

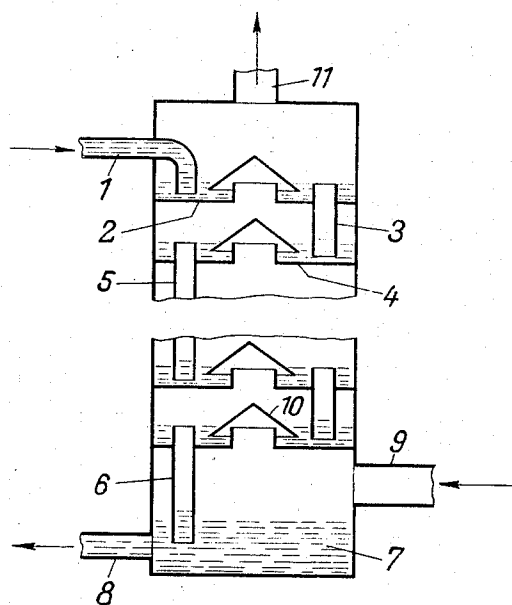
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PROCESS FOR THE CONDENSATION OF ZINC VAPORS

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PROCESS FOR THE CONDENSATION OF
ZINC VAPORS

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This invention relates to a process for the condensation of pure zinc vapors, or zinc vapors diluted by gas.

As a rule, the cooling effect of the walls of a condensation chamber have hitherto been employed to withdraw from metallic vapors the calories to be extracted therefrom for the purpose of liquefaction. In so doing, the attainable yield of liquid metal is limited by the fact that the condensation ceases when the amount of liquefied metal obtained from the vapors has reached the value at which the metallic vapors still present form a mixture saturated at the temperature of the cooling wall, and the endeavor to attain the highest possible degree of condensation leads to the formation of metal dust, the conversion of which into homogeneous metal is difficult and expensive.

Practically the same conditions prevail when, as has already been proposed, the vaporous metal is passed in numerous thin jets through a fused bath of the same metal and the temperature of the bath is kept at the same time at a level only as little as possible above the solidification point of the fused mass, since in this process the cooling condensation chamber is, so to speak, replaced by the molten metal in the fused bath, with which the metallic vapors are brought into heat-extracting contact over a large surface in consequence of their division into jets. In order to prevent premature escape of the vapor jets from the fused bath, it is also necessary in this process to cover the surface of the bath by a protective coating of non-oxidising or inert pulverulent or liquid substance.

According to the present invention, the said principle of bringing metal vapors into contact with a metal melt is utilized for the condensation of pure zinc vapors or zinc vapors diluted by gas, by employing for the melt a metal other than zinc and possessing the power of dissolving zinc, or a metal alloy possessing the same properties, and bringing the melt and the zinc vapors into contact at a temperature not lower than the dew point of these vapors.

The present process is based on the fact that according to Raoult and Henry's law, the vapor tension p of a dissolved body, at a given temperature t , amounts to a fraction of the vapor tension P of the same body in the pure state, in accordance with the equation:

$$p = kP$$

where k is a coefficient smaller than unity, and that, furthermore, the absorption of the vapors

of metals by a metal having a dissolving action on said vapors, or by an alloy having such an action, only ceases when equilibrium between the vapor pressure p' of the condensed and dissolved metal in the alloy or the dissolving metal and the vapor pressure P' of the metallic vapors at the temperature t' in question has been attained in accordance with the equation

$$p' = P'$$

If the temperature and the composition of the metal possessing the dissolving action or of the corresponding alloy be now kept constant in every point of the condensation chamber, t' will be equal to t and p' to p , thus furnishing the equation:

$$P' = kP \text{ or } P' < P$$

since k is smaller than unity. This means that, according to the present invention, the metal to be condensed is converted from the vaporous into the liquid state without needing to pass through the dew point of the vapor, as is necessary when using a cooling wall for withdrawing the calories.

The process of the present invention possesses the great advantage, by comparison with the customary condensation of metallic vapors carried out with the aid of a cooling wall, that practically all of the metal to be treated can be condensed into the liquid state, since no metal is produced in the form of dust, as is inevitably the usual case in condensation with a cooling wall when attempts are made to condense all of the metal present. It is known that metal in the form of dust causes losses in condensation, and the lower in metal the metallic vapors are, the more metal dust is formed when condensing with a cooling wall. A further advantage of the method of working according to the present invention consists in that vapors or gases having a low metal content, for example containing only from 10 to 15% of metal, can also be condensed with favorable results.

More particularly, the process of the invention can be carried out, for example, in the condensation of zinc vapors by using molten lead, which is a solvent for zinc under determined conditions of temperature. If it be assumed that Raoult's law, according to which the vapor pressure of each component of a solution is equal to the vapor pressure of the component in the pure state multiplied by the ratio between the numbers of molecules of the component and of the entire solution, is applicable without correction, then a lead-zinc alloy containing 5 gram-mole-

cules of zinc and 95 gram-molecules of lead, i. e. containing

$$\frac{5 \times 65}{(5 \times 65) + (95 \times 207)} \times 100 = 1.624$$

per cent by weight of zinc, possess a zinc vapor tension which, for any temperature, amounts to only

$$\frac{5}{5 + 95} \times 100 = 5$$

per cent of the vapor tension of pure zinc at the same temperature.

