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PROCESS FOR THE PRODUCTION OF NODULAR CAST IRON

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This invention relates to a process for the treatment of cast iron to improve its physical properties and, more particularly, to a process resulting in cast iron containing graphite in nodular form.

The art is familiar with processes and treatments whereby nodular cast iron may be produced. This material contains graphite which is in part or wholly in nodular form. Essentially such processes and treatments result in the retention by the cast iron of small amounts of nodulizing agents, for example magnesium and cerium. Conventionally these agents are added to cast iron, usually in the form of alloys, and the resulting iron inoculated and cast. The inoculation consists of adding silicon to the cast iron and this has been accomplished in the art either by bulk additions of silicon or silicon alloys to the cast iron in the ladle, by tapping the cast iron into ladles containing the inoculant or by other suitable means.

It has been demonstrated that the efficiency of the nodulizing agent may be increased by resorting to gaseous injections of the agent instead of bulk additions which have been employed in the past. According to this technique the nodulizing agent in suitable form is comminuted and injected below the surface of the molten iron in a stream of an inert gas such as argon. After this treatment the cast iron is inoculated in the conventional manner and cast as nodular iron.

While the treatment of the pricr art has been successfully used to produce nodular cast iron, the efficiency of the inoculant , the homogeneity of the product and the heat losses in the process have left something to be desired.

It is the principal object of the present invention to provide an improved process for the production of cast iron containing nodular graphite. Another object is to provide a process which permits the efficient utilization of both the nodulizing agents and inoculants used in the production of nodular cast iron. Still another object is to provide a process for the production of nodular cast iron wherein heat losses during the process are minimized. Still another object is to provide a process for the production of nodular cast iron which results in the efficient production of an improved homogeneous nodular cast iron.

These objects are accomplished according to the invention by modifying the injection techniques previously described by adding to the nodulizing agent an inoculant in suitable proportions and thus effecting the nodulizing and inoculating in one operation. More specifically the objects are accomplished by mixing in powdered form a nodulizing agent, such as magnesium, and an inoculant, such as calcium silicon, and injecting the powder in a stream of an inert gas, such as argon, into a molten bath of refined and purified cast iron.

Among the nodulizing agents that may be advantageously used in the process of the invention are magnesium, magnesium-ferrosilicon, cerium containing magnesium-ferrosilicon, and rare earth oxides. It will be noted that

these nodulizing agents themselves may contain silicon, an inoculant. However, because of the high rate of recovery of the nodulizing materials when the injection technique is employed, an additional inoculation of the cast iron is necessary to provide sufficient silicon.

The inoculant in the process of the invention may be any silicon containing material ordinarily used for that purpose in the metallurgical art. Examples of those materials that have been found to be particularly efficacious are silicon and alloys of silicon such as calcium silicon and ferrosilicon.

The injection of relatively low melting point materials into molten cast iron is a difficult operation. The low melting point material tends to soften and plug up the equipment. To eliminate this plugging a diluent of a high melting point material may be employed in the process of the invention. A suitable material for this purpose is calcium carbide which has no detrimental effect on the cast iron. Other refractory materials, for example magnesia, which will not adversely affect the cast iron may be employed as diluents.

The nodulizing agent, inoculant, and refractory diluent, if used, are comminuted, preferably to a size of less than about 20 mesh. The comminuted materials are entrained in a stream of an inert gas, preferably argon or one of the other monatomic gases, and injected through a tube, suitably of graphite or wrought iron, into molten cast iron. The flow rates of particles that may be employed have been found to be somewhat dependent on the size of the body of metal into which the stream of gas and particles is being injected. In ladles containing about three hundred pounds of metal a flow rate of about two pounds of particles per minute has been maintained satisfactorily. In larger ladles, up to several thousand pounds of metal capacity, flow rates of ten pounds of particles per minute are possible. In addition to the sizes of the ladle the composition of the powder is an important consideration in determining flow rates. In general if magnesium in elemental or alloyed form is the nodulizing agent, a rate of one pound of magnesium per minute may be used. The total amount of powder involved would of course be greater when the magnesium is present in the form of an alloy than when it is in elemental form.

Nodular iron was obtained using the process of the invention in one test involving a three hundred pound heat of cast iron. A comminuted mixture of 45% calcium carbide, 45% calcium silicide, and 10% rare earth oxides was entrained in a stream of argon and passed through a graphite tube into the molten iron. A flow rate of about two pounds of powder per minute was maintained until a 1.33% addition of the powder had been made. The treated iron was cast without further treatment and proved to have graphite in nodular form.

In another test a mixture of 33⅓% calcium carbide, 33⅓% magnesium ferrosilicon, and 33⅓% ferrosilicon was added to molten cast iron using similar techniques. A nodular cast iron was obtained with a 0.36% addition of the mixture.

In another instance a mixture of 50% calcium carbide, 30% calcium silicide and 20% cerium-magnesium-ferrosilicon was added to cast iron. A 0.93% addition of this mixture according to the process of the invention was sufficient to produce nodular cast iron as cast.

The efficiency of the process of the invention is illustrated by the high recoveries of the constituents of the powder added. For example, silicon recoveries have ranged from 75% up to 100% with the process of the invention.

In some applications the gas used to convey the powdered materials into the body of molten metal should

be inert to the materials being treated. The monatomic gases, and particularly argon, haves proved to be eminently satisfactory when no gas adsorption or reaction can be tolerated. In other instances gases of a more reactive nature may be used.

What is claimed is:

1. A process for the production of nodular cast iron which comprises entraining in a stream of an inert gas a comminuted mixture of a nodulizing agent, an inoculant, and a refractory diluent, injecting said mixture into a bath of molten cast iron, and casting said cast iron.

2. A process for the production of nodular cast iron which comprises entraining in a stream of an inert gas a comminuted mixture of at least one of the nodulizing agents in the group consisting of magnesium and magnesium alloys, at least one of the inoculants in the group consisting of silicon and silicon alloys, and a refractory diluent, injecting said mixture into a bath of molten cast iron, and casting said cast iron.

3. A process for the production of nodular cast iron which comprises entraining in a stream of an inert gas a comminuted mixture of cerium-magnesium-ferrosilicon,

an inoculant, and calcium carbide, injecting said mixture into a bath of molten cast iron, and casting said cast iron.

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