REJUVENATION WORK OF SCR CATALYST FOR MEHRUM POWER STATION

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SUMMARY

Babcock Hitachi K.K. (BHK) received the contract for the rejuvenation of SCR catalyst at the 750 MW coal-fired Mehrum Power Station in March 2003. The contract included 160 m^3, which is one complete catalyst layer. The catalyst, which had been in operation sixteen years since 1987, was originally supplied by BHK.

The rejuvenation process developed for this application consisted of two (2) major steps: the first being to clean the catalyst of dust and remove the catalyst poison. The second step to add active material to enhance the catalyst activity. A drying process followed each major process. Once the process had been established, the full-scale results were confirmed by utilizing it on actual full-size catalyst units. Then, the planning of the actual rejuvenation task began.

In order to minimize the cost and schedule, the rejuvenation activity would take place at the Mehrum station site, eliminating transportation costs and time. It was planned that there be a shared scope of work. The owner's scope was to remove the dust from the catalyst and to treat and dispose both the dust and wastewater generated by the process. This portion of the catalyst processing on site allowed utilization of the owner's existing equipment and systems also saved costs. The cost and schedule for this processing would have been considerably larger if BHK had to establish outside waste treatment facilities, shipping the catalyst back and forth from the generating station.

The total on-site rejuvenation effort took about one-and-half months to complete. The performance of the rejuvenated catalyst showed superior performance with the same level activity as the new catalyst while maintaining the SO2 conversion rate as that of the spent catalyst. This paper gives the details of this coal-fired spent SCR catalyst rejuvenation task.

