Increasing Subsea Production with DRA

Subsea injection provides a method for a drag reducing agent (DRA) to be injected into subsea flowlines to reduce friction and substantially increase production. For many decades, DRA has been widely used in land-based systems, and upstream transfer and export systems. Today, thanks to breakthrough technological advancements, DRA is available for injection into subsea production systems.

For decades, it has been a vision of DRA manufacturers and oil producers alike to use DRA subsea to increase well production by increasing the throughput of subsea flowlines. After years of testing and development, it was determined that transferring long chain polymers through umbilicals was too great a challenge with current technology. To solve this challenge, Safe Marine Transfer, LLC (SMT) took innovative steps to patent, design, and build a subsea DRA storage and injection unit: SMT has 30 patents and others pending. SMT's unit transformed the subsea DRA injection vision into reality.

To move this technology from the qualification test tank to a global reality, a **Cooperation Agreement** was executed between SMT (www.safemarinetransfer.com), LiquidPower Specialty Products Inc. (LSPI), a Berkshire Hathaway Company (www.liquidpower.com), and Subsea 7 (www.subsea7.com) with the objective of combining the strengths of each company to increase the value of their offering to subsea production operators.

LSPI pioneered DRA development over 40 years ago and has accumulated over 70 patents related to drag reduction. LSPI has several commercial DRA products for specific applications. LSPI's strengths in this effort was the development of a subsea multiphase DRA and the ability to evaluate and quantify potential DRA opportunities for the consideration of oil companies.

Subsea 7 has a global footprint, with a world class fleet, and a diverse and talented workforce. These strengths make Subsea 7 uniquely qualified to safely and cost effectively install, commission, recover, and maintain subsea DRA storage and injection units all over the world. The installation and recovery can be accomplished independently or in conjunction with other offshore campaigns.

The combination of SMT's, LSPI's, and Subsea 7's strengths create a unique capability to provide a global, full-service subsea DRA injection solution to oil companies.

Drag Reducing Agents (DRA) are long chain, ultra-high molecular weight polymers (poly-alpha-olefins) made only of carbon and hydrogen atoms and have a strong affinity to crude oil. DRAs interact with the crude oil molecules and reduce the turbulent eddy currents which reduces the frictional pressure lost in the system. A short video of how drag reduction occurs with DRA can be viewed at the following site: *https://vimeo.com/lspi/howdraworks*.

DRAs are injected in parts per million (PPM) and given that DRA is a polyolefin (hydrocarbon polymer), the DRA has no negative impacts on crude oil or refineries. In over 40 years of DRA injection into crude oil, no incompatibilities with other production chemicals or pipeline additives have been observed.

DRA has many positive attributes and misconceptions. Several are listed below:

DRAs DO NOT:

- Coat flowline walls
- Change the crude viscosity
- Change the crude density
- Negatively impact refineries

DRAs DO:

- Increase flowrates/ production
- Reduce turbulence
- Reduce flowline pressure
- Reduce the pressure loss per mile/km
- Fully dissolve with hydrocarbons

DRA Case Studies & Results

While DRA has not yet been injected subsea, DRA has been injected in many multiphase applications since the initial successful multiphase application in 2005. DRA performance is dependent on crude properties and multiphase characteristics. The injection location (subsea or topside) is irrelevant to DRA performance. The information in **figure 1** originates from two different platform-to-platform DRA applications but is shown as a subsea DRA injection for illustration purposes.

