

## Some facts about Alloying and accompanying elements in steel.

### **Al. Aluminium**

This is the most powerful de-oxidiser used which also combines with nitrogen, thereby reducing the susceptibility to strain ageing. Small additions assist fine-grained structure. As aluminium forms very hard nitrides with nitrogen, it is usually an alloying element in nitriding steels. Aluminium improves the scale resistance and is therefore often used as an alloying element in ferritic heat resisting steels.

### **C. Carbon**

Carbon is the most important and influential alloying element in steel. In addition to Carbon every unalloyed steel contains Silicon, Manganese Phosphorus and Sulphur which occur unintentionally during manufacture. The addition of further alloying elements to achieve special effects and intentional increase of Manganese and Silicon contents, results in alloy steel. With increased Carbon content the strength and hardenability of steel increase but its ductility, forgeability and machineability reduces. The carbon content in steel has virtually no effect on the steels corrosion resistance to water, acids and hot gasses.

### **Cr. Chromium**

Chromium increases the hardenability of steel while the ductility is effected minimally. Higher Chrome content in steel increases its corrosion resistance, and by forming carbides the edge holding quality of steel increases. The tensile strength of steel increases by 8 - 100 N/mm<sup>2</sup> for every 1 % chrome added. The yield strength also increases but the notch impact value reduces.

### **Mn. Manganese**

Manganese increases the strength of steel to a lesser degree than Carbon while it favourably influences the forgeability, weldability and markedly increases the hardness penetration depth.

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## Mo. Molybdenum

While Molybdenum improves the tensile strength and increases the heat resistance and weldability of steel, the forgeability of steel with high molybdenum, content decreases. When used in combination with Chromium and Nickel, Molybdenum may produce high yield points and tensile strength values.

## Ni. Nickel

By adding Nickel to steel the notch toughness is increased significantly and is therefore alloyed for increasing toughness in case-hardening, heat-treatable and subzero toughness steels. Nickel combined with Chromium ensures good through hardening. Chrome-Nickel steels are Stainless, heat resistant and resistant to scaling. Nickel does not impair the welding properties of steel.

## P. Phosphorus

Phosphorus is normally regarded as being detrimental to steel and every endeavour is therefore made to keep Phosphorus content in high grade steels to a maximum of 0.03 to 0.05%.

## Pb. Lead

Lead is added in free cutting steels in amounts of 0.20 - 0.50%. Because of its fine homogenous distribution, formation of shorter chips and clean faces of cut is achieved, thus improving machineability. The stated lead content does not effect the mechanical properties of the steel.

## S Sulphur

Sulphur produces the most pronounced segregation of all steel accompanying elements. It leads to red shortness or hot shortness. Sulphur is added to steels for automatic machining in quantities of up to 0.40%. This reduces the friction on the tool cutting edges by means of lubricating action, thereby increasing tool life. It also produces shorter chips during machining. Sulphur also increases susceptibility to welding cracks in steel.

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## Si. Silicon

Silicon, like Manganese is contained in all steel as iron ore contains Silicon in various quantities, depending on overall composition. Silicon is also absorbed from the furnace refractory linings during the melting process. However, only steels containing more than 0.40% of Silicon are called Silicon Steels. Silicon is a deoxidiser and promotes graphite precipitation, it also increases the strength and wear resistance of steel while significantly increasing the elastic limit, thus being a useful alloying element in spring steels. Because of Silicons ability to greatly reduce electrical conductivity, extensive use is made of it in electrical steels.

## V. Vanadium

Vanadium is used as a primary grain refiner in the manufacture of steel. It is also a strong carbide former, thus providing increased wear resistance, edge holding and high temperature strength. Vanadium is therefore used primarily as an alloying element in high speed, hot forming and creep resistant steels

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