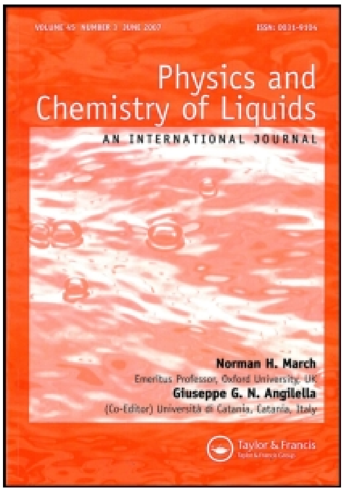

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Viscosity of Hg_5Tl_2 at 14.5°C

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Viscosity of Hg_5Tl_2 at 14.5°C

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By means of a toroidal oscillating viscometer, the shear viscosity of some mercury–thallium alloys has been measured in the composition range 28.5–29.5 atomic percent thallium and over the temperature range from 12.5–15.5°C. Some discussion of the experimental results is given in terms of liquid coordination number.

1 INTRODUCTION

In previous papers[1,2] the viscosity of Hg-In; Hg-Tl amalgams has been investigated using a special kind toroidal oscillating viscometer. As reported in[2] Gebharat affirms that, in systems forming intermetallic compounds in the solid state, we find a maximum in the viscosity-isotherms at the same concentrations where the intermetallic compounds form in the solid state. Figure 1 shows this phenomena in the Mg-Pb system, with the corresponding viscosity-isotherms. Besides, Rocs, *et al.*[2] assert that Hg_5Tl_2 (28.57 at.% Tl) is a maximum.

For these reasons, we have performed some accurate measurements on the viscosity of Mercury–Thallium alloys, both as a function of composition and temperature.

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

The toroidal oscillating viscometer used in the present investigation in the same as employed in Ref. 1,2.

3 EXPERIMENTAL RESULTS

The viscometer dampings have been measured for each alloy composition (28.5; 28.6; 28.7; 28.8; 28.9; 29.5 atomic percent Tl) at different temperatures, from 12.5°C to 15.5°C, and the fluctuations are every 0.25°C.

For each damping the viscosity η has been calculated using formula (1) of Ref. 3, 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 $I = 27845{,}61$ 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 are the periods with and without liquid, respectively, δ, δ_0 are the logarithmic decrements with and without liquid, respectively; 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: $a(2\pi\rho/\eta T)^{1/2}$ and in Ref. 4 conditions; G_1, G_2, G_3 are universal functions of q, which are given in the paper of Ref. 3.

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

Data on the density of the Hg-Tl alloy have been obtained from Ref. 5 and conveniently elaborated to get ρ at each temperature and at each alloy composition.

The analysed experimental results are plotted in Figures 1, 2, 3, 4. In Figure 5 the solid lines represent the dependence of η on the alloy composition, in the neighbourhood of the maximum.

