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MEMORANDUM

Petroleum Technology Alliance Canada (PTAC)
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PROJECT #631467

TO:	Petroleum Technology Alliance Canada (PTAC)	**Date:**	April 13, 2016
C.C.:	Anya Gawor, SNC-Lavalin		
FROM:	Piotr Staniaszek, Ph.D. Senior Technical Specialist, Air Quality	**Ref.:**	631467
Subject:	Summary Report of Heavy Oil Management Technology and Best Practices		

There is a growing problem in the upstream oil and natural gas (UOG) industry relating to smells (i.e., odours) being released from sites (from wells, storage tanks, plants, etc.). In March 2014, the Alberta Energy Regulator (AER) published a *Report of Recommendations on Odours and Emissions in the Peace River Area*, which summarized the results of surveys on communities concerns about UOG activities and odours occurring from those activities. One recommendation from the report suggested a detailed study on ways to control odour emissions released from these sites. As such, the *Environment & Geoscience* (formerly, *Environment and Water*) business unit of SNC-Lavalin Inc. (SNC-Lavalin) was asked by the Petroleum Technology Alliance of Canada (PTAC) to review and provide a best management practice on ways to decrease odours from UOG industrial activities.

This project was divided into four tasks:

1. Background on odours and their impacts;
2. Description of technologies that can aid in stopping the spread of odorous emissions;
3. Guidance on how to select the best technology to treat the odorous emissions; and
4. Best Management Practice (BMP) guide for UOG industries.

1 BACKGROUND ON ODOURS AND THEIR IMPACTS

The main chemical groups that supply smell in UOG industries are chemicals containing sulphur (specifically reduced sulphur compounds [RSCs]) and volatile organic compounds (VOCs). RSCs can smell like rotten eggs or rotten cabbage. VOCs are carbon-based chemicals that easily evaporate and spread through air. One chemical alone may not have a strong smell, but a combination of different chemicals may become noticeable. Strong winds that change directions can help the spread of RSCs and VOCs, but can also help lessen the strong smells. One-directional, weaker winds, combined with higher air temperatures (which causes chemicals' evaporation to increase their presence in air) may contribute to odour problems. On the contrary, rain and snow may lower odour detection in the air.

At UOG sites, there are many locations where odour-causing chemicals can be released. These include tanks which store liquids or gases such as "crude oil", wellheads (which are the topmost point of oil wells), dirty water ponds containing chemicals, piping systems, heaters, waste storage piles (e.g. dirty sand with chemicals), transport trucks, etc. Some emissions of odorous chemicals are intentionally released (i.e. vented) as a normal part of the industrial processes. They are coming from specific locations, from a fixed point (stack, vent). The other kind of emissions are unintentionally leaked (i.e. fugitives) through broken equipment, etc. There are also unintentional/intentional odorous chemical releases from large areas, such as landfills (i.e. dirty soil full of chemicals) or treatment water ponds. Such large areas are difficult to prevent emissions from being released into air.

Odours released from vents, stacks (from a fixed point) can be either: i) cleaned and directed back into the process (i.e. recovered), or ii) they can be completely destroyed. Some cleaning technologies include: adsorption, absorption, and condensation. Some destruction technologies include: biotreatment, combustion (burning), and non-thermal oxidation processes (NTOPs).

2 TECHNOLOGIES THAT CAN AID IN STOPPING THE SPREAD OF ODOUROUS EMISSIONS

Adsorption technologies involve the passing of a gas stream containing odorous chemicals through a penetrable material (like activated carbon), in which odour-causing chemicals are captured onto the surface while the remaining gas stream (now clean from odour-causing chemicals) can be re-used in other processes on site. Absorption technology, also known as scrubbing, uses a liquid which dissolves odorous chemicals, therefore cleaning the gas stream. Condensation involves the physical change of the waste gas stream into liquid by reducing the temperature, and making it easier to handle and treat the waste. These three types of recovery units are well known in the UOG industry; for example, absorption units have been used to remove acid gases from heating sources.

Similarly like adsorption technologies, biotreatment technology involves the gas stream passing through material where odour chemicals are trapped onto the surface. On this surface, micro-organisms (e.g. bacteria) destroy the odour-causing chemicals by consuming them. NTOPs use electricity or stream of electrons to change odorous chemicals into carbon dioxide and water. These two destruction technologies are less known in the UOG industry but show great promise from their use in other industries.

