Reduction of Greenhouse Gas Emissions - The Brewery Contribution

Key words:
Boiler optimisation, energy savings, variable speed drives, reduced maintenance costs, improved combustion, reduced pollution

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Boiler Optimisation using Variable Speed Drives

- Facts about boilers in breweries
- Optimising the performance of boilers
- Case Story: Boiler optimisation at SAB Miller Alrode Brewery in South Africa

Facts about Boilers in Breweries

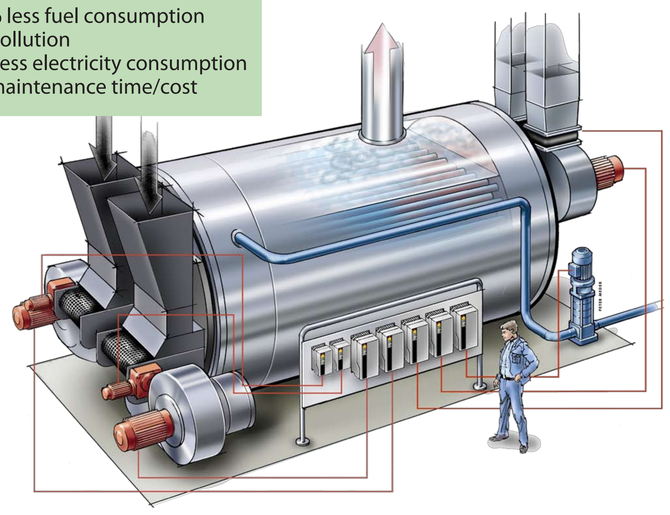
A large part of the energy consumption (fuel and electricity) in a brewery is used in the boiler house. Many breweries are often neglecting the savings achievable by optimising the boiler system.

Most common boiler types:
- Natural gas fired boilers
- Oil fired boilers
- Coal fired stoker boilers

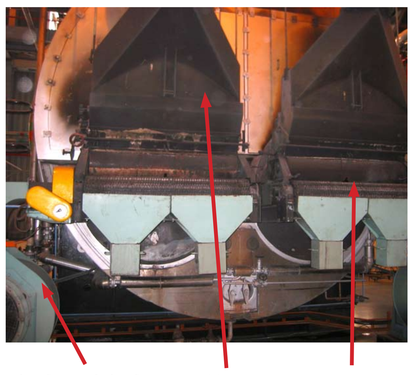
Major boiler operating cost drivers:
- Fuel costs
- Electricity costs
- Maintenance costs

Typical benefits by optimising all boiler types:

- Up to 10 % less fuel consumption
- Reduced pollution
- 30 – 50 % less electricity consumption
- Reduced maintenance time/cost



Typical Coal Fired Stoker Boiler



The forced draft fan is keeping the right air to fuel ratio

Coal hopper

Chain grate stoker

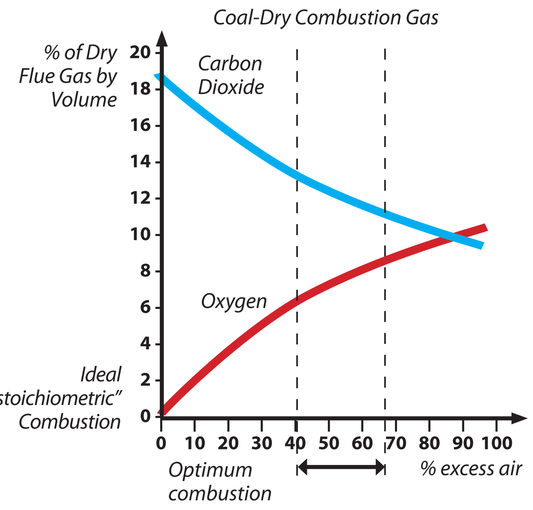
The induced draft fan is keeping the right temperature/pressure in the boiler

To maximise the combustion efficiency of any boiler:

The air to fuel ratio must be kept to a minimum that ensures complete combustion (Forced draft control).

The temperature or pressure of the boiler must be kept at the target to ensure optimum steam generation (Induced draft control).

How to find the optimum Air to Fuel Ratio:



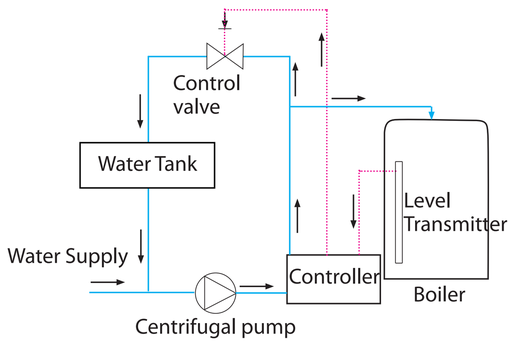
At the ideal combustion point the precise amount of oxygen is available to burn the fuel completely. In practice "excess air" is needed to burn the fuel completely (typ. 30-70% excess air).

