Technical Bulletin

Pre-commissioning cleaning of 5 Heat Recovery Steam Generators (HRSGs) in Oman

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Combined Cycle Power Plant
A Combined Cycle Power Plant has two turbines. The first turbine is a gas turbine that is driven by burning, for example, natural gas. The second turbine is a steam turbine that is driven by the steam that is heated by the residual heat from the exhaust gases of the gas turbine (see the figure). Both turbines drive a generator where the electricity is produced.
The electrical yield of this system is considerably higher (approx. 60 %) than when only one turbine is driven.

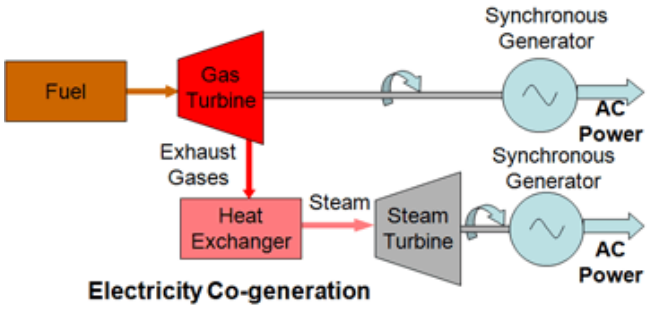

Figure Principle combined cycle [1]

The section where the steam is produced to drive the steam turbine is referred to as a Heat Recovery Steam Generator (HRSG); see photograph 1. An HRSG often has three sections: LP (Low Pressure), IP (Intermediate Pressure) and HP (High Pressure). Every section includes a steam drum and an evaporator section. Water is converted to steam in the evaporators. This steam will run through superheater sections where the temperature of the steam will be increased before it is led to the steam turbine.

Project in Oman
In Sur Oman (Arabian Peninsula), a Combined Cycle Power Plant has been built, consisting of 5 HRSGs. The configuration is 5 gas turbines and 3 steam turbines. Daewoo is the builder of the plant and Petron is the constructor of the boilers. The plant has five 250 MW (megawatt) gas turbines. The exhaust gases of each turbine will be led to its own HRSG. Using the steam of the five HRSGs, three times 300 MW steam turbines will be driven. The net capacity is, therefore, more than 2,000 MW.

Photograph 2: cleaning unit

Often chemical cleaning takes place before an HRSG is commissioned. This is referred to as pre-commissioning cleaning. The contaminants to be removed consist of loose contaminants (including sand), grease, oil, surface rust and welding scales. After the pre-commissioning cleaning,

Photograph 1

the water side of the HRSG will have a clean metallic surface and will have been completely passivated. When the HRSG is commissioned, a magnetite layer will form on the water side that protects the material against corrosion.

Vecom Cleaning Manual
Because the projects in the Middle East are often of this scale, Vecom has a joint-venture partner in Dubai UAE. Petron has placed an order with Corodex/Vecom to carry out the chemical cleaning of the five HRSGs. Vecom has produced a Cleaning Manual for this purpose, based on the special inquiry to clean two boilers in one shot. A Cleaning Manual is a type of script in which the full chemical cleaning is described. It is exactly determined which sections of the HRSG must be cleaned and based on which flow charts this should be performed by using detailed P&IDs (Piping and Instrumentation Diagrams). This is referred to as Engineering. In addition, the full chemical procedure is also described in this manual.

Chemical procedure
Nowadays, many HRSGs are cleaned using hydrofluoric acid (HF), in particular in Europe. However, HF is a toxic acid that can cause serious burns. The five HRSGs in Oman have, for this reason, been cleaned by applying the citric acid method. Chemical cleaning with inhibited citric acid is a good alternative. However, a high temperature (80 – 90 °C) is required to ensure that the iron oxides are correctly dissolved. This can partially be compensated by adding ammonium bifluoride. This ensures that you can clean using a lower temperature.

Hydrofluoric acid or ammonium bifluoride is also necessary for the removal of silicate deposits.

Citric acid method
Chemical cleaning using citric acid includes the following cleaning steps:

- Pre-flushing at high speed to remove all loose contaminants (including sand).
- Degreasing phase: oil and grease contaminants are dissolved by using a detergent.
- Descaling phase: the inhibitor and the citric acid are mixed with the degreasing liquid (using a specific ratio). Next, ammonium bifluoride is added and the pH is slightly increased by adding ammonia to ensure the solution is less aggressive. A number of parameters are analysed continuously during descaling to determine the progress of the cleaning. The iron level and the citric acid concentration provide a picture of the cleaning progress. If this is stable, the descaling phase will be finished (see graph 1).
- Flushing phase at high speed to remove acid residue.
- Removal of flash rust: the flash rust that forms during draining and flushing is removed using a low concentrated citric acid solution.
- Passivation: the citric acid solution is neutralised using ammonia until a high pH is obtained. The passivation is started by adding an oxidator. Passivation involves oxidising the reactive iron surface to a (temporarily stable) uniform gamma-Fe_2O_3 layer.

Two boilers in one shot cleaning
An important new method was the cleaning of two HRSGs in one shot. For this, a special cleaning sequence has been engineered, also to limit the quantity of chemicals and wastewater.

All wastewater is stored in a temporary storage facility, a so called evaporation pit. The water evaporates, leaving a small quantity of sludge which is transported to a local processor. The method as it has been carried out in Oman by Vecom, generates considerably less wastewater than conventional cleaning methods.

See photographs 4 and 5 to view the cleaning result.

Photograph 4

Photograph 5

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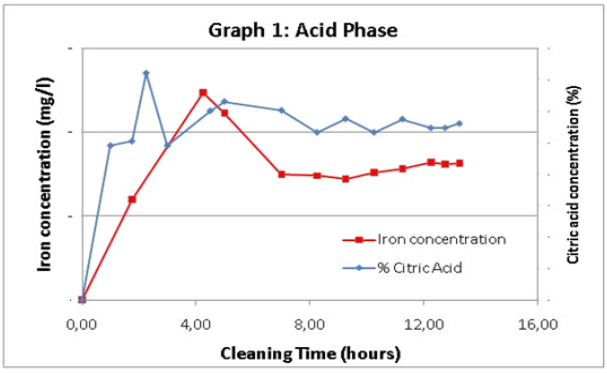
Source: 1) www.mpoweruk.com


Photograph 3: Evaporation pit



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