# Evaluation of Emissions in the Upstream Oil and Natural Gas Industry

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Alberta Environment is currently re-evaluating the ambient air quality objectives (AAQOs) for the province. This initiative includes reviewing the values of currently targeted substance and potentially adding additional substances to the list. A Stakeholder Advisory Committee (SAC) has been established to participate in this review and evaluation process. The first two substances to be reviewed are Acrolein and Arsenic.

The purpose of this study is to provide upstream oil and natural gas (UOG) industry with facility related data that can facilitate defensible science-based decisions in this matter, and allow potential risks to the UOG industry to be assessed.

Accordingly, a series of source emission tests were conducted at facilities in various
operational regions of Alberta covering a range of different UOG industry subsectors.
The emission tests were conducted on a wide range of sources types. Operational

regions included the south east, central, north east and north. Industry subsectors included sweet gas, sour gas, conventional oil, cold heavy oil and thermal heavy oil production facilities. In total, thirteen combustion source samples were collected from six different combustion source types located at seven different facilities across Alberta.

Source sampling was completed using two types of sampling trains. Organic substances and inert gases were sampled using a canister sampling train and inorganics (metals) were sampled using a two stage impinger train. Canisters contents and impinger solutions were analyzed by Alberta Innovates. The organics protocol quantified the target substance Acrolein, and approximately 187 other substances. The inorganics protocol quantified Arsenic, and approximately 35 other substances. In addition, the fuel gas associated with each combustion source was sampled for organic substances and inert gases using the same organics analytical protocol.

A rigorous material balance, considering all fuel and flue gas substances identified, was conducted for each combustion source to determine the actual air to fuel ratio,

combustion efficiency and flue gas to fuel gas ratio. Based on the results of this material balance, emission factors for all compounds expressed in terms of mass emission per unit of energy input were determined.

Acrolein was observed in only one combustion source emission test and the determined emission factor was 9.09E-5 kg/GJ. This value is well above the detection limit of 7.91E-10 kg/GJ. The emission was associated with a compressor engine that was operating with a combustion efficiency of 95.6 , well below the average efficiency of 99.5 for all of the combustion devices samples. The emission factor determined for Acrolein was within the published range for 4-cycle Rich Burn, Natural Gas Internal Combustion Engines (1.13E-3 – 2.65 E-6 kg/GJ).

Based on these tests, it is appears that acrolein formation and emission from combustion sources may be associated with poor combustion efficiency and a follow up sampling program is recommended to potentially confirm this hypothesis. For combustion sources operating within the design specifications of good to excellent combustion efficiency, acrolein formation and emission does not appear to be an issue.

Arsenic was observed in all combustion source emission tests and the average emission factor was determined to be 2.40E-11 kg/GJ, approximately two orders of magnitude above the lower detection limit of 1.46E-13 kg/GJ. Based on evaluations of combustion air and fuel gas as the potential source of arsenic in the flue gases, it was concluded that fuel gas was the most likely source. Calculated theoretical concentrations of arsenic in the fuel gas were within the range noted by others for arsenic in natural gas.

A sampling program to quantify arsenic and potentially other metal substances in raw natural gas, process fuel gas and sales gas in various Canadian regions is recommended.

In addition to acrolein and arsenic, numerous other organic and inorganic substances were identified and quantified. Each source was characterized by its own suite of substances with some substances being associated with several sources. Emission factors were determined for all substances for each source sampled. These results serve as a database for future assessments of trace comtaminant emissions.

Report