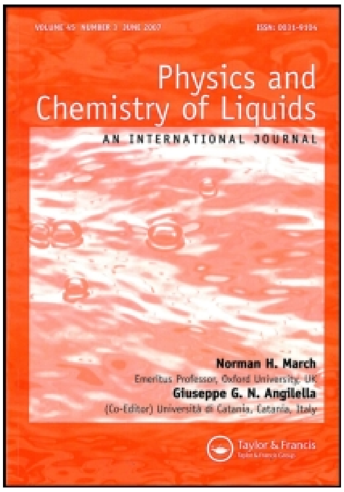

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Experimental Measurements of Hg-K Viscosity at 320°C

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Experimental Measurements of Hg–K Viscosity at 320°C

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By means of a toroidal oscillating viscometer, the shear viscosity of some Hg-K alloys has been measured in the composition range 10-60 atomic percent K at 320°C. Some discussion of the experimental results is given in terms of liquid coordination number.

1 INTRODUCTION

Before determining the bulk viscosity of Hg-K amalgam at 320°C, it is necessary to define its shear viscosity.

Besides, the use of materials easily subject to deterioration and difficult to find in a pure state, suggests to measure, one after the other, all the different atomic percentages (Photograph 1).

For these reasons, we have performed some accurate measurements on the viscosity of Mercury-Potassium alloys, as a function of composition, at the temperature of 320°C. In Section 2, of the present paper, the experimental apparatus is described briefly.

In Section 3 the experimental results are given and are discussed in Section 4.

2 EXPERIMENTAL APPARATUS

Very hard have been the experimental measurements of Hg-K viscosity with the toroidal oscillating viscometer.[2,3]

PHOTOGRAPH 1 Hg, K at a pure state and K ready for use. (Photograph by "IMAGO" s.n.c. 24, via C. Colombo Torino, Italia)

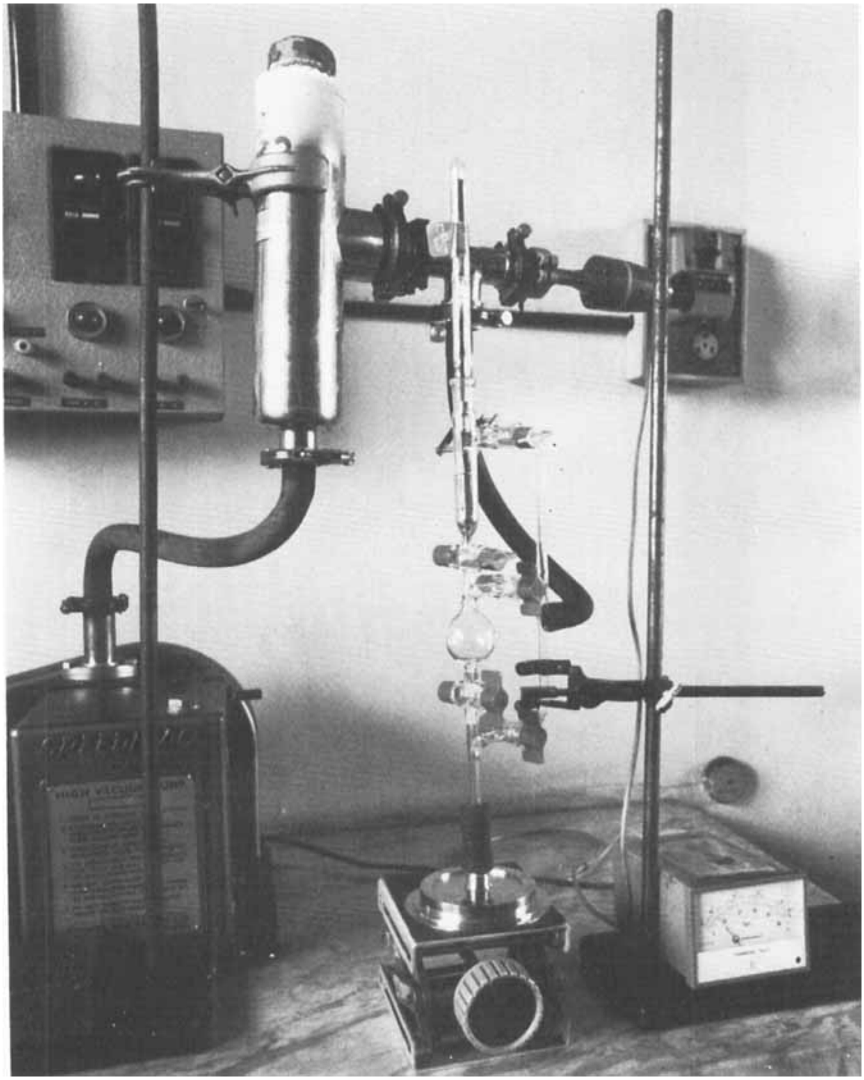
Each measurement is composed of four delicate phases:

