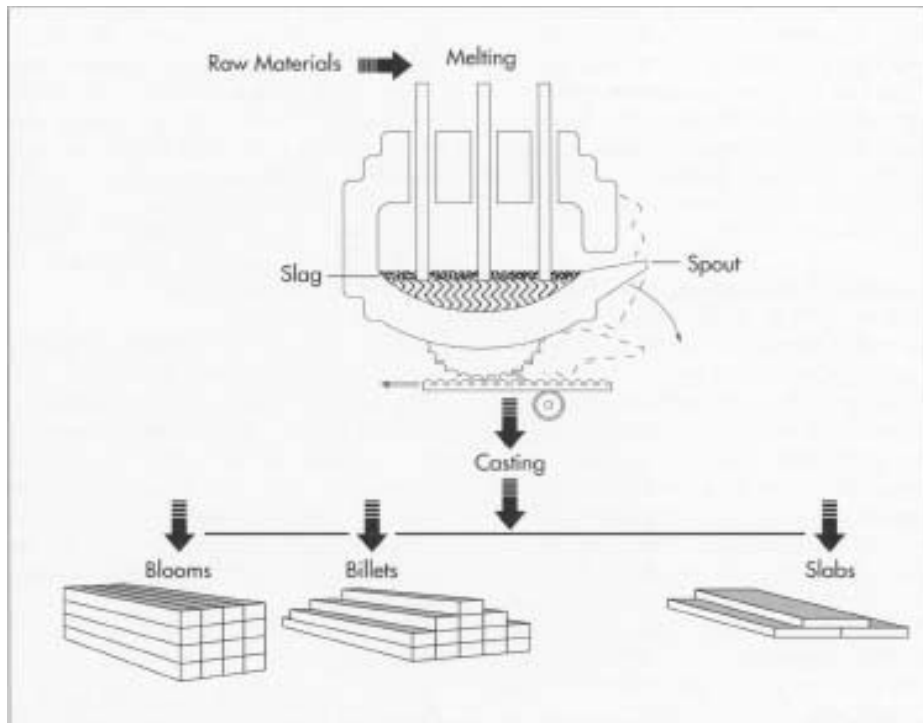


The Manufacturing Process Of Stainless Steel

The manufacture of stainless steel involves a series of processes. First, the steel is melted, and then it is cast into solid form. After various forming steps, the steel is heat treated and then cleaned and polished to give it the desired finish. Next, it is packaged and sent to manufacturers, who weld and join the steel to produce the desired shapes.



To make stainless steel, the raw materials—iron ore, chromium, silicon, nickel, etc.—are melted together in an electric furnace. This step usually involves 8 to 12 hours of intense heat. Next, the mixture is cast into one of several shapes, including blooms, billets, and slabs.

Melting and casting

The raw materials are first melted together in an electric furnace. This step usually requires 8 to 12 hours of intense heat. When the melting is finished, the molten steel is cast into semi-finished forms. These include blooms (rectangular shapes), billets (round or square shapes 1.5 inches or 3.8 centimeters in thickness), slabs, rods, and tube rounds.

Forming

Next, the semi-finished steel goes through forming operations, beginning with hot rolling, in which the steel is heated and passed through huge rolls. Blooms and billets are formed into bar and wire, while slabs are formed into plate, strip, and sheet. Bars are available in all grades and come in rounds, squares, octagons, or hexagons 0.25 inch (.63 centimeter) in size. Wire is usually available up to 0.5 inch (1.27 centimeters) in diameter or size. Plate is more than 0.1875 inch (.47 centimeter) thick and over 10 inches (25.4 centimeters) wide. Strip is less than 0.185 inch (.47 centimeter) thick and less than 24 inches (61 centimeters) wide. Sheet is less than 0.1875 (.47 centimeter) thick and more than 24 (61 centimeters) wide.

Heat treatment

After the stainless steel is formed, most types must go through an annealing step. Annealing is a heat treatment in which the steel is heated and cooled under controlled conditions to relieve internal stresses and

soften the metal. Some steels are heat treated for higher strength. However, such a heat treatment—also known as age hardening—requires careful control, for even small changes from the recommended temperature, time, or cooling rate can seriously affect the properties. Lower aging temperatures produce high strength with low fracture toughness, while higher-temperature aging produces a lower strength, tougher material.