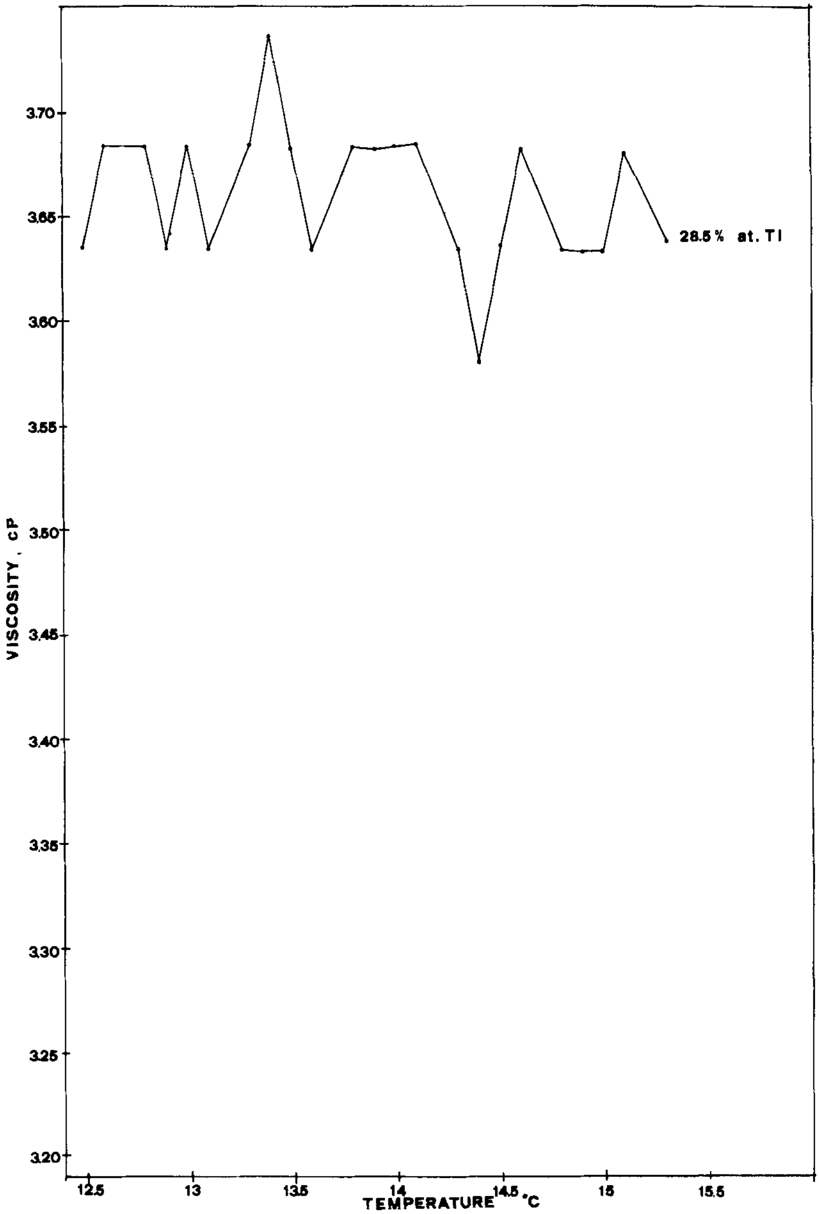
In Figure 6 the maximum at 28.6% at. Tl at 14.5°C.

In Figure 7 are represented the phase diagram and the viscosity-isotherms of the Hg-Tl system.

4 DISCUSSION OF THE EXPERIMENTAL RESULTS

The experimental results, collected in Figures 1–7 show the following qualitative aspects:

a) Hg-Tl amalgam viscosity behaviour as a function of temperature confirms Ref. 6 hypothesis, that is we are in presence of discontinuous changes of the coordination numbers of the liquid that is to say of phase transitions quite similar to the polimorphous transitions of the solid state.



FIGURES 1–4 Are viscosity of Hg-Tl alloys versus temperature.

