FACTORS AFFECTING SELECTION OF A CATALYST MANAGEMENT STRATEGY: AN INDEPENDENT PERSPECTIVE

J.E. Cichanowicz
Consultant

and

L.J. Muzio
Fossil Energy Research Corporation

A present, there is considerable discussion regarding catalyst management and the role of regenerated catalyst. Several catalyst manufacturers and providers of regeneration services have published cost studies evaluating the impact of regenerated catalyst on long-term procurement costs. Depending on the assumptions, either regenerated or new catalyst (or a combination of both) provides a lower cost option. Generally, the benefits of regenerated catalyst increase with the degree of activity (or catalyst potential) restoration, lower unit cost, and the availability of a regenerated catalyst inventory to use for the initial supplement.

The present analysis acknowledges the operator desires to minimize not necessarily catalyst procurement cost, but system production cost subject to the needs of SCR. Accordingly, additional factors related to SCR operation are evaluated. Examples of these include (1) any change in NOx emissions due to catalyst activity change, and the enhanced or reduced value of allowances, (2) the ability to tolerate higher residual NH_3, considering the impact on the air heater, or on the resale or disposal of fly ash, and (3) timing of outages for catalyst maintenance to minimize lost revenue.

The role of these factors is illustrated by considering the cost for SCR operation and catalyst management for a 500 MW plant. This unit is assumed to have retrofit SCR for a capital cost of $80/kW, including $11/kW for the initial catalyst charge. The SCR process is designed to provide 85% NOx removal from 0.43 lbs/MBtu, with a 15 year operating life. The unit is assumed to fire a low arsenic content (<10 ppm) coal, and operate at an annual capacity factor and heat rate of 78% and 9800 Btu/kWh, respectively. The significant cost elements (in mills/kWh) for the SCR process are 1.76 for capital recovery, 0.28 for catalyst management, 0.17 for reagent consumption, and 0.08 for auxiliary power and thermal efficiency losses.

The catalyst management charge of 0.28 mills/kWh over the 15 year period equates to a net present value (NPV) of $6.3 M for the purchase of 6 new layers of catalyst (at approximately $1.4M each). The use of regenerated catalyst, restored to 90% of initial activity for 60% of the initial cost, requires a total of 8 layers to be purchased over the same period, at an NPV of $3.9 million. Thus, considering catalyst procurement cost alone, a $2.5M savings is possible over a 15 period.

The importance of considering system factors is illustrated by comparing these costs to other SCR-related costs. For seasonal operation, catalyst can be maintained and replaced during the 7 month period of non-operation, thus the timing of catalyst replacement outages does not materially affect operations and cost. However, for annual SCR operation (as anticipated by many in 2007-2008), operators must construct a catalyst management program that maximizes utilization of planned major outages for the boiler and turbine, and eliminates or minimizes outages exclusively for catalyst replacement. Additional factors to be considered are the value of either additional NOx removed or compromised, the impact of contaminated ash with ammonia, and lost revenue due to an outage exclusively for catalyst maintenance.

In this example, the unit is predicted to require catalyst replacement at a time 15 months after a major turbine outage, and 12 months prior to a major boiler outage. The production lost from removing this unit from service for a 12 day period to replace catalyst can be compensated for in many ways, ranging from purchase of replacement power to the higher utilization of less efficient coal or gas-fired units. Lost revenue for this scenario will be estimated by the increased utilization of a series of 12,500 Btu / kWh heat rate units that are lower on the dispatch order than the example unit. Accordingly, a 12 day outage to replace new catalyst will cost approximately $1.55 M in higher fuel costs, or more than half of the $2.5 M catalyst procurement savings accrued over 15 years.

An alternative to incurring a major outage is to accelerate or defer catalyst replacement to coincide with a major outage for the boiler or turbine. Deferring the outage by 12 months and compromising NOx removal (by 3%, to maintain constant residual NH_3) will require purchase of an additional 200 tons of NOx credits, requiring $400K (at a NOx allowance costs of $2000 / ton). Another method to defer the outage is to allow residual NH_3 to increase, which (if not limited by air heater plugging from ammonium sulfate or bisulfate formation) may result in ash contamination and lost sales. For this example case, if 50% of the collected ash cannot be sold and incurs a net $28 / ton penalty for lost revenue and additional disposal charges, the cost to the operator could be $2.1 M. Finally, the combustion system could be fired to lower NOx entering the SCR process, but at the expense of higher fuel costs and perhaps compromised ash sales. Conversely, catalyst could be replaced 15 months early during the boiler outage, incurring a higher catalyst charge, but providing higher potential catalyst to increase NOx removal by 1-2%.

These and other options are discussed in this presentation, showing that catalyst management requires a complete system analysis of production and environmental control cost factors.