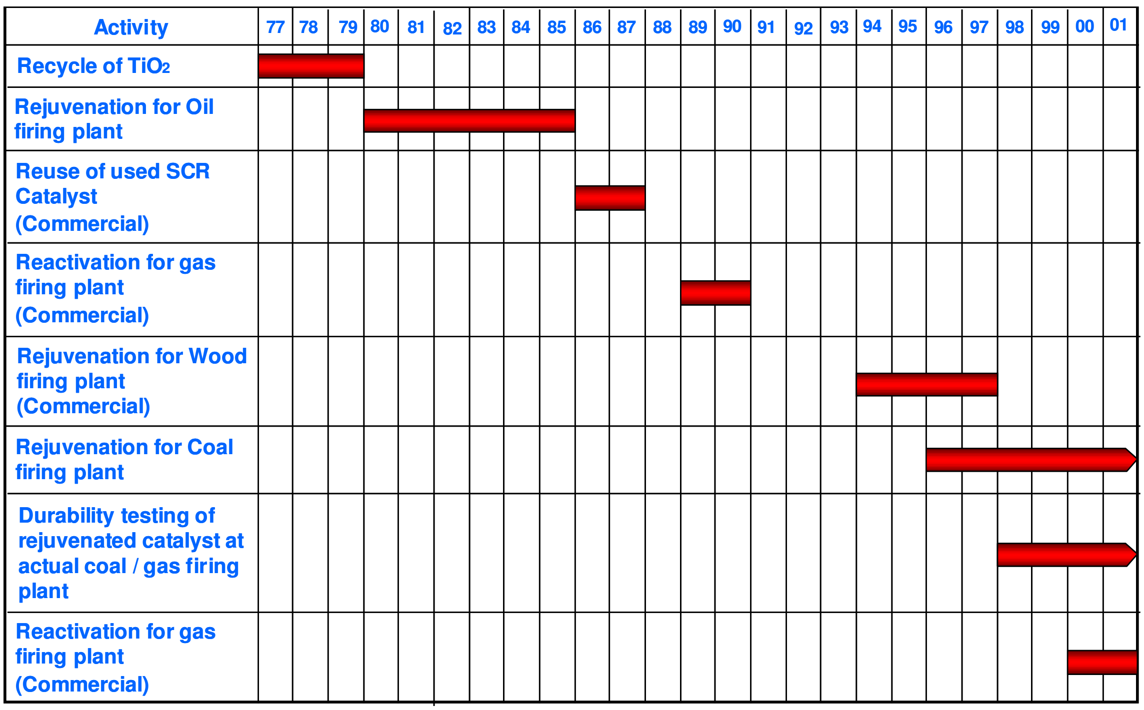
BACKGROUND

Mehrum Power Station is owned by Kraftwerk Mehrum GmbH. Shareholders are E.ON Kraftwerke GmbH (50%) , Stadtwerke Hannover AG (33,3%) and Braunschweiger Versorgungs AG (16,6%). It is a 750 MW coal fired boiler located at Hohenhameln in Germany. The boiler has one SCR that cleans the entire flue gas stream. This SCR system has one reactor, which is one of the largest reactors in the world. BHK designed its arrangement and supplied the catalyst in 1987. After 16 years operation, BHK through Hitachi Europe Ltd received the contract for the rejuvenation work of one layer of catalyst for Unit #3: 160 m3, in March 2003.

CATALYST REJUVENATION EXPERIENCE

BHK has various experience of catalyst rejuvenation since early on in the catalyst development as a SCR supplier. In addition to the laboratory and bench scale tests, BHK's experience includes several commercial stations. The commercial scale's plants include two gas firing plants and a biomass firing plant. The BHK rejuvenation history is shown in Figure 1. The accumulated knowledge gain over a quarter century has enabled BHK to execute Mehrum rejuvenation job successfully.

Figure 1: History of BHK's Activity for SCR Catalyst Rejuvenation

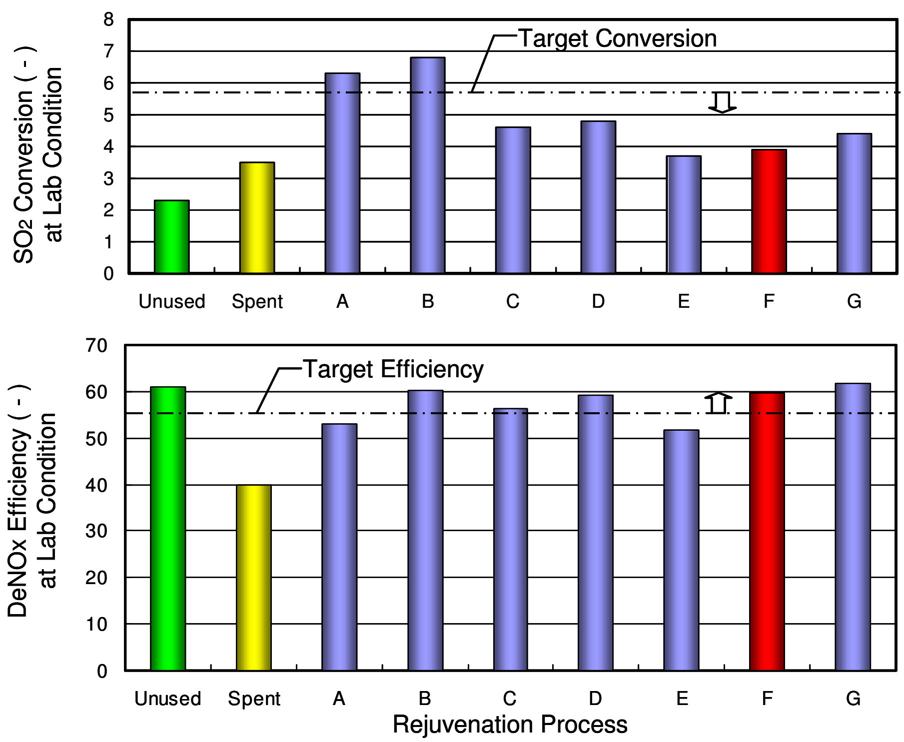


LABORATORY TEST RESULTS

The spent catalyst's activity (DeNOx efficiency) was about two-thirds that of the unused catalyst while its SO2 conversion rate was 50% higher. The targets for the rejuvenated catalyst were higher performance, activity at least 90% of the original while keeping an acceptable SO2 conversion rate, at an acceptable cost to the owner. To achieve these goals, BHK first conducted laboratory scale tests on actual plant sample catalysts extracted from the Mehrum station.

It was relatively easy to recover only activity without considering increase of SO2 conversion rate. However, it is quite difficult to achieve both requirements, as they compete each other. At first simple process was considered but were not acceptable to meet all the technical goals. Multiple processes were then considered. Through elaborate screening tests, the best of these, which met all the goals, was selected. It was Case F in Figure 2.

