NOTATION

A = heat transfer area
C_i = coefficient defined by (19)
F_g = gas mass flow
$g_N\{t\}$ = time function defined by (29)
$G\{q\}$ = function of q, defined by (14)
$\mathcal{L}^{-1}$ = inverse Laplace transform
n = integer, indicating the layer concerned
N = total number of layers
p_i = the roots of equality (20)
q = transform domain of t
Q_s = heat flow to the gas
$Q_{s,n}$ = heat flow to the gas in layer n
r = distance from the centre of the sphere
R = radius of the spheres
t = time
$T_{a,n}$ = the average gas temperature in layer n
$T_{g,n}$, $T_{g,n-1}$ = the temperature of the gas leaving layer n and layer $n-1$, respectively
$T_{g,N}$ = the temperature of the gas at the outlet (of layer N)
$T_{g,0}$ = the constant inlet gas temperature
T_s = solid temperature
$T_{s,0}$ = initial solid temperature
$T_{s,n}$ = solid temperature of layer n
u_n = see Equation (7)
U = heat transfer coefficient
z = coordinate of height

Greek Letters

β = half the normalized height, see Equation (31)
γ_g, γ_s = specific heat of gas and solid material
κ = thermal diffusivity of the solid material
λ_s = thermal conductivity of the solid
μ_s = heat capacity of the solid
$\mu_{s,n}$ = heat capacity of the solid of layer n
ρ_s = specific density of the solid
σ = the number of particles in the layer
τ, τ_1, τ_2 = time constants

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Manuscript received July 1, 1974; revision received November 25 and accepted November 29, 1974.

Dropwise Condensation

LEROY A. BROMLEY and STANLEY M. READ

Department of Chemical Engineering
University of California and Bodega Marine Laboratory
Berkeley, California 94720

It has been recently reported by Lauro and Deronzier (1973) and Niezborala and Claudel (1973) that the fluorocarbon disulfide $(C_8F_{17}C_2H_4S)_2$ is an excellent long lived (500 hr.) drop promoter. Such a compound has been suggested by Bromley, Porter, and Read (1968). A sample of this especially made material was obtained for testing from Ugine Kuhlman through the courtesy of J. Huyghe.* A comparison test of this promoter was made with the two best promoters used by Wilkins and Bromley (1973): tetrakis octadecyl thio silane and *n*-octadecyl mercaptan.

EXPERIMENT

Equipment was assembled for life testing of drop promoters consisting of 4 vertical copper tubes 9.5-cm O.D. with 18 cm exposed to steam but in separate parallel chambers. The steam was prepared by boiling acidified and degassed sea water on a once-through basis. The copper tubes were air cooled for convenience, resulting in a low heat flux of about 5000 W/m^2 (1,600 B.t.u./hr. sq. ft.). The tubes were all initially cleaned with nitric acid, washed with distilled water, and immediately installed. Five cubic centimeters of a 1% solution of drop promoter in 2-ethyl hexanoic acid (warmed if necessary) were injected at the top of the tube with steam present and normal condensation occurring.

Two sets of uninterrupted tests were run. In the first set one tube was left unpromoted. In the second set the tube with the fluorocarbon disulfide was interchanged with the octadecyl thio silane; as in the first test it was noted that venting did not appear to be identical for the four tubes. Also, the unpromoted tube was replaced with one using previously prepared (2 months) solution of thio silane.

The first set was run continuously for one month and the second for six weeks (1000 hr.).

RESULTS

Except for the unpromoted tube which was largely filmwise after a day, all tubes gave 100% excellent dropwise condensation at first.

The fluorocarbon disulfide was the first to show failure with 100% dropwise condensation lasting from 1 week (the first set) to 3 weeks (the second set). Filmwise condensation was essentially complete in 2 more weeks with considerable tube darkening evident.

The octadecyl mercaptan produced 100% dropwise condensation for 3 to 5 weeks but was 100% filmwise after 6 weeks with some tube darkening.

The tetrakis octadecyl thio silane gave 100% dropwise for 4 to 6 weeks except in a poorly vented area which became filmwise after 5 weeks. Only the poorly vented area showed distinct tube darkening. Promotion by a 2-month-old thio silane solution was of somewhat poorer quality although still 90% dropwise after 6 weeks.

