A LABORATORY STUDY OF THE COMBUSTIBILITY OF AGED OILS

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Energetex Limited of Waterloo, Ontario have been undertaking a study of crude oil and petroleum product combustion for AMOP, details of which are reported elsewhere in these proceedings. A small complementary study has been underway at the University of Toronto to determine if it is feasible to devise a small scale combustion test, using only 100 ml of oil, which will give results from which the burning behaviour of large oil pools could be predicted. Of particular interest are (i) ignitability, especially as a function of temperature, degree of weathering, and water content, and (ii) burn efficiency, i.e. percent of the oil burned.

A small scale test apparatus was devised some time ago with grant support from Imperial Oil Ltd. It has been modified and improved and tested on oil samples obtained from Energetex. The results obtained so far indicate that some degree of correlation may be obtained between this laboratory test and the Energetex large scale outdoor tests but, at the time of writing, it is too early to make definitive statements.

If the test apparatus could be proved, it would be immensely useful and economical as a means of exploring the combustibility of various oils and products at various degrees of weathering and various temperatures and water and ice contents. A sketch of the apparatus given in Figure 1.

It is widely recognized that the combustion process is a highly complex assembly of interacting processes involving the poorly defined oil components in fast reactions, heat transfer by conduction, convection and flame radiation, mass transfer by evaporation and momentum transfer in the highly heterogeneous plume, coupled to poorly understood processes such as

Environment Canada. Arctic and Marine Oilspill Program (AMOP) Technical Seminar, 2nd. Proceedings. March 7-9, 1979, Edmonton, Alberta, Canada, Environment Canada, Ottawa, Ontario, 206-211 pp, 1979.

oil sputtering. No sane person would attempt to represent this process mathematically. For our own amusement, we are attempting to devise such a mathematical model, the results of a early version being given in Figure 2.

1.0 SUMMARY

Two of the projects described here have generally had the objective of developing a better quantitative understanding of the six oil spill processes illustrated in Figure 3, while the third has attempted to improve our knowledge of the burning process. We believe that the development of such quantitative information will be useful in oil spill countermeasures and contingency planning in at least two respects as illustrated in Figure 4. Only if the behaviour and state of the oil is reasonably well understood can appropriate devices or systems be developed for recovery or destruction. Examples are the effect of mousse formation on skimmer efficiency or of weathering on combustibility. Second, the real severity of the impact of oil spills can only be appreciated if we can predict where the oil will go, in what state, and in what concentrations.

It is hoped that the findings of these projects will thus be of some small use in contributing to a better countermeasures capability in the Arctic.

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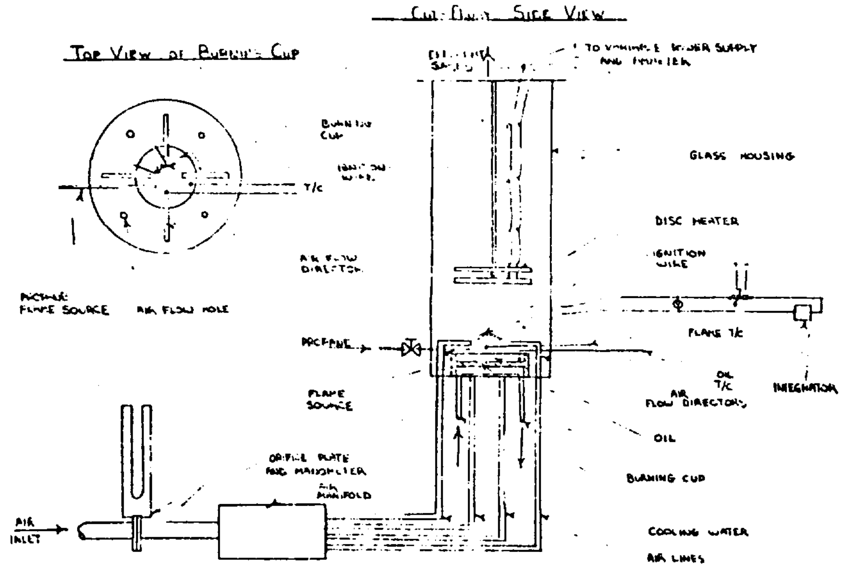