Figure 2: Laboratory test results



PROCESS

This process (Case F in Figure 2) consists of two (2) major steps. Refer to Figure.3. The first step is to clean dust off the catalyst and remove catalyst poisons. The second step is to add active material to enhance the catalyst activity. Catalyst drying is required to follow each major process. Subsequent to method selection, the process results were confirmed by utilizing it on actual catalyst units. Once confirmation was established for the process planning, the actual task of site rejuvenation planning began. Throughout each process, temperature, chemical solution concentrations, and their process time affect rejuvenation performance. Therefore the detail process data was carefully checked and controlled during site work to secure product quality.

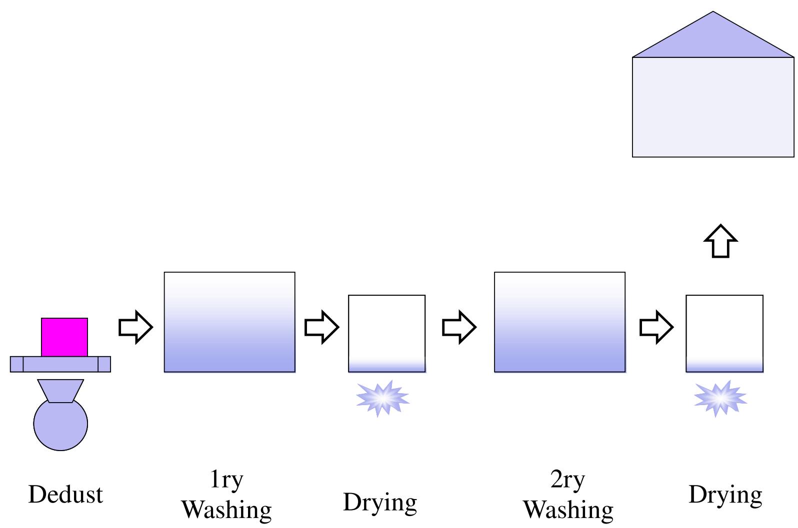


Figure 3: Rejuvenation Process

SCOPE OF WORK

In order to minimize the cost, BHK proposed, and the owner accepted, that the rejuvenation activity would take place at the site and that there would be a shared scope of work. The owner's scope was to remove the dust from the catalyst and to treat and dispose of both the dust and wastewater generated by the process. This approach is effective to minimize the cost as the owner utilizes existing equipment and systems and also save any catalyst transportation costs. The costs would have been considerably higher if BHK had to establish outside waste treatment facilities and ship the 160 m3 of catalyst to and from a separate treatment facility. The owner also supplied the general utilities such as steam, water and electricity for the rejuvenation on site. BHK's scope was supplying mobile rejuvenation equipment with the labor to the site plus overall project management responsibilities in addition to establishing and confirming the rejuvenation process. Table 1 shows the summary of "scope of work".

Table 1: Summary of "Scope of Work "

Owner
Dust removal & disposal
Utility supply & waste water treatment
BHK
Rejuvenation work at site
Laboratory test

REJUVENATION WORK

Figure 4 shows the tent erected at the site to house the rejuvenation work. It was located nearby the boiler house. All the required equipment was installed inside the tent and the rejuvenation processes were conducted there. This setting was conducive to working efficiently under clean conditions.

Figure 4: Working tent located by boiler house

The pictures in Figure 5 show working equipment or working procedure. The dust was removed by vacuum cleaner in combination with de-dusting tools (left). The open storage tank is designed so as to mix the chemical solution uniformly and for easy wastewater removal from inside the units (right). The washing water was neutralized, then transported through waste water pipe line, which connects the nearest point of the existing wastewater treatment system in the power station.

Figure.5 Rejuvenation equipment

Through the work, BHK learned that quick and uniform drying was quite important both for efficient work and product performance. For this purpose, the drying chamber (Figure.6) is designed to make uniform distribution of drying air. This is demonstrated in Figure 7, which shows CFD (Computational Fluid Dynamics) study of the drying chamber.

