CLIFFS

HP MAGNET PLATE

PLATE STEEL

High-Energy Physics Research

Magnetic Resonance Imaging (MRI) Units

Hospital Shielding

Cleveland-Cliffs' **HP (HIGH PERMEABILITY) MAGNET PLATE** was developed to meet the special requirements of large fabricated DC magnets. This low carbon steel provides high density, low hysteresis loss, and powerful induction properties. It is available in plate thicknesses up to and including 16 inches. (Plate thicknesses over 16 inches can be inquired for consideration).

HP MAGNET PLATE is a "soft" steel, making it ideal for magnetization and demagnetization. In addition, the steel is fully silicon killed, wherein silicon is used as a deoxidizing agent to reduce unwanted oxygen in the steel and thus minimize internal inclusions for a more homogeneous internal structure.

HP MAGNET PLATE

Introduction

HP MAGNET PLATE steel is generally furnished to an ultrasonic quality level equal to that defined by ASTM A435, however, more stringent ultrasonic quality levels can be specified when greater internal soundness is required.

For enhanced internal soundness, the steel can be specified to include FINELINE, a refining process unique to Cleveland-Cliffs Plate, which can reduce non-metallic inclusions even more than conventional Cleveland-Cliffs Plate processing. For plates processed with FINELINE, quality levels up to and including ASTM A578 Level C can be specified. In addition, special ultrasonic examination utilizing flat bottom hole calibration standards can be specified and applied to critical portions of the section thickness. This testing method uses 100% scan to the following criterion:

Plate Thickness Inches	1" to 4" Incl.	Over 4" to 8" Incl.	Over 8" to 12" Incl.	Over 12" to 16" Incl.
Flat Bottom Hole Diameter, in.	1/8	1/4	3/8	1/2

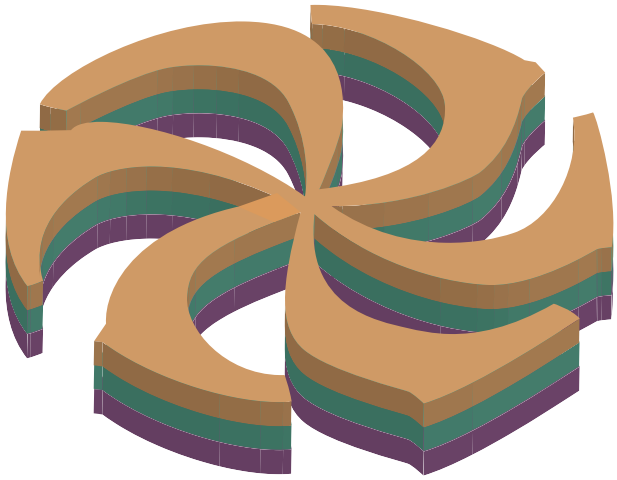
Applications

HP MAGNET PLATE is commonly used in the exciting field of high-energy physics.

This area of science probes into the atomic nucleus using a particle-accelerator. Among the vast and complex array of laboratory equipment in such facilities are massive plate steel cores in which powerful magnetic fields are induced to provide the switching, bending, pulsing and steering functions for manipulating electron and proton beams during experiments with nuclear particles.

In addition to its use in high-energy physics research, HP MAGNET PLATE is frequently specified for other applications where uniform magnetic qualities are required. These include Magnetic Resonance Imaging (MRI) units as well as shielding for hospital MRI rooms.

In general, HP MAGNET PLATE is designed for use wherever high magnetic permeability or high saturation values are required. Its exceptional magnetic qualities result from careful control of sulfur and residual elements plus the special deoxidation practice which minimizes non-metallic inclusions.



HP MAGNET PLATE steel in the form of an 11-3/4 in. thick gascut components for a pole plate for the TRIUMF H- Cyclotron, the world's largest. Negatively charged particles circulate through the magnetic field from these six huge electromagnets and are accelerated through 1500 widening spiral turns to almost 75% of the speed of light.

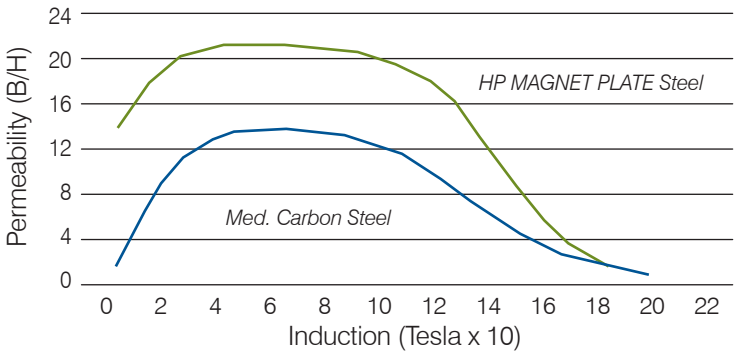
HP MAGNET PLATE

Chemistry

Element	Composition %
Carbon (C)	0.08 Max.
Manganese (Mn)	0.25 - 0.45
Phosphorus (P)	0.025 Max.
Sulfur (S)	0.025 Max.
Silicon (Si)	0.50 Max.
Cu + Ni + Cr + Mo = 0.50 Max.	

