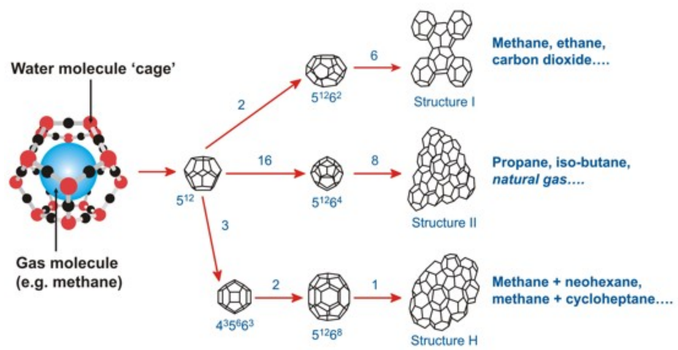
APPLICATION NOTE

ACCURATE OXYGEN MONITORING IN MEG INJECTION SOLUTIONS FOR CLOSED-LOOP GAS CONDENSATE PIPELINES

Introduction

The use of Monoethylene glycol (MEG) for hydrate inhibition in gas production lines is well established and works effectively. Nevertheless, the MEG injection has to be done with some care to avoid generating other potential problems. If present in high concentrations, dissolved oxygen may be a further corrosion generator. For many years, Hach has provided an optical-based technology, the ORBISPHERE K1100*, which meets the requirements for dissolved oxygen measurement in MEG circuits in on-shore and off-shore oil and gas facilities.

Hydrates in Natural Gas



Hydrates are a physical combination of water and other small molecules (e.g., light hydrocarbons methane) that form a solid material having an "ice-like" appearance, but with significantly different structure and properties than ice.[1]

Hydrates have been a longstanding problem in the gas industry. The primary factors influencing hydrate formation include: the fluid must be at or below its water dew point (i.e., it must be water-saturated), temperature, pressure, and composition. In general, hydrate formation will occur as system pressure increases and/or temperature decreases to formation conditions.

MEG as a Hydrates Inhibitor

The principle by which alcohols, glycols and salts inhibit hydrates is the same. A substance soluble in the aqueous phase competes for the water molecule or ion and prevents the water from forming solid hydrates in the gas or non-aqueous liquid phase. To inhibit hydrates, a minimum concentration of the solute or inhibitor is necessary in the solvent or aqueous phase.

In most subsea applications, hydrate formation will be controlled by injection of a chemical hydrate inhibitor, and the inhibitor selection process often involves a choice between either a glycol (usually MEG) or methanol. MEG is non-flammable, which makes it an ideal choice above other hydrate inhibitors like methanol and ethanol. MEG is easier to recycle and recondition, so it is rapidly becoming the preferred Thermodynamic Hydrate Inhibitor (THI) used in the offshore gas industry today.

A particular concern remains: the presence of oxygen in closed-loop condensate pipelines. As significant amounts of MEG are injected, reclaimed and then re-injected into the loop, it is vital that oxygen is removed or maintained at the lowest possible levels in the MEG solutions. The use of oxygen scavengers can be detrimental as these chemicals can build up over time in the pipelines and cause corrosion issues. It can also be very expensive. De-aeration and de-oxygenation of the injected and reclaimed MEG is a vital parameter in this process; accurate oxygen monitoring equipment is needed to ensure reliable measurement and monitoring of very low oxygen levels.

How the Luminescent Dissolved Oxygen Sensor Works

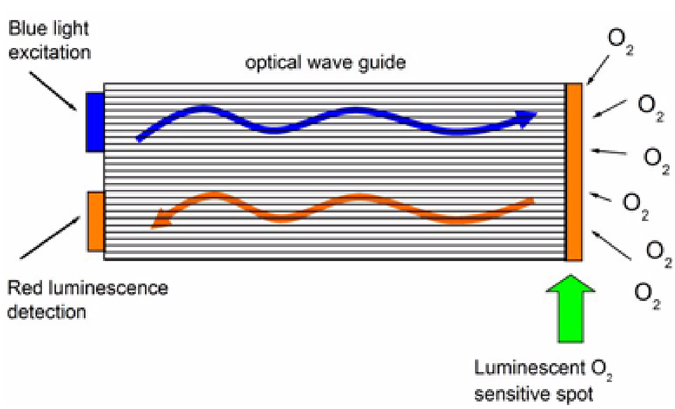


Fig 1: Principle of optical oxygen detection using fluorescent dye

Oxygen can be monitored in MEG easily using an ORBISPHERE K1100 sensor, which works on the Luminescent Dissolved Oxygen (LDO) principle.

