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THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

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COMPARISON OF RIBBED STYLE AND SIRVENE 409241 DIAPHRAGMS
WITH CURRENT COMMERCIAL DIAPHRAGMS

✓ Project 1108-26s

Preliminary Report Four

to

FOURDRINIER KRAFT BOARD INSTITUTE, INC.

October 10, 1961

THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

SUMMARY

As one phase of the current co-operative investigation regarding bursting strength standardization, B. F. Perkins and Son, Inc., submitted to the Institute two new types of diaphragm for evaluation. They were

(a) Type 305B, composition, Sirvene 409241

(b) Ribbed style diaphragms, Sirvene 9641

A comparative evaluation of the diaphragms with respect to their bursting strength results and life was performed. Procedures used were essentially the same as used in previous studies.

The following conclusions may be drawn from the results of the study:

1. No diaphragm failures were encountered in the "life" tests up to 1100 distentions.
2. The ribbed style and current commercial diaphragms gave approximately equal bursting strength results for both 42-lb. kraft liner and 200-lb. series combined board.
3. The Sirvene 409241 diaphragms exhibited higher diaphragm pressures and gave higher test readings for both 42-lb. liner and 200-lb. series combined board.

INTRODUCTION

Because of the importance of the bursting strength tester to the paperboard industry, a subcommittee of the Fourdrinier Kraft Board Institute was set up to enlist the co-operation of B. F. Perkins and Son, Inc., in diaphragm and tester standardization. As a result of the various meetings, it was decided to pursue a research program at the Institute for the general purpose of (a) identifying diaphragm characteristics which govern diaphragm life and contribution and (b) to develop specifications for diaphragms.

In two previous reports to the Technical Committee a comparative evaluation of two diaphragm types (305A and 305B) was made with regard to bursting strength results and diaphragm life (1,2). Type 305B differs from the older design 305A in that the thickness is gradually tapered from the center to the inner edge of the rim. In general, the studies indicated that the two diaphragm types gave approximately equivalent results--implying that the differences in diaphragm contribution between types were not sufficient to cause marked differences in test.

Methods for evaluating the apparent diaphragm contribution to the bursting strength test were also investigated. One method consisted of (a) obtaining pressure versus distention (p-d) curves during sample tests (b) reading the distention at failure from the curves and (c) reading the apparent diaphragm pressure at the failure distention from a p-d curve for the diaphragm alone. A complete description of the apparatus may be found in reference (1). The method was extended to corrugated board in Reference (2) and an alternative approach involving pressure vs. time (p-t) curves was also investigated.

The above techniques were then used to evaluate a series of diaphragms having widely different pressure characteristics in order that the effect of diaphragm pressure on test readings might be re-evaluated. The results were reported to the Technical Committee in Reference (3). On the basis of the limited results obtained, it appears that present diaphragm specifications of 23 to 30 p.s.i.g. at 3/8-inch distention permit about a 2 p.s.i.g. difference in bursting strength of kraft linerboard.

Past experience leads many to question how well new diaphragms meet the above specifications. It is believed that a great deal of the difficulty may be associated with the different methods of measuring diaphragm characteristics. Arrangements have been made with B. F. Perkins and Son, Inc. to cooperatively determine the variance in diaphragm characteristics of the present commercially manufactured diaphragms. To implement this study, the Institute is constructing a simpler apparatus which will facilitate accurate and reproducible measurements of diaphragm pressure by both the Institute and the manufacture. This apparatus has been assembled and is now being checked. It has been arranged with B. F. Perkins and Son, Inc. to evaluate a substantial number of diaphragms from their next large order to the manufacture of the diaphragms.

In the meantime, B. F. Perkins and Son, Inc. forwarded to the Institute two lots of experimental diaphragms for comparative evaluation with current commercial diaphragms. The first is a type 305B diaphragm of improved composition designated Sirvene 409241. The second is a new style ribbed diaphragm designated ProFJT-479, mold XII5562, Sirvene 9641. The latter diaphragms have the same composition as current commercial diaphragms but have three molded

circular ribs on the under side as shown in Figure 1. A modified lower platen is used with the ribbed diaphragm as illustrated in Figure 2. A comparative evaluation of the performance of the above diaphragm is summarized herein.

