Title: Pipeline Flow Measurement - The New Influences

PIPELINE FLOW MEASUREMENT - THE NEW INFLUENCES

INTRODUCTION

There are many considerations that influence our choice of methods and equipment in the measurement of liquids and gases in pipelines. A review of these problems are timely, since we have changing influences that are affecting our choices to accomplish the job of flow measurement. These are accuracy, electronic equipment, economics, fluid characteristics, standards and governmental influences, and testing or proving practices. All of these factors have had importance to some degree in the past; however, their relative importance to flow measurement and more importantly to a pipeline's overall operation has changed considerably as we have seen the prices of the fluids handled make dramatic changes along with supply and demand fluctuations of considerable magnitude versus a steady growth pattern of just a few years back.

ACCURACY

Today's Demand - Better Flow Measurement Accuracy

In analyzing the economics of the flow measurement industry, we find the customers are no longer in an expansion mode. With the turndown in their economies, they are more concerned with improving efficiencies in their present installations. Better measurement accuracy is one way to achieve this. The users are asking the manufacturer to improve his present devices as well as develop new meters and new technology to do the job "better." No one can fault these desires. However, measurement is a very conservative, "traditional-following" market. Industry metering standards are slow to change, and it has been difficult in the past to get the users to adopt new meters and products. In the gas industry, contracts are written by lawyers who are not measurement experts and who tend to follow a contract form that was successful in the past. Manufacturers tried to switch users to electronic readout devices some 20 years ago. Electronic computers and flow recorders have been available to industry all this time, though admittedly not of today's quality. Yet, today in the United States--for pipeline large-volume natural gas measurement--less than 2% of the stations installed utilize electronic computer controls and readouts. The industry has been more successful in applying electronic digital readout devices to liquid metering in conjunction with the turbine meter and are beginning to see production fields being automated for both liquid and gas measurement.

If the industry had a new meter today that offered absolute accuracy; infinite rangeability; met all the environmental requirements, codes, and governmental regulations; could be installed and operated by present personnel with minimal maintenance; was priced low compared to present devices on the market--it would still be difficult to sell it in sufficient quantities in the market place to make it profitable to manufacturers. The companies would at best be willing to try the meter for a year and compare it with present meters. Then and only then, would they add it to their accepted list. The manufacturers are asking the user to change his cash register. The user has to be convinced that he is on solid legal, engineering and procedural grounds.

Costs of Accuracy

Many companies are taking a hard look at all capital expenditures in this time of high interest rates. Management people feel that the high price of the fluids they are handling allows a larger investment in order to get accurate measurement. Simple expenditure of capital does not eliminate the fact that any measuring system has a tolerance. We would like to think that normally the more expensive the device the "better answer" we will get. However, careful consideration must be given to what the "better answer" will mean to our operations. Quite often the flow measurement industry is called upon to solve flow measurement problems of the user. Sometimes the end result is not exactly what the users had in mind. A net seller of natural gas or fluids that has a meter reading low by one percent would be delighted to use the new "more accurate meter." However, a purchaser who was just as interested in his balance sheet and who had his flow figure raised by one percent, would not be too happy with a decision to use this "more accurate meter". Many times, users have evaluated electronic flow computers, and when compared with the existing meter they will read differently. There are good solid technical arguments why the computer is more accurate, but there are also political and economic reasons why customers cannot use more accuracy "if it lowers my billing." When two parties in a contract are involved, you must keep in mind that you can't have a more accurate metering device that will raise measurement for both sides of the equation. As manufacturers, the only path that can be followed is to sell the most accurate metering device they know how to make and to let the customer work with the political and economic consequences. These influences certainly affect the industry's ability to bring out new products and have them accepted based on accuracy.

