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TATA METALIKS LIMITED

Dear Customers,

It gives me immense pleasure to forward this 8th edition of PRAYAS to you all.

Capturing customer requirement has always been the priority of Tata Metaliks. Making customized grades, operating Customer Service Centre, developing energy efficient Tata eFee pig iron, colour coding of pig iron on basis of Silicon level etc are example of our efforts towards customer centricity. Customer centricity is not just for the sales team, it is a value which is followed throughout our organization across all level and function. This value system of Tata Metaliks helps us grow and keeps us ahead of competition. One of the most important aspects of the sales process is sharing knowledge with buyers. Visit of cross functional team to foundries and regular technical meets organized by us is a step towards this endeavor. This has helped us to build a strong relationship with our customers. Our technical service team is always ready to help customers to resolve any process related issues.

In this issue we tell you some basics of UNIT SAND SYSTEM, which we believe is a value proposition besides the high quality product which we will continue to supply.

Yours Sincerely,

SANJAY GUPTA
Chief of Sales

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Editorial

Dear Readers,

The major production of castings is in sand moulds. The tonnage of sand which must be handled in a sand casting foundry is large as the sand-metal ratio may vary from 10:1 to 0.25:1 depending on the type and size of castings and moulding method employed.

The quality of moulding sand depends upon the manner in which it is prepared and mould quality is decisively controlled by the process of moulding-sand preparation. The surface finish of the casting also became as important as the metallurgical parameters because some of the sand defects in critical areas lead to the casting failure in service.

In this PRAYAS issue, unit sand system components are explained in detail with their specifications and properties. Process of unit sand preparation with required properties is explained as good practice reduces non conformities related to sand in a foundry.

We are sure that this issue will enhance your sand knowledge and assure our technical hand holding in systemizing the unit sand preparation and control in your foundry. To know more on this topic, please get in touch with our Customer Service Centre.

Regards,

M Sambasiva Rao and Sukhendu Mukherjee

Editorial Team
M Sambasiva Rao, Sukhendu Mukherjee
Munmun Pal and Monideep Majumder

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UNIT SAND PREPARATION AND CONTROL

In the earlier decades, it was the manufacturer's monopoly to sell the castings produced in their foundries to the customer specified metallurgical specifications but much importance was not given to the surface finish of the castings. The contamination of non calcined core sands (chemically bonded) in the sand circulating systems was affecting the performance of bentonite clay, there by deteriorating the surface finish of castings to a greater degree in comparison to the linseed oil cores which were used earlier. On the other hand, the present day customers insist for improved surface finish of the castings.

UNIT SAND

In green sand moulding, after pouring the moulds and allowing sufficient time for solidification of the castings inside the mould boxes, these are shaken out and the hot sand passes through magnetic separators, polygonal sieves, cooling beds etc and is stored in the storage hoppers. From the storage hoppers, return shake out sand is drawn out along the new sand, bentonite, coal dust or substitute of coal dust from their respective storage hoppers and fed into the sand mixer, mulled for sufficient time along with requisite amount of water addition to develop full strength and then discharged to the moulding lines. Depending on the rate of production and the lay out of the sand plant, the system sand circulates again and again. This often repeated sand, cycled along with some percentage addition of new sand, with proportionate addition of bentonite and carbonaceous additives to develop its workable moulding properties in the sand mixer is termed as

UNIT SAND

It comprises of

- New Sand
- Return shake out sand
- Bentonite
- Coal Dust or substitute of coal dust and
- Water

Basic specifications and properties of these ingredients are detailed below.

NEW SILICA SAND

Silica sand, being the cheapest and available in plenty, is widely used for both core making and moulding. Main criteria for the selection of this base material is:

- Silica (SiO_2) Content: As high as possible, preferably above 97%, with very low alkaline impurities
- Clay Content: Preferably below 0.5%
- Sand Grain Size and Distribution: Grain distribution spread over 4 adjacent sieves with around 90% retention on these sieves
- Sand Grain Shape: Angular or sub angular to rounded

RETURN SHAKE OUT SAND

Return shake out sand coming back to the storage hoppers will be affected by several factors. Important factors are

