Impurities in Steel

Describes the major impurities within Steel

Metallurgy - Impurities In Steel.

The following are impurities commonly found in steel and the impact these have on quality:
Silicon
- Found in small quantities in all Steel (0.1% - 0.3%). In Specialty Steels it may be as low as 0.03% or as high as 1.0%.
- Forms a Solid Solution in Iron.
- Slightly raises the Strength and Hardness of Steel.
- Raises the Critical Points.
- A de-oxidizing Agent.

Sulphur
- A VERY harmful element. Efforts are made to keep it to a minimum (About 0.015% but it may be as high as 0.6% in cheap Steel).
- Forms Iron Sulphide which is a very brittle substance. This forms as a thin film separating the Pearlite or Ferrite grains, thus greatly reducing the Strength of the Steel (Gives rise to "Hot Short or Cold Short").
- Manganese Sulphide is stronger than Iron Sulphide and provided that there is enough Manganese present the Sulphur will all combine with it in preference to the Iron.
- It is common practice to add eight times the Manganese required to combine with the Sulphur.
- Iron Sulphide melts below the working temperature of Iron.

Phosphorous
- Combines with Iron to form a Phosphide.
- It increases the hardness and Tensile strength of Steel.
- It SERIOUSLY affects the ductility and resistance to shock or impact.
- Increases grain size.
- 0.4% is allowable in Structural Steel. 0.035% Maximum in Tool Steel.

NOTE: Both Phosphorous and Sulphur tend to segregate. i.e. These two elements tend to concentrate in the grain boundaries during freezing and in these areas they may greatly exceed the average percentage.

Lead
- Added to all classes of Steel to improve the machinability of the Steel.
- It is supposed to improve tool life.

Manganese
- A powerful and most effective de-oxidant.
- Has a good effect on Sulphur.
- A good element for producing perfectly sound Steel free from internal defects such as Blow Holes and gas cavities.
- Improves the Tenacity of Steel without seriously affecting it's Ductility.
- Increases the depth hardness of hardened Steel.
- With between 11% and 15% manganese an about 1% Carbon Steel retains it's Austenitic condition even after quenching in water after heating to 1000 deg.C. This Steel is non-magnetic. It is also soft but posses a remarkable resistance to abrasion.

Tin
- This metal should be avoided. It forms a low melting point brittle film round the grain boundaries making the Steel practically useless.

Gaseous Impurities
- Oxygen. In general has a bad influence on the properties of steel. It is rarely present in quantities above 0.025%
- Nitrogen. Found in quantities from 0.005% to 0.3% in welds, were it is undesirable. It has a hardening and embrittling effect. Intensionally added to the surface layer in case hardening to produce an abrasive resistant surface.
- Hydrogen. This element has a bad effect. It produces gas cavities near the skin of castings and ingots. Also "flakes" and hair line cracks can be attributed too it'd presence.
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