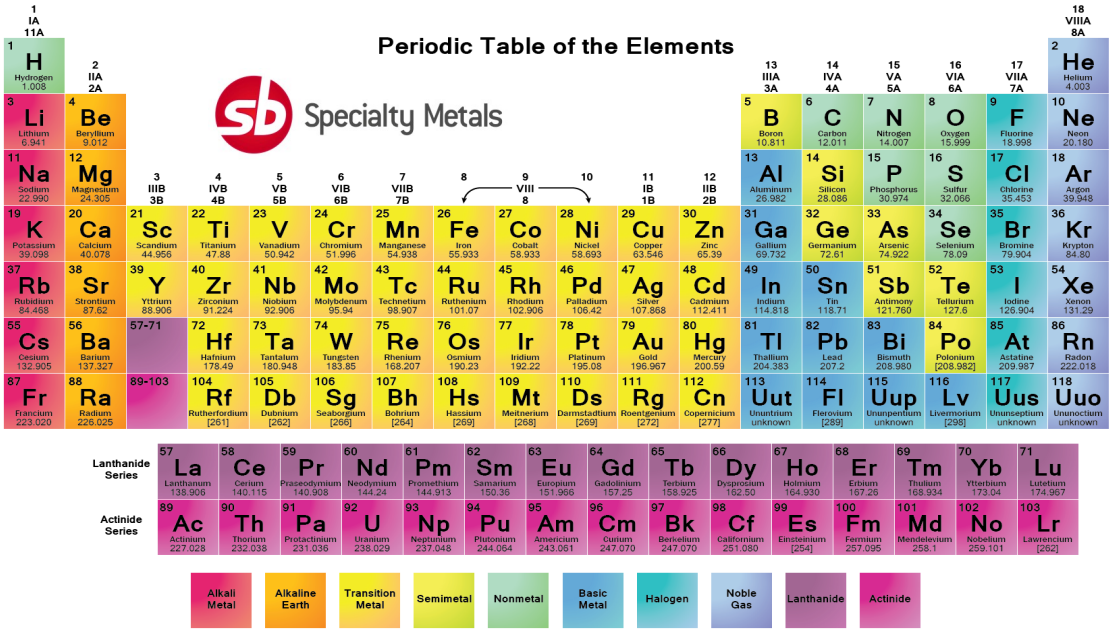

Tool Steel Alloying Elements and Their Effect

Carbon (C):

The most influential and important alloying element in steel.

Increasing the carbon content increases the steels attainable hardness and strength.

Increasing the carbon content decreases the steels ductility, weldability and machinability

Chromium (Cr):

Chromium additions increase hardenability and corrosion resistance.

Chromium is a carbide former and will increase wear resistance in combination with carbon

Molybdenum (Mo):

Molybdenum promotes fine grain formation and secondary hardening during tempering.

Molybdenum is a carbide former and will increase wear resistance in combination with carbon.

Tungsten: (W):

Tungsten increases temper resistance and restricts grain growth.

Tungsten is a strong carbide former and will increase wear resistance in combination with carbon.

Vanadium (V):

Vanadium increases temper resistance and promotes fine grain formation.

Vanadium is a strong carbide former and will increase wear resistance in combination with carbon.

Nickel (Ni):

Nickel increases hardenability and corrosion resistance

Nickel is not a carbide former

Cobalt (Co):

Cobalt increases red hardness and high temperature strength.

Cobalt it not a carbide former.

Manganese (Mn):

Manganese increases hardenability and is used as a de-oxidizer in steelmaking.

Silicon: (Si):

Silicon promotes hardenability and scale resistance and is a main de-oxidizer in steelmaking.

Sulfur: (S):

Sulfur typically has a maximum level to control inclusion content.

Sulfur will combine with manganese to form sulfides that aid in machinability but decrease toughness.