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On the Heat- and Mass Transport during Melting and Dissolution

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1. Introduction

On the melting and dissolution of solids many reaserch works exist. Already known is that the melting starts with freezing (1,2,3).

The influence of the heat conductivity has been reported (Fig.1) (2). Experiments for this research have been carried out for solids in their own melt.

For multi component systems the influence of the mass transport has to be taken into account. By this way it can be explained that the melting time of a solid is a function of contents of the bath (2) .

Further study is related to the melting in multicomponet systems.

2. Melting in a binary system

Experiments were carried out in the Fe - C system.

Pig iron cylinders of a carbon content x_B= 4% (mass) are immerged into a steel bath (x_C = 1,3% (mass). The cylinders have a diameter of 3o mm and a heigth of 5o mm. (2)

By means of a glass rod that is put through the cylinder it is possible to lift the sample out of the bath. Many cylinders were used to study the formation of a shell and the total melting time.

After 18 sec a steel shell was formed around the sample.By lifting the sample out of the bath it was possible to observe, that 'inner melting' had taken place (Fig 2). The top and the bottom of the shell had already been liquid so that the liquid pig iron could flow out. As the glas rod is of some disturbance, solid pig iron is still around the rod (white ring in the center).

3. Heat- and Mass Transport

For a solid melting in a binary eutectic system with thermodynamical equilibrium at the solid and in the solid (high heat conductivity) the result of Chap. 2 can be explained.

After the solid is immerged a shell is formed immediately as the heat transport into the center is greater than the outer heat and mass transport (T = T (Eutectic) . As long as Fe and C are solid the temperature cannot rise.
The inner part will start melting. Because of the equilibrium at the phase boundary C is transported away and Fe to the phase boundary.

If C is molten the temperature can rise . Again because of the equilibrium at the phase boundary and as long as the liquidus concentration is below the concentration of the bath the Fe transported to the phase boundary will freeze and the inner part will melt further.

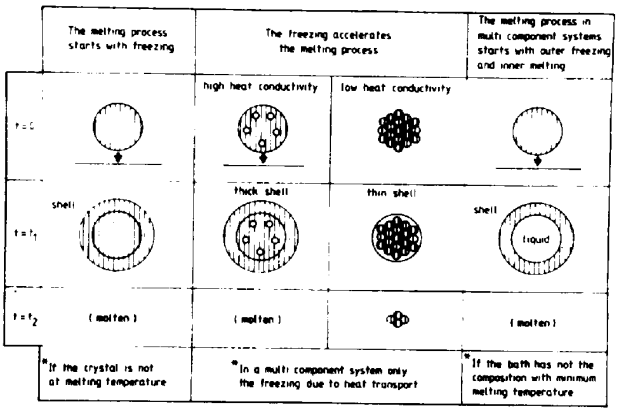

Fig 1: Principles of melting . (Solids have the same initial mass and surface area). Melting starts with freezing. Due to the heat conductivity shells of different thickness are formed. In multi component systems the melting process starts with outer freezing and inner melting .(2)

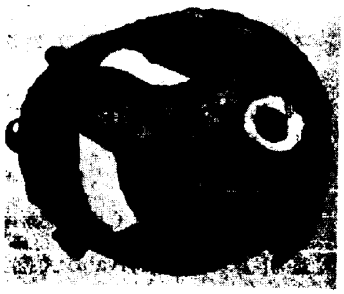

Fig 2: A pig iron cylinder of carbon concentration x_B = 4% (mass) is immerged into a steel bath of x_C = 1,3 % (mass). After 18 sec the cylinder is carefully removed from the bath. A shell (of steel) can be seen (picture). The inner liquid part has flown into the bath. Only a rest has remained at the glas rod . (1)

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