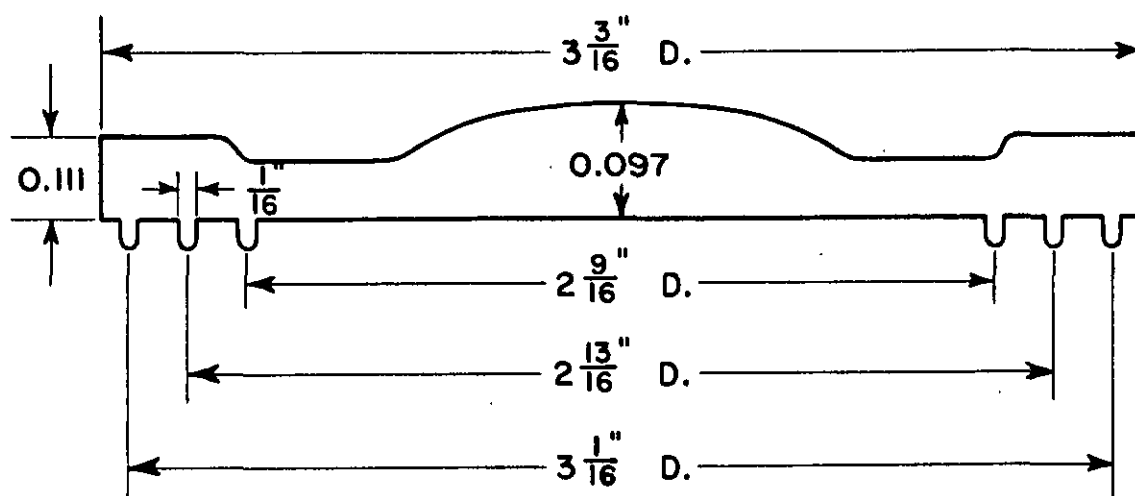
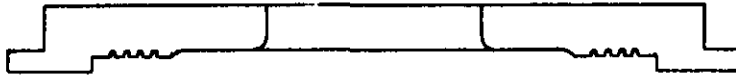
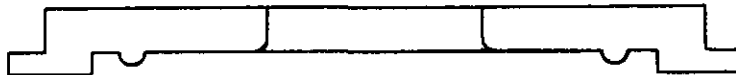


Figure 1. Schematic diagram of ribbed diaphragm.



Ribbed Diaphragm Lower Platen



Conventional Diaphragm Lower Platen

Figure 2. Schematic Diagram of Lower Clamping Platens Used
with Conventional and Ribbed Diaphragms

MATERIALS

A. Diaphragms

The following types of diaphragms were evaluated:

1. Current commercial (Type 305B)
2. Type 305B diaphragms, composition Sirvene 409241
3. Ribbed 305B diaphragms, composition Sirvene 9641

B. Test Materials

One sample of 42-lb. kraft liner and one sample of 200-lb. series A-flute board were used. Both samples were carefully randomized, preconditioned and conditioned. In addition, one sample of 200-lb. series B-flute board was used for "waste" tests.

PROCEDURE

A. Number of diaphragms evaluated for each type: 5

B. Preworking diaphragms: Each diaphragm used in the study was pre-worked using the procedure followed in Reference 1.

C. Testing:

1. After constant diaphragm pressures were obtained, 50-liner tests (wire side down) and 50 combined board tests (double-face up) were obtained. The diaphragm pressure at $3/8$ inch and 1.8 cm. was obtained after every 25 tests.

2. For three of the diaphragms of each type, 450 waste tests were then performed using the 200-lb. test combined board sample. Part C-1 was then repeated.

3. Part C-2 was repeated after an additional 450 waste test.

DISCUSSION OF RESULTS

GENERAL

As discussed in Reference 1, diaphragm suitability is, at present, defined by the condition that its pressure at a given distention must fall within stated limits. Therefore, diaphragm "life" is limited by either rupture of the diaphragm or by failure--after repeated testing--to meet pressure specifications. In the initial discussions on this project, it was felt that in the normal testing of linerboard, any diaphragm should be capable of giving satisfactory service for at least 1000 tests.