* J. Huyghe is Chairman, Heat Transfer Division, French Atomic Energy Commission, Grenoble, France. Ugine Kuhlman is a large chemical company in France.

The thio silane appears to be superior to both the fluorocarbon and the octadecyl mercaptan although if promoter cost is important the latter might be a reasonable compromise.

It is quite likely that had the fluorocarbon been of considerably longer chain length, rather than C_8, it might have indeed proved to be of superior quality.

The problem of cleaning and repromotion in industrial situations still remains unsolved.

ACKNOWLEDGMENT

This work was supported by the Water Resources Center of the University of California.

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Manuscript received September 13, 1974; revision returned and accepted October 18, 1974.

Secondary Nucleation Due to Fluid Forces Upon a Polycrystalline Mass of Ice

J. ESTRIN

National Center for Atmospheric Research
Boulder, Colorado 80303

M. L. WANG and G. R. YOUNGQUIST

Clarkson College of Technology
Potsdam, New York 13676

Recent developments are making possible the use of small-scale laboratory experiments to design full-scale suspension crystallizers including accurately accounting for nucleation. The single crystal experiments of McCabe et al. (1971, 1972, 1974), Strickland-Constable and coworkers (1966, 1969, 1972), Denk and Botsaris (1972), and Larson and Bauer (1974) have revealed much of the fundamental character of collision breeding which is likely to be the dominant secondary nucleation process in many systems. The population balance methods of Randolph and Larson (1962, 1972) and others permit the experimental determination of the nucleation characteristics in a more gross but realistic sense, namely, in a stirred-tank configuration. Attempts to couple these independent approaches (Ottens et al., 1972; Evans et al., 1974) in order to describe nucleation kinetics due to collision breeding have met with some success.

Recently, Evans, Margolis, and Sarofim (1974) have conjectured that as much as 25% of the nucleation which occurred in their ice-brine experiments using a mixed suspension crystallizer was due to fluid shear. Also Sung, Estrin, and Youngquist (1973) demonstrated that fluid shear can induce secondary nucleation in the magnesium sulfate-water system. The object of this work was to determine the secondary nucleation characteristics of polycrystalline ice as brought about by the action of a fluid mechanical disturbance at the ice surface. A jet of brine solution of finite duration was employed as the disturbance. The number of nuclei generated due to the jet action was observed primarily as a function of solution subcooling at the ice seed.

J. Estrin is with Clarkson College of Technology, Potsdam, New York.

EXPERIMENTAL APPARATUS AND PROCEDURE

Figure 1 is a schematic diagram of the apparatus and Figure 2 shows the jet system used. Details are available in the thesis of Wang (1974). The temperature-controlled test chamber was divided into two compartments separated by a check valve, the upper compartment containing 3% and the lower 2% brine solution. The jet was a 2 mm Pyrex tube drawn to a tip diam-

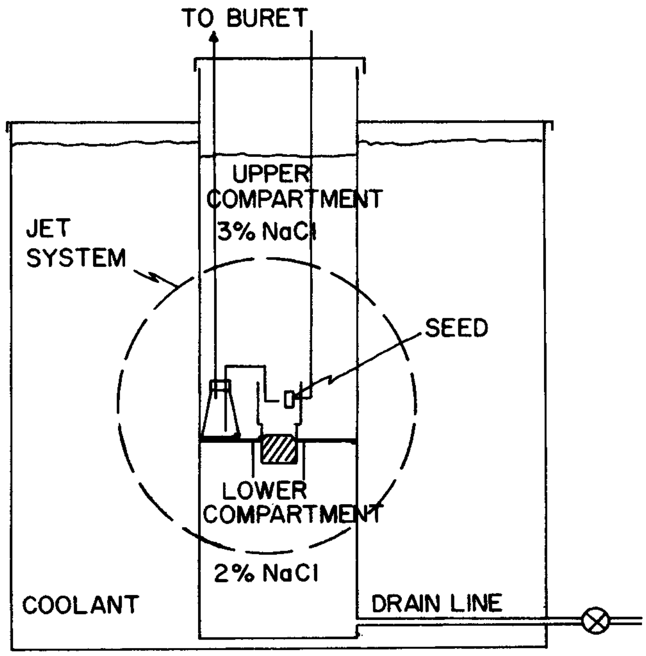

Fig. 1. Schematic diagram of apparatus.