MEAD RESEARCH LABORATORIES

CHILLICOTHE, OHIO

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TITLE CONCENTRATION OF AROCLOR AND FORMALDEHYDE VAPORS IN THE #6 COATER DRYER.

PROJECT 144 - SPECIALTY PAPERS DEVELOPMENT.
Sub-Project A-120 - Impact Printing Paper.

REPORT NO. 13,265

COPIES TO:

Project 144
Library-Circl. to: D. Y. Liversidge
E. B. Brookbank
Mr. R. H. Savage
Mr. W. C. Mathews
Mr. O. B. Mason
Mr. E. A. Hawkins
Mr. F. H. Wagner

SUBMITTED BY: W. C. Mathews

DATE: April 28, 1934.

APPROVED BY: R. M. Griesheimer

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April 30, 1954

PROJECT 144 - SPECIALTY PAPERS DEVELOPMENT

Sub-project A-130 - Impact Printing Paper

Concentration of Aroclor and Formaldehyde Vapors in the #4 Coater Dryer

Report No. 13861

INTRODUCTION:

During the November production of Impact Printing Paper on the #4 air knife coater, the concentrations of Aroclor and formaldehyde vapors in the dryer reached a level that caused excessive irritation to the coater operators. Inasmuch as these chemicals, which are components of the conservate emulsion coating, have toxic properties, it seemed imperative to measure their concentration in the dryer, and establish whether or not an industrial hazard existed. Mr. Francis Wagner of the Safety Department contacted the Monsanto Chemical Company, the manufacturer of Aroclor, who offered to furnish equipment and to instruct Mead personnel in the procedures for determining the concentration of Aroclor and formaldehyde vapors in the dryer. The results of these measurements are the subject of this report.

OBJECT:

The object of the work reported here was to measure the concentrations of Aroclor and formaldehyde vapors in the dryer of the #4 air knife coater during the production of Impact Printing Paper, and to find out if an industrial hazard exists in this operation.

SUMMARY OF RESULTS AND CONCLUSIONS:

Approximately 30 measurements of the concentrations of Aroclor and formaldehyde vapors were made over the period from December 1 to March 10, utilizing procedures and equipment supplied by the Monsanto Chemical Co.

These results indicate an Aroclor concentration of less than 2.0 mg./cu. in. for impermeable emulsions and a concentration below 3.5 mg./cu. in. for the more permeable emulsions that were used. The maximum safe working limit for Aroclor was indicated by the Monsanto representatives to be 10 mg./cu.in.

The concentration of formaldehyde vapor in the dryer, for the most part, was under 2.5 p.p.m., as compared to a maximum safe working limit of 10 p.p.m. A few results indicating a higher level are believed to result from contamination of the absorption water and are probably best disregarded.

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CONCLUSIONS:

The data substantiate the statement made by the Monsanto representatives to the effect that Mead does not have an industrial hazard in respect to Aroclor vapor under the conditions of operation during the period these measurements were made.

Likewise, the data on formaldehyde indicate that Mead does not have an industrial hazard in respect to formaldehyde vapor under the conditions existing during the period of these measurements.

As operations have progressed, improvements have been made in color make-down procedure which have reduced the permeability of the emulsion structure, and this has been reflected in lower concentrations of Aroclor vapor in the dryer.

PROCEDURE:

Using a Willson Products' Chlorinated Hydrocarbon Sampling Apparatus, samples for measurement of the Aroclor vapor concentration were taken from the dryer of the #6 Coater during the application of Impact Printing Emulsion coatings, in accordance with directions given by Mr. A. M. Ellenberg and Mr. Jack Garrett of the Monsanto Chemical Company. Samples were taken over a 35-40 minute period from a position along the east wall of the dryer where the concentration of odor appeared at the highest level. The procedure of testing is based on the combustion of the halogenated hydrocarbon using a platinum catalyst as described in Jacob's "Analytical Chemistry of Industrial Poisons" second edition page 570. Sampling throughout the test period was conducted by Mr. Orville Minear, Division Technical Service. Analysis of the samples was carried out by Research Central Testing, using a silver chloride precipitation and comparing the optical density to that of a standard at 460 mu on the CENPS. Details of the sampling procedure and method of analyses, as supplied by Monsanto Chemical Company, are included in the Appendix.

