

THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

DEVELOPMENT OF AN IMPROVED DIFFUSION BOARD MATERIAL

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SUMMARY

Gas life tests on boards made at a range of pH values showed a significant loss of CK life between pH 7.5 and 6.2 and almost complete loss when pH was dropped to 5.2, indicating necessity of forming boards under alkaline conditions.

Water resistance was tested by an immersion method which showed that washing of the available M & O pulp, although adequate to increase gas life, was not sufficient to remove residual sizing, yielding an "unsized" blank of 15% water absorption compared to 38% for the board made with unsized pulp. Aquapel, used under various conditions, reduced water absorption to approximately 6%, but first gas life tests showed some loss (to 20 minutes).

Testing of mildew resistance by direct inoculation of a nonsterile specimen was initiated. Boards made previously with acidified Dowicide G were found to have poor gas life; boards made with TBTO (tributyl tin oxide) showed erratic but more encouraging gas life. Evaluation of other fungicides was started.

Additional pulps were received from Wood Conversion Company and offered by Armstrong Cork Company. Confirmation of the date of May 15 for pilot plant trials was received from Bauer Bros. Co.

## METHODS OF TESTING

Some of the methods of test pertinent to the evaluation of diffusion board were specified in the contract on the basis of previous experience with this type of product. These methods include density, carbon dioxide diffusivity, smoke penetration resistance, and gas life, and have been described previously. Additional properties are desired in the product being developed in the current program but neither test methods nor acceptable levels of performance have been defined. Properties of interest include water repellency, wet strength, mildew resistance, scuff resistance, tensile strength, and durability.

Two principal sources of standard methods are available for evaluation of these properties. The American Society for Testing Materials has standardized a group of test procedures under ASTM designation D 1037-60 T "Tentative Methods of Test for Evaluating the Properties of Wood-Base Fiber and Particle Panel Materials." Included in this designation are methods for bending, tensile strength parallel and perpendicular to the surface, nail withdrawal tests, hardness, shear strength, water absorption, linear variation with change in moisture content, accelerated aging, cupping and twisting, screw withdrawal, falling ball impact, abrasion resistance, and others. Under the designation LLL-F-321b, the Federal Specification for Insulating Fiberboard covers test methods for a more limited group of properties and also specifications which these materials must meet for several categories. (A new specification LLL-I-535 has been ordered.)

### WATER RESISTANCE

In the Federal Specification, the test for water absorption involves submersion of the board horizontally under a 1-inch head of distilled water and

subsequent weighing. This is the same type of test specified in the ASTM method, although there is some difference in the method of conditioning. Testing procedure is as follows:

"A specimen 12 by 12 inches shall be dried at 160°F. for 24 hours and cooled to room temperature in a dry atmosphere. The thickness of the sample shall be measured and the volume calculated therefrom. The sample shall then be carefully weighed and submerged horizontally under 1 inch of distilled water maintained at a temperature of 70°F. plus or minus 5°F. After 2 hours of submersion, the sample shall be stood on end to drain for 10 minutes, at the end of which time the excess surface water shall be removed by hand with a blotting paper or paper towel and the sample immediately weighed, the volume of absorbed water calculated, and the water absorption expressed in per cent by volume based on the initial volume."

The use of a 6 by 6-inch specimen is more convenient than a 12 by 12-inch specimen; this follows the option given in the water submersion test specification outlined in ASTM D 1037-60 T. In order to make the water absorption test more severe and increase the spread of values for evaluation, future water absorption tests will also consist of 22 hours additional soaking after the initial 2-hour soaking and measurement.

#### MILDEW RESISTANCE

A test procedure involving direct inoculation of a nonsterile specimen according to Federal Specification CCC-T-191b was initiated. Mildew resistance tests on the boards treated thus far have been delayed by difficulties in causing the fungi to grow on the control specimens. This inherent mildew resistance in the untreated specimens might be the result of fungicidal treatments given to the

pulp at the Minnesota and Ontario mill. Some success has been achieved by soaking the control specimens in a mineral salt solution, inoculating them directly with a culture of the fungi, and placing them in contact with agar strata of cultures of the same fungi. The fungi used in this case was Chaetomium globosum. Fungicide-treated samples have not yet been submitted to this test. Previous unsuccessful attempts to produce growth on the control specimens involved suspending the specimens in the vicinity of moldy tapes in a highly humid atmosphere.

