Foam Test Method

W. R. KELLY and P. F. BORZA, Technical Center, Solvay Process Division, Allied Chemical Corporation, Syracuse, New York

Abstract

This method measures the height of foam developed by pouring. The action is intermittent, time being alloted strictly for foam decay, as well as for foam generation. Comparative or duplicate tests can be prolonged indefinitely, or until a steadied state is reached. Tests on solutions may be carried out at various temperatures and in the presence or absence of soils, or foamicides, that may be added at any time. Foam heights can be measured with reasonable precision.

Introduction

When foaming in a particular operation is the primary consideration, there can be no better practical way to study the problem than to simulate operating conditions. Use of the Terg-O-Tometer by Spangler (1) is an example of this and he obtained good correlation with field results because his conditions closely paralleled laundry conditions. Another example in the practical study of the foaming properties of surfactants for use in laundries is the continuous method of Reich, Patton and Francis (2).

There are a number of ways by which foam may be developed. Included among them are whipping, stirring, plunging, shaking, oscillating, bubbling and pouring. In the first two the bubbles are prone to be small. In the third and fourth the foam may be excessively wet at time of measurement. In the fifth, measurement is usually made in a practical way during energy input, which may partially mask decaying tendency. In the sixth, by bubbling air through a formulated aqueous detergent solution it is possible to strip out the surfactant. The resulting foam may become abnormally and selectively concentrated in this one component.

For a more fundamental study of foam the fewer variables involved the better. While the pouring method requires some energy, at least gravity, the energy source, is constant.

Bubble life, because of bubble size, will be more natural and reproducible. Ross and Miles (3) appreciated this when they developed a pouring method. This method has received wide acceptance in the United States and adoption by the American Society for Testing materials (4), and also recently by the French Detergency Committee (5), but only after a thorough screening. Their one-pass method is capable of good reproducibility. Harris (6) has said that this method is the most satisfactory for evaluating foaming agents. It is easy to carry out, and outside variables are reduced to a minimum.

Our first study was on the effect of foamicides. For this we needed a pouring test of long duration. Since the one-pass method was generally satisfactory, the only way we could see to preserve its quality was to make the action intermittent, which we finally did.

By this action, time could be allotted deliberately to the generation of foam and to its decay. The test could be prolonged indefinitely. Unlike most tests on foamers, typical soils could be added, and at any period. Also, comparative and duplicate tests at any usual temperatures were made possible.

One advantage the intermittent and prolonged action uncovered was that about 30 min of operation were needed to reach a steadied state. It was also observed that the ultimate foam level is often much higher than after the first pass. When making comparative tests it has been found on occasion that one solution, after making a slower start, may eventually develop enough foam to surpass the other.

Still another finding with respect to the attributes of this test method is the fact that, with it, a remarkably close correlation can be found between foam stability and the type of "emulsion" naturally tending to form between an oil and an aqueous solution of surfactant. This example is fully described in a companion article (7).

The apparatus is of simple construction, but has yet to be formalized. It is, therefore, presented more as a principle, than as a standardized instrument.

Description of Tester

Apparatus

The apparatus is shown schematically in Figure 1.

A) Valve and connection to source of steady vacuum.

B) Mercury seal, glass, cut-off 100 ml graduated cylinder containing mercury and an open-ended glass tube 180 × 12 mm. Adjustment of the depth of this tube in the mercury determines the pressure at which the seal will blow.

C) Head tubes, two, glass 190 × 33 mm, ends rubber-stoppered as shown.

D) Ducts for raising solutions to head tubes, glass, 8 mm diameter; effective net lengths 600 mm. These may be connected by rubber or Tygon tubing.

E) Pouring tubes, two, 7 mm, made of glass except for sections of thin-walled rubber tubing to permit positive clamping.

F) Clamping device (pinch valve) electromagnetic, with mounting suitable for clamping off the two pouring tubes "E" and the air-intake tube "H" all at the same time. As the insert F shows, the afore-mentioned tubes are passed through guide-holes downward through the clamping device. The device essentially consists of ⅛ in. rods in horizontal positions perpendicular to direction of pull and are pulled by the action of a solenoid. This unit is merely an electomagnet (such as CR503–207E, Cat. No. 4382675-AB202 of the General Electric Company) mounted on a metal base. Also mounted on the base is a frame of sheet iron having two lateral wedge-shaped indentations to insure complete cinching of the three rubber tubes when the horizontal clamping rods are pulled against the tubes by the electromagnet.

G) Interval timer such as Type 1-PSB (R. W. Cramer Co., of Centerbrook, Conn.). This electric time switch controls the clamping device F, and determines the interval during which suction is applied to raise the test solution to the head tubes C. Its 8-sec cycle can arbitrarily be divided into "on" and "off" for 4 sec each.

H) Air intake tube rubber, 7 mm I. D.

J) Cylinders, graduated, 1000 ml identical.

