# Full-Scale Catalyst Regeneration Experience Of a Coal-Fired US Merchant Plant

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**Summary**

This paper outlines the full-scale catalyst regeneration experience of National Energy & Gas Transmission, Inc. (NEGT) for their 360 MW coal-fired Indiantown Generating Plant, which was performed by SCR-Tech LLC. Catalyst regeneration was chosen over catalyst replacement due to the significant overall cost and demonstrated benefits associated with this technology.

A paper presented by the same authors at the 2002 DOE Conference on SCR described the test regeneration results as well as the investigations conducted by NEGT preceding the decision to regenerate their existing SCR catalyst.

As a result of this investigation SCR-Tech regenerated a full layer comprising of 80 modules containing more than 160 $m^3$ of spent plate-type catalyst, which had been deactivated to less than 40% of its original activity after almost operating 60,000 hours. In addition to other catalyst poisons such as sodium, potassium, etc., the catalyst had accumulated almost 20,000 ppm of arsenic, which was determined to be the leading deactivation cause. At the same time, the concentration of vanadium and particularly molybdenum had greatly diminished. Additionally, a strong surface blinding layer had developed characterized by a high concentration of silicates and sulfates on the catalyst surface.

Arsenic was determined to be the leading cause of deactivation with concentrations up to almost 20,000 ppm on the catalyst surface before regeneration. The arsenic content of the catalyst was reduced by more than 90% during regeneration. Other catalyst poisons present in appreciable quantities were sodium and potassium as well as silica ($SiO_2$) and sulfite ($SO_3$) compounds, which are characteristic for a surface blinding layer. All these other catalyst poisons including the surface blinding layer were removed almost completely during regeneration. Thus, the regenerated catalyst was in a state that is comparable with new catalyst after the first several hundred operating hours with respect to the content of catalyst poisons.

The catalyst had also lost significant quantities of such catalytically active ingredients as vanadium pentoxide ($V_2O_5$) and molybdenum trioxide ($MoO_3$). The original concentration of these compounds in the new catalyst of around 1% $V_2O_5$ and about 6% $MoO_3$ was depleted before regeneration to levels around 50% of the original concentrations. Thus, the catalyst was reactivated by reinstating the original $V_2O_5$ concentration while raising the $MoO_3$ concentration back up to levels between 4 and 5%. As a result, the activity of the regenerated catalyst was fully restored to slightly more than

100% ($K/K_0 > 1$) of its original activity $K_0$, which was proven by independent third party bench-scale testing in a certified catalyst testing lab. The residual catalyst activity after about 57,000 operating hours and before regeneration was only $K/K_0 = 0.4$ or 40% of the new catalyst.

At the same time as the catalyst's activity was fully restored during regeneration, the $SO_2/SO_3$-conversion rate was reduced to almost 50% of the catalyst manufacturer's original guarantee value. This was accomplished by using SCR-Tech's proprietary $SO_2/SO_3$-conversion rate reduction treatment process. The original $SO_2/SO_3$-conversion rate guarantee, as provided by the catalyst manufacturer for the new catalyst, was the benchmark for the regenerated catalyst. This marks an important advantage for the operator, since it allows for significantly less $SO_3$ in the flue gas after the SCR while still retaining the full benefit of a catalyst activity as good as new catalyst.

The full written paper, including the overheads, provides detailed data on all chemical catalyst analysis performed before and after regeneration as well as all numerical results from catalyst bench-scale testing before and after regeneration. The regenerated catalyst was installed as the top layer of the SCR in April 2003. During a scheduled fall outage in late October 2003, samples were pulled to verify the deactivation rate of the regenerated catalyst and compare it to the deactivation of new catalyst installed in the same position in the same reactor.

NEGT, as the operator of the Indiantown Generating Plant, has opted for regeneration of their existing spent SCR catalyst rather than its disposal and purchase of new catalyst because of numerous tangible and intangible advantages provided by SCR catalyst regeneration. While not compromising SCR performance in any way, these advantages include:

- Significantly lower cost compared to the purchase of new catalyst;
- Avoidance of the liabilities associated with the disposal of spent catalyst as potentially hazardous waste;
- A lower overall $SO_2/SO_3$-conversion rate than guaranteed by the original catalyst manufacturer;
- A more economical operating plan employing only four half layers of catalyst rather than three full layers resulting in:
    - A reduction in overall pressure drop across the catalyst by one third
    - A reduced parasitic load of the SCR as a result of the lower pressure drop
    - An additional reduction in overall $SO_2/SO_3$-conversion rate of the SCR system by at least one third due to less catalyst installed; and
- The ability to better follow the needs of installed catalyst potential in the SCR reactor thus subjecting as little catalyst as possible to unnecessary deactivation.

Furthermore, the success of the catalyst regeneration performed by SCR-Tech convinced other coal-fired plants operated by NEGT such as the Logan Generating Plant to also have their spent catalyst regenerated by SCR-Tech, thus taking full advantage of all the cost benefits of catalyst regeneration. The results of the catalyst regeneration performed for Logan Generating Plant will be presented at a later point in time.