Samples for measurement of formaldehyde vapor concentration were taken with a Mine Safety Appliance Midget Impinger, and were taken over a 5 to 7.5 minute period from the same area from which the Aroclor samples were taken. Analysis of the samples was carried out by Research Central Testing, using a procedure based on the reaction of formaldehyde with Schiff's reagent, as described in "Colorimetric Methods of Analysis", Snell and Snell, Page 5-8, Volume 2. Because of difficulties in working out the analytical procedures, no determinations were completed until the runs of December 15. Details of the method used for analysis of formaldehyde are included in the Appendix.

Samples of the air from the dryer were taken in the course of normal operations on the coater, except for special runs on December 1 and 2 to measure the concentrations of vapor under three different levels of emulsion permeability. Run (1) was made on December 1 without additives in the color and without colloid milling, to give results with a closed or impermeable emulsion structure. Unfortunately this sample was lost because of evaporation of the absorption reagent, and in the light of subsequent results it did not seem advisable to repeat the run. Run (2) was made on December 2 to show the results with an abnormal degree of permeability as

obtained by colloid milling at a clearance of .018 in., while Run 3 was made on the same date with color milled at a clearance of .050" to show the concentrations of vapors obtained under more nearly normal conditions.

Two color formulations were used in this work, based on the addition of 40 parts of Solka floc on the emulsion solids to reduce smudging, with an added colloid (either Polyco 296 M or Stayco M) added as indicated below: (Trial runs were made on January 7 to study the use of Stayco M as a substitute for Polyco, when added at 5 and 25 parts in the emulsion solids.)

	December 1 to January 11	January 11 to March 16
Emulsion solids	100 parts	100 parts
Solka floc	40 parts	40 parts
Stayco M	-	10 parts
Polyco 296M	3-5 parts	-
Percent solids when coated	15-16%	20%

The change to Stayco M made it possible to reduce the dryer temperature from 155°F. to 130°F. With the elimination of Polyco from the color, the odor of formaldehyde in the dryer became more pronounced. In an effort to reduce the concentration of formaldehyde and also to improve viscosity properties, the pH of the emulsion batches, after formulation, was reduced to 7.0 with acetic acid (1:4), and then adjusted to 7.5 with ammonium hydroxide (1:4). The latter reacts with excess formaldehyde, thus reducing the relative amount of the chemical available for vapor formation.

All colors were premier milled to reduce viscosity and disperse the Solka floc. In the period to February 23, the color was recirculated in drum lots until the viscosity was reduced to less than 150 cps. Average milling time was five minutes with the mill set at .050 in., except as noted in the runs on December 1 and 2nd. Changes in the make-down procedures to reduce the permeability of emulsion structures were made as follows:

February 22 - Began using the new color system in the laminator room and recirculated the color in 200-250 gal. batches, with a reduction in the time of milling.

March 3 - A 3 horsepower Lightnin mixer was installed to predisperse the floc before milling, and started procedure of only one or two passes through the mill, thus reducing the milling time still further. The colloid mill clearance was increased to 0.10 in.

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DISCUSSION:

At the time of the visit of Messrs. Kilenberg and Carrott of Monsanto, a conference was held to discuss the possible existence of an industrial hazard and to decide upon a program for measuring the concentration of Arocolor and formaldehyde vapors. The toxicity of Arocolors or chlorinated diphenyls was discussed at some length by Mr. Carrott who

indicated that much of the published literature on the toxicity of Aroclor was not reliable, since it was based on an article by Dr. Drinker that was later retracted because of a mistake in the identification of the chlorinated diphenyl sample with which he was working. He also stated that later work had indicated a safe working limit of 10 mg./cu. m., and that there was no evidence of liver damage on prolonged exposure as stated in much of the published literature. He stated that Monsanto have worked in the range of 4 mg./cu.m. without encountering difficulties. After adjourning and viewing the coating operation both Monsanto men expressed the opinion that we did not have an industrial hazard.

Because of the small quantities measured in these tests, contamination from outside sources was difficult to control even though extreme care was exercised throughout. For instance, the distilled water in the laboratory had a strong formaldehyde test during those periods when formaldehyde was being used in the pilot plant calender. It is believed that the high results on March 18 were caused by contamination of the water, and is confirmed by the results of the control test. Likewise the Aroclor samples on January 7 and 11 were collected and stored in bottles with a vinyl chloride cap-liner, and were believed to have been contaminated. All of these samples of Aroclor showing a concentration over 6 mg./cu. m. were discolored, indicating that these results were not reliable. In none of these tests did the level of Aroclor in the dryer appear to be at a high level, and it is believed that the results should be disregarded.

