Technologies for Minimizing Odours while Loading and Unloading Truck Tanks and Cleaning and Desanding Tanks

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1 Background

In response to the Peace River panel's recommendation report, the Alberta Energy Regulator (AER) committed to evaluating and implementing appropriate regulatory approaches to minimize emissions and odours associated with truck-loading and-unloading activities. The directive, *Requirements for Hydrocarbon Emission Controls and Gas Conservation in the Peace River Area,* will contain these requirements for operators.

To inform the requirements that will be contained in this directive, the AER reviewed and assessed specific measures to meet these requirements that are available to heavy oil and bitumen operators in the Peace River Area (PRA).

Expanding the topic to include cleaning and desanding storage tanks, the AER has reviewed technical literature, inspected heavy oil sites, and engaged a number of sources in assessing the possible technologies and methods that can reduce odours during truck-loading and -unloading operations; the AER also engaged PRA operators to understand the technologies currently in use. This report summarizes the AER's findings.

This report does not offer a complete list of technologies that could minimize odours in the PRA. Vapour balancing and directing vapours from truck tanks to storage tank heaters could minimize odours, but these controls are not discussed due to technical and safety issues that make them unlikely to be implemented at this time. In addition, pipelines are not discussed in this document. While they may be an option to transport heavy oil and bitumen, they are not an odour control technology for trucking and tank-maintenance activities.

As summarized in table 1, odour control technologies are reviewed for their applicability, safety, availability, current use, concerns, odour control efficiency, and targeted compounds. Targeted compounds are volatile organic compounds (VOC) and reduced sulphur compounds (RSC), which are generally considered to be the odour-causing compounds in truck tank vent streams.

This report does not recommend or endorse any of the technologies mentioned. Each heavy oil facility in the PRA may have its own unique characteristics, and it is up to the licensee to employ appropriate controls in order to meet AER requirements.

2 Combustion Technologies

Three types of combustion technologies can minimize odours from truck-loading and -unloading operations: flares, thermal incineration, and catalytic incineration. These combustion technologies do not currently apply to tank desanding or cleaning due to implementation difficulties and technical or economic factors.

Each form of combustion is designed to destroy RSCs and VOCs with an efficiency of more than 95 per cent. The combustion by-products include carbon dioxide (CO_2), carbon monoxide (CO), nitrous oxides (NO_x), and sulphur oxides (SO_x).

Mixing air and gas from previous loads into flares and incinerators can pose a fire or explosion hazard. One suggested method of mitigating this risk is to enrich the stream with casing gas.[1] Flaring and incinerating of waste gas streams that contain low amounts of hydrocarbons may require additional fuel gas to achieve efficient combustion.

2.1 Flaring

Flare systems are typically composed of process piping, a flare knockout drum to collect liquids, a flare stack, and an ignition system. Flaring is commonly used in the PRA to destroy VOCs and RSCs from tank tops and sometimes to dispose of excess casing gas. Flares can achieve a combustion efficiency of more than 95 per cent as long as the flame remains stable.[2] Currently only one facility in the PRA, a waste management facility, flares truck-loading emissions.

2.2 Incineration

Incineration is different from flaring as combustion occurs in a combustion chamber and no flame is visible from the top of the stack. There are two types of incinerators, thermal and catalytic.

Thermal incinerators are used to safely and cleanly burn waste gases at temperatures that are high enough to ensure a combustion efficiency of more than 99 per cent.[3] Auxiliary fuel is generally required to reach temperatures high enough to completely combust gases.

Catalytic incinerators operate under the same principle as thermal incinerators but require less additional fuel due to a catalyst that accelerates the combustion reaction and reduces the temperature required to

[1] Clearstone Engineering Ltd., *Final Technical Report: Inventory of Atmospheric Emissions from Heavy Oil Production Facilities in the Three Creeks Area* (Calgary: Clearstone Engineering Ltd., 2015), page 42.

[2] Larry Kostiuk, Matthew Johnson, and Glen Thomas. *University of Alberta Flare Research Project Final Report November 1996 – September 2004* (Edmonton: University of Alberta Department of Mechanical Engineering, 2004), page 8.

[3] EPA, *Air Pollution Control Cost Manual*, 6th Edition (Research Triangle Park, NC: United States Environmental Protection Agency, 2002), pages 2–23.

achieve complete combustion.[4] Thermal and catalytic incinerators are currently only applied to truck-loading operations.

3 Scrubber Technologies

Scrubbers are designed to separate components from a fluid stream either by absorption or adsorption. Scrubbers control odours for truck-loading and -unloading, tank-desanding, and tank-cleaning operations. The absorbent or adsorbent material selected will depend on targeted compounds, operating conditions (gas temperature, pressure, flow rate, water content, and component concentration), and ambient conditions. Additional selection considerations include media replacement frequency, waste management, cost of disposal or recycling, and the potential for fires caused by excessive exothermic reaction rate in certain materials.[5]

3.1 Absorption Technologies

Absorption is a chemical process where components from the gas stream are captured in an absorbent material. The absorption unit can scale to fit low-flow vent streams from loading truck tanks or high-flow vent streams from tank desanding and cleaning. Absorption scrubbers can mount permanently on site or directly to a tanker truck. Truck mounted units are typically filled with liquid absorbent, while fixed units typically use solid absorbent materials. Absorption technologies can remove RSCs with an efficiency of more than 99 per cent when operated and maintained according to manufacturer's specifications. These types of technologies are currently in use in the PRA.

