CHAPTER V

RESULTS

The results of this study have been given under the following subsections:

5.1 Preliminary data of the fabrics used

5.2 Preliminary data of the cleaning agents used

5.3.1 General properties of cleaning agents used individually at different concentration

5.3.2 General properties of cleaning agents used in combination with different ratios and concentrations

5.4 Data on reflectance characteristics of scoured, soiled and washed samples

5.5.1 Cleaning efficiency (i.e. % soil removed) of soaps and detergents at different concentration

5.5.2 Cleaning efficiency (i.e. % soil removed) of soaps and detergents by combinations in different ratios and concentrations

5.6 Relationship between soil removal and properties of soaps and synthetic detergents

5.7 Design and fabrication of a small washing machine with stirrer from above and its application for the washing efficiency of soiled fabrics.

5.1 Preliminary data of the fabrics used

Three plain weave fabrics, commercially available, were used in the study; one was cotton fabric, second was polyester/ cotton blend fabric and the third was polyester fabric. The preliminary data of these fabrics on count, thickness and weight per unit area were determined. These have been shown in Table 5.

Table 5 Preliminary data of the fabrics used

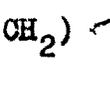
Fabric Code	Fibre Content	Wt/unit Area oz/sq.yd. (gm/sqm)	Fabric Count Yarns/inch (Yarns/cm) Warp	Weft	Thickness inch (cm.)
A	100% cotton	4.4 (145.2)	114 (45)	90 (36)	.0058 (.0147)
B	67% polyester 33% cotton	2.8 (98.4)	103 (41)	86 (34)	.0041 (.0104)
C	100% polyester	2.5 (88.2)	104 (41)	70 (28)	.0031 (.0078)

These three fabrics (namely a natural (cotton), a manmade (polyester) and their blend) were so chosen as they are common in clothing and undergo the maximum laundering in everyday use. From the above table it was seen that they were equivalent in their data, the fabric A being somewhat heavier as compared to other two, but was open as others.

5.2 Preliminary data of the cleaning agents used

Two soaps and three synthetic detergents were used in this work. Their preliminary data has been given in Table 6.

Table 6 Preliminary data of soaps and synthetic detergents used

Sr. No.	Name	Type and Nature	Chemical Composition
1	501 Bar soap	Soap Anionic	Sodium salt of a fatty acid or acids
2	Sodium oleate	Soap Anionic	$CH_3(CH_2)_7CH = CH(CH_2)_7COONa$
3	Teepol Secondary alkyl sulphate	Synthetic detergent Anionic	$CH_3(CH_2)$ 
4	Sodium lauryl sulphate	Synthetic detergent Anionic	$C_{12}H_{25}OSO_3Na$
5	Lissapol N nonphenol/ ethylene oxide	Synthetic detergent Nonionic	$C_9H_{19}C_6H_4(CH_2CH_2O)\ CH_2CH_2OH$

1 and 3 were purified
Others were pure as such

Two anionic soaps - one commercial and one pure product, two anionic synthetic detergents, one commercial and one pure and a nonionic synthetic detergent were taken as representatives for soaps and synthetic detergents.

The pH of the solutions of the soaps and synthetic detergents have been given in Table 7.

Table 7a pH of soaps and synthetic detergents at different concentrations

Conc. g/l	Purified 501 bar soap	Sodium oleate	Purified Teepol	Sodium lauryl sulphate	Lissapol N
1.0	7.9	8.2	7.0	8.2	7.2
2.0	8.2	8.2	7.6	8.2	7.2
3.0	8.2	8.5	7.9	8.5	7.2
4.0	8.5	8.5	7.9	8.5	7.5
5.0	8.5*	8.5	7.9**	8.5	7.6

Water - 7.5 pH

* Commercial 501 bar soap 10 pH

** Teepol 7.0 pH

Table 7b pH of the combination of soap and synthetic detergents at different concentrations and ratios

Per cent Ratio		I			II			III			IV		
Soap :	Synthetic Detergent	1.25 g/l	2.5 g/l	5.0 g/l	1.25 g/l	2.5 g/l	5.0 g/l	1.25 g/l	2.5 g/l	5.0 g/l	1.25 g/l	2.5 g/l	5.0 g/l
100 :	0	7.9	8.2	8.5	8.2	8.5	8.5	7.9	8.2	8.5	7.9	8.2	8.5
75 :	25	7.6	8.0	8.2	8.0	8.2	8.0	7.9	8.2	8.5	7.9	8.2	8.5
50 :	50	7.6	8.0	8.2	7.6	8.2	7.9	8.0	8.2	8.5	7.9	8.0	8.5
25 :	75	7.5	7.9	7.9	7.5	8.0	7.9	8.0	8.2	8.5	7.6	7.6	7.9
0 :	100	7.2	7.9	7.9	7.2	7.9	7.9	8.2	8.2	8.5	7.2	7.2	7.6

I Purified 501 bar soap + Purified Teepol
II Sodium oleate + Purified Teepol
III Purified 501 bar soap + Sodium lauryl sulphate
IV Purified 501 bar soap + Lissapol N

5.3.1 General properties of cleaning agents used individually at different concentration

The complete evaluation of a surface active agent (particularly a detergent substance) includes tests to measure the primary effects such as soil removal, soil redeposition or its prevention. Several other factors also affect the general performance and acceptability of the substance. Some of these are surface tension, wettability, wetting time, emulsification and foaming power.

The general properties that were studied were thus surface tension, wettability, wetting time, emulsification and foaming power. Their importance along with the data have been discussed below.

Surface tension

Surface tension is an important property of an agent that makes it surface active. No direct relationship between soil removal and surface tension has been reported, but surface tension does help in the first step of detergency, namely, wetting of the fabric. This helps to dislocate soil/foreign matter from soiled fabrics. Low surface tension can also improve the wetting time of the detergents in actual laundry process. Burick (37), in the course of studying the rate of surface tension lowering, has noted that the factors which increase the rate of lowering of surface tension also increases its detersive power.

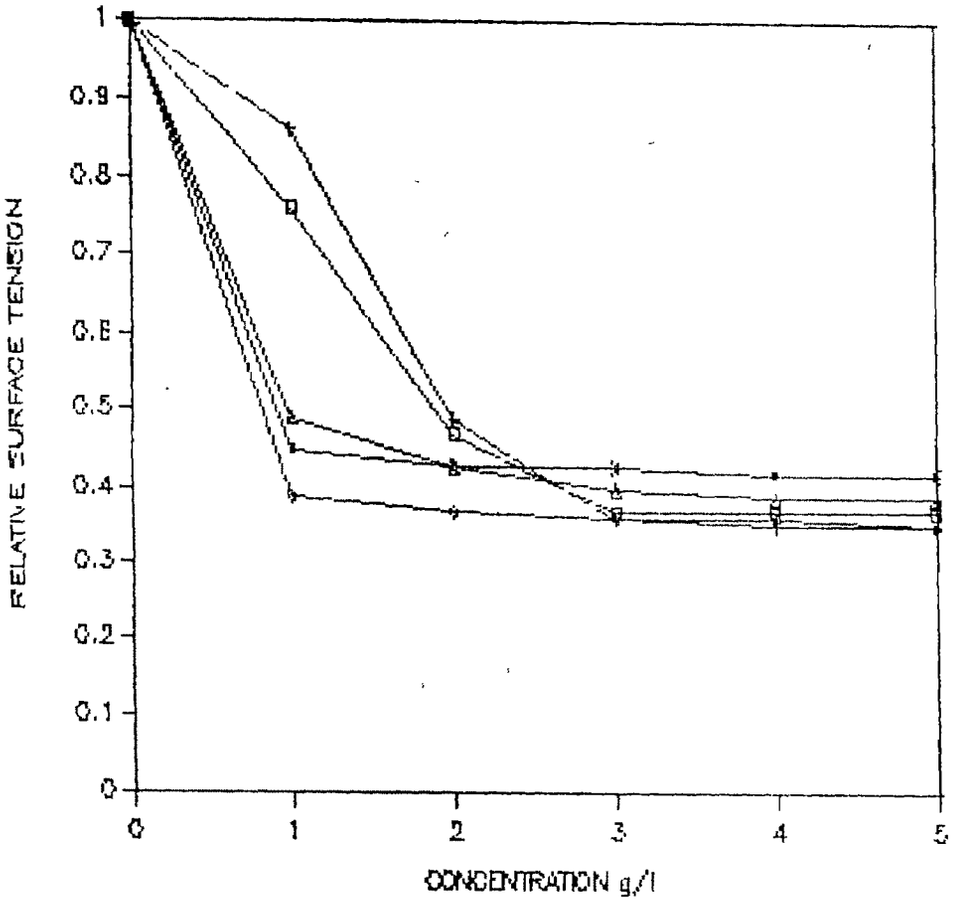
The surface tension was thus studied for the soaps and the synthetic detergents at different concentrations. It was determined by the drop method (page 63) and was calculated as relative surface tension (and also as surface tension in dynes/cm). The data has been given in Table 8a and 8b and illustrated in Graph 1a and 1b.

Table 8a Relative surface tension of soaps and synthetic detergents at different concentrations

Agent: Conc. g/l	Relative surface tension				
	Purified Bar soap	Sodium Oleate	Purified Teepol	Sodium Lauryl Sulphate	Lissapol N
1.0	0.76	.86	.39	.49	.45
2.0	0.47	.49	.37	.43	.43
3.0	0.37	.36	.36	.40	.43
4.0	0.37	.35	.36	.39	.42
5.0	0.37	.35	.35	.39	.42

Relative surface tension of water = 1

GRAPH Ia- RELATIVE SURFACE TENSION OF SOAPS & SYNTHETIC DETERGENTS VERSUS CONCENTRATION.



(□) Purified 501 Bar Soap (+) Sodium Oleate
(◇) Purified Teepol (△) Sodium Lauryl Sulphate
(*) Lissapol-N

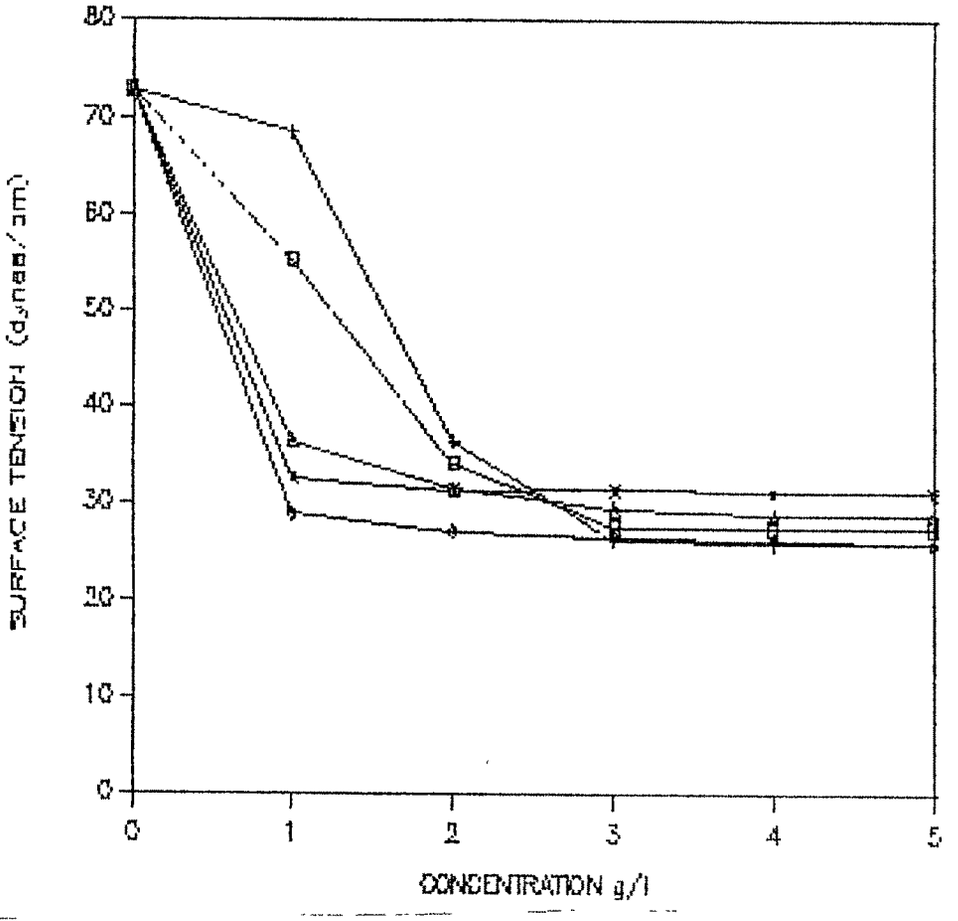
Table 8b Surface tension in dynes/cm of soaps and synthetic detergents at different concentrations

Agents: Conc. g/l	Surface tension (dynes/cm) Purified Bar soap	Sodium Oleate	Purified Teepol	Sodium Lauryl Sulphate	Lissapol N
1.0	55.43	68.53	28.86	36.52	32.61
2.0	34.15	36.52	27.11	31.47	31.29
3.0	27.56	26.31	26.60	29.38	31.47
4.0	27.44	25.89	26.42	28.79	31.21
5.0	27.36	25.89	25.89	29.01	31.11

Surface tension of water = 72.80 dyne/cm

It was seen that at the higher concentrations the surface tension was of the similar low values for both soaps and the synthetic detergents. The surface tension of the synthetic detergents came down to its low value from the concentration of 1.0 g/l. Whereas for the soaps after 3.0 g/l there was no further decrease in its value. Therefore the decrease was quite rapid for the synthetic detergents and was rather slow for the soaps.

