Memo

Gas Lift Surveillance

Well Intervention-Less Tracer Surveillance System - WITSS

N_2 and CO_2 tracer medium evaluation for gas lift surveillance

SUMMARY

A gas lifted operation is highly dependent on quality data and team competence to operate the assets efficiently. WITSS system provides the industry a unique tool for surveillance and maintenance of gas lift facilities.

It provides a large amount of digitally accessible data that leads to enhanced value of information. Even assets with limited instrumentation and operational constraints can have easy access to a state-of-the-art surveillance technology for gas lifted production.

Increased competency across the organization generates improved decisions analysis with respect to vendor choices, scaling plans, P&A strategy, maintenance, troubleshooting and well integrity.

All those generate cost effective management of the asset, while improved well optimization and EOR processes, provides immediate gain in production.

BACKGROUND

The idea of using tracers for surveillance of gas lifted wells is over 30 years old. The instrumentation and modelling necessary to allow accurate surveying only became available in recent years.

ScanWell has developed cutting-edge instrumentation and methods, with a customized survey, that provides high accuracy data and a repeatable tracer interpretation.

During 3 years of research, in collaboration with SINTEF petroleum and a large North Sea operator, ScanWell developed a model for the propagation of a tracer gas, studied the mixing and propagation properties of different tracer gases combined with sensitivity analysis of the model for a range of inputs.

The main challenge was found to be matching the recorded tracer concentration as a function of time (fingerprint) to the lifting depths in the well.

In developing a unique method for tracer gas measurements, annulus temperature profiling and continuous compositional analysis, ScanWell has been able to maximize the accuracy of this fingerprint matching and provide an additional set of valuable data for the operator.

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NOVELTY OF N_2 TRACER METHOD

1. To our knowledge, using of N_2 fluid as a tracer medium is a novel approach that has never been applied for gas lift surveillance in the industry before.
2. Continuous compositional analysis of both injected and produced gases, provide additional surveillance aspect and again, provides more accurate input for well model. H_2S analysis add valuable data for reservoir souring related strategies, while CO_2 measurements provide data for EOR WAG models. At last, integrated methods for complete integrity evaluation of primary barriers and intermediate casing, provide valuable data for well integrity management systems.
3. Unique method of measuring temperature at each side pocket using in-house developed acoustic method. This provides measured data for one of the most challenging inputs to the model. Temperature in the gas lifted volumes is very different from well to well, while the travel time model is extremely sensitive to that input.
4. Direct lift gas measurements using dilution method. This unique method, using N_2 as a dilutant component for direct measurements of pressurized gas streams, is highly accurate and repeatable, compare to available methods. This can be applied on gas lift and production lines, separators and even export pipes. The method is suitable for both single and multiphase flow and can be used for calibration, allocation, and metering purposes.
5. Different methods used in WITSS system are patented by the provider. Patented method related to dilution analysis of produced and injected gasses. Another patented method for temperature determination from the acoustic response. All the other instruments, methods and software used in the approach are in-house developed and the provider holds the IP related to those.

DIFFERENCES BETWEEN CO_2 AND N_2

Thermodynamic properties

CO_2 is a high-density gas that is liquified at 35bar at room temperature. CO_2 is highly soluble in water producing a corrosive solution. It is associated with the greenhouse effect and global warming. It is difficult to model as a tracer in a gas lifted well because it undergoes a phase change from liquid to super-critical upon injection. Due to its mixing and thermodynamic properties it cannot be used to dilute gas lift streams.

N_2 is a widely available, inert gas used everywhere in the oil field. With extremely low solubility and a very low critical temperature, so that it is always a gas, it is easy to model, and is thus a very good candidate for tracing and dilution of pressurized gas streams. It provides better accuracy when interpreting the results of its propagation, even in multiphase streams. Additionally, there is no environmental impact or corrosive solutions to worry about.

Logistics

Due to its unusually high critical temperature, CO_2 introduces additional risks with respect to its use and logistics. CO_2 cylinders can only be pressurized to 50bar for oil field use and must be equipped with burst valves, to prevent overpressure due to phase change. This is especially important in warmer regions or where there is a radiant heat source such as a flare. Thus, in order to use CO_2 as a tracer gas in a gas lifted well, where the gas lift pressure can be as high as 160bar, an additional pressure source is needed to raise the pressure of the CO_2 cylinder to close to the valve burst pressure in order to inject the CO_2 efficiently into typical gas lifted well.

N_2 is supplied in standard 300bar cylinders that do not require any pressure releasing safety elements. This allows reduced risk when transporting and rigging, simpler storage, even in warmer regions, and the gas will flow naturally into a typical gas lift supply with no additional pressure source.

