

THE CORRELATION OF HYDROPHILE - LIPOPHILE BALANCE OF FILTERS WITH VIRUS  
DESORPTION

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ABSTRACT

The rise of water and rise of carbon tetrachloride on positively charged microporus filters were determined. The percentage of rise of carbon tetrachloride/rise of water was determined after both solutions had risen for 4 minutes. The values obtained were found to correlate well with previous measurements of the contact angle of carbon tetrachloride on water saturated-filters and with results of studies on the effect of detergents on elution of viruses adsorbed to the filters. With relatively simple measurements, it is possible to determine the relative hydrophilic-lipophilic balance of microporus filters.

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filters have been used to recover viruses. Studies on virus adsorption to microporous filters were used (1,2,3). These filters have (5) and require the addition of relatively such as magnesium or aluminum chloride to to pH 3.5 to promote virus adsorption microporous filters that have net positive at pH values near neutrality have been (5,6,7). Virus adsorption to positively of added salts and with little or no Although the positively charged filters ar in their charge characteristics and in they differed significantly in the virus because of differences in the strength of and the filters (6). We found that this phile - lipophile balance (HLB) of the of the filters by measuring the contact the water-soaked filters and by measuring carbon tetrachloride/rise of water on owed a correlation between the effects of of adsorbed viruses and the HLB of the s study and their sources are as follows: ose/surface modified resin) and Zeta plus th/charge modified resin) AMF Cuno, Inc., ylon 66, polyamide resin), Pall Trinity

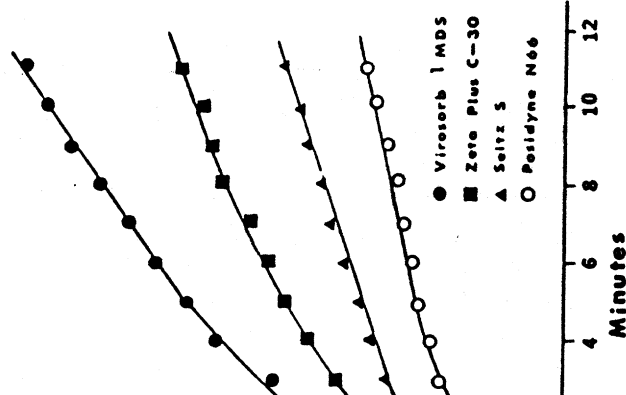
Micro Corp., Cortland, N.Y.; Seitz S (asbestos-cellulose), Republic Filters, Milladale, Conn.

Capillary Rise Measurements. Filters were cut in strips measuring 20 x 1 cm. These strips were then dipped in distilled water or carbon tetrachloride to a depth of one cm. The time at which the strip was dipped in the liquid was taken as the zero reference time. The rise of liquid on the filter was measured at one minute intervals for 10 to 12 min. The ratio of the distance travelled by carbon tetrachloride over that of water was determined for values taken after the liquids had risen for 4 minutes. The values shown in Figures 1 and 2 represent the mean values of at least three trials for capillary rise of water or carbon tetrachloride in four different positively charged filters.

Statistical analysis. Correlation coefficients ( $r$  values) were determined between the physical measurements of the filters (contact angle of carbon tetrachloride and the ratio of the rise of carbon tetrachloride/the rise of water) and measurements of virus desorption (the concentration of Tween 80 required for > 50% of virus elution and the percent of viruses eluted with 0.1% Tween 80).

#### RESULTS AND DISCUSSION

All filters can be considered as composites of hydrophilic and hydrophobic sites. The relative number of these sites influences the capillary rise of water and hydrophobic liquids on the filters. Water rose at different rates on the four filters tested (Figure 1). The relative order of the filters (highest to lowest rise of water) was as follows: Virosorb 1 MDS > Zeta plus C-30 > Seitz S > Posidyne N66. These results suggests that the 1 MDS filters are the most and the Posidyne N66 filters the least hydrophilic of the filters tested. Carbon tetrachloride also rose at different rates on the filters (Figure 2). The relative



water on positively charged filters.

rise of carbon tetrachloride) was as follows: Virosoorb 1 MDS > Posidyne N66. Since the rise of carbon tetrachloride are determined by the relative porosities, we decided to compare the values of rise of carbon tetrachloride for the height of the carbon tetrachloride.

rate of rise had reached a plateau (4 min.) after that time. It was assumed that by taking the rise of two liquids on the same filter, the permeability of the filter would be eliminated.

