

“What Do The Sand Testing Numbers Mean”

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Minimum Sand Testing Program

Two categories for green sand testing:

1) to check the consistency of the prepared green sand.

2) to determine if the green sand has the physical and chemical properties to produce good castings.



Daily Testing

- **Compactability**
- **Moisture**
- **Specimen Weight**
- **Permeability**
- **Green Compression Strength**
- **Dry Compression Strength**
- **Methylene Blue Clay Content**

Weekly Testing

- AFS or 25 Micron Clay Content
- Screen Analysis
- Total Combustibles (LOI)
- Volatiles at 900F (482C)
- Available Bond
- Working Bond
- Muller Efficiency

Compactability of Molding Sand Mixtures, Rammer Method AFS 2220-00-S

Purpose:

- **To determine the percentage decrease in height of a loose mass of sand under the influence of compaction.**



COMPACTABILITY

- Tells you how wet or dry the green sand is
- Controls the most green sand defects

SIGNIFICANCE OF COMPACTABILITY

- **Directly related to the performance of the green sand in the molding operation and reflects the degree of temper of the green sand.**
- **It duplicates how fixed volume of green sand will react to a fixed energy input.**



COMPACTABILITY

Select a compactability level high enough to avoid:

- **Cuts and washes, friable broken edges, hard to lift pockets, cope downs, crushes, penetration, burn on, erosion scabbing.**

COMPACTABILITY

Select a compactability level low enough to avoid:

- **Oversize castings, shrinks, blows, pin holes, super voids, poor finish, expansion defects, gas and rough surfaces, shake-out problems, high ramming resistance.**

Moisture Determination, Forced Hot Air Method AFS 2218-00-S

Purpose:

- **To determine the percentage of moisture in the molding sand.**



MOISTURE

- Control water or temper water
- Hydration of the binder composite
- Coating of the sand particles
- Muller efficiency, working bond, available bond
- Effects all other green sand properties, most abused ingredient in green sand
- Direct correlation on compactability

SIGNIFICANCE OF MOISTURE

Moisture in molding sand develops the plasticity of the clay bond, which controls most sand related defects.



SIGNIFICANCE OF MOISTURE

Moisture content of a green molding sand is not an arbitrary number, it must be maintained within a narrow range.

The two major factors that affect the moisture requirement are:

- the type and amount of clay**
- the type and amount of additives in the green sand mix.**

SIGNIFICANCE OF MOISTURE

Excess water

- **Produces an oxidizing atmosphere in the mold**
- **Excess gas evolution**
- **Lowers permeability**
- **High dry and hot strength**
- **Lowers mold hardness**
- **Poor flowability.**

SIGNIFICANCE OF MOISTURE

Insufficient water

- **Produces dry friable green sand the that is difficult to mold.**

SPECIMEN WEIGHT

- Indicator of consistence in the green sand
- Indicates the presents of Oolitic materials, referred to as dead clay or ash, is diluted by new sand additions.
- Indicates changes in sand distribution

SIGNIFICANCE OF 2"x 2" SPECIMEN WEIGHT

- **Should be recorded at or near a predetermined compactability. A variation in the specimen weight indicates green sand density changes are taking place in the system.**

SIGNIFICANCE OF 2"x 2" SPECIMEN WEIGHT

- **When specimen weight drops, it indicates a build up of oolitic material. This build up can lead to burn-in, burn-on, and penetration defects.**
- **A trend of lower specimen weight indicates there is not enough new sand entering the green sand system to dilute the oolitic material.**

Compression Strength, Green and Dried AFS 5202-00-S

Purpose:

- **To determine the compression strength of an AFS 2 in. dia. x 2 in. specimen.**



SIGNIFICANCE OF GREEN COMPRESSION STRENGTH

- **Maximum compression stress which the mixture is capable of sustaining.**
- **Used to control the rate of clay addition to the green sand system.**

SIGNIFICANCE OF GREEN COMPRESSION STRENGTH

Significant affects on Green Compression Strength

- **Degree of mulling**
- **Sand to metal ratio**
- **Clay content**
- **Compactability range**
- **Type of additives**