The results of these tests indicate that the concentration of Aroclor vapor follows a regular pattern of decreasing concentration in inverse relation to the degree of openness in the emulsion structure. Disregarding the high results that are believed due to contamination, the concentration of Aroclor is less than 3.5 mg./cu. m. for those emulsions of slight to moderate permeability, and under 2 mg./cu. m. for those emulsions with the desired (closed or very slightly open) structures. As the operations have progressed, definite improvement has been made in emulsion make-down procedures to maintain the structure at a high degree of impermeability, and this improvement is reflected in the results of measurements on March 12, and March 17, which were under 1.4 mg./cu. m.

The results of the formaldehyde vapor tests indicate a concentration well under the 10 p.p.m. that is indicated as the maximum safe working level. Except for the result on March 18 which was believed high because of contamination of the absorption solution, the highest result was 3.7 p.p.m. and for the most part, the concentrations were under 2.5 p.p.m. The level of formaldehyde concentration is a function of the amount added by NCR, and the reactions that take place in the hardening process, with the result that there appear to be rather wide spread variations over which Mead has little control. Generally, the level of formaldehyde vapor was lower in the formulations containing Polyco, but ammonia was added to react with excess formaldehyde after changing to the Stayco M formulation and this is believed helpful in holding down the vapor concentrations. In this connection, it was noted qualitatively that the run without selka flex or any other additive Dec. 1 had an especially high level of formaldehyde vapor, but unfortunately the measurement was lost because of inexperience with the method.

With the improvement in emulsion make-down procedures there have also been improvements in center operations, which have materially cut down the time that must be spent in the dryer by the operator. In the early phases of the work, complaints of irritation of the nasal and throat membranes were frequent, and on occasion the operators experienced loss of voice after being in the dryer for extended periods. As a result of the improvement in operation and procedures, these complaints have been less frequent although they are still experienced on occasion. Should it become necessary for personnel to spend long periods in the oven it would appear advisable to make the use of masks mandatory to provide positive protection.

Notebook references - Book 514 pp. 126-131
Book 564 pp. 156-157

APPENDIX

TABLE I

Concentration of Aroclor and Formaldehyde Vapor in the #6 Cooler

Sample		Emulsion Structure-	Aroclor Vapor	Formaldehyde Vapor	Remarks
Date	Time	Openness	Mg./cu.m.	PPM	
Dec.1	2:50	-	3.3	-	Control sample probably contaminated.
Dec.1	4:00	Closed	Sample lost	-	No additives in emulsion. See Note 1.
Dec.2	11:50	Slight to Mod.	3.3	-	Color Premier milled at 0.018".
Dec.2	1:35	Very slight	4.9	-	Premier mill setting increased to .050" for milling color. Not changed until March 3. See Note 2.
Dec.2	2:13	Very slight	1.2	-	
Dec.2	3:00	Very slight	1.1	-	
Dec.7	-	Slight	1.9	-	
Dec.7	-	Slight	2.1	-	
Dec.14	1:10	Slight	12.7	-	This sample was off-color and was believed to be contaminated. This result should probably be discharged.
Dec.14	2:40	Slight	2.1	-	
Dec.15	1:35	Very slight	1.5	1.2	
Dec.15	2:45	Very slight	2.0	1.4	
Jan.7	10:15		3.3	-	Color contained 5 parts Polyco as additive.
Jan.7	1:40		8.0	-	Color contained 5 parts Stayco M starch as additive.
Jan.7	3:35		5.4	2.1	Color contained 25 parts Stayco M starch as additive.
Jan.11	1:50	Slight to Mod.	3.7	1.8	
Jan.11	3:00	"	19.5	3.8	
Jan.19	9:50	Very slight	.9	2.6	Began using glass stoppered bottles for retaining Aroclor samples.