FIGURE 1

SCHEMATIC DIAGRAM OF OIL BURNING APPARATUS

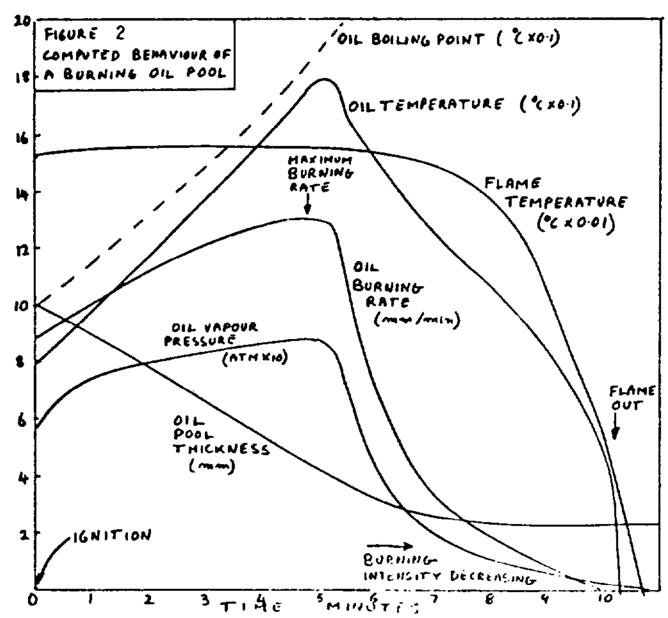

FIGURE 2

COMPUTED BEHAVIOUR OF A BURNING OIL POOL

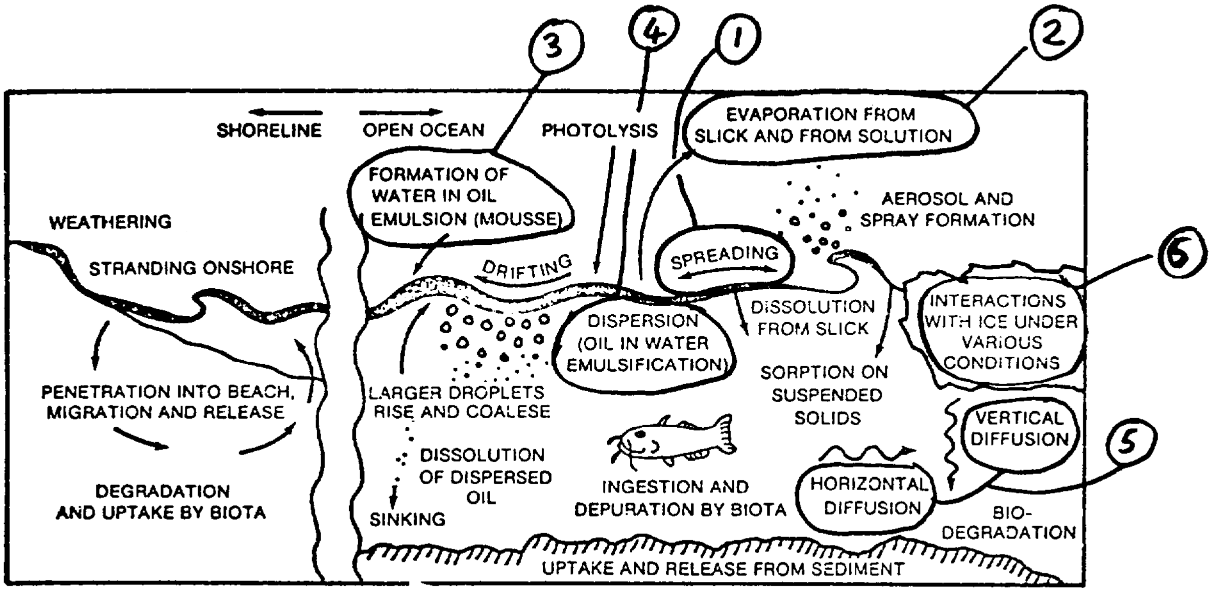

Figure 3

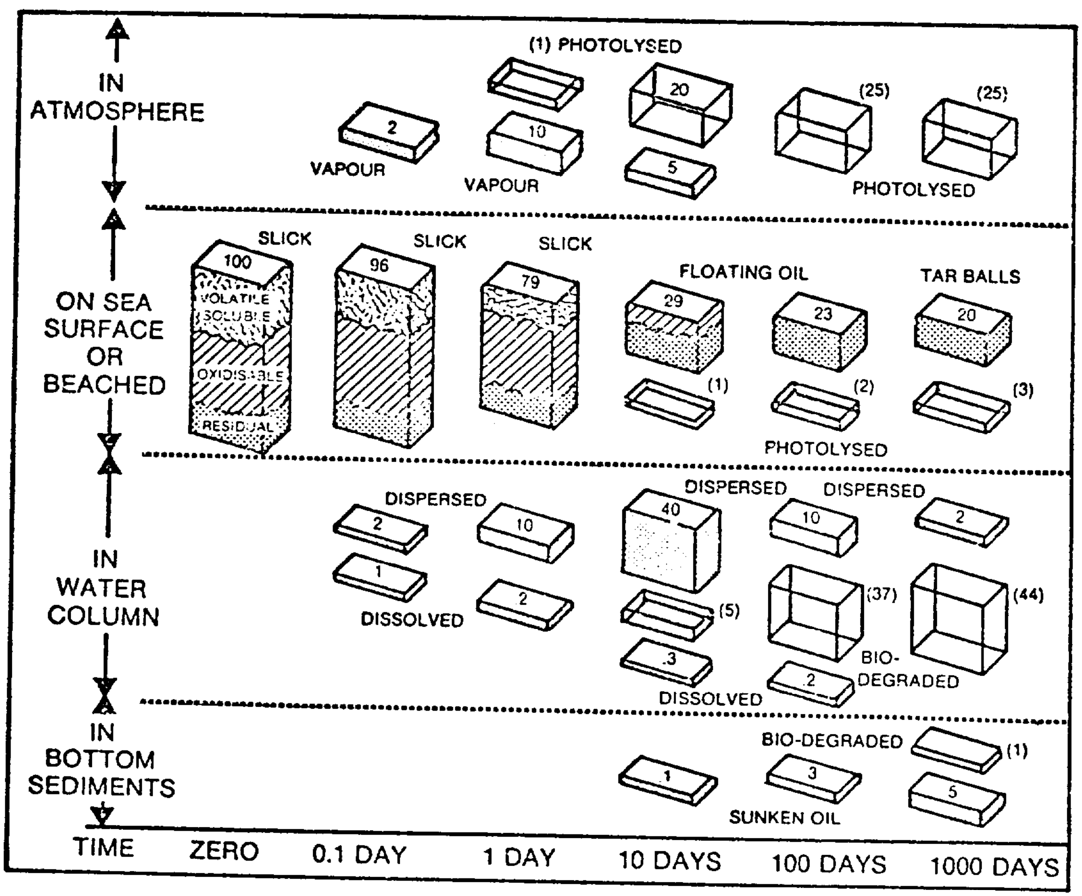

Figure 4

DISCUSSION

Q. This question is not directly related to this presentation but with your experience I would like to ask if you agree with the previous results that there is negligible evaporation losses from diesel with weathering?

A. That is marine diesel. It is not particularly volatile material so I think the results are right.

Q. In your combustion efficiencies, did you measure how much soot there was going up the chimney?

A. We did not, but from some previous work that we had done, we had invented an apparatus and measured that very thing. It is rather small. It is only a few percent of the mass of the oil that ends up in soot, but it looks impressive.

Q. Even with the old weathered crude, there is no difference between fresh and weathered?

A. We haven't done any experiment with the weathered. I don't know.

Q. I was just wondering if perhaps the lower flame temperatures could be partly due to the amount of particulate that is going up?

A. It may be. I think you could argue a strong case for what you are saying because the sputtering process is, I think, one of the dominant mechanisms by which you get soot formation.

Q. Again, with the weathered crude burning efficiencies; could it be in trying to explain your higher burning efficiency that your lighter volatile hydrocarbons, which have already evaporated, aren't really volatile?

A. Well, lighter what? The lighter material which evaporates is by definition the volatile material.

Q. How can you explain your higher burning efficiencies?

A. The higher burning efficiency must be due to some mechanism other than inherent volatile material. There is another explanation we can think of and that is in higher temperatures you are getting coke formation in the oil.

Q. I would like to ask how you defined your burning efficiency? What terms did you use and how did you measure those?

A. Burning efficiency is the mass of oil burned divided by the original mass of oil put into the cup. The mass of oil burned is the original mass put into the cup minus the amount of the oil left in the cup, after the burn is over, we mop up all the oil out of the cup and weigh it and in that way figure out how much was not burned.