LESSON PLAN

Date_______________ Trade:- Welder

Name_____________ Week No:-eighteen & nineteen

Subject :- Classification of steel. welding of low, medium, high carbon and alloy steel. Effects of alloying elements on steel. Stainless steel- types. weld decay and weld ability.

Motivations:- in previous week we learned about weld ability of metals, importance of pre-heating, post –heating and maintenance of inter pass temperature.

PREPARATION: - Teaching Aids:-Chalk, Charts,

INTRODUCTION: -steel is a very important metal for general industry. More than 80 industry establish for steel work. So it is also important for welding.

PRESENTATION:-

Topic	Information Point	Spot Hint

Plain Carbon Steels

These steels usually are iron with less than 1 percent carbon, plus small amounts of manganese, phosphorus, sulfur, and silicon. The weldability and other characteristics of these steels are primarily a product of carbon content, although the alloying and residual elements do have a minor influence.

Plain carbon steels are further subdivided into four groups:

1. Low
2. Medium
3. High
4. Very high

Low. Often called mild steels, low-carbon steels have less than 0.30 percent carbon and are the most commonly used grades. They machine and weld nicely and are more ductile than higher-carbon steels.
Medium. Medium-carbon steels have from 0.30 to 0.45 percent carbon. Increased carbon means increased hardness and tensile strength, decreased ductility, and more difficult machining.
High. With 0.45 to 0.75 percent carbon, these steels can be challenging to weld. Preheating, postheating (to control cooling rate), and sometimes even heating during welding become necessary to produce acceptable welds and to control the mechanical properties of the steel after welding.
Very High. With up to 1.50 percent carbon content, very high-carbon steels are used for hard steel products such as metal cutting tools and truck springs. Like high-carbon steels, they require heat treating before, during, and after welding to maintain their mechanical properties.

Low-alloy Steels

When these steels are designed for welded applications, their carbon content is usually below 0.25 percent and often below 0.15 percent. Typical alloys include nickel, chromium, molybdenum, manganese, and silicon, which add strength at room temperatures and increase low-temperature notch toughness.
These alloys can, in the right combination, improve corrosion resistance and influence the steel's response to heat treatment. But the alloys added can also negatively influence crack susceptibility, so it's a good idea to use low-hydrogen welding processes with them. Preheating might also prove necessary. This can be determined by using the carbon equivalent formula, which we'll cover in a later issue.

High-alloy Steels
For the most part, we're talking about stainless steel here, the most important commercial high-alloy steel. Stainless steels are at least 12 percent chromium and many have high nickel contents. The three basic types of stainless are:

1. Austenitic
2. Ferritic
3. Martensitic

Martensitic stainless steels make up the cutlery grades. They have the least amount of chromium, offer high hardenability, and require both pre- and postheating when welding to prevent cracking in the heat-affected zone (HAZ).
Ferritic stainless steels have 12 to 27 percent chromium with small amounts of austenite-forming alloys.
Austenitic stainless steels offer excellent weldability, but austenite isn't stable at room temperature. Consequently, specific alloys must be added to stabilize austenite. The most important austenite stabilizer is nickel, and others include carbon, manganese, and nitrogen.
Special properties, including corrosion resistance, oxidation resistance, and strength at high temperatures, can be incorporated into austenitic stainless steels by adding certain alloys like chromium, nickel, molybdenum, nitrogen, titanium, and columbium. And while carbon can add strength at high temperatures, it can also reduce corrosion resistance by forming a compound with chromium. It's important to note that austenitic alloys can't be hardened by heat treatment. That means they don't harden in the welding HAZ.