a) In vacuum, at a temperature $\geqslant 65°C$ we have: melting of Potassium, realization of the amalgam and filling up of the viscometer with the apparatus of Photograph 2, completed with accessories of Photograph 1 or 3.

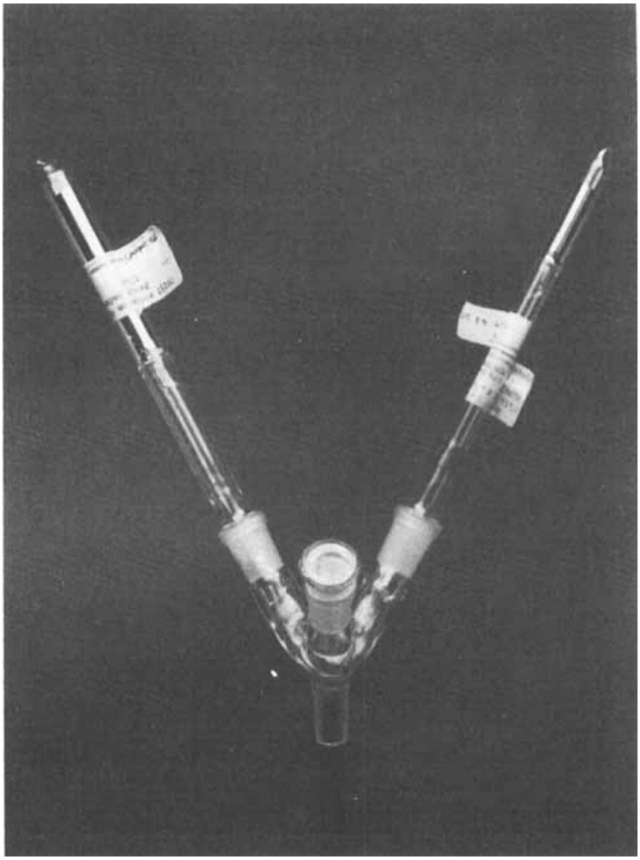
b) The viscometer reaches the ambient temperature, at which the amalgam becomes solid (Photograph 4). At this point the viscometer is put in an argon-atmosphere in the apparatus[3] introduced in an oily bath, which later will reach the temperature of 320°C.

c) Viscosity measurements are performed when the temperature becomes stable at 320°C and when the graphic spot indicates, with the logarithmic decrement, that the all amalgam, contained in the torus, is perfectly liquid.

d) We make the bath cool and pull out the viscometer, which is put again at a temperature $\geqslant 65°C$ so that we can extract the amalgam and clean the viscometer with care.



PHOTOGRAPH 2 Experimental apparatus. (Photograph by "IMAGO" s.n.c. 24, via C. Colombo Torino, Italia)