GREEN COMPRESSION STRENGTH

Low green compression strength

Positive

- **good flowability**

Negative

- **broken molds, poor draws**

Indicators: low clay content, dry sand, poor mulling

GREEN COMPRESSION STRENGTH

High green compression strength

Positive

- **stronger molds**

Negative

- **difficult shake-out, poor castings dimensions, poor flowability, high ramming resistance, higher cost**

Indicators: high clay content

SIGNIFICANCE OF DRY COMPRESSION STRENGTH

- **Maximum compression load a dry sand is capable of sustaining. Indicates the resistance of the mold to stresses during pouring and cooling of the casting. Indicates the ease of shake-out.**
- **With high dry compression strengths the greater the number of hard lumps are present at the shake-out and more sand carry out will occur.**

SIGNIFICANCE OF DRY COMPRESSION STRENGTH

Significant affects on Dry Compression Strength

- **An increase in moisture content**
- **The type and amount of clay**
- **The rammed mold density**
- **An excessive amount of moisture absorbing materials will decrease the dry strength. Excessive water and clay can make bricks.**

DRY COMPRESSION STRENGTH

Low Dry Compression Strength:

Positive

- **easy shake-out**

Negative

- **loose friable sand, cuts and washes, burn-in, inclusions, erosion**

Indicators: low clay content, dry sand, poor mulling

DRY COMPRESSION STRENGTH

High Dry Compression Strength:

Positive

- stronger molds

Negative

- difficult shake-out, loss of return sand, cracks, hot tears

Indicators: high clay content

Permeability, Standard AFS 2 in. dia. X 2 in. Test Specimen AFS 5224-00-S

Purpose:

- **To determine permeability of standard AFS 2 in. dia. X 2 in. test specimen.**

Permeability is a test of the venting characteristics of a rammed green sand.



SIGNIFICANCE OF PERMEABILITY

Important factors in regulating the degree of permeability:

- **Sand grain size, shape, distribution, type**
- **Quantity of binder composite, density to which the green sand has been rammed**
- **Moisture content**

PERMEABILITY

Low Permeability:

Positive

- **smooth surface finish**

Negative

- **blows, pinholes, expansion defects**

PERMEABILITY

High Permeability:

Positive

- **reduced gas pressure**

Negative

- **mechanical penetration, rough surface finish**

Methylene Blue Clay Test, Molding Sand AFS 2211-00-S

Purpose:

- **The test measures the amount of live clay present in a sample of molding sand.**
- **Determines the amount of active clay**



SIGNIFICANCE OF METHYLENE BLUE CLAY

- **Determines the amount of exchangeable ions present in the active clay by adsorption of the methylene blue dye.**
- **Clay that still has ion exchange capability will contribute to green, dry, and hot strength properties of the green sand.**
- **The methylene blue clay value varies depending on the type of clay in the binder composite.**

Clay, AFS Method

Purpose:

- To determine the percentage of clay and other particles that settle at a rate of less than one inch per minute in water (typically material under 20 microns). Indicates the amount of fines and water absorbing material in the green sand system.

SIGNIFICANCE OF AFS CLAY

- Any particle that does not settle through 5 inches of water in 5 minutes. May contain active clay, dead clay, silt, seacoal, cellulose, cereal, ash, fines, all other materials that float in water.
- Only the active clay gives bonding capacity to the green sand system.

Sieve Analysis (Particle Size Determination of Green Sand) AFS 1105-00-S

Purpose:

- **To determine the particle size distribution and estimate the average sieve size of green sand (washed and dried) using standard testing sieves.**



ASTM E-11	Cumulative Wt.	Individual Wt.	Individual %
<u>Sieve Size</u>	<u>Retained on</u>	<u>Retained on</u>	<u>Retained on</u>
6	0.00 g	0.00 g	0.0
12	0.00 g	0.00 g	0.0
20	0.00 g	0.00 g	0.0
30	1.50 g	1.50 g	2.0
40	3.12 g	1.62 g	2.2
50	13.92 g	10.80 g	14.4
70	39.35 g	25.43 g	34.0
100	63.83 g	24.48 g	32.7
140	73.75 g	9.92 g	13.2
200	74.85 g	1.10 g	1.5
270	74.85 g	0.00 g	0.0
Pan	74.85 g	0.00 g	0.0
Totals	74.85 g	74.85 g	100.0



