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Optimisation of a steam boiler plant with O_2 regulation and CO regulation

STEAM BOILER PLANT | The firing capacity of the Friesian brewery in Jever no longer matched the requirements of modern production. The brewery identified potential savings and carried out a retrofit. The following article describes the current optimised CO_2 and CO regulation which has made it possible to improve the efficiency of the plant.

THE FRIESIAN BREWERY IN JEVER in the North German region of Friesland produces approximately 1.4 million hl of Jever Pils, Light, FUN and Dark beer per annum. At the production site in Jever, a three-pass steam boiler with a firing capacity of 13.8 MW (2 off 6.9 MW ELCO Klöckner burners) has been in operation since 1989. This ensures the supply of power for beer production and bottling. Two further steam boilers are installed but because of their low capacity (7.6 MW) and age (efficiency), they cannot supply the power for the whole facility. Fluctuating O_2 values in the off-gas meant that the burners had to be readjusted regularly and lead to an increased level of susceptibility to faults in the existing plant. On account of rising energy prices and additional costs, studies are constantly being carried out in order to improve the efficiency of the heat supply by means of technical but also other types of measures. The main aim was that these investments and technical modifications would enable savings to be made on primary costs in the short term.

EMISSIONS TRADING

…will bring new opportunities and risks for companies from 2005.
That is when the CO_2 emission laws will be put into practice throughout the EU. Companies affected will have to provide relevant proof of authorisation for their CO_2 emissions. The sale of emission rights which are not required can be a worthwhile investment. When planning investments, companies should work out potential savings to be made as well as their own emission requirements.
Tips and background information can be found at www.co2ncept.net.

Fig. 1
A familiar sight – the Jever towers at the Friesian brewery

Fig. 2
The retrofitting of the O_2 measurement devices for the boilers has enabled considerable savings to be made in the ecological balance-sheet

Influencing factors

The following external reasons could be responsible for reducing the firing efficiency of heat supply systems:

- Combustion air: temperature, pressure, humidity
- Fuel: calorific value, temperature
- Pollution: burner, boiler (a 1 mm layer of soot will increase the temperature of the off-gas by approximately 50 °K. This will mean an increase of 4% in fuel consumption)
- Mechanics: hysteresis (wear during routine operation).

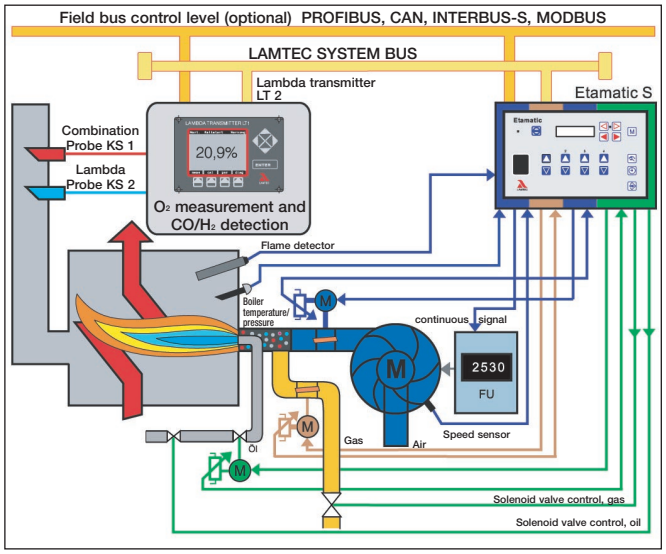

Fig. 3
System linking for the Etamatic S with integrated CO regulation

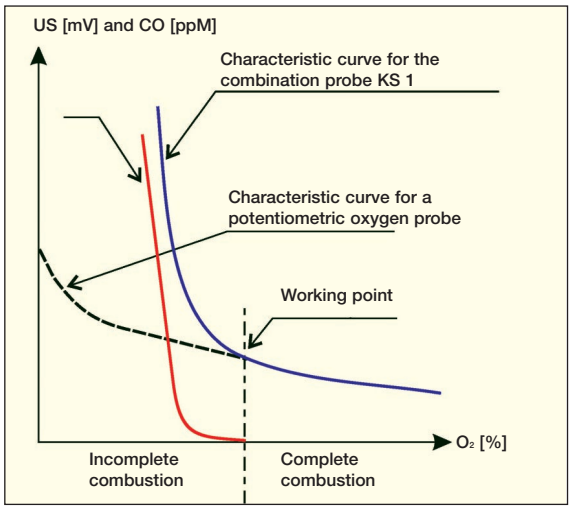

Fig. 4
Typical plant (burner) and probe characteristics, plotted on top of the oxygen concentrations in the off-gas

Potential and solutions

The application of and potential savings to be made with O_2 regulation were investigated by means of collaboration with LAMTEC Mess- und Regeltechnik für Feuerungen GmbH & Co KG from Walldorf (Baden).

