DAN JOSEPH: MONDAY NOV. 25, 1996

This is a report of my meetings with INTEVEP's people working on cementing and gas lift on the afternoon of Monday Nov. 25, 1996. The time I had available for these meetings was too short.

CEMENTING

I met with Doris Pestana and Armando Blanco, who were on their way to the airport. We had no time to go deeply into their problems, however I got the impression that their major problem has to do with the Rayleigh - Taylor instability when heavy liquid is above a light one. They have a much better understanding of their problems than when I visited them last, two or one year ago. I am on the lookout for good papers. I think I sent the paper by Signier and Bakhtiyarov, which is cited below, to Mayela, but Pestana and Blanco did not get it. They probably should have this reference.

ESP'S and GAS LIFT

I met with Escalante, Pessoa, Caicedo, Marcano, Manzanilla and Hernández about gas lift for forty minutes, but we got a lot done. I think that is a fine group of young people who could do excellent works and can profit greatly from strong leadership. Three problems were discussed.

1. SUBMERSIBLE PUMPS.

Evidently these pumps are rated for water but they have to pump oil and gas. We confronted, perhaps an allied problem, in pumping Syncrudes froth. I don't know which pumps are submersible and how they operate. It is characteristic, unfortunately, at INTEVEP that there is lack of communication between different groups and people with overlapping interests and skills. The first thing that the submersible pump people should do is find the best local experts on pumps in the company. For example, Emilio's extensive background on two-phase flow pumping might be useful. Probably the problems with submersible pumps have been met before and the solutions of these problems are out there to find without doing new research.

2. RHEOLOGY OF MIXTURES OF DILUENT, CRUDE AND GAS DOWNHOLE.

The problem is that it is too hard to measure rheology downhole. I would try to develop a small down-hole simulator, which could be used for testing in the lab. It is worthy to make an effort to get flexible measuring instruments to do repeated measuring at low cost. Maybe oil companies have a lot of money and don't encourage workers to look for creative low cost solutions.

3. FALL BACK IN INTERMITTENT GAS LIFT

Evidently when a gas slug is initiated to lift oil, some of the oil falls back at the wall. I am not certain, but this may be considered to be a form of fouling. The phenomenon could be framed as transient hold-up.

A man whose name I forgot (he seemed to be a group leader) has an idea, which I like very much. He wants to put kerosene (intermittently?) on the top of the oil slug to initiate lubrication of the oil with kerosene - coreflow. The ease of lifting could be increased by orders of magnitude if the oil slug can be put into core flow. I guess the cost would go way down, less gas is required and the rate of lifting enhanced greatly. This could be a BLUE SKIES business opportunity. We have to see if kerosene (or any other diluent or mobile liquid) will wet the carbon steel lining better than the oil. The options to use surfactants or polymers to help in lubrication are also open. I will remain excited about this idea until and unless I see that it doesn't work or is too expensive.

Generally speaking, you can't lubricate oils with viscosity less than 500 cp: the more viscous the oil, the better is the lubrication (except for fouling). I think that the chances of getting a preferential wetting / lubricating fluid will be increased greatly if we can use diluents.

We should build a gas lift apparatus in the lab. For example, I can imagine first trying a 1" diameter, 4' tall pipe made out of PVC or glass to see what's going on, and to have some fun. PVC would be cheaper. Eventually we would look for gas lift simulator out of materials like the ones used in the field.

SOME OBSERVATIONS

The kind of technical review I did could be useful because it gives the working researcher the idea to look outside, the reviewer should encourage researchers to look to find help inside the company increasing communications. In general, people everywhere, and INTEVEP's also, are looking for a "big daddy" to help them out; in our case, numerical simulations are like a "big daddy". Ultimately, to use math, we have finally to compute, but it is important to teach "garbage in - garbage out". You can't replace ideas with computations. I noticed that the researchers at INTEVEP may go for big equipment, like in the field, in cases where small and sometimes cheap bench top models would be better. Another point is that INTEVEP ought to acknowledge the need for a dedicated team of two-phase models to educate everybody in fundamental approaches using also data obtained from easy experiments. I know Mayela is thinking along these lines. Perhaps it would be a good idea to develop some short courses inside house. These courses, with a change of emphasis, should be given regularly, but not too frequently. They have to be tied somehow to ongoing INTEVEP's problems or otherwise be constrained from becoming overly academic. The time spent in such courses should be valuable to the company and to the researcher's career advancements. Otherwise you can waste people's time. I guess it is worth the effort to develop this at least to the point where we know what's out there of use to us. Then we would have people trained to look at the models behind the numerical packages they hope to utilize. Some kind of educational initiatives maybe required to transform INTEVEP into a technology driven business.

VISIT TO THE DRILLING MUD FLOW LOOP ON NOV. 22

Lirio, Gustavo and I visited this facility and tried to understand how this loop could be of value for drilling mud applications.

The loop is presently envisaged as very large scale viscometer for measuring the flow resistance of different mud. The loop can be run through either 2", 3", 4", 5", 6" or 7" pipes. All the pipes are perfectly horizontal. There is a huge mixing tank. The pipes are the same size as those used in the fields. Maybe it would make more sense to study full scale effects in the field.

The facility must be very expensive to operate; this will surely discourage experimentation which can be carried on in a much smaller facility.

The rheological information which can be obtained from this loop is routine; basically this type of information can be obtained from more standard rheometers and small scale flow loops. Flow resistance measurements and the properties of different muds do not require such expensive testing.