Series Designation	Types and Classes
10xx	Nonresulfurized carbon steel grades (plain carbon steel)
11xx	Resulfurized carbon steel grades (free-cutting carbon steel)
13xx	Manganese 1.75%
20xx	Nickel steels
23xx	Nickel 3.50%
25xx	Nickel 5.00%
30xx	Nickel-chromium steels*
31xx	Nickel 1.25%, chromium 0.65% or 0.80%
33xx	Nickel 3.50%, chromium 1.55%
40xx	Molybdenum 0.25%
41xx	Chromium 0.50–0.95%, molybdenum 0.12% or 0.20%
43xx	Nickel 1.80%, chromium 0.50% or 0.80%, molybdenum 0.25%*
46xx	Nickel 1.55% or 1.80%, molybdenum 0.20% or 0.25%
47xx	Nickel 1.05%, chromium 0.45%, molybdenum 0.25%*
48xx	Nickel 3.50%, molybdenum 0.25%
50xx	Chromium 0.28% or 0.40%
51xx	Chromium 0.80%, 0.90%, 0.95%, 1.00%, or 1.05%
5xxxx	Carbon 1.00%, chromium 0.50%, 1.00%, or 1.45%
60xx	Chrome-vanadium steels
61xx	Chromium 0.80% or 0.95%, vanadium 0.10% or 0.15% min.
70xx	Heat-resisting casting alloys
80xx	Nickel-chrome-molybdenum steels*
86xx	Nickel 0.55%, chromium 0.50% or 0.65%, molybdenum 0.20%
87xx	Nickel 0.55%, chromium 0.50%, molybdenum 0.25%
90xx	Silicon-manganese steels
92xx	Manganese 0.85%, silicon 2.00%
93xx	Nickel 3.25%, chromium 1.20%, molybdenum 0.12%
94xx	Manganese 1.00%, nickel 0.45%, chromium 0.40%, molybdenum 0.12%
97xx	Nickel 0.55%, chromium 0.17%, molybdenum 0.20%
98xx	Nickel 1.00%, chromium 0.80%, molybdenum 0.25%*

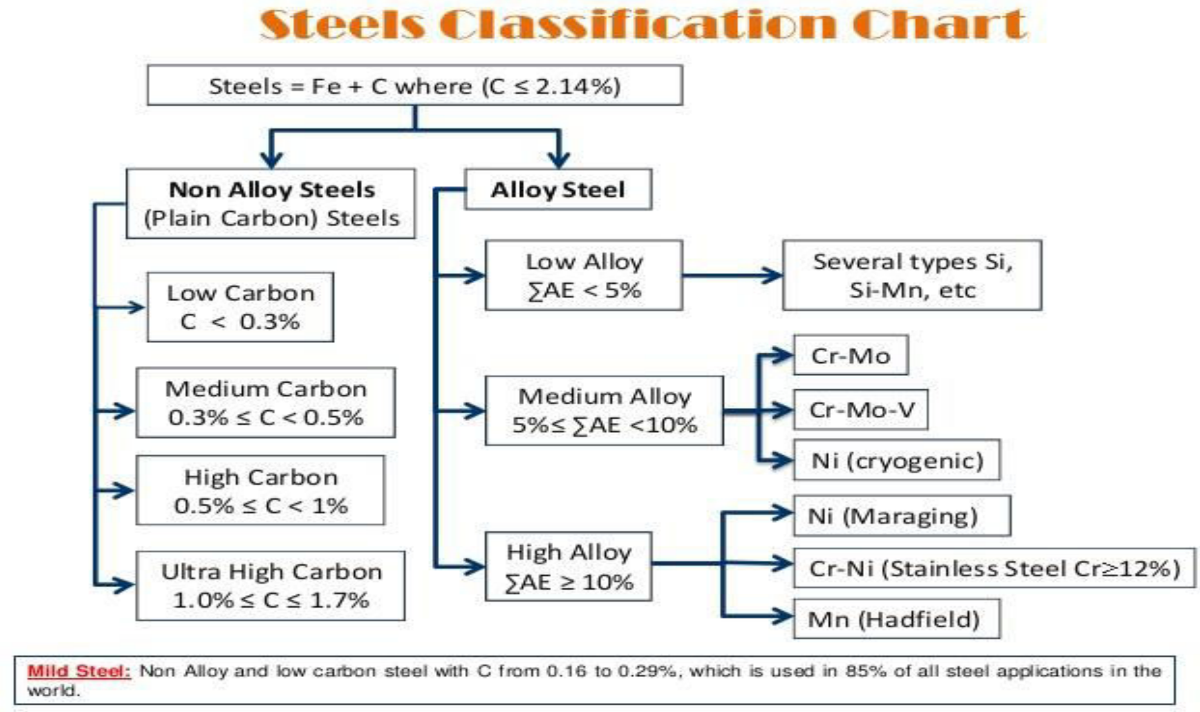
* Stainless steels always have a high chromium content, often considerable amounts of nickel, and sometimes contain molybdenum and other elements. Stainless steels are identified by a three-digit number beginning with 2, 3, 4, or 5.