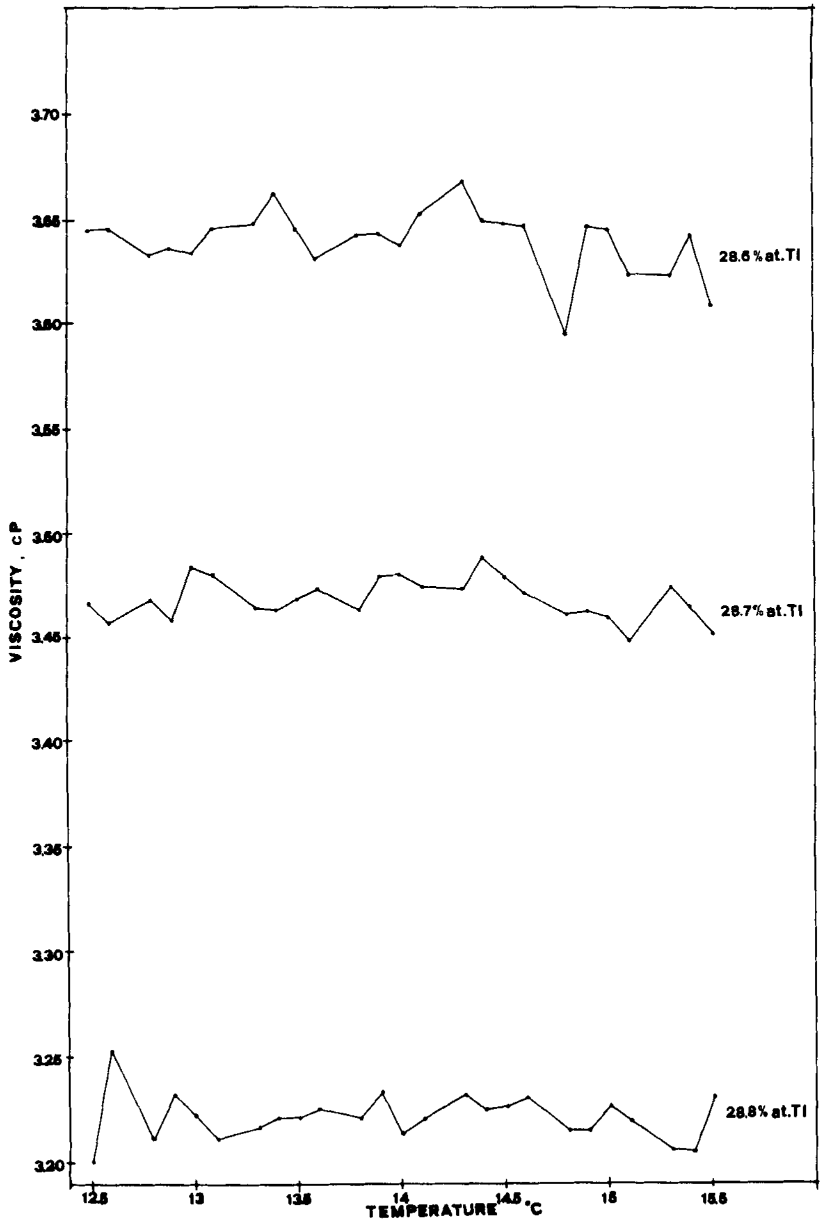

3.70
3.65
3.60
3.55
3.50
3.45
3.40
3.35
3.30
3.25
3.20
VISCOSITY, cP
28.6 % at.Tl
28.7% at.Tl
28.8% at.Tl
12.5
13
13.5
14
14.5
15
15.5
TEMPERATURE °C