GRAPH Ib- RELATIVE TENSION IN dyne/cm OF SOAPS & SYNTHETIC DETERGENT VERSUS CONCENTRATION.



(□) Purified 501 Bar Soap
(◇) Purified Teepol
(+) Sodium Oleate
(△) Sodium Lauryl Sulphate
(*) Lissapol-N

This led to conclude that a good wetting of a surface can be achieved at a surface tension of 30 ± 5 dynes/cm (lowering its relative surface tension to below half its value). It is also of interest to note that the surface tension of nonionic detergent (Lissapol N) though equivalent to others is still slightly above throughout the concentrations studied.

Percentage wettability and wetting time

The first step in detergency is good wetting and if the fabric to be laundered is wetted quickly and properly can the detergent molecule act on the adhered dirt particles and help to remove it. Therefore percentage wettability and wetting time are also important to study and could play an important role in understanding the removal of soil. The wettability and wetting time were thus studied and are discussed below.

To study these properties for the soaps and the synthetic detergents, grey fabric was used to serve as a control fabric. Wettability is the amount of the solution absorbed by wetting and retained after centrifuging. The wetting and centrifuging done as per standard procedure (Chapter IV p64) while the rate of wetting is the time (in secs) taken for a drop of the solution to completely penetrate the fabric as observed from the front (Chapter IV p64).

The data for the above is given in Table 9 and has been illustrated in Graph 2.

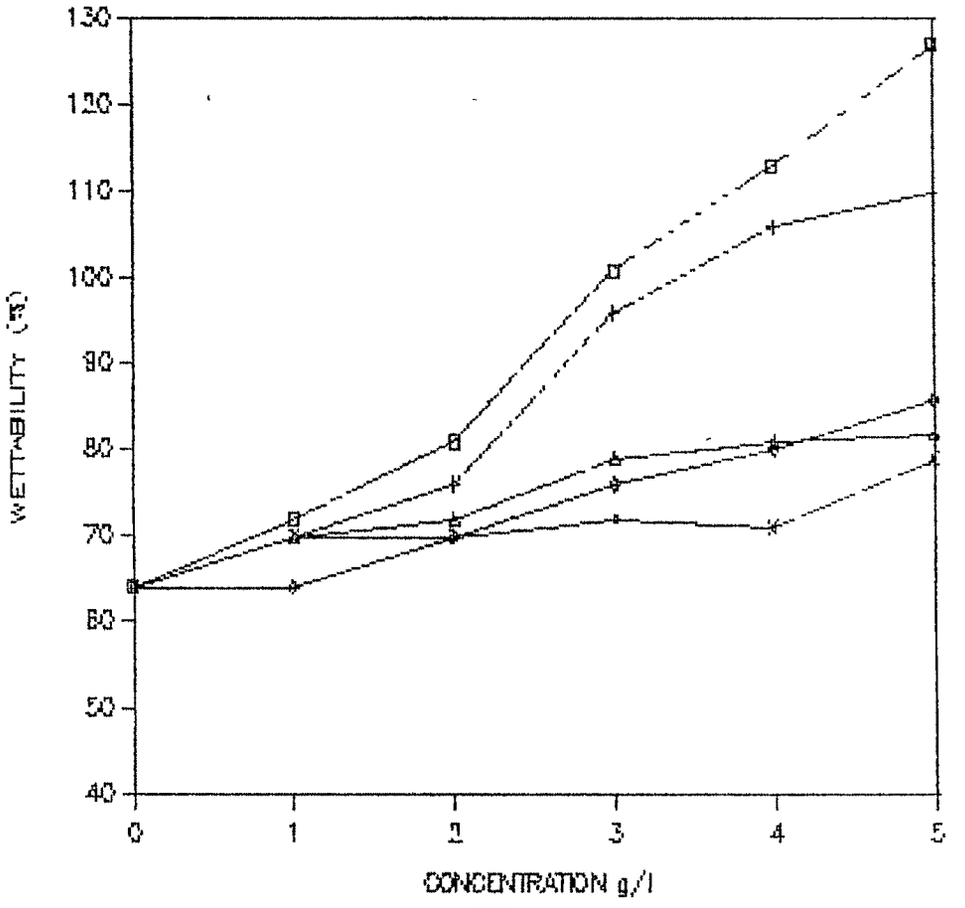
Table 9 Wettability characteristics of soaps and synthetic detergents at different concentrations

Agents: Conc. g/l	Wettability (%) Purified 501 Bar soap	Sodium Oleate	Purified Teepol	Sodium Lauryl Sulphate	Lissapol N
1.0	72.0	70.3	64.1	70.0	70.4
2.0	81.0	76.5	69.9	72.1	70.5
3.0	101.3	95.8	75.8	78.7	72.7
4.0	113.5	106.3	80.5	80.7	70.7
5.0	127.7	109.8	85.8	82.2	79.5

% wettability of water = 64

It has been seen that percentage wettability increases, gradually with synthetic detergents but quite rapidly with soaps, with increase in concentration. The rise in percentage wettability is specially noticeable for soaps after 2.0 g/l concentration. For the anionic synthetic detergents the increase is a little, though not much; while for the nonionic synthetic detergent not much of increase in wettability with the increase in concentration was noticed.

GRAPH 2- PERCENTAGE WETTABILITY OF SOAPS & SYNTHETIC DETERGENTS VERSUS CONCENTRATION



(□) Purified 501 Bar Soap (+) Sodium Oleate
(◇) Purified Teepol (△) Sodium Lauryl Sulphate
(*) Lissapol-N

Thus this may mean that soaps although anionic in nature, differ from the anionic detergents by retaining higher solution and this increase becomes steeper with increasing concentration. At around 5.0 g/l anionic and nonionic detergents have similar wettability values but soaps have considerably higher values.

In the case of soaps therefore, gradual lowering of surface tension, with increasing concentration (as noted on page 82) is associated with increasing wettability. It would be of interest to see its relation with any micelle tendency of soaps.

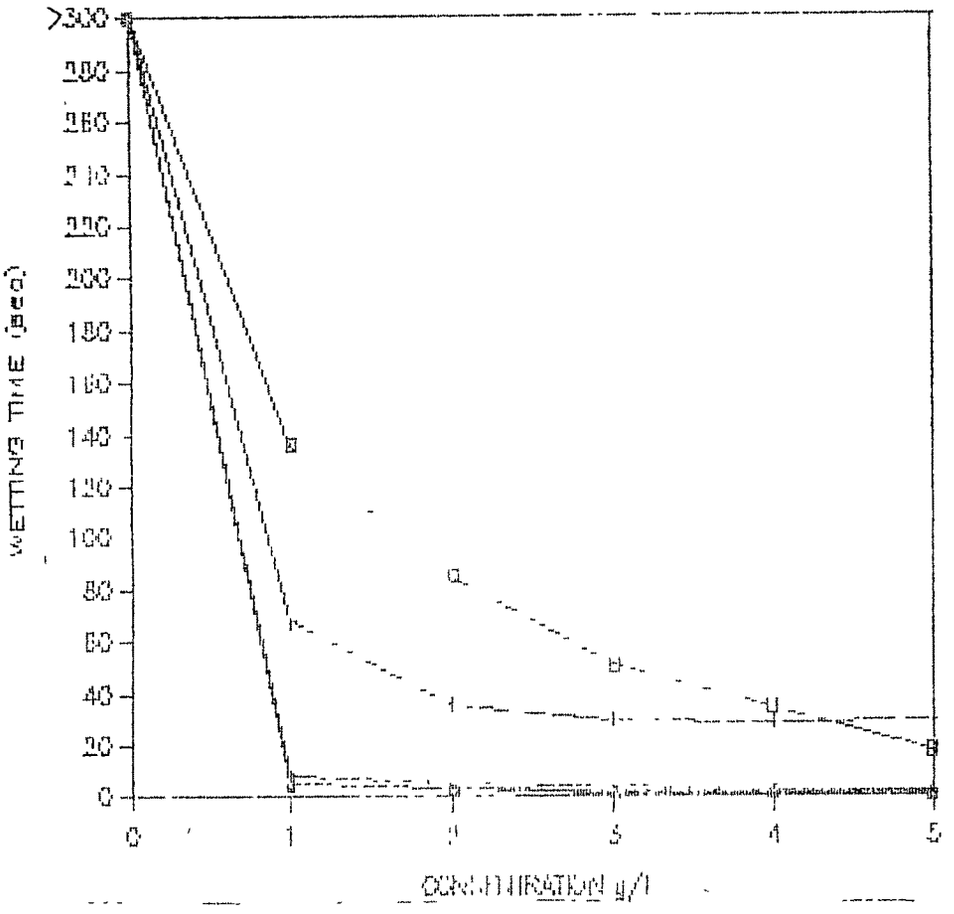
The rate of wetting was also studied for these cleaning agents and the data has been given in Table 10. In this the amount of time required for a drop of the test solution to penetrate a grey fabric was recorded.

Table 10 Rate of wetting of soaps and synthetic detergents at different concentrations

Agents / Conc. g/l	Wetting time (sec)				
	Purified 501 Bar soap	Sodium Oleate	Purified Teepol	Sodium Lauryl Sulphate	Lissapol N
1.0	136	68	5	5	8
2.0	85	36	3	3	5
3.0	51	30	1	2	4
4.0	35	29	1	2	2
5.0	18	30	1	1	2

Wetting time of water = > 5 mins.

GRAPH 3- OF WETTING OF SOAPS &
SYNTHETIC DETERGENTS VERSUS CONCENTRATION



(□) Purified 501 Bar Soap (+) Sodium Oleate
(◇) Purified Teepol (△) Sodium Lauryl Sulphate
(*) Lissapol-N

From the data on wetting time given in Table 10, it can be noted that the soaps have a slow rate of wetting, while the synthetic detergents have a rapid wetting ability. Even at higher concentration, the wetting time for soaps is about half a minute or so, that is why detergents are termed as wetting agents as well. Considering that if rapid wetting is associated with other cleaning properties, it would be worth to study how the two (one like soap and the other like synthetic detergent) in combination would behave since the concentration could supplement each others' properties.

The wetting time versus concentration have been illustrated in Graph 3; it was seen from this graph that the trend was similar to the graph (No.1 p 84) of the surface tension.

Emulsifying ability

Once the cleaning solution has entered the fabric to remove the dirt particles, which mainly constitute grease or oil, it is necessary to break it up or to emulsify it. Therefore it was important to study the emulsification ability for the various solutions used.

