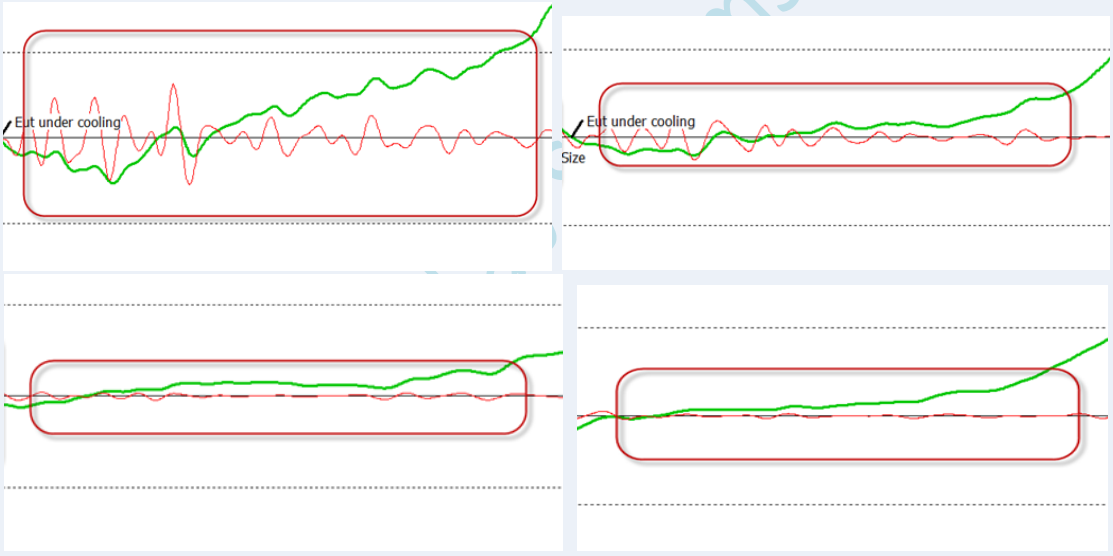
Discovery

When Galileo first invented the microscope and the telescope, he alone saw what no one else had seen before. Likewise, with MeltLab being able to look with fine detail at thermal analysis curves, we have found new and exciting things that no one had expected before. This Hot Topic is about how quietly or how noisily graphite forms in a ductile iron sample, and likewise in grey iron. While there are different views of whether nodules form between dendrite arms or in austenitic shells, most agree that spheroidal graphite grows through diffusion, as opposed to the graphite flake that grows out into the liquid through the interface. And what about the in-between state of vermicular graphite? One would guess that it would grow faster than spheroidal graphite but slower than flake graphite.

Could that difference in growth rates be seen under a thermal analysis microscope? Take a look at the four curves below showing the rate of cooling curve and the 5th derivative. The dotted line is 1 degree F for the green rate of cooling curve and 1/100th degree for the light red 5th derivative.

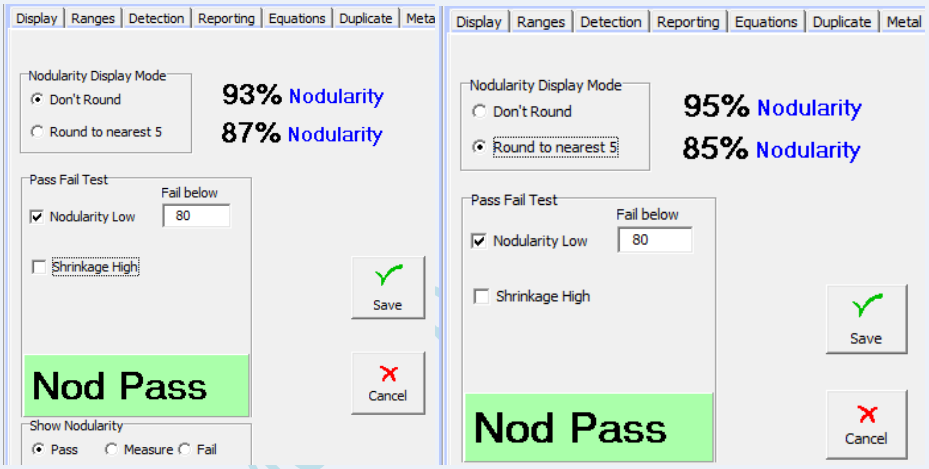
5th Derivative Noise in Final Ductile Iron – about a 2 minute span



Which do you think has the better nodularity or diffusion growing graphite opposed to rapid growing vermicular? Visually you can see the difference, but there has to be a standard by which to measure it. You will notice that the red curve cycles around the solid zero line. Since each line is composed of 9 readings per second, what we have done is take the individual points and calculate a standard deviation during the part of the curve enclosed by the red box. This gives us an average measure of the 80%, 85%, 90% and 95% nodularity curves shown above. The values increase rapidly as you move from 90% nodularity down to 80% and lower. We use a log form of an equation to try to fit the graphite noise to the nodularity.

Some of the tricks we have to do to get this to work include:

- The iron must be fully inoculated as the castings will be. You can't compare partially inoculated iron with fully inoculated castings. This can be a problem with in-stream inoculation. But, if the sample cup is inoculated properly, the iron will behave as a fully inoculated iron.
- Care must be taken to properly fill the cup. Under-filled cups will have trouble detecting the starting and stopping points of this measurement.
- The wiring must be shielded from electromagnetism, or else your nodularity will drop every time you turn the furnace power on.
- Finally, the smoothing level should be set and not moved once the equation is set up. There is a little judgment factor in the equation as some foundries differ on what is an 85% and an 80% nodularity. This adjustment is left to the customer. The usual cautions should be taken to measure the nodularity in the middle of the sample away from defects and skin effects.



Other options include rounding or not rounding results and setting a Fail below limit to warn of poor nodularity. Please remember, this is a quick test, and though a very good one, if you get a fail message, you should hold and sample the castings from that treatment. The human, not the machine, should be the last judge. With the use of this technique, your foundry should be able to steer away from trouble before it happens.

Though we haven't done much testing in Grey, we have seen similar differences between well inoculated grey and poorly inoculated grey. But even good grey iron is much rougher that a ductile iron, so the equations need to be adjusted. We are open to working with foundries that want to look at that more. Give us a call if you are here in the States, and we can arrange for a day of testing and verification.