Chapter 1

Theoretical Review & Literature Survey

1.1 Medium Carbon Low Alloy Steels:

Alloy steels are those steels when one or more of the alloying elements are intentionally added to plain carbon steels to enhance, or induce some property, or properties. The American Iron and Steel Institute (AISI) adopted the following definition, steels are regarded as carbon steels which contain not more than 1.65% manganese, 0.60% silicon, and 0.60% copper, and all other steels being regarded as alloy steels. Common alloying elements are nickel, chromium, vanadium, silicon, manganese, etc. When the total alloy content in iron is small, 5-10%, the steel is called ***low alloy steel*** [4]. Low alloy Steels with carbon varying from 0.25 % to 0.65 % are referred to as **medium carbon low alloy steels.**

Medium carbon low alloy steels have good strength and ductility. The response of these steels to heat treatment is excellent and a wide range of mechanical properties can be attained with the help of suitable heat treatment. Medium carbon, low chromium steel finds applications in manufacturing gears, jaws of wrenches, machine gun barrels, axles, and shafts. Also, it can be used for making springs and compressed air tools. The properties of low chromium steels can be improved significantly by the addition of alloying elements such as nickel and molybdenum. The beneficial effects arising from the presence of chromium in steels are enhanced by the addition of molybdenum. Applications of chromium-molybdenum are similar to those of corresponding chromium steels.

Triple alloy steels such as nickel-chromium-molybdenum steels are superior to corresponding double alloy steels i.e. nickel-chromium, chromium-molybdenum, or nickel-molybdenum steels. A general engineering purpose steel has 0.35-0.45 % carbon, 1.3-1.8 % nickel, 0.9-

1.4 % chromium, and 0.2-0.35 % molybdenum. This steel possesses good strength, ductility, toughness and hardenability. Typical uses include axle shafts, bolts and studs, high duty engine connecting rods and high temperature bolts and oil refining and steam installations [8].

1.2 Isothermal Transformation Diagram (I-T Diagram)

In the great majority of heat treatments, the time parameter is one of the determinative factors, the influence of which is shown by the so- called time-temperature–transformation diagrams or isothermal transformation diagram (I-T diagram) [9]. The I-T diagram of a steel may be regarded as a kind of map which charts the transformation of austenite as a function of temperature and time and permits approximation of how the steel will respond to any mode of cooling from the austenitic state.

In the simple case of a eutectoid plain carbon steel, the I-Tcurve is roughly 'C'-shaped (fig.1.1) with the pearlite reaction occurring down to the nose of the curve and a little beyond. At lower temperatures bainite and martensite form. The diagrams become more complex for hypo- and hyper-eutectoid alloys as the ferrite or cementite reactions have also to be represented by additional lines.

The I-T diagrams of medium carbon low alloy steels which are used in this study can be shown in figs. 1.2, 1.3, and 1.4. [10]

Alloying elements, on the whole, retard both the pro-eutectoid reactions and the pearlite reaction, so that I-T curves for alloy steels are moved increasingly to longer times as the alloy content is increased. Additionally, those elements, which expand the γ-field, depress the eutectoid temperature, with the result that they also depress the position of the I-T curves relative to the temperature axes. This behaviour is shown by steels containing manganese or nickel. In contrast, elements, which favour the ferrite phase, raise the eutectoid temperature and the I-T curves move