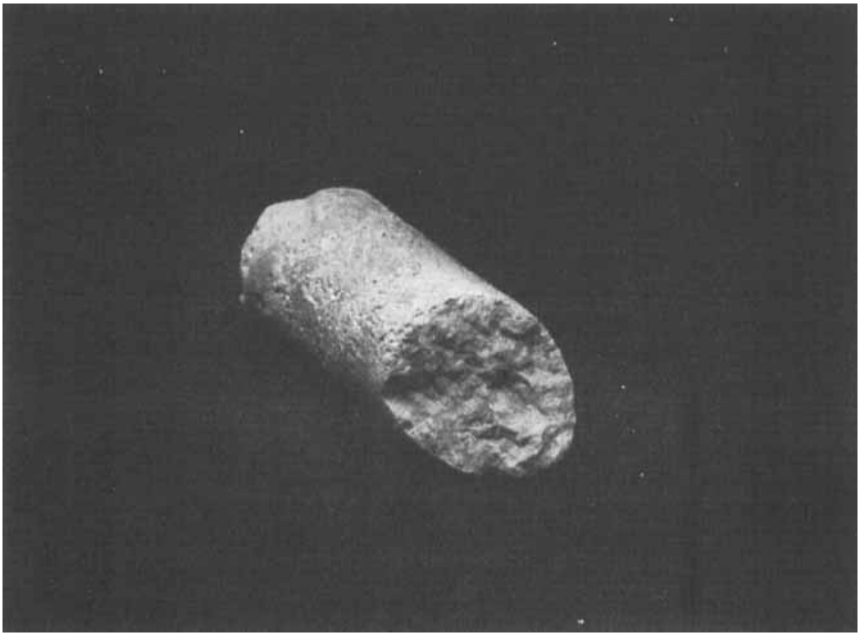
PHOTOGRAPH 3 Accessories for experimental apparatus. (Photograph by "IMAGO" s.n.c. 24, via C. Colombo Torino, Italia)

3 EXPERIMENTAL RESULTS

The viscometer dampings have been measured for each alloy composition (10; 20; 20,4; 30; 36,19; 40; 45; 50; 60 atomic percent K) at the temperature of 320°C. For each damping, the viscosity η has been calculated using formula (1) of Ref. 2 which for convenience is written below.

$$\frac{I\sqrt{2}}{4\pi^3 a^2 R^3 \rho}\left[\left(1 + \frac{T^2}{T_0^2}\right)\delta - 2\frac{T}{T_0}\delta_0\right] = G_1(q) - \delta G_2(q) + \frac{a^2}{R^2}G_3(q) \quad (1)$$

In the above formula $I = 27.845,61$ u.c.g.s. is the total moment of inertia of the system obtained by putting onto the crucible some calibrated disks; T, T_0



PHOTOGRAPH 4 Solid amalgam at ambient temperature. (Photograph by "IMAGO" s.n.c. 24, via C. Colombo Torino, Italia)

are the periods with and without liquid, respectively; δ, δ_0 are the logarithmic decrements with and without liquid respectivey; ρ is the density of liquid; η is the viscosity of the liquid; $a = 0{,}348$ cm is the inner radius of channel; $R = 2{,}69$ cm is the radius of the torus; q is the dimensionless parameter given by: $a(2\pi\rho/\eta T)^{1/2}$; G_1; G_2; G_3 are universal functions of q, which are given in the paper of Ref. 2.

The experimentally determined logarithmic decrements are introduced in Eq. (1). In order to get the q (and from q to get η) it is necessary however, to know ρ.

Data on the density of the Hg–K alloy have been obtained from Ref. 4 and conveniently elaborated to get ρ at each alloy composition at the temperature of 320°C.

The analysed experimental results are plotted in Figure 1 and Table I.