FIGURE 2

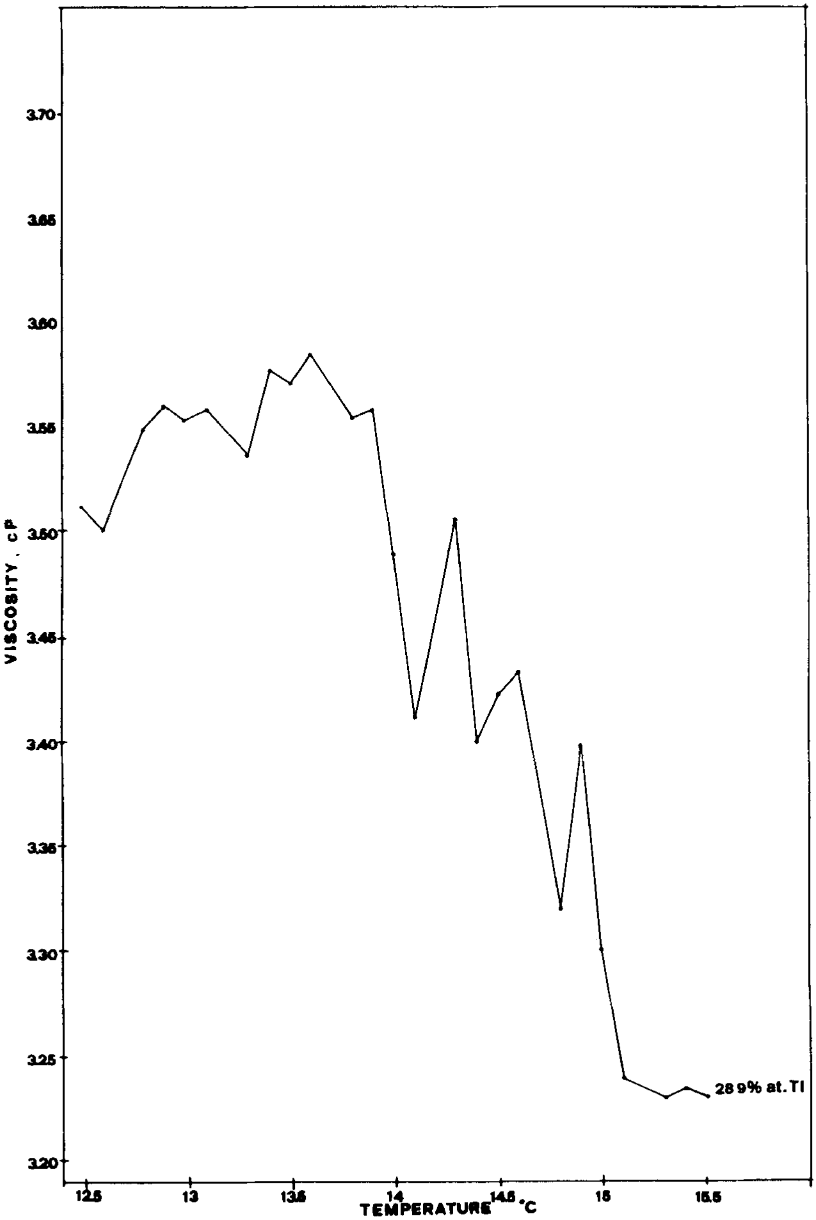

3.70
3.65
3.60
3.55
3.50
3.45
3.40
3.35
3.30
3.25
3.20
VISCOSITY , cP
12.5
13
13.5
14
14.5
15
15.5
TEMPERATURE °C
28.9% at. Tl

