RJM International is a UK-based business that works with power generation plant and large combustion plant all over the world to help them improve efficiency rates and meet current regulations governing emissions. In Europe, the Large Combustion Plant Directive (LCPD) is one of the main pieces of legislation covering the sector, imposing ever-tightening limits on emissions of Nitrogen Oxide (NOx) into the atmosphere.

In order to help it comply with the limits set out in the LCPD, AES, a global power and distribution business called in RJM International to look at one of its power plants at Tiszaújváros in Hungary, 180km west of Budapest.

AES Tisza II is an 860MWe unit, capable of firing on either oil or natural gas, providing steam to four boilers, each with a capacity of 215MWe. The company needed to reduce the original NOx level for gas firing for two of these boilers by almost two thirds. For oil firing, the challenge RJM faced was to reduce the original NOx level by more than half.

Following burner modifications final NOx figures achieved were 205mg/m$^3$ on gas, and 250mg/m$^3$ oil. Other benefits included a 1.1 per cent increase in boiler thermal efficiency and better temperature distribution of the fluegas to the convective boiler heat exchangers.

When generators are faced with significantly lower NOx emission targets, one would normally expect a loss in efficiency due to the decrease in combustion efficiency, experienced when delaying the mixing of the fuel and air. However, in many cases, the existing combustion system is not fully optimised to start with and this can provide a window of opportunity where emission reductions can still be achieved, with no detrimental effect on efficiency. In many cases, with the right approach, an efficiency improvement can actually be achieved as well.

In order to identify if such opportunities do exist, it is important to carry out a comprehensive study on the performance of the existing system. RJM uses sophisticated Computational Fluid Dynamics (CFD) models to do this, together with thorough discussions with the operational team managing the plant to really understand how it operates and why existing settings and parameters have been set.

CFD modelling is employed to verify that the desired emission reductions can be achieved; to define the combustion performance of both the existing system and the upgrade; and to highlight any areas of concern with respect to the performance of the existing system. This is then combined with a comprehensive combustion optimisation programme to ensure the fuel and air are delivered to the combustion system evenly and predictably, which in turn means the mixing of these two elements is controlled within the combustion system itself and is not influenced by abnormalities in their delivery.

At AES Tisza II, the CFD work undertaken did confirm problems with the existing set-up. This can be seen in Figure, A, which shows both the temperature contours and the NOx contours in the vertical plane of the furnace confirming uneven temperature distribution. A characteristic feature of burners that fire upwards directly into the outlet is that flames tend to converge together, towards the centre.

In contrast, following the burner modifications designed and built by RJM using the data from the CFD analysis, one can see that in Figure B the flame temperature is more diffuse, resulting in improved heat transfer in the furnace and then through the convective heat exchangers in the boiler.

This results in improved heat transfer in the furnace and a decrease in peak flame temperature, which in turn reduces NOx levels.

John Goldring, RJM’s managing director comments, “Delivering NOx reductions and energy efficiency improvements can often be mutually exclusive, but in this case, thanks to a detailed CFD analysis we were able to do both.”

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