LONGANNET GAS REBURN PROJECT

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SUMMARY

UK and European legislation regarding the emissions of pollutant from fossil fuelled plant continues to become ever stricter. In the UK, there are limits on the NO_x concentration in the boiler flue gas which are currently set at 650 mg/Nm^3 @ 6% O_2 and existing boilers have to comply with the limits within a timescale agreed with the Pollution Inspectorate. Each utility has an overall, company wide, pollution limit commonly termed emission bubbles with targets for reduction of the bubble relative to 1980 emissions. It is therefore possible for an operator to comply with the flue gas limit but come up against the pollutant bubble if the operating hours increases subsequent to 1980.

Scottish Power, a leading UK multi-utility company recognised the need to have available NO_x reduction technologies that gave NO_x emissions which were significantly lower than that which could be achieved with low NO_x burners. In conjunction with BG plc they commissioned a feasibility study in 1993 to identify advanced NO_x reduction technologies for their 4 x 600 MWe Longannet Power Station in Scotland. This study strongly favoured the use of gas reburn over other technologies, however at that time gas reburn technology had only been applied to much smaller boilers, most in the USA. Due to the technical and financial risks in scaling up the technology to 600 MWe boilers a number of boilermakers and utilities formed a partnership consisting of Scottish Power, Mitsui Babcock Energy Limited, Ansaldo Energia,BG Plc,ENEL, EdF,ESB to apply for a European Union Thermie demonstration grant. This was awarded and the demonstration project was initiated in August 1994.

The Process Design of the project was undertaken by the partners and has involved the extensive use of in-house experimental and theoretical modelling aimed at determining the position, number and operating conditions of the gas injector and overfired air ports to maximise the potential NO_x reduction. Based on these studies functional specifications were produced from which the detailed design was developed.

Once the installation was successfully commissioned the plant was handed over for the test team comprising of staff members from the partnership to execute a six month programme of demonstration testing.The objective of the test programme was to confirm the performance of the Gas Reburn System by comparing the performance at various operating conditions with baseline operation.

High load tests were carried out at 530-550 MWe, the baseline NO_x emissions under single stage combustion being measured as 760 and 670 mg/Nm^3 @ 6% O_2 for high and low firing patterns respectively for a primary combustion zone stoichiometry of 1.1

With Gas Reburn in service and 20% of the heat input being injected through the reburn ports the NO_x emissions varied from 440 to 275 mg/Nm^3 @ 6% O_2.The reason for the wide

variation is due to the sensitivity of the performance to firing pattern and reburn zone stoichiometry.The overall NO_x reduction performance can be summarised with respect to reburn zone stoichiometry (λ) as follows:-

	NO_x Reduction from Single Stage Combustion (%)			
	λ = 0.825	λ = 0.85	λ = 0.875	λ = 0.9
High Firing	54	51	47	42
Low Firing	59	55	54	49

Gas Reburn NO_x Reduction Performance

The combustion performance of 530 MWe baseline single stage combustion at a stoichiometry of 1.1 in primary combustion zone with respect to CO and Carbon in Ash gave less than 20 mg/Nm^3 @ 6% O_2 of CO and carbon in ash levels of 4-5.5% for high and low firing respectively. This was somewhat unexpected as higher firing patterns normally give higher carbon in ash levels. The reason for this anomaly is not clear however it is possible that different mills producing different mill product fineness may have been part of the reason.

The CO emission levels at 550 MWe with gas reburn in service show similar levels (less than 20 mg/Nm^3 @ 6% O_2) to single stage combustion at a reburn zone stoichiometry of 0.9. As the reburn zone stoichiometry reduces the CO level increases with levels of 140 and 350 mg/Nm^3 @ 6% O_2 at reburn zone stoichiometries of 0.85 and 0.825 respectively.

The carbon in ash levels at 550 MWe with gas reburn in service show that Carbon in Ash levels increase as the gas reburn stoichiometry decreases, again with the lower firing pattern showing higher carbon in ash levels than the higher pattern. At a gas reburn stoichiometry level of 0.9 the carbon in ash is 5 and 7.0% compared to 4 and 5.5% for single stage combustion at a primary combustion zone excess air level of 10%. This is a very modest increase in Carbon in Ash considering that a reburn zone stoichiometry of 0.9 gives a NO_x reduction of 42-49%. At a reburn zone stoichiometry of 0.85 the Carbon in Ash increases to 7.8-9.0% and approaching the point where the carbon in ash is increasing at a faster rate than the NO_x is decreasing. This would tend to indicate that the optimum reburn zone stoichiometry lies between 0.85 and 0.9.

i) The demonstration of gas reburning on a 600MWe boiler at Scottish Power's Longannet Power Station has been successfully completed. This represents the largest scale application of this advanced low NOx reduction technology anywhere in the world

ii) High load test data indicates that at a reburn zone stoichiometry of 0.9 the NO_x reduction being achieved with gas reburn is 42-49% with little or no increase in Carbon In Ash and CO emissions..

iii) Further NO_x reduction up to 59% can be achieved by reducing the reburn zone stoichiometry, however these further reductions are accompanied by increased Carbon In Ash and CO levels.

Scottish Power has already indicated that they are considering implementing gas reburning on the remaining three boilers at Longannet. The future prospects for commercial exploitation of this technology are being investigated. A world-wide survey of potential coal-fired retrofit boilers indicates a substantial market opportunity, particularly in the first quarter of the next century when the more stringent environmental legislation is expected.