Figure.6 Drying Chamber

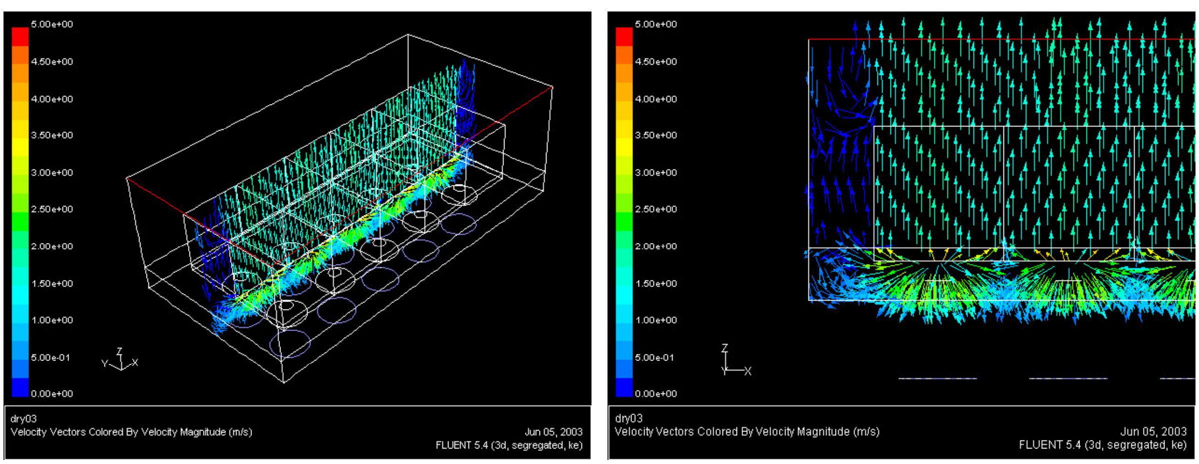


Figure 7: CFD study of drying air flow

SCHEDULE

The work started in May of 2003. Before starting the actual rejuvenation of Mehrum catalyst, a half-month was needed for equipment preparation. Preparation included equipment set-up plus adjustments and confirmation of performance. The actual catalyst rejuvenation work took about one and a half months for the 160 m3 catalyst layer, although work was interrupted in the middle due to the owner's convenience. The rejuvenation facility was operated on a single shift basis.

Month	'03/5	6	7	8	Remarks
Dust removal					
PreTest & preparation					
Rejuvenation Effort		Work Interruption		21 Completion	

Figure 8: Rejuvenation schedule

PERFORMANCE

The performance test was conducted at BHK's bench scale test facility to confirm DeNOx activity and SO2 to SO3 conversion rate of the rejuvenated catalyst at Mehrum site. Figure 9 shows test condition and photographs of bench scale test facility. The catalyst elements were cut into small plate, in order to prepare sample catalyst units to be used in this test.

Test condition for rejuvenated SCR catalyst	
Flue gas flow rate :	98.7 m3(normal)/h
Flue gas temperature :	380 deg.C
Flue gas composition :	NOx = 390 ppm
	SOx = 1,074 ppm
	O2 = 4.4 %

