FOOD ENGINEERING REPRINT

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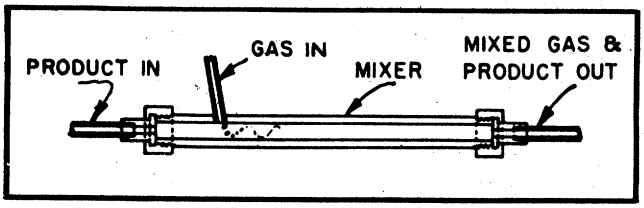
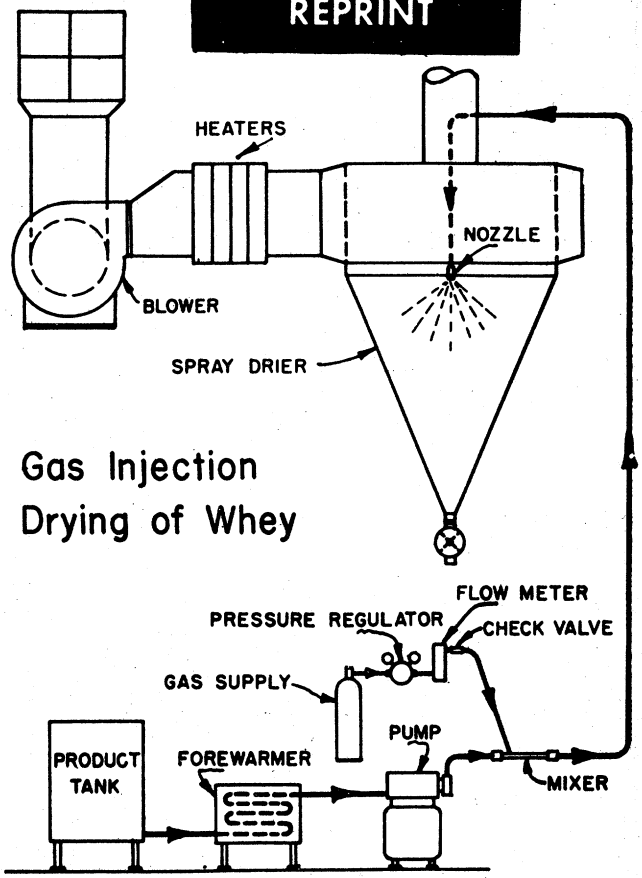


GAS MIXING CHAMBER is heavy walled cylinder with flush-tapped orifice for entrance of gas. Cylinder can be removed from fluid line easily for cleaning.



Gas Injection Drying of Whey

FLOWSHEET shows how conventional spray drying operation is modified to inject 2,000-psig. gas for foam drying. Gas enters fluid line through mixer between pump and spray nozzle.

USDA Develops Foam-Spray Drying

Gas injected at 2,000 psig. expands droplets to make moisture removal easy—for cottage cheese whey and other difficult-to-dry liquids

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WASTE DISPOSAL has always been a problem with cottage cheese whey. Now it is a very critical one, what with more than 3 billion lb. being produced annually in the United States.

Factories that dump whey into streams may have to discontinue cottage cheese manufacture. They may, that is, unless they can find a cheap method for disposing of the whey so that it will not contribute to the pollution problem.

Since cottage cheese whey contains approximately 93½% water, any utilization method must remove the water economically and produce a product that can be conveniently handled and shipped.

Sweet low-acid cheese whey has been dried by several patented processes. We refer to whey like that from Cheddar cheese, which at pH 6.2 has a titratable acidity of 0.13-0.15. However, cottage cheese whey at pH 4.6 and a titratable acidity of 0.55-0.60 has been difficult, if not impossible, to dry satisfactorily by conventional methods.

The large amount of lactic acid present in cottage cheese whey causes it to dry less readily and to agglomerate and form lumps in spray drying equipment. The resulting unsatisfactory product hinders the drying process by clogging the drier.

Additives, such as skim milk or cereal products, have been used as aids in drying the whey. No additives are needed with the new process. Dry cottage cheese whey can be easily and economically handled for shipment to food and feed manufacturers.

Effects of Foaming

The new process requires a

Versatile Process

Gas-injection spray drying is being applied to other fluid dairy products. It seems especially adaptable for the drying of products from which the moisture is difficult to remove, such as high-acid liquids. It is useful, too, where large dried particles are required.

small alteration in the conventional spray process for drying fluid milk products. Compressed air is injected into the pumped-fluid line through a mixing device located between the pressure pump and the spray nozzle.

