# WETTABILITY OF CARBON AND GRAPHITE BY METAL MELTS

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## INTRODUCTION

This investigation was induced by problems with graphite-dies in continous die-casting machines. The effect of chemical reaction between graphite and metal-melt on the wear rate of the graphite die should be established.

An indicator for the chemical reaction is the wettability which can be described quantitatively by the wetting angle when using the sessile drop method.

According to the initial problem technically relevant metals as cast-iron, copper and copper alloys have been investigated. As substrate carbon and graphite of different porosity have been used.

## EXPERIMENTAL

The sample of metal (0,3 g each) was positioned on the graphite substrate, the surface of which was polished and cleaned by ultra sonic erosion.

Sample and substrate were placed in a high temperature furnace so that the molten metal drop could be observed and photographed and temperature measurement could be carried out by a registrating pyrometer.

Before heating the whole system was evacuated to $10^{-5}$ bar and then filled with argon of purest quality to atmospheric pressure. After heating to definite temperature and reaching equal temperature in the whole system the molten drop was photographed. Accurate adjustment of the camera was assured.

From the photographs the wetting angle was taken as shown in Fig. 1. The wetting angle of the molten drop on the graphite substrate was considered as measure for the grade of reactivity.

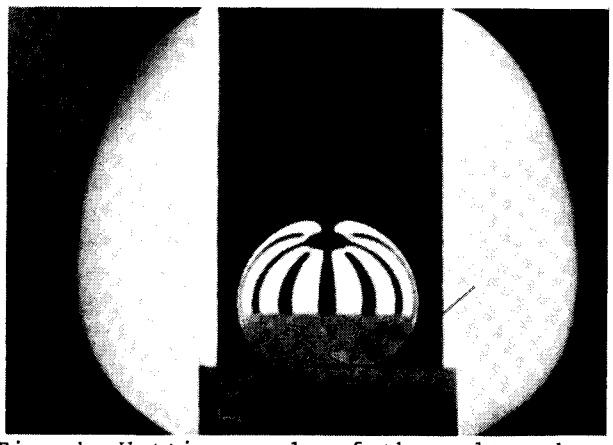

Fig. 1. Wetting angle of the molten drop

## RESULTS

### 1. Cast iron

The wetting angle of the cast iron samples as function of the temperature is shown in Fig. 2. As expected a strong effect of the temperature on the reactivity between cast iron and graphite is observed. In the range of 1500 °C the drop begins to 'creep' ($\theta \sim 90$ °).

Practically no differences between graphite grades can be observed.

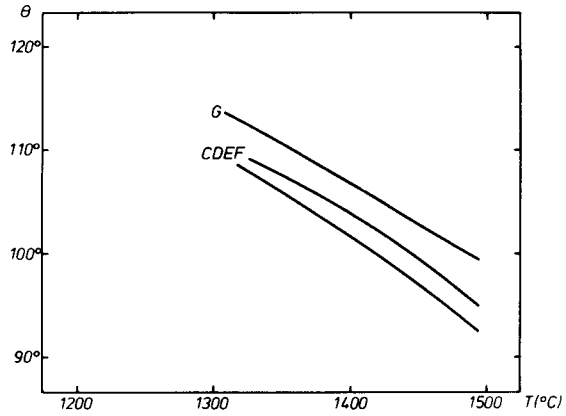


Fig. 2. Effect of temperature on the reactivity of cast iron

### 2. Copper

The effect of temperature on the wetting angle of the copper samples is shown in Fig. 3. As expected copper as a nonwetting metal shows practically no reactivity with graphite even at high temperatures. Graphite grade "G" has the lowest porosity and shows the lowest reactivity.

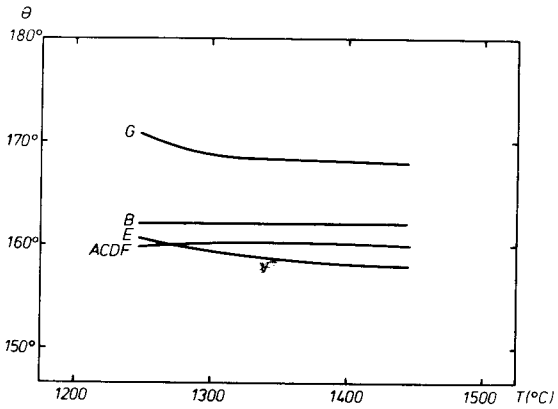


Fig. 3. Effect of temperature on the reactivity of copper

3. Copper-alloy (CuZnNi12)

The results are shown in Fig. 4. Clearly the dependance of the reactivity from the graphite grade appears. The grade with the highest porosity shows the strongest reactivity. With decreasing porosity reactivity decreases too.
The effect of temperature on the reactivity is of second order.

Surprising is that the lowest reactivity is shown by grade "A", a carbon grade. This fact led to a study on the effect of the degree of graphitisation on the reactivity.

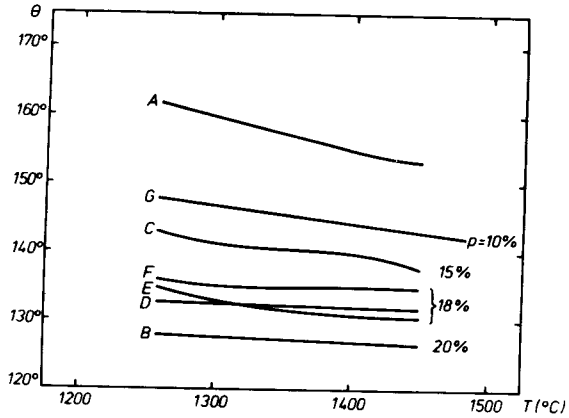


Fig. 4. The effect of porosity on the reactivity of CuZnNi12)

4. Effect of high temperature treatment

Carbon grade "A" changes with increasing high temperature treatment (HTT) into grade "B". The variation in the wetting behavior by CuZnNi12 with increasing HTT of grade "A" is shown in Fig. 5. The wetting measurements have been carried out at 1200 °C.

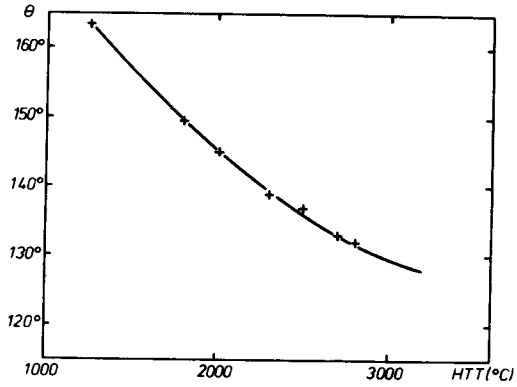


Fig. 5. Effect of degree of graphitisation on the reactivity of CuZnNi12

DISCUSSION

The results of the measurements led to the following conclusions:

- the reaction between a wetting metal and graphite is a function of the temperature, not of the grade of graphite
- the reaction between a nonwetting metal and graphite can not be induced by temperature
- the reaction between an alloy consisting of wetting and nonwetting metals and graphite is a function of the porosity. The reaction is a function of the degree of graphitisation too.

LITERATURE

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