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A Comparison of the Use of the Plastic Membrane Vs. the Glass-Fiber Filter in Handling Aqueous Samples: Speed, Cost, and Data

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OBJECTIVE:

The purpose of the present study was to investigate which type of filter--the plastic membrane or the glass-fiber filter--is more suitable for the filtration of a wide variety of aqueous samples. The following discussion compares the speed, cost, and accuracy of the two methods of filtration.

INTRODUCTION:

Within the past water year the spectrographic laboratory analyzed a total of 956 samples. Because our interest lies mainly with those trace elements in solution, all suspended matter must be removed before the actual analysis is performed. This filtration step is frequently a time consuming operation as well as an expensive one when several plastic membranes are required. Thus, an improved method of filtration would be desirable.

Prior to the completion of this study, the procedure employed allowed the suspended material to settle before filtering thru a plastic membrane with a pore size of 0.45 micron. In this way the clear supernatant could be decanted from the main portion of suspended material.

With many samples, however, a very fine material remained in suspension which clogged the membrane pores quite rapidly. With these samples, it was not uncommon to use as many as four to six filters, especially if large volume samples were required by the spectrographic procedure. In addition to the cost of the filters, the man-hours required to process a sample became significant. Thus, any improvement that would reduce the time of sample treatment or analysis was desirable.

Recently, a new type of filter, the glass-fiber filter, has been introduced on the market. It is reported that because of its larger pore size, this filter does not clog as easily. Also, its cost is half that of the membrane. The glass-fiber filter is now being used by this laboratory except when suspended solids are to be analyzed.

EXPERIMENTAL AND RESULTS:

During the first phase of the study, duplicate 250 ml portions of five samples were taken for comparison. The samples were chosen such that a wide range of turbidities would be represented. One aliquot of each sample was filtered thru a single glass-fiber filter, while its 250 ml counterpart was passed thru a single plastic membrane. The time required for each filtration was recorded. Comparison of the total times of 66 minutes with plastic membranes and 49 minutes with glass-fiber filters, as derived from Table I, shows a savings in time of approximately 25% when glass-fiber filters are used in place of plastic membranes. Moreover, many actual samples require 500 ml and often 1 liter for analysis; thus, the times listed in Table I would be much greater if actual sample requirements were considered.

Table I also lists the number and cost of filters required to filter a 250 ml sample. Filters were changed when the filtrate slowed down to less than several drops per minute. The total cost of the plastic membrane used to filter the five aliquots was $2.16 while the cost of the glass-fiber filters totaled $1.00. The data presented shows a savings in cost of more than 50% when glass-fiber filters are substituted for plastic membranes. Again, it must be remembered that for actual samples two to four times this volume is actually processed.

While the first two points considered are significant, the analytical results are by far the most important. If the analyses do not agree, no amount of savings in cost would off-set the analysis error. Tables II thru VIII show the spectrographic results of these analyses for Zn, Fe, Mn, Ba, Sr, Na, and K. Comparison of these data show very good agreement between the two sets of samples. The other elements not listed—Cd, As, B, Mo, Al, Be, Ni, Co, V, and F—also showed excellent agreement. Five elements, Cu, Ag, Pb, Cr, and P, showed some lack of reproducibility, but these inconsistencies are believed to be within the range of experimental error and not great enough to prevent the adoption of the glass-fiber filter for routine use.

DISCUSSION:

Table I shows that the glass-fiber requires less time and fewer filters to process equal volumes of a particular composite as with the plastic membrane. Since most of our samples contain large amounts of suspended matter, filtration can be a very time consuming operation. This is a very important consideration since a savings in time means a savings in money also. On the basis of $3.61/hour or approximately $.06/minute the savings in time amounts to 16 minutes on this series of five 250 ml filtrations, or approximately $1.00. On the basis of this study, the following savings can be extrapolated. On an annual basis, assuming 800 ml volumes on the average for approximately 700 samples, about $450.00 could be saved.

