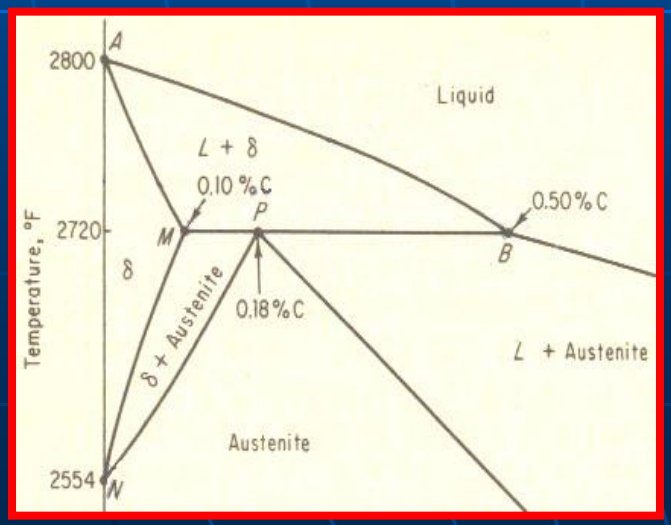
Heat Treatment

Introduction:

Looking to Fig. (1), it shows 3 (three) lines which indicate isothermal reactions, these lines are:

- **HJK line (A_1) lower critical temp. (Eutectiod reaction) at 1333 °f.**
- **CED line (Eutectic reaction) at 2065 °f.**
- **MPB line (Peritectic reaction) at 2720 °f.**



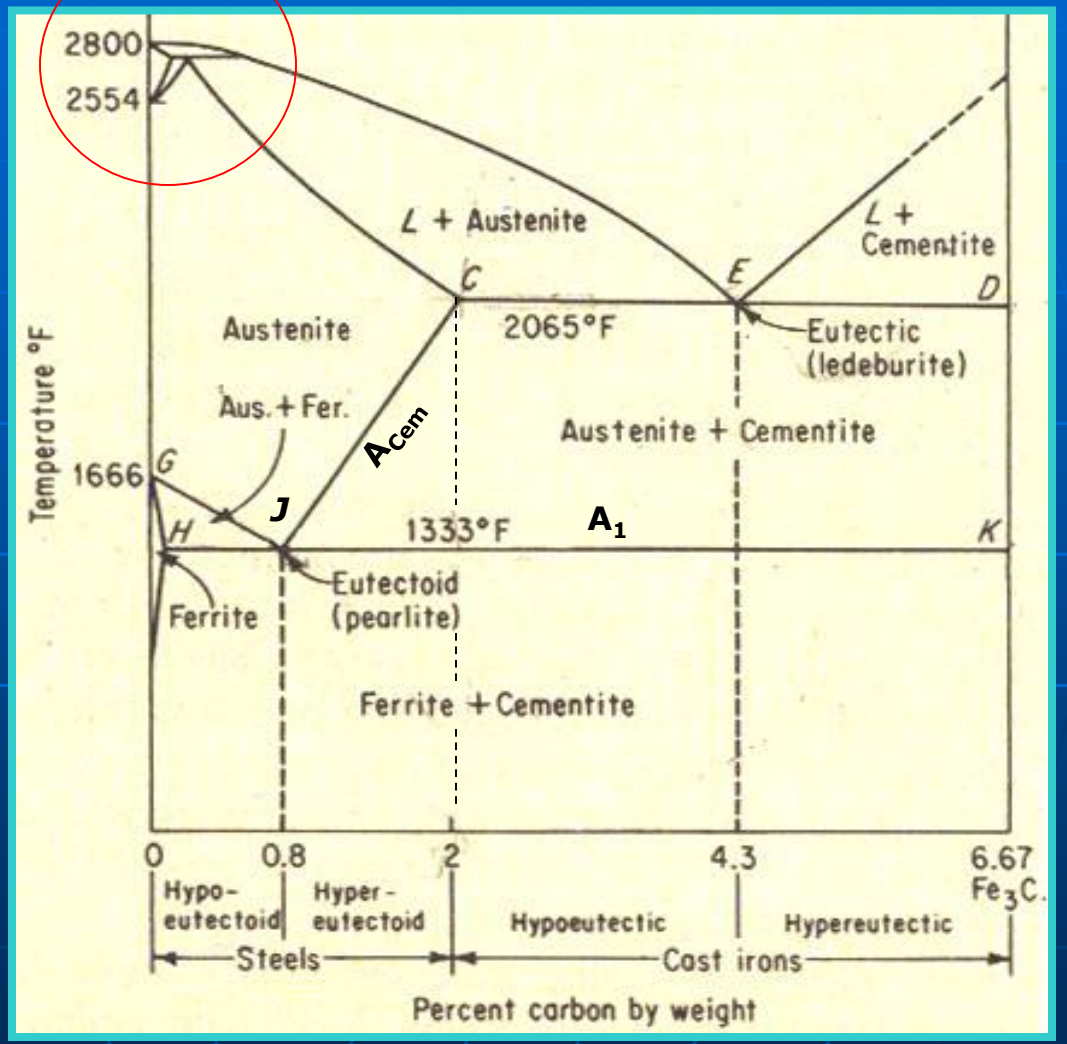


Fig. (1): The Fe – Fe_3C diagram

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❖ **Peritectic reaction may be written as:**

$$L + \delta_1 \longrightarrow \delta_2$$

$$L + \delta \longrightarrow \gamma$$

- **It is an isothermal reversible reaction in which a liquid phase reacts with a solid phase to produce another solid phase on cooling.**