The emulsification ability was determined by shaking the test solution with the soil mixture. The method has been given in Chapter IV page 65. The data for the emulsification ability is given in Table 11a and 11b and illustrated in Graph 4.

Table 11a Emulsifying ability of soaps at different concentration

Agents:	Emulsifying ability (cm)					
	Pure 501 bar soap			Sodium oleate		
Conc. g/l	2 mins	5 mins	10 mins	2 mins	5 mins	10 mins
1.0	3.6	3.6	3.5	3.5	3.5	3.5
2.0	3.8	3.8	3.6	3.6	3.6	3.6
3.0	3.8	3.7	3.6	3.8	3.7	3.7
4.0	3.9	3.9	3.9	4.1	4.0	4.0
5.0	4.1	4.1	3.9	4.2	4.1	4.1

Table 11b Emulsifying ability of soaps at different concentration

Agents	Emulsifying ability (%)					
	Purified 501 bar soap			Sodium oleate		
Conc. g/l	2 mins	5 mins	10 mins	2 mins	5 mins	10 mins
1.0	8.6	8.6	0	4.3	0	0
2.0	47.1	37.1	18.6	18.6	8.6	8.6
3.0	37.1	22.9	18.6	37.1	32.9	22.9
4.0	61.4	57.1	51.4	85.7	75.7	71.4
5.0	85.7	80.0	65.7	94.3	90	85.7

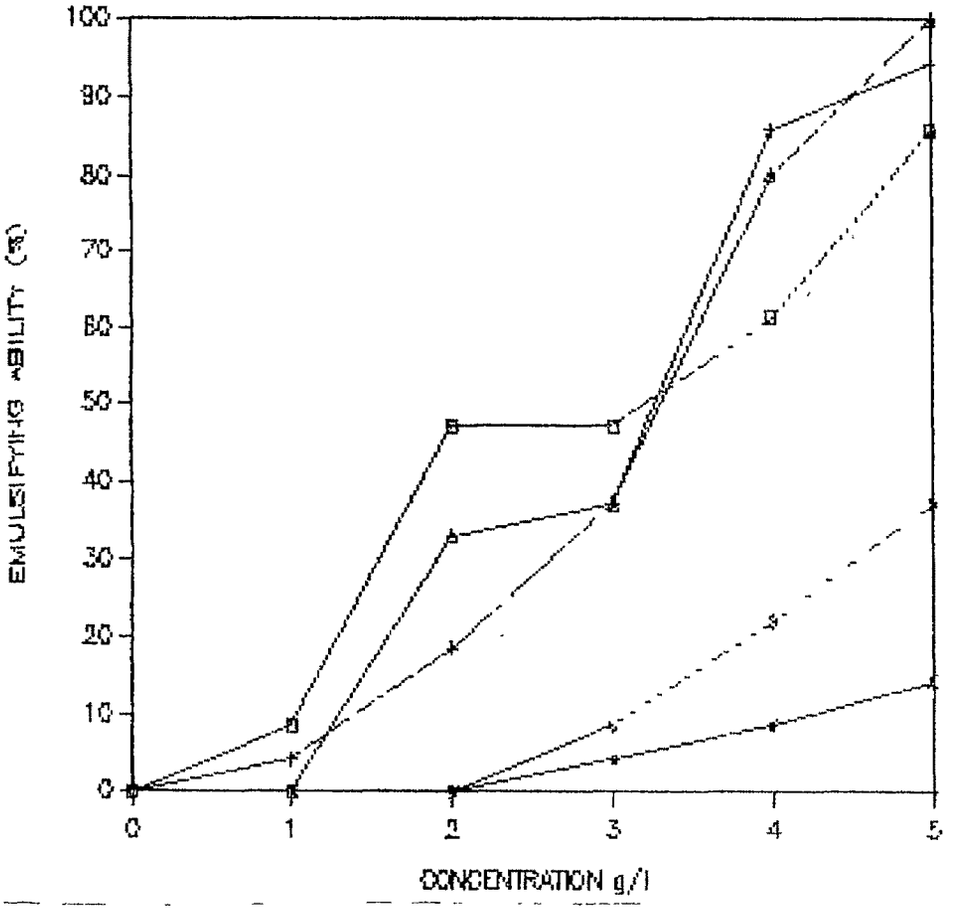
Table 12a Emulsifying ability (cm) of the synthetic detergents at different concentrations

Agents	Purified Teepol			Sodium lauryl sulphate			Lissapol N		
Conc. g/l	2 min.	5 min.	10 min.	2 min.	5 min.	10 min.	2 min.	5 min.	10 min.
1.0	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
2.0	3.5	3.5	3.5	3.7	3.6	3.6	3.5	3.5	3.5
3.0	3.6	3.5	3.5	3.8	3.8	3.6	3.5	3.5	3.5
4.0	3.7	3.6	3.6	4.1	4.0	3.9	3.6	3.6	3.5
5.0	3.8	3.7	3.7	4.2	4.2	4.2	3.6	3.6	3.6

Table 12b Emulsifying ability (%) of the synthetic detergents at different concentrations

Agents	Purified Teepol			Sodium lauryl sulphate			Lissapol N		
Conc. g/l	2 min.	5 min.	10 min.	2 min.	5 min.	10 min.	2 min.	5 min.	10 min.
1.0	0	0	0	0	0	0	0	0	0
2.0	0	0	0	32.9	14.3	8.6	0	0	0
3.0	8.6	0	0	37.1	37.1	18.6	4.3	4.3	0
4.0	22.0	14.3	8.6	80.0	75.4	61.4	8.6	8.6	4.3
5.0	37.1	22.9	22.9	100	100	100	14.3	8.6	8.6

GRAPH 4- EMULSIFYING ABILITY OF SOAPS & SYNTHETIC DETERGENTS VERSUS CONCENTRATION



(□) Purified 501 Bar Soap (+) Sodium Oleate
(◇) Purified Teepol (△) Sodium Lauryl Sulphate
(*) Lissapol-N

With the increase in concentration the emulsifying ability also increased. It was seen from the graph that the soaps and anionic synthetic detergent (Sodium lauryl sulphate) showed better emulsifying ability than Teepol and the nonionic synthetic detergent (Lissapol N).

Foaming power

The movement of cleaning solution and the garments during washing and the agitation associated with it causes formation of foam. The dirt that is emulsified gets mixed up with foam so often the cleaning efficiency could change.

Foaming power of the individual detergent at varying concentration was studied as the foam height noted after 30 sec, 2 min, 5 min and 10 min. Some references suggest that not only the emulsion but also the foam be stable and washed off without breaking. Hence these properties of cleaning agents indicate to their ability towards soil to get emulsified or foamed and emulsified. The procedure to determine these involves shaking with or without soil mixture and to assess the amount of emulsified layer or foam. The amount of foam formed and the stability of the foam so obtained has been given in Table 13a and 13b and illustrated in Graph 5.

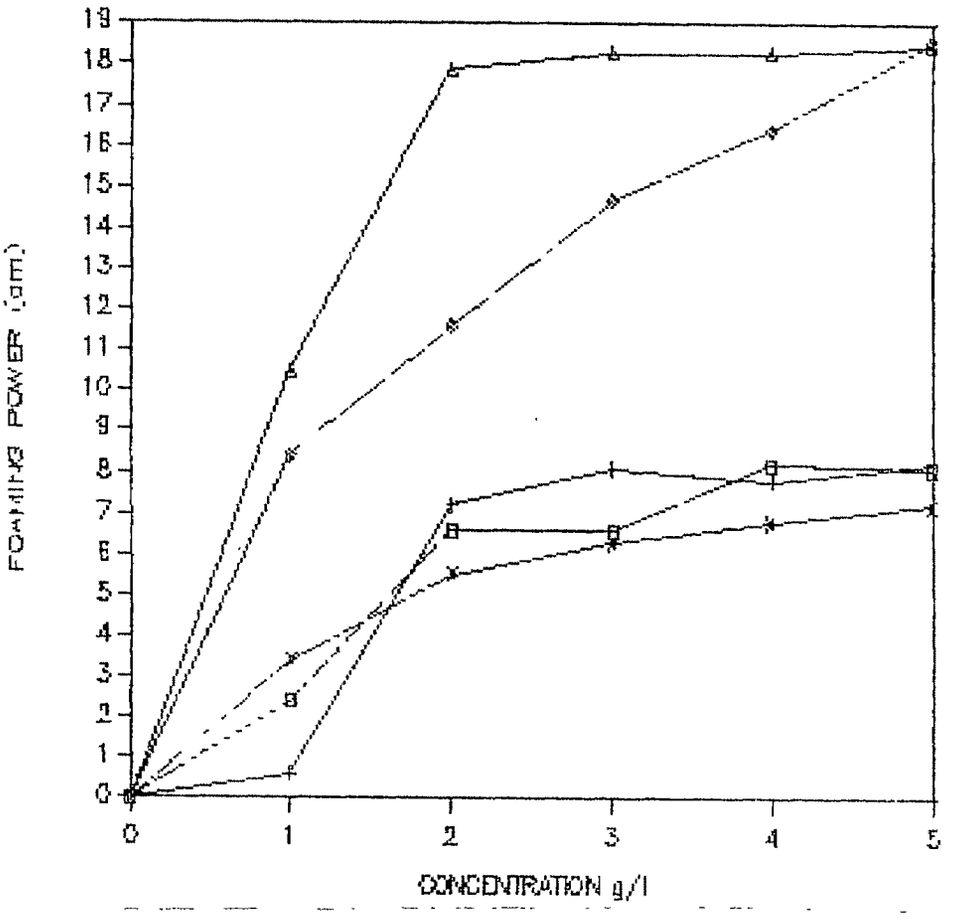
Table 13a Foaming power of the soaps at different concentration

Agents:	Foaming power (cm) Purified 501 bar soap				Sodium oleate			
Conc. g/l	30 sec.	2 min.	5 min.	10 min.	30 sec.	2 min.	5 min.	10 min.
1.0	3.2	2.4	1.7	1.3	1.0	0.6	0.6	0.6
2.0	7.7	6.6	6.3	5.5	7.5	7.2	6.7	6.4
3.0	7.7	6.6	6.4	6.0	8.6	8.1	7.8	7.6
4.0	8.7	8.2	7.8	7.8	8.3	7.8	7.5	7.3
5.0	8.6	8.1	7.8	7.6	8.7	8.2	7.7	7.3

