SO_2 Monitoring at the Tail of the Claus Process

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OPSIS' distributor in Lithuania, UAB SiemTecha, has recently concluded an installation of two CEM systems at the Orlen Lietuva refinery in Mazeikiai in northern Lithuania, close to the Latvian border. The systems are applied to SO_2 emissions monitoring from the sulfur production part of the refinery.

Hydrogen sulfide, H_2S, is a by-product from crude oil refineries. It can be utilized to form pure sulfur, which is a common base for sulfuric acid production, which in turn is one of the fundamental substances in many different chemical production processes. The industry standard process to convert H_2S to pure sulfur is called the Claus process after the 19th century inventor Carl Friedrich Claus. With some modifications and improvements, the process is still widely used today, not only at refineries but also in e.g. natural gas production and other industrial processes.

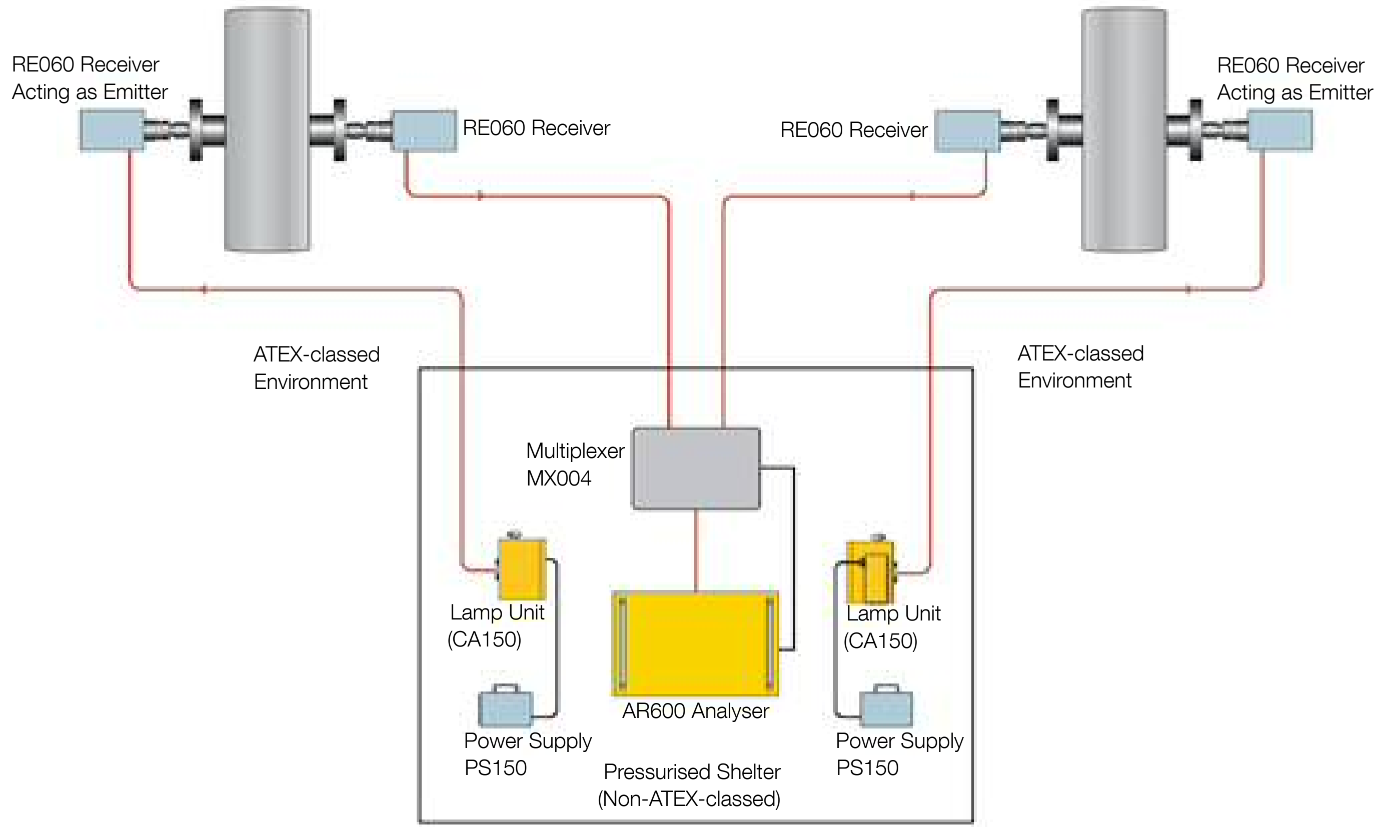
The Orlen Lietuva sulfur plant has two identical Claus sulfur recovery blocks. The tail gas from the blocks are sent to incinerators to convert any remaining H_2S, COS, CS_2, and other sulfuric compounds to SO_2 prior to emission to the ambient air. Two gas ducts come out of each block and share a common stack. There are no SO_2 scrubbers or other cleaning equipment in place, resulting in very high SO_2 concentrations at high temperatures.

