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Photoacoustic System for On-line Process Monitoring of Hydrogen Sulfide (H_2S) and Water Vapor Concentration in Natural Gas Streams

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Nowadays natural gas (NG) is one of the most important energy source. The quality of natural gas is strictly regulated and controlled. Natural gas is a combustible mixture of primarily hydrocarbon gases. Its composition can vary widely; the main components are methane (with a typical concentration from 70 to 90%), ethane, propane, butane (collectively from 0 to 20 %), carbon dioxide (0 to 10 %), nitrogen (0 to 5 %), hydrogen sulfide (0 to 5 %), water vapor (0 to 2 %) and oxygen (0 to 0.02 %). NG containing significant amounts of hydrogen sulfide is called 'sour gas'. H_2S in combination with water corrodes the gas pipelines, and when it is burned, environmentally harmful sulfur-dioxides (SO_x) is generated. Natural gas, which contains high amounts of water vapor can cause hydrate plugs in the gas pipelines. Therefore the concentration of hydrogen sulfide and water vapor in natural gas is a crucial quality parameter. The ISO standards set maximum allowable H_2S and water vapor concentrations for commercialized natural gas. Removing and on-line monitoring of hydrogen sulfide and water vapor concentration is recommended to protect the air quality, downstream equipment and increase safety.

We developed a diode laser based combined, portable, on-line process monitoring photoacoustic system for hydrogen sulfide and water vapor measurement in natural gas (WaSul-Ex). The system uses two single mode, fiber coupled, room temperature op-

erated, telecommunication type diode lasers with wavelength of 1574.5 and 1371 nm and output optical power of 40 and 20 mW. Our system can measure H_2S and water vapor concentrations in the range of 0-100000 ppm with a precision of about 0.5 ppm. WaSul-Ex system received the approval from the Hungarian Approval Service for Ex-proof Electrical Equipment because it was improved for industrial measurements within explosive area.

Photoacoustic (PA) has proven to be one of the best analytical techniques for the identification and quantitative determination of trace constituents in gas mixtures. The important features of the PA system are: multi-compound detection, high sensitivity for the detection of very low concentration (ppb part per billion), high selectivity to differentiate different species present in a multi-components mixture, a large dynamic range to monitor both low (sub-ppm part per million) and high concentrations (several per cent) with a single instrument, good temporal resolution which enables online monitoring, portability for *in-situ* measurements and exceptionally long operation time (which is expected to exceed ten years!). Moreover, the installation and operational costs for these systems are practically negligible. The first WaSul-Ex system was installed more than three years ago and today there are several WaSul-Ex systems operating at different natural gas plant of the Hungarian Oil and Gas Company Plc (Mol Nyrt). In our presentation various examples of measurement results together with their analysis will be given.