Too high air to fuel ratio is increasing flue gas losses (reducing boiler efficiency).

Too low air to fuel ratio results in unburned fuel – soot, smoke and carbon monoxide in the exhaust (increased pollution and explosion risk).

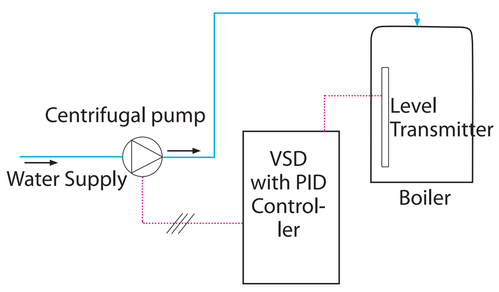
- 5° C increase in stack temperature = approx. 1% higher efficiency loss
- Flue gas loss at optimum Air to Fuel Ratio: 15 – 20%

Traditional Boiler Feed Water System with Control Valve:



- Pump is running constantly at full speed
- Flow rate is controlled by control valve
- High electricity consumption

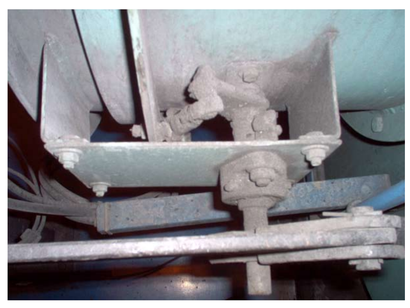
Boiler Feed Water System with Variable Speed Drive:



- Flow rate is controlled by variation of pump speed
- 30-50% electricity savings compared to traditional system

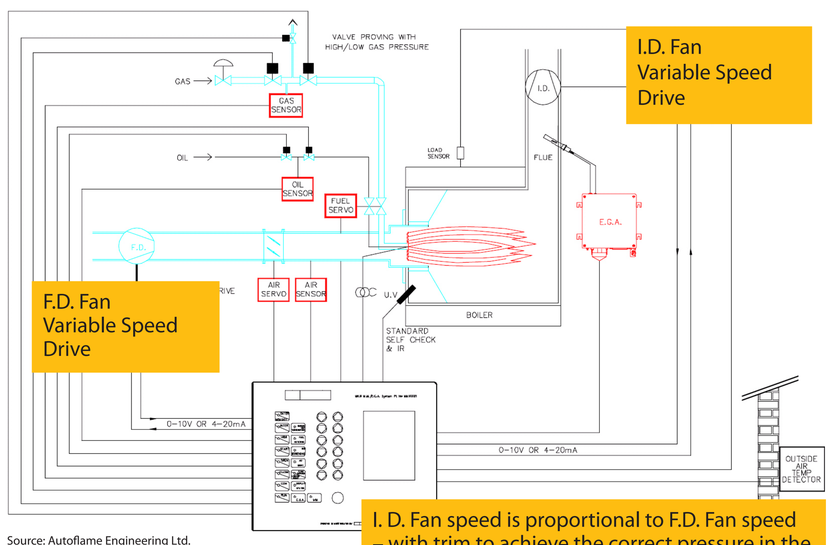
Limitations with Traditional Mechanical Systems:

- Poor air to fuel ratio accuracy due to inaccurate mechanical cam and linkage systems (poor repeatability).
- Air flow is controlled by mechanical dampers restricting the air flow. This method is wasting a lot of electricity compared to variable speed control.
- Unstable steam pressure/temperature (risk of high pressure trips) as the response time is too long to cope with fast load changes.
- Poor turn down ratio makes it difficult to operate to boiler at low steam consumption.



Mechanical damper systems

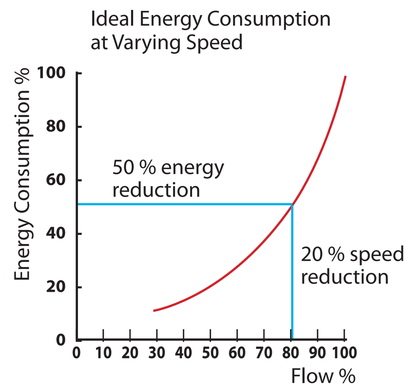
Modern Boiler Management System Schematic :



Source: Autoflame Engineering Ltd.

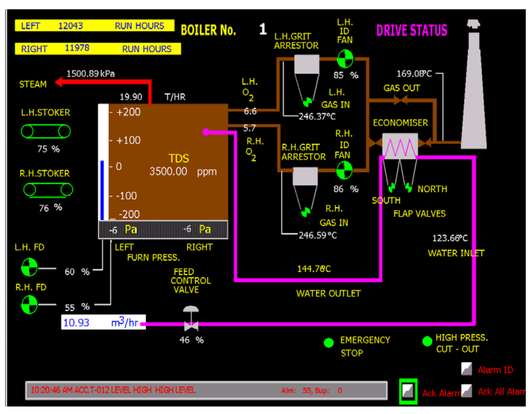
I. D. Fan speed is proportional to F.D. Fan speed – with trim to achieve the correct pressure in the combustion chamber

Energy savings on fans and pumps using variable speed drives:



Variable speed control:
- 50% energy savings when the fan speed is reduced from 100 to 80%.

