Chapter I

Introduction

1.1 Motivation, Objective, and Scope

The interest of glass scientists and technologists in a deeper understanding of the batch melting process is high. Although many details of this process have been investigated, no comprehensive understanding have been reached, and predictive modelling is still based on unproven assumtion.

Since batch melting is the first step of the glass melting processes, it controls the overall rate of melting processes, so, the knowledge of batch melting process is very important in order to optimizing, and enhancing the pull rate of the glass melting process. Unfortunately, few studies are known that report experimentally verified descriptions of batch melting. It was the objective of this study to build up suited equipment for melting campaigns in the 10 kg range to emulate the environment of actual glass melting furnaces in the industries and to closely record and document vertical resistivity distribution (which was related to the formation of liquid phase in the system), vertical temperature distribution, and also study the melting behavior by direct observation into the furnace and by cross-section of the crucible after the batch melting.

1.2 Literature Survey

The first generation approach to batch melting was focused on the thermochemistry of batch melting. Kröger and co-workers (1952, 1955) alone published a series of more than ten comprehensive papers in this fields. The state of first generation knowledge is reviewed by Kautz (1969).

The second generation approach was focused on physical and mathematical modelling of the process (Fuhrmann, 1973), (Mase and Oda, 1980), and (Hilbig and Kirmsse, 1986). Very different procedures revealed a general pattern, i.e., that batch melting can be understood in terms of a quasi-stationary, quasi-isothermal process to a large extent. During the 2nd International Conference on Advances in Fusion and processing of glass, 1990, de Waal pointed out the achievements and shortcomings of our present understanding. Physical modelling is a need. This is reflected in recent publications on the thermal behavior (Backmann, Cable, Karlsson, and Pennington, 1990), the heat demand (Conradt and Pimkhaokham, 1990), and the kinetics of batch melting (Hrma, 1990). But most of all, there is far too little experimental work on realistically dimensioned batch blankets. On the microscopic scale, interesting investigations are available, such as Wilburn, Metcalf, and Warburton (1965). But as far as more realistic dimensions are concerned, only two experimental contributions (Daniels, 1973), and (Ungan and Viskanta, 1986) have attracted broader attention until 1990. Recently, Faber, Beerkens, and de Waal (1992) worked on a similar topic during the same time and results on vertical temperature distribution were published.