Phone 712-347-5500 800-831-9252
Fax 712-347-6166

EFFECT OF ALLOYING ELEMENTS

ALUMINUM -- Aluminum is probably the most active deoxidizer in common use in producing steel. It is used in controlling inherent grain size.

BORON -- Boron is added to steel in amounts of 0.0005 to 0.003% to improve hardenability. In combination with other alloying elements, boron acts as an "intensifier", increasing the depth of hardening during quenching.

CARBON -- When a small amount of carbon is added to iron, the properties which give steel its great value begin to appear. As the amount of carbon increases up to .80 or .90%, the metal becomes harder, possesses greater tensile strength, and, what is most important, becomes increasingly responsive to heat treatment with corresponding development of very high strength and hardness.

If carbon were to be increased beyond certain limits in plain carbon steel, the ability to be worked either hot or cold would disappear almost entirely, and it would begin to assume the characteristics of cast iron, which usually has 1.7 to 4.5% carbon.

CHROMIUM -- Chromium increases response to heat treatment. It also increases depth of hardness penetration. Most chromium-bearing alloys contain .50 to 1.50% chromium. Stainless steels contain chromium in large quantities (12 to 25%), frequently in combination with nickel, and possess increased resistance to oxidation and corrosion.

COLUMBIUM -- Columbium in 18-8 stainless steel has a similar effect to titanium in making the steel immune to harmful carbide precipitation and resultant inter-granular corrosion. Columbium bearing welding electrodes are used in welding both titanium and columbium bearing stainless steels since titanium would be lost in the weld arc whereas columbium is carried over into the weld deposit.

COPPER -- Copper is normally added in amounts of .15 to .25% to improve resistance to atmospheric corrosion and to increase tensile and yield strengths with only a slight loss in ductility. Higher strength properties can be obtained by precipitation hardening copper-bearing steel.

Phone 712-347-5500 800-831-9252
Fax 712-347-6166

EFFECT OF ALLOYING ELEMENTS

IRON -- Iron is the chief element of steel. Normally commercial iron contains other elements present in varying quantities which produce the required mechanical properties. Iron lacks strength, is very ductile and soft and does not respond to heat treatment to any appreciable degree. It can be hardened somewhat by cold working, but not nearly as much as even a plain low carbon steel.

LEAD -- Lead in steel greatly improves its machinability. When the lead is finely divided and uniformly distributed it has no known effect on the mechanical properties of the steel in the strength levels most commonly specified. It is usually added in amounts from .15% to .35%.

MANGANESE -- Next in importance to carbon is manganese. It is normally present in all steel and functions both as a deoxidizer and also to impart strength and responsiveness to heat treatment. Manganese is usually present in quantities from 1/2% to 2%, but certain special steels are made in the range of 10% to 15%.

MOLYBDENUM -- Molybdenum adds greatly to the penetration of hardness and increases toughness. Molybdenum tends to help steel resist softening at high temperatures and is an important means of assuring high creep strength. It is generally use in comparatively small quantities ranging from .10 to .40%.

NICKEL -- Nickel increases strength and toughness but is one of the least effective elements for increasing hardenability. The most general quantity addition is from 1 to 4%, although for certain applications, percentages as high as 36% are used. Steels containing nickel usually have more impact resistance, especially at low temperatures. Certain stainless steels employ nickel up to about 20%.

PHOSPHORUS -- Some phosphorus is present in all steel. In addition to increasing yield strength and reducing ductility at low temperatures, phosphorus is believed to increase resistance to atmospheric corrosion.

Phone 712-347-5500 800-831-9252
Fax 712-347-6166

EFFECT OF ALLOYING ELEMENTS

SILICON -- Silicon is one of the common deoxidizers used during the process of manufacture. It also may be present in varying quantities up to 1% in the finished steel and has a beneficial effect on certain properties such as tensile strength. It is also used in special steels in the rage of 1.5% to 2.5% silicon to improve the hardenability. In higher percentages, silicon is added as an alloy to produce certain electrical characteristics in the so-called silicon electrical steels and also finds certain applications in some tool steels where it seems to have a hardening and toughening effect.

SULPHUR -- Sulphur is an important element in steel because when present in relatively large quantities, it increases machinability. The amount generally used for this purpose is from .06 to .30%. Sulphur is detrimental to the hot forming properties.

TELLURIUM -- The addition of approximately .05% tellurium to leaded steel improves machinability over the leaded only steels.

TITANIUM -- Titanium is added to 18-8 stainless steels to make them immune to harmful carbide precipitation. It is sometimes added to low carbon sheets to make them more suitable for porcelain enameling.

TUNGSTEN -- Tungsten is used as an alloying element in tool steel and tends to produce a fine, dense grain and keen cutting edge when used in relatively small quantities. When used in larger quantities of 17 to 20% and in combination with other alloys, it produces a high speed steel which retains its hardness at the high temperatures developed in high speed cutting. Tungsten is also used in certain heat resisting steel where the retention of strength at high temperatures is important. It is usually used in combination with chrome or other alloying elements.

VANADIUM -- Vanadium, usually in quantities from .15 to .20% retards grain growth, even after hardening from high temperatures or after periods of extended heating. Tool steel containing vanadium seem to resist shock better than those which do not contain this element do.