#### CORRECTION OF CK LIFE RESULTS

In an attempt to improve consistency of results on CK gas life tests, results are corrected to a standard charcoal loading of 5.0 grams per 100 square centimeters. Charcoal loading is calculated from density, caliper, and charcoal content (from ash test). This correction would be of doubtful validity over a wide range of thickness, charcoal content, or board structure but should be helpful in a narrow range.

THE EFFECT OF pH ON GAS LIFE

Report Five included a test of the effect of pH on gas life of boards made from repulped newspapers, showing a serious difference in CK gas life between a forming pH of 7.6 and a forming pH of 5.0. A series of boards were also made with Minnesota and Ontario pulp as described in Table IV of Report Five. Gas life evaluations are now available for these boards and are summarized in Table I. It is apparent from these results that gas life begins to suffer at a pH between 7.5 and 6.2 and is seriously affected at a pH between 6.2 and 5.2. This effect limits the use of sizing materials and fungicides or other additives to conditions which will permit the forming of the board at a pH of 7 or above.

TABLE I

THE EFFECT OF pH ON GAS LIFE

Board No.	Washing of Pulp	Forming pH	Gas Life, min.		Charcoal Content, g./100 cm. <sup>2</sup>	Corrected CK Life, min.
			PS	CK		
41-1	Hot	7.5	35.6	45.6	5.19	44
-2	Hot	6.2	34.0	30.2	5.61	27
-3	Hot	5.2	37.5	6.1	5.38	5.7
-4	Hot	4.1	31.0	2.5	5.14	2.4
44-1	Cold	5.0	36.0	3.8	5.21 <sup>a</sup>	3.7
-2	Cold	4.1	38.6	3.0	5.06 <sup>a</sup>	3.0

<sup>a</sup>Calculated on assumed charcoal content of 19%.

### DEVELOPMENT OF SIZING

A method for evaluation of water-resistance was chosen as described above and used to test samples of the diffusion board made in the commercial run in 1954, and of boards previously made with the unsized M & O pulp, with the sized pulp as received, and with the sized pulp after washing. (With the exception of the commercial sample, the pH at formation of all of these boards fell in the range of 7.5 to 8.6.) These results were as follows:

		2-hr. Water Absorption, % by volume
0-0	Commercial run (1954)	51.4
22-2	Unsize pulp, 20% charcoal	38.5
17-3	Sized pulp, 25% charcoal	7.9
12-2	Sized pulp, no charcoal	6.4
26-3	Sized pulp after washing, 25% charcoal	15.1

The unsized pulp board did not have as high a water absorption as the commercial run, although made with a comparable pulp. This difference might be due to a number of factors, including a difference in caliper, the age of the commercial board, or the fact that the skin of this board had been removed in the process of manufacture. Board made with the sized pulp showed a definite sizing even though formed at a pH above that which would normally be used for production of sized board. The extensive washing which had been conducted on this pulp (and which had improved the gas life markedly) apparently has removed some but not all of the sizing material, resulting in a water absorption of 15%. This raises a question with respect to the validity of using this pulp to evaluate other types of sizing, which are now known to be required by the pH effect on gas life. However, this series had already been initiated and other suitable pulps had not yet been received and the tests were continued.

Because of the effect of pH below 7 on CK gas life, sizing and wet strength additions must be limited to those permitting formation under alkaline conditions. Two types of material for sizing on the alkaline side were received, one being Aquapel from Hercules Powder Company and the other being Cyron from American Cyanamid Company. These materials were described briefly in Report Five. Both of these materials were evaluated in a number of combinations with Minnesota and Ontario pulp which had been washed to remove the alum and sizing materials. The results of tests with the Aquapel are reported here; those on Cyron were not complete within this report period and will be discussed later.

Literature from Hercules Powder Company describes Aquapel as an alkylketene dimer which spreads and reacts with the hydroxyl groups of the cellulose at a finite rate, mostly after the fiber is dry. For good sizing, from 0.05 to 0.15% is needed on unbleached kraft and up to 0.3% on bleached fibers. With respect to our particular application, the supplier stated that it would be difficult to get good sizing with Aquapel, that the inclusion of some unbleached kraft in the furnish might help and that keeping the boards hot at a temperature of 250°F. for 15 to 20 minutes after they were oven dried might also be helpful.

