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Products | Alloys | Austenitic Manganese Steels

Metallurgical Affect of Manganese on Steels

Manganese is present in all steels as a de-oxidizer. Manganese reduces the tendency towards hot-shortness or popularly known as red-shortness resulting from the presence of sulphur, which enables the metal to be hot-worked. When manganese is absent or very low, the predominant sulphide in iron sulphide (FeS), which forms the eutectic with iron, has affinity to form thin continuous films around the primary crystals during solidification of the steel.

Manganese improves the strength properties of steel, while marginally impairing its elasticity. In addition, manganese has favourable influence on forging, welding and grain refining properties in steel castings. A higher content of manganese in the presence of carbon substantially increases the wear resistance. With up to 3% of manganese, the tensile strength of steels increases by about 10 kg/mm^2 for every added percentage of manganese. With addition of manganese in contents above 3% to 8%, the increase rises more slowly and at content more than 8% of manganese, it drops off again. The yield point behaves in a similar manner. Manganese enhances the depth of hardening of steels.

What are Manganese Steels?

It is only when the manganese content exceeds about 0.08% that the steel may be classed as an alloy steel. When manganese content exceeds about 10%, the steel will be austenitic after slow cooling. One particular type of steel, known as Hadfield manganese steel, usually contains 12% manganese.

Austenitic Manganese Steel-Standard & Specifications

ASTM Designation 128 A/ 128M

Standard specification for steel castings, austenitic manganese.

This specification covers Hadfield austenitic manganese steel castings and alloy modifications. Cast cross-section size precludes the use of all grades, and the buyer should consult us, as to

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grades practically obtainable for a particular design required. Final selection is to be based on consensus between the buyer and Acme Alloys.

ASTM 128 A/ 128 M: Chemical compositions of different grades of austenitic manganese steels

Grade	Carbon % C	Manganese % Mn	Chromium % Cr	Molybdenum % Mo	Nickel % Ni	Silicon % Si max	Phosphorous % P max
A	1.05-1.35	11.0 min	-	-	-	1.00	0.07
B- 1	0.90-1.05	11.5-14.5	-	-	-	1.00	0.07
B- 2	1.05-1.20	11.5-14.5	-	-	-	1.00	0.07
B- 3	1.12-1.28	11.5-14.5	-	-	-	1.00	0.07
B- 4	1.20-1.35	11.5-14.5	-	-	-	1.00	0.07
C	1.05-1.35	11.5-14.5	1.5-2.5	-	-	1.00	0.07
D	0.70-1.30	11.5-14.5	-	-	3.0-4.0	1.00	0.07
E- 1	0.70-1.30	11.5-14.5	-	0.90-1.20	-	1.00	0.07
E- 2	1.05-1.45	11.5-14.5	-	1.80-2.10	-	1.00	0.07
F	1.05-1.35	6.0-8.0	-	0.90-1.20	-	1.00	0.07

Properties

The wear resistant cast steel is generally, referred to as Hadfield manganese steel. Although the above mentioned ten grades of austenitic steels have chemical composition to the Hadfield's original composition, its primary reason for existence is the assurance it provides the user from unexpected failure in demanding applications where downtime cannot be accepted.

Manganese steel is a low-strength, high-ductility material. But properly controlled heat treating by austenizing and followed by water quenching or controlled air cooling, the 12% manganese steel, ASTM 128 A, consists of a meta-stable austenitic phase having a face centred cubic (fcc) lattice with strengthening from interstitial carbon and substitutional manganese atoms. Another property of great significance is its ability to work-harden from an initial hardness of 240 BHN (23 R_c) to well over 500 BHN (51 R_c). The face centred cubic (fcc) lattice has 12 equivalent slip systems and deformations that result in conversion of some austenite to martensite. As this

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work-hardnening deformation process continues, it increases hardness of the affected metal and eventually results in increasing abrasion resistance. Thus, manganese steels perform most efficiently when external conditions cause extensive work hardening of the wear component's surface. If cracking of the work hardened layer occurs, the crack propagation would quickly be checked and prevented by the tougher un-worked hardened core. Hence, in demanding applications such as primary rock crushing austenitic manganese steels are widely used.

Applications

These steels are, often used for gears, spline shafts, axles, and rifle barrels, mineral and mining equipment, grinding and crushing machinery, power shovel buckets, railway track work, cement plants- kiln and mill liners, stone crushers- jaw and gyratory crushers and ore processing, to name a few.