FIGURE 3

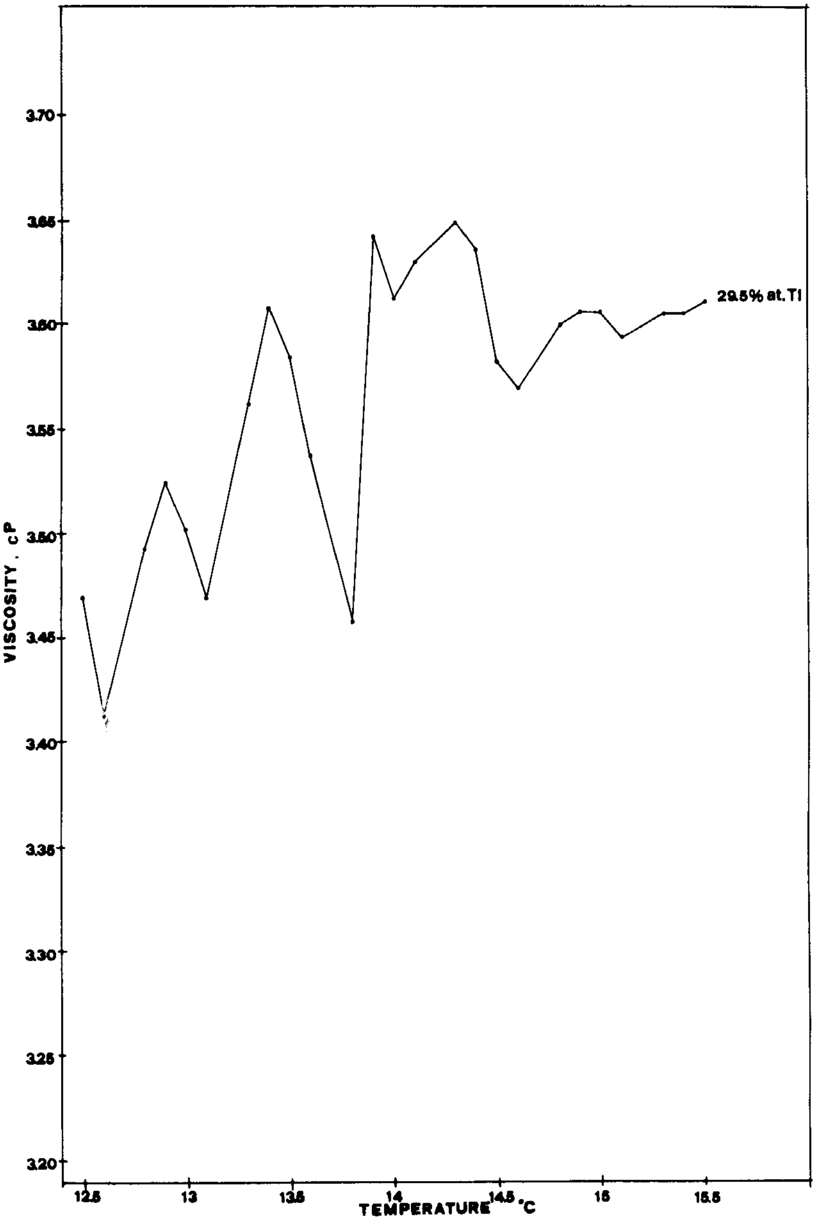

3.70
3.65
3.60
3.55
3.50
3.45
3.40
3.35
3.30
3.25
3.20
VISCOSITY, cP
29.5% at. Tl
12.5
13
13.5
14
14.5
15
15.5
TEMPERATURE °C

FIGURE 4

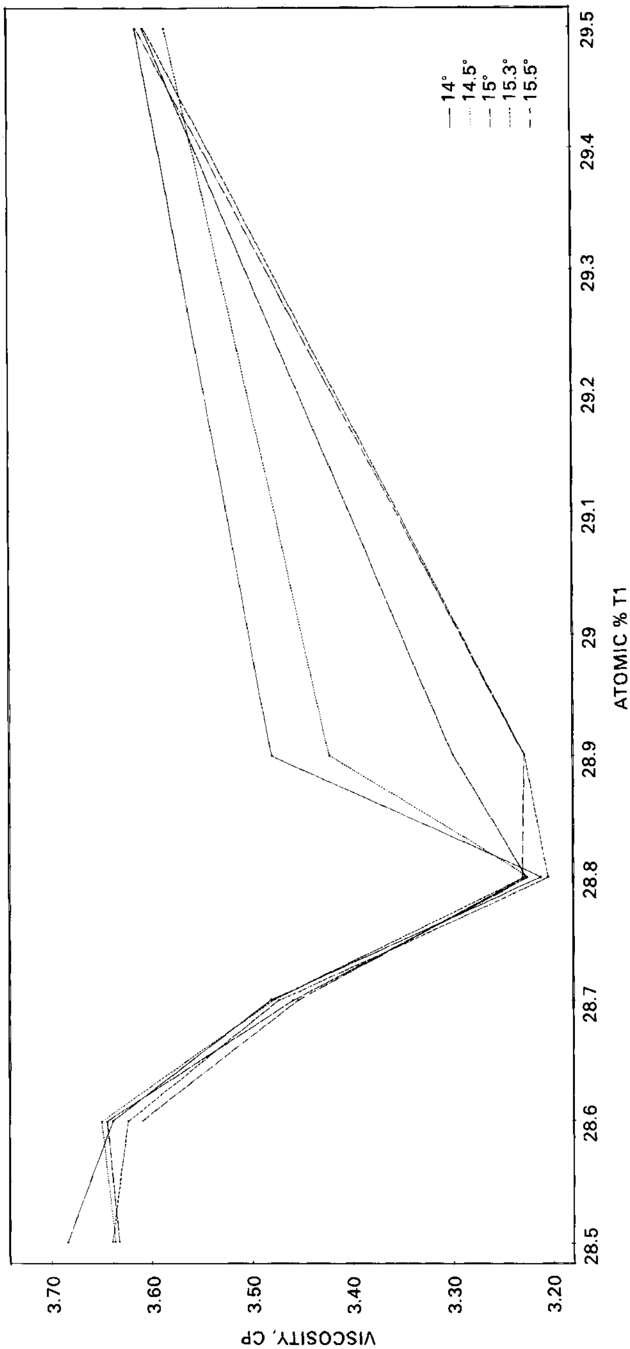


FIGURE 5 Viscosity versus amalgam composition in the neighbourhood of the maximum.

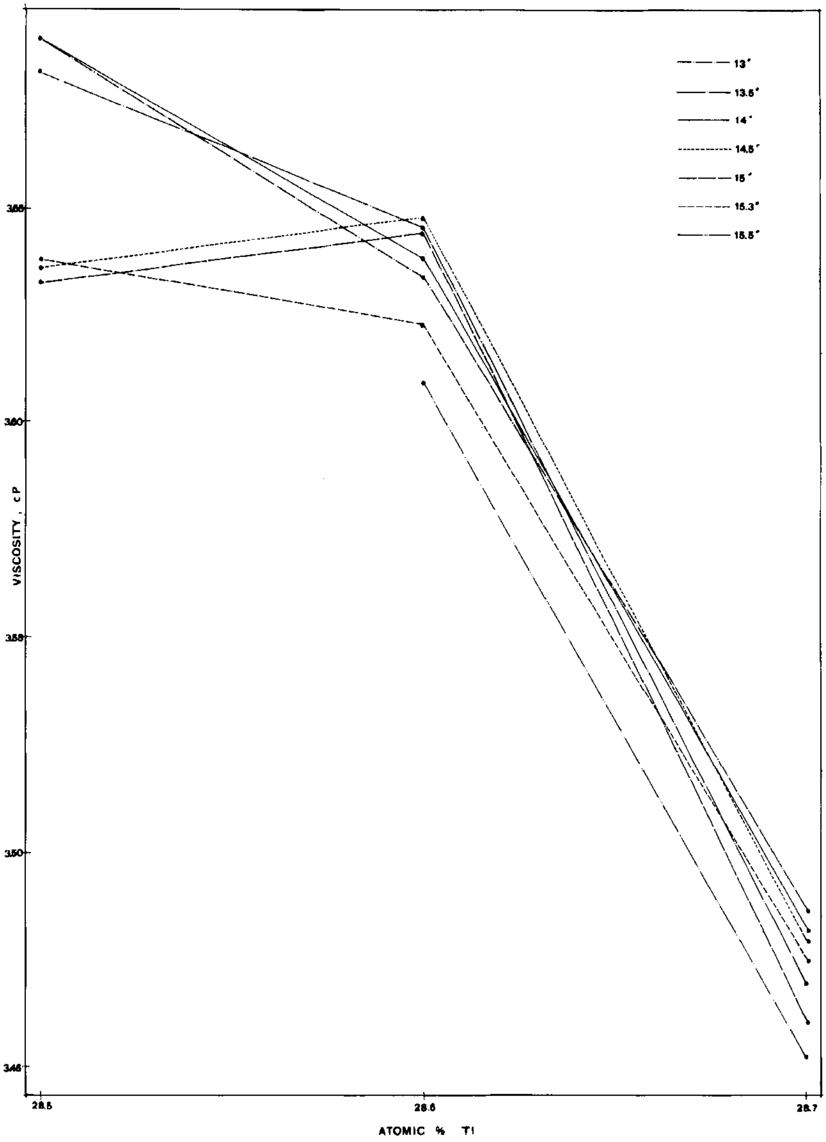


FIGURE 6 Maximum at 28.6% at. Tl at 14.5°C.