K) Water bath, glass, temperature-controlled.

Operation

The operation is simple. By means of a steadily applied vacuum and an interval controller, portions of detergent solution are raised to a fixed height and then allowed to pour back by gravity to the lower level. The action is intermittent, and can be prolonged indefinitely.

1) Prepare water bath K and heat to desired temperature.

2) Place 600 ml, more or less, of each of the test solutions in the respective graduated cylinders J and start warming them to desired temperature.

3) Assemble the rest of the apparatus and place in position as schematically shown in Figure 1.

4) Set Timer G (control) for an interval of 4 sec "on" and 4 sec "off." The choice of timer and timing are arbitrary.

5) Set mercury seal B to somewhat more of a "head" than that corresponding to a height difference (head) of the test solutions measured from the level they will attain in head tubes C to the lowest level the solution will attain in graduated cylinders J during operation. Final adjustment of the dip tube (vent) in the mercury seal may be necessary to insure that the seal will not blow unless the attained level of the solution in the head tubes is less than about 2 in. from their tops.

6) With the rubber sections of the pouring tubes E and the air-intake H in place in the clamping device F (insert), turn on the time controller to actuate the clamping device.

7) Open valve A to connect the system with a source of steady vacuum.

8) The system is now in operation. Make final adjustments of mercury seal by adjusting the dip tube.

Since foaming often reaches a steadied state well before 30 min of operation, measurement times are not critical. At the instant the liquid, draining from the head tubes (C), momentarily stops pouring, the liquid level in the graduated cylinder can be ascertained. If necessary several of these readings can be made and averaged. The measuring procedure applies also to the foam. The averaged difference corresponds to the foam height.

The two upright cylinders (J) may be graduated in inches or centimeters. If the graduation marks

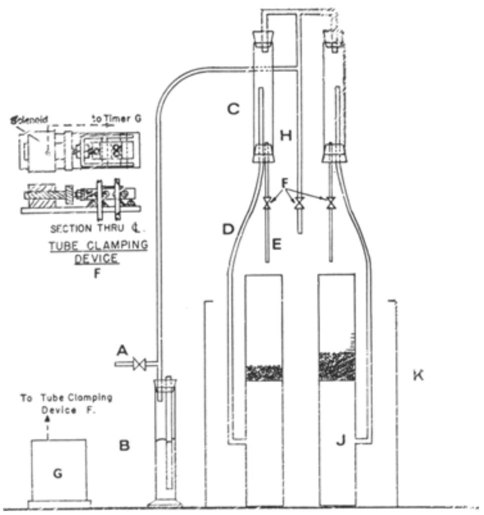

FIG. 1. Foam tester.

TABLE I

Duplicate Foam Tests at 39C on Tap Water Solutions of an Alkaline Detergent Formulation at Three Different Concentrations[a]

Duplicate Test No.	Foam height, inches for three concentrations, %					
	0.10%		0.25%		0.75%	
	A	B	A	B	A	B
1	0.4	0.6	2.1	2.1	2.9	2.9
2	0.4	0.4	2.0	2.1	2.4	2.6
3	0.4	0.6	2.0	1.9	2.6	2.7
4	0.4	0.4	2.3	1.9	2.7	2.9
5	0.4	0.4	2.1	2.0	2.6	2.7
Averages	0.4	0.5	2.1	2.0	2.6	2.8

[a] Homogenized milk used as soil.

are in milliliters, this can be translated into terms of length.

Illustrative Data

The foam tester is simply an instrument designed to produce measurable amounts of foam in a consistent manner. What really matters is how sharply differences in foaming tendencies can be discerned when, for example, the conditions are independently varied with respect to concentration or temperature.

For the data obtained in Table I, the 95% confidence limit for a single observation was calculated to be 0.21 in. The foam heights are small. Larger foam heights and differences could improve these limits.

For Table I an alkaline detergent formulation was tested at concentrations of 0.1, 0.25 and 0.75% in tap water at 39C. The volume of solution in each graduated cylinder was 600 ml. The duration of this duplicate test was 30 min. Ten milliliters of homogenized milk was added as soil to each 600 ml portion. The duplicate tests at each concentration were repeated four more times.

Results simply serve to show that the tester is capable of sensing comparatively small differences in foam height with reasonable precision. We have used it successfully for a long time, and on many nonroutine occasions.

Precautions and Possible Modifications

The parts of the apparatus coming into contact with the test solution should be clean. The simultaneous pinching of the rubber sections of the pouring tubes and the air-intake tube should be positive and complete. The effective height differentials of the solutions in the duplicate systems should be equal. The two graduated cylinders should be fairly exact duplicates, and placed close to each other even if it means cutting off parts of their footings. The lower ends of the pouring tubes should be fixed, and aimed dead center.

Possible modifications include (1) changes in ratio of durations of "on" and "off" time; a multiplicity of commonly controlled units for getting the foam spectrum of a detergent solution at once.

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