

Anode Casting Processes:

Sand Casting involves pouring molten cast iron into moulds made by binding sand grains together by clay and water, or chemical binders. Sand is a refractory "insulator" that transfers heat relatively slowly in comparison to moulds made from metal, used for centrifugal or chill casting. The low rate of heat transfer by sand, combined with heat created by burning binders, results in slow cooling of sand castings. Slow solidification promotes formation of metallurgical properties that weaken corrosion resistance and most mechanical properties.

For anodes, sand casting is pretty well restricted to production of solid rod stick anodes in HSCI. Tubular anodes require either Centrifugal or Chill Casting.

In **Centrifugal Casting**, molten metal is poured into a rapidly spinning metal mold. Centrifugal force presses the metal against the outer wall of the metal mould, resulting in rapid solidification of the molten metal. Centrifugal forces concentrate lighter constituents, like slag and inclusions, toward the inside of anodes. In practical terms, wall thickness and weight are relatively difficult to control because centrifugal casting employs an open mould. Overall, centrifugally formed diameters have to be uniform and featureless like a pipe, in contrast with Chill Casting as perfected by Anotec, which creates anodes with beneficial design features and superior metallic qualities,

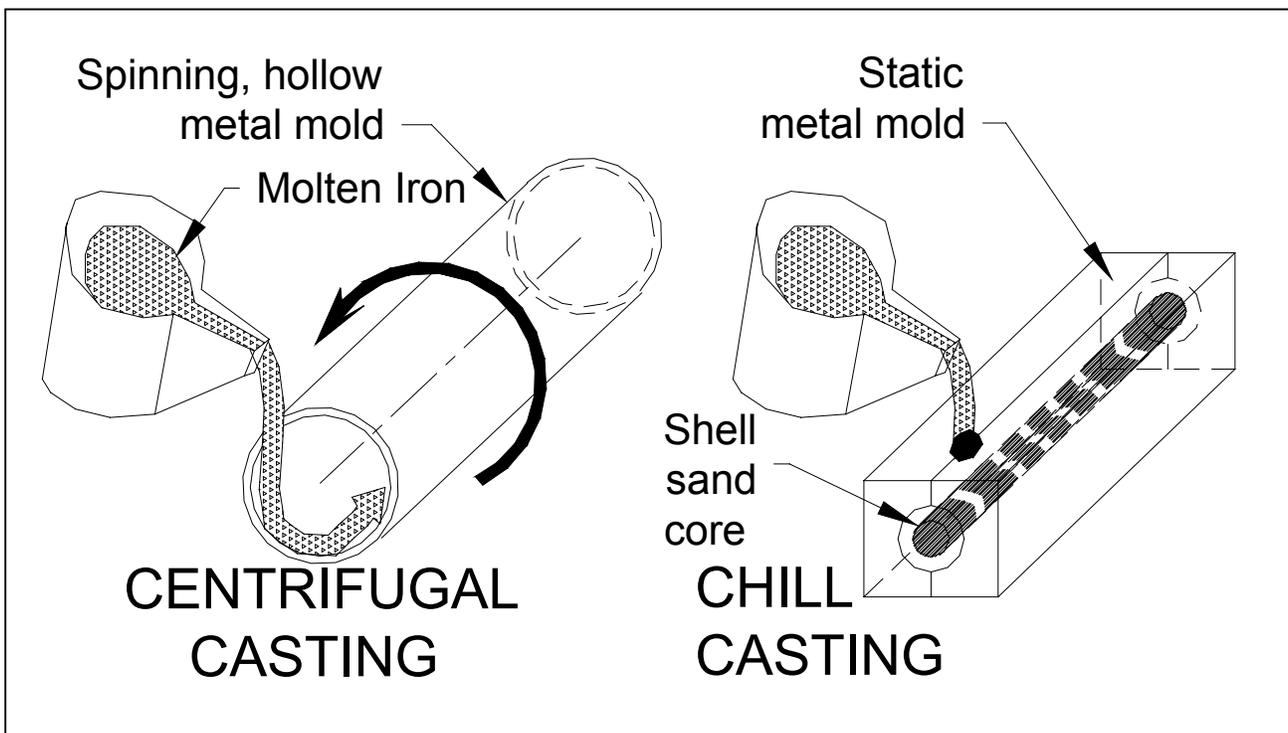


Figure 1: Anode Casting in Metal Moulds

Production Methods for HSCI Anodes: Sand, Centrifugal and Chill Casting.

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In contrast to Centrifugal tubular anodes, “Chill Cast” tubular anodes are made in static “closed moulds” that use precision shell sand cores to form the anode bore. After the casting cools, two (or more) parts of the mould open wide to release the casting. A shell core on the ID, and a 2-part mould for the OD, permit strategic dimension variations not possible by Centrifugal Casting. For example:

- A tapered connector seat for cable connection (think of the holding power of a tapered drill stem, set into the matching taper of a drill press spindle)
- Retention features inside the anode, to secure anchors and epoxy.
- Expanded wall thickness around the central connection zone to prolong life and raise impact resistance.

Besides shape feature, another advantage of Chill Casting is minimization of anode weight variation.

Typically, weight can be controlled to within 1 % total variation, representing 0.5 lb for a 50lb casting, even with gradual mold wear over time. An additional advantage of Chill Casting is that it is suitable for casting solid stick anodes, as well as relatively thick walled tubular anodes, not possible by centrifugal casting. For example, a Chill Cast 4.8” od x 1.8” id x 84” long tubular anode has 1.5” wall thickness, and weighs 315lb. It is useful for sea-bottom anodes where large impressed currents are needed. Even slightly thickened walls significantly improve impact resistance. Centrifugal anodes in FeSi are limited to a 0.75” wall in the largest heaviest catalogue size 175lb.

For any tubular anode of specific weight and length, the thicker the wall, the smaller must be the diameter, both exterior and interior. Reduced interior diameter, up to a point, enhances the quality of seal used to protect the cable connection from the environment. This is explained in: [Cable to Anode Connection](#). The seal enhancement features are a significant benefit proprietary to Chill Cast tubulars.

In metal mould casting, whether static or centrifugal, directional solidification takes place very rapidly from the mould wall inwards toward the anode centre. Thus although the desirable microstructure first forms at the working surface of the anode, it continues inward toward the centre, even through the thicker walls achievable by Chill Casting.

This is not to say that the Chill Casting process for anodes is without challenges. In fact the process is sensitive, and process control is extremely important. But by dedicating production exclusively to high silicon iron anodes by Chill Casting, Anotec assures reliable control of the process to ISO 9001.2000, to deliver a line of HSCI anode products second to none for the CP market.

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References Note: Superscripts reference Anotec Document Numbers

- (22) = reference listed below
- (#22) = Anotec Article
- (L22) = Anotec Private Library Item

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