Note 3

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TABLE I (Continued)

Concentration of Aroclor and Formaldehyde Vapor in the #6 Coater

Sample Date	Sample Time	Emulsion Structure Openness	Aroclor Vapor Mg./cu.m.	Formaldehyde Vapor ppm	Remarks
Jan.19	1:45	Very slight	1.1	3.7	
Jan.19	2:40	"	1.0	-	
Jan.22	1:20	Slight	3.4	-	
Jan.22	2:50	Slight	3.2	-	
Feb.1	1:50	Slight-Mod.	3.5	1.6	
Feb.1	3:15	Slight to Mod.	2.1	-	
Feb.2	10:10	Slight to Mod.	3.3	.4	
Feb.2	2:10	Slight to Mod.	1.6	.3	
Feb.2 3	3:05	"	-	.7	
Feb.3	11:05	Slight	-	1.4	
Feb.3	2:05	Slight	1.6	.8	
Feb.3	2:55	Slight	1.3	.8	
Feb.4	10:20	Slight to Mod.	2.8	1.0	
Feb.4	11:45	Slight to Mod.	-	1.1	
Feb.4	1:35	Slight to Mod.	3.4	-	
Feb.4	2:55	Slight to Mod.	-	.2	
Feb.23	10:40	Slight	3.4	2.2	
Feb.23	1:20	Slight	-	2.1	
Feb.23	2:00	Slight	3.2	-	
Feb.23	2:50	Slight	-	2.7	
Feb.24	10:15	Very slight	11.3	2.5	Note 2 probably applies to this sample
Feb.24	12:45	Very slight	-	3.5	
Feb.24	2:00	Slight	5.4	-	Note 2 also probably applies to this sample. The odor in the dryer was not noticeably higher on this date.

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TABLE I (Continued)

Concentration of Aroclor and Formaldehyde in the #6 Coater

Sample		Emulsion Structure-	Aroclor Vapor	Formaldehyde Vapor	Remarks
Date	Time	Openness	Mg./cu.m.	ppm	
Feb.24	2:50	Slight	-	3.1	
Feb.25	1:40	Very slight	-	1.6	
Feb.25	2:30	Very slight	-	1.6	
Feb.25	3:15	Very slight	-	1.7	
Mar.12	1:15	Closed	0.6	1.2	
Mar.12	2:05	Closed	-	1.3	
Mar.12	3:10	Closed	0.6	-	Control- Run outside of dryer.
Mar.17	9:30	Very slight	0.8	-	
Mar.17	10:30	Very slight	1.4	-	
Mar.17	2:40	Very slight	1.2	-	
Mar.18	9:40	Closed	-	4.6	Note 5.
Mar.18	10:40	Closed	-	2.0	" "
Mar.18	2:40	Closed	-	4.7	" "
Mar.18	3:40	-	-	2.5	Control sample taken outside of dryer.

* The results before Dec.7 were reported in Dr. Brookbank's letter to Mr. Francis Wagner. The results shown above have been re-evaluated on the basis of a new calibration curve that is believed more reliable than the one used initially.

Note 1: Apparatus placed inside of the dryer for this determination. Temperature was too high, causing evaporation of the absorption reagent. All subsequent samples were taken with the apparatus outside the dryer, and with the air sample drawn through a hole in the dryer.

Note 2: Conditions prevailing during this and following samples were not greatly different. In view of the results on samples before and after this sample it is concluded that the 1:35 sample was contaminated from outside sources and should be discarded.

Note 3: The Aroclor samples were retained in bottles with a bottle cap containing a vinyl chloride liner. Results of these samples are not believed reliable in view of the lower results obtained with subsequent samples that were retained in glass stoppered bottles.

Note 4: The color formulation was changed to include 10 parts of Stayco M starch on the emulsion solids, as a replacement for Polyco 296N, in this and all subsequent runs.

Note 5: Because of contamination of the absorption water a control sample was run outside the dryer. These results are probably high.

OPERATING PROCEDURE FOR WILSON PRODUCTS, INCORPORATED, CHLORINATED HYDROCARBON SAMPLING APPARATUS

The following outline of operating procedure for this apparatus has been found quite satisfactory, and is considerably more detailed than the operating instructions supplied with the apparatus:

1. Mount the absorption apparatus on the tripod and start heating the furnace so that it reaches a bright red heat (850°C.) within 15-20 minutes. A rheostat setting of 40 was found to be about right on the instrument used here. This same setting is maintained throughout the run.

2. Connect the suction pump to the apparatus. A needle valve for bleeding in air to regulate the rate of flow through the apparatus affords much better control than does the bleeder cock on the pump alone. The base of an ordinary laboratory gas burner containing a needle valve is satisfactory.

3. Prepare the absorption column as follows:

   a. Close all outlets and fill with distilled water, drain and repeat to wash the column.

   b. Pipette 1 cc of the absorption solution into the column and allow to drain thoroughly. Add another 1 cc of absorption solution and drain. This prevents the absorption solution's being diluted by residual water from the washing operating. Close the stopcock and attach suction tube to top of column.