- Size of the moulding boxes
- Weight of the casting
- Surface area and section thickness of the casting
- Sand to metal ratio
- Metal composition and pouring temperature
- Time duration it takes for the poured boxes to reach the shake out station
- Type of effective cooling system
- Storage capacity of the hoppers and their design to ensure minimum sticking of the sand to the walls, there by maximizing effective sand storage capacity
- Dilution with core sands – Quantity and quality of burnt, semi burnt resin bonded cores
- Type of sand mullor and water addition facility

All these factors, including shift wise casting production schedule, use of cores during casting production and the types of cores used will significantly affect the characteristics of the return shake out sand. Each factor singly or in combination with other factors, will influence the quality of the final prepared sand reaching the moulding station.

Effective separation of iron particles from the shake out sand is of prime importance. Heavy duty magnetic separator located after the shake out will easily take care of bigger iron pieces. But small iron fins, globules etc formed at the time of pouring due to spurting and splashing of the molten metal over the mould surfaces, do not get caught at the first location of the magnetic separator as these small pieces are hidden inside the sand mass and do not always come to the surface. Hence another magnetic separator before the sand enters the cooling system is essential. In this second operation chances of these iron particles being separated out are more.

In many sand plants of the earlier designs, proper cooling arrangement system has not been incorporated. This results in hot sand entering the main storage hopper. Once the hot return sand enters the main hopper, possibility of its further cooling is practically nil in spite of the retention of the sand in the hopper for a longer period.

Return sand below 40°C can be tempered to the correct moisture by the mullor operator by addition of more or less measured quantity of water through the water meter. Also at temperatures above 40°C and below 50°C, the operator can use his judgement and with guidance from sand laboratory can add extra water to cover up evaporation losses. But at temperatures beyond 50°C water addition to control the moisture is very difficult unless some provision is made to cool the hot return sand. But in any case provision must be made to control the temperature of the return shake out sand below 40°C.

BENTONITE

Bentonite is one type of bonding clay. It is the main binder for moulding sands and is also added in smaller percentages to oil core sands. Clay is an earthy or stony mineral aggregate, consisting essentially of hydrous silicates of

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alumina. It is plastic when pulverized into fine powder and wetted, rigid when dry and vitrous when fired at sufficiently higher temperature.

Clays are in structural form of minute plates, varying in particle size from 0.01 to 0.001mm in breadth. The lesser the particle size the higher the bonding strength and plasticity with addition of water.

The main constituents of clays are KAOLINITE, MONTIMORILLONITE and ILLITE. In addition to the clay minerals, minor amounts of quartz, organic material, limonite etc are also found in many clays. For foundry purposes, clays are classified into two groups. One is kaolinite clay under which come china clay and fire clay. The other is bentonite, consisting of clay mineral montimorillonite.

Bentonites are abundantly available in KUTCH region of Gujarat state. These are of two distinct grades. One is sodium base and the other is calcium base. The purity of bentonite is dependent on its montimorillonite content. The binding capacity and thermal properties are influenced by the chemical composition of the montimorillonite and the predominable exchangeable ions on the clay coatings. GCS (Green Compressive Strength) of Calcium base bentonite is higher than that of Sodium base bentonite. This is attributed to the hydration of Ca^{+} ions which develop more rigid water layers on the montimorillonite crystal surface.

Sodium base bentonite gives much higher dry compression strength than calcium base bentonites , because Na^{+} ions allow the montimorillonite flakes to separate and disperse, giving a uniform clay coating over the sand grains. Hot strength of Na bentonite is higher and the degradation due to thermal heat is low in comparison to Ca bentonite.

Bentonite should be dry powder, free from lumps, sand and other foreign materials. Ground and fine powder with minimum 95% passing through 200 mesh(i.e.75 micron) U.S. Sieve, moisture content 12% maximum and pH value between 8 and 10.

Bentonite mined from KUTCH region is definitely of superior grade in comparison to bentonite mined from other regions. The other grades also develop green compressive strength to bond the sand grains but their water absorption and holding capacity is less in comparison to that of KUTCH bentonite. This is mainly due to their mineralogical formations.Bentonite should be stored in a covered dry area, free from moisture content.

