11.2.3. Produced Gas Measurement Standard for Heavy Oil Sites

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Description
The current standards for measurement and estimation of produced gas from various types of primary heavy oil sites are contained in Directives 017\(^1\) and 060\(^2\) in Alberta, and Directives PNG17\(^3\) and S-10\(^4\) in Saskatchewan. These documents describe the need for and timing of tests, as well as general methodologies and calculations for estimating well gas-to-oil ratios (GORs) for reporting produced gas volumes. However, they do not define what constitutes an acceptable test. This best practice seeks to improve the current standards by adding testing of the quality of the measurements to establish a standard acceptable test and estimation of the GOR for a well. These standardized metrics will help in estimating total gas production, fuel use, and venting/flare volumes.

Recent information from the Alberta Energy Regulator (AER) indicates that significant differences persist between estimates of produced gas volumes before and after conservation practices are implemented, which contributes to continuing problems with equipment sizing. In many cases actual volumes captured can be two to three times higher than the volumes estimated, which may result in either production cut-backs to avoid odour violations, or continued venting until facility modifications are made.

Background:
In 2002, a group of producers identified large errors and a lack of consistency in how primary heavy oil solution gas GORs were being determined. These errors led to issues with evaluating and designing vent gas mitigation options, as facilities were either over- or under-sized.

A 2003-2004 joint industry project sought extensive industry input and developed a vent gas quantification standard requiring assessment of the produced gas flow profile to determine acceptability for use in determining a stable GOR. Additional recommendations were made related to determining fuel use and oil production to allow calculation of a repeatable GOR. The focus was on GOR calculation on any heavy oil lease site where gas streams are not continuously measured. The Directives are based on the assumption that a GOR is a consistent characteristic of the oil in the reservoir that remains relatively constant for any given well or pool over its producing life. However, many operators found that GORs reported by field operations were highly variable over time, in which case either continuous metering of gas should be required, or testing methods must be improved until consistent GORs are being obtained. The 2004 standard was not widely adopted at the time and, as a result, the problems persist, creating potentially large errors in estimations of produced gas and GORs for heavy oil leases. The intent of this best practice is to adopt the produced gas (vent gas) quantification standard from 2004, adapted to recognize additional changes that have occurred since that standard was developed.

\(^1\) https://www.aer.ca/rules-and-regulations/directives/directive-017
\(^2\) https://www.aer.ca/rules-and-regulations/directives/directive-060
The main sources of error in GOR estimates were identified as:

- Gas flow rate variations: While produced gas flows from many wells were steady and shown to be consistent over days and weeks (Designated “Type A” in the Standard), others showed significant flow fluctuations. As a result, 24-hour flow tests were being used to determine GOR, despite being deemed unacceptable for use in GOR estimates because they do not provide repeatable results. Other deviations were seen on leases where some of the produced gas was being used as fuel, and in foamy wells where no gas was vented from the well annulus so all the produced gas was venting off tanks. The graphs below show a range of flow behaviours observed in various primary heavy oil wells operated by one producer. A consistent GOR can only be assured with data from a 24-hour test using wells with a Type A gas flow profile. All others require either longer gas flow tests or continuous measurement to determine produced gas volumes, unless operating conditions in Types B or D can be adjusted to get Type A. Type C indicates production of associated gas or gas build up in a developing solution gas cap adjacent to the well. Type F is usually seen only in older wells when there is communication between adjacent wells.

Examples of Gas Flow Variability in 24-hour Tests. Only Type A is Valid for Determining a GOR for Production Reporting of Facility Design Purposes

- Non-representative oil volumes used for GOR calculations: To obtain a valid GOR, the gas rates measured either over a 24-hour or a longer produced gas flow test, MUST be matched to oil volumes produced over the same period, or over a longer period when the well was in steady operation with constant pump speeds and operating conditions. Often one month’s worth of heavy oil production is matched with a 24-hour gas test. If the pump rate changes, other conditions change, or if volumes of oil are transferred or allocated from other wells, then the regulations state that the test is invalid and must be redone.

Technology Group
Wellhead Venting - Recommended Practices
Site Applicability
Any primary heavy oil site where produced gas is not continuously metered, and where a GOR is determined through periodic gas measurements combined with representative oil production volumes. For multi-well sites, each well on the lease must be tested separately while it is isolated from other wells on the lease.

