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Stainless Steel - Magnetic Properties

Background

Magnetic permeability is the ability of a material to carry magnetism, indicated by the degree to which it is attracted to a magnet. All stainless steels, with the exception of the austenitic group, are strongly attracted to a magnet.

Austenitic Grades

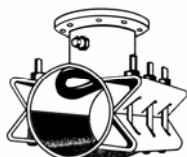
All austenitic grades have very low magnetic permeabilities and hence show almost no response to a magnet when in the annealed condition; the situation is, however, far less clear when these steels have been cold worked by wire drawing, rolling or even centreless grinding, shot blasting or heavy polishing. After substantial cold working Grade 304 may exhibit quite strong response to a magnet, whereas Grades 310 and 316 will in most instances still be almost totally non-responsive. The change in magnetic response is due to atomic lattice straining and formation of martensite. In general, the higher the nickel to chromium ratio the more stable is the austenitic structure and the less magnetic response that will be induced by cold work. Magnetic response can therefore be used as a method for sorting grades of stainless steel, but considerable caution needs to be exercised.



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Stress Relieving

Any austenitic (300 series) stainless steel which has developed magnetic response due to cold work can be returned to a nonmagnetic condition by stress relieving. In general this can be readily achieved by briefly heating to approximately 700 - 800°C (this can be conveniently carried out by careful use of an oxyacetylene torch). Note, however, unless the steel is a stabilized grade it could become sensitized to carbide precipitation. Full solution treatment at 1000 - 1150°C will remove all magnetic response without danger of reduced corrosion resistance due to carbides. If magnetic permeability is a factor of design or is incorporated into a specification, this should be clearly indicated when purchasing the stainless steel from a supplier.



Cold Working

Many cold drawn and/or polished bars have a noticeable amount of magnetism as a result of the previous cold work. This is particularly the case with grades 304 and 303, and much less so for the higher nickel grades such as 310 and 316. Even within the chemical limitations of a single standard analysis range there can be a pronounced variation in the rate of inducement of magnetic response from cold work. Therefore, slight magnetism is not unusual nor should it lead the end user to believe that parts and subcomponents are not stainless steel.