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Photoacoustic system for monitoring hydrogen sulphide (H_2S) in natural gas and in biogas

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Biogas is one of the most important sources of renewable energy. Biogas can be used for heat and electricity production or as biofuel for vehicles. Biogas consists mainly of methane (CH_4) and carbon dioxide (CO_2), with smaller amounts of water vapor and trace amounts of hydrogen sulfide (H_2S), and other impurities. Hydrogen sulfide is typically the most problematic contaminant because it is toxic and together with water vapor extremely corrosive to most equipment. Furthermore combustion of H_2S leads to sulfur dioxide (SO_2) which is harmful to the environment. The biogas is similar in composition to raw natural gas therefore the natural gas industry developed a lot of purification techniques and ISO standards set maximum allowable H_2S and water vapor concentrations for commercialized natural gas. The concentrations of trace gases in biogas is not so strictly regulated and controlled wherefore it is not an environmentally-friendly energy source. Removing and monitoring of hydrogen sulfide and water vapor concentration is recommended to protect the air quality, downstream equipment, increase safety, and enable utilization of gas turbines.

For this purpose a photoacoustic (PA) system was developed with two fiber-coupled distributed-feedback (DFB) diode lasers. The system uses two single mode, fiber coupled, room temperature operated, telecommunication type diode lasers with wavelength of 1574.5 and 1371 nm and output optical power of 40 and 20 mW and two identical resonant photoacoustic cells to achieve minimum detectable H_2S and water vapor concentration at 0.5 ppm (3σ) in measured gas stream.

The photoacoustic method is one of the simplest optical methods, it can be easily automated. The photoacoustic measure system enables the use of small sample volumes (several cm^3). Photoacoustic has proven to be one of the best analytical techniques for the identification and quantitative determination of trace constituents in gas mixtures This simple method has high sensitivity, suitable for detection several gases at ppm or ppb level. Like other optical method photoacoustics has high selectivity and specificity. The method has a uniquely wide dynamic range; through five to six orders of magnitude the photoacoustic signal depends linearly on the concentration of the measured gases. The photoacoustic instrument is able to follow quick and heavy concentration fluctuations or small changes of large concentrations. We have developed and deployed four photoacoustic measuring systems at different natural gas processing plants. One of these systems is a portable online hydrogen sulfide and water vapor detector. The results of their operation demonstrate the high reliability of these systems.

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