Meter Calibration
Bulletin

Leading Causes of Retail Petroleum Inventory Handling Losses

July 2003

Inventory handling losses are weighing on the profits of petroleum retailers. This problem has plagued the industry since inception and the current annual cost is in the millions of dollars. Losses occur when the volume of petroleum sold to consumers is inaccurately measured and extra product is given away. This causes the cost of goods to increase and profit margins to decrease.

In addition to the inventory costs, a significant amount is also spent trying to resolve the problem. Petroleum retailers have environmental regulatory requirements to maintain inventory records and to determine the cause of inventory variances greater than 0.50 per cent. It is extremely important to complete the investigation and determine the cause of the losses. Inventory losses can be caused by tank, pipe or equipment leaks that are in turn causing safety and environmental issues. This liability can be devastating to large and small businesses alike.

Solving these problems can be difficult. Countless dollars are spent chasing variances with audits, inspections, repeated meter calibrations and leak detection testing. The problem can appear to be solved after a petroleum service company has calibrated the meters. However, in many cases, the losses return a short time thereafter. Time moves on, as the investigators anxiously wait for results and improvement. More time and money is spent trying to solve the inventory reconciliation variance and reduce inventory handling losses.

Petroleum retailers are dissatisfied with overall product shortages and are trying to minimize inventory-handling losses. Many are targeting losses to be less than 0.30% of petroleum volume throughput. A 0.10% reduction in inventory shortages, at a 5 million-litre facility, creates a 5000-litre inventory savings. This smallest amount of improvement can generate significant savings in the high volume petroleum business.

For many petroleum retailers, their efforts have made little effect on reducing the overall shortages. This situation is unlikely to change until a key problem is solved. The development and use of alternative meter calibration procedure was necessary, in order to fully understand the problem and identify the primary causes of inventory handling losses.

Until recently, a "20 - litre measure" has been the most commonly used method of inspecting dispenser meters. The device is also commonly referred to as a "proving can". A 20 - litre measure can be extremely accurate when used under controlled conditions, by a trained individual following strict procedures. However, the results' accuracy can be adversely affected when the measure is subjected to field conditions or inappropriately used by a technician. Numerous variables may influence the accuracy which results in calibration errors. These include product and ambient temperature, dispensing flow rates, evaporative loss and human intervention.

Calibration errors result in an inaccurate determination of meter measurement error, inaccurate meter adjustments and unrecognized meter equipment failures. These inaccuracies and unrecognized equipment failures cause meter measurement errors that result in inventory variances. Inaccurate meter calibration is the leading cause of inventory handling losses and reconciliation variances.

The following will further illustrate the variables that impact the results' accuracy of a 20-litre measure.

Evaporative Loss

The International Organization of Legal Metrology (OIML) was established in 1955 in order to promote the global harmonization of legal metrology procedures. Since that time, the OIML has developed a worldwide technical structure that provides its Members with metrological guidelines for the elaboration of national and regional requirements concerning the manufacture and use of measuring instruments for legal metrology applications. Measurement Canada is a member of OIML.

OIML Bulletin Volume XLI, Number 2, April 2000 "Practical Hints for Verification of Fuel Dispensers" describes the usage of volumetric provers to evaluate petroleum fuel dispenser meters and the evaporative loss caused by splash filling a 20 – litre measure. The evaporative loss generated by the procedure is

described in this excerpt: *"Another aspect should also be considered concerning the filling of provers: the fuel or diesel will be dumped into the prover for the top, for, where air will be displaced. The air will become partially saturated with fuel and comes back out of the volume standard. Therefore, a small proportion of the filled fuel will not be measured inside the flask. Experts are in disagreement as to how much fuel evaporates in the form of gas. A quantity of 0.15% is estimated depending on the form of the prover."*

Up to .30 millimeters or 0.15 per cent of gasoline will evaporate when the measure is splash filled. This small amount may seem inconsequential, but it has a critical impact on the evaluation results accuracy. Small calibration errors that occur during meter evaluations and adjustments result in measurement errors that quickly accumulate to cause inventory losses. For example: calibration is completed at a five million per year retail petroleum facility. A 20 - litre measure was utilized and the work was completed on a typical summer day. If 0.15 per cent (30 mls) of the test product was lost to evaporation, the calibration error would result in a 7500 litre inventory loss within a one year period. The degree of loss due to vaporization, as a result of splash filling the measure, will vary with the ambient temperature and constitution of the fuel.

Automatic Temperature Compensation Measurement Error

Additional measurement errors are created by inaccurate temperature measurements. Product temperature is required in order to convert measurement from gross to net volume. The maximum allowable variance for ATC temperature measurement is one degree Celsius. Therefore, ATC temperature measurement probes must measure temperature within one degree Celsius of the verification thermometer. A one – degree Celsius temperature inaccuracy will result in a 0.125 per cent measurement error.

Additional measurement errors are attributable to the expansion and contraction of the 20 – litre measure itself. The further the ambient and product temperature is away from 15 degrees Celsius, the greater likelihood of a calibration error and the amount. Calibrating during extreme temperatures will have the greatest impact on the results accuracy.

Human Intervention

The technician is an additional source of errors that will result in inaccurate calibration results. Errors related to a technician using a 20 - litre measure or larger volumetric provers occur as a result of:

- Appropriate procedures and standards are not followed
- Lack of training and or experience
- Inconsistent flow rates during prover filling
- Inadequate evaluation of metering system
- Data recording and calculation errors
- Temperature evaluation and applicable calculations

Evaluation Procedures and Standards

The meter and ATC system require evaluation to determine equipment condition and performance prior to completing any measurement error adjustments. Failure to identify and correct meter or ATC equipment failures, prior to making adjustments, will result in continuous measurement errors. Adjusting a worn out meter or a meter with a repeatability failure may correct measurement error on a short-term basis. However, the meter will continue to fail and be the cause of measurement errors on a longer-term basis. Previous to understanding this problem, many believed that "the adjustment did not hold" and a second calibration was required. Yesterday's explanation is not the correct answer. This situation is actually illustrating unrecognized equipment failures and calibration errors.

Appropriate procedures, standards and accurate calibration results are required to recognize and correct these equipment failures:

- mechanical failures – worn out meters will not maintain adjustment
- repeatability failures – inconsistent measurements occur during the dispensing cycle
- ATC failures – fails to measure accurately or accurately convert measurement from gross to net volume

Regulatory Standards

Metering systems are required to meet these regulatory equipment performance standards:

Assessment	*Regulatory standard*
Measurement error	**+ or – 0.50% or less**
Mechanical condition – slow to fast variance	**0.50% or less**
Measurement repeatability – fast flow results consistency	**0.20% or less**
Temperature measurement	**within 1 degree C**

Inaccurate Results and Calibrations

Inaccurate meter evaluations and adjustments will result in:

- failure to meet the regulatory requirement of delivering fair trade to the consumer
- inventory shortages, high cost of goods and reduced profit margins
- inaccurate inventory reconciliation results and leak detection reliability
- mask leaks in the inventory reconciliation process when the meters keep extra product
- inaccurate automatically calculated tank charts and subsequent electronic inventory reconciliation results

Reduce Inventory Handling Losses and Resolve Variances

Meter measurement errors and their causes are accurately being resolved with the new, master meter proving technology. A closed loop, flow through design with computerized data collection and results generation has been incorporated to generate reliable and consistent results in the field. This technology is identifying the causes of meter measurement errors and reducing inventory-handling losses. The benefits of this new technology are available through a meter calibration service offered exclusively by Cantest Solutions.

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