Aquapel is available in several forms but the two that were recommended for our use were the Aquapel 360 (an emulsion of 6% Aquapel 364 and 3% of starch) and Aquapel 486 (an experimental material consisting of Aquapel 364 deposited on an equal weight of fine silica for stock addition). Aquapel 486 can be added dry or in a slurry form, preferably before beating or refining. In an open system, Cato 8 added near the headbox at a ratio of 5 to 10 lb. per ton is beneficial. The emulsion (360) can be used for surface applications or for stock addition. For the latter, retention is improved by the use of a cationic starch (such as National Starch Company's Cato 8) or Kymene 557 (a cationic water-soluble polymer produced

by Hercules Powder Company for wet strength applications). When used with starch, a ratio of 2 parts of starch to one of dimer is recommended and, when used with a resin, an addition of resin of not over 0.5% is recommended because more than this has a detrimental effect on sizing. Addition should be made after any severe turbulence, preferably to low consistency stock and in a manner to keep the time from addition to formation of the sheet at a minimum. A pH below 7 or over 8.5 can be detrimental. The cation-exchange capacity of the pulp is believed to be an important factor; high concentrations of aluminum ion prevent sizing and it has been suggested that this may be the reason groundwood is difficult to size with Aquapel.

These materials were incorporated into the slurries of boards formed with 25% charcoal furnishes, except blank boards which contained no charcoal, according to the procedure set up as a standard for our laboratory production of boards (i.e., slushing the charcoal into the slurry at 4% consistency, forming at 1% consistency, draining with a water-leg followed by the application of a 25-in. Hg. vacuum, wet pressing for ten minutes at 150 p.s.i., and drying at 105°C.). The pulp used was the M & C stock initially containing wax-rosin size which had been washed with hot water in an effort to remove the size materials and any alum that might be present. After drying, sections of some of the boards treated with Aquapel were heated for one hour at 250°F. in order to determine the effect of curing. Descriptions of all of the boards formed are given in Appendix I. All additions were made on the basis of active material.

The results on the use of Aquapel 486 are shown in Table II and those on the use of Aquapel 360 are shown in Table III. From these figures it appears that the presence of the charcoal does make sizing slightly more difficult but not to a very great extent. Excluding the values for the boards made without

TABLE II  
 THE USE OF AQUAPEL 486  
 (Washed M & O pulp)

Run No.	Additions, % of fiber			Order of Addition <sup>a</sup>	2-hr. Water Absorption, % by volume	
	Charcoal (C)	Aquapel 486 (A)	Cato 8 (S)		Dried	Overdried <sup>b</sup>
53-2	--	0.5	--	--	5.3	5.3
53-1	25.0	0.5	--	A C	6.3	5.8
-3	25.0	0.5	--	C A	5.9	5.8
-4	25.0	0.1	--	A C	7.3	6.1
57-2	--	0.25	0.5	A S	6.0	5.8
-1	25.0	0.25	0.5	A S C	6.7	6.6
-3	25.0	0.25	0.5	C A S	6.1	6.1
-4	25.0	0.25	0.25	A S C	6.8	6.7

<sup>a</sup>All additions were made to the 4% slurry.

<sup>b</sup>For an additional hour at 250-262°F.

TABLE III  
THE USE OF AQUAPEL 360  
(Washed M & O pulp)

Run No.	Additions, % of fiber				Order of Addition <sup>a</sup>	2-hr. Water Absorption, % by volume	
	Charcoal (C)	Aquapel 360 (A)	Cato 8 (S)	Kymene 557 (K)		Dried	Overdried
58-1	--	0.5	--	--	-A	5.3	5.8
-2	25.0	0.5	--	--	C - A	7.4	6.7
-3	25.0	0.5	--	--	AC-	5.9	5.9
-4	25.0	0.5	1.0	--	C - (AS)	6.4	5.9
-5	25.0	0.5	--	0.5	KC - A	7.7	6.5
-6	25.0	0.5	--	0.5	C - AK	7.5	6.2
-7	25.0	0.5	--	0.2	KC - A	6.4	6.1
-8	25.0	0.5	1.0	0.5	KC - (AS)	6.8	6.3

<sup>a</sup>All additions before the dash were made at 4% consistency, those after the dash at 1%; symbols enclosed in parentheses indicate materials were mixed before addition to stock.