Injection of air expands the normal spray droplet, increasing its surface and lowering its density. The buoyant particle appears to remain longer in the drying air than the unexpanded particle with comparatively less surface. The foamed particle dries as a fragile eggshell type of particle which exhibits excellent flow characteristics in the drying cone, conduits and collectors. The dried powder shows no tendency to adhere to the surface of the equipment, and it flows like a liquid into collection containers.

Cottage cheese whey is concentrated in vacuum equipment to 45 to 50% solids and immediately spray dried. The characteristics of three of the fluid wheys that were successfully concentrated and dried are as follows:

Normal cottage cheese whey—pH 4.6; titratable acidity 0.55-0.60%.

Deproteinated cottage cheese whey—pH 4.6. The milk from which the cheese was made was heated to 210F. for 15 sec. The heat-coagulable whey protein (0.36% protein) was carried down with the curd, leaving a low protein whey.

Cultured cottage cheese whey—The whey was inoculated with a 2% inoculum of **L. bulgaricus** and incubated at 98F. for 24 hr. The acidity changed from pH 4.6 to 4.0. This increased the lactic acid in the dried whey from 7% to 10½%.

How Air Is Injected

The dryer was a 9-ft. Grey-Jenson unit equipped with a spray nozzle having a 0.040-in. dia. orifice. The rate of feed was 60 gal./hr. at a temperature of 130F. and a hydraulic pressure of 1,800 psig.

Key to the process for spray-drying cottage cheese whey is the introduction of gas, usually air, into a specially constructed mixer before the concentrate reaches the drier. In the experimental work, air compressed to 2,000 psig. was injected at 75F. at a rate of 1 to 1½ cfm. into whey concentrate (45% T.S.) pumped at a rate of 1 gpm. Under the conditions of these experiments, less gas than 1 cfm. resulted in powder of such high moisture that it clogged the drier.

Injection of gas before the spray produces a foam, and the relatively large surface of the foamed droplets makes moisture removal easy.

Introducing gas into the product before it enters a high-pressure reciprocating pump will cause erratic pumping if the gas is not totally dissolved. Injection of gas after the product leaves the pump, however, will permit uniform pumping regardless of the amount of gas required for foaming.

Stabilizing Powder

The dried cottage cheese whey produced by this procedure is hygroscopic. Lactic acid and amorphous lactose, both of which readily absorb moisture, are present. It must be packaged in moisture-tight containers, and partially used portions should not be unduly exposed to moisture. Moisture absorption by the powder permits lactose crystallization, leading to hardening and caking.

A stable, noncaking powder can be obtained from the dry gas-injected cottage cheese whey by using the process described here as the first drying stage. The second stage in the process consists of moisture pickup, lactose crystallization and subsequent re-drying. This can be done according to conventional procedures.

Another method for obtaining a partially moisture-stabilized powder is to crystallize the lactose in the concentrated whey and spray the crystallized suspension directly. This will produce a powder in which at least half the lactose is crystalline.

Effect of Gas Injection at Dryer on Properties of Spray-Dried Cottage Cheese Whey

Drying conditions					Powder properties			
	GAS INJECTION		DRYING AIR TEMPERATURE					
Sample	Gas used	Pressure (psig)	In (F.)	Out (F.)	Moisture (%)	Crystalline lactose (%)	Particle size (microns)	Physical properties
1a	air	2,000	265	200	1.3	21	112	Free flowing
1b	none		270	200	2.2	30	60	Lumpy on cooling
2a	air	2,000	255	190	2.0	30	114	Free flowing
2b	none		260	190	2.6	45	57	Caked on cooling
3a	air	2,000	248	180	1.3	32	125	Free flowing
3b	none		250	170	2.6	34	54	Lumpy from dryer
4a	air	2,000	240	165	2.4	35	129	Free flowing
4b	none		240	165	4.2	37	55	Caked before cooling

NOTES: Moisture determined by toluene extraction. Crystalline lactose determined by x-ray diffraction. Particle size is average of 10 microscopic fields.

Useful Ingredient

Dried cottage cheese whey should be useful in food manufacture where lactose and lactic acid are desirable ingredients. It is a potential ingredient for sherbets, certain kinds of bakery items, soups, and other special food products. A less attractive market is as a component in animal feeds.

NOTE—Part of the data in this paper were presented at the 56th Annual Meeting of the American Dairy Science Association, June 14, 1961.

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Characteristics of Spray-Dried Cottage Cheese Whey

Composition	Normal whey (%)	Cultured high-acid whey (%)
Protein	11.5	11.5
Lactose	71.5	68.1
Lactic acid	7.0	10.5
Ash	8.0	7.6
Moisture	2.0	2.3
Acidity (pH)	4.4	3.9

NOTE: Density of dried whey relative to water was 0.30–0.40. Average equilibrium relative humidity for powders = 25%.