Smoke Reduction for In-Situ Burning

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A major, 4-year experimental project, funded by the **Canadian Multi-Partner Research Initiative (MPRI)** program is underway at the **Lakeland Emergency Training Centre** in Alberta, Canada. This involves using a catalyst (ferrocene) to reduce smoke emissions from fires of both diesel and crude oil in 2-metre diameter tanks. Ferrocene has been tested, both encapsulated in an inert matrix and dissolved in an accelerant solvent, added to the oil slick, floating on water and on ice. Results are recorded using photographic, video and drone video recording and particulate and VOC emissions are measured using an array of Temtop detectors.

Ferrocene acts by first inducing smoke formation and then burning the so-formed soot through a redox reaction, the solid carbon being converted into gaseous carbon oxides. It is used commercially, pre-dissolved in a fire training fuel (Tekflame) and reduces smoke emissions from a burning hydrocarbon solvent by more than 90%. The goal of the current research and development project is to be able to add ferrocene to an already existing oil-slick, so as to achieve similar results, and be able to deliver this solution to accidental oil spills in the field. At the time of writing, two burn campaigns were conducted in 2023 using diesel and heavy crude oil, a third in in the winter of 2024. The solvent method was tested during this winter campaign using Alberta Sweet Mix crude oil. This was successful from the point of view of demonstrating the effectiveness of the catalyst but this method is not optimal for an actual spill event. The second 2024 test will be in October just after this submission and it will concentrate on the encapsulated ferrocene pellet method with the same crude oil.

One thing that is found to be critical for the encapsulated ferrocene method is that the ferrocene containing pellets must not be in contact with underlying water as this leads to cooling of the material so that it does not achieve a temperature of at least 100°C, the temperature at which ferrocene sublimes, passing directly from the solid to the vapor phase so that it can enter the flame zone. A new system has been devised that will allow the pellets to float on the oil layer while keeping them our of contact with the water. This method will be tested in October 2024 and the information sought will be the quantity of

ferrocene needed using this method for a given quantity of fuel and second, what will be the duration of effectiveness of the method. An advantage of the encapsulated pellet system is that it is possible to add fresh pellets during a burn if the level of smoke reduction becomes insufficient due to exhaustion of the ferrocene.