charcoal, the total spread of water absorption results for all the boards made with Aquapel 486 fell within the range of 5.8 to 7.3, and the latter figure is with a minimum amount of Aquapel. Using 0.5% active material in the form of Aquapel 360, boards made with and without the use of Cato 8 and Kymene 557 and with various orders of addition showed water absorption values in a range from 5.9 to 7.7. Thus, it appears that none of these factors have a very great influence on the water absorption, but lower water absorption seems to be favored slightly by additional drying, and in the case of Aquapel 486 by addition of sizing agent after the addition of charcoal. Contrary to recommendations, the addition of the Aquapel 360 to the more concentrated slurry (before the addition of charcoal) gave better results than addition of the Aquapel 360 after dilution to the 1% consistency. The use of Cato 8 or Kymene 557 showed slight improvements. In general, the use of the two Aquapels was approximately equivalent, with a slight trend in favor of the Aquapel 486.

Gas life tests were available on only two samples, one being board 58-4 and one being board 58-8. Each of these showed a PS gas life of 21-1/2 minutes and a CK life (corrected to 5.0 grams per square centimeter of charcoal) of approximately 21 minutes. Compared with a corrected gas life of approximately 55 minutes on boards made with this pulp alone, this indicates some effect of these materials on the gas life but detailed results are not yet available to determine what effect the various components and order of addition might have had.

### THE EFFECT OF FUNGICIDES

Report Five included the description of the manufacture of several boards utilizing Dowicide G and TBTO [bis(tri-n-butyl tin)oxide] as fungicides. Evaluation of the fungicidal value of these materials has been delayed because of some apparent inherent resistance in the control specimens themselves (see above). Gas life evaluations have now been received for these materials. Boards 49-3 and 49-4 (utilizing 4 and 1% Dowicide G, respectively), had PS gas life in the range of 27 to 33 minutes; however, the CK gas life was seriously affected, dropping to a level of 2 to 3 minutes. Since these boards were made at a pH of approximately 5 in order to precipitate the pentachlorophenol, it is impossible to separate the effect of pH from the effect of the Dowicide itself. However, since the low pH is recommended and required for the use of this material as a stock addition, this approach does not appear to be feasible.

Boards 51-2 and 51-3 made with TBTO at a pH of approximately 8.2 had more promising gas life results. Board 51-2 containing 1.0% TBTO had a PS life of 28 minutes, and two samples had a CK life of 6.6 and 17.3 minutes. Board 51-3 containing 0.1% TBTO had a PS life of 10 and 27 minutes, and CK life of 32 and 45 minutes. The poor reproducibility of the tests suggests that poor control was obtained in the method of addition of the TBTO, but that the effect on gas life was not as serious as in the case of the acidified Dowicide G.

Other boards have been prepared with Cunilate No. 2419 (manufactured by Scientific Oil Compounding Company) and with Dowicide G precipitated as a copper salt with copper sulfate. Complete evaluations will be reported later.

Cunilate No. 2419 is an emulsion containing 10% Copper-8-quinolinolate and 50% solids. It was added to 4% consistency slurries of washed M & O pulp

immediately before the addition of charcoal. Two addition levels were used, 5 and 2.5% Copper-8-quinolinolate, based on oven-dry fiber.

According to Dow Chemical Company literature, 0.4 lb. of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  added to a solution of 1.0 lb. of Dowicide G produces an optimum yield of 0.85 lb. of copper pentachlorophenate. Using this ratio of copper sulfate to Dowicide G, boards were formed from the washed M & O pulp with additions of copper pentachlorophenate using two levels of Dowicide, 1.0 and 4.0% based on oven-dry fiber. The copper pentachlorophenate was precipitated in a 4% consistency slurry of the pulp by adding a solution of copper sulfate after the addition of Dowicide G, all of this being done before the addition of charcoal.

#### OTHER CONTACTS

##### ARMSTRONG CORK COMPANY

A letter dated March 21 confirmed their willingness to supply an experimental quantity of both willow and pine groundwood.

##### BAUER BROS. CO.

Under date of March 8, a letter was received in reply to our request of January for a date for pilot plant trials. The suggestion of May 8 was found to be impossible for Institute personnel and agreement was reached to schedule pilot trials in the week beginning May 15.

