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THERMOANALYTICAL INVESTIGATIONS INTO THE GLASS MELTING PROCESS

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ABSTRACT

The glass melting process is characterized by a complex system of consecutive and parallel reactions under non-isothermal conditions. Not all thermoanalytical methods are equally suitable for a qualitative and quantitative characterization of the processes. The integral methods such as DTA or TGA always yield information only on the temperature range of reaction and the total mass change as functions of temperature. By selective methods such as EGA (MS-analysis) a possibility to determine single reactions steps is provided. The problems of a technical application is explained by the example of the soda-lime-silica-system.

INTRODUCTION

The investigation of glasses by means of thermal analysis has a more than 50 years' history /1/. Today there exists a well developed field of knowledge and techniques for the thermoanalytical characterization of glasses. Moreover, because of the dynamic measuring principle the thermoanalytical methods also suitable for the investigation into the glass melting process. Fig.1 schematically shows the temperature and the gas partial pressure in a glass manufacturing system as functions of time. The present task is the optimation of this process with respect to energy consume, the tons production per day, the different kinds of raw and recycling materials, the furnace life, the enviromental quality and safety and the economy.

The control of a glass making system is possible on the basis of temperature measurement, the determination of the composition of evolved gases and other technical paramters.

Because of the long term reaction of batch components in the melt it is profitable to analyze the batch mixture before introducing it into the container tanks. In this paper the present possibilites and limits of thermoanalytical techniques for a technical use will be discussed.

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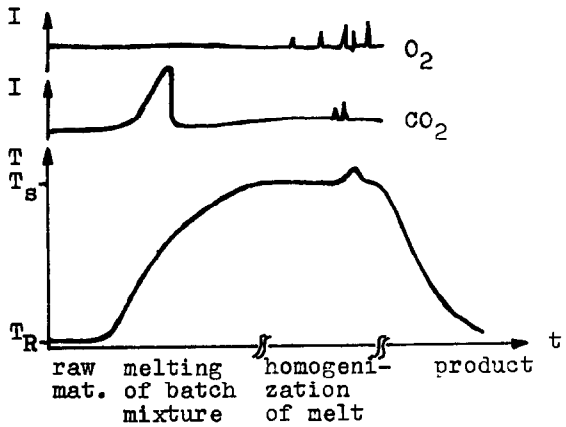

Fig.1
The temperature and partial gas pressure of CO_2 and O_2 in a container tank for glass melting as functions of time

MEASURING METHODS

For the investigation of raw materials batch mixtures, melts and glasses TGA and DTA were used simultaneously with EGA and X-ray diffraction and high temperature microscopy. The methods are used were described more detailed in previous papers /2,3/.

For the investigations under atmospheric pressure an interface is used for pressure reduction between TA and QMS systems /2/. In this case the sample weight was ca. 100 mg in the original particle size of raw materials. Cullet was investigated either as single fragments or ground to the grain size of the other raw materials.

RESULTS AND DISCUSSION

Fig.2 summarites the results of the effect of CO_2-degasing of the batch mixtures in dependence on batch composition under atmospheric pressure. The CO_2- degasing temperature decreases in dependence on the concentration of additives.

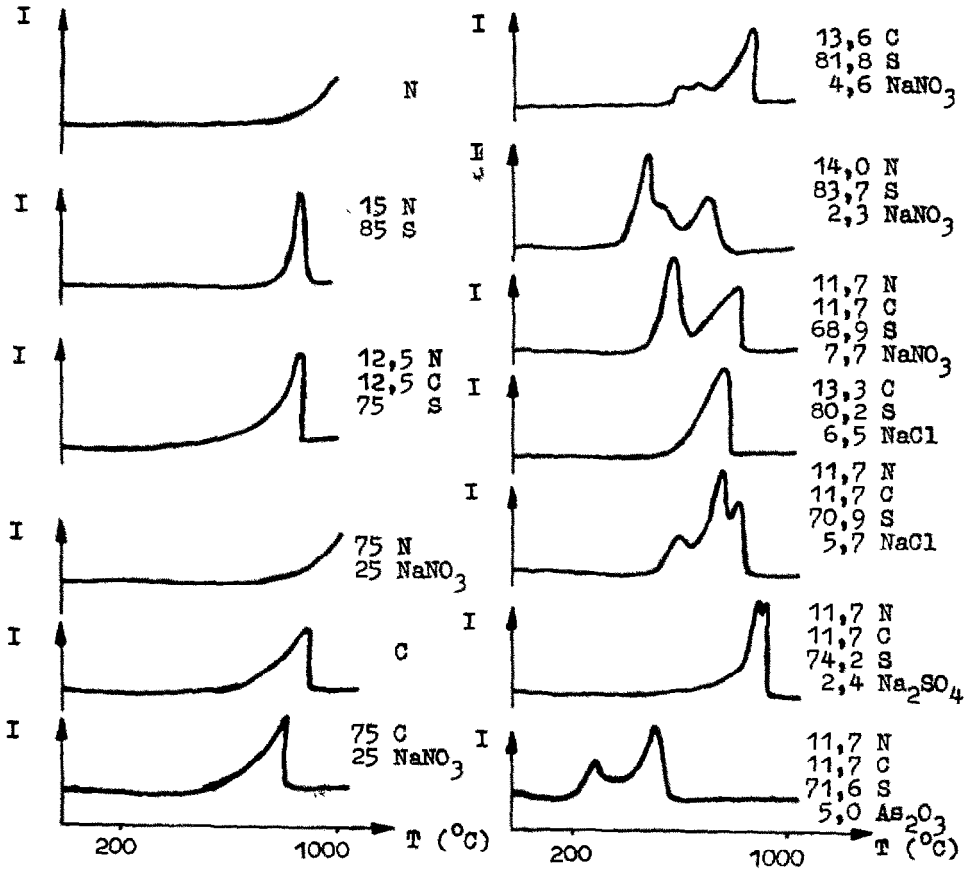

Fig.2 CO_2-degasing of raw materials mixtures at heating under atmospheric pressure

N = Na_2CO_3 ; S = SiO_2 ; C = $CaCO_3$

By means of X-ray analysis it was found that the decomposition rate of carbonates does not suffice to determine the formation of silicates in the glass batch. Only in the binary mixture of Na_2CO_3 - SiO_2 such a correlation is permitted. Consequently the change of partial pressure of CO_2 by heating of a glass batch mixture is not a control-value for the silicate forming process.

For the optimation of the melting process we must conduct the reaction in such a way that the raw materials are activated in the same temperature range. The carbonate melt is an important factor in the silicate forming process.

REFERENCES

1 Tool,A.Q., J.opt.Soc.Amer. 4 (1920) 340
2 Heide,K., Lichhorn,H.-J., Höland,W., Silikattechnik 28 (1977) 177
3 Heide,K., Lichhorn,H.J., Höland,W., Thermal Analysis Proc. 5th ICTA Kyoto (1977), 91