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Conventional Steelmaking vs. Powder Metallurgy Steelmaking

Conventional steelmaking begins by melting steel in a large electric arc furnace. The initial melting of the steel is usually followed by a secondary ladle refining process such as Argon Oxygen Decarburization (AOD) or Vacuum Oxygen Decarburization (VOD). After refining, the molten metal is cast into ingots.

Ladle Refining

Cast Ingots

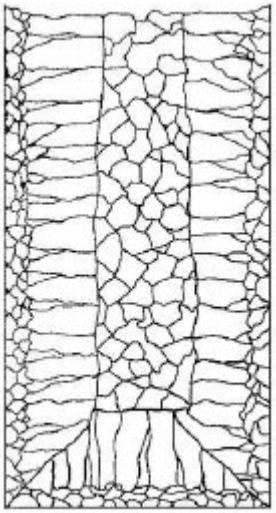
Conventional Steelmaking - Ingot Structure

Cast steel is very homogeneous in the molten state but as it slowly solidifies in the ingot molds, the alloying elements segregate producing a non-uniform as-cast structure. In high speed steels and high alloy steels, carbides precipitate and form coarse networks that must be broken up by hot working of the ingots. The hot processing will improve the structure but the segregation effects are never fully eliminated.

Cast Ingot

And

Internal Structure



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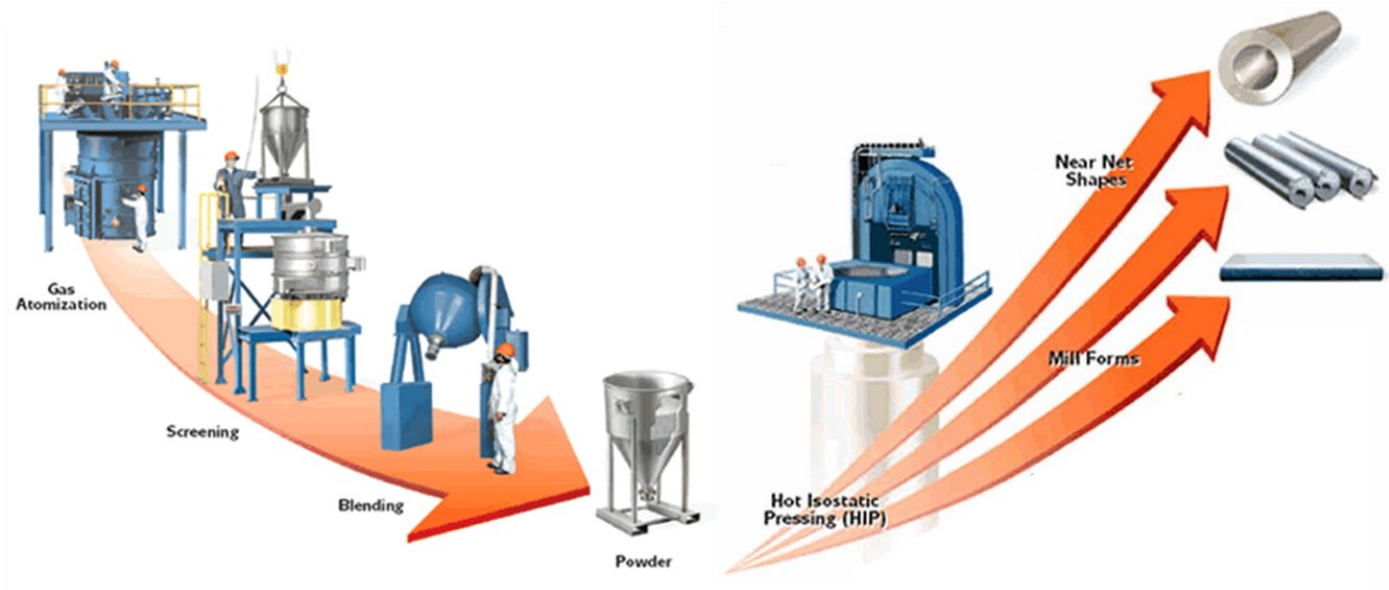
Powder Metallurgy Steelmaking using Hot Isostatic Pressing (HIP)

Making tool steels using Hot Isostatic Pressing begins with an initial melt furnace similar to a conventional melting process but on a much smaller scale.
Instead of pouring and casting the melt, the molten metal is poured through a small nozzle where high pressure gas atomizes the liquid stream. The droplets fall and rapidly solidify into powder which is collected in the atomization chamber.
Each powder particle is essentially a micro ingot with minimal segregation and fine carbides. The fine carbide size is retained through the mill processing.

After atomization the powder is collected, screened to specific mesh requirements, and blended. The powder is loaded into steel containers, evacuated of air, then sealed.
The steel containers full of powder are then loaded into an autoclave and Hot Isostatically Pressed at pressures and temperatures approximately the same as used for forging.
The powder consolidates bonding the loose powder into a fully dense ingot.
The PM ingot will then be forged and or rolled to final finished dimensions.