##### MINNESOTA AND ONTARIO PAPER COMPANY

In reply to an inquiry following up the report on tests made at the Army Chemical Center (see Report Five, p. 15), Minnesota and Ontario Paper Company submitted information on the pulps involved and also a quantity of paper mill groundwood and a small sample of Asplund pulp.

##### WOOD CONVERSION COMPANY

Three samples of pulp were received from the Wood Conversion Company in accordance with previous discussions. At the end of the reporting period, we had no information as to the identities of the pulps; the samples were simply labeled 10-853, 10-854, and 10-855. Boards were formed from the individual samples according to our standard forming techniques with the incorporation of 25% charcoal, based on oven-dry fiber in the pulp slurries. Wet pressing conditions for the boards were varied in order to determine the effect on density and to indicate what blend might be required for suitable physical properties.

THE INSTITUTE OF PAPER CHEMISTRY

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APPENDIX I

USE OF SIZE AND NET STRENGTH AGENTS WITH MINNESOTA AND ONTARIO PULP

Sample	Material	Additions			Where Added	Forming pH	Drying		Density, lb./cu. ft.	CO <sub>2</sub> Diffusivity, -2 cm. <sup>2</sup> /sec. x 10 <sup>-2</sup>	Gas Life <sup>a</sup> FS, CK min. min.	Water Absorbed, %, by vol.
		% based on O.D. fiber	Order of Addition	Temp., °C.			Time, hr.	Caliper, inches				
00	Commercial sample											
2256-	Wax-Rosin Sized Pulp											
12-2	--											
17-3	Charcoal ASC	25.0			4% slurry	8	15	59	0.248	20.30	1.88	51.4
22-2	Charcoal ASC	20.0			4% slurry	7.5	2.0	105	0.289	22.00	2.36	6.4
26-3	Wax-Rosin Sized Pulp, hot water washed	25.0			4% slurry	8.0	4.0	105	0.250	22.50	2.13	7.9
53-1	Charcoal ASC	1.0	1		4% slurry	8.6	2.0	105	0.347	21.47	2.49	38.5
53-1A	Aquapel 486b	25.0	2		4% slurry	8.7	2.0	105	0.356	20.19		15.1
53-2	Same as 53-1, cured 1 hr. at 262°F.	1.0			4% slurry	8.7	15.25	105	0.294	18.58		6.3
53-2A	Aquapel 486b	25.0	1		4% slurry	9.3	2.0	105	0.335	20.77		5.8
53-3	Charcoal ASC	1.0	2		4% slurry	9.3	2.0	105	0.335	20.77		5.8
53-3A	Aquapel 486b	25.0			4% slurry	9.2	2.0	105	0.343	20.45		5.3
53-4	Same as 53-3, cured 1 hr. at 262°F.	0.20			4% slurry	9.2	2.0	105	0.343	20.45		5.3
53-4A	Aquapel 486b	25.0	1		4% slurry	9.2	2.0	105	0.343	20.45		7.3
57-1	Charcoal ASC	0.50	2		4% slurry	8.8	1.75	105	0.331	20.60		6.1
57-1A	Aquapel 486b	0.50			4% slurry	8.8	1.75	105	0.331	20.60		6.6
57-1B	Charcoal ASC	25.0	3		4% slurry	8.7	16.0	105	0.293	18.95		6.0
57-2	Same as 57-1, cured 1 hr. at 250°F.	0.50	1		4% slurry	8.7	16.0	105	0.293	18.95		5.8
57-2A	Aquapel 486b	0.50	2		4% slurry	8.7	16.0	105	0.293	18.95		6.6
57-2B	Charcoal ASC	25.0	1		4% slurry	8.7	15.0	105	0.331	20.66		6.0
57-3	Aquapel 486b	0.50	2		4% slurry	8.7	15.0	105	0.331	20.66		5.8
57-3A	Charcoal ASC	0.50	3		4% slurry	8.7	15.0	105	0.331	20.66		6.1

[Note: Please see end of table for footnotes.]