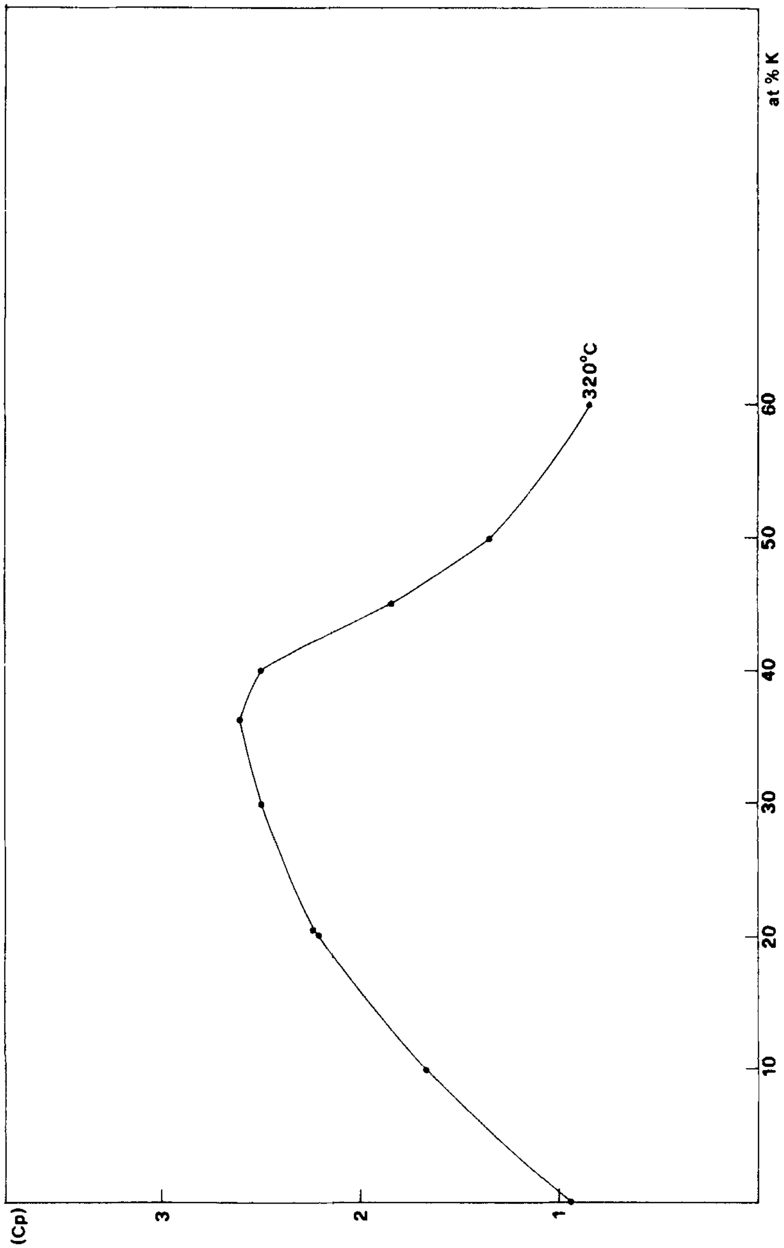


FIGURE 1 Hg–K viscosity versus amalgam composition at 320°C.

TABLE I

At. % K	0,0	10	20	20,4	30	36,19	40	45	50	60
η viscosity (cp) at 320°C	0,938	1,688	2,219	2,250	2,503	2,613	2,503	1,844	1,341	0,844

4 DISCUSSION OF THE EXPERIMENTAL RESULTS

Measurements of Hg-K viscosity as a function of the atomic percentage at 320°C experimentally realized, as above mentioned, and plotted in Figure 1 and Table I, let us compare these results with those present in literature,[5] about Hg-K amalgam viscosity at 300°C. This comparison, as shown in Figure 2 (- - - - - -), brings out a doubt.

The experimental measurement, with the same method above mentioned, of Hg-K viscosity at 32,9% at. K and at 37,5% at. K at 300°C gives the values of 2,827 cp. and 2,856 cp. respectively. We can affirm that Hg-K amalgam viscosity decreases with the increase of the temperature.

The linear regression about the melting temperature, obtained from the state diagram Figure 3 for each percentage, points out the intermetallic compounds at 20% at. K and at 45% at. K (Figure 4, Table II).

SUMMARY

Using the toroidal oscillating viscometer, the shear viscosity of some Hg-K alloys has been measured in the composition range 10-60% at. K at 320°C.

The experimental measurement of Hg-K viscosity at 32,9% at. K and at 37,5 at. K at 300°C gives the values of 2,827 cp. and 2,856 cp. respectively.

We can affirm that Hg-K amalgam viscosity decreases with the increase of the temperature.

