COMPARISON OF VACUUM PRECOAT

TEST LEAF AND OPERATION UNITS

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An early drum vacuum filter was patented by William Hart in 1872 and a unit under vacuum was designed for Solvay by Trump in 1886.[(1)] However, the modern drum filter from which the rotary drum vacuum precoat evolved really started with 1908 design by E. L. Oliver. This basic drum filter consists of individual filtering compartments, connected to outlet piping which in turn are connected to discharge piping and a vacuum source through a rotary valve. This rotary valve was designed so that different gradients could be used for filtration, washing, drying, and removal.

In 1913 diatomite was used to beneficiate the filtration of a cane sugar syrup on a Sweetland pressure filter. It succeeded admirably and by 1930 thousands of tons of diatomite were being used as filteraids by assorted industries.

Diatomite is a sedimentary rock consisting of the skeletons of minute aquatic plants called diatoms. Chemically the material is essentially SiO_2 making it inert in most systems.

It was used on pressure filters as a thin coating over the medium called a precoat which helps protect the medium while serving as a surface upon which the filter cake may form. The material is also used as a body feed to the slurry to improve the filtration.

The rotary drum filter which had been in use in the ninteenth century was developed into a precoat type in the 1930's. It had been found that many problems involved solids which were compressible and when large volumes were encountered, the cost of filteraid made filtration of that suspension impracticable on batch pressure filters. Attempts to use drum filters failed, since the medium quickly blinded. The solution was to modify the drum filter to accept a precoat of filteraid several inches in thickness. The solids removed by filtration are deposited on essentially the surface of this precoat and are removed along with a thin layer of precoat by a scraper knife with each revolution, exposing a clean precoat for filtering.

The rotary drum precoat filter by the very nature of its design and concept involves many variables. These apply to the precoat and medium, to the operational choices available with the equipment, as well as the incoming liquid solid system and their interrelationship. Test programs prior to installation as well as during operation must evaluate these.

An overall view of the interrelationship of these variables provides a base of understanding.

The Filteraid -

Influences: Ability of the system to precoat, clarity, cutting efficiency, rates, cost, cake losses, delivery and handling systems for the filteraid.

The Medium -

Influences: Ability of system to precoat, quality of precoat, clarity, rates, repeatability of cycles.

The Filter Design -

Influences: Latitude of choice for rotation speed, submergence, maximum precoat thickness, the outlet resistance involved, slurry suspension, and cut cake disposal.

The Vacuum System -

Influences: Ability of system to precoat, quality of precoat, retention of precoat, removal of filtrate, rate, costs, and maximum precoat thickness.

The overall system must be considered in two phases, precoating and filtration, with the filtration phase being highly dependent upon the precoat quality.

Initially, since the rotary drum vacuum precoat filter was an outgrowth of the rotary drum unit, it is not surprising that similar test equipment and procedures were used for laboratory analysis for both types. A simple vacuum test leaf of approximately .1 $ft.^2$ was precoated with approximately two inches of a middle grade diatomite. This was usually dipped under vacuum into a suspension of a fine collodial clay which effectively sealed the precoat surface. With a knife, fine layers of the top of the precoat were removed until clean precoat was reached. The collodial clay prevented filtration through the side of the precoat cake. By successfully submerging the leaf under vacuum in the liquor to be filtered for timed periods, the volume of filtrate may be measured vs time. The leaf is, in its various forms, a very useful item of equipment.

The standard test leaf used for rotary drum analysis was modified by Neu, Kobato, and Leppla in 1957-1958 (2) to allow the measurement of knife cut. With this addition, the unit became more versatile. It was designed to operate with a sample in the five gallon size, small enough to be handled in a laboratory, and to provide the ability for cutting the cake.

The operation of a pilot RDVP filter for test purposes is a reasonably lengthy procedure. Considerable time can be saved if a test leaf is employed as a screening device. While the leaf as indicated can be used to predict parameters of submergence and rotation speed, it is most valuable in conjunction with a pilot unit to narrow the choice of filteraids. If the filteraid can be quickly selected for the pilot test program and the submergence, knife cut, and drum speed indicated, then the pilot can be focused on the study of the filtration characteristics of the liquid solid system being filtered.

In Table 1, data is tabulated for test runs on a leaf which was employed initially as a screen for pilot studies.

TABLE 1

Run "A"
Speedplus Precoat Only
PCD - 21.1#/ft.^{3}; 33% submergence; ambient temperature

Cycle No.	Vacuum in Hg.	Drum Speed RPM	Cut Inches	Est.% Cut	Avg.Flow Ml/Cycle	GPH Ft.^{2}	#FA/ 100 gals.
1-4	22	1/2	.020	90	27	2.1	50
5-9	22	1/4	.010	90	18	0.7	37
10-12	22	1/6	.010	90	23	0.6	29

Run "B"
Speedplus Precoat + 2.0% Speedplus Bodyfeed
PCD - 21.1#/ft.^{3}; 33% submergence; ambient temperature

Cycle No.	Vacuum in Hg.	Drum Speed RPM	Cut Inches	Est.% Cut	Avg.Flow Ml/Cycle	GPH Ft.^{2}	#FA/ 100 gals. Includes Bodyfeed
1-5	22	1/2	.005	100	74	5.8	21.2
6-10	22	1/2	.002	100	76	6.0	18.5
11-15	22	1/2	.002	100	76	6.0	18.5

TABLE 1 (Continued)

Run "C"
4200 Precoat + 2.0% Bodyfeed 4200
PCD - 22.7; 33% submergence; ambient temperature

Cycle No.	Vacuum in Hg.	Drum Speed RPM	Cut Inches	Est.% Cut	Avg.Flow Ml/Cycle	GPH $Ft.^2$	#FA/ 100 Gals.
							Includes Bodyfeed
1-5	22	1/2	.002	90	88	6.9	18.2
6-10	22	1/2	.003	50	78	6.2	19.4
11-15	22	1/2	.005	60	74	5.8	Precoat Clogging

Run "D"
Speedex Precoat + 2.0% 4200 Bodyfeed
PCD-20.1; 33% submergence; ambient temperature

							Includes Bodyfeed
1-5	22	1/2	.005	50	72	5.7	20.7
6-10	22	1/2	.010	90	74	5.9	25.2
11-12	22	1/2	.002	80	73	5.8	20.1

Run "E"
Speedplus Precoat + 2.0% Special Speedflow Bodyfeed
PCD - 21.1; 33% submergence; ambient temperature

							Includes Bodyfeed
1-5	22	1/2	.002	100	70	5.6	18.6

This first series of leaf tests showed in Run A- Table 1 that a precoat of Speedplus would effectively remove the solids without significant clogging due to penetration; however, the rate indicated was low. In Run B, an admix of filteraid was added and this significantly improved the rate while at the same time reducing the overall filteraid usage. Run C was with a coarser precoat and admix. Note that the effectiveness of the knife cut was considerably less. There was also a steady drop in rate. Penetration was indicated so this grade was ruled out.

In Run D, a filteraid was checked between 4200 and the Speedplus involved in Runs A-C. It showed no significant improvement over the Speedplus on rate and a less effective knife cut. As a result, a pilot unit of 9.7 $ft.^2$ was started using a Speedplus precoat with 2% Speedplus bodyfeed. This gave an average rate of 5.2 $gals./hr./ft.^2$ vs 6.0 predicted by the leaf. As the pilot unit was started, leaf tests continued this time screening perlite vs diatomite.

While many tests have been run with this leaf, the value of the leaf can best be ascertained when it is run simultaneously with a full scale filter using a representative sample and duplicate operating conditions.

Rather than rely on relating leaf data to plant averages taken later, a series of leaf tests were run simultaneously and the results compared for rate. These tests were run on various types of liquors and the results are shown in Table 2. There are basic differences between the leaf and a pilot or operating unit. These would be in the depth of precoat, method of precoating, in the knife cut, slurry suspensions, and in the outlet resistances. Nevertheless, the leaf is, as indicated by the comparative data useful in indicating the expected flow rates to be expected as well as for the screening of the other parameters.

TABLE 2-A

	FILTER			FULL SCALE FILTRATION					VACUUM LEAF FILTRATIC		
PROD.	TYPE	AREA SQ M	VAC MM HG	DRUM ROT. SPEED/ REV/HR	SUB %	CUT MM/ REV	TEMP °C	RATE L/M SQ/ HR	RATE L/M SQ HR	VAC MM HG	TEMP °C
Dextrose	Dorr-Oliver	20	600	15	65	0.3	50	375	321	700	50
Citric Acid Broth	Vernay	6	550	44.4	33	0.108	Amb.	365-	550		Amb
Manganese Sulphate	Vernay	10	500-550	60	33	0.075	35	250-415	317-400	550	25
Glutamic Acid Broth	Philippe	30	650	44.4	44	0.25	60-65	133	147	550	60-65
Tetracyclin Acid	Vernay	25	600	60	40	0.09	Amb.	152-168	160	600	Amb.
Enzymes	Feinc	16	600	31.3	33	0.15	22-24	40-60	43	600	22-24
Protease	Vernay	25	600-650	27-34	33-40	±0.125	Amb.	88	110	700	Amb
Corn Syrup	Eimco	56	600	40	33	.25	74	509	477	600	74

TABLE 2-B

CORRELATION DATA BETWEEN FULL-SCALE AND VACUUM LEAF RESULTS

			FILTER		FULL-SCALE FILTRATION						VACUUM LEAF FILTRATI[ON]		
NO.	PROD	F.A.	TYPE	AREA SQ M	VAC MM HG	DRUM ROT. SPEED/ REV/HR	SUB %	CUT MM/ REV	TEMP °C	RATE L/M SQ/ HR	RATE L/M SQ/ HR	VAC MM HG	TEM[P] °C
1	Tetra-cyclin Broth 100%	478	Dorr-Oliver	20	600-650	18	30	160	Amb.	95	100	650	Amb.
2	TiO.SO4 Sludges	4258-S2	Dorr-Oliver	40	650-680	15	33	67	40-60	42-50	41	650-700	55
3.	Effluent	4158	Stock-dale	9.4	450	60	33	150-160	Amb.	370-425	403	450	Amb.
4.	Pectins	4108 2/3 + Fine Wood-flour	Unknown Old Type	18	450	12	15-25	250	60-75	90-100	110-120	650	70

REFERENCES

1. Tiller, F., Theory and Practice of Solid-Liquid Separation - University of Houston - 1975 - Page 349.

2. Neu, E.L., Kobata, H.T., and Leppla, P.W. - Chemical Engineering Progress - Volume 54, No. 6 - June 1958 - Pages 65 thru 68.