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HSLA STEEL : A 100 Year History

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Barclay's Center in Brookyln, NY. Exterior façade constructed from HSLA Steel.

HSLA STEEL 100 YEARS

High-Strength, Low-Alloy steel, referred to by its acronym HSLA, is commonly used in water well applications where increased strength and corrosion resistance are valued by the well owner. With a history that covers over 100 years, HSLA steel continues to be a proven option for those looking to extend the life of their water well.

History of HSLA Steel

Development of HSLA steel traces back to the 1920's and 1930's where industry leaders such as United States Steel (USS) and Kaiser Steel began extensive research and investment to develop steels with enhanced strength and corrosion resistant advantages over structural carbon steels. USS spent over 10 years experimenting and testing various metallurgy compositions, which culminated in 1933 with the release of the first commercial high-strength, corrosion-resistant steel that would give engineers new opportunities for lightweight construction. Labeled COR-TEN, this steel contained carefully proportioned amounts of chromium, nickel, silicon, copper, and phosphorus required to achieve the intended beneficial properties. COR-TEN steel provided 50% higher effective strength and 4-6 times the corrosion resistance of structural carbon steel.

Early Uses

As industrial innovation continued to expand throughout the first half of the 20th century, HSLA steel's superior strength and increased corrosion resistance made it the go-to option for engineers requiring a more effective and efficient material than mild steel. Industrial products made from HSLA include:

- Railroad Freight Cars
- Railroad Passenger Cars
- Mine Cars
- Automotive Equipment
- Tanker Trucks
- Container Ships
- Bridge Trellis and Supports

Today, HSLA steel continues to be used in the production of various heavy machinery components, as well as structural projects including bridges and buildings. Given HSLA's 100-year record of successful use, water well designers and owners rely on HSLA casing and screen for construction of wells requiring strength, longevity, and economic efficiency.

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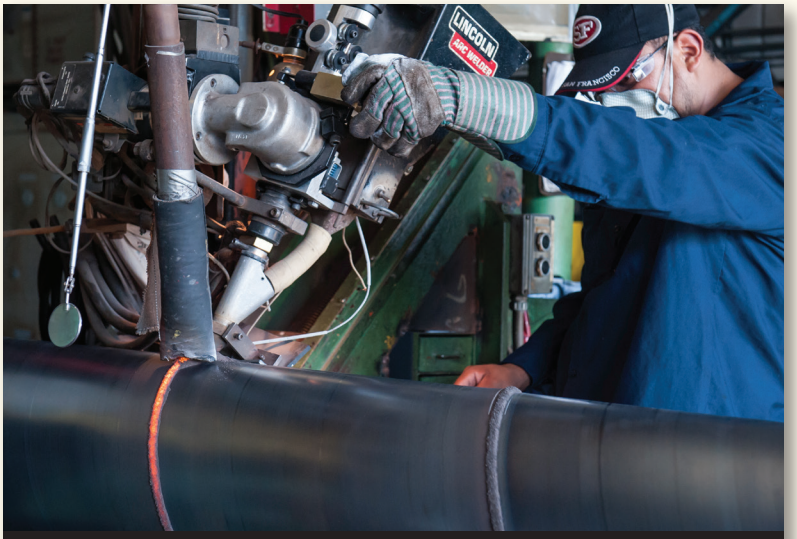
Physical and Chemical Requirements for HSLA Steel Used for Water Well Casing and Screen

It is imperative well designers and owners be aware that steel labeled "HSLA" does not certify specific corrosion resistance. Some structural grade steels designated as HSLA do not contain the minimum alloying elements to increase its corrosion resistance to the level required for water wells.

Well owners must be informed HSLA steel used to fabricate water well casing and screen with requirements for enhanced strength and corrosion resistance be specified as meeting ASTM Standard A606 Type 4.

ASTM A606 Type 4 unique requirement is explicitly described below:

For [HSLA] Type 4 steel, the basis for this evidence is a corrosion-resistance index calculated from the chemical composition of the steel in accordance with Guide G101. To comply with ASTM Standard A606 Type 4, steel shall have a minimum corrosion-resistance index of 6.0, based upon Guide G101.



HSLA A606 Type 4 Pipe Manufactured at Roscoe Moss Company's Los Angeles Facility

ASTM Guide G101 presents a method for estimating the atmospheric corrosion resistance of low-alloy, weathering steels such as A606 Type 4. Specifically, the ASTM Guide calls out the following: Equations for predicting corrosion loss of low-alloy steels after 15.5 years of exposure to various atmospheres, based on the chemical composition of the steel, were published by Legault and Leckie. For use in this guide, the Legault-Leckie equation for an industrial atmosphere was modified to allow calculation of an atmospheric corrosion resistance index based on chemical composition.

The Legault-Leckie equation is listed below:

Atmospheric Corrosion Resistance Index (I)

$$(I) = 26.01*(\%\ Cu) + 3.88*(\%\ Ni) + 1.2*(\%\ Cr) + 1.49*(\%\ Si) + 17.28*(\%\ P) - [7.29*(\%\ Cr)*(\%\ Ni)] - [9.10*(\%\ Ni)*(\%\ P)] - 33.39*(\%\ Cu)^2$$

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Typical Chemical Composition of HSLA Steel – ASTM A606 Type 4

Corrosion Resistant Properties

Typical % Composition by Weight | Strength (in psi)

TIME PERIOD	STEEL TYPE	Cu	Cr	Ni	Si	P	G101 CORROSION INDEX	YIELD	TENSILE
1900-1940s	Hard Red	0.20	0.00	0.00	0.00	0.01	4.11	55,000	70,000
1940-1980s	COR-TEN	0.41	0.84	0.28	0.48	0.09	8.35	50,000	70,000
	Kai-Well	0.27	0.00	0.00	0.09	0.04	5.36	55,000	70,000
	USS Well Casing	0.26	0.00	0.00	0.08	0.03	5.06	50,000	70,000
1980-Present	HSLA ASTM A606 Type 4	0.31	0.72	0.26	0.29	0.02	6.87	55,000	75,000
	Copper Bearing	0.20	0.02	0.01	0.00	0.00	3.91	44,000	68,000
	Mild Steel	0.00	0.00	0.00	0.00	0.00	0.00	35,000	50,000

Benefits of HSLA ASTM A606 Type 4 Steel

As illustrated by the table above, today's HSLA steel conforming to A606 Type 4 must possess a minimum quantity of alloying elements such as Copper, Chromium and Nickel. When these minimum alloy amounts are added to the carbon-based iron, field analysis has confirmed the corrosion resistance is increased by up to a factor of 9x compared to standard mild steel (Williams – 1990). Furthermore, the Tensile Strength and Yield Strength of A606 Type 4 registers at 75,000psi and 55,000psi respectively. This is a substantial increase over the Mild Steel Tensile and Yield Strengths of 50,000psi and 35,000psi.

HSLA steel's benefits in the operation and longevity of water wells has been proven to designers and owners for over 100 years. Ensuring continued success requires those involved with steel selection understand HSLA designation nuances. Only by specifying water well casing and screen steel conforms to ASTM Standard A606 Type 4 can one be confident of increased corrosion resistance over other HSLA types.