COAL DUST AND COAL DUST SUBSTITUTES

Coal dust is added to iron foundry moulding sands to improve the surface finish of castings with a bluish glean and to reduce the incidence of scab defects. On exposure to hot metal, the sand grains coated with coal dust form an adherent film of lustrous carbon, which is not wetted by the molten metal. This impedes chemical reaction with the moulding materials and improves the casting surface finish. Also reducing gas atmosphere is created on pouring the metal and this gas cushion prevents the molten metal from direct contact with the mould surface. This reducing atmosphere prohibits the formation of iron silicate which causes penetration and burn on.

Coal dust loses its volatile matter on being heated. During the period the volatile matter is being given off, coal dust softens and the presence of soft constituent around the sand grains helps to prevent metal penetration. When all the volatile matter has been removed, the coal dust again hardens, forming very fine grained coke, which is brittle and which accumulates in the sand system affecting sand properties. The evolution of this volatile matter should persist until the casting has formed a solid skin, resulting in better surface finish of the casting. So it is essential to select a coal dust high in volatile matter so that reducing atmosphere is created in a mould within a shorter interval after metal pouring.

Grading of the coal dust is related to section thickness of castings. For heavy section castings of 12 mm to 50 mm thickness, medium fine to coarse grade powder is required to prolong the evolution of volatile matter. For thin section castings, fine powder is to be used. In general, coal dust should match the AFS Grain Fineness Number of the base sand in use and can be slightly finer. Large size particles can act as localized areas high in gas content and give a pitted surface.

The material shall consist of high quality fine crushed non coking bituminous coal and shall be free from any foreign material. Its moisture content shall not exceed 3%.

PROXIMATE ANALYSIS (ON DRY BASIS)

Volatile matter	: 30% min.
Ash	: 18% max.
Sulphur	: 1.0 max.

Pick up of sulphur by the molten metal at the mould face from coal dust of high sulphur content can cause defects. Also the acidifying effect from the sulphur will considerably decrease the wet tensile strength of sand. Hence sulphur should not exceed 1.0%.

Coal dust can catch fire easily due to its spontaneous combustion. It should be stored in a dry, non-smoking area. It should not be stacked high and large quantity stocks should be avoided. During storage of coal dust, all precautions should be taken to prevent fire hazard.

Coal dust substitutes utilizing polystyrene, various forms of asphalt, pitch and bitumen derivatives and a combination of two or more materials are manufactured as proprietary products with different brand names. Most of these are available in powder form. Liquid carbonaceous substitutes are also available and some foundries do use these. Being petroleum based products, these reduce the swelling characteristics of the bentonite. Being of high concentration, any minor variation in dispersion causes major fluctuations in casting quality. The liquid product does not have the necessary volume combustibles to take care of sand expansion defects, while powder additives do have these.

Some suppliers market one shot additive, combining bentonite and carbonaceous additives and report satisfactory results. The function of coal dust and other carbonaceous additives is to prevent sand burn on with the formation of lustrous carbon film on the mould surface.

SAND MIXERS

Sand preparation plant must be equipped with the appropriate type of mixing units to ensure

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proper treatment of sand with the binders, other ingredients and moisture to obtain workable sand mixtures with optimum properties. There is difference between mixing and mulling a sand batch.

Mixing is done to distribute various additives in a uniform manner throughout the synthetic sand mixtures. Intensive rubbing and kneading action is not required in this mixing procedure. The mixing action is done with the aid of specially designed, slow revolving scraper arms, placed over the bottom pan of the sand mixer. Hard faced, easily replaceable scrapers are fitted at the tip of the scraper arms. During the slow revolution, the scraper arms force the sand upwards round the periphery of the sand mixer walls fitted with the rubbing strips. These rubbing strips increase the mixing action. Continuous slow upward and downward turning coats the sand grains with the binder and other ingredients evenly and uniformly, without abrasive action.

The term mulling generally applies to moulding sand mixes which require high working strength in comparison to core sand mixes. Mulling is to apply a strong work force to a mixture of clay, carbonaceous additives and other ingredients to develop the strength and plasticity to the sand mix and coating the sand grains with the clay bond uniformly with a thin film of clay carbonaceous additives water. Mixing alone cannot develop the required strength as some of the ingredients in the moulding sand mix cannot be easily dispersed in view of their high viscosity or strong cohesive nature. For developing maximum plasticity and green strength, it is necessary to apply a smearing, kneading or rubbing and shearing action in the mulling process, causing the materials to flow under pressure.

WATER ADDITION IN THE MULLOR

Theoretically, all the dry materials and additives should be fed in to the mullor, dry mixed for a very short time and then water addition to be done quickly, at least within less than half the specified mixing cycle time for the sand batch. This means sufficient mixing time should be allowed for the sand to develop its optimum properties after water addition is completed. Then only the batch of sand will be mulled to the correct temper water. Otherwise, the sand grains will carry more free water, which will cause pin holes etc. on the castings. When water is added before clay addition, mulling time has little effect on dry strength. When water is added after clay addition, mulling time improves dry strength.

As most of the modern sand mixers are of intensive mixing types, water addition is started within a few second of the ingredients being fed in to the sand mixer and completed within 40 to 50 seconds and then allowed to wet mull for the specified mixing time of 120 seconds or so. If water addition is done manually then the operator gets some time to feel the sand and add little extra water at least 25 to 30 seconds before discharge of the sand batch. So that all the water which is added gets homogenized, leaving very little free water on the sand grains.

UNIT SAND COMPOSITON AND PROPERTIES

For conventional jolt squeeze and high pressure highly automated moulding lines the main ingredients added for UNIT SAND are similar viz. return shake out sand, new sand , bentonite and carbonaceous additives. But properties in the prepared sand will differ and are provided for your ready reference. Out of the four main ingredients, return shake out sand is the most fluctuating component. Once its properties are evaluated due to degradation on repeated recycling and thermal exposure, weakening of the bonding capacity of bentonite due to dilution of non calcined resin bonded core sands, then new sand percentage addition can be fixed to near accuracy to prepare sand batches within specified range of properties. If return shake out sand and new sand additions are in correct proportion, then bentonite and carbonaceous additives can be controlled so that sand batches can be made to correct temper within the compactability range.

UNIT SAND COMPOSITION & PROPERTIES

PARAMETER	UNIT OF MEASUREMENT	CONVENTIONAL JOLT SQUEEZE MOULDING	HIGH PRESSURE AUTOMATED MOULDING
MULLOR ADDITIONS			
Return shake out sand	Kg.	1,000	1,000
New sand	%	4 to 8	4 to 6
Bentonite	%	0.5 to 1.0	0.5 to 1.0
Coal dust	%	0.5 to 0.8	0.4 to 0.8
Substitute of coal dust	%	0.2 to 0.4	0.2 to 0.3
Water	%	To temper	To temper
These percentages are based on sand weight.			
SAND PROPERTIES			
Compactability	%	40 to 46	36 to 42
Moisture	%	3.7 to 4.2	3.2 to 3.7
Permeability	No.	110 to 160	110 to 140
Green Compressive Strength	gms/cm^2	950 to 1200	1600 to 2000
Green Shear Strength	gms/cm^2	250 to 350	400 to 550
Wet Tensile Strength	gms/cm^2	10 to 12	15 to 20
Shatter Index	%	68 to 72	70 to 76
Total AFS Clay	%	11.5 to 12.5	12.0 to 13.5
Active Clay	%	7.5 to 8.5	8.0 to 9.5
Loss on Ignition	%	4.25 to 4.75	4.0 to 4.25
Volatile Matter	%	3.0 to 4.0	3.0 to 4.0
Specimen Weight(3 rammed)	gms	140 to 155	140 to 155

Each foundry should fix up its own norms of sand properties to suit its best working conditions. This can be achieved by analyzing the data collected, critically co-relating with casting defects. Excess addition of new sand, bentonite, coal dust powder or substitute of coal dust powder should be avoided.

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TATA METALIKS LIMITED

Mr.Nisith Kumar Mondal,
Managing Partner
M/s Imperial Casting Corporation, Howrah.

CUSTOMER VOICE

We are highly satisfied with the technical service provided by Tata Metaliks with regard to cupola operation, air volume calculation & adjustment as per our cupola. We are expressing our full satisfaction towards the development of casting quality by using TML Technical services.

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