Their Place in Flow Measurement

There is no denying that the high technology age is upon us. This basically refers to electronic calculating and data handling systems as far as the pipeline flow measurement problems are concerned. These tools have been available for several decades; however, we are finally seeing the beginning of the significant use of electronics to replace our previous mechanical methods of converting meter readings to custody transfer volumes. This is basically due to the availability of low cost, reliable electronic devices that will meet the field conditions where flow measurement takes place, and a growing awareness of the user on the requirements to successfully apply these devices. We have moved through stages of applications from "flow computers can do anything," to "flow computers don't operate in the field," to the stage we are in now where "properly applied flow computers are a viable consideration" for accomplishing the job we have done in the past, plus additional timely uses of the flow data to improve operations. However, this decision is not made without a serious look at the economic consequences.

ECONOMICS OF FLOW MEASUREMENT

Accuracy Versus Cost

As the cost of the fluids handled goes up, there is a demand by all parties involved in its purchase and sale to: "reduce the tolerances;" "get more accurate measurement;" or "get more sophisticated equipment to get a better answer." Capital investment required to upgrade measurement is getting a hard look by pipeline management as are all of their expenditures. So our desires for better measurement is tempered by available capital and the resulting savings to be expected. The definition of "more accurate answers" of various measuring devices, both in terms of theoretical and practical use, must be reviewed to improve our ability to get the best measurement for the dollars invested. If you

are producing a well at .25 MMCF/day; one level of equipment and procedure investment is justified; whereas, a station delivering 25 MMCF/day or 250 MMCF/day may require another. Similar thinking applies to liquid measurement. Physical limitations such as available power, cost of space to install equipment, effect on the environment must also be considered. On offshore platforms, where space costs a premium, meters that can be installed with a minimum of piping have been used because of the savings realized. A large portion of the new metering devices' electronic readouts require good quality and dependable power. In some remote locations where commercial power is not available, the cost of getting the proper power may exceed the cost of the metering. In this case, the cost of power may dictate the use of mechanical or pneumatic readout devices or some local generated source such as solar or thermoelectric. These power sources are normally low wattage devices, which may restrict the capabilities of the electronics or limit the choices of devices.

Personnel Requirements

A very definite consideration affecting the economics of flow measurement is the personnel required to accomplish a given job. This may mean at least a retraining if not a replacing of our present measurement people. Generally they will be in an upgraded position that requires both electronic and mechanical skills along with a solid understanding of flow measurement. Otherwise, you may end up with an electronics oriented person chasing the details of proper programs and round-off procedures of the measurement readout system while not recognizing that the basic meter may be improperly applied or functioning and the total system is in error. The reverse can be true if a mechanical oriented person is lacking in electronic knowledge. Fortunately, in the last few years most new workers have had good exposure to electronic devices and are more comfortable with electronic flow approaches than some of our older personnel. This problem exists at all levels of our company's operations and to a large degree will be the deciding factor of the final success of our system. It has a definite economic impact on our choice of changing our flow measurement systems.

Improving Present Flow Measurement

Since most pipelines are in a non-expansion mode, if not a reduction in throughput, operating people are spending a large portion of their efforts in improving efficiencies of their systems. This includes much closer attention to the efficiencies of compressor or pump stations. We are not talking about large percentage reductions in efficiencies being significant cost savings. As an example, some gas pipelines have as much as 80% of their total cost of operation coming from fuel costs, even a 5% reduction relates to reduction in operation cost of 4%. To study these efficiencies for real results requires very accurate flow measurement including individual measurement on each compressor or pump and engine. This is a case where the use of flow measurement to reduce costs is the driving factor rather than custody transfer service that we generally worry about.

FLUID CHARACTERISTICS

A Changing Problem

For years we have had the luxury of handling fairly simple fluids with well-defined and/or accepted correction factors to reduce fluids at flowing conditions to fluids at base conditions. We now are being faced with pipelines handling "dense fluids" such as carbon dioxide and ethylene and liquids such as non-stabilized crudes, light hydrocarbons operating at their vapor pressures, and refrigerated LPG. In these cases, the choice of the basic meter is less of a

concern than the proper preparation of the fluid prior to passing through the meter, and the proper factors for making corrections to base conditions. Sometimes we are trapped by our previous practices established with well-behaving fluids and can find very large errors when these practices are applied to ill-defined fluids. In these cases the problems are not in the basic flow meter, but in the flow meter system application of the correcting factors based on inadequate knowledge. The proper answer to these problems has not been worked out to give the accuracy of flow measurement we desire, but with the recognition of the problem we have been able to minimize some of the errors while continuing to seek new flow meters or methods of correcting for the fluid characteristics to solve the problem.