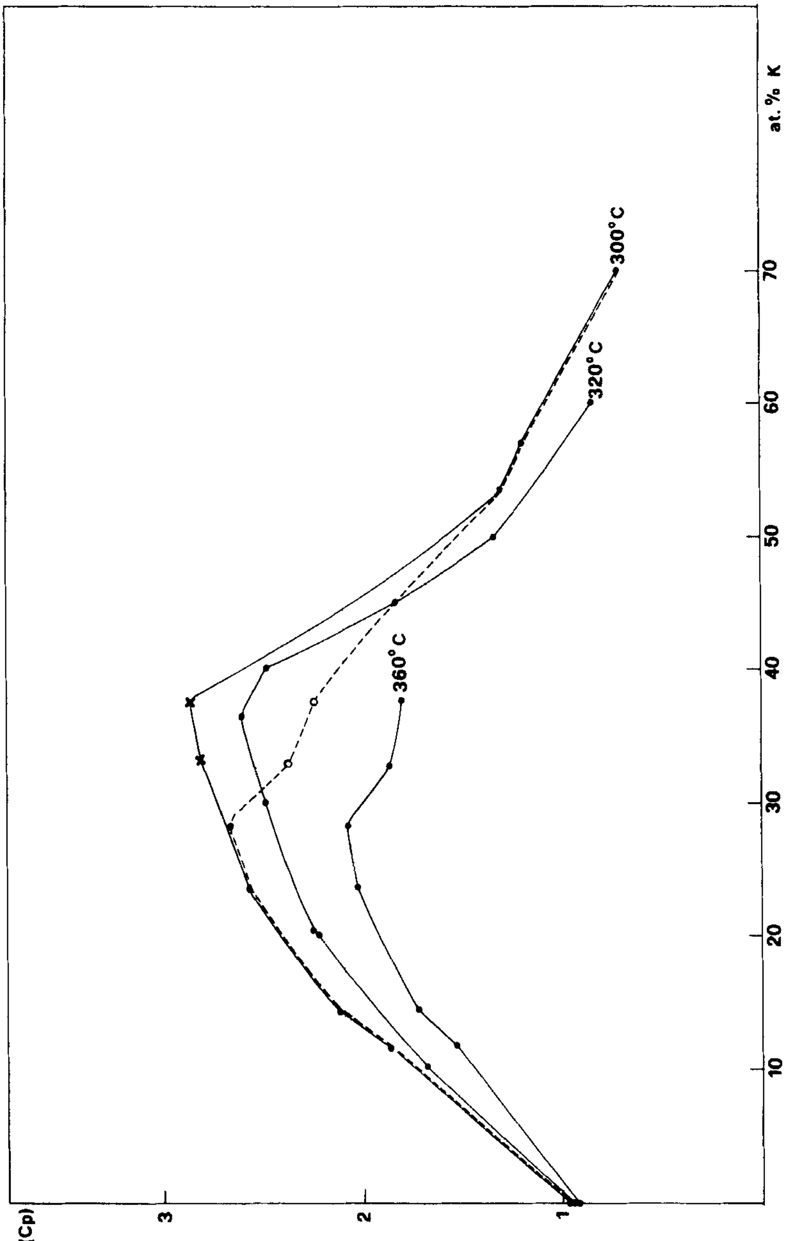


FIGURE 2 Hg–K viscosity versus amalgam composition at 300°C; at 320°C and at 360°C.

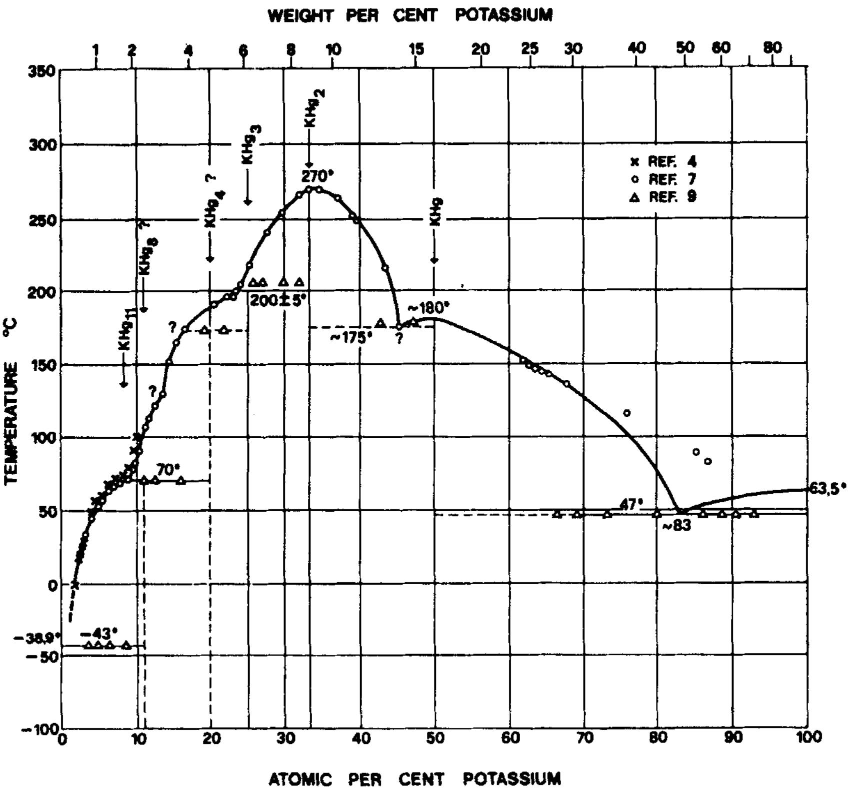


FIGURE 3 Phase diagram.

