Controlling Shrinkage Defects in Graphitic Cast Irons

AFS Cast Iron Gating and Rising Committee
John W. Anderson, principal author
QIT-Fe et Titane, Inc
Montreal, Quebec, Canada

A recent task of the AFS Cast Iron Gating and Rising Committee was to decide the future direction of committee activities. Committee members, representing various sectors of the iron foundry industry, determined that the first objective should be to advance the industry's understanding of solidification phenomena in cast irons. More specifically, the committee decided identifying the causes and remedies of shrinkage defects in graphitic cast irons should have highest priority.

Literature Review

An extensive literature survey was undertaken by the committee using the resources of the AFS Library. Abstracts of more than 350 subject-related papers were reviewed and 35 were selected for detailed study. Of these, ten are considered "recommended reading" by the committee and are listed at the end of this article.

In several respects, the literature presented conflicting views on the phenomena associated with volume changes in cooling and solidifying graphitic irons. There was, however, agreement by a number of authors on several issues and the need for further research is apparent.

There were several areas of broad agreement among the authors:
- Volume changes in cooling and solidifying graphitic irons are complex. They consist of an initial liquid contraction followed by expansion, which does not continue to the end of solidification.
- Expansion during cooling and solidification can produce pressures of hundreds of pounds per square inch in a rigid mold. In a nonrigid mold, expansion may produce mold wall movement.
- Volume changes are not material constants. They can be influenced by production process variables of the liquid iron.
- In nonrigid molds, two components can produce enlargement of the mold cavity: expansion of the cooling liquid; or mold "self-enlargement" due to heating of the molding medium.
- Many riser design methods have been proposed to compensate for volume changes. Although the various methods appear to provide satisfactory results in specific circumstances, none can be universally applied.
- Caution must be exercised in attempting to apply volume change principles to the risering of castings. A volume increase during cooling and solidification has been interpreted to mean that castings may need little or no risering. Recorded in the literature are examples of castings that have been produced without risers or with extremely small risers. These castings have subsequently been proved to be free of shrinkage defects by radiographic examination. Such castings have always been produced in rigid molds with iron metallurgy controlled to very close limits. When unstable (sand) molds are used, risering to provide feed metal may be necessary, even though there is an expansion of the liquid metal during cooling and solidification.

Future Work

There is at least a basic understanding of the qualitative factors that combine to produce volume changes in graphitic irons. However, many shortcomings are obvious in the published attempts to quantify the effects of volume changes on casting integrity. Future efforts should move to address such questions as:
- optimum riser and riser neck geometry;
- optimum riser feeding distance;
- quantification of the effects of production process variables on the magnitude of volume changes.

Until these questions are resolved, risering of graphitic iron castings is needed except where the castings will be produced in rigid molds with metalurgy and pouring practice tightly controlled.

References


For a free copy of this article circle No. 308 on Reader Action Card.