HP MAGNET PLATE steel is fully killed.

Comparison of the Relative Permeability of HP MAGNET PLATE and Medium Carbon Steels



Note: the datum contained here are actual test values obtained by testing at Cleveland-Cliffs and should not be considered minimum values offered or guaranteed. Magnetic properties should be considered to be characteristic for low-carbon steels. Actual testing is not normally performed.

Availability

HP MAGNET PLATE is furnished in thicknesses of ¼ in. to 16 in. inclusive. Plate thicknesses over 16 inches can be inquired for consideration.

Heat Treatment

Optimum magnetic properties of HP MAGNET PLATE are obtained through a full-anneal heat treatment. This consists of heating to 1600 – 1700°F, holding for a sufficient time to attain uniform temperature throughout the thickness, then slowly cooling. For example: hold 1 hour per inch of thickness at 1650°F, cool at 50°F max. per hour to 1000°F, then air cool. Other applications, such as shielding, may not require annealing.

Mechanical Properties

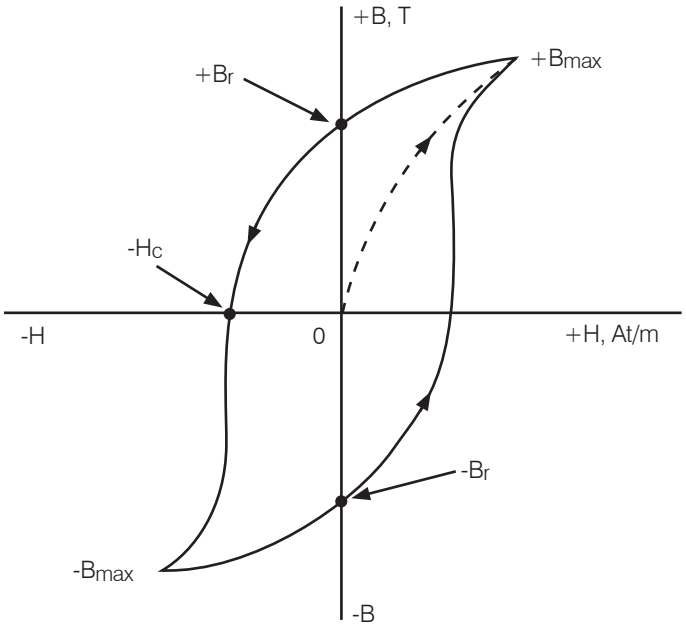
Normally, Cleveland-Cliffs magnet steels are not supplied to mechanical property requirements. However, mechanical properties that have been obtained through testing are as follows:

Yield Strength, psi	25,000
Tensile Strength, psi	35,000
Elongation in 2 in.	30%

General Conditions for Delivery

Material furnished under this specification shall conform to General Requirements for Delivery of Rolled Steel Plates for Structural Use (ASTM A6).

Typical Hysteresis Loop for HP MAGNET PLATE Steel



Fabrication

Fabrication procedures for HP MAGNET PLATE steel are similar to those used for ordinary carbon steels.

Shearing

Heavy-duty shearing equipment with sharp blades is suggested for cutting plates up to and including 1-1/2 inches thick.

Thermal Cutting

For thicknesses exceeding 1-1/2 inches, use of oxy-gas equipment is suggested. Preheating or postheating is not required.

Cleveland-Cliffs has facilities for supplying gascut components up to and including 25 inches thick and has the capacity for machining components. Inquiries should be directed to the Cleveland-Cliffs plate sales department at 610.383.2589.

Machining

Fabrication of magnet plate components frequently requires machining of all surfaces to close tolerances. Speeds and feeds should be elected in accordance with standard practices for machining low carbon steels.

Welding

Cleveland-Cliffs HP MAGNET PLATE steel can be welded by any of the techniques regularly applied to low carbon steels. Should weld repairs be necessary on heavy thickness plates, mild steel electrodes conforming to E60XX or E7018 may be used. Repairs should be made prior to heat treatment to provide deposited welds with magnetic characteristics similar to the base or parent metal. In special cases, low hydrogen-coated ingot iron electrodes may be procured.

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Additional Technical Information

MATERIAL TEST CERTIFICATE

A material Test Certificate, identifying the source of the steel plates as Cleveland-Cliffs Plate LLC, will be included for delivery with each shipment.

Cover photos: Shutterstock (Erich Sacco, Stoyan Yotov, SeanRhinoPhotography, D-VISIONS)

About Cleveland-Cliffs Inc.

Cleveland-Cliffs is the largest flat-rolled steel producer in North America. Founded in 1847 as a mine operator, Cliffs also is the largest manufacturer of iron ore pellets in North America. The Company is vertically integrated from mined raw materials, direct reduced iron, and ferrous scrap to primary steelmaking and downstream finishing, stamping, tooling, and tubing. The Company serves a diverse range of markets due to its comprehensive offering of flat-rolled steel products and is the largest supplier of steel to the automotive industry in North America. The Company is headquartered in Cleveland, Ohio with mining, steel and downstream manufacturing operations located across the United States and in Canada. For more information, visit www.clevelandcliffs.com.

CLIFFS

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