# Foxboro® CFT50 Digital Coriolis Mass Flow Transmitter

## Increasing Yields in Mature Oil Fields



## Summary

The Foxboro CFT50 Digital Coriolis Mass Flow Transmitter features a patented digital processing system and allows mass flowmeters to operate uninterruptedly during difficult-to-measure applications, including problematic liquid/gas flow and is designed to control the Coriolis meter throughout all stages of gas void fraction for continuous, precise measurement.


## Business Value

The Foxboro CFT50 Digital Coriolis Mass Flow Transmitter precisely monitored how much gas is injected into each well. This information was used to create a better understanding of the impact of the $CO_2$ on the reservoir and its subsequent increase in production.

### About The CFT50 Transmitter Description

The Foxboro® CFT50 Coriolis Mass Flow Transmitter features a patented digital processing system that allows mass flowmeters to operate uninterrupted during traditionally difficult to measure applications, including two-phase flow. Capable of performing in batch applications starting with empty flowtube conditions, the CFT50 is designed to control the Coriolis meter throughout all stages of gas void fraction for continuous, precise measurement.

### Benefits

- Accurate flow measurement of $CO_2$ in changing two-phase flow conditions
- Improved efficiency of oil extraction process
- Maximized oil production from mature fields
- Precise measurement of $CO_2$ to minimize wasted resources
- Support development of long-term production efficiency strategies

### Technical Challenge

Using carbon dioxide ($CO_2$) for enhanced oil recovery (EOR) is a proven method to greatly increase yields in mature oil fields. However, accurate measurement of $CO_2$ at subcritical conditions in a non-miscible flood is a proven challenge. One of the largest midstream energy companies in America has found the solution by applying advanced Coriolis metering technology.

The company began injecting $CO_2$ into one of its West Texas oil fields as an immiscible flood to maintain pressure in the oil reservoir. While the process went as planned, engineers felt that they could do even better if they accurately measure the $CO_2$ flows in each well. However, $CO_2$ is an elusive element to measure under changing process conditions. When it is above the critical point it exists as a “liquid” and is easily measured with standard flow measuring devices such as an orifice meter. Below the critical point, $CO_2$ can coexist in two phases, liquid, and gas. Traditionally, two-phase flow measurement has proven too difficult and plagues flow measurement in nearly all process operations.

## Technical Challenge (continued)

In this application, the company transfers the $CO_2$ in pipelines to each of the injection wells throughout the field. During transport, variations in ambient temperature and pressure outside the pipeline cause the $CO_2$ to vary from a liquid to a gas. For example, on a cool morning the lines are primarily liquid $CO_2$. However, in the afternoon, with elevated outside temperatures, the liquid turns primarily to gas. This phase variation presents a flow measurement challenge, which there is no easy solution.

Possible options are orifice plates with multivariable DP transmitters and conventional Coriolis flowmeters. While traditional Coriolis technology is highly accurate in single phase flow, with a 0.02 percent plus or minus error level, two-phase flow boosts the error rate to 20 percent or higher. None of these options met the performance level the company required, so the orifice flanges were used as an inexpensive, temporary option.

With the orifice plate arrangement, measurement data consisting of orifice differential pressure and flow temperature was relayed using pressure transmitters and thermocouple, respectively, to a PLC. The PLC was programmed with $CO_2$ density data as a function of temperature and pressure. This information was used in a standard gas equation to calculate flow.

The company realized poor measurement performance immediately. Measurements from the orifice plate arrangement were compared to the custody transfer field sales meter, which operated upstream of the injection wells in a single dense phase at higher pressure. The difference in measurement between the sales meter and well measurements was off by as much as 80 percent.

## The Foxboro Solution

In search of a solution, the company tested Foxboro's CFT50 transmitter a few months after the startup of $CO_2$ injection. The initial results were encouraging. Once everything was set up and running it became apparent that the Foxboro CFT50 meter was tracking expected flow significantly better than the orifice meters. The success of the initial tests led to a full field test that proved successful and resulted in the company installing Foxboro CFT50 meters at each of the 10 injection wells throughout the field.

A typical wellhead installation system includes the Foxboro CFT50, a control valve, PLC, and SCADA equipment. As oil is produced, $CO_2$ volumes are increased or decreased to maintain constant reservoir pressure. The control valves open and close based on flow measurements from the CFT50 compared to set points established for each well.

The CFT50 provided the solution as an information tool to precisely monitor how much gas is injected into each well. This information is used to create a better understanding of the impact of the $CO_2$ on the reservoir and its subsequent increase in production.

## Results

With the added ability to accurately measure two-phase $CO_2$, this company is optimistic about the long-term advantages of developing strategies to maximize production efficiency.

With the Foxboro CFT50, they have achieved a total combined accuracy of +5 percent over 10 meters. Now they can better correlate production efficiency with the volume of $CO_2$ injected, which is critical for developing oil reservoir strategies.

**Ask about our next generation flow transmitter, Model CFT51 which offers all of these benefits and more!**

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