porosities and permeabilities could then be

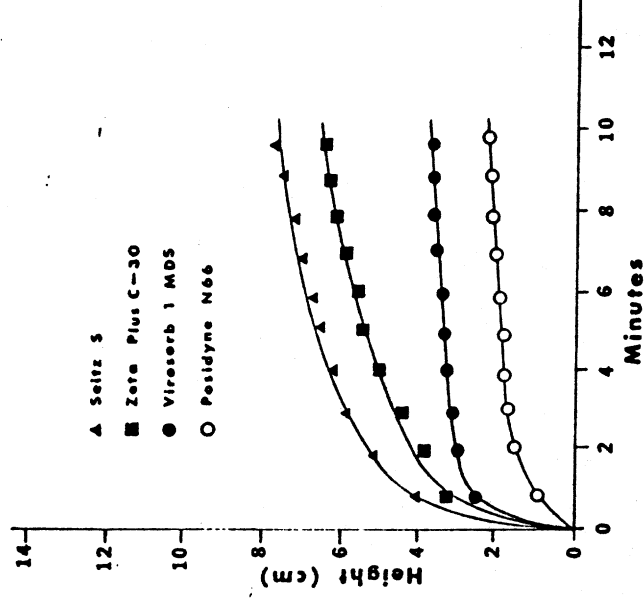


FIG. 2. Rise of carbon tetrachloride on positively charged filters.

compared on the basis of their interaction with water and a nonpolar liquid such as carbon tetrachloride.

Values for the ratios of the rise of carbon tetrachloride/rise of water are given in Table 1. These results show that this ratio was greatest for the Seitz filter (1.33) and lowest for the 1 MDS filter (0.44). Values for the Posidyne N66 and the Zeta plus C-30 (.50 and 0.76, respectively) were intermediary between the values for the Seitz and 1 MDS filters. These results indicate that the Seitz filters are the most and the 1 MDS filters the least hydrophobic filters among the filters used in this study. The Posidyne N66 and Zeta plus C-30 filters were less hydrophobic than the Seitz but more hydrophobic than the 1 MDS filters.

of carbon tetrachloride on water and for the influence of detergent sorbed viruses were obtained (6). It can be seen from the data that the ratio of rise of water with carbon tetrachloride; ratio of rise of water; the effect of detergent sorbed viruses, and the amount of virus sorbed, all appear to be greater the higher the concentration of the eluting solution. It appears that the greater the contact angle of a filter, the lower the contact angle of water, the lower the contact angle of carbon tetrachloride, the lower the ratio of capillary rise of carbon tetrachloride, and the greater the concentration of sorbed viruses. With a fixed surfactant concentration, the elution of virus in a 0.5 M EDTA solution, the elution of virus, the contact angle and capillary rise measurements are all greater than in a 0.5 M NaCl solution. The measurements of virus desorption are all greater in a 0.5 M EDTA solution than in a 0.5 M NaCl solution. The contact angle of carbon tetrachloride and the ratio of rise of carbon tetrachloride/rise of water. Higher contact angles were found between the measurements of virus desorption and the rise of carbon tetrachloride/the rise of water. The contact angle measurement may be substituted for the more direct measurement of the contact angle of a liquid on a filter in the form of the contact angle measurement on the charge on a filter and the contact angle of water on a filter. The ratio of rise of a nonpolar liquid/rise of water on microporous filters is a measure of the contact angle or characterizing the HLB of filters. The data confirm our hypothesis that hydrophobic

The Effect of Hydrophile - Lipophile Balance of Filters on Capillary Rise and Virus Desorption

TABLE I

Filter	Contact angle of carbon tetrachloride/water saturated filters	Rise of carbon tetrachloride/rise of water	Concentration of Tween 80 in 1 M NaCl required to elute filters by 0.1% Tween 80 + 0.5 M EDTA	Elution of 17 from filters by 0.1% Tween 80 + 0.5 M EDTA	% of adsorbed virus
Virosorb 1 MDS	151°	0.44	0	105 ± 20	
Posidyne N66	128°	0.50	0.001	78 ± 14	
Zeta plus C-30	128°	0.76	0.1	72 ± 2	
Seitz S	113°	1.33	>0.8**	22 ± 8	

\* - Data from Shields et al. (6)

\*\* - Less than 1% of the adsorbed virus could be eluted using 0.8% Tween 80; higher concentrations of Tween 80 were not soluble in 1 M NaCl.

interactions are important in certain virus - filter associations (8). The desorption of viruses from filters appears to depend upon the HLB of the filters, which is determined by the chemical composition of the filters.

#### ACKNOWLEDGEMENTS

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Data from Table 1.

0.88	0.94	Elution of T7 from filters by 0.1% Tween 80 + 0.5 M EDTA
		NaCl required to elute >50% of water-saturated filters
0.95	0.97	Concentration Tween 80 in 1 M Chloride/rise of water
		NaCl required to elute >50% of T7 adsorbed to filters
0.93	-0.96	Elution of T7 from filters by 0.1% Tween 80 + 0.5 M EDTA