4. When the combustion tube reaches the proper temperature start the pump before opening the stopcock to prevent the absorption solution from draining into the tube connecting the absorption tube to the combustion tube. Turn the stopcock to the operating position, and simultaneously start the stop watch.

5. Adjust the rate of flow by manipulation of the bleeder valves to a rate of one to two liters per minute as indicated by the flow meter. The flow meter must be previously calibrated for use under the conditions of operation. This may be done by operating the apparatus with a calibrated gas meter (such as a wet-test meter) attached to the intake of the combustion tube.

   It takes 3 to 5 minutes for the pump to reach a constant rate and the bleeder valves must be adjusted frequently during this time to maintain the proper sampling rate. The adjustment of the sampling rate must always be done with the furnace for the combustion tube on and the furnace must then remain on during the entire run. Since the furnace draws current from the same source as the pump any large changes in the load on the line will affect the speed of the pump.

6. Continue the run for the desired period, 30 to 40 minutes for concentrations below 10 mg. of chlorinated material per cubic meter of air.

7. Close the stopcock, stop the pump, and turn off the current to the furnace.

8. Wash the absorption column by filling with distilled water to just above the beads. The beads are washed in this manner just twice and the washings containing the chloride are collected in a clean, 2-oz. bottle. The chloride in the washings is then determined by Anniston Analytical Methods. The concentration in the air may then be calculated.

   It is convenient to remove the apparatus from the tripod and to place it at a lower level to carry out the washing operations, but it may be done in place by using a step ladder if desired.

9. Repeat steps 1 through 8 as the normal operating cycle.

   Reagent Blank - Although the reagents used in the absorption solution are specified as chlorine free, it is advisable to run a blank determination on the reagents. This blank is run by preparing the absorption column as in step 3 for a regular run. Then without drawing air through the apparatus the column is washed and the sample taken as in step 8. The chloride is then determined in the usual manner.

   Absorption Solution: Recrystallize sodium carbonate twice from distilled water in order to obtain chloride-free sodium carbonate. With this sodium carbonate make a saturated water solution (saturated at 25°C.). To 80 cc. of the sodium carbonate solution add 20 cc. distilled water. Add one gram chloride-free arsenic trioxide to the 100 cc. carbonate solution.

   Chloride-free water may be obtained by distillation from sodium hydroxide; and chloride-free arsenic trioxide, by sublimation.

Sample Calculations:

1. $MgCl_1^- = \frac{ppm. \times gm.\ washings}{10^3}$

   $MgCl_1^-$ = milligrams Cl^- in washings.
   ppm. = Cl^- concentration in washings.
   gm. = wt. of washings in grams.

2. $MgCl/cu.\ m = \frac{MgCl_2^- \times 10^3}{liters\ of\ sample}$

   = milligrams of Cl per cubic meter in the sample.

   $MgCl_2^-$ = $MgCl^-$ in washings minus $MgCl^-$ in reagent blank.

Example No. 1:

Data:		
	Rate of sampling, lpm.	1.5
	Duration of sampling, min.	30
	Total vol. of sample, liters	45
	Net wt. of washings, gm.	15.25

Total Cl^- in blank, mg. 0.006
% Cl in vapor being sampled 54
Concentration of Cl^- in washings, ppm. 6.3

Calculations:

1. $MgCl_1^- = \frac{6.3 \times 15.25}{10^3}$

$= 0.096$

$MgCl_2^- = 0.096 - 0.006$

$= 0.090$

2. $MgCl/cu.\ m. = \frac{0.090 \times 10^3}{45}$

$= 2$

Chlorinated hydrocarbon concentration would then be:

$\frac{2.0}{0.54} = 3.7$ mg./cu m.

Example No. 2:

Data: Rate of sampling, lpm. 2.0
Duration of sampling, min. 43
Total vol. of sample, liters 86
Net wt. of washings, gm. 14.91
Total Cl^- in blank, mg. 0.006
% Cl in vapor being sampled 42
Concentration of Cl^- in washings, ppm. 3.2

Calculations:

1. $MgCl_1^- = \frac{3.2 \times 14.91}{10^3}$

$= 0.048$

$MgCl_2^- = 0.048 - 0.006$

$= 0.042$

2. $\frac{MgCl}{cu\ m} = \frac{0.042 \times 10^3}{86}$

$= 0.49$

Chlorinated hydrocarbon concentration would then be:

$0.49/0.42 = 1.2$ mg./cu. m.

