
Physics. — *The origin of fluctuations in rising mixtures of gas and liquid, elucidated by moving pictures.* By J. VERSLUYS.

(Communicated at the meeting of February 27, 1932.)

In 1928 a principle was derived which explained the fluctuations which often occur in a rising mixture of gas and liquid. The considerations underlying this principle were read for the first time at this meeting in February 1929. Since then this principle has been set forth in various articles which are mentioned in the list at the end of this paper and to which reference can be made. Only a brief explanation of the principle involved is given below.

When a mixture of liquid and gas is rising, two half stable conditions are possible, viz. the foam and the mist conditions.

The *foam* condition arises in a mixture when the volume of liquid exceeds that of the gas. The gas, then, is distributed in the liquid in the form of bubbles, so that a cross section would diagrammatically be represented as shown in Fig. 1 (the liquid is shown in black, the blanks being gas).

In a liquid which is at rest gas-bubbles tend to rise with a small velocity, which in this paper for sake of simplicity will be taken at 30 cm. per second. When the liquid rises this relative velocity of the

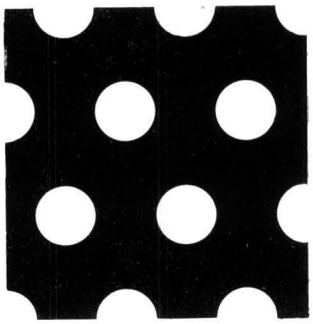

Fig. 1

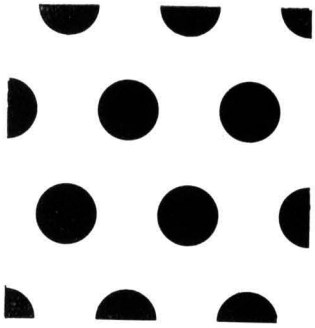

Fig. 2

gas is not materially altered, so that the gas bubbles will rise with a relative velocity of 30 cm. per second, or, in other words, the gas rises

with greater velocity than the liquid and the differential velocity is 30 cm. per second (for more details see VII).

The *mist* condition prevails when there is more gas in the mixture than liquid. Then the liquid is distributed in the gas in the form of drops. A section showing the mist condition is represented by Fig. 2. When the gas is at rest, drops of liquid tend to fall in a gas-filled space and the final velocity of the drops in then say 8 metres per second. Therefore the gas has to rise with a speed of more than 8 metres per second before drops of liquid will be carried up by it. It may be said that when the mist condition prevails the gas rises with a greater velocity than the liquid and the differential velocity is 8 metres per second (for more details see VII).

Summarizing it may be said that two conditions are possible:

A. The foam condition with the following characteristics:
   1. more liquid than gas in the mixture, and
   2. a small differential velocity.

B. The mist condition, with the following characteristics:
   1. more gas than liquid in the mixture, and
   2. a great differential velocity.

A theoretical consideration based on the above conditions was set forth in various papers (III-VII). These papers aimed to show that a direct transition from foam to mist and vice versa is not possible and that (see VI and VII) the general consideration is not substantially altered if 50 % gas in the mixture is not the exact limit of transition. The intermediate state between the foam and mist conditions has been assumed in the theoretical consideration to be occupied by an unstable condition wherein the fluctuations arise.

It is not necessary to elaborate on this question any further; the whole object of these introductary remarks has been to introduce a moving picture which shows a series of experiments performed with air and water in glass tubes of about 2″ internal diameter. This film clearly illustrates the three conditions, viz. foam, mist and the intermediate state which causes the fluctuations.

The experiments were financed by the Bataafsche Petroleum Maatschappij, The Hague, and they were carried out by Mr. W. TEMPELAAR LIETZ in the Machine en Motorenfabriek v/h THOMASSEN, De Steeg, Holland. The main part of the film was made by Mr. J. J. GLATZ of the B. P. M. while the slow motion pictures were made by the "Orion Filmfabriek" in The Hague.

Former papers by the author on rising mixtures of gas and liquid:

I. "De werking van de gaslift", De Ingenieur, 1928, pp. M. 65—70, The Hague.

II. "Mathematical development of the theory of flowing oil wells". A. I. M. E. Technical Publication N⁰. 213, New-York 1929; see also A. I. M. E. Transactions, Petroleum Development and Technology, 1930, pp. 192—205, and "The Oil and Gas Journal", October 3, 1929, p. 160.

III. "How can intermittence of springs be explained". Proc. Royal Academy of Sciences in Amsterdam, Vol. **32**, pp. 88—93, 1929.
IV. "Some principles governing the choice of length and diameter of tubing in oil wells". A. I. M. E. Technical Publication N⁰. 344, New-York 1930, see also A. I. M. E. Transactions, Petroleum Development and Technology 1931, pp. 279—292 and "The Oil and Gas Journal", October 2, 1930, p. 377.
V. "The cause of periodicity generally occurring with rising mixtures of gas and liquid". Proc. Royal Academy of Sciences, Vol. **33**, pp. 450—456, Amsterdam 1930.
VI. "De oorzaak der fluctuatie bij heete en gasvoerende bronnen". De Ingenieur 1931, N⁰. 8, Mijnbouw 2, The Hague.
VII. "The cause of fluctuations in rising mixtures of gas and liquid", Journal of Rheology, III, pp. 3 – 15, 1932.

Physics. — *The Supraconductivity of Hg—Cd Alloys.* By W. J. DE HAAS and J. DE BOER. (Communication N⁰. 220a from the Physical Laboratory Leyden).

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§ 1. The purpose of this research was to investigate in which way the transitionpoint of mercury is changed by the addition of cadmium.

From the constitutional diagram (Fig. 1) of the system Hg—Cd [1]) we see that Hg and Cd can form a series of mixed crystals, interrupted by one "Mischungslücke" only.

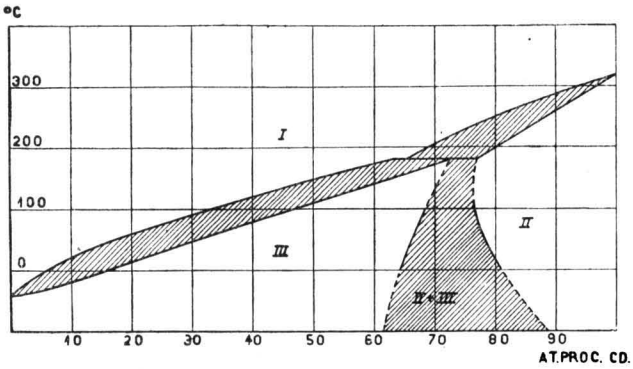

Fig. 1.

Röntgenographic investigations have shown that we have here to do with two different lattices. The mixed crystals, consisting principally of Hg are found to crystallize in the rhomboëdric crystal lattice of Hg. In this lattice the relative few Cd-atoms have replaced an equal number of Hg-atoms,

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[1]) M. C. NEUBURGER. Röntgenographie der Metalle und ihrer Legierungen. CL. V. SIMSON. Zeitschrift für Phys. Chem. 109—183, 1924.