TABLE II

at % K	Melting Temperature °C	η (cp) Viscosity Hg-K
10	67,54	3,245
20	173,77	3,709
30	268,85	3,298
36	272,13	3,421
40	255,74	3,682
45	209,84	4,668
50	178,69	2,351
60	154,10	1,497

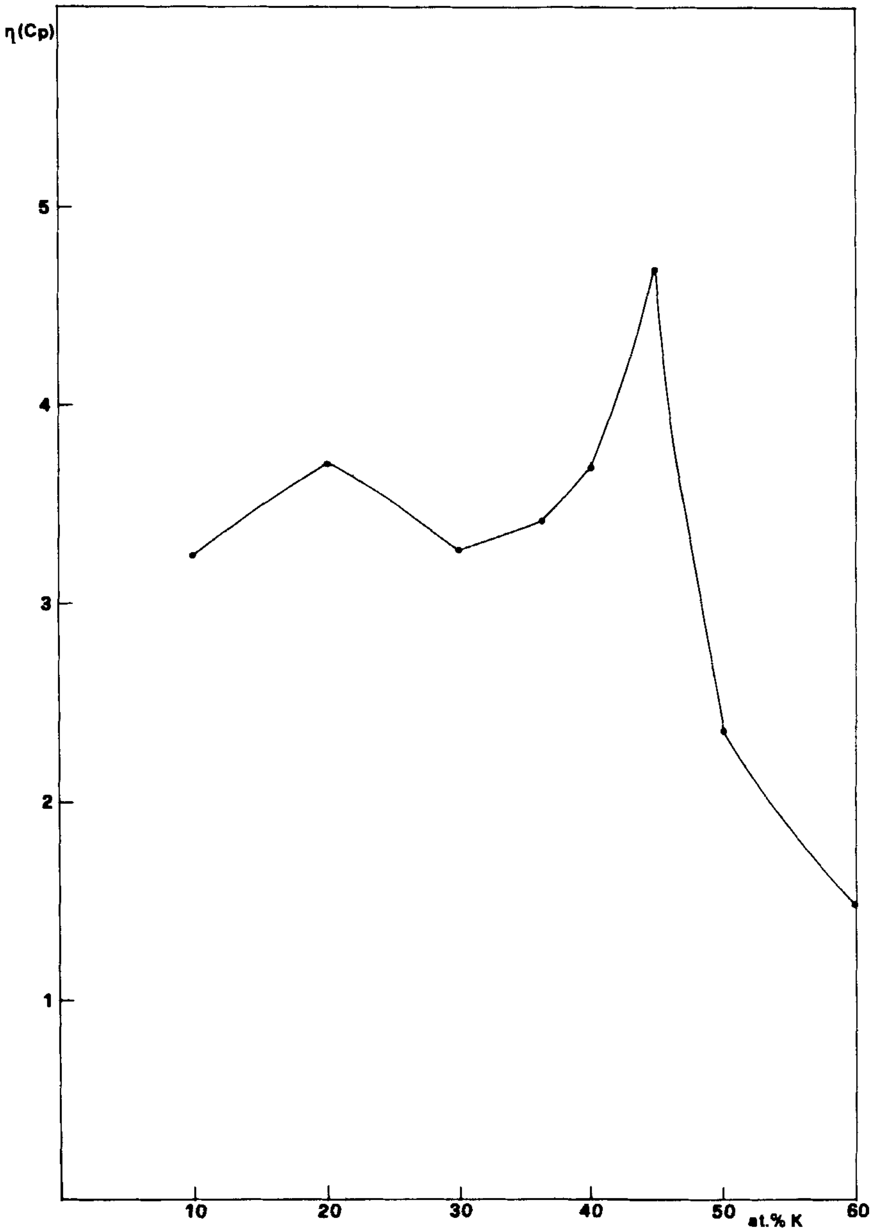


FIGURE 4 Hg–K viscosity versus amalgam composition at the melting point.

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