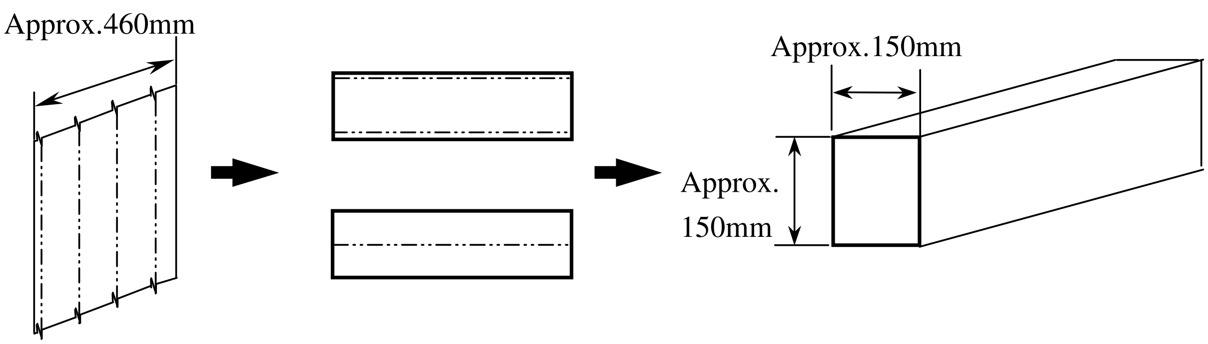
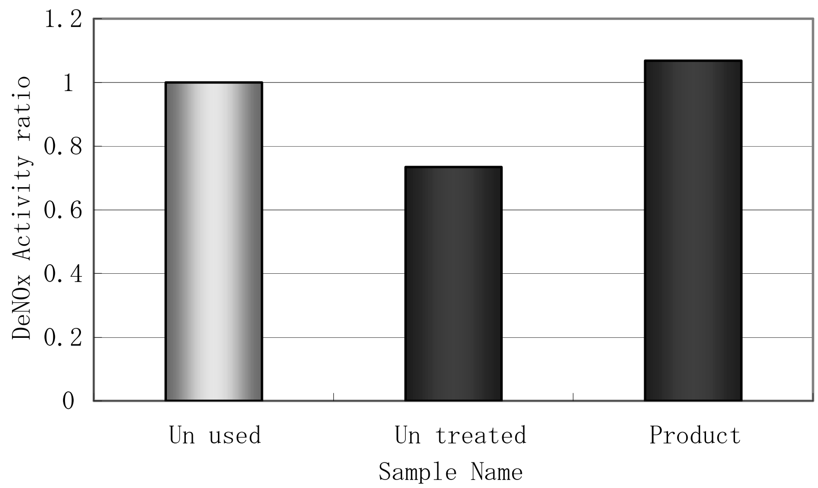


Figure.9 Bench Scale test facility and test condition

Figure 10 shows the test results for rejuvenated catalyst at bench scale test facility.
The rejuvenated catalyst showed superior performance with the same level activity (DeNOx efficiency) as the fresh (unused) catalyst while maintaining the same SO2 conversion rate as that of the spent catalyst. The bench scale tests showed that the expected performance was achieved in spite of large scale of the site work. BHK has concluded that the strict quality management achieved these goals.



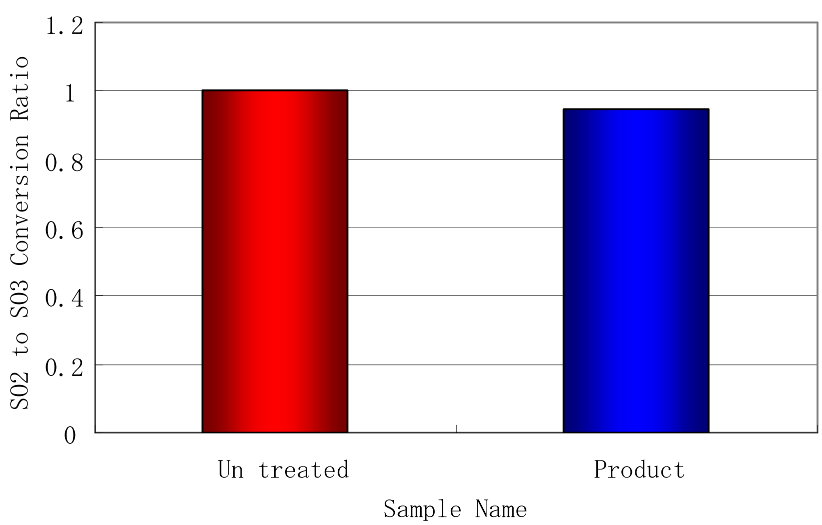


Figure.10 Obtained Performance of Product

CONCLUSIONS

The rejuvenated catalyst at Mehrum Power station showed superior performance with the same level activity as the fresh catalyst and with keeping the same level SO2 conversion rate as that of the spent catalyst, where all the rejuvenation performance goals were achieved. This work also proved that the on-site rejuvenation process can minimize the cost by utilizing the owner's existing facility to dispose the dust and wastewater generated through the process as well as saving the catalyst transportation costs. Thus BHK has added catalyst rejuvenation to their overall services of catalyst management such as catalyst lifetime estimation, supply of replacement catalyst, and rejuvenation services.