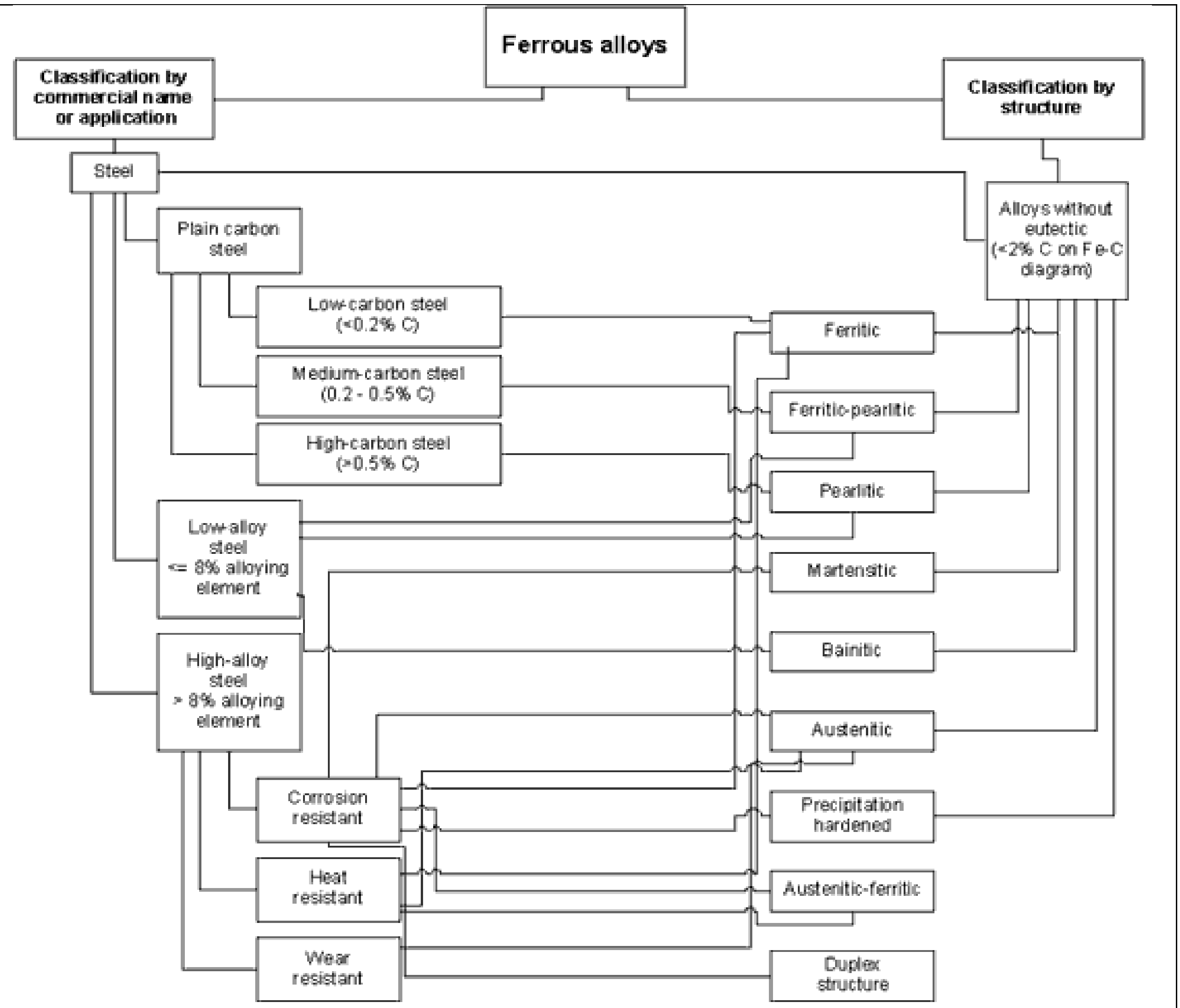
Steel Classification Systems

Before we look at a couple of common steel classification systems, let's consider one more high-carbon metal, cast iron. The carbon content of cast iron is 2.1 percent or more. There are four basic types of cast iron:

1. **Gray cast iron** , which is relatively soft. It's easily machined and welded, and you'll find it used for engine cylinder blocks, pipe, and machine tool structures.
2. **White cast iron**, which is hard, brittle, and not weldable. It has a compressive strength of more than 200,000 pounds per square inch (PSI), and when it's annealed, it becomes malleable cast iron.
3. **Malleable cast iron**, which is annealed white cast iron. It can be welded, machined, is ductile, and offers good strength and shock resistance.
4. **Ductile cast iron**, which is sometimes called nodular or spheroidal graphite cast iron. It gets this name because its carbon is in the shape of small spheres, not flakes. This makes it both ductile and malleable. It's also weldable.