Incineration technologies use very high temperatures combined with air or oxygen to burn waste gas stream and the resulting emissions should have less odorous chemicals. Incineration technologies are known in UOG industries and are used according to rules stated by the government.

3 SELECTION OF TECHNOLOGIES TO TREAT ODOUR EMISSIONS

Choosing which technology would be the best to clean gas stream from odorous chemicals is dependent on many conditions. These conditions include:

i) What is the amount of odorous chemicals that can be removed by the technology?

ii) What is the cost of setting up technology at the site?

iii) What is the cost to continually use this technology (e.g. how often to clean the unit, etc.)?

iv) Is said technology is well known by the industry?

v) Can workers be easily trained to use the technology?

vi) Is there need for a lot of space to place this technology on site?

There should also be focus on the gas stream itself:

i) Is the gas stream flowing fast or slow?

ii) Is the amount of odorous chemicals in the gas stream high or low?

In order to choose the best technology for cleaning gas streams, a number scoring for each condition was used to evaluate technology. For example, if technology is new, and not used in this kind of industry, a low number (e.g. 1) was associated with that technology. If the technology is popular and commonly used in heavy oil industry, a high number was assigned (e.g. 4).

Some of conditions can be more important than others, when making a decision which technology to use. For example, cost and how good this technology is to remove odorous chemicals are two important conditions. A second set of numbers was set up to score the significance of these conditions. If a condition was important, it was scored high (e.g. cost assigned a 4), and if condition was less important it got a lower score (e.g. space requirements was thought to be less important and was assigned 1). Obviously the decision on number scoring is subjective at best in that it's the person's judgement and knowledge how to score each condition. By the combination of the above (i.e., importance of condition and technology's qualification to fulfill condition) the following order of which technologies to use first has been recommended:

Adsorption >> Absorption > Biotreatment > NTOPs > Incineration >> Condensation

This number scoring was calculated assuming a common speed of gas stream released from a typical source and the common amount of odorous chemicals in gas. In more specific situations, the ranking order may change; for example, situations where emissions are released at high temperatures. These high temperature gas streams would be treated better by absorption technologies rather than adsorption technologies.

4 BEST MANAGEMENT PRACTICES

Best management practices (BMP) were established to focus on point, fugitive, and area source odour emissions during i) normal operating conditions, ii) unusual/unexpected conditions, or iii) maintenance conditions. When establishing BMP for a specific UOG site, an inventory list should be created, highlighting where the top odour emitters may be. Workers should understand the BMP and keep themselves aware of any unusual smells present on site.

4.1 Normal Operating Conditions

Some BMPs during normal operating conditions include using quality fuel, adjusting process parameters (e.g. temperature, pressure), and applying maintenance, housekeeping, and training plans. Some facilities have direct inspection and maintenance (DI&M) plans in place to address leaking of odorous chemicals from pipelines and other equipment. These DI&M's generally focus on greenhouse gas emissions; however can be for odorous emissions as well. For all equipment, there should be a tracking record highlighting location, personnel responsible, inspection frequency, method of inspection, any repairs performed to control the emissions, and what chemicals does the emission have.

4.2 Unusual/Unexpected Conditions

In events when unexpected emissions are released due to equipment problems, outages, or an increased push in liquid products into the system, the source and cause of the emissions must be quickly found. Some possible sources include doors left open, equipment rusting, valves left open, etc. Some of these emissions can be avoided if proper handling is put into place, including having routine equipment inspections and keeping close watch on delicate equipment during extreme weather conditions (i.e. rapid changes in temperature, high winds, etc.). Some of the source of emissions released during unusual conditions can be repaired immediately. If emissions cannot be stopped at once, using masking or neutralizing agents to hide the smell is possible – noting that these agents may not completely hide the odour.

4.3 Maintenance Conditions

During maintenance conditions, equipment is taken off service. These conditions are scheduled and do not occur frequently. Some examples of maintenance include: tank cleaning, equipment replacements, flaring (burning off waste), or when technologies treating odours themselves need to be cleaned. Ideally, maintenance should occur during cold weather conditions to discourage chemical evaporation into air.

The report goes into more detail about best practices to manage odours at UOG industries, including a more detailed study of different technologies that can be used to treat and find odour emissions. The report also talks about common areas of odour releases on site and findings of two research studies on odour in the Peace River Area.