SCAN TRONIC
COMBUSTION OPTIMIZING
HADSTEN - DANMARK

Possible savings using oxygen control systems.

Savings operating burners and boilers used for energy production in district heating plants and industry can be separated into three different groups. These groups shall briefly be described and the magnitude of the achieved savings shall be mentioned:

1) Direct saving fuel due to a better efficiency.

2) Saved emission of unwanted chemical compounds - saved due to reduced fuel consumption.

3) Saved emission of unwanted chemical compounds - saved due to better combustion quality.

Combustion is a process where the oxidizable compounds of a fuel is oxidized by the oxygen (21 %) contained in the atmospheric air. If the oxidation is ideal no (0 %) oxygen is left when the mixture has passed the boiler.
In reality fuel and air cannot be mixed sufficient to achieve an ideal combustion. Due to this a small amount of excess air has to be present to achieve an adequate combustion of the fuel under all conditions. Lack of excess air results in formation of carbon-monoxide being poisonous, explosive and still containing energy. Excess air derates the efficiency of the plant.

Figure 1.

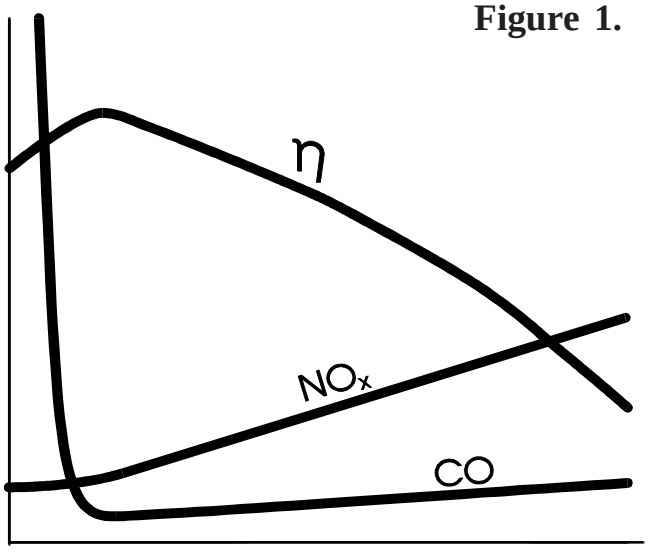

Figure 1 illustates the relation between excess air, efficiency and the compounds the minimization of which is reckoned as crucial for optimum function of the plant.
Referring to Figure 1 the curve of efficiency has a peak at optimal efficiency.
Reducing excess air below this optimum peak reduces efficiency as a part of the fuel-energy is passing the boiler as uncombusted CO. By to large amount of excess air energy is lost heating up this extra air. Simultaneous the formation of NO_x will increase characteristic. NO_x is an unvanted chemical compound playing a leading role in the formation of the acid-rain destroying our forests.
Unfortunately the optimum ratio between air and fuel cannot be maintained during different conditions why a slight extra excess air has to be added to form a safety margin to secure this ratio never to get below the limit giving CO formation. This safety margin however derates the efficiency - why boilers where optimum efficiency is a must - have to be adjusted regularely. If these adjustments are not done or done using poor equipment the excess air in may boilers can be remarkably large.
Is such a boiler fitted with equipment - continuous measuring excess air (as the amount of remaining oxygen) in the flue-gas and which furthermore automatically is readjusting the air fuel ratio to the optimum peak - it is possible to avoid extra excess air, increasing efficiency and last of all giving a better economy.
To illustrate the possible savings we have to use an example:
A typical natural-gas powered district heating plant are using 5 MW boilers. As an average such a boiler burns 1.3 million m^3 of natural-gas pr. year. Using a gas price of 3 DKr pr. m^3 this is a budget of 3,9 million DKr. Burning 1.3 million m^3 of natural gas forms around 15.6 million m^3 of flue-gas.
Using a oxygen control system this boiler can me maintained at a oxygen percentage (according to figure 2) of 1.5%. Without a control system but, regularely adjusted the average oxygen percentage can be 3.7% whereas a generally bad maintained boiler will have a typical average oxygen percentage of 6%.
This results in the following annual savings using the above figures and figure 2. The figures in brackets are conservative figures from the manual adjusted (ideal) boiler:

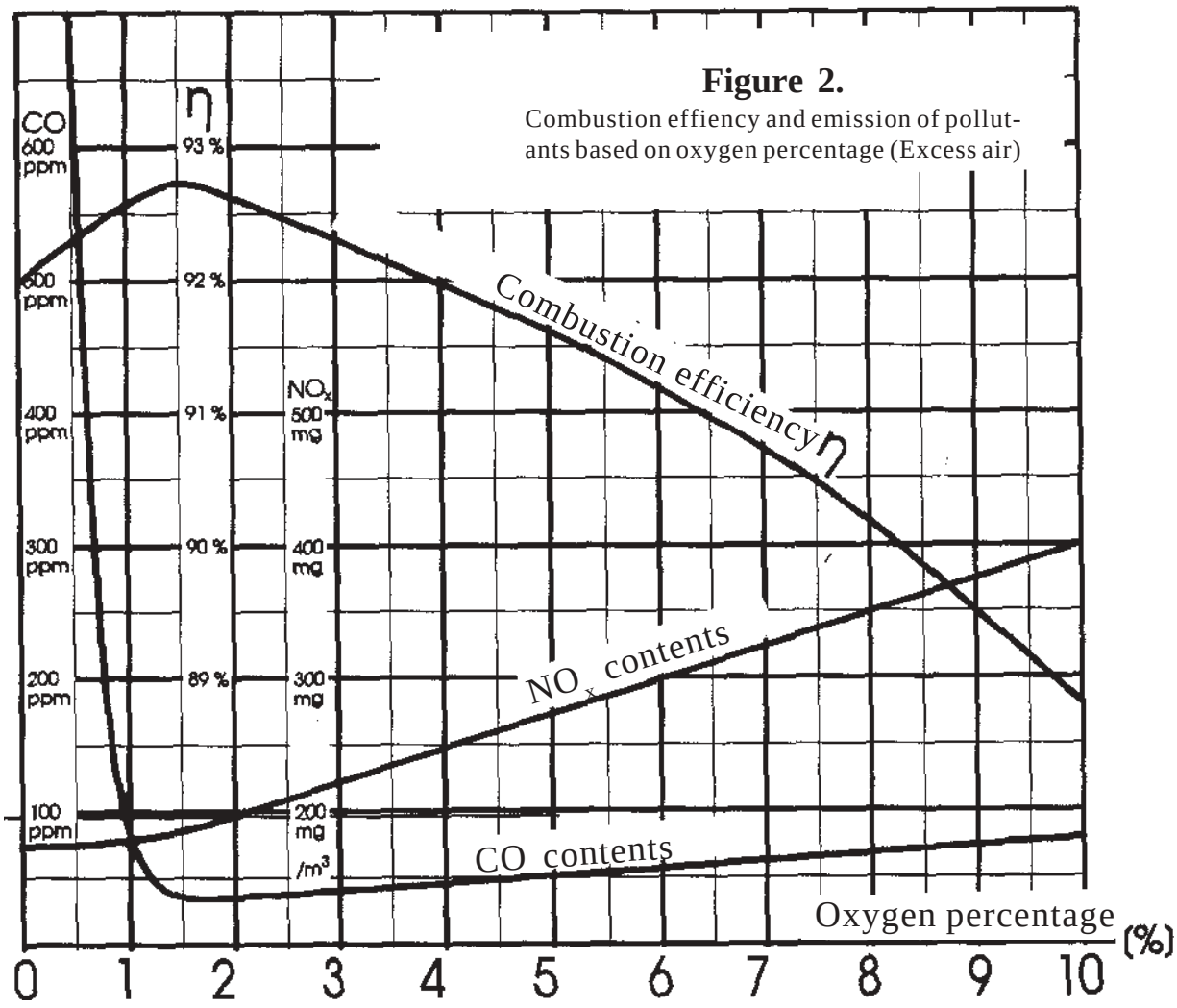

Figure 2.
Combustion effiency and emission of pollutants based on oxygen percentage (Excess air)

1)	Direct savings on the gas-budget	60,000 Kr	(25,000 Kr)
2)	Saved emission due to lower fuel consumption:		
	CO_2	54,000 Kg	(14,000 Kg)
	*Sulphur compounds	8 Kg	(3 Kg)
	* Natural-gas contains very little sulphur. Using light-oil containing 0.5 % sulphur we would avoid emitting this amount of sulphur compounds:	463 Kg	(194 Kg)
3)	Saved emission due to a better combustion:		
	NO_x	1,875 Kg	(775 Kg)
	This would today living in Sweden save us for a polluting tax (40 SKr i Kg) of:	75,000 SKr	(31,000 SKr)

Conclusive:

Fitting oxygen control equipment (controlling excess air), even a conservative estimation predicts a good rate of return of an investment based on the saved fuel. Apart from this and in conjunction with the announced taxes on NO_x emission the savings in this tax - alone can return the necessary investment.

Require additional information by:

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