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THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

VARIABILITY OF COMMERCIAL DIAPHRAGMS

PART II. COMPARISON OF DIAPHRAGM PRESSURE EVALUATIONS BY INSTITUTE AND MILL

Project 1108-26

Report Eight

A Preliminary Report

to

Technical Committee

FOURDRINIER KRAFT BOARD INSTITUTE, INC.

December 4, 1962

INTRODUCTION

As one phase of the current investigation of factors affecting bursting strength results, the Institute and B. F. Perkins and Son, Inc. initiated a study designed to determine the variability in commercially manufactured diaphragms. The diaphragms at present are manufactured in a 25-cavity mold in batches or orders of about 10,000 diaphragms. For the initial study it was decided to study the variability between diaphragms in a given order, i.e., (a) the differences between cavity locations in the master die and (b) differences between moldings or "heats."

For this purpose, the 13 odd-numbered diaphragms were selected from the following mold impressions or heats: 1, 100, 200, 300, and 400 in one order. The diaphragms were evaluated at the Institute for hardness, thickness and diaphragm pressure at 3/8-inch. The results obtained were summarized in Preliminary Report Seven to the Technical Committee dated September 1, 1962.

Among the conclusions reached were the following:

1. All diaphragms gave pressures materially higher than that specified in Rule 41. The over-all average of 37.9 p.s.i. gage was 7.9 p.s.i. gage higher than the upper specification limit of 30 p.s.i. gage.

2. The differences in pressure between diaphragms were relatively modest--ranging from 36 to 40 p.s.i. gage. Thus, on the basis of these data, the principal problem appeared to be one of lowering the average level to meet Rule 41 requirements.

3. Statistical analysis of the differences in diaphragm pressure between cavities or heats revealed no significant differences.

After reviewing the above results, the Technical Committee requested that five of the diaphragms evaluated be sent to committee members for mill evaluation. In compliance with this request, five diaphragms were forwarded to each member. A copy of the letter accompanying the diaphragms is attached. This report summarizes the replies received.

DISCUSSION OF RESULTS

A summary of the diaphragm pressure measurements by mill and Institute is shown in Table I. Of the six comparisons, it may be noted that Institute and mill agreement is satisfactory for mills A and B. In contrast, for the remaining mills, Institute and mill results differ by from 12 to 25%. No reasons for this lack of agreement in the case of mills C, D, E, and F are known. All of the mills submitting results indicated that the procedure outlined in Report Seven was followed except for differences in pressure gage capacity.

The apparent conclusion is that differences in techniques of measuring diaphragm pressure at 3/8-inch may give quite different results. Under these circumstances, diaphragm standardization by the manufacturer is impossible. The causes of these differences must be identified and some standardized method of measuring diaphragm pressure must be established if progress in diaphragm standardization is to be made.

Mill D reported that erratic results could be obtained when the thicker center portion of the diaphragm is not centered with respect to the orifice. There is a difference in diameter between the recessed area on the under surface of the lower platen and diaphragm of about 1/8 inch. Thus the center of the diaphragm may be off center as much as about 1/16 inch. To investigate the effect of off-center placement, pressure measurements were obtained on four diaphragms in two positions as follows:

1. centered.
2. about 1/16 inch off center.

The data are shown in Table II.

TABLE I

COMPARATIVE EVALUATION OF DIAPHRAGMS BY INSTITUTE AND MILL

	Gage Capacity	Diaphragm Pressure at 3/8 Inch, p.s.i. g. Diaphragm No. 1	2	3	4	5	Average	Difference, p.s.i.g.	Difference, %[b]
IPC[a]	60	38	37	39	38	38	38.0		
Mill A	200	39	38	38	39	38	38.4	+0.4	+1.1
IPC[a]	60	38	39	37	40	39	38.6		
Mill B	400	39	40	40	40	40	39.8	+1.2	+3.1
IPC[a]	60	39	38	39	38	37	38.2		
Mill C	200	28	29	29	30	28	28.8	-9.4	-24.6
IPC[a]	60	38	39	37	38	37	37.8		
Mill D	60	30	31	31	31	34	31.4	-6.4	-16.7
IPC[a]	60	38	39	39	37	37	38.0		
Mill E	200	29	30	32	32	30	30.6	-7.4	-19.5
IPC[a]	60	37	38	37	39	38	37.8		
Mill F	60	33	34	34	34	31	33.2	-4.6	-12.2

[a] Taken from Report Seven, Project 1108-26 and rounded to nearest p.s.i.

[b] Based on Institute results as reference.

TABLE II

EFFECT OF OFF-CENTER PLACEMENT ON DIAPHRAGM PRESSURE

Diaphragm No.	Diaphragm Pressure, p.s.i. g.[a] 3/8-inch Distention: Centered	3/8-inch Distention: Off Center (1/16 inch)	3/8-inch Distention: Difference	0.71-inch Distention: Centered	0.71-inch Distention: Off Center (1/16 inch)	0.71-inch Distention: Difference
1	34.8 (0.5)	34.5 (0.9)	-0.3	72.4 (4)	72.4 (1)	0
2	35.4 (0.3)	34.8 (0.5)	-0.6	96.4 (5)	77.2 (4)	-18.8
3	36.5 (0.7)	36.0 (0.3)	-0.5	91.8 (1)	77.4 (1)	-13.4
4	36.6 (0.3)	36.4 (0.3)	-0.2	81.0 (0)	78.8 (1)	-2.2

[a] Figure in parenthesis is the difference between maximum and minimum readings.

As may be noted, placement of the diaphragm off center tended to give only slightly lower diaphragm pressures at the 3/8-inch distention level. The results at 0.71 inch (1.8 cm.) were more erratic though the direction of change was the same. While these measurements suggest that off-center placement has little effect on diaphragm pressure at 3/8-inch, good practice suggests that care should be taken to center diaphragms.

In any event, the above apparently does not explain the differences between Institute and Mill C, D, E, and F results in Table I. Other variables which might affect diaphragm pressure measurements are listed below:

A. Instrumental variables

   1. Lower platen

      a. Dimensions and design

      b. Smoothness and frictional characteristics around orifice.

   2. Gage

      a. Capacity

      b. Calibration

   3. Distention height stop

      a. Manual

      b. Automatic (as used in Report Seven)

B. Diaphragm insertion

   1. Centering

   2. Pressure applied to lower platen when tightening lower platen. (Note: Institute uses 150 p.s.i.)

   3. Glycerin or other lubricants applied to top surface of diaphragm or to lower clamping platen.

   4. Air under diaphragm.

Of the aforementioned, unpublished work at the Institute has shown that, in the pressure range from 50 to 150 p.s.i., the clamping pressure during tightening has little effect on diaphragm. In addition, the work cited in previous pages suggests that diaphragm centering is not responsible for the differences. A number of the other variables could, in theory at least, contribute to the differences between Institute and mill results. Perhaps, as a first step, both Institute and interested mills should prepare detailed step-by-step outlines of the procedures used in changing diaphragms and evaluating their diaphragm pressure.

In addition to the above, Mill E also performed hardness and caliper determinations on the diaphragms. These results appeared to be in reasonable agreement with the values obtained at the Institute. They also included the following remarks regarding their current practices.

"We have found recently that, if we stretch the diaphragm by hand several times, holding the diaphragm by the rim, we get between 25 to 30 p.s.i. on the first distention to 3/8 inch. This is much quicker and each individual diaphragm does not have to be put in the tester. All diaphragms from an ordered batch are stretched by hand and then about 20% of these are put in the tester and distended to 3/8 inch. If all of these fall within our 25 to 30-p.s.i. limits, the whole batch is accepted. If not, then the whole batch is stretched in the tester at 70 to 80 p.s.i., until they are within the limits of 25 to 30 p.s.i. at 3/8-inch distention."

For diaphragms which exhibit pressures appreciably above 30 p.s.i. using a particular method of evaluating diaphragm pressure, it may be doubted that either technique mentioned above would be helpful. For example, in Report Six, a number of diaphragms were held at 1.8-cm. distention for time periods ranging from 5 to 120 minutes. For one lot of diaphragms the diaphragm pressure decreased from

34.8 p.s.i. to 32.4 p.s.i. after 120 minutes--a change of 2.4 p.s.i. Even this change was not permanent, as allowing the diaphragms to recover for 15 minutes brought their average pressure back to 34.3 p.s.i.--or very near to the original distention pressure. Thus the change brought about by holding the diaphragms at a high distention were not permanent. Stretching the diaphragm by hand strains the diaphragm to a smaller extent than distention in the machine to 1.8 cm. (0.71 inch). Thus manual stretching should have even less effect than stressing the diaphragm to 0.71-inch distention on the machine.

ADDENDUM

THE INSTITUTE OF PAPER CHEMISTRY
Appleton, Wisconsin

October 3, 1962

Project 1108-26

At the September Technical Committee meeting of the Fourdrinier Kraft Board Institute, the Institute submitted a report to the committee discussing the variability of commercial Jumbo Mullen diaphragms. A copy of the report is attached. The Technical Committee requested that five of the diaphragms evaluated be sent to committee members for mill evaluation. In compliance with this request, five diaphragms are enclosed--each coming from a different cavity position.

It is suggested that the diaphragms be first evaluated for diaphragm pressure at 3/8-inch distention following the procedure outlined in the attached report as closely as possible. We would appreciate receiving the individual pressure measurements for each diaphragm and a description of any deviations from the procedure.

If you evaluate the diaphragms in other ways, we would appreciate receiving any data you develop together with a description of your procedure.

Yours very truly,

R. C. McKee, Chief
Container Section

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Enclosures--6