STANDARDS / GOVERNMENTAL EFFECTS ON FLOW MEASUREMENT

Outside Influences on Flow Measurement

Industry practices, standards and contracts, along with the ever-increasing governmental requirements must be considered to complete the picture of present day pipeline flow measurement. It is the belief of some of the bodies that measurement can be accomplished by legislation. All orifice plates in some countries, for example, have to be stamped by a government inspector, which makes them acceptable and correct. The manufacturer or user then can adopt the attitude that if the standards body or government finds it correct, it is not his worry and he really does not need to know much about flow measurement. This fundamentally has a serious flaw, since it removes the one item effective in obtaining accuracy--personal commitment and responsibility to accomplish the job. The manufacturers and users in countries where this is acceptable practice have passed the responsibility back to the government. They have reduced the caring as to whether or not their metering is accurate or properly installed, and whether or not it maintains this accuracy in long-term service.

As we get further into the governmental agencies controlling our business we have seen that the cost of doing the job is of secondary importance to meeting DOE, EPA or OSHA standards, as an example. Unfortunately, the governmental bodies are looking at getting further in the measurement of fluids business with every passing day. Experience tells us that present economics of fluid measurement will be less of a controlling factor as this continues to occur.

TESTING OR PROVING FLOW METERS

Present Practices

The term "proving" in flow measurement means a throughput test and comes to us from the liquid measurement people who developed the mechanical displacement prover (now termed the "pipe prover") for proving turbine and positive displacement meters on crude oil and petroleum products. Prior to this development, we had critical flow and low flow provers used on PD meters on gas, but these had relatively limited use. On the other hand, "proving head meters" was never done. We substituted mechanical inspection of the primary devices and calibration of the secondary devices for the throughput test. Proving is the checking of the throughput of a meter versus a standard determination of volume from another device. The purpose of all inspection and calibration or proving is to establish a meter's performance accuracy to some tolerance. This tolerance is dependent on the basic accuracy of the standard used plus the conditions of the test. The allowable tolerance is dependent on the value and quantity of the product handled. Because of this, some metering installations cannot justify an extra few dollars in cost. In those cases we continue to use inspection and calibration to determine the meter's accuracy. Proving meters can be quite expensive in terms of permanently installed provers. The decision is based on

"cost considerations" and is balanced by the degree of "accuracy needed" and operations and maintenance money available to be spent in obtaining and maintaining the "accuracy." Here, then, are several of the influences that affect our measurement testing and proving: present practice, standards, accuracy desired, and economics of the measurement job.

Improvement of Present Practices

Present practices will be continued in concept; however, equipment development has improved our tools such as air deadweight devices for differential pressure tests and precision test gauges for static pressure for gas meters. Liquid meters have improved equipment available for sampling and fluid characteristic testing. The standards for flow measurement have had a great deal of study done recently to improve the accuracy and application range with such programs as the American Petroleum Institute work on the fluid characteristics, the development of the small provers for liquids, and the basic flow coefficient research on the orifice by the American Petroleum Institute and the Gas Processors Association. This work of upgrading standards to improve accuracy is continuing at a rapid pace. The accuracy requirements for all flow measurement is being required to be improved because of the high cost of the measured fluids, and we anticipate that this demand will increase.

SUMMARY

The business of pipeline flow measurement has assumed a more important role in the overall pipeline operation picture because the economics of the job to be done requires: more accuracy; better knowledge of the fluids being handled; wider application of electronics to accomplish the basic flow measurement plus other uses of this data to improve operations; the adaptation to changing standards and governmental rules and the use of new equipment and techniques to determine the accuracy of a flow meter. The people who are responsible for flow measurement have a challenge to respond to these changing influences to improve their company's flow measurement.