The procedure used herein is essentially the same as that used previously (1,2). In brief, for three of the diaphragms of each type 1100 tests were performed--after initially conditioning the diaphragm using 8 to 10 distentions to 1.8 cm. Linerboard test readings were recorded for tests 1 to 50, 500 to 550, and 1050 to 1100. Combined board readings were obtained during tests 50 to 100, 550 to 600, and 1100 to 1150. Two other diaphragms of each type were evaluated after the initial pre-working of the diaphragm but the life tests were not carried out.

The three types of diaphragms evaluated were

- (a) Current commercial (type 305B): Sirvene 9641
- (b) Type 305B diaphragms, composition: Sirvene 409241
- (c) Ribbed diaphragms, composition: Sirvene 9641.

PART 1. LINERBOARD RESULTS

The results obtained using 42-lb. kraft linerboard as the test material are summarized in Tables I through III. In terms of over-all averages, the diaphragm types compare as follows:

Diaphragm Type	Diaphragm Pressure, p.s.i.g.		Bursting Strength, p.s.i.g.	Diff., p.s.i.g.
	3/8 inch	1.8 cm.		
Current commercial	29	52	122.7	--
Sirvene 409241	54	73	128.3	+5.6
Ribbed style	32	64	122.8	+0.1

The results obtained with the ribbed style diaphragm were of the same magnitude as those obtained with the current commercial diaphragms. However, it may be noted that the diaphragm pressure at 3/8 inch was generally above the specified tolerance range of 23 to 20 p.s.i. The Sirvene 409241 diaphragms exhibited considerably higher diaphragm pressures and the test readings averaged 5.6 p.s.i.g. higher than those obtained using the current commercial diaphragms. It is concluded, therefore, that use of the Sirvene 409241 diaphragms would result in shift in bursting strength level because of their high diaphragm pressure. Although the three different diaphragms exhibited different diaphragm pressures at 3/8-inch distention, it may be noted that all diaphragms withstood 1100 tests without rupture and with little or no fatiguing relative to diaphragm pressure at 3/8-inch distention; thus, satisfactory life would be anticipated when used on linerboard.

TABLE I
 SUMMARY OF LINERBOARD BURSTING STRENGTH RESULTS USING CURRENT COMMERCIAL DIAPHRAGMS
 (Type 305B—Sirene 964L)

No. of Diaphragms	Diaphragm 1		Diaphragm 2		Diaphragm 3		Diaphragm 4		Diaphragm 5		Composite Average	
	Diaphragm Pressure, p.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, p.s.i.g.	Diaphragm Pressure, p.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, p.s.i.g.	Diaphragm Pressure, p.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, p.s.i.g.	Diaphragm Pressure, p.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, p.s.i.g.	Diaphragm Pressure, p.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, p.s.i.g.	Diaphragm Pressure, p.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, p.s.i.g.
0-50 Start	29	53	27	56	25	47	34	80	31	72	29	61
Middle	29	53	27	49	26	48	34	83	31	77	29	61
End	23	51	26	47	26	45	34	71	32	76	29	61
500-550 Start												
Middle			23	34	23	34	34	55	30	54	30	51
End			25	37	25	37	34	60	34	66	30	51
			26	37	26	37	34	60	31	57	30	51
1050-1100 Start			24	34	24	34	32	54	30	47	29	45
Middle			25	34	25	34	31	54	31	47	29	45
End			23	34	23	34	33	54	31	46	29	45
Composite Average	29	52	27	51	25	47	33	63	31	60	29	52