Emissions Reduction
This best operating practice is focused on ensuring that estimates of total produced solution gas, and fuel, vent, and flare volumes are realistic and accurate enough to be used for planning and designing mitigation actions. Implementing this practice at the appropriate facilities will ensure that the produced gas volumes reported as having been produced from a well are more consistent and representative of actual well production. This will in turn allow more accurate determinations of volumes and potential revenues related to conservation of the stream and for reporting or mitigating greenhouse gas (GHG) emissions.

Accurate equipment sizing is an additional benefit of accurate measurement. The AER has noted that on a large number of facilities of this type, the gas being produced following implementation of mitigation measures has been significantly higher than what was previously reported, so equipment was undersized. Some companies have had the opposite experience where they thought they had a lot of gas, but facilities installed turned out to be over-sized. Right-sizing equipment will not only provide financial benefit, but will avoid generation of excess GHGs through operating oversized equipment.

Baseline:
Current solution gas flare and vent emissions from crude and bitumen batteries are estimated and reported in the latest ST-60B 2016 report as Flared $419 \times 10^6$ m$^3$/yr (Limit $670 \times 10^6$ m$^3$/yr) and $354 \times 10^6$ m$^3$/yr (no limit set) respectively. This translates to ~1.3 to 1.7 MtCO$_2$e/yr from flaring and 6.0 MtCO$_2$e/yr from venting. However, there is a large uncertainty inherent in these numbers due to the lack of standards for measuring and reported solution gas and vent/flare gas volumes.

Economic Analysis

Capital Cost: Implementing the 2004 Vent Quantification Standard prepared by New Paradigm Engineering Ltd. as a Best Practice should not incur any capital costs. However, it will eliminate the various increased costs associated with installing improperly sized equipment.

Operating Cost: Implementing the 2004 Vent Quantification Standard prepared by New Paradigm Engineering Ltd. as a Best Practice should not incur any operating costs. However, it may take a few more minutes for a production engineer to review tests for wells to ensure they are acceptable, and potentially retest (cost variable depending on how testing is managed in a field) if the gas measurements do not result in repeatable, representative GOR values. This may not result in any net additional time as retesting may already be required to meet the requirements of the directives.

Payback Period: The payback period varies depending on how current measurements differ from actual volumes, and on the specific impacts inaccurate design information has had on capital facilities additions due to sizing problems.
Marginal Abatement: Implementation of the 2004 Vent Quantification Standard should directionally reduce abatement costs of options by reducing over/under sizing and rework of mitigation installations.

Reliability
The key to installation of reliable and appropriate mitigation measures, such as compressors for gas conservation or use of lease produced gas for purchased fuel displacement, is to ensure that the data being used to make decisions or to design equipment is reliable. Ensuring that consistent GOR determination procedures are followed should result in better data for equipment design.

Expected Lifetime: The Vent Quantification Standard from 2004 is still valid. In a recent report for Environment Canada and Climate Change, New Paradigm Engineering recommended updating the Vent Quantification Standard to reflect changes in regulations, measurement devices/methods, and industry’s growing use of multi-well leases. The Standard would then be expected to continue to be valid until major changes are made in regulations, such as implementation of a carbon tax on these streams which would require continuous metering for accounting purposes.

Maintenance: Directive 60 requires GORs to be determined every six months depending on the volumes. GORs should be consistent between tests if the testing and calculations are done properly.

Parts and Skills Required: Measurement methods and skills should be found in every operation already, and personnel involved in produced gas or vent/flare gas determinations should already be familiar with and understand the requirements of Directives 060 and 017 in Alberta, and Directives S-10 and PNG17 in Saskatchewan. The only required skill change is to ensure that personnel involved in GOR determinations are familiar with the 2004 Vent Quantification Standard, and that they are provided with gas measurement devices that allow them to determine the type of flow characteristics for each gas flow test. Production accounting and reporting personnel should be aware of when tests are being done to ensure oil production volumes used for GOR determinations are correct.

Safety
Adoption of the Vent Quantification Standard should not present any safety issues beyond the scope of normal operations.

Regulatory
Ensuring that GORs determined for a well are representative of actual reservoir GORs is a basic requirement to meet the intent of Directives 017 and 060 in Alberta and Directives PNG17 and S-10 in Saskatchewan. These directives are all based on the assumption that the GOR in a given formation is consistent, so major deviations or errors in GOR are due to inadequate measurement standards or a lack thereof. Significant changes in GOR of oil or gas flows between consecutive tests should be flagged and potentially audited by regulators to ensure reported gas volumes are being properly estimated.
Service Provider/More Information on This Practice

References:


