An Experimental Micro Filter

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In the study of the filtration characteristics of factory slurries and experimental materials the need for a miniature filter is often felt. Such a filter should be capable of operating on a small volume of material, yet furnish precise and reproducible data. Olof Wiklund and Lars Lindblad (l)[2] describe the use of such a filter—the Dedek Micro Filter—for the study of carbonation slurries (Figure 1).

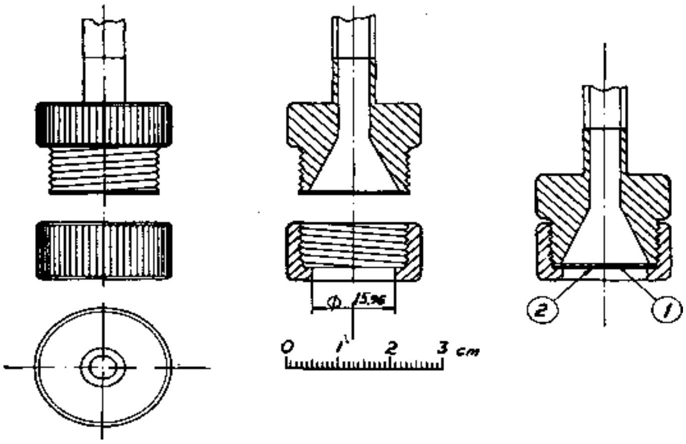

Figure 1.—Dedek Micro Filter (Filter Area 2cm.^{2}). 1 = wire grid, 2 = filter paper. From: Olof Wiklund and Lars Lindblad, Socker 5, 162-63 (1949) by permission.

It consists essentially of a measuring pipette with a septum holder attached. The septum holder accepts a sheet of filter paper with an effective area of 2cm^2. The pipette is graduated in units of 2 ml. In use the septum holder is immersed in the beaker containing the slurry, which is being agitated by a small stirrer, and the pipete connected to a source of vacuum. From the times (in seconds) required to pass the first, second and third graduation marks on the pipette a filtration coefficient, Fk, is calculated by the Brieghel-Mueller method (2).

During an investigation of filtration characteristics of slurries from low-lime defecation this filter was found to be unsuitable. The agitation of

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[2] Numbers in parentheses refer to literature cited.

the slurry—necessary for the maintenance of a constant mixture—provided sufficient attrition on the surface of the cake to impair the value of the data. A further disadvantage, especially when working with very low filtration pressures, is the progressive reduction in effective pressure due to the column of filtrate accumulating above the septum.

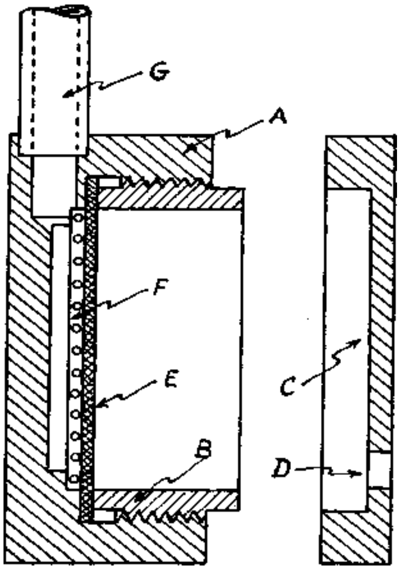

Figure 2.—Improved Micro Filter

A—filter housing

B—septum retainer

C—cover

D—slurry inlet

E—filter septum

F—supporting screen

G—filtrate outlet

A new filtration appartatus (Figures 2 and 3) was designed to overcome these shortcomings of the Dedek filter. To prevent attrition due to agitation the septum is enclosed in a filter chamber and a small opening provided in the cover for entrance of the slurry from the beaker, where it is subjected to the required agitation. The filtrate leaves the septum holder at the top, thus displacing all air in the holder; it enters the measuring pipette above the maximum filtrate level and thus insures a constant filtration pressure. A water bath around the beaker provides for a constant temperature. Agitation is supplied by a crescent-shaped paddle which oscillates slowly in a vertical direction. The paddle is driven by a geared motor through a connecting rod and horizontal beam. Speed and stroke are adjustable to meet the requirements of different slurries. The effective filter area—2.46 cm^2—was selected to facilitate the conversion of data; a filtrate volume of 10 ml. through the micro filter is equivalent to 1 gallon through a filter area of 1 ft^2.

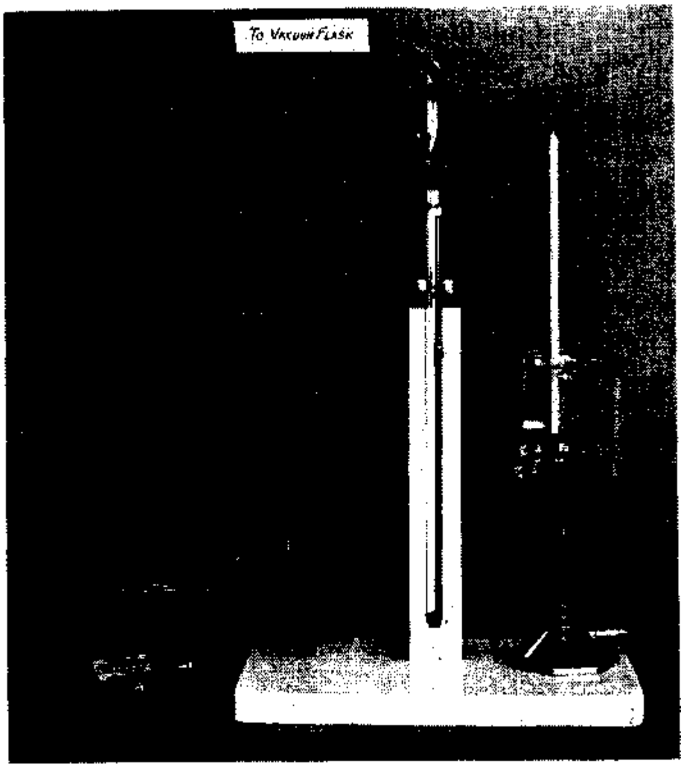

Figure 3.—Microfiltration Apparatus.

The Brieghel-Mueller calculation of Fk was abandoned. While the constant, Fk, permits a comparison of the relative filterability of slurries, it does not readily lend itself to the calculation of the capacity of factory filters. After a search of the literature the method of B. F. Ruth, G. H. Montillon and R. E. Montonna (3) was adopted as most suitable. In combination with the micro filter, using reasonable care, this method yields filtration constants with an accuracy exceeding the requirements for precise engineering calculations. The entire filtration cycle follows the equation $(V + C)^2 = K(\theta + \Theta_0)$, wherein V is the filtrate volume passed in the time Θ, K is the filtration constant and C and Θ_0 are related to septum resistance. B. F. Ruth shows that this simple equation holds true for all types of slurries, regardless of rigidity or compressibility of the filter cake. *Since* many of the materials encountered in the sugar industry exhibit compressibility of varying degrees, the advantage of the Ruth equation is obvious.

To perform a filtration the apparatus is assembled as shown in the photograph (Figure 3). With the pinch clamp at the top of the pipette closed, a five-gallon flask is evacuated to the desired filtration pressure— indicated on a mercury manometer. With the agitator in operation and the filter chamber in place and connected to the pipette, the temperature of the slurry is adjusted by manipulation of the burner below the water bath. A thermostated water bath is of advantage when a large number of filtrations must be performed. An electric stopwatch is used to measure elapsed time. Depending on filtration rates, times at 1, 2 or 4 ml. intervals are recorded. The count of time starts with the application of vacuum to the filter by opening of the pinch clamp. Table 1 shows a set of data from a slow filtering slurry of high compressibility, with a sample calculation. Observed and calculated values are tabulated side by side.

Since the data of a filter test, according to Ruth, comprise a portion of a perfect parabola it is permissible to calculate the values for C and K from only three points on the curve with a fair degree of accuracy. This was done in the sample calculation and the validity of this statement is indicated by the close check of observed and calculated values for Θ and V.

Table 1.

V(ml.)	Θ(sec.)		Θ(sec.)	V(ml.)	
Obs.	Obs.	Calc.	Obs.	Obs.	Calc.
2	35	36	35	2	1.95
4	100	98	100	4	4.05
6	190	190	190	6	6.01
8	310	311	310	8	8.00
10	460	461	460	10	10.00
12	642	641	642	12	12.03
14	856	850	856	14	14.07
16	1090	1088	1090	16	16.03
18	1356	1356	1356	18	18.02

Sample Calculation

Θ	ΔΘ	V	ΔV	V+ΔV/2	ΔΘ/ΔV
35		2			
	425		8	6	53.13
460		10			
	896		8	14	112.00
1356		18			
			Difference:	8	58.87

Slope = 58.87/8 = 7.358
K = 2/7.358 = 0.272
C = (53.13/7.358)—6 = 1.22 ml.

Θ_0 may be calculated by substituting several early values of V in the equation $(V+C)^2 = K(\Theta+\Theta_0)$, and averaging the results. Thus Θ_0 = 1.7 sec.

The small deviations in the example are doubtless due to the difficulty of reading elapsed time on the stopwatch at the precise moment when the liquid level in the pipette passes the graduation.

During a study of the effects of controlled variables on filtration rates of factory and experimental slurries, several hundred filtrations were performed with this micro filter for the determination of constants. While a more elaborate timing apparatus may appear desirable, the data from the present equipment were found sufficiently reliable.

Literature Cited

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