GREEN SAND PLANT MACHINES: STATE OF THE ART

Sand preparation has often – and wrongly – been considered secondary to other main issues, such as moulding or casting plant. Investments have often been aimed at increasing productivity ("to make more flasks") and capacity of furnaces ("to fill the flask"). This right corporate policy has often created problem to the sand plant, that has more or less brilliantly withstood all these changes.

Today, expressions like "efficiency", "quality", "integration of processes" are part of our daily job. So, if the company is seen as an organism working as a strongly integrated system (and not by separate sectors), also the sand plant (the "poor relative") needs a new approach.

Sand plant (goals)

The modern sand plant must satisfy three fundamental requirements:

- production of high quality sand;
- guarantee of constant quality in time;
- production of a constant high quality at the lowest cost possible.

Production of high quality sand:

What does "high quality sand" mean?

High quality sand must have the following characteristics:

- **compactability** that allows a good moulding and consequent shakeout, without causing any defects due to moisture excess / deficiency;
- **strength** that allows to produce moulds resistant to handling, core laying and casting, and that does not cause any problems during shakeout;
- **temperature** below 45 – 48°C and without any sudden variations, as higher values hinder the correct activation of additives (with consequent higher bentonite consumption with equal strength) and increase water demand, causing defects on castings;
- **permeability** that enables the evacuation of gases from the mould without causing any blowholes.

Of course, it is necessary to control also other characteristics, such as moisture, bentonite and fines content, etc.. However, if above-mentioned features are kept in a limited range, the whole sand system will be stabilized.

In our experience, we have never found two foundries using the same sand parameters, even if production typologies were almost the same.

This "uniqueness" is absolutely normal and justifiable. In fact, sand is a means to obtain high quality castings and every foundry must optimize its own castings by producing a distinctive type of sand.

This specificity is not only due to different casting types, but also to the usage of different moulding systems (high pressure, shot, shock wave, manual).

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So, there is not one sand which is fit for all, but there are many sands of different qualities that satisfy every single requirement.

Guarantee of constant quality in time

It is of the utmost importance to maintain the same sand quality in time. In fact, if the “right” quality of sand allows to obtain a better casting, quality constancy in time extends such advantage to “all castings”.

Constant quality at low cost

Of course, it is extremely important to make the first two conditions available at the lowest possible cost so as to obtain from the sand plant the efficiency and the cost abatement which render our product more competitive.

The attainment of this goal is pursued on two levels: first of all, a constant quality of sand leads to a reduction of rejects, unpoured flasks, sandblasting times, broken flasks and to an improvement of casting “skin”.

For instance, the muller must have just one motor to reduce energy losses and to ease maintenance; the rotary sand and casting drum is to be considered as a multifunction machine, as it allows to cool both sand and castings at the same time and to pre-sandblast castings; besides lowering temperature, the cooler must homogenize sand and enable the controlled removal of fines and a preventive moisturizing.

Sand plant (theory, dimensioning)

How to design a sand plant fit for a high-pressure moulding?

Sand is the key element required to obtain a good quality mould and so a good quality casting, whatever moulding principle is applied.
The characteristics of the sand to be prepared change according to the type of moulding machine chosen, whereas the machines necessary to prepare sand do not change.
During preparation, sand undergoes different stresses, which can be distinguished into two groups:

- mechanical stresses
- temperature stresses.

Mechanical stresses cause the breaking and erosion of silica grains which compose sand skeleton. Signs of mechanical stresses are: decrease of permeability and higher bentonite requirement.
Temperature stresses cause the increase of sand temperature.

A higher water demand causes an increase of compactability and a decrease of bulk density (this phenomenon can be explained by a higher sand viscosity at high temperature). Therefore, hot sand produces moulds which are not very compact: the more compactability increases the more flowability decreases.

Sand compactability is very important. To obtain good quality moulds it is required a low water addition and also a limited temperature variation.
Therefore, it is of fundamental importance that sand has always the same characteristics when returning to the moulding machine. So, it is absolutely necessary to quantify the entity of above-mentioned phenomena in order to correctly dimension the various machines to be used, avoiding the mistake of undervaluing important phenomena or overestimating negligible phenomena.

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We turn our attention to sand cooling: for this reason we have studied the layouts of two classic types of plant (with drum and with cooler).
For both of them we have plotted the average trend of sand temperatures. As already said before, temperature must not undergo any great variations from the mixing phase to the moment in which sand returns to the mixer for restoration of its characteristics.
In a circuit without drum or sand cooler, temperature continuously tends to increase until the heat exchange between structures (flasks, silos walls, transfers from one conveyor to another) reaches and maintains very high values (balancing heat exchanged with the environment and heat put into the casting). Only the utilization of cooling machines allows to definitely maintain temperature below 45°C in order to avoid serious problems when moulding. Moreover, carefully chosen machines must homogenize sand and avoid great variations in uniformity of sand moisture.
Therefore, we have ascertained that batch coolers are better than continuous coolers, as batch coolers always keep parameters (moisture and temperature) under control, with a higher guarantee of uniformity at the end of the process.
We produce the following coolers:

- sand and casting cooling drum TDR for sand and castings – continuous type;
- cooler and homogenizer for sand only – batch type.

Usually, the utilization of one machine excludes the other machine.
One peculiarity of our plants is that silos are considered as double-function machines:

a) sand storage mechanics that allows to empty flask storage lines, when necessary;
b) chemical physical characterization of bentonite curing and of cooling improvement before sand returns to the muller.

So, we are convinced that silos have to be appropriately studied in order to avoid the “funnel effect” which drastically reduces effectiveness.
The silo must empty completely both for its inner shape and for the particular configuration of the emptying hopper and of the ejector feed system (belt type or with vibrating cone).
Therefore, it is important that sand inside the silo is proportionate to its volume: only in this way the residual bentonite in the sand can be activated and all other above-mentioned phenomena can take place.
The logic employed to dimension these machines starts from the determination of the quantity of heat put into the sand during casting and from the setting of the parameters that allow to complete the theoretical calculation of heat exchanges during the further processings of the sand.
The balance of the suction system is fundamental for sand reclamation. As regards such system, our model gives the hourly capacity values at key points.

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