MONSANTO CHEMICAL COMPANY
Anniston, Alabama

Analytical Laboratory

Anniston Test Number 20-25-41

Determination of Chlorides in Water Solution.

Range:
5 - 120 micrograms in 20 ml. maximum volume.

Apparatus:
1. Fisher Electrophotometer with blue filter and 25 ml. sample tube.
2. 25 ml. glass stoppered volumetric flask or graduate.
3. 10 ml. measuring pipette and 10 ml. transfer pipette.

Solutions:
1. 3N Nitric Acid - 190 ml. CP conc. HNO_3 diluted to 1,000.
2. 0.3% Silver Nitrate - 3 grams dissolved in 1,000 ml. distilled water. Store in dark bottle out of light.
3. 1% Phenolphthalein. 1 gram solid in 100 ml. CP Methanol.

Procedure:
1. Pipette required volume of water solution into 25 ml. volumetric graduate. Adjust sample size to obtain 10-120 micrograms of Cl in less than 22 ml. For testing scrubber solutions of Aroclor vapor tests use 10 ml.

2. Add 1 drop Phenolphthalein and neutralize with 3N nitric acid (or dilute caustic if sample is acid).

3. Dilute to 22 ml. with distilled water.

4. Add 1 ml. HNO_3 and 1 ml. $AgNO_3$ in this order.

5. Mix by inverting Only Once and set in complete darkness for 30 min.

6. Balance Electrophotometer with distilled water in both tubes, using blue filter and 25 ml. cylindrical sample tubes.

7. Transfer sample to the Electrophotometer tube quickly with minimum exposure to light and read density on "A" scale. Read quickly without prolonged exposure of sample to the beam of blue light.

8. Compare the scale reading with a calibration chart made from identical determinations of standard chloride solutions.

9. Make a blank run on all reagents and subtract from reading of step (8) or plot data of standard runs to include the chlorides of the blank, in which case the reading may be taken directly from the curve. However a new curve must be made when reagents change.

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10. To calculate parts per million (ppm.) of chlorides, divide answer in micrograms by volume of sample.

$$ppm. = \frac{\text{Micrograms Cl}}{\text{Volume of Sample}}$$

$$\% = \frac{\text{Micrograms Cl}}{\text{Volume X 10,000}}$$

Formaldehyde Analysis

Schiff's Reagent: Bubble sulfur dioxide into 100 cc. of water for about 5 minutes and determine the amount absorbed by the increase in weight of the solution. Dissolve 0.17 grams of fuchsin in 50 ml. of water in a 250 ml. volumetric flask. Add a volume of sulfur dioxide solution corresponding to 0.60 grams of sulfur dioxide and let stand for 1 hour with frequent shaking. The color should disappear. Dilute to volume and for very small amounts of aldehyde use within 6 hours. For larger amounts it may stand several days. Some excess of sulfur dioxide must be present but the smaller the excess the more sensitive the reagent.

Standard: Prepare a standard solution of formaldehyde in water for use with aqueous samples. A suitable standard is the commercial 37% solution of which 2.7 ml. is diluted to 1000 ml. and therefore contains approximately 0.1 mg of formaldehyde per ml. For accurate work standardize by iodine titration. Then further dilute as necessary.

Procedure: Add 2 ml. of Schiff reagent to test cup. Add sample and dilution water (total 10 ml.) to the reagent. Mix as quickly as possible and compare after 3 minutes.

Unknown: 10 cc sample
Add 0.3 cc Schiff's reagent. Let set well stoppered for 1 hour.
Determine optical density against blank.

From: Colorimetric Methods of Analysis
Snell and Snell (Page 58, Vol. 2)

Materials

Trade Name	Identity	Use	Manufacturer
Aroclor	Chlorinated diphenyl	Dye Solvent	Monsanto Chemical Co.
Coacervate emulsion		Emulsion of colorless dye dissolved in oil.	Natl. Cash Register Co.
Formaldehyde		Hardening agent used in emulsion	Natl. Cash Register Co.
Polyco 296M	Sodium salt of acrylic acid co-polymer	Adhesive	Polymer Chemical Co.
Solka floc	Ground cellulose	Anti-smudge agent	Brown Co.
Stayco M	Chlorinated starch	Adhesive	A. E. Staley Mfg. Co.