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Sonic Dewatering of Large Particle Dispersions

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COMMUNICATION

Sonic Dewatering of Large Particle Dispersions

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Abstract

A new phenomenon has been discovered wherein separation of liquids from large particle dispersions can be accomplished with ultrasound. In our experiments, sonic capillary-wave action produced small droplets of water ejected using about 10% of the energy needed to thermally vaporize the water. In order for the separation to occur, the solid particle diameter must be greater than the droplet size, which can be predicted by Lang's formula. The solid particles remain behind as a disintegrable clump bound by occluded liquid.

A new phenomenon has been discovered in the West Virginia University Ultrasonics Laboratory. The separation of most of the liquid from dispersions containing solid particles (50 μm and larger) can be accomplished with sonic atomization. This could be a nonthermal alternative to filtration.

The separation is caused by a sonic action producing small liquid droplets which are ejected from the crests of standing sonic capillary waves (*1*). The liquid droplets are related to the wavelength of the standing waves and are smaller than the solid particles remaining. The solid particles tend not to be ejected from the dispersion as they interfere with the wave action. As liquid is ejected, the solid particles tend to accumulate into a ball-like jell, with liquid remaining between the interstices of the particles. The standing sonic waves can no longer form, as the wavelength

TABLE 1

Separation of Water from Char Dispersions[a]

Power: Watts	Power: dB	Average sonic energy input unit water (cal/g)	Initial water content (%)	Final water content (%): $\bar{X}$ Deviation	Char lost with water splash droplets (%): $\bar{X}$ Deviation
Particle size (146 to 220 μm)					
25	154	39.8	91.6	48.3 ± 4	3.7 ± 3
30	156.5	30.5	93.0	46.3 ± 3	25.0 ± 6
50	158	17.4	92.5	42.7 ± 8	40.0 ± 15
100	159	36.0	92.9	48.2 ± 3.5	72.0 ± 12
150	160	50.8	92.6	43.6 ± 15	80.1 ± 11
Particle size (74 to 104 μm)					
25	154	104.1	92.2	44.3 ± 11	1.8 ± 2
30	156.5	100.5	92.7	49.6 ± 14	15.2 ± 8
45	158	18.1	91.2	53.2 ± 7	55.1 ± 16
50	158	41.3	93.1	40.1 ± 11	73.1 ± 10
100	159	37.4	94.3	40.1 ± 25	91.4 ± 5

[a]Sonic frequency = 20 kHz, mean water droplet size was 45 to 50 μm depending on dB level. Char solid density = 1.18 g/cc. The values shown are averages of 3 to 5 determinations each.

is longer than the free-liquid distances. The outside of the ball appears dry, and the ball disintegrates with a light touch.

Results of our experiments with a char–water dispersion (Table 1) show the final water content to be ~45%, where initially the water content was 90 to 95%. Thus about 92% of the water has been removed. The remaining water corresponds to that held by surface tension in the void space between particles. The energy input of transducer power was ~10% of the energy needed to thermally vaporize the water which was separated. It was noted that at higher power levels, large amounts of char were in fact ejected during atomization. This is conjectured to be due to cavitation effects (*2*, *3*) where we have found (*2*) that higher transducer power results in splash droplets with broader distribution of the liquid droplets. Cavitation is enhanced by low vapor-pressure liquids or high dissolved gas contents (*3*). As higher viscosities require larger transducer power to initiate atomization (*3*), lesser separation would probably result with viscous materials.

With micron or submicron solid particles, the droplets that are formed contain the solid, and solids drying can in fact be accomplished (*4*). Thus it is apparent that the ratio of particle size to droplet size is a primary factor, the criterion being:

$$D_{\text{solid}}/D_{\text{drop}} > 1, \qquad \text{for separation}$$

As D_{drop} is related to sonic frequency for capillary action by (*1*)

$$D_P = 0.34\left(\frac{\sigma\mu\pi}{\rho f^2}\right)^{1/3}, \qquad \text{where} \quad \sigma = \text{surface tension}, \quad f = \text{sonic frequency}, \quad \mu = \text{damping decrement}$$

higher sonic (ultrasonic) frequencies would provide for separation of smaller-particle dispersions. Lower sonic frequencies provide for easier power input but the solid particles separated would be larger in size.

In summary, low sonic levels which just produce liquid atomization will eject and separate liquid droplets from a dispersion, leaving the larger solid particles in a moist ball.

REFERENCES

1. R. J. Lang, "Ultrasonic Atomization of Liquids," *J. Acoust. Soc. Am.*, *34*, 6 (1962).
2. K. L. Huang, "Ultrasonic Atomization of Liquids," M.S. Thesis, West Virginia University, 1977.
3. J. T. Sears, K. Huang, S. Ray, and H. V. Fairbanks, "Effect of Liquid Properties on the Production of Aerosols with Ultrasound," in *Proceedings, 1977 IEEE Ultrasonics Symposium*, 1977, p. 131.
4. S. Ray, "The Effect of Ultrasonics on Spray Drying Processes," M.S. Thesis, West Virginia University, 1977.

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