Grain Fineness Number, AFS GFN, Calculation AFS 1106-00-S

Purpose:

- **To calculate the AFS Grain Fineness Number (AFS GFN), an estimate of the average sieve size of a sand sample.**



ASTM E-11	Individual %		
<u>Sieve Size</u>	<u>Retained on</u>	<u>Multiplier</u>	<u>Product</u>
6	0.00	0.03	0.00
12	0.00	0.05	0.00
20	0.00	0.10	0.00
30	2.00	0.20	0.40
40	2.20	0.30	0.66
50	14.40	0.40	5.76
70	34.00	0.50	17.00
100	32.70	0.70	22.89
140	13.20	1.00	13.20
200	1.50	1.40	2.10
270	0.00	2.00	0.00
Pan	0.00	3.00	0.00
Totals	100.00	<i>AFS GFN = 62.0</i>	62.01



SIGNIFICANCE OF SCREEN ANALYSIS AND AFS GRAIN FINENESS

- **The distribution of the green sand has a bearing on the physical properties that can be developed by the green sand system. The distribution influences the amount of bond required and the surface finish of the castings.**

SIGNIFICANCE OF SCREEN ANALYSIS AND AFS GRAIN FINENESS

- **The screen analysis should be run on the washed system sand and the dried system sand. A comparison of the dried sand screen analysis and the washed screen analysis shows how much agglomeration is taking place in the green sand system.**

Loss on Ignition, LOI

AFS 5100-00-S

Purpose:

- **Measurement of the weight change of a sample, consisting of weight losses and weight gains when a sample is fired at 1800F (982C).**



Loss on Ignition, LOI

- This includes weight loss due to volatilization of organics, removal of chemically bound water, dissociation of inorganic compounds (with one or more components given off as a gas), and weight gain due to oxidation reactions.

SIGNIFICANCE OF TOTAL COMBUSTIBLES (LOI)

- **Loss on Ignition (LOI) determines the total amount of combustible material in the green sand. The green sand sample is fired at 1800F (982C) until it reaches a constant weight. The quantity of gas forming materials in the green sand will affect casting results.**

SIGNIFICANCE OF TOTAL COMBUSTIBLES (LOI)

A high LOI may produce gas defects such as pinholes, blows, and scabbing. In steel castings a high LOI could lead to carbon pick up on the casting surface. A low LOI can lead to poor casting peel and a rough finish on the casting surface.



Volatile Material at 900F (482C)

AFS 2213-00-S

Purpose:

- **To determine the amount of material in foundry system sand or additives that will volatilize at a temperature of 900F (482C).**



Total Combustibles (LOI) 1800F (982C) Volatiles at 482C (900F)

Low Combustibles and Volatiles

Positive

- **Lower cost and less moisture required**

Negative

- **Poor casting peel, poor finish, poor shakeout**

Total Combustibles (LOI) 1800F (982C) Volatiles at 482C (900F)

High Combustibles and Volatiles

Positive

- **Lower expansion**

Negative

- **Pinholes, smoke, blows, brittle sand,
higher cost, higher moisture requirements**

Available Bond

Available bond indicates the moisture-absorbing material in the sand system, including live, latent and dead clay and additives.

Procedure - The available bond value is derived by relating green compression to moisture using a prepared graph, a special slide rule, or calculation. $(0.105 * GCS) + (1.316 * MOIST)$

Significance - The live clay actively bonds the sand, and the latent clay can be activated with further energy input. The dead clay does not add to green tensile or green splitting strength, but does absorb moisture.



Working Bond

The working bond percent indicates the amount of clay that actually is producing bond strength in the sand mix.

Procedure - Working bond (or effective clay) is derived by relating green compression to compactability using a prepared graph, a special slide rule or calculation. $(15.29 * GCS) / (132.1 - COMP)$

Significance - Higher working bond indicates more efficient use of the clay present. Large variation indicates variation in the clay additions or in the effectiveness of the mulling.