TABLE III
 SUMMARY OF LINERBOARD BURSTING STRENGTH RESULTS USING RIBBED STYLE DIAPHRAGMS

No. of Distastions	Diaphragm 1		Diaphragm 2		Diaphragm 3		Diaphragm 4		Diaphragm 5		Composite Average	
	Diaphragm Pressure, P.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, P.s.i.g.	Diaphragm Pressure, P.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, P.s.i.g.	Diaphragm Pressure, P.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, P.s.i.g.	Diaphragm Pressure, P.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, P.s.i.g.	Diaphragm Pressure, P.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, P.s.i.g.	Diaphragm Pressure, P.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, P.s.i.g.
0-50 Start Middle End	30	79	32	83	31	82	31	84	30	73	33	79
	33	71	32	79	32	75	37	89	35	80	33	79
	34	59	33	81	34	78	34	88	33	78	33	79
500-550 Start Middle End	30	79	32	83	31	82	31	84	30	73	33	79
	33	71	32	79	32	75	37	89	35	80	33	79
	34	59	33	81	34	78	34	88	33	78	33	79
1050-1100 Start Middle End	30	79	32	83	31	82	31	84	30	73	33	79
	33	71	32	79	32	75	37	89	35	80	33	79
	34	59	33	81	34	78	34	88	33	78	33	79
Composite Average	32	73	32	81	30	62	33	68	31	63	32	64
	73	123.4	126.9	126.9	121.2	121.2	119.9	123.8	123.2	123.0	123.2	122.8
	123.4	123.6	126.9	126.9	122.9	122.9	120.8	123.8	123.2	123.0	123.2	122.5

PART 2. COMBINED BOARD RESULTS

The combined board test results for each diaphragm type are summarized in Tables IV through VI. In terms of over-all averages, the diaphragm types compared as follows:

Diaphragm Type	Diaphragm Pressure,		Bursting Strength, p.s.i.g.	Diff., p.s.i.g.
	3/8 inch	1.8 cm.		
Current Commercial	29	51	232.2	--
Sirvene 409241	53	73	236.1	+3.9
Ribbed style	31	62	232.1	-0.1

Thus, as in the linerboard tests, the Sirvene 409241 gave higher bursting strength results because of their higher diaphragm pressures. Similarly, the current commercial and ribbed style diaphragms exhibited equal test results on the average.

TABLE VI
 SUMMARY OF COMBINED BOARD BURSTING STRENGTH RESULTS USING RIBBED STYLE DIAPHRAGMS

No. of Orientations	Diaphragm 1		Diaphragm 2		Diaphragm 3		Diaphragm 4		Diaphragm 5		Composite Average	
	Diaphragm Pressure, P.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, P.s.i.g.	Diaphragm Pressure, P.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, P.s.i.g.	Diaphragm Pressure, P.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, P.s.i.g.	Diaphragm Pressure, P.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, P.s.i.g.	Diaphragm Pressure, P.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, P.s.i.g.	Diaphragm Pressure, P.s.i.g. 3/8 inch 1.8 cm.	Bursting Strength, P.s.i.g.
50-100 Start Middle End	34	69	33	81	34	78	34	88	33	78	33	75
	34	67	32	76	32	80	37	90	35	77	35	75
	32	65	31	70	31	77	34	86	35	80	35	75
550-600 Start Middle End					29	55	33	56	29	57	29	56
					30	56	31	57	31	54	31	56
					29	54	34	58	30	54	30	56
1100-1150 Start Middle End					29	53	32	54	30	54	30	54
					28	54	31	56	31	54	30	54
					30	51	31	54	31	54	31	54
Composite Av.	33	66	32	76	30	62	33	64	31	60	31	62

LITERATURE CITED

1. An investigation of diaphragm characteristics. Part I. Comparison of diaphragm types 305A and 305B in a simulated life test and an exploratory investigation of diaphragm contribution. Project 1108-26s Preliminary Report One to the Fourdrinier Kraft Board Institute, Inc., Sept. 21, 1960.
2. An investigation of diaphragm characteristics. Part II. Comparison of diaphragm types 305A and 305B in a simulated life test using combined board and additional exploration of means of measuring diaphragm contribution. Project 1108-26s, Preliminary Report Two to the Fourdrinier Kraft Board Institute, Inc., Nov. 29, 1960.
3. Effect of diaphragm pressure on bursting strength. Preliminary Report Three to the Fourdrinier Kraft Board Institute, Inc., June 6, 1961.