APPENDIX I (Continued)  
USE OF SIZE AND WET STRENGTH AGENTS WITH MINNESOTA AND ONTARIO PULP

Sample 2256-	Material	Additions		Where Added	Forming pH	Drying		Density, lb./cu.ft.cm. <sup>2</sup> /sec. x 10 <sup>-2</sup>	CO <sub>2</sub> Diffusivity, PS, CK, min.	Gas Life <sup>a</sup> min.	Water Absorbed, %, by vol.
		%, based on O.D. fiber	Order of Addition			Time, Temp., hr. °C.	Caliper, inches				
57-3B	Same as 57-3,	cured 1 hr. at 250°F.									
57-4	Aquapel 4868	0.50	1	4% slurry							6.1
	Cato 8	0.25	2	4% slurry							
	Charcoal ASC	25.0	3	4% slurry	8.6	2.0	105	0.325	21.04		6.6
57-4B	Same as 57-4,	cured 1 hr. at 250°F.									
58-1	Aquapel 360c	0.50	1	1% slurry	8.9	2.5	105	0.286	18.89		6.7
58-1B	Same as 58-1,	cured 1 hr. at 250°F.									5.3
58-2	Charcoal ASC	25.0	1	4% slurry	9.4	2.0	105	0.326	20.14		5.8
	Aquapel 360c	0.50	2	1% slurry							7.4
58-2B	Same as 58-2,	cured 1 hr. at 250°F.									6.7
58-3	Aquapel 360c	0.50	1	4% slurry	9.0	16.12	105	0.333	19.80		5.9
	Charcoal ASC	25.0	2	4% slurry							5.9
58-3B	Same as 58-3,	cured 1 hr. at 250°F.									
58-4	Charcoal ASC	25.0	1	4% slurry							6.4
	Cato 8	1.0	2	1% slurry	9.0	15.33	105	0.336	19.80		5.9
58-4B	Aquapel 360c	0.50	2	1% slurry							
58-4A	Same as 58-4,	cured 1 hr. at 250°F.									
	Charcoal ASC	25.0	1	4% slurry							21.4
	Cato 8	1.0	2	1% slurry							21.5
58-5	Aquapel 360c	0.50	2	1% slurry	7.6	1.5	105	0.349	20.18		
	Kymene 557	0.50	1	4% slurry							
	Charcoal ASC	25.0	2	4% slurry							
	Aquapel 360c	0.50	3	1% slurry	7.1	2.0	105	0.330	20.24		7.7
58-5B	Same as 58-5,	cured 1 hr. at 250°F.									6.5
58-6	Charcoal ASC	25.0	1	4% slurry							
	Aquapel 360c	0.50	2	1% slurry							
	Kymene 557	0.50	3	1% slurry	7.8	2.0	105	0.338	19.90		7.5
58-6B	Same as 58-6,	cured 1 hr. at 250°F.									6.2

[Note: Please see end of table for footnotes.]

APPENDIX I (Continued)  
USE OF SIZE AND WET STRENGTH AGENTS WITH MINNESOTA AND ONTARIO PULP

Sample 2256-	Additions			Forming		Drying		CO <sub>2</sub> Diffusivity, lb./cu.ft.cm. <sup>2</sup> /sec. x 10 <sup>-2</sup>	Gas Life <sup>a</sup> PS, CK, min.	Water Absorbed, %, by vol.
	Material	% O.D. fiber	Order of Addition	Where Added	pH	Time, hr.	Temp., °C.			
58-7	Kymene 557	0.20	1	4% slurry						
	Charcoal ASC	25.0	2	4% slurry						
	Aquapel 360 <sup>c</sup>	0.50	3	1% slurry	7.6	2.0	105	0.340	19.83	6.4 6.1
58-7B	Same as 58-7, cured 1 hr. at 250°F.									
58-8	Kymene 557	0.50	1	4% slurry						
	Charcoal ASC	25.0	2	4% slurry						
	Cato 8	1.0	3	1% slurry	7.4	2.0	105	0.340	20.26	6.8 6.3
58-8B	Same as 58-8, cured 1 hr. at 250°F.									
58-8A	Kymene 557	0.50	1	4% slurry						
	Charcoal ASC	25.0	2	4% slurry						
	Cato 8	1.0	3	1% slurry	7.7	2.0	105	0.331	21.15	21.2 20.8
	Aquapel 360 <sup>c</sup>	0.50	3	1% slurry						

<sup>a</sup> Gas life values corrected to 5 g./100 cm.<sup>2</sup> charcoal loadings.

<sup>b</sup> Additions of Aquapel 486 are total amounts added; Aquapel 486 contains 50% active Aquapel.

<sup>c</sup> Additions of Aquapel 360 are the amounts of active Aquapel 364 added; Aquapel 360 in a 6% emulsion of Aquapel 364.