Table 13b Foaming power of the synthetic detergents at different concentration

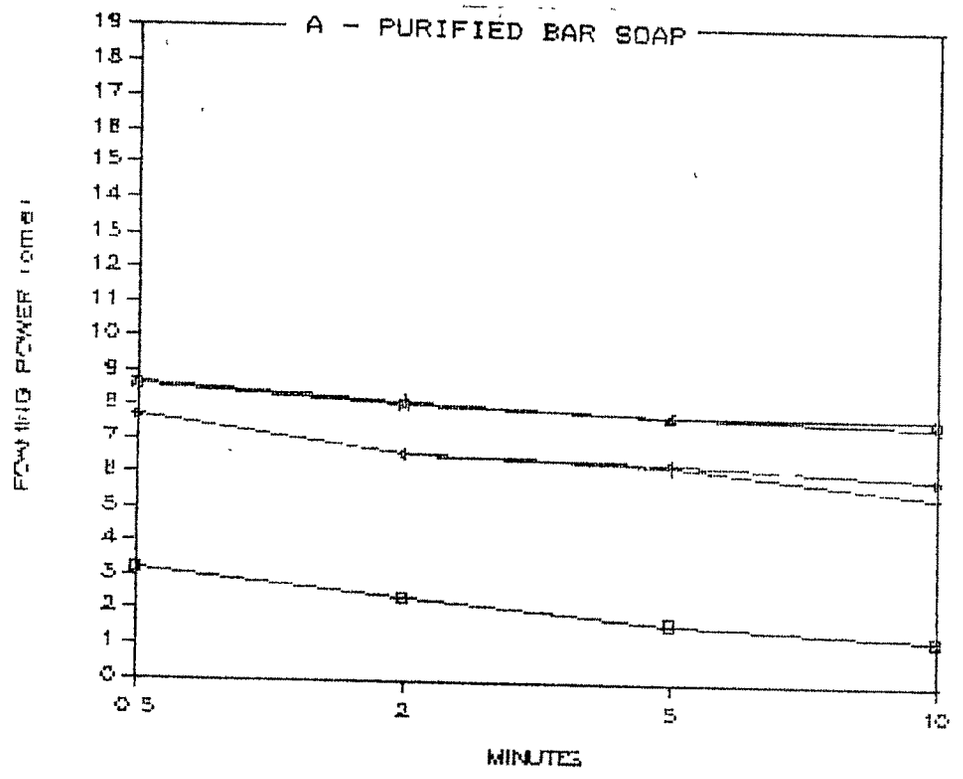
Agents	Foaming power (cm) Purified Teepol				Sodium Lauryl Sulphate				Lissapol N			
Conc. g/l	30 sec.	2 min.	5 min.	10 min.	30 sec.	2 min.	5 min.	10 min.	30 sec.	2 min.	5 min.	10 min.
1.0	8.4	8.4	8.1	7.9	11.7	10.5	10.2	10.1	3.4	3.4	3.2	3.1
2.0	11.8	11.6	11.1	11.0	18.5	17.9	17.4	16.5	5.6	5.5	4.8	4.3
3.0	15.9	14.7	14.6	14.3	19.3	18.3	17.6	16.5	6.7	6.3	6.2	5.9
4.0	17.3	16.4	16.0	15.6	19.2	18.3	17.5	17.1	7.2	6.8	6.5	6.0
5.0	19.2	18.6	17.9	17.6	19.6	18.5	17.5	16.9	7.5	7.2	6.7	6.1

GRAPH 5- FOAMING POWER OF SOAPS & SYNTHETIC DETERGENTS VERSUS CONCENTRATION

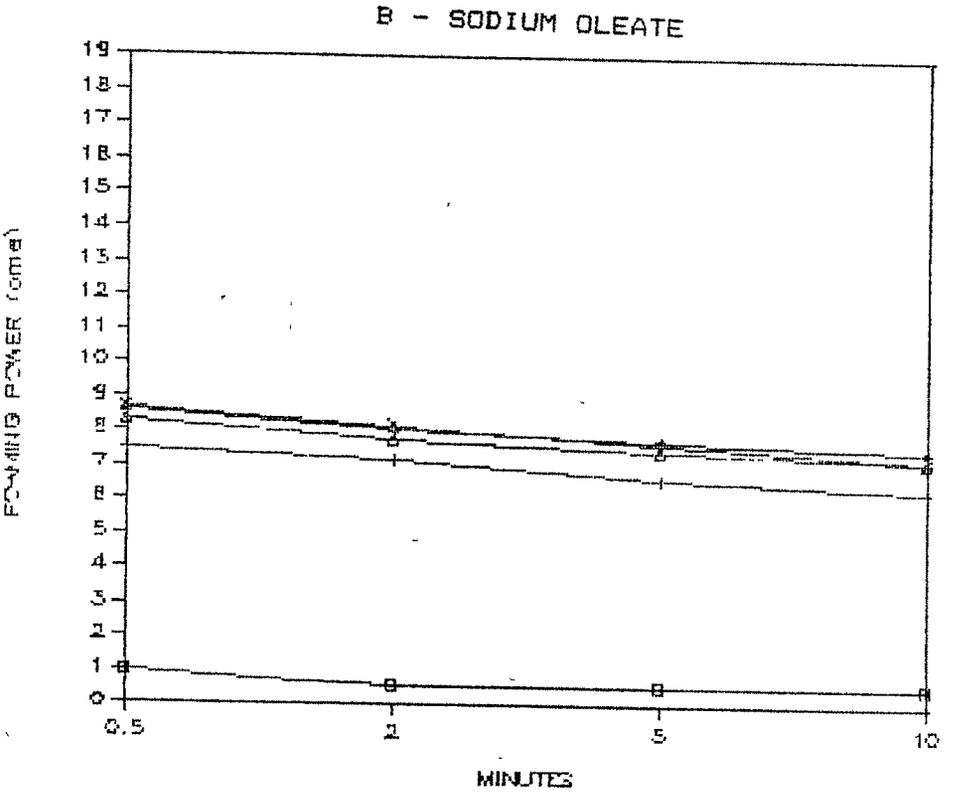


(□) Purified 501 Bar Soap (+) Sodium Oleate
(◇) Purified Teepol (△) Sodium Lauryl Sulphate
(*) Lissapol-N

GRAPH 6- STABILITY OF FOAM OF SOAP & SYNTHETIC DETERGENTS AT DIFFERENT CONCENTRATION

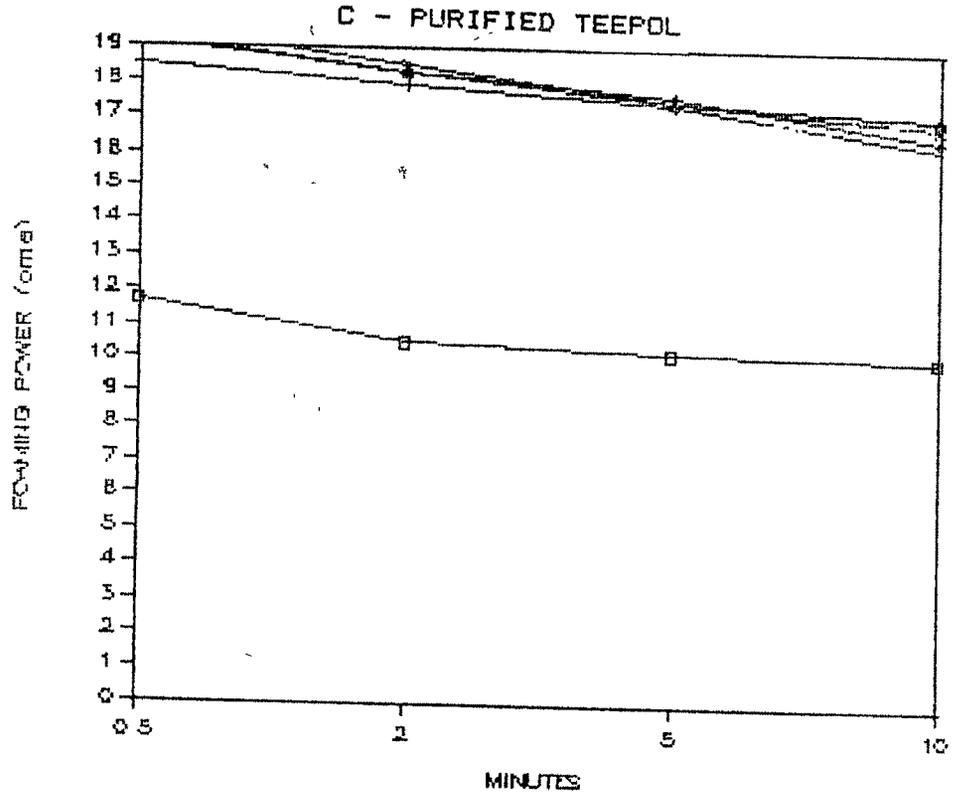


(□) 1.0 g/l
(+) 2.0 g/l
(◇) 3.0 g/l
(△) 4.0 g/l
(*) 5.0 g/l



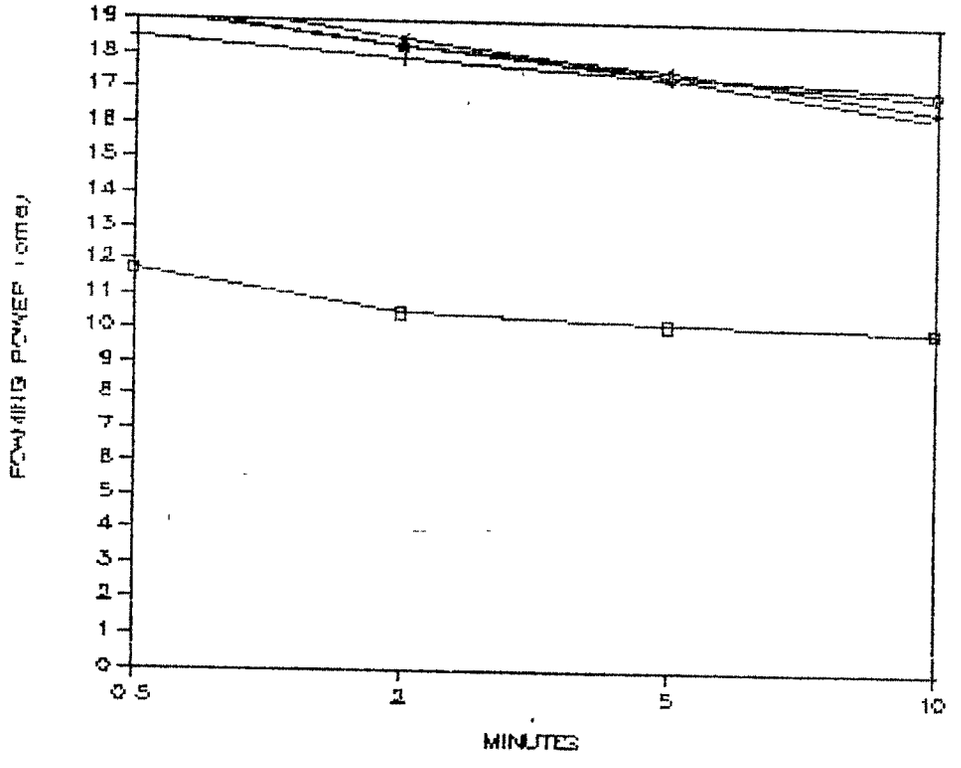
GRAPH 6- STABILITY OF FOAM OF SOAP & SYNTHETIC DETERGENTS AT DIFFERENT CONCENTRATION

C - PURIFIED TEEPOL

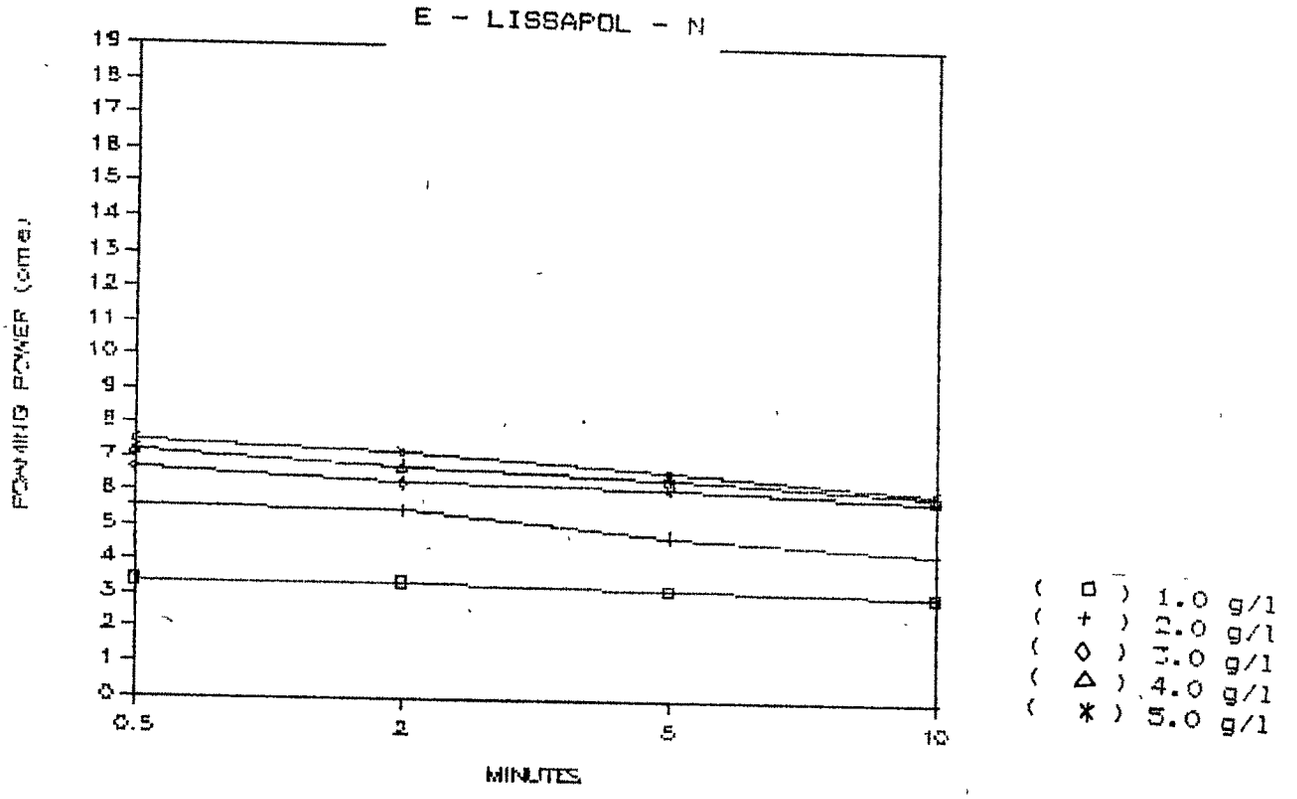


(□) 1.0 g/l
(+) 2.0 g/l
(◇) 3.0 g/l
(△) 4.0 g/l
(*) 5.0 g/l

D - SODIUM LAURYL SULPHATE



GRAPH 6- STABILITY OF FOAM OF SOAP & SYNTHETIC DETERGENTS AT DIFFERENT CONCENTRATION



It can be seen from the graph that the anionic synthetic detergents had very high foaming power and much higher than that of the soaps and the nonionic synthetic detergent. All solutions showed stability of foam after 2 mins. (Graph 6)

