

First of all, I would like to thank Dr. Hashemabadi and Mr. Zahedi for their kind invitation and I do express my sincere apology that due to other projected event in Mauritius Island I could not attend this important conference.

I am really glad to hear that University of Science and Technology, School of Hydrocarbons, IOTC and eventually the Ministry of Oil have initiated such gathering to improve petroleum custody transfer measurement particularly metering within the Iranian ports and terminals and hopefully minimize the related terminals measurement uncertainties.

There is no doubt that with the current global market and oil prices, the need for accurate hydrocarbons measurement becomes obvious and as a result, exact unbiased hydrocarbons measurement should be an essential objective of all responsible companies, organizations and eventually governmental sectors.

Although for any choice of reliable measurement accuracy is the leading factor however, the main objective should remain within the following four key criteria.

- Accuracy
- Confidence
- Convenience
- Cost of Ownership

An understanding of the process conditions, both operating condition and the physical properties of the hydrocarbons fluid is fundamentally important before designing, analyzing or deciding any measurement facilities.

Different methods and various types of equipment are all utilized to obtain accurate measurement however; the basic measurement process remains the same “the act of comparing a standard known quantity to an unknown quantity”.

High volume metering systems must be equipped with the type of meters that will provide the highest overall measurement accuracy. The most accurate measurement system is the most economical in the long term. In custody transfer measurement metering, it never pays to sacrifice meter accuracy to save on meter cost. The benefit of increased meter accuracy will quickly offset any additional extra costs in the purchase of high quality meters. Just remember, "Cheap is too expensive".

For example, consider an operation where a berth at Kharg Island loads a vessel with 2 million barrels of crude oil in a loading, the value of that crude oil loaded (at around \$100 per barrel) will be around \$200 million. An improvement in the overall measurement accuracy of this berth, by 0.02%, would be worth a saving of at least \$ 40,000 per loading and if that berth is utilized 100 times per year, then there should be a saving of \$4 million a year for this one berth only.

As such, in my opinion the objective of this conference should be concentrated on improving the custody transfer measurement to an acceptable accuracy in accordance with the internationally recognized petroleum standards particularly American Petroleum Institute (API), Energy Institute (EI) and International Standards Organization (ISO) and their stated accuracy requirement.

Typically custody transfer metering of petroleum fluids is normally accomplished with high-performance versions of turbine, displacement (PD) and recently ultrasonic meters. There are many situations where one or the other meter is preferred, and other situations in which any type of meters can be used satisfactorily.

Each time the petroleum changes ownership, a "custody transfer" is completed and both buyer and seller expect their asset share to be accurately measured. Dynamic measurement provided by meters is a convenient and accurate means to measure valuable crude oil and petroleum products.

Selecting the right meters with a high level of confidence is imperative to ensure accurate measurement at the lowest cost of ownership. In another word, for a good and reliable custody transfer meter measurement and fiscal purposes a “metering system” should have the following criteria;-

- Appropriate custody transfer **Meters** installed.
- Properly installed **Meter Station** and facilities.
- Properly selected and installed **Prover**.
- Properly selected and installed **Meter Proving** System.
- Putting appropriate **Prover Calibration** system and procedure in place.
- Putting a proper **Meter Operating Procedure** in place.
- Proper **Meter Proving Procedures** implemented.
- Proper and traceable **Calculations Procedures** for meter factor (meter proving) and meter ticket (meter batch).
- Experienced **Operating Team** with good understanding of dynamic measurement (metering) technique and definitions.
- Processing the **Meter Performance Procedure** and identification of factors affecting meter performance.
- To back up such a proper measurement system the operating company should have a regular and ongoing **Training Program** for all the related staff from technicians to engineers and managers.
- A proper taking sample method and **standard sampling system** as an Auto sampler also **certified laboratory** for sample analyzing is necessary.
- A complete library of all **Reference Standards and Guidelines** for measurement and calculations, and finally a well documented **Quality System** to ensure their accurate and reliable measurement system.

Operating the system in accordance with the recognized latest standards and guidelines is important to keep the system accurate and reliable.

The most recognized standards are:

- ✓ American Petroleum Institute (API),
- ✓ American Society for Testing Materials (ASTM),
- ✓ International Organization of Legal Metrology (OIML),
- ✓ International Standards Organization (ISO)
- ✓ Energy Institute (EI) ex-Institute of Petroleum (IP)

Once a proper measurement system is put in place then the accuracy become a MUST to secure a reliable quantity delivered to the customers.

When dealing with accuracy certain distinction should be made between "overall measurement accuracy" and "meter accuracy" , as these two are not the same. Overall Measurement Accuracy is the accuracy of the volume measured through a complete system; whereas Meter Accuracy is simply the accuracy of a meter relative to the prover used, usually for a constant set of operating conditions.

Overall measurement accuracy is determined by factors such as:

- ✓ Meter repeatability and linearity.
- ✓ Prover calibration (i.e., water-draw) accuracy.
- ✓ Meter proving procedure.
- ✓ Variations in operating conditions from those during meter proving, and their effect on meter performance.
- ✓ Adequacy of air (vapor) elimination.
- ✓ Accuracy of correction(s) for liquid density changes due to varying temperature (and pressure).

Meter accuracy is described as the degree of closeness between measured values and the true value. For example the metered volume multiplied by the meter factor is defined as the true value.

The accuracy of a meter is also limited by several considerations as shown below.

- ✓ Equipment performance
- ✓ Random and systematic errors
- ✓ Operating condition and fluid properties
- ✓ Adequacy of the meter and prover valves leak testing.
- ✓ Prover Volume Calibration Errors
- ✓ Meter proving performance
- ✓ Calculation Errors

With meter accuracy we do unfortunately see in many meter specifications leaflets certain percentage is indicated as the meter accuracy which is completely incorrect and wrong. In actual fact, meter "repeatability" and "linearity" are usually used to define the meter accuracy, i.e. +/- 0.15% Linearity and 0.05% Repeatability (for 5 proving runs).

Again I would emphasize that the most accurate measurement system is the most economical in the long term. In custody transfer metering it never pays to sacrifice meter accuracy to save on meter cost. As such I would strongly recommend refraining from having the idea of building or manufacturing meters or provers locally for whatever reasons and justifications. As I have mentioned earlier the benefit of accurate meter will quickly offset any additional extra costs in the purchase of high quality meters.

The other important message that I would like to advise my colleagues is to avoid defining or establishing an extra ordinary accuracy which is beyond our oil measurement criteria. We know very well that we measure our crude oil to nearest barrel which is far away from the accuracy required in other industries such as manufacturing sophisticated electronic devices or space rocket science. We should set a desired measurement uncertainty to operate and maintain the facility properly to deal with custody transfer measurement in the oil market.

API states that the 95% level (two standard deviations) of statistical confidence is recommended for evaluating uncertainties associated with commercial applications of petroleum measurement. It is also stated that in certain limited circumstances, a different degree of (statistical) confidence may be required. i.e. three standard deviations when dealing with master meters.

Maintaining the meters in good performance, securing a good flow condition on turbine and ultrasonic meters with minimum swirl and maximum Renolds Number (over 10,000), calibrating the provers annually and proving the meters per each loading are essential for an accurate and un-bias measurement for the current oil market.

For a good and reliable loading and discharge operations, in my opinion any Bill of Lading and Outturn difference between -0.16% to -0.24% should be acceptable by all parties. Any result beyond these two limits must be treated carefully.

I hope that this brief note can be of help to the discussions of this conference. I do also apologize that I could present the text in Farsi. If there is any question, please do not hesitate to let me know.

Thanks you.

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Geneva, Switzerland