Lecture 37: Surface hardening

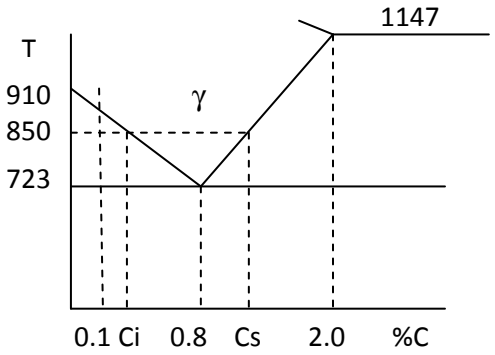
Questions:

1. Induction heating followed by quenching is a common method of surface hardening of steel. Can it be applied to an alloy steel having 18Cr8Ni0.15C?
2. Can steel having 0.1% carbon be case carburized at 850^{o}C?
3. Cite three main reasons for surface hardening of steel.
4. Explain why core refining heat treatment may not be required for case carburized aluminium killed steel.
5. What is the white layer on steel that forms during nitriding?

Answers:

1. No. 18Cr8Ni0.15C is an austenitic steel. It cannot be hardened by heating & quenching.

2. It would carburize but the process would be too slow. At 850^{o}C it will have ferrite austenite structure. Solubility of carbon in ferrite is very small. Only the austenitic region will pick up carbon. The concentration gradient for carbon to diffuse into austenite is also less. Since both temperature & concentration gradients are low rate of carbon pick up will be extremely slow. Therefore carburization at 850C is not recommended. The following figure illustrates how %C at the interfaces can be estimated.



$$Ci = \frac{910 - 850}{710 - 723} \times 0.8 = 0.26$$

$$\frac{2 - Cs}{2 - 0.8} = \frac{1147 - 850}{1147 - 723} \; or; Cs = 1.16$$

$$\Delta C = 1.16 - 0.26 = 0.9$$

3. Three most important reasons for surface hardening are: (i) to have hard surface but soft (tough) core in components like gears, shafts etc. (Hardening is often accompanied by loss of toughness.) (ii) to overcome section size effect which makes it difficult to get required surface hardness in large sections by quenching and (iii) to get a favorable residual stress on the surface which would inhibit crack initiation.

4. Purpose of core refining treatment is to get fine austenite grain in case carburized steel. Aluminum killed steel are resistant to austenitic grain growth. Aluminum reacts with dissolved oxygen to form oxide particles during solidification. These are located along austenite grain boundaries and restrict their movements. In such steel grain growth during carburization heat treatment may not be significant. This is why core refining treatment may not be necessary.

5. Nitriding is done on steel after it has been hardened and tempered. Sample is heated to around 500^{o}C which is lower than the eutectoid transformation temperature in Fe-N phase diagram. The eutectoid consists of ferrite and Fe_4N. While some N would diffuse through ferrite to form fine carbo-nitrides some may form a white nitride layer made of Fe_4N at the surface. This is hard and brittle. It is harmful and it must be removed by lapping.