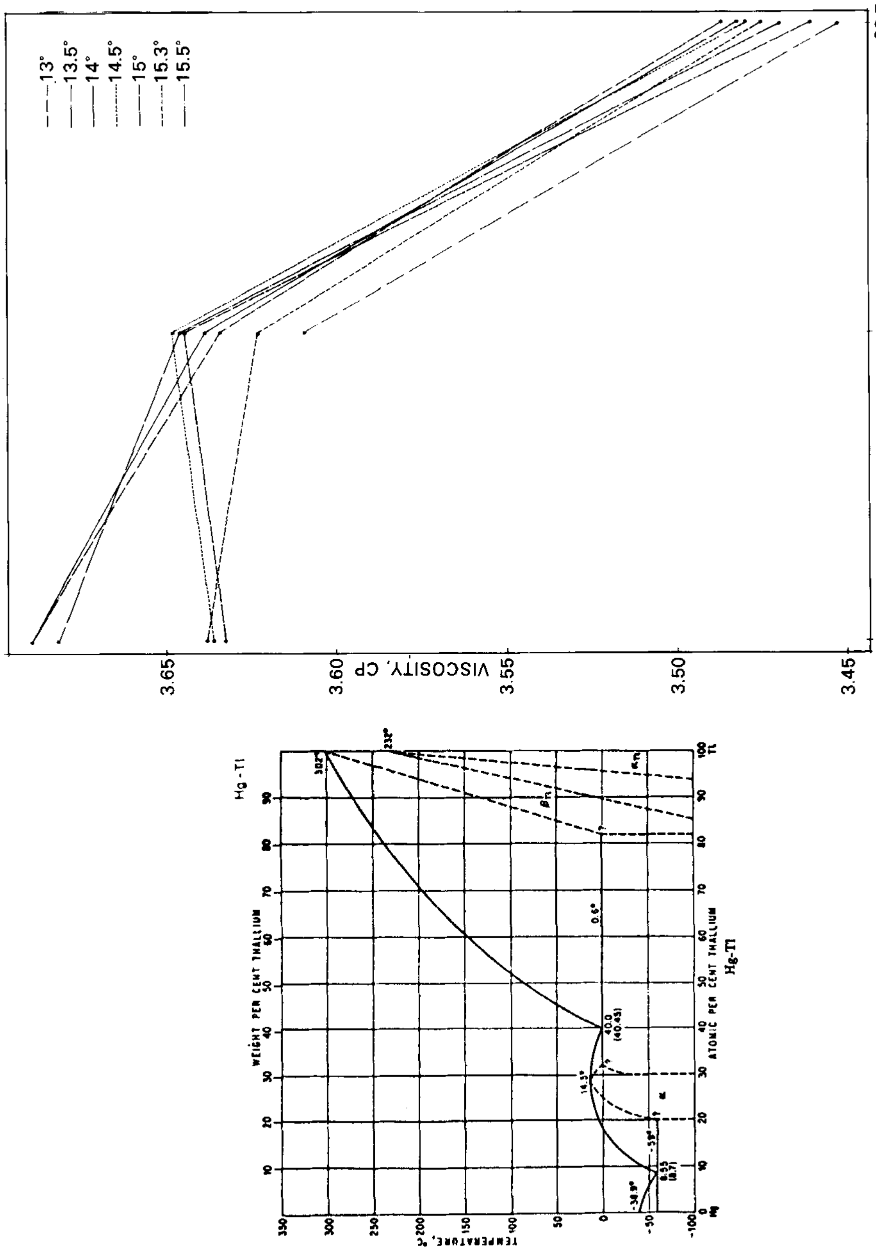


FIGURE 7 Phase diagram and viscosity isotherms of the Hg-Tl system.

b) Viscosity versus amalgam composition shows a maximum at 28.6 atomic percent Tl at the temperature of 14.5°C.