Let it now be assumed, for the sake of example, that the zinc is to be condensed from a mixture coming from any apparatus and comprising 50% of zinc vapors and 50% of carbon monoxide at a temperature of 1000° C. If this condensation of the zinc be carried out by contact with a cold wall, which is kept at a uniform temperature of, for example, 800° C., the percentage of zinc contained in the condensed vapor can be calculated. The condensation ceases when the gaseous phase has given up such an amount of zinc that the remaining mixture of carbon monoxide and zinc vapor is a saturated mixture at a temperature of 800° C.

The vapor pressure of pure zinc at 800° C. is 175 mm. mercury, i. e. 1 kg. of CO contains at this temperature

$$\frac{65}{28} \times \frac{175}{760 - 175} = 0.695 \text{ kg. of zinc,}$$

while the originating mixture, in which the partial pressure of the zinc vapor was 380 mm. mercury, contained

$$\frac{65}{28} \times \frac{380}{760 - 380} = 2.321 \text{ kg. of zinc}$$

per 1 kg. of CO. Accordingly,

$$\frac{2.321 - 0.695}{2.321} \times 100 = 70\% \text{ of the zinc}$$

has condensed.

If the condensation of the zinc be now brought about not by contact with a cooling wall, but by bringing the zinc vapors into contact, according to the present invention, with a molten lead-zinc alloy which is kept at the same temperature of 800° C. and the composition of which is likewise maintained constant by a suitable device, the condensation will cease when the vapor pressure of the remaining mixture of carbon monoxide and zinc vapor is equal to the vapor pressure of the zinc in the alloy. At a temperature of 800° C. the latter vapor pressure is 0.05×175 mm. mercury = 8.75 mm. mercury and the remaining gaseous mixture then only contains

$$\frac{65}{28} \times \frac{8.75}{760 - 8.75} = 0.027 \text{ kg. of zinc}$$

per 1 kg. of CO. Accordingly,

$$\frac{2.321 - 0.027}{2.321} \times 100 = 98.84\% \text{ of the zinc}$$

has condensed.

The dew point of a mixture of CO and zinc vapor, which contains 0.027 kg. of zinc per 1 kg. of CO, is reached at a temperature of 606° C. The condensation of the entire quantity of zinc between 70% and 98.84% has thus necessarily been effected above the dew point of the mixture of CO and zinc vapor.

Any apparatus may be employed for carrying the process of the present invention into practical effect which is adapted to effect an intimate contact between a liquid and a gas or vapor and which permits periodical or constant renewal of the liquid and withstands the operating temperatures, if necessary after suitable modification.

Reference will now be made to the accompanying drawing, which illustrates diagrammatically and by way of example one embodiment of apparatus, which is suitable for example for condensing zinc vapors with the aid of molten lead.

In said drawing, the molten lead passes through the pipe 1 into the condensation chamber, which is kept at a temperature of about 800° C., and flows into the annular vessel 2 disposed therein, whence it passes by way of an overflow pipe 3 to a second annular vessel 4 disposed thereunder, leaving the latter through an overflow pipe 5 which leads to another annular vessel lying at a lower level. In this manner the molten lead passes through a series of superimposed spaced annular vessels in the condensation chamber, which are in communication with each other through overflow pipes, while the lowest of these vessels is connected to the container 7, which closes the condensation chamber at the bottom, by way of a further overflow pipe 6. From the container 7 the lead-zinc alloy which is formed is discharged through the pipe 8.

The mixture of CO and zinc vapor passes, below the bottom annular vessel, into the condensation chamber through the pipe 9. Since the overflow pipe 6 leading out of this annular vessel projects into the mass of metal contained in the container 7, the mixture of CO and zinc vapor is obliged to make its way upwards by way of the edge of the conical cap 10 which is immersed in the molten metal contained in the bottom annular vessel as far as a point which lies below the top edge of the overflow pipe 6. After the mixture of CO and zinc vapor has passed through the molten metal contained in the bottom annular vessel, the same operation is repeated from one of the annular vessels disposed one above the other to the next, in each of which annular vessels is submerged a conical cap acting in the same manner as the cap 10.

On this path the mixture of carbon monoxide and zinc vapor, which becomes lower in zinc with every contact with molten metal, encounters lead which is progressively lower in zinc and progressively colder, which is favorable to the economy of the process. The completely liberated carbon monoxide escapes through the pipe 11 passing out of the top end of the condensation chamber.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. The process of condensing pure zinc vapors or zinc vapors diluted by gas, comprising transferring the zinc vapors into a liquid condition without previous reduction below the dew point of zinc vapor and without formation of dust, by bringing the zinc vapor into contact with a molten mass of a metal different from zinc and having the property of dissolving zinc at a temperature above the dew point of zinc vapors.

2. The process of condensing pure zinc vapors or zinc vapors diluted with gas without passing through dew point of zinc vapor and without formation of zinc dust, comprising bringing the

zinc vapors into contact with a molten mass of a metal alloy different from zinc and having the property of dissolving zinc vapors at a temperature at or above the dew point of zinc vapors.

3. The process of condensing pure zinc vapor or zinc vapor diluted by gas in which the zinc is transformed from vapor into liquid condition

without passage through the dew point of zinc vapor and without formation of dust, comprising bringing the zinc vapor into contact with molten lead at a temperature at least as high as the dew point of zinc vapor.

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