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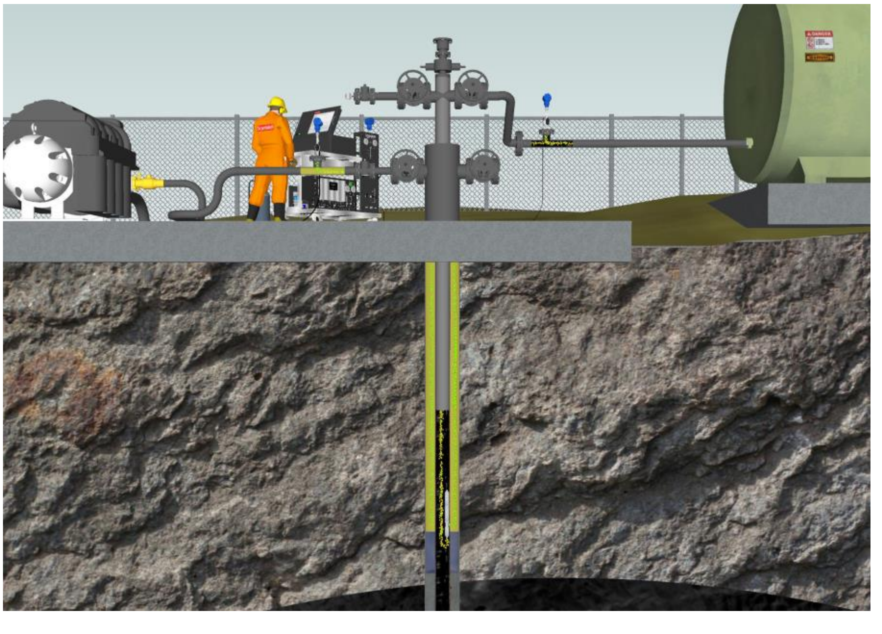
POTENTIAL RISKS AND BENEFITS

CO_2

1. Increased HSE risk – CO_2 cylinders always equipped with burst disks due the nature of liquid CO_2. Max injection pressure of 120 bar require additional pressure safety components on the injection system. Equipment failure and human errors increase significantly the risk related to tracer injection.
2. Additional HSE concern related to CO_2 is manual handling of CO_2 bottles. These are 90 kg each and must be manually removed from the rack to the injection point.
3. CO_2 results an increased logistical footprint on the operation, since both N_2 and CO_2 required for tracer injection when using CO_2.
4. Typical CO_2 surveys equipped with CO_2 analyzer only and does not provide any additional measurements of the composition.
5. Due to its mixing properties, CO_2 is not suitable for dilution, and does not provide any direct measurements of gas lift rate. In addition, Its soluble nature results errors in mass balance calculations.
6. Combining its mixing and propagational properties, with limited ability to provide gas rates, compositional analysis and temperature profiles, CO_2 method is highly dependent on third party input, hence results additional risk in wrong interpretation, especially related to lifting depths and lift gas rates.

N_2

1. N_2 - has no HSE related concerns. Pressure and temperature conditions at the surface and downhole do not affect any properties of N_2. N_2 pressure in typical cylinder is 300 bar, which sufficient to flow naturally into the GL supply.
2. N_2 is suitable for dilution measurements and mass balance analysis. These provide valuable data of the injected and produced gas rates, significantly increase the interpretation accuracy related to lifting depths, in particular depth analysis of tubing leaks that cannot be correlated to a given depth of downhole valve or SPM.
3. Use of N_2 results increased resolution on small tubing leaks, due to very low N2 concentration in typical produced or injected fluids.
4. Use of N_2 removes the concerns related to corrosive nature of the tracer injected into the well.



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SUMMARY OF FUNDAMENTAL DIFFERENCES BETWEEN CO_2 AND N_2 AS A TRACER MEDIUM

	CO_2	N_2
Thermodynamics	Liquid when injected, phase change takes place in the well. Not suitable mixing properties as a dilutant. Significantly different properties from those of a typical natural gas.	Low critical temperature, no phase change during the survey. Similar properties to natural gas.
Solubility/Acidity	High solubility gas producing corrosive solution. Risk of introducing corrosive components in annulus, mixing with the liquid under GLV, creating acidic mix and resulting corrosion.	Low solubility inert gas. No concerns related to introducing corrosion in the well.
Environment	High environmental footprint.	Low environmental footprint.
Logistics	Usually not available, requires special dip tube dual valve with burst disc. Requires dedicated storage space.	Widely available standard product. No issues related to transport, storage and use at well site.
Operations	Requires N_2 as drive gas. Increases operational risk due to pressure limitation on the CO_2 cylinders. Increased rig-up duration and complexity.	No operational concerns. Flows naturally into gas lift supply without drive gas and pressure restricting elements. Reduced rig-up time, complexity, and risk
HSE	Increased operational risk, manual handling of heavy cylinders filled with liquid CO_2.	Reduced operational risk, no manual handling of supplied cylinders.
Tracer behavior	Not suitable as a dilutant. Less predictable mixing and propagational properties. Phase change during propagation, high solubility in produced fluids. Not suitable for mass balance calculations.	Suitable as a dilutant. Highly predictable mixing and propagation properties. Low solubility in produced fluids. No phase change during propagation. Suitable for mass balance calculations.

INTERESTED IN KNOWING MORE?

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