Mulling Efficiency

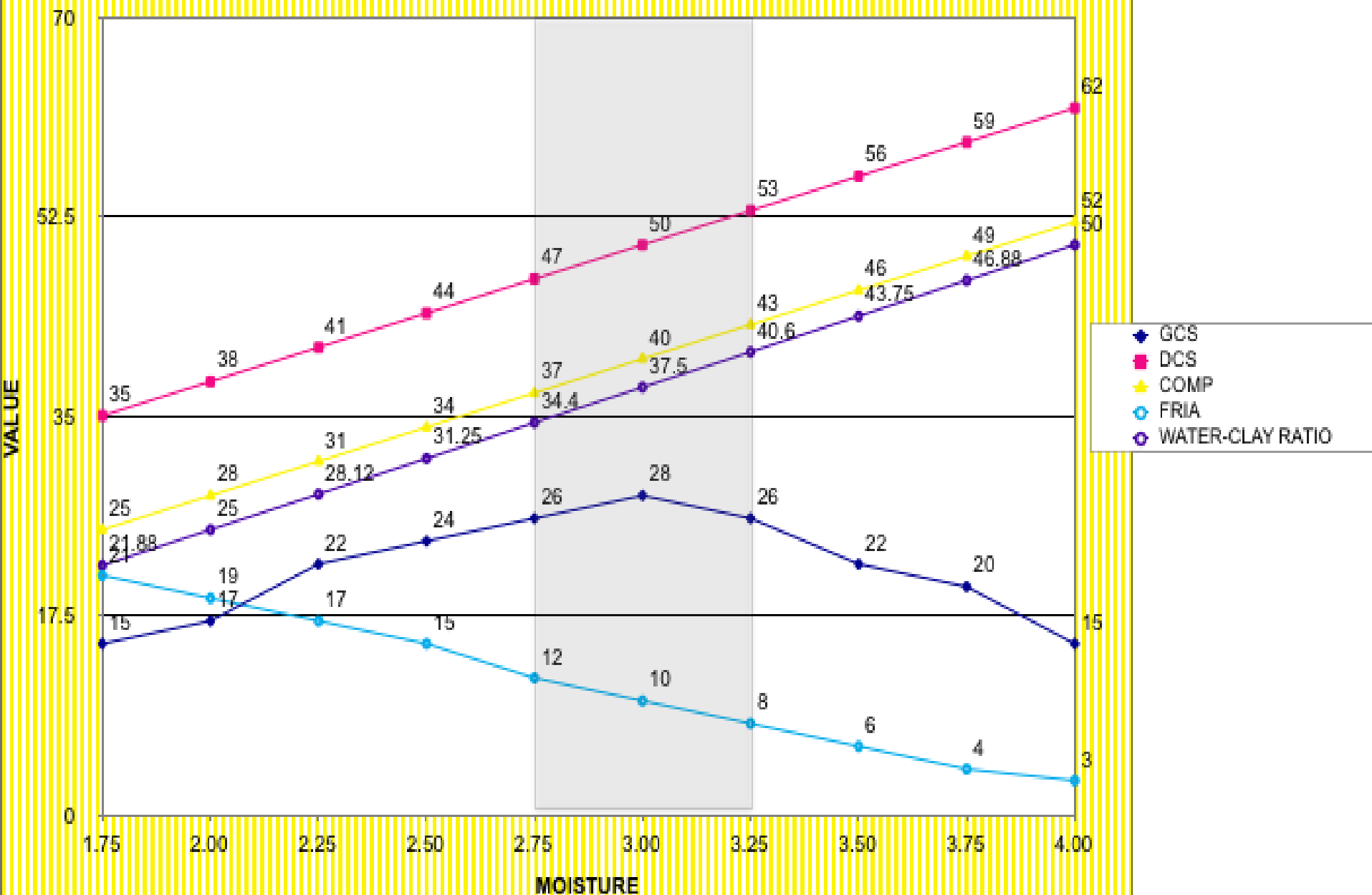
The higher percent mulling efficiency, the greater the clay utilization and the lower the clay content required.

Procedure - The working bond value divided by the available bond value (and multiplied by 100) gives a percent mulling efficiency reading.

Significance - Segregation in transport, loss or buildup of fines due to lack of dust collection, quality of the bond, temperature, muller or mixer condition all may affect mulling efficiency.



TEMPER ZONE 8.0 % MBC



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