From the above properties studied it was seen that the soaps have better percentage wettability and emulsifying ability. The anionic synthetic detergents showed better surface tension, rate of wetting and foaming power. Sodium lauryl sulphate also showed good emulsifying ability. The nonionic synthetic detergent showed good rate of wetting.

From the above it is seen that soaps have certain advantages and synthetic detergents also have their advantages. So if the two were combined or used in mixture and their general properties (in combination) are studied, one would know which are the properties improved, and which are retained. This will help in their economical use for washing.

5.3.2 General properties of cleaning agents used in combination with varying ratios and concentrations

One soap and one synthetic detergent were studied in these combinations. Sodium oleate and sodium lauryl sulphate were limited to one combination for economy, while soap was in other combinations. These were chosen thus on the basis of common usage of each in the mixture and for their economical use in this work.

These four combinations were : I Purified 501 bar soap with purified Teepol, II Sodium oleate with purified Teepol, III Purified 501 bar soap with sodium lauryl sulphate, IV Purified 501 bar soap with Lissapol N. Concentrations used were 1.25, 2.5 and 5.0 g/l. The three per cent ratios in combinations 75:25, 50:50, 25:75 and 100% each were included for all solutions.

Surface Tension

The data for the relative surface tension (and surface tension in dynes/cm) for the four combinations has been given in Tables 14 to 17 and illustrated in Graphs 7 to 10.

Table 14a Relative surface tension of combination I (501 bar soap and Teepol) at varying ratios and concentration

Combination I Per cent ratio S_1 : d_1	Relative Surface Tension		
	1.25 g/l	2.5 g/l	5.0 g/l
100 : 0	.50	.48	.37
75 : 25	.47	.49	.37
50 : 50	.45	.48	.37
25 : 75	.42	.43	.40
0 : 100	.39	.37	.35

Relative surface tension of water = 1

S_1 - Purified 501 bar soap

d_1 - Purified Teepol

Table 14b Surface tension in dyne/cm of combination I (501 bar soap and Teepol) at varying ratios and concentration

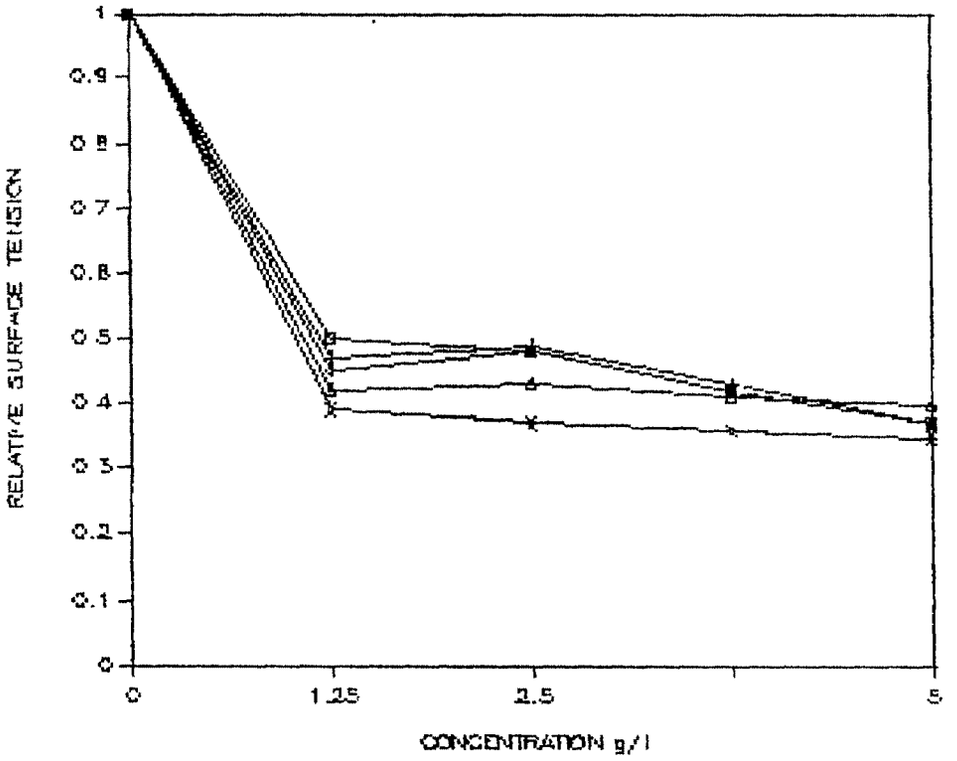
Combination I Per cent ratio S_1 : d_1	Surface Tension (dynes/cm)		
	1.25 g/l	2.5 g/l	5.0 g/l
100 : 0	36.40	34.98	27.36
75 : 25	34.57	35.62	27.36
50 : 50	33.26	35.07	27.17
25 : 75	30.96	31.73	29.23
0 : 100	28.32	27.36	25.89

Surface tension of water = 72.8 dynes/cm

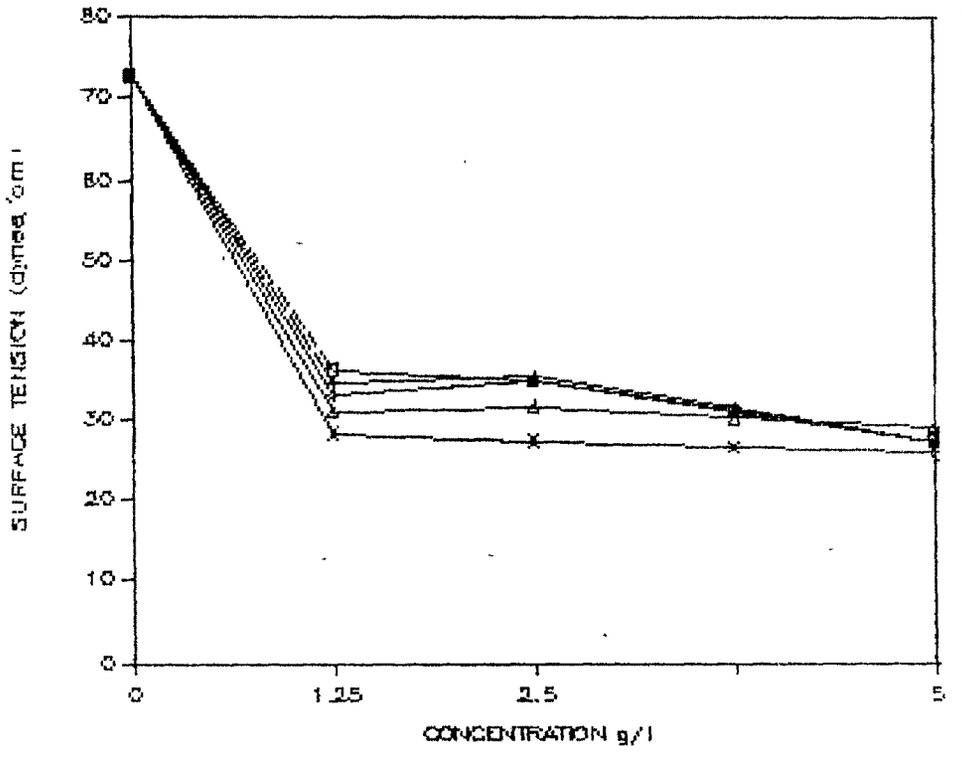
S_1 - Purified 501 bar soap

d_1 - Purified Teepol

GRAPH 7a- RELATIVE SURFACE TENSION OF COMBINATION I (501 BAR SOAP & TEEPOL) VERSUS CONCENTRATION



GRAPH 7b- SURFACE TENSION IN dynes/cm OF COMBINATION I (501 BAR SOAPS & TEEPOL) VERSUS CONCENTRATION



Combination I	
501 Bar Soap	: Teepol
100	: 0 (□)
75	: 25 (+)
50	: 50 (◇)
25	: 75 (△)
0	: 100 (✳)

Table 15a Relative surface tension of combination II (sodium oleate and Teepol) at varying ratios and concentration

Combination II Per cent ratio S_2 : d_1	Relative Surface Tension		
	1.25 g/l	2.5 g/l	5.0 g/l
100 : 0	.53	.43	.35
75 : 25	.44	.42	.37
50 : 50	.43	.41	.38
25 : 75	.41	.39	.41
0 : 100	.39	.37	.35

Relative surface tension of water = 1

S_2 - Sodium oleate

d_1 - Purified Teepol

Table 15b Surface tension in dyne/cm of combination II (sodium oleate and Teepol) at varying ratios and concentration

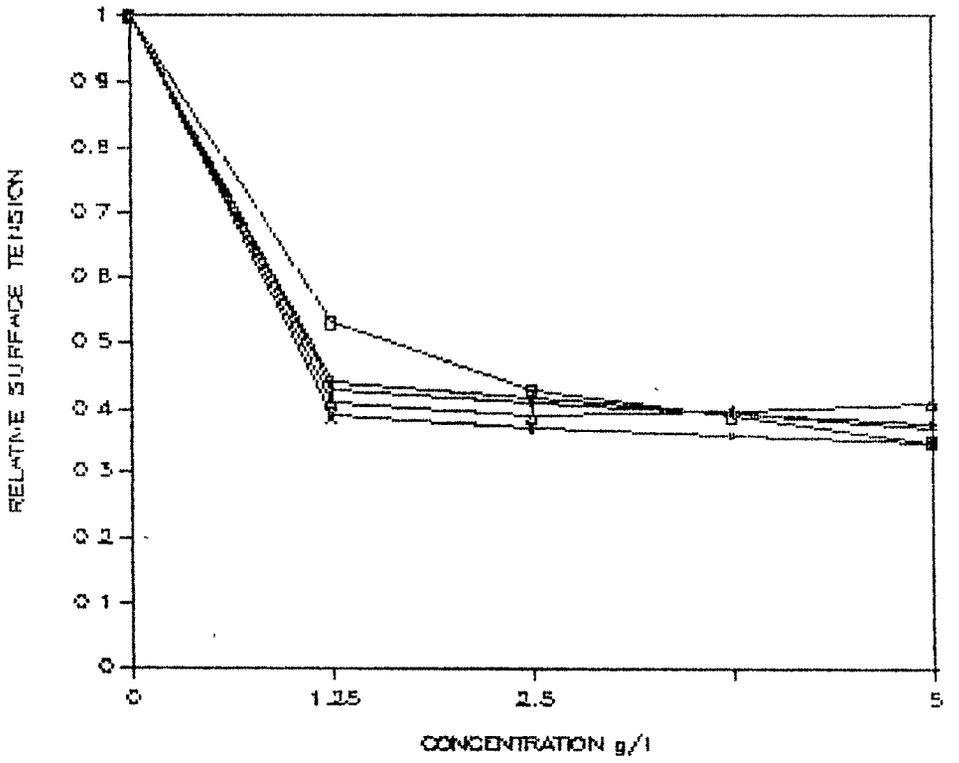
Combination II Per cent ratio S_2 : d_1	Surface Tension (dyne/cm)		
	1.25 g/l	2.5 g/l	5.0 g/l
100 : 0	38.89	31.80	25.89
75 : 25	32.53	30.86	27.05
50 : 50	31.73	29.91	27.95
25 : 75	30.14	28.51	30.30
0 : 100	28.32	27.36	25.89

