Application Report

Safe even in the desert

Gas analysis increases efficiency and protects the environment

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Figure 1: Building a gas processing plant in the Persian Gulf: South Pars

High demands are made on analysis technology in exploiting the world's largest offshore natural gas field. Producing and processing of natural gas is monitored in a hot desert climate and during sandstorms. This increases the yield and relieves environmental pollution. In the fifth expansion stage again the worldwide proven process gas chromatographs (PGC) of a German system supplier have been chosen and integrated in a special desert-capable system.

A treasure 3,000 meters under the ocean bed

The largest offshore gas field is located along the border between Iran and Qatar (Figure 1). The Iranian share is 10 % of the world's gas resources, which in figures is twelve billion cubic meters or 12,000 cubic kilometers. By comparison: Lake Erie holds about 484 km^3 – albeit of fresh water. This gas is enough to supply the whole world for five years. The Iranian part has been used as a source of energy since 2002. The whole gas field will be exploited over the next few years in a total of 25 expansion stages, whereby the first five are either already in operation or under construction. Every expansion stage requires an investment of about 0.8 billion Euro. Siemens process analysis technology was used in every expansion stage to date. Siemens was chosen as the system provider for the complete analytics of stages one, two and three. Hyundai Engineering & Construction Company Ltd from South Korea is the company generally responsible for expansion stages four and five.

With a depth of 70 m the Persian Gulf is relatively shallow. The gas is mined from rigs and then pumped 100 km to the shore for further processing through a 31 inch pipe.

Desert-capable analysis technology

Extreme ambient conditions with almost 50 °C in summer, sandstorms, and a corrosive maritime atmosphere place high demands on the technology. Therefore, compressor air conditioning systems have been largely omitted. Instead either air coolers or convection coolers operated with water have been used. This cooling technique gets by without fans and external heat exchangers.

The disadvantage, however, is the relatively low cooling performance, which is why classic compressor coolers are finally used for some systems. Four meter high pipes tower up from the analysis stations which suck in the fresh air. Combined with a sand trap, the purging air is sufficiently clean even during sandstorms. Every analysis station has its own safety system which monitors other safety parameters in addition to the fresh air supply. The heart of this safety system is a Logo! module from Siemens. This Logo! module can easily be reprogrammed on the building site if the safety concept changes.

Products of natural gas processing

Raw natural gas consists of more than 80 % methane. The rest of the raw gas is made up of higher value hydrocarbons, water vapour, nitrogen, CO_2, and sulphur compounds. These components are separated in natural gas processing. Natural gas for burners in industry and households consists of more than 99 % methane. Further products are also obtained from the raw gas, such as the liquid gas, which occurs as a condensate isused for example as a vehicle fuel. Due to the decomposition of sulphuric amino acids during its production, natural gas contains sulphur compounds which are found as hydrogen sulphide among other things. This sulphur is obtained in natural gas desulphurization plants in elementary form using the Claus method. In the Claus process, the most important gas desulphurization method worldwide, the hydrogen sulphide is oxidized into sulphur in two stages using a catalyst. The sulphur obtained in this way is of a very high purity (approx. 99.5 %) and is used to manufacture pharmaceutics, in the cosmetic industry, in the vulcanization of rubber, in plant protection etc. Since Claus plants are increasingly subject to environmental restrictions worldwide, the Claus process is combined with other methods in modern plants to satisfy the demand for a higher sulphur recovery rate. Recovery rates of 99.5 % and more can be achieved depending on the method used, and under optimum conditions. ➔

Figure 2: Sample taking and pipes of the steamheater. The sample must be heated exactly to 145 °C continously

Figure 3: Analysis cabinet with gas chromatograph PGC Maxum Edition II and convection cooling

Gas chromatography in the Claus process

Analyses are required for controlling and monitoring the Claus process. Process gas chromatography has proven to be a reliable and low-cost method.

The most important analysis is the measurement of the concentrations of hydrogen sulphide (H_2S) and sulphur dioxide (SO_2) in the desulphurized gas (tail gas) and from this the calculation of the ratio of $H_2S : SO_2$. This ratio is 2:1 during optimum operation. In addition the H_2S content of the feed acid gas and the gas space above the sulphur pit is measured.

The composition of the measuring gases at the measuring points mentioned is very different but there are common factors which represent the real challenge for analysis:

The sample gas is already saturated by sulphur vapor or elementary sulphur may be produced under unfavorable conditions when a sample flow contains H_2S and SO_2 at the same time. The elementary sulphur may block sample lines and the analyzer due to its chemical-physical properties. Sulphur becomes solid or semiliquid when the sample temperature drops below 135 °C or rises above 150 °C. Therefore, the sample temperature must be kept at 145 °C.

If the measuring gas also contains large quantities of CO_2 such as is the case in tail gas, COS and CS_2 may be produced by secondary reactions. COS and CS_2 interfere with a UV-spectrometer measurement of H_2S and SO_2. However, when using a process gas chromatograph, these components have no negative influence on the measurement.

The sample must be heated to 145 °C continuously from the tapping point to the analyzer. Slight deviations from this temperature can lead to failure of the analyzer. Steam heaters for sample taking and transport with an exact temperature control and complex insulation meet this requirement.

This narrow temperature range may (Figure 2) not be left even for the sample conditioning with its various components such as valves and filters. A reliable and low-cost solution in this case is the integration of the sample conditioning in the analysis oven of a PCG.

Figure 4: Two oven technology of the process-gas chromatograph Maxum Edition II: detector and sample conditioning are separated into two rooms

For this reason PGC models with two ovens are suitable for the Claus gas analysis.

The Claus gas analyzer Siemens PGC Maxum edition II (Figure 3) is equipped with separately heatable ovens with mass heating (›double airless‹). The right oven contains the analysis system with separating columns, circuit and detector (Figure 4). The left oven contains the sample conditioning, the calibration media dosing, and the dosing valve.

The sample conditioning contains a safety purge: The sample line is purged with nitrogen or air in the event of a fault (PGC ›not ready‹, power failure, temperature alarm) to prevent blockage by solid or plastic sulphur.

All Claus gas analyzers in a plant can be networked with other process gas chromatographs of the Maxum edition II type and monitored by a central operating station. It is also possible to link up to the process control system via the MODBUS log. Siemens has already delivered almost 40 Claus Gas Analyzers with this double-oven technology either as PGC 302 or Maxum edition II to date.

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