Ö. Savaş, ME-UCB May 30, 2010

Kink Spill Flow Observations

I have spent the last two days looking at the videos I downloaded from the `ftp` site. I tried numerous players. In particular, the accelerated play feature of `VLC Media Player` was quite helpful. The figure below summarizes my observations of the discharge flow pattern at the kink. I captured a random image and annotated it to describe my observations. I suggest that you play the videos at 4× speed to better observe the patterns sketched in the figure.

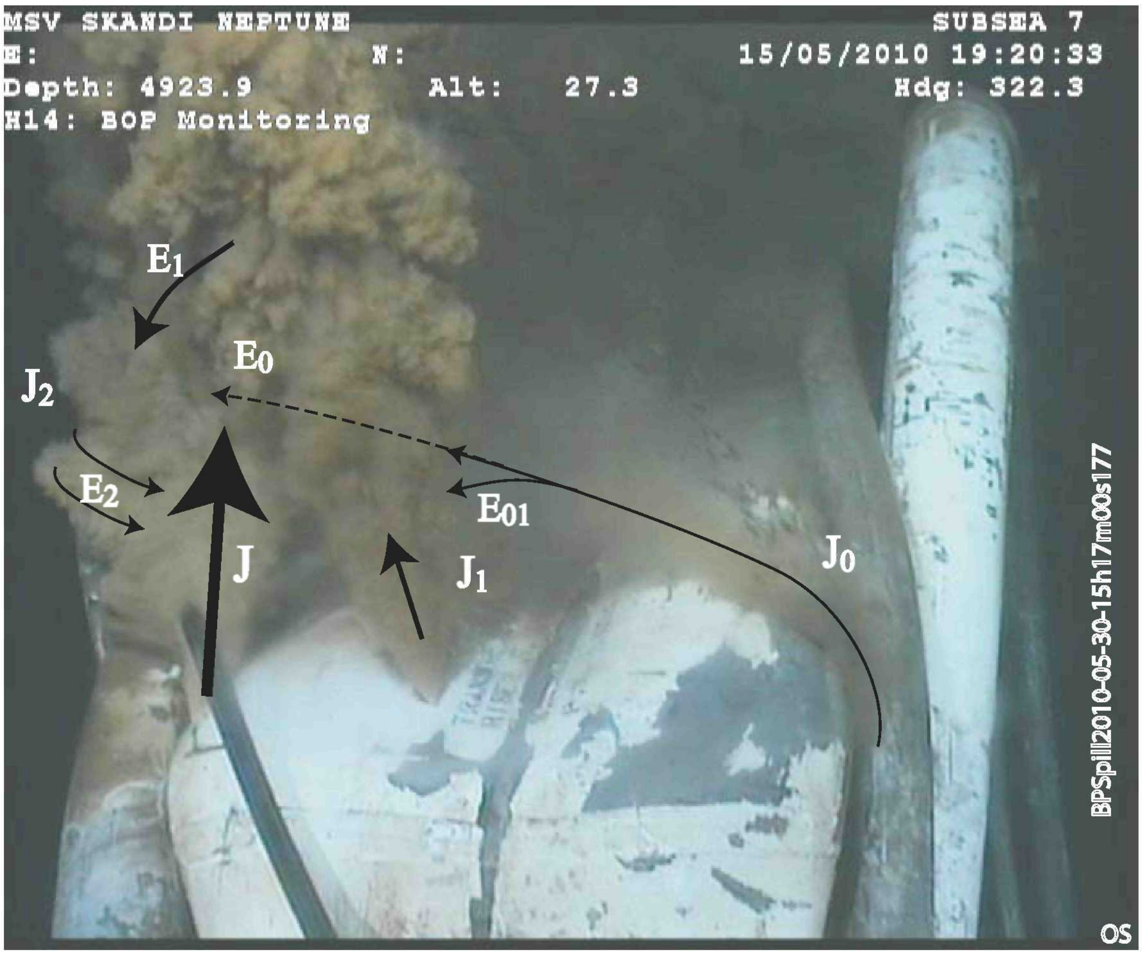

Figure 1: Discharge flow field at the kink. J-jet, E-entrainment.

The flow field has one very clear, classic turbulent jet, J_1. Then, there is the faint stream of discharge coming from the underneath of the buckle, labeled J_0, the origin of which is evidently under the bend. On the right side of the picture, I marked as J what I consider to be the main discharge jet which seems to be pointing away from the picture. There seems to be a fourth jet J_2, obscured by J, which seems to be discharging somewhat toward J, but slightly to its left.

Thus far, we have focused almost exclusively on J_1, and partly on J_0, including myself. For example, I now see that my estimate of the cross section area at the discharge point of J_1 may be tenuous. J_1 shows all the characteristics of a classical turbulent jet e.g. linear growth, sharp intermittent interface. Fortuitously, the weaker jet J_0 acts as an exquisite marker of the entrainment field of J_1, marked as E_{01}. I propose that we use our PIV measurements to estimate the entrainment velocity at the *edge* of J_1. J_1, however, oscillates back and forth, an at times its plume is entrained by J, behind J_1. I have marked this entrainment as E_0.

There is strong inflow at the left edge of J, marked by E_2. This is especially clear when the video is paled at high speed. I am thinking that the fluid in E_2 is the plume of a jet hidden from the view, yet I marked as J_2. Velocities in E_2 seem to be much higher than in E_{01}. Lastly, the plume of J_1 itself is being entrained by J!, which may be observed at the upper regions of the flow field.

Based on my observations of the relative velocities in the entrainment fields, I conclude that

$$J \gg J_1 > J_2 \gg J_0.$$

We can quantify the relative strengths of J and J_1 by comparing our estimates of the entrainment velocities at their edges. This will pose some challenges for E_2. A relative comparison of the gas/ liquid ratio of the two is also needed since they J is lighter colored than J_1, indicating gases in J.

If quantified, these observations suggest that our estimates must be revised substantially upward.