COST AND DESIGN IMPLICATIONS OF SCR APPLIED TO REHEAT FURNACES

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The steel production industry has not previously utilized SCR to any significant degree. However, new pressures are being brought to bear that may change this trend. Reheat furnaces are the primary source of NOx emissions in the steel mill. The reheat furnace imposes special constraints upon SCR operation, including the need to deal with an emissions stream that varies constantly in terms of flow rate, temperature and composition. Control and maintenance issues arise which are not typical considerations for SCR applications at utilities. Additionally, the inclusion of SCR changes the economics of reheat system supply and results in the need to change accepted design practices so that fuel efficiency and emissions can be properly balanced.

A typical steel products manufacturer will cast molten steel into intermediate products such as slabs, blooms, or billets. These intermediate products are rolled to shape in a steel mill. In order to facilitate the rolling process the steel is heated to a temperature in the range from 1900 to 2400 F in a reheat furnace. The furnace is refractory lined to conserve heat and generally includes a mechanism for transporting slabs continuously from one end to the other. Heat to the furnace and steel is provided by natural gas or fuel oil burners placed strategically along the furnace length. The products of combustion flow counter to the steel and exit the furnace at a temperature between 1400 and 2000 F. The products of combustion enter a flue and pass through a recuperator before being exhausted to atmosphere. The recuperator preheats combustion air for use by the reheat furnace burners as a means to increase fuel efficiency.

Prior to special emissions considerations, the primary necessity of reheat furnace design was to balance capital cost with fuel efficiency. The trend has been for longer furnaces having lower flue gas temperatures and increased combustion air preheat. Low flue gas temperatures have a positive impact on NOx emissions by decreasing the total amount of fuel burned. High air preheats also lower the amount of fuel burned but tend to increase overall NOx emissions. This is because the flame temperature increase raises NOx faster than fuel use is decreased. While new furnaces invariably utilize low NOx burners in their design, emissions factors fall in the range from 0.15 to 0.90 lb/MMBtu. Many parameters affect the emissions factor including air preheat, air to fuel ratio, burner turndown, fuel type, furnace temperatures, furnace pressure, and proximity of burners to each other.

The use of SCR imposes additional restrictions on the reheat furnace. New furnace designs often have waste gas temperatures below 600F after the recuperator. These temperatures are too low for SCR to work effectively. While an auxiliary burner can be utilized to increase the waste gas temperature, this is not typically the best approach. Auxiliary burners add to the installation cost and themselves contribute to NOx emissions. The alternative is to limit the furnace length so that the waste gases exit the recuperator at a temperature in the appropriate range for SCR. This lowers the system capital cost while providing the same system fuel efficiency.

The reheat furnace imposes constraints on the SCR unit which are not typically encountered in the utility industry. Due to downstream requirements, it is not uncommon for production to come to a stop from full production, and production turndown can be as low as five to one. As a result, the waste gas flow can go from 100% of the design flow rate to as low as 15% in a few minutes. As production changes, the air preheat and waste gas temperature also vary. Different production rates can result in waste gas temperatures either too high or too low for SCR to work effectively. This requires installation of both a dilution air system for those situations when the gas is too hot and a recuperator bypass for when the gas is too cold. Since air preheat and firing rate both have a significant effect on emissions factors, the concentration of NOx in the waste gases varies greatly. Thus, control of ammonia flow requires a two level system considering both waste gas flow and NOx concentration in the waste gases. This can be achieved to some extent through instrumentation, but control response times are such that some form of predictive control of ammonia may be required.

SCR is a high cost approach to NOx abatement for reheat furnaces. The capital cost is high in terms of the base equipment and the special controls required. Judicious furnace design can minimize this impact. Because SCR imposes special constraints on the waste gas temperature, fuel use is increased, adding to the operating cost of the reheat furnace. This is above and beyond the operating costs associated with the SCR unit itself. Despite its high cost, recent developments in negotiations between EPA and steelmakers indicate that SCR may become a reality on some steel reheat furnaces.