Technical Bulletin

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Demclean 94® cleaning of 2 HRSG boilers of Rijnmond Energy power plant

At the end of 2002 construction began of the Rijnmond-Energy power plant commissioned by InterGen. InterGen, a joint venture of Shell and Bechtel Enterprises, builds and operates worldwide more than 21 power stations that supply collectively in excess of 18,000 MW per year. Rijnmond Energy's power plant will become operational at the end of 2004. It will be a gas-fired Siemens V94 combustion turbine with a final output of 790 megawatts of electricity. As by-product steam (maximum 350 tonne/hour) will be supplied to the nearby Shell Pernis. Construction will be undertaken by BEJV (Bechtel-Enka Joint Venture), a collaboration between the American Bechtel and the Turkish Enka. The special feature of this power station will be the water used for steam generation; it will come from Nieuwe Waterweg and will be purified by filtration and reverse osmosis to demineralized water. This will be the first large commercial installation in the Netherlands to generate steam independently of the national drinking water network.The water discharged will be cleaner than the water taken in!

Fig. 1: Rijnmond energy powerplant

A power station is made up of various components, specifically combustion chamber, boiler, turbine, heat exchangers and cooling towers. We will restrict our attention here to the boiler itself, which is of the type HRSG (Heat Recovery Steam Generator). The HRSG comprises three sections, an LP (Low Pressure), IP (Intermediate Pressure) and HP (High Pressure). The Rijnmond Energy power plant incorporates two HRSG boilers, each with a capacity of 350 m^3. Baroscopic inspection of the water side of these sections revealed that there was a sufficient amount of corrosion present to require so-called pre-commissioning cleaning. The purpose of this type of cleaning is to remove the (fly) rust present and to a lesser extent light grease and atmospheric pollution. After the pre-commissioning cleaning has been carried out the water side will be metallic pure and fully passivated. At the moment that the boiler is put into operation a magnetite layer will form on the water side that will protect the material from further corrosion.

Demclean 94® cleaning procedure

For the cleaning a pickling agent has been selected based on EDTA. Vecom Industrial Services B.V. has in its service package the much-praised Demclean 94® method, which is based on EDTA.
This Demclean 94® method enjoys a number of benefits:

- The iron oxides are dissolved in a neutral medium (pH ca 5).
  Advantage: No aggressive/corrosive fluids are required during the pickling phase.
- Pickling and passivation are conducted in 1 step. Advantage: There is less waste product; for most conventional pickling methods a separate passivation phase is required with pre-rinsing.
- The temperature is not so high as that required for cleaning with a citric acid agent.
  Advantage: less heat and therefore less power (Energy) required.

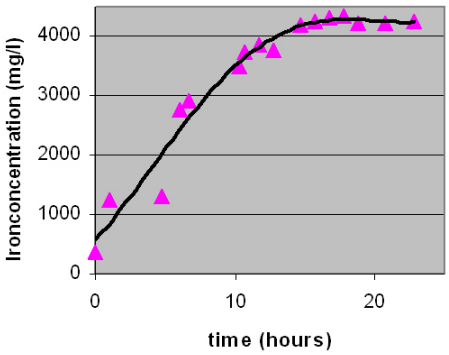
Fig. 2: EDTA-Fe complex

Cleaning with Demclean 94® is therefore safer and quicker and produces less waste than a conventional pickling and passivation procedure.

Demclean 94® is applied in a mildly acidic medium, pH ca. 5 – 5.5, and at a temperature of 50-60°C. In a mildly acidic medium the iron oxides will decompose into iron ions and water (reaction 1). During the cleaning therefore the pH of the fluid will start to rise. EDTA will form with the iron ions a very stable EDTA-iron complex. This complex is so stable that the iron will not deposit in an alkaline medium as iron hydroxide. It is this property of EDTA that renders it possible to pickle and passivate in 1 step.

(1) $6H_3O^+ + Fe_2O_3 \rightarrow 9H_2O + 2Fe^{3+}$

Graph 1: Iron measurements



During EDTA cleaning a number of parameters are continuously analyzed with a view to determining the status of the cleaning process. The iron and EDTA contents reflect the progress of the cleaning process. The reaction equation above shows clearly that the pH value is also important and when it increases it is corrected.
When the EDTA and iron contents are stable the pickling phase is completed and the process moves onto the passivation phase. Passivation is conducted in an alkaline medium created by adding ammonia to the pickling fluid. Passivation involves oxidizing the reactive iron surface to a (temporarily stable) uniform gamma-Fe_2O_3 layer. The Demclean 94® method employs sodium nitrite as oxidizing agent.

Demclean 94® pre-commissioning reiniging in practice

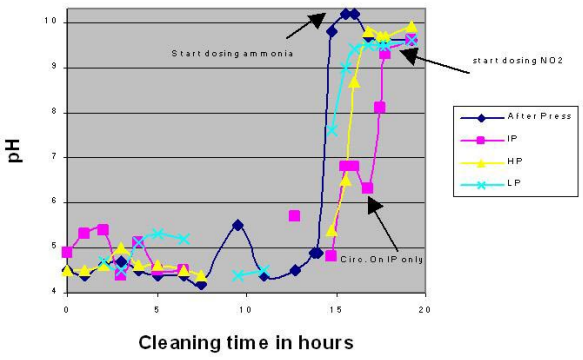
The two HRSG boilers were cleaned in two separate periods. A cleaning circuit was constructed for each boiler using the following equipment:

- 2 Boilers each with a capacity of 3000 kg steam/h
- 2 pumps each with a capacity of 450 m^3/h 90mwc.
- One heat exchanger
- 2 circulation/dosing tanks of 5 m^3
- Reception tanks (entire contents of the system)
- Laboratory set-up (determination of Fe, EDTA, pH, corrosion value and potential).

Fig. 3: Set-up Demclean 94® cleaning

Prior to the actual cleaning a hydro test was carried out, after which a high velocity flush was conducted to remove any gross contamination from the construction phase. The system was then filled with water and heated to ca. 50°C. After discharging sufficient water the Demclean 94® was dosed. During the pickling phase each section and all sections were alternately circulated until the analysis values were stable. The progress of the cleaning process was controlled by measurements of the pH, the iron content and the quantity of free EDTA. Graph 1 expresses the iron value during cleaning.
The cleaning fluid was converted to an alkaline medium using ammonia. Circulating once more through the separate sections served to ensure that the pH was equal throughout the entire system. Graph 2 exhibits clearly how the pH levels fluctuated throughout the separate sections, finally stabilizing over the entire system.
After the pH had increased sufficiently throughout the entire system, sodium nitrite was added to increase the redox potential. This procedure is designed to passivate the material.

Graph 2: pH during cleaning



Photographs 4 and 5 clearly show the situation prior to cleaning and the result after cleaning.

Fig. 4: Surface prior to the cleaning

Fig. 5: After Demclean 94 ® cleaning

Author: M. Sijbrandij (Director Vecom Industrial Services BV) and ing. T. van Os (Head Laboratory)
Reactions and/or questions: e-mail: tb@vecom.nl