Absorption technology has challenges related to the properties (e.g., composition, temperature, pressure, etc.) of the gas being fed into the scrubber; absorbent materials may also be toxic or harmful, may not be reusable, or may have to be disposed of at an appropriate waste management facility. Operators have experienced challenges with identifying when an absorbent is, or will be, spent. Monitoring and predictive maintenance programs can address these issues.

3.2 Adsorption Technologies

Adsorption is a physical process where the compound extracted from the gas stream adheres to the surface of the adsorbent. Often, the adsorbent can be used for multiple cycles of adsorption and regeneration before being sent to a waste management facility. Adsorption technology can achieve greater than 99 per cent removal efficiency of targeted components when operated and maintained according to manufacturer's specifications. Adsorption technologies are currently only applicable to truck loading.

[4] EPA, *Air Pollution Control Cost Manual*, pages 2–4.

[5] Clearstone Engineering Ltd., *Final Technical Report*, page 42.

Activated carbon is an example of an adsorbent that is used in other industry areas. It is designed to be more than 99 per cent effective at VOC removal. However, the adsorption process produces heat, which may create significant fire and explosion hazards, which require engineered controls, such as instrumentation and computer programming that automatically shut the system down under certain circumstances. Currently, no activated carbon scrubbers are used for truck-loading and -unloading activities in the PRA.

Enhanced scrubber technologies such as caustic impregnated carbon, catalytic carbon, and enhanced chemical solutions can remove both RSCs and VOCs.[6] However, these technologies can increase the cost of regenerating the adsorbent material or prevent regeneration altogether, thereby producing waste. These technologies are currently most applicable to truck loading and are not used in the PRA.

3.3 Scrubbers Used in Series

Another method of removing truck tank loading RSC and VOC odours is to use two scrubbers in series, each one designed to remove a targeted compound. This method is not currently in use in the PRA and would need to be designed per current engineering standards to be used.

4 Pressure Truck Tank Loading

Pressurized loading prevents odorous emissions from truck loading. However, loading under pressure decreases load capacity by 10 to 30 per cent because truck tanks reach a pressure limit before the volume limit resulting in more trucks being required to carry the same volume. Pressurized loading is not currently applicable to tank cleaning and desanding.

Pressurized loading poses safety hazards requiring specific procedures and precautions. PRA trucking companies also have a limited number of truck tanks that can load under pressure. Currently, there are pressurized truck tanks only in use where required under *Environmental Protection and Enhancement Act* approvals.

5 Procedures

Odorous emissions can be reduced by implementing new procedures or improving and using current procedures. The following are a few options that may be considered:

- Using truck loading procedures that minimize free fall and splashing of product, such as loading from the bottom and slowing down loading rates;

[6] Clearstone Engineering Ltd., *Final Technical Report*, page 42.

- changing chemical additives to reduce odours from certain additives, such as using methanol instead of naphtha demulsifiers;[7] and
- directing vapours to the flare header before the manway is opened for tank-cleaning activities.[8]

6 Conclusion

While the specific details of technologies and procedures vary, technological and procedural options can be implemented to minimize odours from truck-loading and -unloading and tank-cleaning and -desanding activities in the PRA. As stated earlier, this report is not exhaustive and there may be other technologies that will meet the AER requirements to minimize odours from these activities.

[7] Clearstone Engineering Ltd., *Final Technical Report*, page 48.

[8] Clearstone Engineering Ltd., *Final Technical Report*, page 48.

Table 1. Summary of Odour Control Technology Options for the Peace River Area

	Combustion		Scrubbers				Other	
Technology	**Flare**	**Incineration**	**Absorption products**	**Adsorption products**	**Enhanced scrubber technologies**	**Scrubbers in series**	**Pressure loading**	**Procedural**
Applicable activities	Truck loading, truck unloading	Truck loading, truck unloading	Truck loading, tank desanding, tank cleaning	Truck loading	Truck loading	Truck loading, truck unloading	Truck loading, truck unloading	Truck loading, truck unloading, tank desanding, tank cleaning
Currently inapplicable activities	Tank desanding, tank cleaning	Tank desanding, tank cleaning	Truck unloading	Tank desanding, tank cleaning	Tank desanding, tank cleaning	Tank desanding, tank cleaning	Tank desanding, tank cleaning	–
Current availability	High	High	High	Medium	Medium	Medium	Medium	High
Currently used on truck tank vapours	One OWMF[1]	No	Yes	No	No	No	Yes	Maybe
Total odours controlled	No	No	No	No	No	No	Yes	No
Targeted compounds	VOC/RSC	VOC/RSC	RSC	VOC	VOC/RSC	VOC/RSC	VOC/RSC	VOC/RSC
Odorous Emission removal efficiencies[2]	>95%	>99%	>99%	>99%	>99%	>99%	100%	Variable
Consequences and additional concerns	Incomplete combustion by-products	Auxiliary fuel required	Waste treatment required	Waste treatment required	Waste treatment required	Waste treatment required	Increased truck traffic	Variable

[1] Oilfield waste management facility

[2] Generally accepted efficiencies

7 References

Clearstone Engineering Ltd. *Final Technical Report: Inventory of Atmospheric Emissions from Heavy Oil Production Facilities in the Three Creeks Area*. Calgary: Clearstone Engineering Ltd., 2015. http://www.northernsunrise.net/include/get.php?nodeid=1417

Kostiuk, Larry, Matthew Johnson, and Glen Thomas. *University of Alberta Flare Research Project Final Report November 1996 – September 2004*. Edmonton: University of Alberta Department of Mechanical Engineering, 2004. http://www.mece.ualberta.ca/groups/combustion/flare/papers/Final%20Report2004.pdf

EPA, Air Pollution Control Cost Manual, 6th Edition (Research Triangle Park, NC: United States Environmental Protection Agency, 2002).