Though the heating rate to reach the aging temperature (900 to 1000 degrees Fahrenheit or 482 to 537 degrees Celsius) does not effect the properties, the cooling rate does. A post-aging quenching (rapid cooling) treatment can increase the toughness without a significant loss in strength. One such process involves water quenching the material in a 35-degree Fahrenheit (1.6-degree Celsius) ice-water bath for a minimum of two hours.

The type of heat treatment depends on the type of steel; in other words, whether it is austenitic, ferritic, or martensitic. Austenitic steels are heated to above 1900 degrees Fahrenheit (1037 degrees Celsius) for a time depending on the thickness. Water quenching is used for thick sections, whereas air cooling or air blasting is used for thin sections. If cooled too slowly, carbide precipitation can occur. This buildup can be eliminated by thermal stabilization. In this method, the steel is held for several hours at 1500 to 1600 degrees Fahrenheit (815 to 871 degrees Celsius). Cleaning part surfaces of contaminants before heat treatment is sometimes also necessary to achieve proper heat treatment.

Descaling

Annealing causes a scale or build-up to form on the steel. The scale can be removed using several processes. One of the most common methods, pickling, uses a nitric-hydrofluoric acid bath to descale the steel. In another method, electrocleaning, an electric current is applied to the surface using a cathode and phosphoric acid, and the scale is removed. The annealing and descaling steps occur at different stages depending on the type of steel being worked. Bar and wire, for instance, go through further forming steps (more hot rolling, forging, or extruding) after the initial hot rolling before being annealed and descaled. Sheet and strip, on the other hand, go through an initial annealing and descaling step immediately after hot rolling. After cold rolling (passing through rolls at a relatively low temperature), which produces a further reduction in thickness, sheet and strip are annealed and descaled again. A final cold rolling step then prepares the steel for final processing.

Cutting

Cutting operations are usually necessary to obtain the desired blank shape or size to trim the part to final size. Mechanical cutting is accomplished by a variety of methods, including straight shearing using guillotine knives, circle shearing using circular knives horizontally and vertically positioned, sawing using high speed steel blades, blanking, and nibbling. Blanking uses metal punches and dies to punch out the shape by shearing. Nibbling is a process of cutting by blanking out a series of overlapping holes and is ideally suited for irregular shapes.

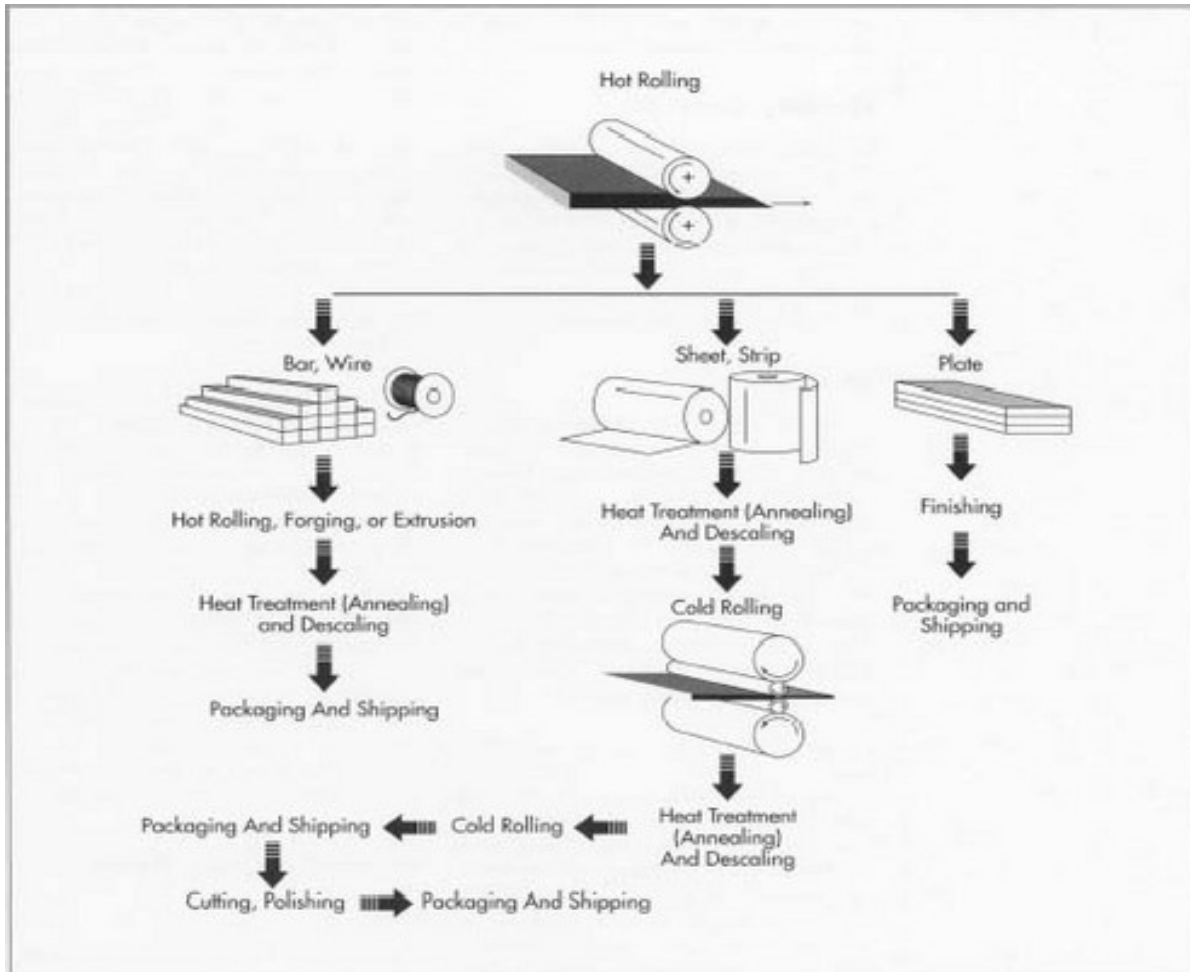
Stainless steel can also be cut using flame cutting, which involves a flame-fired torch using oxygen and propane in conjunction with iron powder. This method is clean and fast. Another cutting method is known as plasma jet cutting, in which an ionized gas column in conjunction with an electric arc through a small orifice makes the cut. The gas produces extremely high temperatures to melt the metal.