Optical oxygen sensing is based on the measurement of the red fluorescence of a dye or indicator illuminated with a blue light (Fig 1).

The dye fluorescence is quenched by the presence of oxygen. The oxygen concentration can be calculated by measuring the decay time of the fluorescence. The higher the oxygen concentration is, the shorter the decay time will be. By modulating the excitation, the decay time is transformed into a phase-shift of the modulated fluorescence signal, which is independent of fluorescent intensity and thus of potential aging.

Where to Measure Oxygen

Oxygen must be monitored at three major places in the loop. The first place is the MEG storage, where reclaimed MEG is kept until it is required to be re-injected. The tank content can be very static in nature, without internal circulation. For this reason, the LDO principle of oxygen monitoring is preferred. Other sensors that use an electrochemical/galvanic method will deliver a 'false low' reading in solutions that are immobile.

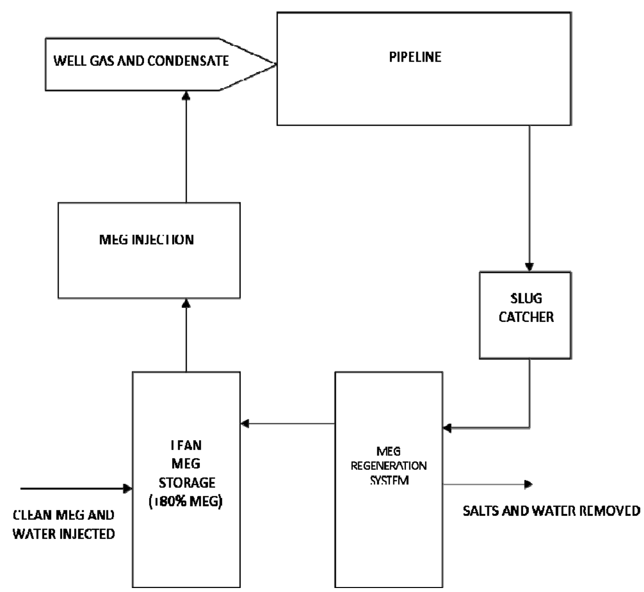


Diagram 1 - Example Closed Loop Gas Condensate Line

The second place where oxygen monitoring is required is on the water and pure MEG lines feeding into the MEG storage tanks. It is vital that oxygen is not carried with the pure water and pure MEG into the storage tank, otherwise it would be extremely difficult to maintain less than 20ppb in the loop. Again, as MEG and water are only required to make up the lean MEG requirement, these lines are also likely to face long periods of time with no flow. To avoid 'false lows' in this scenario, the K1100 sensor is the only possible choice for accurate measurements.

The third and most crucial measuring point for monitoring oxygen is at the point of MEG Injection itself. Unless the dissolved oxygen content is accurately monitored at this point, oxygen could be injected into the pipeline, giving rise to significant and costly corrosion.

ORBISPHERE K1100

The Orbisphere K1100 is the perfect choice for O_2 monitoring in MEG closed condensate gas loops for several reasons:

Fig 2: Orbisphere K1100 Sensor

- Long term stability. The LDO principle also requires significantly less ongoing maintenance than other O_2 monitoring sensors, especially those employing a galvanic cell arrangement. As a result, the K1100 can be left for up to 1 year without the need for time consuming maintenance and re-calibration.
- The Orbisphere K1100 can be mounted in an external flow cell, ensuring there is no accidental ingress of oxygen into the MEG loop.
- No liquid flow required. This allows accurate oxygen trace measurement in tanks.
- Trace measurements, typically oxygen levels, must be maintained below 20ppb at all times. This is easily achieved with the Orbisphere K1100's Limit of Detection (L.O.D.) of 0.6ppb
- The Orbisphere K1100 is available in Hastelloy, allowing it to be installed at any stage in the MEG Circuit.

ORBISPHERE 410 CONTROLLER

K1100 sensors feedback their crucial oxygen measurements to a PLC or SCADA system with the aid of the Orbisphere 410 Controller. The Orbisphere 410 features a color touch screen, live graphing functionality, and numerous data export options to provide real-time information and feed valve control.

The Orbisphere 410 Controller can be placed in areas requiring ATEX/Ex compliance, with the aid of a suitable enclosure. Orbisphere pre-made panels (DG33301) allow for easy installation with flow cell mounting, isolation valve and all required connectors for fast and simple installation.

*In some areas, the K1100 may be referred to as the M1100

[1]RECLAMATION/REGENERATION OF GLYCOLS USED FOR HYDRATE INHIBITION. Kerry van Son, CCR Technologies Inc., USA Charlie Wallace, Consultant

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