The refinery has to comply with the European Union 2010/75/EU Industrial Emissions Directive (IED) and uses Best Available Techniques (BAT) to reduce the emissions. The SO_2 concentration limit for the site (at 3% O_2) is 29,000 mg/m^3_N (1 volume-%). The refinery needed CEM systems and an RFQ was issued, aimed at extractive systems. However, good sales work from UAB SiemTecha eventually resulted in the installation of two in-situ CEM systems from OPSIS, each with two monitoring paths to cover the emissions from the two sulfur recovery blocks.

The areas around the monitoring paths have potentially explosive atmospheres under ATEX classification, but the shelter installation areas are not ATEX rated. However, the atmosphere around the shelters is very corrosive and powder of elementary sulfur is sometimes flying in the air. The shelters for the instruments are therefore pressurised with clean air in order to protect the equipment from direct contact with the aggressive atmosphere. To comply

One of the four tail gas incinerators converting remaining sulfuric compounds to SO_2. The brick structure to the right is the base of the stack, another incinerator feeding the same stack is located further to the right (outside picture). The picture was taken during the installation, hence the ladder on the platform and the fire extinguishers (mandatory, ATEX-classed environment!) on the ground. An RE060 can be seen behind the ladder.

One of the two instrument shelters. The shelter is fed by clean air and kept at a slight over-pressure in order to protect equipment from direct contact with the corrosive atmosphere. Pressure monitors trigger alarms in case of lost over-pressure.



Schematic drawing of one of the two CEM systems at Orlen Lietuva. Note the double-fibre solution with CA150 light sources to avoid electrical equipment in the ATEX-classed areas around the monitoring paths. Oxygen and flow monitors as well as temperature and pressure sensors (all ATEX-approved) are also in use, although not shown in the figure.

with the ATEX requirements for the light emitters, the regular EM060 light emitters have been replaced by CA150s also located inside the shelters together with the PS150s. Light from the CA150s are led via optical fibres to "reversed" RE060s acting as light emitters at the in-situ paths, thereby avoiding electrical components in the ATEX classified areas. Regular RE060s pick up the light after having traversed the ducts, and send it via return optical fibres back to the shelters and the analysers. Due to "light budget" constraints, this solution is not possible for all types of gases, but SO_2 is measured in a wavelength range where there is plenty of light available so the solution works very well in this case. A single CA150 could have provided light to both paths by multiplexing also the outgoing light, but that solution was not chosen, partly due to the light budget, partly not to lose monitoring on both paths if the single xenon lamp would fail.

The analysers of type AR600 are calibrated for a monitoring range of 0-2% SO_2 at approximately. 500 °C. They also have a secondary SO_2 monitoring range of 0-5,000 mg/m^3_N, utilized under special operating conditions.

The OPSIS DOAS in-situ system is very well suited for this application with very high SO_2 levels at high

The reason why extractive systems are not suitable for this type of monitoring application. During the installation process of the OPSIS systems, the RE060s mounted on the gas ducts were temporarily without supply of purge air. The result is shown in the picture: rapid build-up of condensed sulfur and sulfuric salts on the window surface facing the flue gas. Imagine what will happen when sending such gas through extraction lines, valves and dilution units to a conventional SO_2 analyser! The monitoring paths now work fine with cleaned windows and proper supply of purge air.

temperatures and relatively high humidity (around 20%). Competing extractive systems would have a very hard time coping with the aggressive flue gases. We expect this installation to be an eye-opener to the refinery industry, enabling more business in this application!