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Accurate Controlling and Monitoring Sand Properties by sensing in Green Sand Treatment System

Yuichi Ogura[1], Katsuhito Sato[1], Tsuyoshi Sakai[1]
[1] Sintokogio, LTD. Toyokawa, Aichi 442-8505, Japan

In a casting process, green sand cannot always keep its stable properties due to loss of additives, water evaporation and change in the Oolistics layer, etc. caused by pouring heat.

On the other hand, to achieve "production of superior castings", it is desired that sand of high quality and stable properties is fed to a molding machine, which leads to prevention of defects. The sand after pouring and cooling is adjusted as appropriate in sand treatment equipment[1]. Since sand properties in a line depend on cooling time, number of cores and sand to metal ratio, etc. sand conditions are not always the same. Sand is required to be adjusted according to such conditions. This is not easy. Under these circumstances, the authors have developed a new feedback system using sensing technologies for sand treatment equipment in order to stabilize mold sand properties. The feedback system enables molding sand to be supplied in a state of stable properties.

This system can contribute to increased improvement of the quality assurance of cast products from the perspective of sand and equipment. Furtheremore, a foundry can become competitive by constantly managing the data collected by a sand control system.

Keywords: *Sensing, Feedback, Quality assurance*

1. Introduction

This paper explains accurate controlling and monitoring sand properties by sensing in green sand treatment system. This system can supply the sand of high quality and stable properties.

2. Sand treatment control system

2.1 Overall structure of control system

A sensor required of each process of sand treatment equipment[1] consisting of shake-out equipment, cooling device, sand muller and sand feeder to the molding machine are arranged in this system. The measured data by each sensor manage if the equipment is in proper operation and if the sand is adjusted and adapted to its appropriate properties in each relevant stage. Fig. 1 shows an outline of sand treatment control system. To measure sand properties, a sensor is fitted before and after each device and the sand situation in each process can be confirmed with the measurement results.

The development of this control system focuses on sand temperature and moisture. The first consideration is the sand temperature. In the shake-out equipment, heat-affected sand is mixed with sand not affected by heat. And the whole temperature of sand is lowered by spraying water on the recovered sand. In the cooling equipment the sand temperature is more lowered by latent heat of vaporization of water sprayed on the sand. Proper sand treatment following these basic principles ensures that molding sand is supplied at an appropriate temperature.

The next consideration is the sand moisture. Sand water affected by pouring heat is vaporized and discharged outward and the moisture level decreases in the whole mold. After that, the moisture level increases by spraying water on the sand in the shake-out and cooling equipment. In the sand muller, the moisture level is adjusted to reach its target value. After that, the moisture is slightly vaporized in the conveyance process between the sand muller and the molding machine.

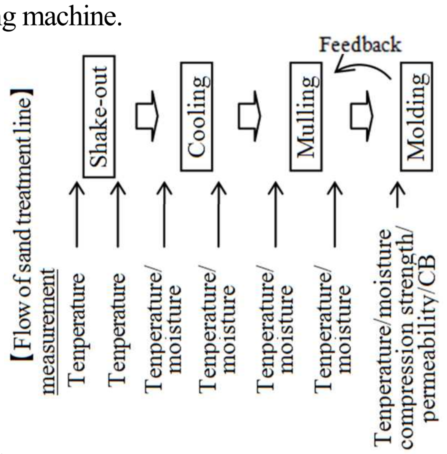

Fig. 1: Outline of sand treatment control system

Most foundries control sand temperature and moisture by using a factor of compactability (CB) closely correlating with the moisture. However, this system stabilizes the properties of molding sand by measuring the CB just before sand feeding to the molding machine and feeding it back to the controller of the sand muller.

2.2 Control results in each equipment

(1) Shake-out equipment

The shake-out equipment is equiped with a rotary-type mold cooler. The mold cooler measures the temperature of sand and products at its inlet and sprays water on them according to their temperature. Measuring the temperature of products at the inlet of the cooling equipment of the downstream process makes it possible to confirm the cooling effect in the shake-out equipment.

(2) Hydrous cooling equipment

The sensors arranged on the belt conveyor measure the sand temperature and moisture and the cooling equipment sprays water on the sand accordingly. After water spraying, the sand is fed to the sand cooler and cooled by laten heat of vaporization in it. The sand temperature and moisture is measured at the outlet of the sand cooler, which makes it possible to confirm the cooling effect in the cooling equipment. Thus, measuring and controling the sand temperature and moisture at the inlet and outlet of the cooling equipment lead to preventing sand inclusion due to insufficient cooling equipment.

(3) Sand muller, molding machine

In the sand mixing process the temperature and moisture of sand fed into the sand muller is measured and the sand is moistened accordingly and mixed. Eventually, the CB controller fitted on the sand muller measures CB. The CB controller feeds the sand to the molding machine after checking that the CB is within its target. The properties of sand to be molded are not yet automatically confirmed although the sand properties change due to external factors until the sand is supplied to the molding machine. Some foundries take by hand and test sample sand at regular intervals. In this case, the test is carried out at most several times per day. Therefore, it is difficult to understand the then sand properties and take appropriate measures against defective molding even if defective molds are produced due to the sand. In this context a device measuring the sand properties automatically is fitted just prior to the molding machine. The device provides data about the properties of sand molded actually and the operating conditions of the molding machine and such data can be used for traceability and measures to be taken against defective molding.

Moreover, comparison was made between the measured data by the sand property measuring device just prior to the molding machine and the measured data by the CB controller fitted on the sand muller. As a result, it was found that there was a close correlation between the CB just prior to the molding machine and the temperature of mixed sand. The measured reults are shown in Fig. 2. Correlating the data of sand properties just prior to the molding machine with various factors made it possible to feed back the data to the targeted CB of the sand muller. The authors are challenging to construct a system introducing such sensing technologies, control the upstream process with the measured results just prior the molding machine and accordingly stabilize the sand introduced into the molding machine.

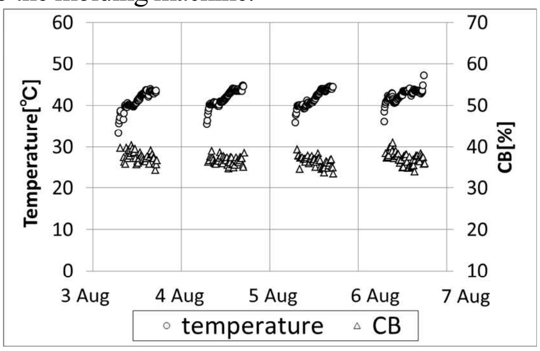

Fig. 2: CB just prior to the molding machine and sand temperature in the sand muller

3. Conclusion

Sand control in the past depended on the experiences and/or intuition of a skilled worker. However, this development ensures that the sand control is “visualized“ with sensing technologies and that the sand properties can be understood in real time. In addition, the feedback function between equipment with sensing technologies ensures that sand of more stable properties can be produced automatically, not by a skilled worker.

Furthermore, the sand treatment control system can be used as a tool for measures against defective molding by analyzing the sand properties in each process, the operating conditions of equipment and a trend of defect occurrence due to the sand. The authors are expecting that use of the data for “visualizing“ the entire foundry with sensing technologies ensures increased improvement of the product quality important for the operation of a foundry.

References

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