Saving Money in Operating Cupola*

Conditions of Operation, Coke and Moisture, Sulphur, Heat Units, Limestone, Lining, Blast Pressure, Mixing Irons, Action of Elements, Future of Iron and Steel Castings.

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The operation of the cupola has become a question of dollars and sense of the keenest importance, and future operation must bow to the will of intelligent furnacemen, and must no longer hold the position of "man of mystery" it once held.

Cupola Mystery and History.

In years gone by it was customary to consider the cupola as a "mysterious thing," quite beyond the control of human beings. But those times have changed. Every year has marked an advance in the detail of cupola operations, until to-day we stand face to face with the scientific explanation of the once seemingly impossible.

Let us consider the practical side and ask what are the conditions necessary to successful operations. There are many kinds of iron that may be obtained from the cupola; some may be quite soft, others quite hard, and both be desirable. The soft iron may be made from a mixture of entirely different composition from the hard mixture, and between these two limits exist all the important irons obtained from the cupola.

Coke Conditions.

Coke, of course is the common fuel, and with a fairly good coke, which should run uniform as to composition and cellular structure, a good iron should be obtained.

What should be done, however, is to keep the coke dry. It is wrong to expect the cupola to work well and feed wet fuel into it. I will try to explain why wet fuel is detrimental. First, let us assume we wish a charge of 600 pound of coke per charge of iron. If, as is possible, especially in winter where the coke is exposed to the weather, it contains as high as 33⅓ per cent. moisture, for every charge of 600 pounds of wet coke weighed, 200 pounds is water and only 400 pounds is coke that is serviceable to produce heat. Of this amount of heat produced some is necessary to drive that very 200 pounds of water, put in with it, out of the cupola, so that the actual amount of heat available to melt iron is still lowered by that amount. It naturally follows that, if a reduction of one-third of the amount of coke required to melt iron at the proper temperature were made, the iron obtained would be too dull to pour.

Calculation of Moisture.

There is a way by which this evil of wet coke may be overcome, which is both simple and easy to carry out. To do this it is only necessary to determine the amount of moisture the coke contains and make proper adjustment of the scale weight of coke per charge, to be added. This determination of the moisture content is very easy and simple: first, weigh out say 10 pounds of the wet coke, put it in a hot oven or other warm place to dry. The loss in weight, as found by again weighing the coke (which of course is the dry coke), represents the amount of water that was present. It is only necessary then to add extra coke to make up for this difference so that when the coke descends in the cupola to the melting zone the requisite amount will be there to do the work intended for it.

This method has been tried at several plants and has been found highly satisfactory. Of paramount importance is the condition of the coke as it enters the cupola to form the bed before lighting up. This coke should, by all means, be thoroughly dried; in fact so important is this item that whatever expense is incurred in drying this bed coke is amply repaid by the good work it does.

Sulphur in Coke.

Another evil of the fuel is the ever-present sulphur. The amount of sulphur absorbed by the iron from the fuel is not at all constant. It is an established fact that all the sulphur in the coke does not go into the iron, although the amount absorbed by the iron may render it unsuitable for the work in hand. Only a chemical analysis will determine the amount of sulphur a fuel may contain and still be safe as a fuel.

Combustion and Coke Charges.

Assuming the coke is of average quality, the manner in which it is to be used will next claim our attention. We add fuel for the heat units it gives up on combustion. It is also added to support the burden and to maintain the proper melting points. To do this a careful watch of the melting conditions must be maintained. It is quite possible to spoil an otherwise good heat by the improper feeding of the fuel. It should always be carefully leveled off after each charge is in the cupola or slightly dished. By dished I mean it should be drawn toward the outer edge or against the lining, leaving a slight hollow in the centre. By charging in this manner more resistance is offered to the blast, which escapes more or less freely around this part of the furnace. It sometimes happens that the coke bed in the melting zone becomes uneven and it is at once necessary to rebuild it to the proper and uniform height This can be done most effectively by adding a few hundred pounds of extra coke over the weak spot when only half of the iron charge is in the cupola, then finish charging the balance of that iron charge and proceed as usual. The extra coke is added when one-half of the iron charge is in the cupola to insure its being placed and retained in the proper position in the cupola. In a short time, depending on the speed of melting, this extra coke will be down to the melting zone and will very materially rebuild that part of the bed.

It is very important, for economical reasons, that the melting proceed as even and regular as is possible, for the result of bad melting manifests itself throughout the entire plant and is the cause of otherwise valuable castings being thrown out on the scrap heap.

Use of Limestone.

To keep the furnace open and free for a long period of time, the dirt of the charges must be separated and removed from the iron. This is both easily and cheaply effected by adding a substance along with the charge that will unite with this foreign matter and become so fluid that it may be drawn from the cupola. The substance commonly employed is limestone, although other materials can be used. This limestone should be broken to about the size of eggs.

There are many different grades of limestone, and before a furnaceman can decide intelligently what is wanted he should obtain a complete chemical analysis of the particular kind he desires to use.

Burning the Shell.

The use of limestone, however, is not altogether without limit, for too much stone is as bad or worse than too little, The repeated large doses of limestone are apt to cause the cupola to burn through the shell. The writer remembers one experience of this character. He was working on a 100-inch cupola, lined to 81 inches at melting zone, melting 22 tons of iron per hour for several consecutive hours, when the report came up that the cupola had gone through the shell. It was necessary to act quickly, and this is what was done. About 16 or 18 lining brick were placed in the cupola on the top of the iron charge, over the place where the cupola had eaten its way through. These brick were allowed to descend along with the other charges. While they were descending, the hole (which was about 4 inches above the wind box) was stopped with mud and the outside cooled with a stream of water. When the brick reached this place they lodged in the depression of the lining, and were found there next morning, having performed the work intended for them. The heat was finished successfully, after taking the blast off for about 10 minutes only, while mud was being placed in the hole.

Character of Slag.

It is possible to completely change the character of the slag. If the mixture carries a large percentage of sulphur which requires let us say 100 pounds of stone to produce a low sulphur iron (the stone effecting the removal of some sulphur) and we drop the amount of stone to 40 or 50 pounds per charge, or even less, the iron will be changed from soft to hard or even white iron. I am speaking now of a heat of 10 or 12 hours' duration. For a heat of but an hour or so, little stone if any will be required, but for a heat of several hours or even days special precautions must be taken in order to keep the quality of the iron the same.

Lining the Cupola.

The best brick made from silica sand should be used for lining, and the patching material should be of the best. This material or mud should be mixed dry, for a more intimate mixture can be obtained in this way than when it is first wet and then mixed. Experience has proven that less fire-clay is necessary when handled this way than when mixed wet. After mixing it should be wet down and allowed to remain over night before using. In this way the plasticity of the clay is at its highest.

It is not uncommon to go into a cupola

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