Surface tension of water = 72.8 dynes/cm

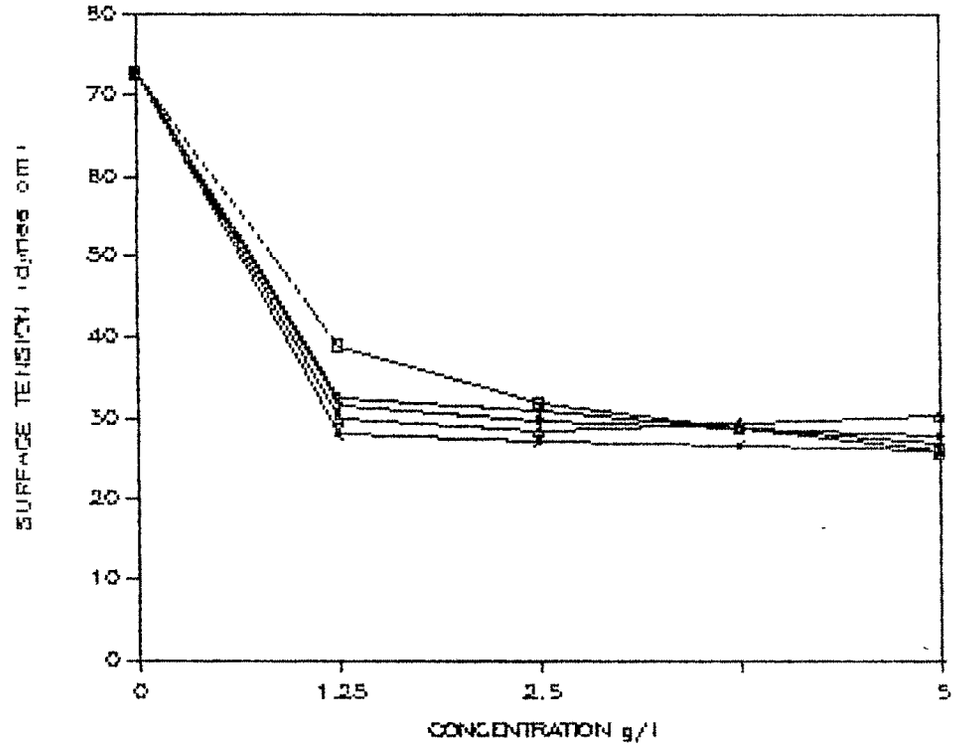
S_2 - Sodium oleate

d_1 - Purified Teepol

GRAPH 8a- RELATIVE SURFACE TENSION OF COMBINATION II (SODIUM OLEATE & TEEPOL) VERSUS CONCENTRATION



GRAPH 8b- SURFACE TENSION IN dynes/cm OF COMBINATION II (SODIUM OLEATE & TEEPOL) VERSUS CONCENTRATION



Combination II Sodium Oleate	:	Puried Teepol
100	:	0 (□)
75	:	25 (+)
50	:	50 (◊)
25	:	75 (△)
0	:	100 (*)

Table 16a Relative surface tension of combination III (501 bar soap and sodium lauryl sulphate) at varying ratios and concentration

Combination III Per cent ratio S_1 : d_2	Relative Surface Tension 1.25 g/l	2.5 g/l	5.0 g/l
100 : 0	.5	.48	.37
75 : 25	.56	.44	.42
50 : 50	.53	.46	.43
25 : 75	.52	.43	.43
0 : 100	.49	.42	.39

Relative surface tension of water = 1

S_1 - Purified 501 bar soap

d_2 - Sodium lauryl sulphate

Table 16b Surface tension in dyne/cm of combination III (501 bar soap and sodium lauryl sulphate) at varying ratios and concentration

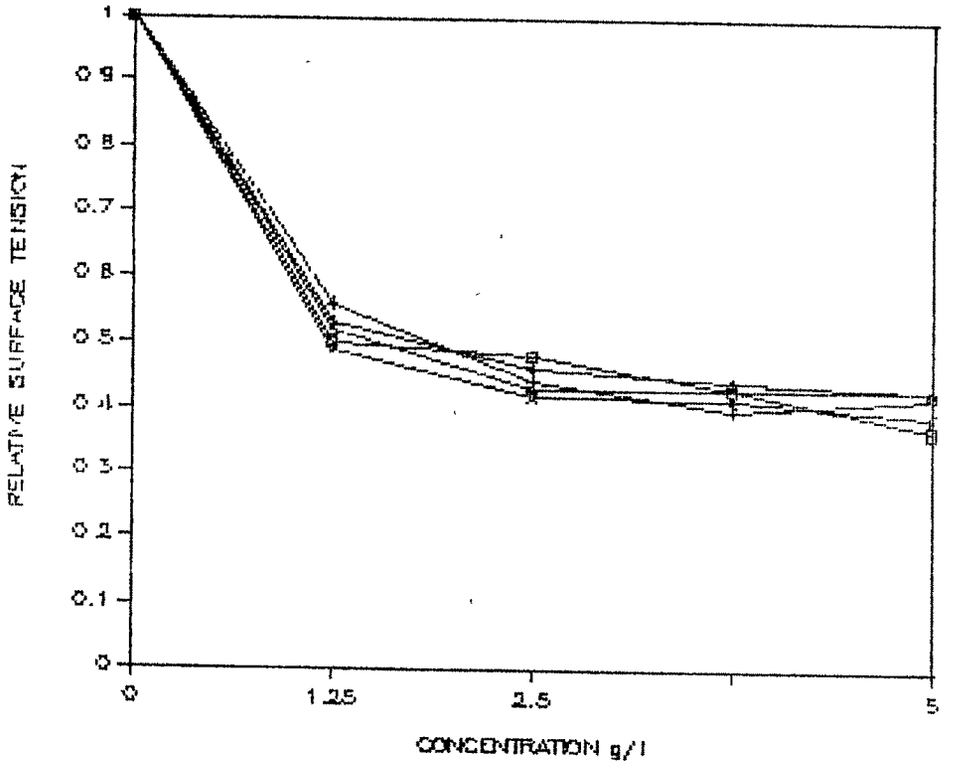
Combination III Per cent ratio S_1 : d_2	Surface Tension (dynes/cm) 1.25 g/l	2.5 g/l	5.0 g/l
100 : 0	36.4	34.98	27.36
75 : 25	41.35	32.07	30.86
50 : 50	38.97	33.55	31.99
25 : 75	38.20	31.88	31.47
0 : 100	35.95	31.11	29.01

Surface tension of water = 72.8 dynes/cm

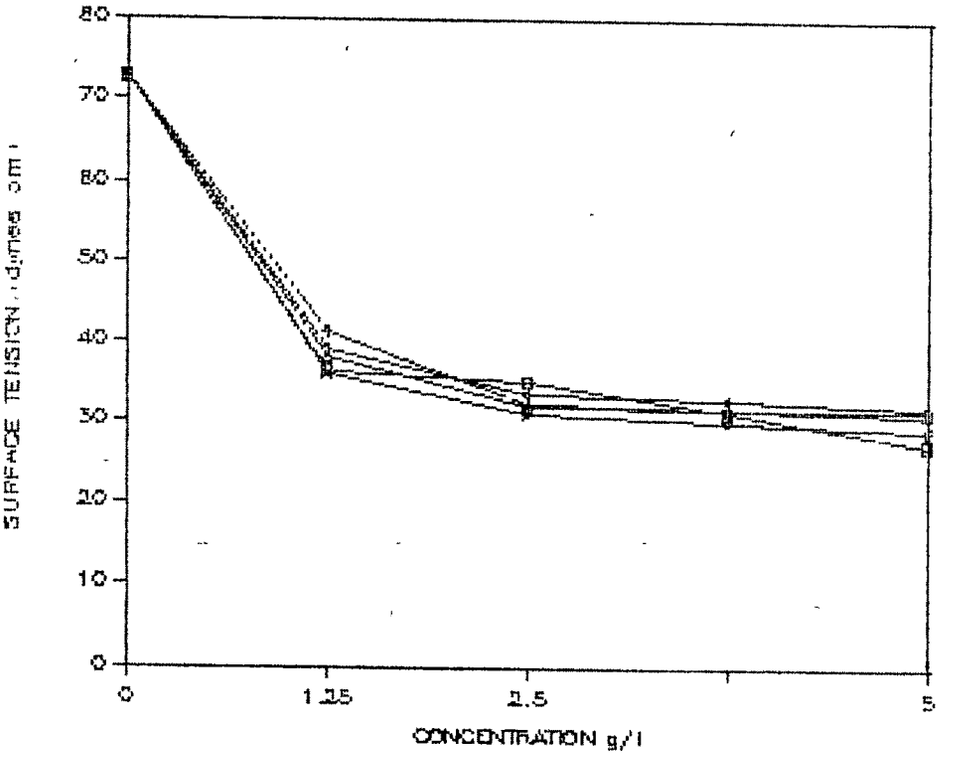
S_1 - Purified 501 bar soap

d_2 - Sodium lauryl sulphate

GRAPH 9a- RELATIVE SURFACE TENSION OF COMBINATION III (501 BAR SOAP & SODIUM LAURYL SULPHATE) VERSUS CONCENTRATION



GRAPH 9b- SURFACE TENSION IN dynes/cm OF COMBINATION III (501 BAR SOAP & SODIUM LAURYL SULPHATE) VERSUS CONCENTRATION



Combination III
Purified : Sodium
501 Bar : Lauryl
Soap : Sulphate
100 : 0 (□)
75 : 25 (+)
50 : 50 (◇)
25 : 75 (△)
0 : 100 (✱)

Table 17a Relative surface tension of combination IV (purified 501 bar soap and Lissapol-N) at varying ratios and concentration

Combination IV Per cent ratio S_1 : d_3	Relative Surface Tension 1.25 g/l	2.5 g/l	5.0 g/l
100 : 0	.5	.48	.37
75 : 25	.48	.44	.38
50 : 50	.49	.44	.43
25 : 75	.52	.45	.44
0 : 100	.44	.43	.42

Relative surface tension of water = 1

S_1 - Purified 501 bar soap

d_3 - Lissapol-N

Table 17b Surface tension in dyne/cm of combination IV (501 bar soap and Lissapol-N) at varying ratios and concentration

