INTERPRETATION AND APPLICATION OF SAND LABORATORY TEST RESULTS – WHAT THEY MEAN IN THE FOUNDRY

PRIORITY OF SAND TESTS

1. Screen analysis – screen distribution and AFS grain fineness number

About 90% of a mold is sand, so the base sand screen distribution is very important. In most iron foundry green sand systems, the ideal screen distribution would be a four screen sand (at least 10% or more on four adjacent sieves), with a minimum of 10.0% on the 140 screen. The amount on the 140 screen is important for casting finish. Most aluminum and brass foundries run even higher on the 140 screen.

2. Compactability

Running compactability is a must. Compactability measures the relationship of the water absorbing materials in the sand and the amount of moisture. The water absorbing materials in the sand include bentonites and other types of clay, cereal, wood flour, seacoal, other sand additives, AFS clay, and excessive fines (U.S. Sieve #200, #270, and pan).

Automatic molding machines such as Hunter or Disamatic generally prefer a compactability range of 35 to 40 at the molding machine, occasionally going up to 42. Large cope and drag molding will generally require higher compactability numbers, usually in the 44 to 48 range, but occasionally up as high as 52.

The compactability number can be affected by a number of things. Here are some examples of how you can raise or lower the compactability number.

a. You can raise the compactability number by raising the moisture content, without changing the clay content, or decreasing the clay content without changing the moisture content.

b. Hot sands influence the compactability number. In a sand system where the sand is very hot, you may have a compactability reading of 50 coming out of the muller, yet the molding station will have a compactability number of less than 40. Any time there is more than a 10 point drop in compactability between the muller and the molding stations, chances are that there is a hot sand problem.
3. **Methylene Blue Content**

This is a measurement of the actual bentonite content in a molding sand system. This is not the most scientific test, but it is the best one we have available.

4. **Moisture Content**

This test measures the actual moisture content of the molding sand.

These first four (4) tests determine every other sand property, so they are the basic building blocks of a sand system. The screen distribution of the sand system, the compactability, the methylene blue, and the moisture content determine what the green compression strength, green permeability, dry compression strength, muller efficiency and dry and hot compression strengths will be. Control of these four tests will control the physical characteristics of your sand system, with the exception of the combustibles content.

5. **Loss on Ignition**

The loss on ignition is the amount of combustible material in a molding sand. The test is run by placing a dry sand sample in an oven at 1800°F Fahrenheit for two (2) hours. Seacoal, cereal, wood flour, seacoal replacements, gilsonite, lignite, and other organic materials show up on the loss on ignition tests. Ideally, loss on ignition should not exceed 6.5% in an iron sand system. The gray iron or ductile iron foundry should also be running the volatile combustible material, which is a measurement of the materials that come off at 900°F Fahrenheit when placed in a furnace for one (1) hour. A good casting peel in iron foundries is usually obtained when the VCM is kept at a minimum of about 1.7%.

6. **Green Compression Strength**

The green compression strength of a molding sand is measured by making a standard 2” x 2” specimen and placing it in a Universal Sand Strength machine, then compressing it to its rupturing point.

Numbers on green compression strength can vary all over the map depending on the type of molding machine used. However, almost everyone is running green strengths in the 20’s these days, with most automatic machines running between 25 and 30 PSI.

Green compression strength is greatly affected by mulling. If all the sand properties are correct and the green compression strength is not there, it means that the mulling is insufficient.

7. **Permeability**

The permeability number is a relative number that measures the “venting ability” of the sand. The primary influence on permeability is the sieve analysis of the molding sand. The higher the fines, the lower the permeability.
8. **Dry and Hot Compression Strengths**

Dry compression strength is measured by using a 2” x 2” sand specimen, and drying it in an oven for 220° Fahrenheit. It is then put on a sand strength machine similar to a green strength specimen.

The hot compression strength is done with a 1” x 2” sand specimen in a dilatometer at 1800° Fahrenheit.

The dry and hot compression strengths are influenced by the type of bentonite being used. Western bentonite has higher dry and hot compression strengths then southern bentonite. Dry compression strengths and hot compression strengths can also be increased by increasing the temper water in the molding sand (or the compactability). Dry compression and hot compression strengths are drastically reduced by adding organic materials.

The following is a list of sand properties followed by what happens when that property is too low or too high.

**Compactability**

When low: Loose sand, friable mold edges, cuts and washes, inclusions, broken molds.

When high: Burn-on, sticking to the pattern, pinholes, poor shakeout, blows, poor casting dimensions, expansion defects.

**Methylene Blue Clay Content**

When low: Broken molds, cuts and washes, poor draws, burn-on, expansion defects.

When high: Poor shakeout, swells, poor casting dimensions.

**Combustibles**

When low: Poor casting peel, poor finish, poor shakeout.

When high: Pinholes and other gas defects, high smoke, brittle sand.

**Green Compression Strength**

When low: Broken molds, poor draws, crush.

When high: Poor shakeout, poor casting dimensions, and poor flowability.
Dry Compression Strength

When low: Loose sand, cuts and washes, friable mold edges
burn-on and metal penetration, inclusions, erosion.

When high: Hard shakeout, loss of returned sand.

Screen Analysis

When too coarse: Mechanical metal penetration and poor casting finish.

When too fine: Pinholes, blows and other gas defects.

Friability Test

When too Friable: Dirt & Erosion Defects, Systems of high core sand influx

0-10% Adequate
over 10% Erosion, Inclusion defects

Cone Jolt Toughness

A measure of bulk brittleness

0-30 Jolts: Brittle, difficulty pulling deep pockets
30-50 Jolts: Borderline
over 50 Jolts: Adequate