To: Ken Sury
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Research Proposal to Syncrude Canada
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The Syncrude project is to be embedded in a corporate effort between Syncrude, the University of Minnesota and the National Science Foundation. The NSF has agreed to fund this at a level of $100,000 per year for each year of three under their GOALI initiative (Grant Opportunities for Academic Liasons with Industry). Three other partners are Stimlab (Duncan, OK), Dowell-Schlumberger and Intevep. Syncrude can choose whether or not they wish to have interactions with other partners. Intellectual property agreements between Dan Joseph and Syncrude will not be compromised. We need supplemental industrial funding, to which all partners have agreed in principle, to finance the research. The university overhead and fringe rates raise the costs by over 3/2. I prefer to have industrial contributions in the form of unrestricted research gifts to Prof. Dan Joseph. These gifts do not carry overhead; $90,000 to the University is the same as $60,000 to me. Gifts have been given to me by other companies. I am including a sample letter of a gift from Hoechst Celanese. In any case Syncrudes' money will be greatly leveraged by the NSF and we do very good research cheap.

Overview of projects related to self-lubrication of bitumen froth

1. Factors governing water release

   We know that there is a critical velocity for water release leading to lubricated flows. We have conjectured that the release is related to a critical shear stress. The underlying fundamentals for water release leading to self-lubrication need further study.

   It is necessary to vary froth speed, composition, temperature and pipe diameter at the border between lubricated and non lubricated flows. These factors, which should enter to understanding of the fundamentals are just the parameters which enter into control of start and restart and are basic to the operation of froth pipelines.

2. Test facilities

The studies will be carried out in our 1 inch pipeline. We need information on scale up. We want to consider setting up a 2 inch and 1/2 inch pipeline for scale up studies. Perhaps a small facility could be set up in Canada.

We intend to equip our pipeline with an observation sector at the pipe inlet where lubrication is formed and the conditions of lubrication are most severe. It would be useful to examine viewing sections at different locations.

Many useful studies of froth can be carried out between rotating cylinders and parallel rotating plates. These batch studies do not require large amounts of froth, are easy to control and give rise to precise measurement of flow properties.

3. Determination of the effective thickness of the lubricating layer

The effective thickness is related to the amount of free water released. We need to know how the amount of free water varies with froth speed, composition, temperature and pipe diameter. We propose to create a data base for free water from experimental measurements on our 1 inch pipe. The free water studies are important for understanding of shear induced release and for the determination of optimal conditions for lubricated transport.

4. Study of wave structure on the froth core

The waves (Tiger waves) on the froth depend on the flow speed and the amount of free water. The wavelength is shorter when the wave speed is larger and when more free water is liberated. Maybe we can find a way to predict the amount of free water from observations of the speed and amplitude of waves.

5. Study the effects of water addition on self lubrication

I think we should try to know more about how injection of top water effects self lubrication. This kind of knowledge is needed for restart under difficult conditions.

6. Remedies for fouling

We would look at wall treatments and materials of pipe construction which resist fouling, as we did in the past with cement lined pipes. We have not tried clay pipes, though we know that clay is highly oleophobic. Clay pipes and clay water might have good synergy; small sections of a pipeline at greatest risk for fouling could be made of clay or with clay linings.

The problem of fouling is more severe with heavy crudes than bitumen froth. We could think of collaborations with Intevep in this area. It would be of interest to see if clay water would reduce fouling of Venezuelan crudes.

First-year research projects (4/1/97-98)

The three projects listed below are submitted to Syncrude for consideration for the first years' work.

1. Modification and improvement of the test system for the 1" pipeline (3 months)

    a. Maintenance of Moyno pump: change the stator (maybe rotor) and the sealing packing.

    b. Modify test system for loading and unloading froth, clean the pipeline and cover the top of the supply tank. These changes must be done for environmental health and safety, but they can also reduce the waste of froth.

    c. Add a cooling system to control the temperature of the test system. We need an additional tank for storing ice or cold water. If the temperature in system is too high, we turn off the heat and pump cold water through the heating system.

    d. Equip the pipeline with glass or plastic glass sections at the pipe inlet where lubrication is formed and the conditions are most severe. We will examine viewing sections at different locations for each fixed flow speed.

2. Experiments to correlate the pressure gradient, flow rate, free water and wave structure of lubricated flows in the one inch line (9 months)

    We want to create an extensive database for flows with different pressure gradients and flow speeds by systematic variations of the temperature and froth composition. We need to know how the free water correlates with flow speed to get a handle on the mechanism of water release under shear.

We believe that the wave structure is important here and we want to create data in which the flow speed, free water and wave length and structure are measured for each value of the pressure. The wave parameters can be measured with our high-speed video system. It would be desirable to create this data for high and low temperatures, at least, and for relatively dry and wet froths.

3. Study the critical shear rate for water release between rotating cylinders and rotating parallel plates.

   We would like to build something inexpensive to do this kind of batch testing. The idea is to determine if and what kind of useful data can be obtained from modest equipment. We may evolve a froth tester from this work and it should serve us well in our study of the mechanism of water release.

   As usual, the plan proposed may and probably will be changed as dead ends and good opportunities come into evidence.