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DISCUSSION OF THE DISTRIBUTION OF THE PARTICLES IN EMULSION PREPARED BY HIGH PRESSURE.

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Introduction.

Previously, for the purpose of preparing the emulsion of cod-liver oil, the authors used the way of the high pressure jet under the following conditions, pressures: 250 and 1250 atms, nozzle diameters: 0.42 ~ 1.16 mm, and the distance between nozzle and crashing plate: 2 and 20 mm.(1) In this paper the experiments in a more prolonged distance between the nozzle and the crashing plate will be reported, and the effects of the crashing plate, the pressure and the nozzle diameter discussed. The apparatus, the samples, the experimental procedure and the way of determining the distribution of the particles are all the same as the previous paper.

Experimental.

The authors determined the distribution diagrams of the samples from the experiments of the following conditions, pressure: 1250 atm, nozzle diameter: 1.00 mm and the distances between nozzle and crashing plate 20 and 100 mm, and collected the results of these experiments and those of the previous paper in Table 1.

Table 1.

Exp. No.	Press. (atm)	Nozzle dia. (mm)	Nozzle direction	Dis. (mm)	A (%)	B (μμ)	C (%)	D (%)	E (%)
1	250	1.16	↳	2	22.7	137.5	—	23.0	54.3
2	1250	〃	〃	〃	23.4	78.4	5.3	56.7	14.6
3	〃	0.50	〃	〃	22.8	58.6	24.1	33.3	19.8
4	〃	〃	〃	20	29.2	49.9	34.4	24.3	12.1
5	〃	1.00	↓	2	20.4	63.8	27.6	37.0	15.0
7	〃	0.42	〃	〃	30.1	50.7	30.0	26.3	13.6
8	〃	1.00	〃	20	26.5	53.5	32.0	32.7	8.8
9	〃	〃	〃	100	26.4	47.0	49.2	17.5	6.9

Dis. Distance between nozzle and crashing plate.

A. Percentage of particles without coagulation.

B. Minimum radius of coagulation particles.**

C. Percentage of particles between minimum radius of coagulation particles and 80 μμ.

D. Percentage of particles between 80 μμ and 200 μμ.

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E. Percentage of particles between 200 $\mu\mu$ and maximum radius.
** It seems to reach the apparent coagulation equilibrium, as the contraction of the oil layer already separated and the layer successively formed cancelled each other. The minimum radius means the smallest particle radius of the separated layer when the apparent coagulation equilibrium is reached. Accordingly the smaller size of the minimum radius of coagulation shows that the distribution of the particles is more abundant on the side of the smaller radius.

Discussions.

(1) Effect of the situation of the crashing plate. In Exps. No. 5, 8 and 9 of Table 1, the distance between the nozzle and the crashing plate is changed to 2, 20 and 100 mm. and the minimum radius of the coagulation particles in the distribution diagrams is 63.8, 53.5 and 47.0 $\mu\mu$, and it is clear that the radius of particles becomes smaller as the distance between the nozzle and the crashing plate becomes longer. The quantity of A plus C, namely smaller than 80 $\mu\mu$, respectively 48.0, 58.5 and 75.6 %, becomes larger as the distance between the nozzle and the crashing plate becomes longer. And the quantity of particles 80 ~ 200 $\mu\mu$, 37.0, 32.7 and 17.5 %, and that of those greater than 200 $\mu\mu$, 15.0, 8.8 and 6.9 %, becomes smaller as the distance becomes longer. Consequently, as the distance between the nozzle and the crashing plate becomes longer, the minimum radius of the coagulation particles becomes smaller, the quantity of the particles smaller than 80 $\mu\mu$ becomes larger and that of those greater than 80 $\mu\mu$ smaller. Therefore, when the liquid is spouted from the same nozzle by the same pressure, it is clear that the particles becomes smaller as the flying distance becomes longer. The spouted liquid is shattered by the friction of the neighbouring fluid caused by high speed flying. The same tendency exists in Exps. No. 3 and 4. Namely, when the nozzle diameter is 0.50 mm, pressure 1250 atm, the distance between the nozzle and the crashing plate 2 and 20 mm, the minimum radius of the coagulation particles, the quantity of the particles smaller than 80 $\mu\mu$, those of 80 ~ 200 $\mu\mu$, and those greater than 200 $\mu\mu$, are 58.6 and 49.9 $\mu\mu$, 46.9 and 63.6 %, 33.3 and 24.3 %, 19.8 and 12.1 % respectively.

(2) Pressure effect. It seems that the speed of spouted liquid is higher as the pressure is higher, when the radius of the nozzle and the distance between the nozzle and the crashing plate are all the same. Therefore, it is anticipated from the idea of the previous section that the radius of the particles becomes smaller as the speed becomes higher. In Exps. No. 1 and 2, the pressures are respectively 250 and 1250 atm. The minimum radius of the coagulation particles is 137.5 and 78.4 $\mu\mu$, and the quantities of the particles smaller than 200 $\mu\mu$ and greater than 200 $\mu\mu$ are respectively 45.7 and 54.3 % at 250 atm, 85.4 and 14.6 % at 1250 atm.

(3) Effect of nozzle diameter. It seems that the speed becomes higher as the nozzle diameter becomes smaller in the case of a given pressure, the nozzle of a given diameter and the solution of a given viscosity. Therefore, it is anticipated that the radius of the particles becomes smaller as the nozzle diameter becomes smaller under the same pressure and the same distance between the nozzle and the crashing plate. In Exps. No. 2, 3 and 5, 7, the pressure is 1250 atm, the distance between the nozzle and the crashing plate 2 mm. and the nozzle diameters respectively 1.16, 0.50, and 1.00, 0.42 mm. But in Exps. No. 2 and 3, the directions of the nozzle are bended rectangular and in Exps. No. 5 and 7, straight. Consequently, the pressure drop at the exit of the nozzle is larger in the former, and so it is anticipated that the shattering is low in efficiency in the former when the other conditions are the same. The minimum radius of coagulation particles is respectively 78.4, 58.6 and 63.8, 50.7 $\mu\mu$, and the quantities of the particles smaller than 80 $\mu\mu$, are respectively 28.7, 46.9 and 48.0, 60.1 %.

From the above considerations the shattering mechanisms of the liquid spouted from the nozzle by pressure are due to the shatter to individual drops from the bulk liquid forced out of the exit of the nozzle and secondarily due to the surface layer of drops stripped off successively by the friction of neighbouring fluid by high speed flying. Therefore, for the purpose of preparing emulsion, it is effective to make higher the speed and longer the distance of flying.

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