Typical operational data after optimisation:



Steam production:	**19.9 t/h**
Left F.D. fan:	**60%**
Right F.D. fan: (too large difference indicates that the boiler needs maintenance)	**55%**
Left stoker chain:	**75%**
Right stoker chain:	**76%**
Left I.D. fan:	**85%**
Right I.D. fan:	**86%**
Left O_2 sensor:	**6.6%**
Right O_2 sensor:	**5.7%**
Flue gas temperature:	**169° C**

Case Story: SAB Miller Alrode Brewery South Africa:

Boiler Upgrade Project
Project manager: Jay Mistry

Project paid back in less than 12 months:

- Reduced electrical power consumption
- Reduced coal usage
- Less maintenance
- Less pollution of the environment
- Lower noise level in boiler house

Boiler system at Alrode Brewery:
6 John Thompson (Alstom) coal fired twin stoker boilers (20 ton steam/hour).
4 boilers are on-line during normal production:

Pre project findings:

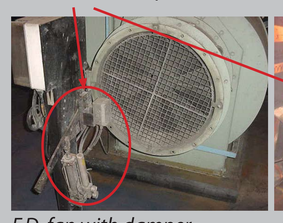
- High coal usage due to inconsistent air/fuel ratio.
- Inaccurate feed water level control.
- The economisers needed frequent cleaning. Water temperature after economiser was too low.
- High maintenance cost for fans, dampers and mechanical control system.
- The stoker speed on some of the boilers not working optimally due to faulty oxygen meters.

Objective for optimisation project:

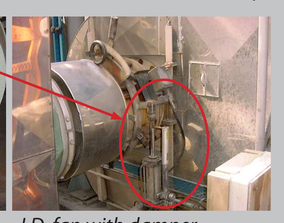
- To implement the correct control strategy to ensure a cost effective utilization of the boiler house regardless of the quality of the fuel used.
- Replace capacity modulation with inlet guide vanes or dampers by retrofitting combustion air fans with variable speed drives in order to optimise air to fuel ratios, reduce control complexity and save electricity for the fans.
- Provide precise air flow for correct level of "excess O_2" in the flue gasses by O_2 transmitter feedback from the stack.
- Reduce frequent high pressure tripping.

Project solutions:

Pneumatic damper controls on F.D. and I.D. fans were replaced by variable speed drives:



F.D. fan with damper



I.D. fan with damper

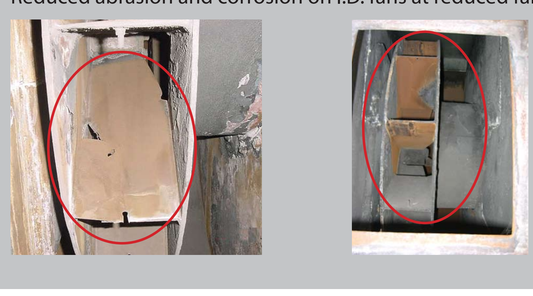
Problems:
- Much mechanical play
- Non-linear motion
- High compressed air consumption

V-belts on I.D. fans were replaced by direct drive couplings:

Problems:
- V-belts had to be replaced every 1-2 years
- Frequent maintenance and adjustment
- Creating noise

New solution:
- No maintenance
- Less energy consumption

Reduced abrasion and corrosion on I.D. fans at reduced fan speed:



Problems:
- Lifetime of fans was 3-5 years only
- Costly and time consuming replacement

New solution:
- Lifetime yet to be seen – but clearly less abrasion and corrosion

Environmental Sustainability

The Danfoss Group has joined "The Business Charter for Sustainable Development" issued by the **International Chamber of Commerce (ICC)** and the **Global Compact Initiative** issued by the United Nations.

The Danfoss Group, its companies and its factories have thus undertaken the obligation to:

- Support a precautionary approach to environmental challenges
- Undertake initiatives to promote greater environmental responsibility
- Encourage the development and diffusion of environmentally-friendly technologies

Pay back for optimisation project: < 12 months:

- **Electricity savings**
- **Less need for maintenance**
- **Coal savings** (is not documented due to variations in coal qualities. Coal savings may have same value as electricity savings)
- **Less downtime** (high pressure alarms are eliminated)
- **Additional benefits:** Reduced noise and reduced air pollution

Boiler Optimisation using Variable Speed Drives:

- Up to 10 % less fuel consumption
- Reduced pollution
- 30 – 50 % less electricity consumption
- Reduced maintenance time/cost

Optimisation methods:

- Forced Draft speed control to ensure correct Air-to-Fuel ratio
- Induced Draft speed control to ensure correct furness pressure
- Coal fired boilers only: Stoker chain speed control
- Feed water pump speed control