As the results showed that there were considerable potential savings to be made, two O_2 probes were retrofitted in the second turning chamber of the boiler. A fail-safe TÜV-approved Etamatic® controller from LAMTEC was installed for regulating O_2 as well as the speed of the combustion air blower. As a result of the self-optimising control, it has been possible to reduce the excess air (O_2 value) and thus the off-gas losses in the medium- and high-output ranges considerably and keep them constant regardless of external influences. Almost at the same time as the installation of a steam turbine to reduce the eco

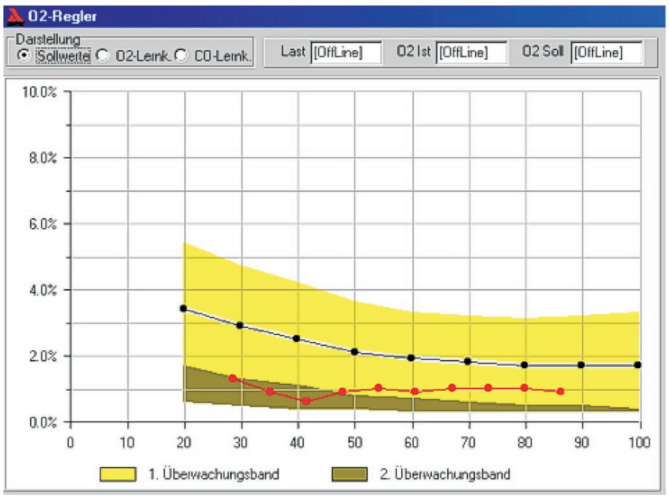

Fig. 5
The characteristic curves for the plant appear on the PC monitor, here for burner 2

tax load, the 14-stage pressure-dependent burner capacity controller was replaced by a variable continuous load regulator. As a result, there is a virtually constant controlled boiler pressure as fluctuations in the pressure within the steam network on account of load variations and system deviations have been compensated for. During commissioning, the TÜV testing of a new binary combustion optimisation system with cyclic detection of the CO side integrated in the Etamatic® controller was achieved by LAMTEC which has enabled optimisation of firing efficiency in addition to the above-mentioned measures.

In Spring 2004, the additional probes required for CO regulation (combination probe KS 1) were retrofitted in the off-gas channel and CO regulation was put into operation.

The system itself determines the optimum working point of the burner (combustion) dynamically at each load point without influencing load regulation by using the by-products of combustion – carbon monoxide (CO) and hydrogen H_2 – as indicators of incomplete combustion. It starts the “CO side” and controls the burner according to the working point determined using this method within the range of complete combustion.

In order to improve control further, in connection with this the two burners were converted by changing

the mechanical fuel/air composite control system to an electronic system with a facility for regulating the speed of the combustion air blower. The resources required in order to do this are integrated in the Etamatic® controller and had not been used until now. This innovative, dynamic, self-optimising control technology for industrial plants brings additional primary energy savings through further reduction of the O_2 off-gas value while at the same time minimising the output of pollutants. The savings are shown in tables 1 and 2. An additional aspect which should also be taken into consideration is the emissions trading which is planned from 2005. CO regulation will save approximately 80,000 Nm^3 of natural gas per annum which corresponds to a CO_2 output of 200 t.

THE AUTHOR

Wolfgang Janssen from the Technical Plant Management team at the Friesian brewery of Jever GmbH & Co. KG in Jever produced this article in conjunction with Lamtec Mess- und Regeltechnik für Feuerungen GmbH & Co KG of Walldorf (Baden).

SAVINGS AS A RESULT OF O_2 REGULATION BURNER 1

	Light load	Medium load	Full load	
Operating hours	1600	5600	800	
Fuel costs EUR/Nm^3		approx. 0.30		
Total savings (%) O_2 regulation	1.19	1.47	1.20	
Savings/annum (EUR) O_2 regulation	343.05	7877.42	1669.21	9889.68
Additional savings (%) CO regulation	0.77	0.38	0.39	
Additional savings CO regulation (EUR/annum)	222.94	2053.61	545.20	2821.75
Total savings O_2 and CO regulation (EUR/annum)				12,711.43

SAVINGS AS A RESULT OF O_2 REGULATION BURNER 2

	Light load	Medium load	Full load	
Operating hours	1600	5600	800	
Fuel costs EUR/Nm^3		approx. 0.30		
Total savings (%) O_2 regulation	1.20	1.49	1.22	
Savings/annum (EUR) O_2 regulation	403.90	8116.02	1695.55	10,215.48
Additional savings (%) CO regulation	0.79	0.43	0.40	
Additional savings CO regulation (EUR/annum)	265.89	2331.43	563.15	3160.46
Total savings O_2 and CO regulation (EUR/annum)				13,375.94

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