CHAPTER - 1

INTRODUCTION

The phenomenon of stress corrosion cracking in brasses, which was detected in the beginning of this century, has become a subject of extensive investigation all over the world, and there has been phenomenal growth in the number of research papers in this area over the last few decades. There is a complex interplay of metallurgical, mechanical and chemical factors in the stress corrosion cracking of various alloys and, naturally, the attempts to explain its mechanism have become confined to only certain aspects of the process. Different mechanisms have been suggested for stress corrosion cracking in different alloys, and even in the case of a single alloy system like brass, no unanimity has so far been achieved on a unified mechanism for intergranular and transgranular cracking.

Stress corrosion cracking in brasses has mostly been investigated with the homogeneous alpha variety, obviously for the sake of simplicity by avoiding a two-phase system. Even in alpha brass transition in the mode of cracking presents a very interesting observation, and the explanations for transgranular cracking based on planar dislocation model or formation of surface films proved to be inadequate to explain such transitions under the conditions of change in solution chemistry or applied potentials. Work carried out in this laboratory for the last 14 years has led to the proposal of a new model for stress corrosion cracking in alpha brass based on adsorption of chemical species on the heterogeneous reaction sites and the subsequent electrochemical reactions at these sites. This model could successfully explain the transition in mode of cracking and other observations in alpha brass in Mattsson solution.

The applicability of the above model in the case of stress corrosion cracking of alpha-beta brass, a two phase alloy, has been investigated in the first part of the present work. This alloy gives transgranular cracking in ammoniacal solutions. It has been felt that a comparison of the stress corrosion behaviour of this alloy with that of the well-investigated alpha brass could lead to a better understanding of the process.

The stress cracking of alpha and alpha-beta brasses in mercurous nitrate solution and in liquid mercury constitutes the second and main part of the present work. The embrittlement of brasses caused in these media has also been known for a long time and the first report dates back to as early as 1914. Since then, specially after 1960, there has been a tremendous growth of research work in the field of liquid metal embrittlement. The 'Rebeinder Effect' in metals has been attempted to be explained in terms of adsorption-induced lowering of surface energy or, later, on atomistic models through the pioneering works of Rostoker and Nichols, Kamdar and Westwood, Stoloff and Johnston, and more recently of Latanision as well as Lynch. But the controversy still centres around the specificity of the medium and whether the role of adsorption is to supress or trigger a local plastic deformation at the crack tip.

The apparent similarity between liquid metal embrittlement, stress corrosion cracking and hydrogen embrittlement, at least in some alloys, has been indicated by some investigators, but no elaborate work has been reported in this respect so far. Rather, there remains a controversy even in the nature of stress cracking of brasses in mercurous nitrate solution : some hold it as a brittle fracture without any electrochemical step, others refer it as a case of stress corrosion cracking.

In the present work, the factors affecting the stress corrosion behaviour of brasses in ammoniacal solution has also been applied for investigating the stress cracking behaviour of these alloys in liquid mercury as well as in mercurous nitrate solution so as to observe the similarities and dissimilarities and judge the processes in the light of the existing theories.

The application of acoustic emission studies in the studies of fracture processes has emerged as an useful tool in the recent years and the application of this technique to environment sensitive fracture processes has started only very recently. The qualitative difference in the acoustic signals in the various environment sensitive processes can serve as an indication of the difference in the mechanisms of crack formation and this has been attempted in the present work.