This flow loop is not set up for studies of cuttings' transport and hole cleaning, which are among the principal issues for controlling costs in drilling. For such studies, tilted pipes are required. It would very expensive to modify this loop for such studies and even if it could be modified, the resulting facility would be greatly over sized.

The building and some of the equipment there might be used for other studies which give value for money. I don't see any good reason to do the expensive testing which was planned for this facility. On the other hand, it would also be very expensive to dismantle the loops. One option is to leave the facility inactive until such time that a good use for the building and equipment is proposed.

Moving this facility to Tia Juana will not make it more useful. Such a move is likely to be a waste of money too.

DISCUSSION WITH JORGE ROBLES ON ARTIFICIAL LIFT ON FRIDAY NOV. 22.

We met for about two hours; I think this dialogue may have been useful. We discussed three problems.

1. PROGRESSIVE CAVITY PUMPS.

Jorge wanted to know if the pressure drop of oil and gas moving though the eccentric space between a rotating eccentric rod and fixed inclined pipe could be determined theoretically (Fig. 1). This is a very simple problem for a single phase flow which may be in the literature but, in any case, can be easily calculated in a few days by Mariano. Jorge and Mariano should get together for this problem. The viscosity of the oil and gas should be measured rather than computed.

Note added on 3/13/97. Now I see that this is complicated because it’s two phase flow. We need to know the flow type (see Taitel-Duedler flow charts).

2. GAS ANCHORS.

The question Jorge asked is how to determine when the oil velocity down the annulus is small enough so that the drag from the oil will not pull down buoyant gas bubbles (Fig. 3a). We want the gas bubbles to rise and separate. To study this separation problem, Jorge proposed the rather complex apparatus shown in Figure (2)

I don't think it is a good idea to build expensive equipment until we understand kind of value for money will yield. In every case, is better to do some preliminary studies using small equipment in which the geometry and control parameters can be readily and cheaply varied.

For this case, we should discuss building a slit separator with the same plan form as in Figure 3. but maybe 1/4" thick.

We got good results with a slit reactor of this type in the thesis work of Jose Guitian because we could see everything. I don't know if we can see through the oil Jorge needs to study. In the worst case, we could look for a see - through oil substitute.

In such case, you could see the bubbles rise and see if they are large enough, deform much and get a good idea about the drag. Of course you would have to think how to factor away the effects of closed walls, but you could change the relative sizes of the operating parts cheaply and get a hands-on understanding of the main effects.

3. **SUCKER ROD PUMP** (cartoon in Figure 4).

The problem seems to be associated with the down stroke of the pump, due to high viscosity. One solution is to have the rod in a mobile low friction liquid. This can be and is done with the packer in Figure 5. Evidently this has some problems which Jorge doesn't like. The packer being used is fixed downhole. I wondered why the rod wasn't like a bearing as in Figure 6. I would like to understand this better. Its probably hard to find incremental improvement to such an old technology.

MEETING WITH MIGUEL FORD & PEDRO ACUÑA, NOV. 25, 1996

We discussed two topics

1. Drill string performance.
2. Novel drilling muds: Foams and aerated muds.

Drill String Performance:

Evidently improved performance has been achieved in reducing drill string failure by implementing procedures of DS-I from Tom Hill Associates (Metodología Adios).

There are still too many failures which are associated with particular features of formations and procedures encountered in VZ drilling practice.

The VZ geological formations are very complex with shale, limestone and other strata all together. Vendors assume 100% formulations; for example they tell you how to drill in shale.

We agreed that it would be useful if we could find a consultant or company to look for criteria to guide Intevep and affiliates workers on particular problems that belong to VZ practice outside the usual API and statistical standard.

I am going to look for good consultants to address this problem. I have already talked to Paul Paslay, who recommended a retired expert, Roy Castor, from Shell who has his own company. Also, Ken Nolte from Dowell-Schlumberger helps me with these kind of problems. We will get information on potential consultants and we could discuss their potential for helping us to get the knowledge we need for the resolution of special drilling problems. I guess a well educated, but very practical person is required.

Foams and Aerated Muds:

They are using the MUDLITE model for foams rhreology. The rheology of foams is very complicated and good rheological models are very much in demand. I am going to work on this with Mayela. We have to develop some good internal tests for MUDLITE; it may not hold up under evaluations.

Foams and aerated muds are aggressive and mechanical MWD (Measure While Drilling) tools used in more benign muds don't work. At present, an electromagnetic MWD is used for these aggressive muds. The electromagnetic MWD don't have a pressure sensor which we need to measure downhole pressure. The solution for this is simple: get a vendor to design such a sensor or we do it ourselves and maybe patent it for license.

BLUE SKIES IDEA FOR NEW BUSINESS

Here is a proposal for downhole creation of foaming muds from aerated muds I am going to call it "Aerated Muds A Bubbly Mixture"; In fact, it is a bubbly mixture since the mud is aqueous and has a low viscosity (15 cp), so the air bubbles will rise rapidly in a still mud.

José Guitian (and I) in his thesis and in some papers circulating in INTEVEP studied how foams form the above bubbly mixtures when the gas velocity is high enough. Here is the foaming criterion:

$$aU_l = bU_g + C$$

U_l	superficial liquid velocity
U_g	superficial gas velocity
a, b, c	depend on the surfactant.

When U_l is large, there is no foam. Increase U_g to a critical value; then foam appears at the top of the reactor, like the head on beer. Increase U_g more, holding U_l fixed; then more and more of the reactor is consumed by foam (Figure 7).

We could foam aerated muds downhole in the same way (Figure 8).