

CASE STUDY

DM Petroleum Operations Relies on FPI Mag Flow Meter For Tough U.S. Strategic Petroleum Reserve Application

Authors: *By Nicholas, Voss, Product Manager, McCrometer*

Overview

New tests recently performed by DM Petroleum Operations Company with the FPI Mag® Flow Meter from McCrometer continue to confirm the flow meter's accurate performance and reliability on two rugged Texas brine disposal lines supporting the U.S. Strategic Petroleum Reserve (SPR). The first FPI Mag Flow Meters were originally selected for conducting periodic tests on the brine lines in 1996, and the latest generation of FPI Mag meter validates the dependable performance first experienced over 17 years ago.



U.S. Strategic Oil Reserve

“For years we have counted on this flow meter to perform testing, to date we have always performed the tests successfully,” said James Nguyen, Senior Pipeline Engineer with DM.

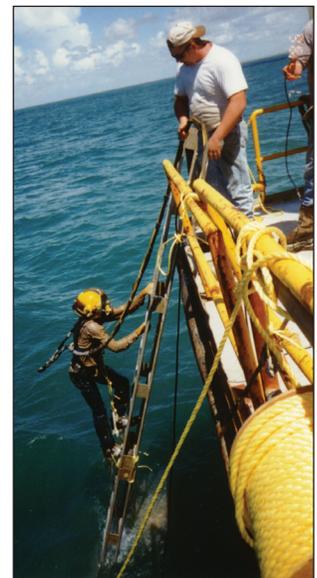
With a capacity of 727 million barrels, the U.S. Strategic Petroleum Reserve (SPR) is the world's largest stockpile of government-owned emergency crude oil.

Established after the 1973-74 oil embargo, the SPR provides the nation with a powerful response option should a disruption in oil supplies

threaten the U.S. economy. It is also the critical component for the United States to meet its International Energy Agency obligation to maintain emergency oil stocks and it provides a national defense fuel reserve.

The oil is stored in man-made salt domes created by injecting fresh water into the salt deposits which dissolves the salt leaving an open cavern for storage. To retrieve oil from the salt caverns they pump water in the bottom and since oil floats on water, the oil rises to the surface and then can be transferred to interstate pipelines or loaded into ships. When oil is added into storage they pump the brine water out for disposal.

DM Petroleum Operations Company, Inc., formerly known as DynMcDermott, manages and operates the SPR under contract to the U.S. Department of Energy (DOE). DM has been the SPR management and operating (M&O) contractor since 1993. The company manages four storage sites: two in Louisiana and two in Texas.



Divers Testing Brine Lines

Problem

The U.S. Environmental Protection Agency (EPA) requires periodic integrity tests on each brine disposal line at the SPR's site for leak detection. The flow rate is measured simultaneously at a point on shore and at a second point that is miles out into the Gulf of Mexico near the dispersion nozzles. The meters are transported by barge offshore, inserted for testing purposes, then removed from the line and stored until the next tests are conducted. The onshore and offshore flows measured by the flow meters are compared to determine if the pipeline has a leak. The criterion for a successful test is a difference of 4% or less between the two measurements.

Once each year, usually between May and June when the weather tends to be calm and before the hurricane season starts, the two lines in Texas are tested. The Big Hill Brine Line in Jefferson County Texas is a 14-mile long, 48-inch diameter pipe and is one of the DOE's toughest flow metering applications. The second site is a 24-inch pipeline located approximately six miles offshore. In the past a pitot tube type meter was used to profile the pipe and measure the flow at the two points.

The valuable time required by divers to accomplish flow profiling on the gulf sea floor and less than satisfactory results led to a search for a better means of measurement.

A lift boat, essentially a barge with legs, is used to transport the meters, crew and divers out to the off shore site. Once at the site, the legs are lowered to lift the barge off the water, providing a stable working platform. Divers locate the opening in the pipe, which is at a depth of about 40 feet for the Big Hill Brine Line, and insert the FPI meter sensor. Once inserted, brine is flowed through the pipe and the flow data is collected and recorded at one minute intervals for a minimum two hour test period.

The same type of test is conducted on shore simultaneously. The on-shore crew connects McCrometer's converter directly to a laptop to convert the electrical signal from the sensor to live flow rates. The integrated system then compares the offshore and onshore measurements. A difference of 4% or less is considered a successful test. The tests are submitted to the EPA, and it is with these results that the EPA determines whether to renew SPR's discharge permit.

Solution

The Big Hill Brine Line was originally tested by DM using FPI Mag Flow Meters. The FPI Mag Flow Meters replaced the problematic pitot tube meters, over a required 2-hour period on June 29, 1996. The recorded flows from the FPI Mag flow meters matched to within 0.21% and proved them as an excellent choice for the demanding task.