In addition, millipore membranes cost $.18 each while glass-fiber filters cost $.10 each. During the past water year, approximately 700 of the 956 samples needed filtering. This required 1400 plastic membranes at $.18 each for a total of $252.00. Had glass-fiber filters been used only 750-800 would have been required at $.10 each for a total of \$75.00-80.00. Thus, \$175.00 could have been saved in materials in addition to \$450.00 salary-wise for a total of \$625.00.

Spectrographic results showed very good agreement between the two sets of samples for the majority of elements. While five elements did show some lack of reproducibility, these inconsistencies were small and considered to be within the range of experimental error.

CONCLUSION:

From the data presented, it can be concluded that the glass-fiber filter is as efficient in our work as the plastic membrane. Because the glass-fiber filter is faster, less expensive and just as accurate, it is recommended that for all future samples, the glass-fiber filter be used in place of the plastic membrane except in those instances where suspended solids are to be analyzed.

Table I

Station	St. Joseph	Shiprock	Loma	Cairo	Philadelphia
Turbidity in Jackson Units	470	255	180	98	25
Time (in Minutes) to Filter 250 ml of a Sample Without Changing the Filter: Plastic/G.F.	23/21	17/13	17/11	8/4	1/.2
Number of Filters Used to Filter 250 ml of a Sample: Plastic/G.F.	4/3	3/2	2/2	2/2	1/1
Cost to Filter 250 ml of a Sample: Plastic/G.F.	$.72/.30	.54/.20	.36/.20	.36/.20	.18/.10

Table II

Zinc

Station No.	PPB Plastic Membrane	PPB Glass-Fiber
15	18	12
20	30	<30
21	<15	<13
31	<46	60
35	30	46
40	<16	<15
57	4	7
66	14	14
97	16	30
116	7	6
127	<30	<30
130	<14	16

Table III

Iron

Station No.	PPB Plastic Membrane	Glass-Fiber
15	5	<4
20	8	8
21	<8	9
31	<12	14
35	<7	12
40	<8	<8
57	5	6
66	2	2
97	21	17
116	5	7
127	<8	24
130	<7	<7

Table IV

Manganese

	PPB	
Station No.	Plastic Membrane	Glass-Fiber
15	4.3	<4.0
20	<4.5	<4.5
21	<7.5	<6.5
31	<6.9	9.2
35	<3.9	5.2
40	<4.8	<7.5
57	<1.7	<1.7
66	<1.5	<1.5
97	<1.3	<1.3
116	<2.3	2.5
127	<4.5	<4.5
130	<7.0	<7.0

Table V

Barium

Station No.	PPB Plastic Membrane	PPB Glass-Fiber
15	18	17
20	75	62
21	59	63
31	67	81
35	44	61
40	34	48
57	11	19
66	8	11
97	14	15
116	17	23
127	32	39
130	36	44

Table VI

Strontium

Station No.	PPB Plastic Membrane	PPB Glass-Fiber
15	81	67
20	140	150
21	141	143
31	334	391
35	143	169
40	165	177
57	12	19
66	15	13
97	36	28
116	46	44
127	255	255
130	150	172

Table VII

Sodium

Station No.	PPB Plastic Membrane	PPB Glass-Fiber
15	6.0	6.0
20	24	24
21	20	20
31	63	64
35	20	20
40	25	25
57	5.0	5.0
66	1.0	1.0
97	2.0	2.0
116	7.0	7.0
127	19	19
130	20	20

Table VIII

Potassium

Station No.	PPB Plastic Membrane	Glass-Fiber
15	0.8	0.8
20	4.1	4.1
21	4.0	3.8
31	5.6	5.6
35	3.5	3.3
40	3.8	3.6
57	1.0	1.0
66	0.2	0.2
97	0.6	0.7
116	0.9	1.1
127	4.7	4.7
130	3.2	3.1