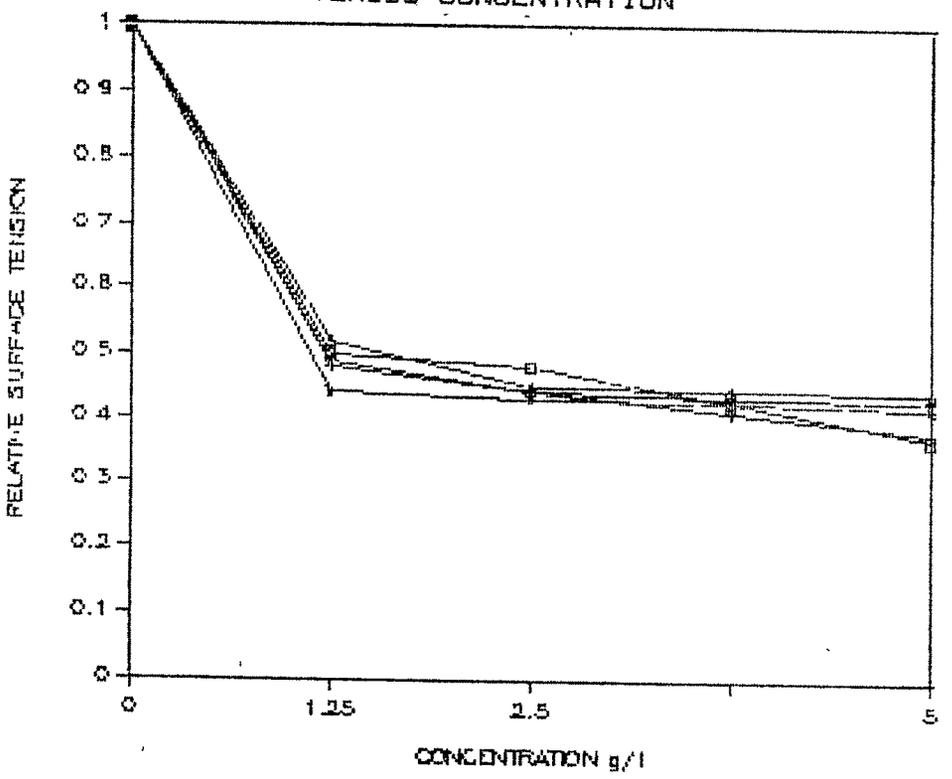
Combination IV Per cent ratio S_1 : d_3	Surface Tension (dynes/cm) 1.25 g/l	2.5 g/l	5.0 g/l
100 : 0	36.4	34.98	27.36
75 : 25	35.30	32.26	27.95
50 : 50	36.05	32.15	31.36
25 : 75	38.35	33.26	32.42
0 : 100	32.26	31.86	31.11

Surface tension of water = 72.8 dynes/cm

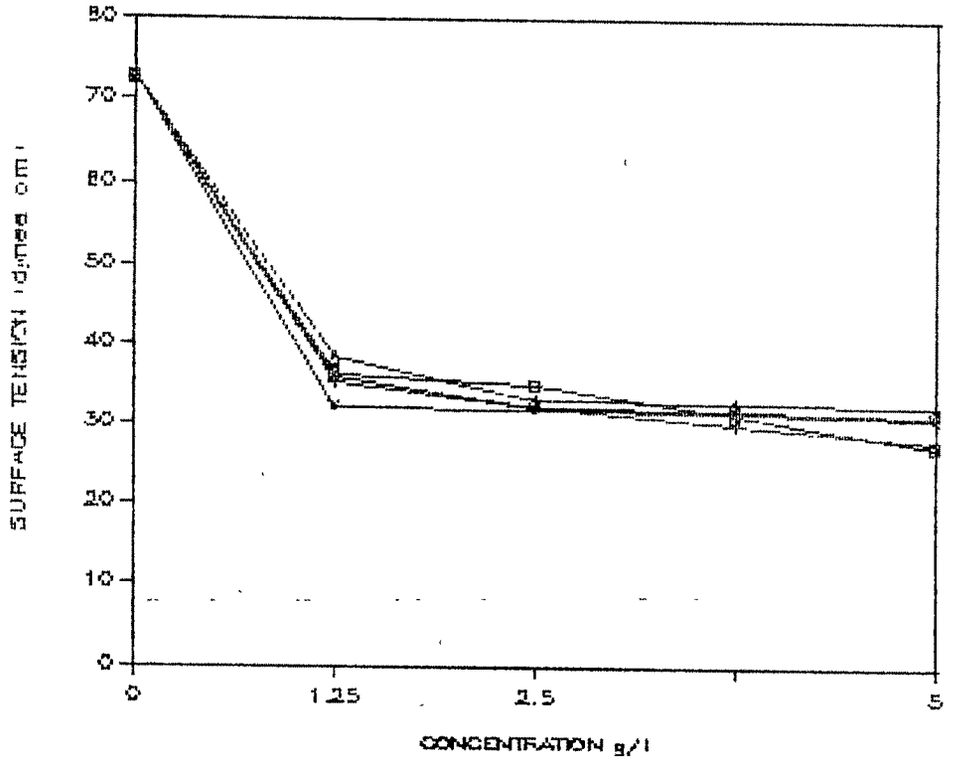
S_1 - Purified 501 bar soap

d_3 - Lissapol-N

GRAPH 10a- RELATIVE SURFACE TENSION OF COMBINATION IV (501 BAR SOAP & LISSAPOL -N) VERSUS CONCENTRATION



GRAPH 10b- SURFACE TENSION IN dynes/cm CO COMBINATION IV (501 BAR SOAP & LISSAPOL N) VERSUS CONCENTRATION



Combination IV
501 Bar : Lissapol
Soap : -N
100 : 0 (□)
75 : 25 (+)
50 : 50 (◊)
25 : 75 (Δ)
0 : 100(✳)

It was seen from the above data for the combinations that the surface tension has been lowered to half and the surface tension lies between the two individual readings. In the lower concentrations the synthetic detergents had a lower surface tension as compared to that of soaps. In combinations the lower surface tension of these synthetic detergents had a lowering effect on the higher surface tension of the soap. All surface tension readings of the combinations lie within a narrow range (as noted in Tables 14 - 17).

The above is seen from the Graphs 7 to 10 and it can be concluded that for the combination surface tension readings lie inbetween the individual readings and are low even at the low concentration of 1.25 g/l.

Percentage wettability

The percentage wettability for the combinations was determined by the centrifuge method. The data has been given in Tables 18 - 21 and illustrated in Graphs 11 - 14.

It was seen from the above data that the percentage wettability for the combinations was between the two individual readings. In the analysis of wettability data of the solutions, Containing individual soap or synthetic detergent (given on page 88) it was indicated that a specific rise in wettability was noticed for soaps from 2.0-3.0 g/l onwards and that this was due to higher

micellae. It was thought that in combination with soaps, one would expect this to be prominent and would influence the wettability due to the other agent in the mixture. The wettability is due to the water absorbed in capillary etc. along with the molecules of the agents therein. Some agents try to cling on (like soap) and thus giving more and more wettability with concentration. However, as the wettability values continue to lie between the values of the individual agents therein, such a tendency of specific assistance between molecules was not evident. A difference between detergents, Teepol, sodium lauryl sulphate and Lissapol-N and the soaps was observed, the synthetic detergents had lower wettability at a higher concentration.

When the soap and synthetic detergent is combined the percentage wettability tends to lie inbetween the individual readings at the higher concentrations. The effect is lowered sometimes even below the individual reading as in case of bar soap and Teepol. An increased adsorption from anionic/nonionic mixtures is expected to result in increased washing efficiency in the low concentration range (39).

Table 18 Wettability characteristics of combination I (501 bar soap and Teepol) at varying ratios and concentration

Combination I Per cent ratio S_1 : d_1	Wettability (%)		
	1.25 g/l	2.5 g/l	5.0 g/l
100 : 0	72.1	85.6	127.7
75 : 25	61.7	82.1	100.7
50 : 50	62.5	85.8	76.1
25 : 75	57.9	85.3	72.9
0 : 100	65.6	71.0	85.8

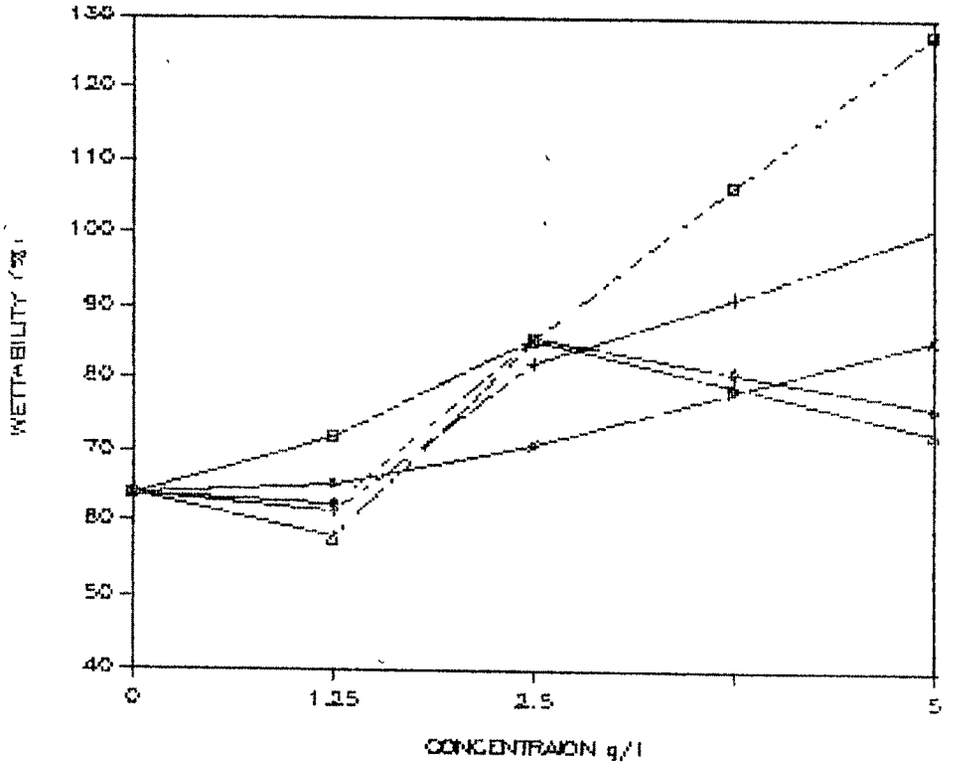
Water - 64%
S_1 - Purified 501 bar soap
d_1 - Purified Teepol

Table 19 Wettability characteristics of combination II (sodium oleate and Teepol) at varying ratios and concentration

Combination II Per cent ratio S_2 : d_1	Wettability (%)		
	1.25 g/l	2.5 g/l	5.0 g/l
100 : 0	78.9	92.2	109.8
75 : 25	76.6	93.8	101.8
50 : 50	78.4	89.9	95.6
25 : 75	76.1	87.9	80.6
0 : 100	65.6	71.0	85.8

Water - 64%
S_2 - Sodium oleate
d_1 - Purified Teepol

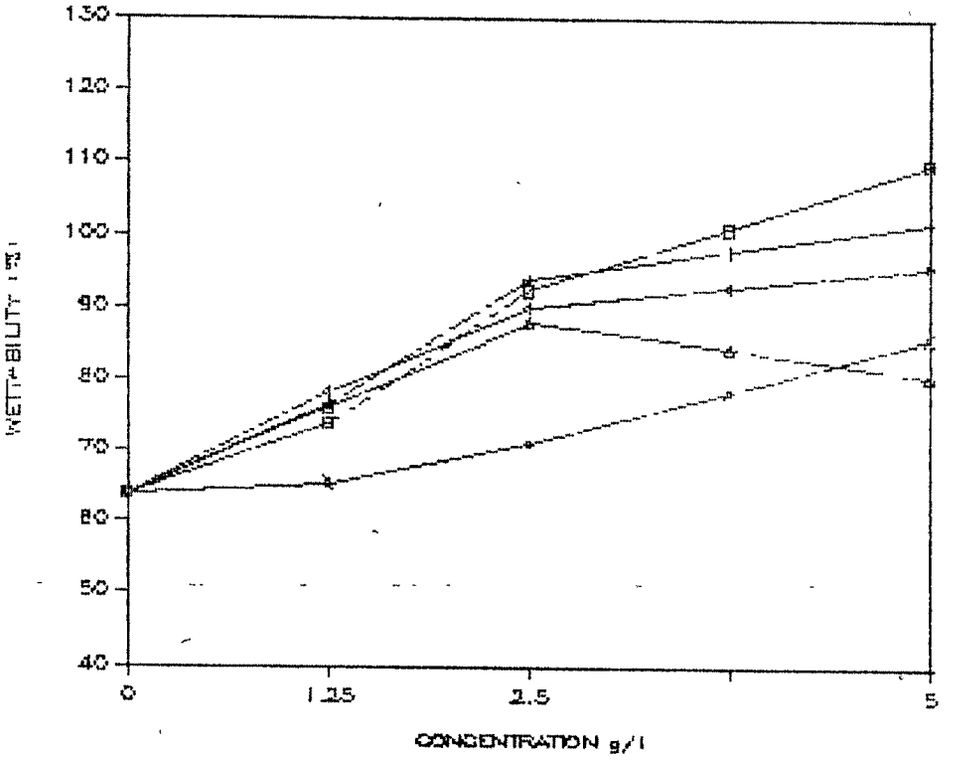
GRAPH 11- PERCENTAGE WETTABILITY OF COMBINATION I (501 BAR SOAP & TEEPOL) VERSUS CONCENTRATION



