Chapter - 1

I N T R O D U C T I O N

1.1. Definition and Importance of Stress Corrosion Cracking :

The phenomenon of destruction of metals and alloys under the combined action of static tensile stress and corrosive medium is termed as 'Stress Corrosion Cracking'. The corrosive medium is specific for a particular alloy, and the stress, residual or applied, must be tensile. The destruction is caused by cracks, intergranular or transgranular, initiated and propagated in a direction perpendicular to the acting tensile stress even though the general corrosion of the metal surface may be of very low order. The cracking is associated with very little plastic deformation, as such the metal may be deemed to behave like a brittle material. The facts that the final failure of a metal part is often unpredictable from the consideration of the extent of corrosion, and that in structural applications of a metal often it has to withstand certain amount of tensile stress make the problem of stress corrosion cracking vital from the engineering point of view.

The earliest record of stress corrosion cracking is associated with the cracking of cold drawn 13 carat gold in a solution of ferric chloride as reported by Roberts-Austen[1]. 'Season cracking' of brass cartridge cases[2] encountered in the early nineteenth century is possibly the first instance which led to a systematic study of the problem. The studies show that an interplay of the residual stress and ammonia in

the atmosphere cause stress corrosion cracking. Research conducted over last 75 years has further established that a number of other alloy systems are susceptible to stress corrosion cracking in specific media.

1.2. Aims and Object of the present study :

Stress corrosion cracking of homogeneous alloys presents an interesting problem to study from the viewpoint of metallurgical and chemical aspects. Absence of a second phase and occurrence of both inter and transgranular cracks complicate the problem of crack initiation and crack propagation. For proper understanding of the problem a thorough probe is needed.

The present investigation was undertaken with a view to examine the role of various physical and electrochemical factors in stress corrosion cracking behaviour of some homogeneous binary copper alloys so as to gain an insight into the mechanism of the process. This constitutes a part of the programme being carried out at the National Metallurgical Laboratory, Jamshedpur. Copper alloys were chosen due to their relatively greater susceptibility to stress corrosion cracking and their importance in industrial application. Copper forms solid solution to a considerable range with a large number of alloying elements, and a good amount of work has been done on physical metallurgy of copper-base alloys which may help in the consideration of stress corrosion cracking.

Copper-manganese alloys are finding greater applications in India as a substitute for copper-nickel alloys due to the

acute scarcity of nickel in this country. Abundance of manganese in India brightens the possibility of development of these alloys suitable for various applications. In this context it is worthwhile to study the stress corrosion behaviour of copper-manganese alloys so as to make the best use of them by minimising stress corrosion susceptibility. Copper-manganese system provides a wide range of solid solution which is of interest from the viewpoint of theoretical considerations ; an effective comparison is possible with the copper-zinc system the stress corrosion studies of which have been carried out extensively. In the present work, therefore, stress corrosion cracking of
3) copper-manganese alloys has been studied in greater detail. One composition from copper-zinc system and two from copper-tin system have also been studied for the sake of comparison.

Extensive work is being carried out in the field of stress corrosion cracking which deals with the mechanism of crack initiation and crack propagation, but much less importance has been laid on a quantitative study of cracking time and its relation
4) to the various constituents of the alloy and the corroding media. In the present work an attempt has been made to arrive at such a quantitative relationship in the stress corrosion of copper-manganese alloys.

The thesis presented compiles the observed data on the following aspects of stress corrosion cracking :

1) Influence of different alloying elements on susceptibility to stress corrosion cracking.

2) Effects of variation of corrosive conditions and temperature on stress corrosion cracking.

3) Effects of applied stress and prior cold work on stress corrosion cracking.

4) Effects of various metallurgical and chemical factors on mode of cracking.

5) Dependence of stress corrosion cracking on the arrangement of dislocations in the alloy.