This is due to a pre-freezing phenomena which can indicate the influence of the forces that lead to the formation of the intermetallic compound Hg_5Tl_2 in the solid state.

c) At 28.8 atomic percent Tl, at the temperature of 15.5°C there is a minimum.

d) Figure 7 consents to add to Gebhardt's systems, the Hg-Tl system.

e) It remains to prove if the maximum, found at 28.6 atomic percent Tl, at the temperature of 14.5°C, is an absolute maximum. In order to prove it, it is necessary, according to Ref. 7 to investigate the Hg-Tl amalgam viscosity behaviour at 33.3 atomic percent Tl, at the temperature of 15°C.

SUMMARY

Using an oscillating viscometer, accurate measurements on the Hg-Tl amalgam viscosity have been performed, at various temperature, ranging from 12.5°C to 15.5°C and for different amalgam compositions.

It has been found that the Hg-Tl amalgam viscosity behaviour as a function of temperature confirms the hypothesis, that is we are in presence of discontinuous changes of the coordination numbers of the liquid, that is to say of the phase transitions quite similar to the polimorphous transitions of the solid state.

At 28.8 atomic percent Tl, at the temperature of 15.5°C, there is a minimum.

Viscosity versus amalgam composition shows a maximum at 28.6 atomic percent Tl, at the temperature of 14.5°C. This is due to a pre-freezing phenomena, which can indicate the influence of the forces that lead to the formation of the intermetallic compound Hg_5Tl_2 in the solid state. It remains to prove if this maximum is an absolute maximum. In order to prove it, it is necessary, according to Kurnakow and Pushin, to investigate the Hg-Tl amalgam viscosity behaviour at 33.3 atomic percent Tl, at the temperature of 15°C.

Acknowledgements

I express my thanks to Mr. A. Carnino for his help in the course of the present research.

TABLE I

Temperature °C	η* at 28.5% at. Tl	η at 28.6% at. Tl	η at 28.7% at. Tl	η at 28.8% at. Tl	η at 28.9% at. Tl	η at 29.5% at. Tl
13	3.683	3.634	3.485	3.222	3.553	3.501
13.5	3.682	3.646	3.469	3.221	3.570	3.583
14	3.683	3.638	3.481	3.213	3.489	3.611
14.5	3.636 ± 0.003	3.648 ± 0.008	3.479 ± 0.008	3.226 ± 0.008	3.422 ± 0.005	3.581 ± 0.005
15	3.633	3.645	3.460	3.227	3.300	3.605
15.3	3.638	3.623	3.474	3.206	3.229	3.604
15.5	—	3.609	3.452	3.231	3.229	3.610

* η (cP) is the viscosity of the Hg-Tl amalgam.

References

1. M. Bosco Masera and R. Malvano, Viscosity of Hg-In Amalgam. *Phys. Chem. Liq.*, Vol. 5, pp. 151–161 (1976).
2. M. Bosco Masera, Viscosity of Hg-Tl Amalgam. *Phys. Chem. Liq.*, Vol. 9, pp. 219–228 (1980).
3. V. Gallina, R. Malvano, and M. Omini, A new kind of Oscillating Crucible viscometer. *Rev. Sci. Instrum.*, **42**, 1607 (1971).
4. M. Bosco Masera, Viscosity of the Melting Point Hg-Tl Amalgam at 30 at. Percent Tl. *Phys. Chem. Liq.*, Vol. 10, pp. 121–126 (1980).
5. William T. Foley, Arun K. Basak, and John R. Dolorey Canadian, *Journal of Chemistry*: **42**, 2749-2753 (1964).
6. F. Lihl, E. Nacktigall, A. Schwaiger, *Z. Metallkunde*, **59**, 213 (1968).
7. N. S. Kurnakow and N. A. Pushin, *Z. Anorg. Chem.*, **30**, 1902, 101–108.