Now let's take a look at a typical steel classification system. Both the Society of Automotive Engineers (SAE) and the American Iron and Steel Institute (AISI) use virtually identical systems. Both are based on a four-digit system with the first number usually indicating the basic type of steel and the first two numbers together indicating the series within the basic alloy group.
Keep in mind there may be a number of series within a basic alloy group, depending on the amount of the principal alloying elements. The last two or three numbers refer to the approximate permissible range of carbon content in points (hundredths of a percent).
These classification systems can become fairly complex, and Figure 1 is just a basic representation. Be sure to reference the most recent AISI and SAE publications for the latest revisions.
That's a look at some basics concerning the iron-carbon-steel relationship and its influences on welding and metal alloys. Next time we'll look at hardening and ways to make metals stronger. We'll also consider the influences of some key alloying elements and the effects of welding on metallurgy.



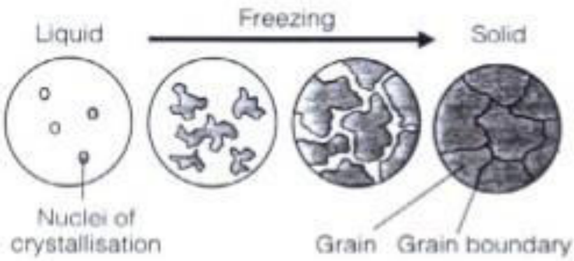


Elements	Effect of element
Aluminum	Strong deoxidizer. Forms nitrides and refines grains.
Chromium	Ferrite stabilizer. Raises tensile strength, fatigue strength, hardness and wear resistance.
Cobalt	Prevents grain growth. Retains hardness and strength at high temp. Also, improves thermal conductivity.
Copper	Raises yield point.
Manganese	Carbide stabilizer. Improves strength, hardness and hardenability. Eliminates evil effects of sulphur.
Molybdenum	Enhances resistance to creep and minimizes temp embrittlement. Also, increases resistance to corrosion of high chromium steels.
Nickel	Arsenite stabilizer acts as graffitizers and increases basic strengths.
Neobium	Forms stable carbides, enhances high temp strength and creep resistance.
Silicon	Stabilizes and hardens ferrite. Improves resistance to corrosion.
Titanium	Forms hard and stable carbides. Stabilizes stainless steel and raises strength.
Wolframite	Stabilizes carbides, improves strength and hardness and also enhances cutting power of tool.
Vanadium	Refines grains and stabilizes ferrites. Most of the same effects as Wolframite.
Boron	Improves hardenability of steel remarkably.

Stainless Steel Alloy	Classification	Typical Applications
430	Ferritic	Used for moderately corrosive applications involving vegetables, fruits, and dry foods. Ideal for table surfaces, equipment trim, and places with little welding or forming.
420	Martensitic	Very durable; excellent corrosion resistance. Used for knife blades, spatulas, and other utensils.
316	Austenitic	Superior durability; ideal for food processing equipment and components. Can withstand corrosive foods and frequent cleaning and sanitizing.
304	Austenitic	Excellent corrosion resistance; often used for items requiring welding and forming, such as vats, bowls, and piping.
303	Austenitic	Less weldable but more machinable than 304. Good corrosion resistance; widely used in trim and other applications not intended for direct contact with food.
1.4539	Austenitic	Suitable for hot or cold corrosive foods that sit for long periods, such as brines and other salty liquids.
1.4462	Duplex	Stronger than 1.4539; ideal for same applications.
6% Molybdenum	Austenitic	Well suited for corrosive foods and high temperatures such as steam heating and hot work areas.

SENSITIZATION (weld decay)

- When 18-8 stainless steel is heated to 400^0-900^0c.
- Formation of chromium carbide at grain boundaries highest at 650^0c.
- An inter- granular corrosion occurs and a partial disintegration of the metal may occur.



Questions:-

1. What is steel ?
2. What is high carbon steel ?
3. What is alloy steel ?
4. What is weld decay?

Next Lesson: - Brass –types-properties and welding methods. Copper–types-properties and welding methods.

Assignment:- Classification of steel. welding of low, medium, high carbon and alloy steel. Effects of alloying elements on steel. Stainless steel- types. weld decay and weld ability.

Checked by…………………………   Instructor………………..