Mg-Wire Treatment of Ductile Iron

Metallurgical treatment by means of wire has been a normal practice for many years in the microalloying, deoxidizing and degassing of molten metals. The magnesium treatment of ductile and compacted graphite irons in volumes of from 100 to 30,000 lb ingot molds is a more recent development that is being done successfully in European and North American foundries. This article investigates the suitability of wire treatment for small ductile iron quantities ranging from 100-2000 lb.

The most widely used magnesium treatments for producing ductile iron are the sandwich, tundish and flow-through methods. These are most often applied in front of the melting or holding furnace and require subsequent, time-consuming handling of the treated iron which can result in treatment fade, particularly with small batches of ductile iron.

In addition, these treatment methods often require a significant number of large silicon additions (0.7-1.0%) during the Mg treatment. Since the treatment normally occurs minutes before pouring, these late additions of Si can cause increased quantities of slag that often results in inclusion problems in the finished casting. Because "clean" metal is a significant factor in the ultimate quality of a ductile iron casting, it is important to avoid late additions of large Si quantities, especially with automatic pouring systems.

Considering the requirement for "clean" iron, the Mg treatment by means of tubular wire offers several distinct advantages:

- It is done with almost no Si, resulting in a cleaner iron;
- It can be performed anywhere in the foundry—when it is done near the pouring line, fading can be minimized;
- Small quantities can be accurately and effectively treated in the pouring ladle at lower temperatures with no reloading required;
- The process can be automated.

Tubular Wire Treatment

In general, any ladle can serve as the treatment vessel using the tubular wire procedure, and a specially designed ladle is not required. In operation, the ladle is filled and transported to the desired treatment location, preferably as close to the pouring line as possible. The addition rate of the treatment wire is fixed, based on the known parameters (e.g., sulfur content, metal temperature and weight, required residual Mg content, etc.).

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In the tubular wire Mg treatment of ductile iron, the wire is fed through the specially designed ladle cover (see inset) at a predetermined rate. The system can be located anywhere in the foundry, but nearer to the pouring line better reduces Mg fade.
A removable cover is then placed on the ladle, either manually or automatically, and the predetermined quantity of wire is spooled into the ladle. The feeder is started by a push button and stops automatically. The ladle cover is then removed, allowing slag to be skimmed off. The iron is ready for pouring. Stream or in-the-mold inoculation is recommended when utilizing the tubular wire method.

The tubular wire treatment system is comprised of three major components.

Wire—The tubular wire and its filling is a proprietary process patented by Metalgesellschaft, A.G. (patent no. EP 0066 305 B1).

Wire Feeder—Movement of the wire is accomplished either by a tachigrapher-controlled, semi-automatic drive which enables feeding of the wire at infinitely variable speeds of between 0-12 in./sec, or a fully automatic system with a wire speed of 1-10 ft/sec for each of the two wires utilized.

For each feeder, the number of feet required per wire feed operation can be preselected. For additional feeding operations using the same number of feet, it is sufficient to simply use the push-button operation. During the feeding operation, the wire length used is computed and feeding speed is displayed. Once the desired quantity of wire has been added to the melt, the feeder stops automatically.

Ladle Cover—A specially designed ladle cover prevents splashing during treatment. The flat-shaped lid is provided to enlarge the reaction volume which causes a good separation of the reaction products from the melt contributing to metal cleanliness.

Arrangement of the system involves mounting the feeder and ladle on a sliding carriage. By manually or automatically shifting the carriage or trolley, the ladle cover engages the bail of the pouring ladle. The ladle is then lifted against the lid and the treatment operation can be started by pressing the start button of the wire feeder.

During the reaction phase of the operation the lid on the ladle prevents the iron from splashing and promotes the precipitation of Mg vapor. Consequently, only a minimal amount of fumes and smoke escape into the foundry atmosphere. Because the process uses the same ladle for both Mg treatment and pouring, temperature losses are minimized.

In addition to the features of the tubular wire system illustrated above, this Mg treatment can also provide other benefits. For example, starting with a sulfur level in the base iron of 0.010-0.020%, final sulfur levels of 0.005-0.010% are attainable. It also provides a high level of Mg recovery, usually within a tolerance of ±3%.

Conclusion

Production of ductile iron by means of Mg treatment wire is especially suitable for the treatment of small iron melts or when an automatic pouring system is utilized. The process enables a simple sequence of operations to be carried out in minimal time anywhere in the foundry using only one ladle for tapping the iron from the furnace and pouring the treated iron. Initial investment costs are relatively low and the method can be automated.

This close-up view shows the fully automatic wire feed system that can achieve feed rates of between 1-10 ft/sec.