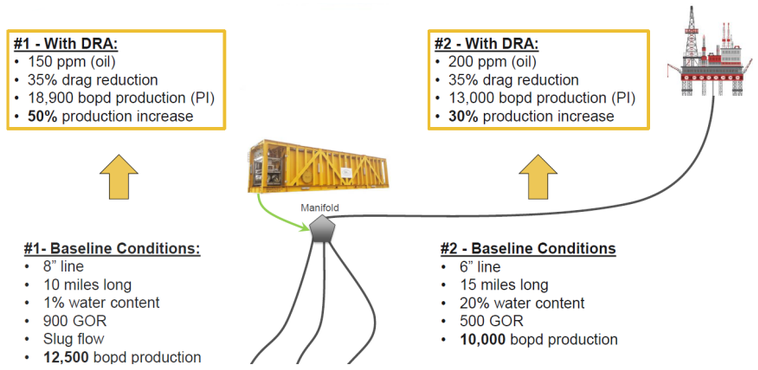

Figure 1. *Multiphase DRA Case Studies*

The baseline conditions reflect the characteristics of the crude oil, flowline, and system. The gold box shows the system characteristics while injecting DRA. Even though the drag reduction is the same in both case studies (35%), the percent increase in production differs (30%–50%). The production increase depends upon the DRA performance in addition to the well's productivity index (PI–STB/day/psi). The well's PI reflects the well's ability to convert the reduction in frictional pressure loss to a production increase.

Figure 2. *A dry factory acceptance test (FAT) was completed, followed by a system integration test (SIT).*

DRA Benefits

In addition to increasing production by debottlenecking the flowline, DRA can provide offshore operators with additional benefits and operational flexibility, including:

SHORT-TERM BENEFITS:

- Achieve/increase production targets
- Reduce slugging by increasing flowrates and sweeping
- Increase flowrates during early flush oil
- Eliminate valuable topside space requirements with subsea equipment

LONGER-TERM BENEFITS:

- Add wells to an existing flowline
- Increase tie-back distances
- Increase flexibility: Portable units can be moved when conditions and economics change
- Complement or substitute subsea boosting systems
- Reduce capital costs via higher production through smaller flowlines
- Retain production and reduce flowline pressure (if a flowline's MAOP is reduced)

LSPI DRA has been successfully used for over 40 years at greater than 1,000 locations, by more than 100 customers (e.g., national oil companies, integrated oil companies, production companies, and pipeline companies). Now, with a successfully qualified subsea DRA storage and injection unit specifically designed for LSPI's DRA, coupled with a DRA uniquely engineered for subsea multiphase flow, customers can enjoy the benefit of subsea production improvement.

SMT's Subsea DRA Storage and Injection Unit consists of two primary components:

1. **A subsea DRA storage unit:** A steel storage unit encasing a flexible bladder which together provide a dual barrier to the marine environment. A leak detection system was designed, patented, fabricated, and tested to further enhance environmental protection.
2. **A subsea DRA injection unit:** Affixed into the end of the subsea DRA storage unit. This unit features an all electric operation with pumps, meter, actuated valves with a fail to desired position and a smart battery backup, and a variety of sensors and controls to ensure safe and reliable operation.

Subsea DRA Storage and Injection Unit Evaluation

The subsea DRA storage and injection unit successfully completed a series of qualitative risks assessments (QRA) and Failure Mode, Effects and Criticality Analysis (FMECA) to identify risks and then eliminate or mitigate these risks to an acceptable level. The design and risk assessment considered the full life cycle of the unit including transport to site, subsea deployment, operation, recovery, inspection, and refill. Many factors were engineered into the bladder design:

- Dual barrier feature and overall constructability
- Reliability
- Inspection, Maintenance and Repair (IMR)
- Fill/depletion manifolding equipment
- API and military recommended practices and specifications

Individual sub-assemblies were subjected to qualification tests. The sub-assemblies were then combined to create the storage unit and injection unit, which was subjected to additional qualification tests. A dry factory acceptance test (FAT) was completed, followed by a system integration test (SIT) as shown in **figure 2**.

Conclusion

DRA has been successfully proven in offshore and onshore applications to increase flowrates and decrease pipeline pressures. With the availability of a subsea multiphase DRA, the capability to deliver projects and services to the offshore industry, and the development of subsea DRA storage and injection units, an unprecedented full-service solution to increase subsea crude oil production is now available to subsea well operators. ●