

## Multivariate Analysis of North Sea Natural Gas

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Downhole collection and analysis of gas samples (mud gas samples) would avoid atmospheric contamination which current afflicts all mud gas determinations. Analysis of drilling mud gas (the term “mud” describes the liquid used to lubricate the drill bit and remove rock debris and formation gas from the hole) signatures provides an insight into the hydrocarbon heterogeneity within both oil and gas reservoirs. Such determinations are crucial for aiding identification of the presence of oil and gas but also reservoir connectivity (If an oil field is poorly connected development will required more wells and therefore significantly more expense).

Miniature Quadrupole Mass Spectrometry (QMS) offers a convenient and robust method for online instrumentation in harsh environments. However some of the potential information available is lost due to constituent elements of the sample gas producing fragments at identical mass numbers. Generally as a result of this, quantitative information with mass spectrometry occurs only when a peak individual to the analytes of interest is available (single/multiple ion monitoring). We report here multivariate methods employed to access more of this information from a typical downhole Natural Gas (NG) sample.

NG as a sample is a troublesome matrix with large numbers of overlapping hydrocarbons in the lower mass region. Major components of natural gas include methane, ethane and propane, all of these fragment to give overlapping mass signals and are the focus of these experiments. Also present are higher order hydrocarbons and aromatics and occasionally significant quantities of non-hydrocarbon gases (CO<sub>2</sub>, N<sub>2</sub> & H<sub>2</sub>S), all of which may also interfere with the calibration and have to be considered. A suitable calibration method is necessary to quantify true natural gas samples offline and highlight the possible affects of any contaminants. Results show it can be possible to quantify online Natural Gas components down to sub 1000 ppm levels with a capillary inlet.

An additional problem in online QMS monitoring of natural gas systems is the drift within the system from the point of calibration to the point of sampling. The measurement system can be optimised to reduce drift but this cannot be prevented. This can have adverse affects on the multivariate calibration even over short time periods, possible methods to overcome this are using internal standards or alternatively switching a standard into the system on a regular basis. We discuss various calibration strategies to correct for this and highlight the problems of each.

Miniature and micro-QMS systems have distinct advantages over the traditional QMS not only in size but higher operational pressures and lower power consumption characteristics that are advantageous to performing and carrying out such measurements under harsh conditions. The work shows the possibility of using such systems in online oil and gas monitoring processes.