Making PM tool steels with the Hot Isostatic Press (HIP) process

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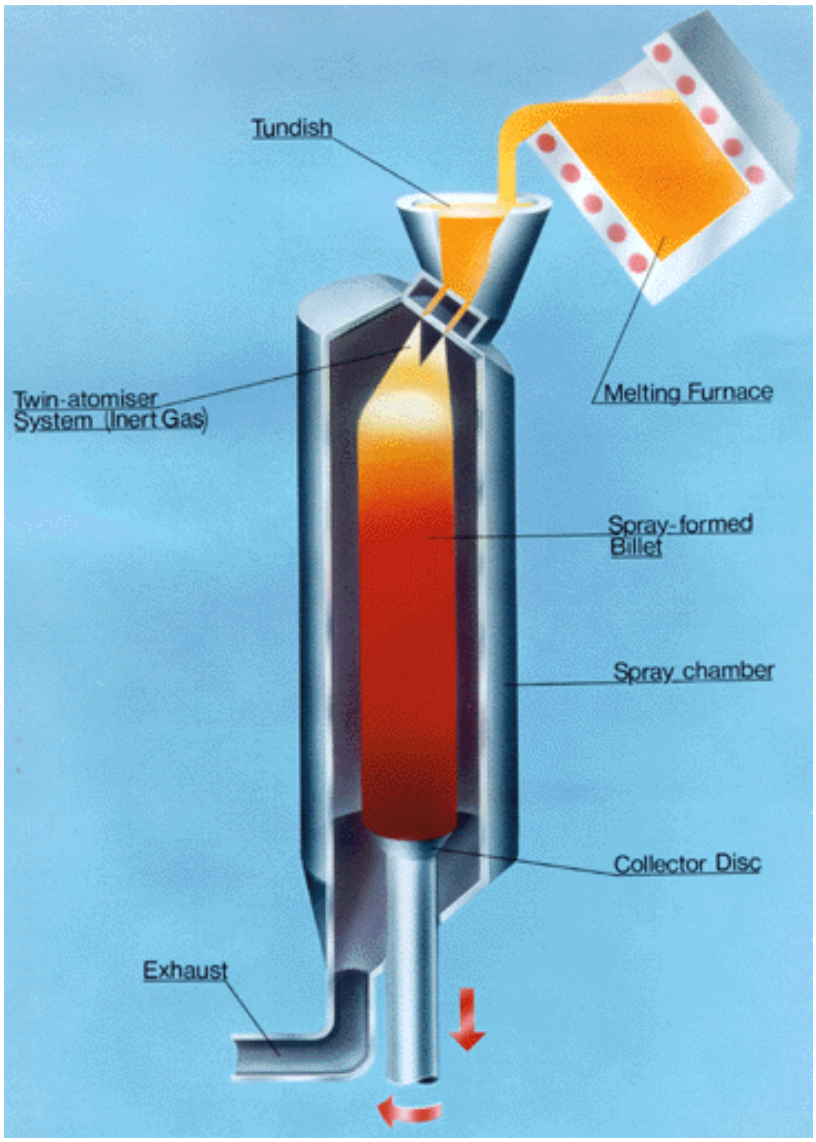
Powder Metallurgy Steelmaking using the Sprayform process

Making tool steels using the Sprayform process begins with an initial melt furnace similar to a conventional melting process but on a much smaller scale.
Instead of pouring and casting the melt, the molten metal is poured through a small nozzle where high pressure gas atomizes the liquid stream. The atomized droplets are directed onto a rotating platen where they collide and fuse, building up into a fully formed ingot.
Each powder particle is essentially a micro ingot with minimal segregation and fine carbides. The fine carbide size is retained through the mill processing.

After the Sprayform ingot is formed it will be forged and or rolled to final dimensions.



Making PM Tool Steel using the Sprayform Process

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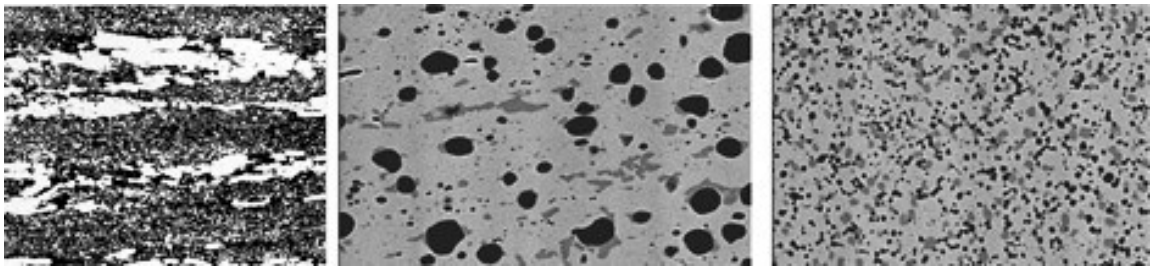
Conventional Steelmaking vs. Powder Metallurgy Steelmaking

Steel Structure

PM steel processes result in uniform structures and homogeneous carbide distribution.
PM Steels offer properties above and beyond conventional steel making capabilities.



Conventional **Sprayform PM** **HIP'd PM**

PM Tool Steel Advantages

For Most applications, the PM tool steels offer many benefits over ingot cast tool steels.
The enhanced properties are gained from the uniformity of the PM structure
and the unique alloys produced by the process.

Advantages for the end user

Highly alloyed grades available
Improved toughness and chip resistance
Improved Wear Resistance
Good grindability and machining characteristics
Consistent Tool performance from heat to heat
Higher productivity with higher properties

Advantages for the tooling manufacturer

Good grindability and machining characteristics
Consistent and predictable heat treatment response
Homogeneous carbide structure good for coatings
Consistent wire EDM cutting