Control of dead clay and spent coaldust helps maintain moulding sand quality

What is meant by 'dead' clay and 'spent' coaldust?

When molten iron comes in contact with the face of a greensand mould, the clay and coaldust in the sand, at and near the mould face, are affected by the heat. The clay changes to a condition in which it cannot readily recombine with water during remilling of the sand, and the clay thus loses its bonding properties. In this condition, it can be described as 'dead' clay. At the same time, the coaldust loses its volatile content and thus becomes 'spent'. Because in this condition it is much less effective in producing a good surface finish on the casting, the thicker the casting, the greater the depth of mould face affected by heat, and the larger the quantity of dead clay and spent coaldust formed.

How are sand properties affected?

If dead clay and spent coaldust are allowed to accumulate in a moulding sand, extra additions of water will be required to maintain what appears to be a satisfactory sand condition, the green strength will markedly increase and the shatter index will decrease. In addition, the permeability of the sand decreases. These trends in properties can be readily detected by the regular graphical recording of sand test results as shown below.

When the amount of dead clay and spent coaldust in a moulding sand reaches a harmful level, difficulties will be encountered with bad lifts, broken casts and poor stripping.

How can a harmful build-up be prevented?

Regular additions of new sand to the moulding sand system and a corresponding regular discard of old sand from the system prevent a harmful accumulation of dead clay and spent coaldust.

The weight of new sand which should be added, preferably continuously over a working shift, should amount to 10-15 per cent of the total weight of metal poured into moulds during the shift. With a synthetic sand system, based on silica sand, the required amounts of clay and coaldust must be added with the new sand. With natural sand, only coaldust additions are necessary.

The breakdown of cores provides a source of new sand and this should be taken into account in calculating the amount of new sand to be added to the system. Dry burnt sand which accumulates around knockouts or which is removed from castings during cleaning should be discarded. This quantity should be allowed for in determining the amount of old sand to be discarded to make room for the new sand additions.

Effect of an increase in spent coaldust and dead clay on sand properties
What laboratory tests are employed to determine dead clay and spent coaldust content of moulding sand?

It is not practicable to determine precisely the dead clay content in a moulding sand, but since the amount of dead clay is closely related to the spent coaldust content in a particular sand system, a reliable indication of the content of these materials can be obtained, for control purposes by determination of the spent coaldust content.

The spent coaldust content of a sample of sand can be calculated with sufficient accuracy if the loss on ignition, volatile matter and clay grade figures for the sample are known. These are obtained on a sample of sand dried at 110°C.

Loss on ignition A weighed sample of the sand (not less than 20 g) is ignited at 925°C ± 10°C to constant weight (i.e., for at least 2 hours), in a silica dish or crucible, then cooled, re-weighed, and the loss in weight determined.

Volatile matter A 5 g sample of the sand is maintained at 925°C ± 10°C for 7 minutes, either in a closed crucible or under an inert atmosphere (e.g., nitrogen at a flow rate of 1 litre/min). The sample is then cooled, re-weighed and the loss in weight gives the volatile matter content.

Clay grade A 50 g sample of the sand is boiled carefully in an ammoniacal solution, followed by a repeated setting and syphoning-off procedure as recommended in Methods of Testing Prepared Foundry Sands.

The spent coaldust content is calculated as follows:

1. Assume 10 per cent of the clay content to be the combined water in the clay.
2. Subtract the percentage of combined water from the volatile matter content to obtain a 'corrected' value.
3. The 'corrected' value is then multiplied by 3 (this means that about one third of coaldust is volatile). The resulting figure represents the active coaldust in the sample.
4. Subtract the combined water content and the active coaldust content from the loss on ignition figure, thus obtaining the spent coaldust content.

For example—if tests on a sample of sand give:

Clay grade 10-0% — Loss on ignition 10-6% — Volatile matter 9-9%

Therefore the combined water content is 1-0 per cent (10 per cent of the clay grade), and the active coaldust = 3 (volatile matter — combined water)

= 3(2-9 — 1-0)
= 5-7%

Therefore, the spent coaldust = (loss on ignition — combined water — active coaldust)

= (10-6 — 1-0 — 5-7)
= 3-9%

What level of dead clay and spent coaldust can be permitted in moulding sand?

Taking the spent coaldust content as an indication of the total content of spent coaldust and dead clay, it has been BCIRA’s experience in many foundries that:

1. Up to 1-0 per cent of spent coaldust — satisfactory.
2. Between 1-0 per cent and 2-0 per cent — regular test results for spent coaldust content, supplemented by green strength and shatter test figures, should be recorded graphically to detect adverse trends.
3. If the spent coaldust is found to exceed 2-0 per cent, immediate steps should be taken to increase the input of new sand to the system.

Recommended further reading

- JOINT COMMITTEE ON SAND TESTING
  Third Report: Methods of Testing Prepared Foundry Sands
- PARKES (W. B.)
  Available as BCIRA publication:
- TAYLOR (D.A.)
  Paper presented to one-day lecture course on the theme ‘Quality Control in Iron Foundries’ and available in
  BCIRA publication: