Second spin Casting test - December 17th,2004

A second test was conducted to look at how the introduction of powdered graphite into the molten paraffin before spin casting would affect the final product.

In our previous fuel grains we used a small percentage of graphite as an opacifier. The grains were cast in place in the liner using a mandrel to create the central port. This worked fine. We had some concern that if we used spin casting for our grains that the graphite might separate out of the paraffin and and go to the outside of the fuel grain due to it's higher density.

This was found to be true in this test. The above picture shows a much higher graphite concentration near the outer walls of the fuel grain. The graphite concentration decreases as we move in towards the port of the grain. The distribution of graphite does not seem to be a linear distribution, but in this particular test there almost seems to be 3 discrete regions. A black band, a grayish band, and a white band...not sure what to make of this.

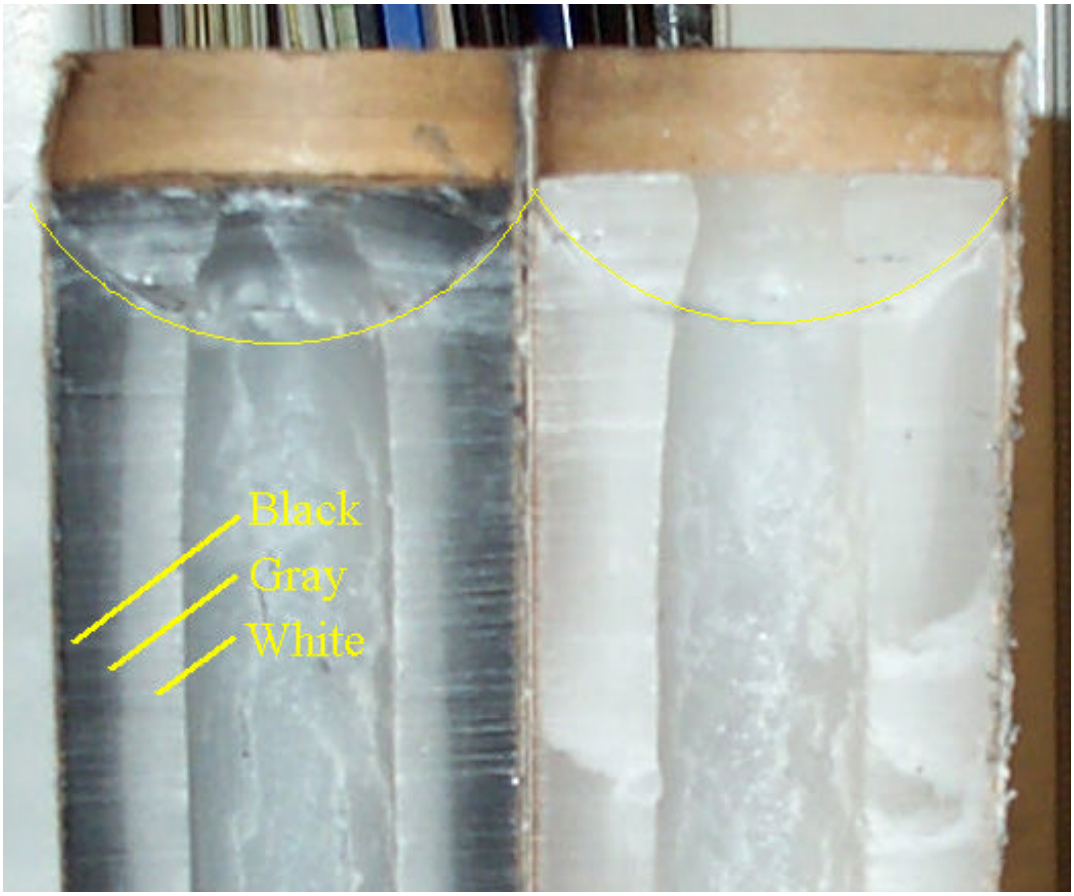
The overall integrity of this grain is much better than the first grain. The first grain had many cracks in it. This may have been due to an apparatus tail stock adjustment midway into the cooling cycle that could have caused cracking in the partially solidified grain.

This most recent grain pictured above only has minor interior surface cracking that probably does not exceed 0.05 inches in the worst case. The only other crack is a major fault line at one end of the grain. This domed or semi-conical portion of the grain actually came out when the end plugs were being removed. An identical fracture occurred on the first grain but was thought to just be a random crack in the paraffin that was aggravated by the act of cutting the grain in two.

As can be seen in the following picture the faults are in the same position in both cases.

In both cases, this is this region of paraffin is in contact with the aluminum plug that is on the motor end of the spin caster. We will perform another test and see if this happens again. It may have something to do with the nature of the cooling of the grain near the plug or it may have to do with the disassembly of the grain holder after cooling has occured.

The dome region and the striation of the graphite can be seen a little more clearly in the following picture.



More attention was paid to the exact volume of paraffin that went in to the grain this time and our shrinkage was determined to be 15.8%

The grain was spun for 2 hours and 30 minutes at 65 deg F, at a still to be measured RPM.

Calculations :

$Grain_{OD} = 1.75in$

$GrainLength_{initial} = 4.90in$

$GrainLength_{final} = 5.18in$

$GrainPort_{avg} = .79in$

$$Volume_{liquidparaffin} = \left(\frac{\pi \cdot Grain_{OD}^{2}}{4}\right) \cdot GrainLength_{initial}$$

$$Volume_{liquidparaffin} = 11.786\,in^{3}$$

$$Volume_{solidparaffin} = \left(\frac{\pi \cdot Grain_{OD}^{2}}{4} - \frac{\pi \cdot GrainPort_{avg}^{2}}{4}\right) \cdot GrainLength_{final}$$

$$Volume_{solidparaffin} = 9.92\,in^{3}$$

$$PercentShrinkage = \left(1 - \frac{Volume_{solidparaffin}}{Volume_{liquidparaffin}}\right) \cdot 100$$

$$PercentShrinkage = 15.829$$