The original FPI Mag meters and subsequent generations of the product have been in continuous use for periodic testing service since their original adoption for this application. The latest test, again conducted with FPI Mag meters, confirms their performance results.

"Accuracy is extremely important to the testing process, said Nguyen, "because of time and money. We can't afford to have equipment that is not working properly. The annual test cost for the contracting alone is \$200,000 to cover the lift boat, a five man diver team and equipment set up. Plus we have our own offshore and onshore crews."

As the next generation mag meter, the FPI Mag meter combines the ease of hot tap installation with an accurate measurement across the full flow profile. The FPI Mag meter is accurate to $\pm 0.5\%$ from 1 ft/s to 32 ft/s (0.3 m/s to 10 m/s), and up to $\pm 1\%$ from 0.3 ft/s to 1 ft/s (0.1 m/s to 0.3 m/s) of reading and installs in line sizes from 4 to 138 inches.

Cost-effective for new or retrofit applications because of its compact insertion design, the FPI Mag meter fits easily into limited access confined spaces. It also can be removed from pipes under pressure for easy inspection, cleaning or calibration verification without an expensive shutdown and re-start sequence, helping cut plant maintenance and instrument ownership costs.

FPI Mag Meter Technology

Mag meters, including the FPI Mag, operate under the principle of Faraday's Law of Electromagnetic Induction to measure water velocity. The principle of operation states that a conductor, such as water, moving through a magnetic field produces a voltage which is directly proportional to the velocity of the water flowing through it.

The FPI Mag flow meter's unique sensor features multiple electrodes across the entire pipe diameter. Electromagnetic coils installed inside of the sensor produce magnetic fields. Stainless steel electrode pairs installed on the outside of the sensor collect the induced voltage cause by the flowing water. The total of each voltage signal is transmitted to the converter electronics, where it is converted to an average flow velocity. The converter then multiplies the average flow velocity by the pipe's cross-sectional area to create a volumetric flow rate.

Multi-electrode sensing provides accurate measurement without long upstream and downstream straight pipe runs. The FPI Mag provides a large range-ability and the multi-electrode sensor design compensates for variable flow profiles, including swirl, turbulence, and low-flow conditions. The FPI Mag's unique sensor configuration continually measures and reports the average flow rate over the full diameter of pipe for greater accuracy and repeatability.

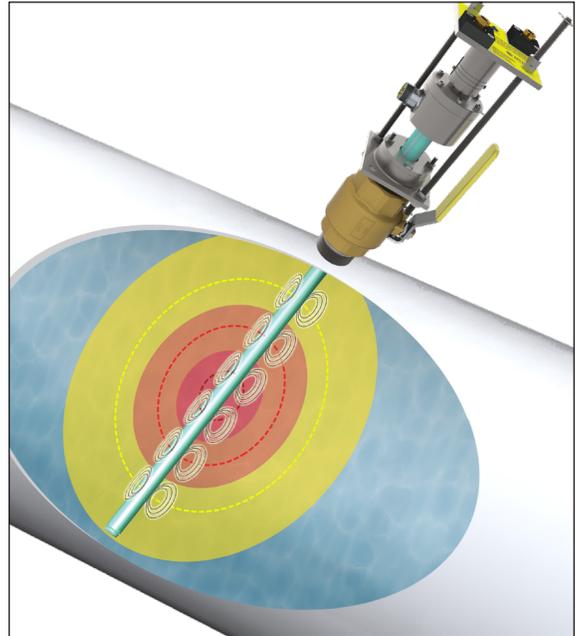
The user-friendly FPI Mag uses McCrometer's preprogrammed, plug-and-play signal converter. This converter, standard with all McCrometer mag meters, features built-in dual 4-20mA outputs for communication flexibility, additional programmable outputs to support SCADA systems and a simplified menu structure for ease of use.

The FPI Mag is packaged with a heavy-duty 316 stainless steel sensor body for maximum structural integrity, and for this application the optional Hastelloy® electrodes compatible with the corrosive seawater environment. The sensor is coated with a NSF certified 3M fusion-bonded epoxy coating for operational longevity. With no moving parts and a single-piece design, the FPI Mag flow meter contains nothing to wear or break, and is generally immune to clogging by grit or other debris.

Conclusions

"Over the years the product has been upgraded from the original fiberglass construction to steel. The more rugged the product is the better for this tough environment. We need to rely on the equipment to perform accurately and properly so no re-testing is needed. I'm not sure if any other meter could have been chosen to do the job with the given requirements," said Nguyen.

After more than a decade of periodic testing service, the FPI Mag Flow Meter continues to demonstrate performance accuracy in demanding environments. The meter's unique multi-point sensing capability combined with intelligent signal conversion and a robust package design make it an excellent choice in a wide range of industrial process water measurement applications.



The Multiple Electrodes Of The FPI Mag Create A Magnetic Field Across The Full Profile Of The Pipe