed water supply line to the steam boiler, measured continuously.

Economic Aspects

To determine the vapour losses from an individual thermal degassing system it is necessary to carry out an on-site study during live and fully representative operating conditions. The flow rate and frequency of vapour discharge can be roughly determined using an impeller flowmeter. Vapour discharges can also be evaluated by collecting, condensing and weighing the discharged condensate over a known period. By multiplying the vapour discharges and the degasser operating time (usually 8760 hours per year) it is possible to evaluate and compare the losses. In many cases the achievable savings are > 90 %. This is highly significant when considering the ongoing economic benefits of the Centec OxySteam.

Vapour losses represent a waste of heat and energy which can largely be avoided. In many countries energy efficiency initiatives and the reduction of CO_2 emissions attract financial subsidies. In Germany, for example, through the "KfW Energy Efficiency Programme - Waste Heat" (KfW Bank = Kreditanstalt für Wiederaufbau) subsidies of 30 % or even 40 % can be granted for a well-prepared application. Needless to say, the financial benefits can be significant for any business with a steam boiler and thermal degasser.

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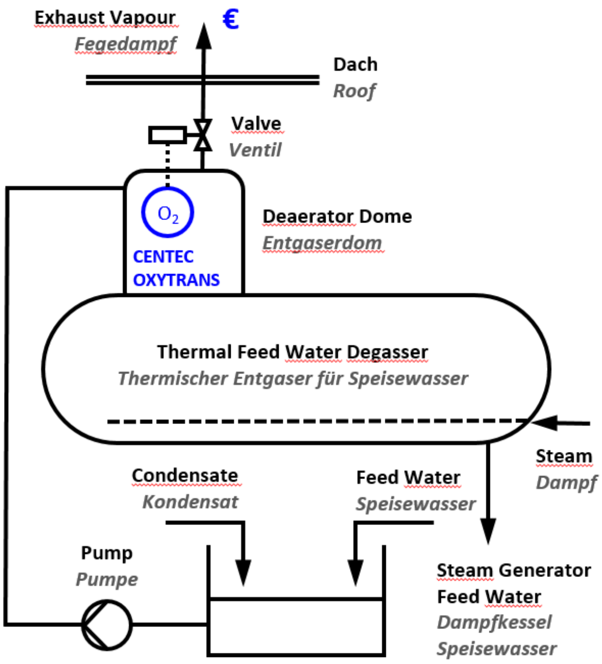

Fig. 4 Schematic structure of the process

Example calculation

As an example of the potential savings available when using this system:
Assume a steam boiler - Capacity: 10 t/hour.
Assume a Steam Loss from the degasser at: 0.3 %
Result: A steam loss of 263 t/year at max. 8760 hours operation per year.
This corresponds to a mass flow loss of 30 kg/hour, of which up to 95 % or 250 t/year can be saved.
Assume 1 tonne of steam costs about 30 - 40 EUR. (depends on fuel and purchase quantities).
The savings are about **7.500 - 12.500 EUR/year**.

Depending on the size of the system and the equipment required, the costs for the OxySteam system are about 10.000 EUR. So, including a possible subsidy, this usually results in a short payback period (0.5 - 1.5 years).

Almost all larger industrial companies now have an energy management system. What all these systems have in common is a voluntary commitment to continuous improvement. This means audits must be held at regular intervals and measures to improve energy efficiency must be implemented. The OxySteam system presented here is well-suited for meeting the requirements and can usually be implemented easily and economically.

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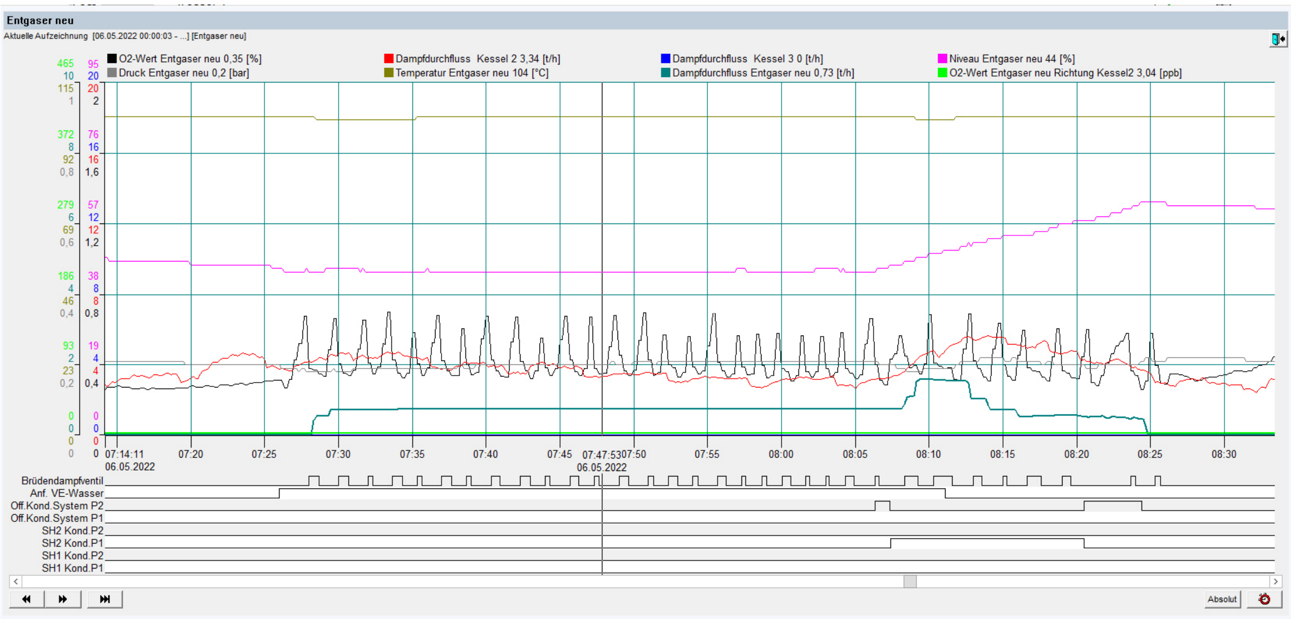
Practice process readings



Summary

During the thermal degassing of boiler feed water, vapour losses occur that are discharged to the environment. With the method presented, the vapour losses can be adapted to the actual demand and thus reduced by up to 95 %. Due to the avoidance of waste heat, the investment may even be subsidized. As a rule, this results in good economic efficiency. In addition, it is a sustainable energy efficiency measure that can be implemented within the framework of existing energy management systems.

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