- **The maximum solubility of (C) in (δ) Fe [b. c. c] is 0.1% C at point M.**

❖ **Eutectic reactions may be written as :**

$$L \underset{\text{Heating}}{\overset{\text{Cooling}}{\rightleftharpoons}} \underbrace{\gamma + \text{Cementite } (Fe_3C)}_{\text{Ledeburite (Eutectic mixture)}} \longrightarrow (\ L \longrightarrow S_1 + S_2\ )$$

- **It is an isothermal reversible reaction in which a liquid solution is converted into two or more mixed solids on cooling, the no. of solids formed being the same as the no. of compositions in the system.**

❖ **Eutectoid reaction may be written as:**

$$S_1 \underset{\text{Heating}}{\overset{\text{Cooling}}{\rightleftharpoons}} S_2 + S_3 \quad (\text{at } 1333\ ^0f) \longrightarrow \gamma \underset{\text{Heating}}{\overset{\text{Cooling}}{\rightleftharpoons}} \underbrace{\alpha + Fe_3C\ (\text{Cementite})}_{\text{Pearlite (Eutectoid mixture)}}$$

- **It is an isothermal reversible reaction in which a solid phase (usually a solid solution) is converted into two or more mixed solids on cooling, the no. of solids formed being the same as the no. of compositions in the system.**

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Types of Microstructure in Fe – Fe_3C diagram:

1. Cementite (Fe_3C):

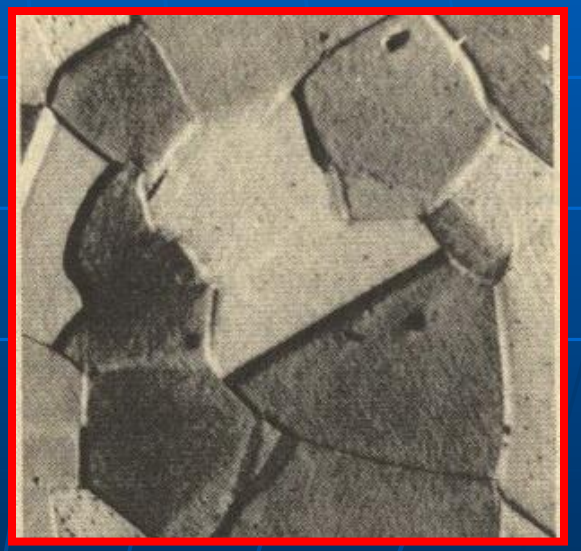
It's a typical hard and brittle interstitial compound of low T. S (σ) ≈ 5000 psi, but high Compressive Strength, contains 6.67% C, its crystal structure is Orthorhombic crystal structure.

E% ≈ 0% , R_c ≈ 72

2. Austenite (γ):

It's an interstitial solid solution of C dissolved in γ (f. c. c) iron. Maximum solubility is 2% C at 2065 ^{o}f point (C) in fig. 1. Its normally not stable at T_{room} (R_T), but under certain conditions it is possible to obtain γ at R_T.

T. S ≈ 150,000 psi, E% ≈ 1 0% , R_c ≈ 40



γ microstructure

3. Ledeburite:

It is a Eutectic mixture of (γ) and Cementite (Fe_3C). It contain 4.3% C and it is formed at 2065 ^{o}f point (E).

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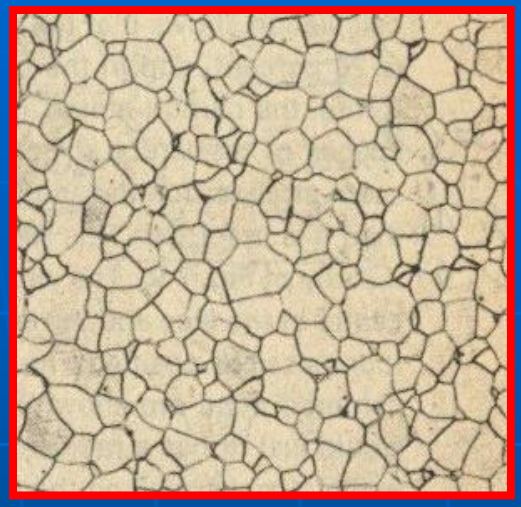
4. Ferrite (α):

It's an interstitial solid solution of small amount of (C) dissolved in α (b. c. c) iron. Maximum solubility is 0.025% C at 1333 °f point (H) in fig. 1. It is the softest structure. The average properties are:

T. S ≈ 40,000 psi, E% ≈ 40% , R_c ≈ 0

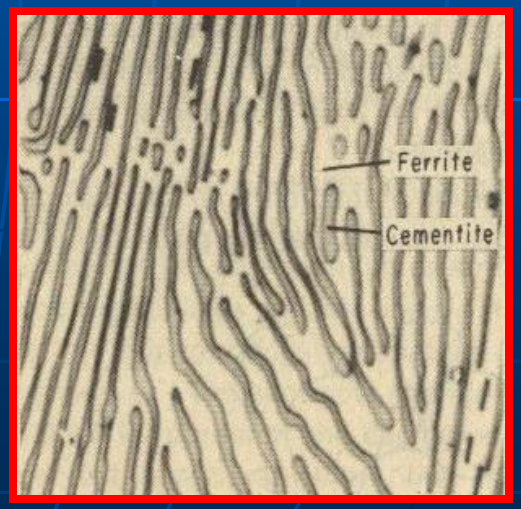


α microstructure

5. Pearlite:

It is a Eutectic mixture containing 0.8% (C) and is formed at 1333 °f point (J) in fig. 1 on very slow cooling. It is a very fine plate like or lamellar mixture of (α) + Fe_3C. The average properties are:

T. S ≈ 120,000 psi, E% ≈ 20% , R_c ≈ 20



Pearlite microstructure