Finishing

Surface finish is an important specification for stainless steel products and is critical in applications where appearance is also important. Certain surface finishes also make stainless steel easier to clean, which is obviously important for sanitary applications. A smooth surface as obtained by polishing also provides better corrosion resistance. On the other hand, rough finishes are often required for lubrication applications, as well as to facilitate further manufacturing steps.

Surface finishes are the result of processes used in fabricating the various forms or are the result of further processing. There are a variety of methods used for finishing. A dull finish is produced by hot rolling, annealing, and descaling. A bright finish is obtained by first hot rolling and then cold rolling on polished rolls. A highly reflective finish is produced by cold rolling in combination with annealing in a controlled atmosphere

furnace, by grinding with abrasives, or by buffing a finely ground surface. A mirror finish is produced by polishing with progressively finer abrasives, followed by extensive buffing. For grinding or polishing, grinding wheels or abrasive belts are normally used. Buffing uses cloth wheels in combination with cutting compounds containing very fine abrasive particles in bar or stick forms. Other finishing methods include tumbling, which forces movement of a tumbling material against surfaces of parts, dry etching (sandblasting), wet etching using acid solutions, and surface dulling. The latter uses sandblasting, wire brushing, or pickling techniques.



The initial steel shapes—blooms, billets, slabs, etc.—are hot rolled into bar, wire, sheet, strip, and plate. Depending on the form, the steel then undergoes further rolling steps (both hot and cold rolling), heat treatment (annealing), descaling (to remove buildup), and polishing to produce the finished stainless steel. The steel is then sent the end user.

Manufacturing at the fabricator or end user

After the stainless steel in its various forms are packed and shipped to the fabricator or end user, a variety of other processes are needed. Further shaping is accomplished using a variety of methods, such as roll forming, press forming, forging, press drawing, and extrusion. Additional heat treating (annealing), machining, and cleaning processes are also often required.

There are a variety of methods for joining stainless steel, with welding being the most common. Fusion and resistance welding are the two basic methods generally used with many variations for both. In fusion welding, heat is provided by an electric arc struck between an electrode and the metal to be welded. In resistance welding, bonding is the result of heat and pressure. Heat is produced by the resistance to the flow of electric current through the parts to be welded, and pressure is applied by the electrodes. After parts are welded together, they must be cleaned around the joined area.