Combination I

501 Bar Soap	: Teepol
100	: 0 (□)
75	: 25 (+)
50	: 50 (◇)
25	: 75 (△)
0	: 100 (✳)

GRAPH 12- PERCENTAGE WETTABILITY OF COMBINATION II (SODIUM OLEATE & TEEPOL) VERSUS CONCENTRATION



Combination II

Sodium Oleate	: Purified Teepol
100	: 0 (□)
75	: 25 (+)
50	: 50 (◇)
25	: 75 (△)
0	: 100 (✳)

Table 20 Wettability characteristics of combination III (501 bar soap and sodium lauryl sulphate) at varying ratios and concentration

Combination III Per cent ratio S_1 : d_2	Wettability (%)		
	1.25 g/l	2.5 g/l	5.0 g/l
100 : 0	72.1	85.6	127.7
75 : 25	62.0	86.4	103.5
50 : 50	70.5	72.6	101.3
25 : 75	57.9	75.1	80.9
0 : 100	70.1	72.7	82.2

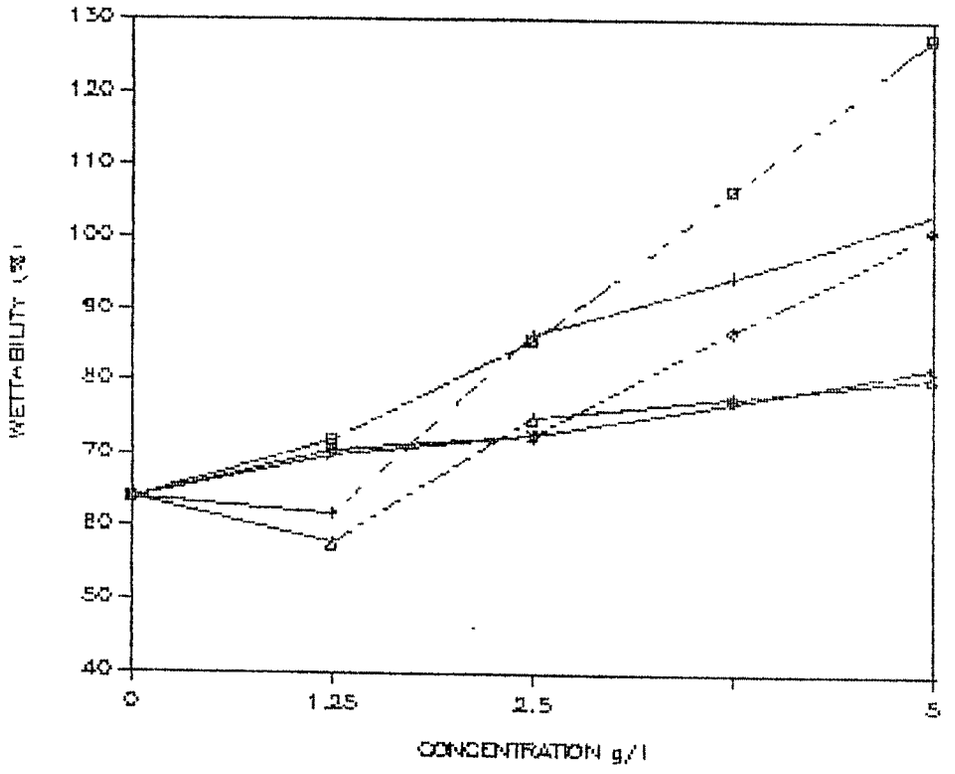
Water - 64%
S_1 - Purified 501 bar soap
d_2 - Sodium lauryl sulphate

Table 21 Wettability characteristics of combination IV (501 bar soap and Lissapol-N) at varying ratios and concentration

Combination IV Per cent ratio S_1 : d_3	Wettability (%)		
	1.25 g/l	2.5 g/l	5.0 g/l
100 : 0	72.1	85.6	127.7
75 : 25	70.7	85.6	102.7
50 : 50	70.2	76.1	103.8
25 : 75	66.6	69.6	94.8
0 : 100	70.3	70.4	79.5

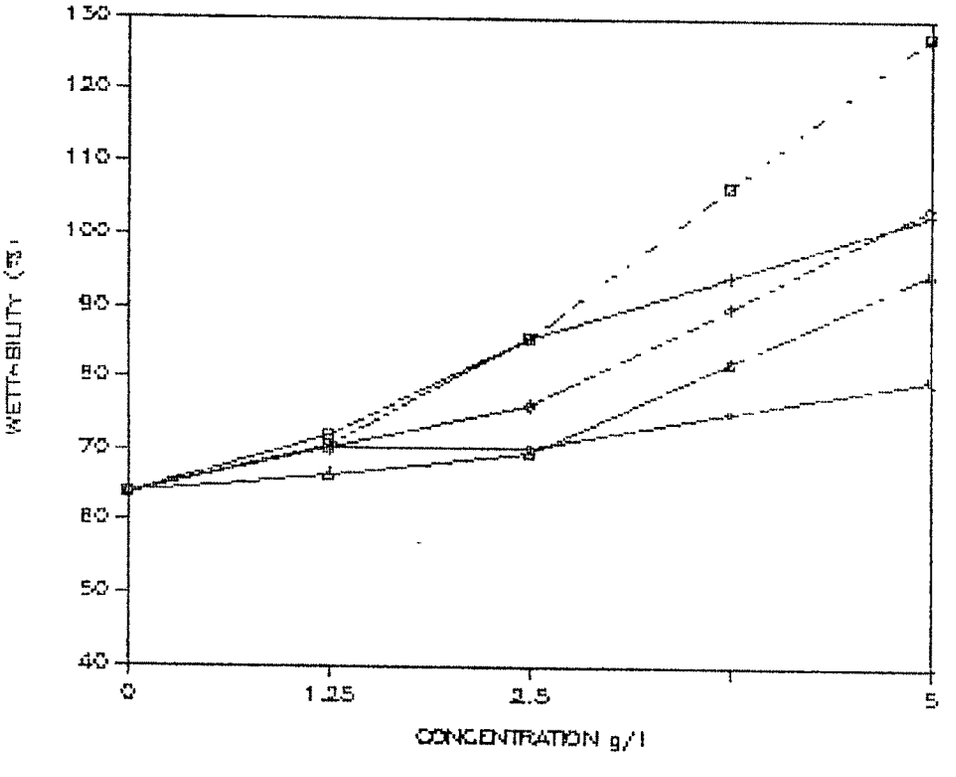
Water - 64%
S_1 - Purified 501 bar soap
d_3 - Lissapol-N

GRAPH 13- PERCENTAGE WETTABILITY OF COMBINATION III (501 BAR SOAP & SODIUM LAURYL SULPHATE) VERSUS CONCENTRATION



Combination III
Purified : Sodium
501 Bar : Lauryl
Soap : Sulphate
100 : 0 (□)
75 : 25 (+)
50 : 50 (◊)
25 : 75 (△)
0 : 100(✳)

GRAPH 14- PERCENTAGE WETTABILITY OF COMBINATION IV (501 BAR SOAP & LISSAPOL N) VERSUS CONCENTRATION



Combination IV
501 Bar : Lissapol
Soap : -N
100 : 0 (□)
75 : 25 (+)
50 : 50 (◊)
25 : 75 (△)
0 : 100(✳)

Rate of wetting

The data for the wetting time has been given in Tables 22 - 25 and illustrated in Graphs 15 - 18. It was seen from the earlier results that the synthetic detergents had very low wetting time. Soaps had higher wetting time. On combination it was seen that there was rapid wetting irrespective of the concentration and ratio. Even with the addition of a small quantity of a detergent to a soap the wetting time gets reduced to almost as low as that of the synthetic detergent.

According to Swartz and Perry (47) the wetting power of soap which is generally poorer than that of the synthetic detergents is greatly improved by the addition of relatively small proportion of synthetic detergents.

This property could prove useful in laundering because when soaps are combined with the synthetic detergents they would have the added advantage of having a low wetting time. This rapid wetting would be useful in detergency.

Table 22 Rate of wetting for combination I (501 bar soap and Teepol) at varying ratios and concentration

Combination I Per cent ratio S_1 : d_1	Wetting time (secs) 1.25 g/l	2.5 g/l	5.0 g/l
100 : 0	113	60	18
75 : 25	45	14	13
50 : 50	28	8	2
25 : 75	6	4	2
0 : 100	4	2	1

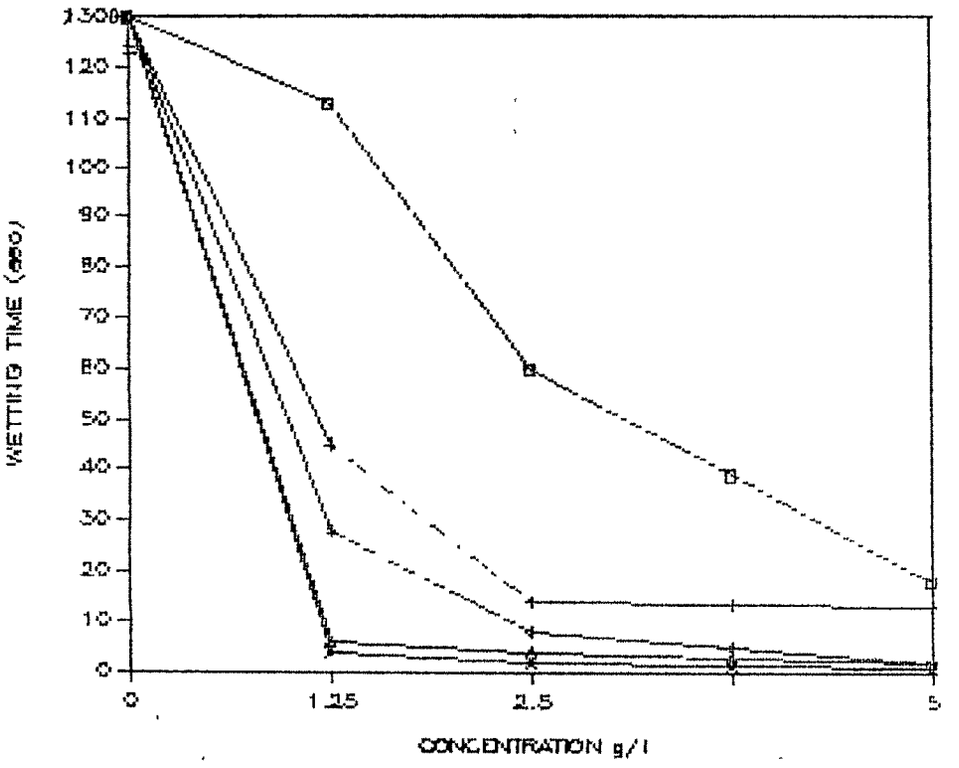
Water > 5 mins
S_1 - Purified 501 bar soap
d_1 - Purified Teepol

Table 23 Rate of wetting for combination II (sodium oleate and Teepol) at varying concentration

Combination II Per cent ratio S_2 : d_1	Wetting time (secs) 1.25 g/l	2.5 g/l	5.0 g/l
100 : 0	46	29	30
75 : 25	30	17	3
50 : 50	13	11	1
25 : 75	5	3	2
0 : 100	9	2	1

Water > 5 mins
S_2 - Sodium oleate
d_1 - Purified Teepol

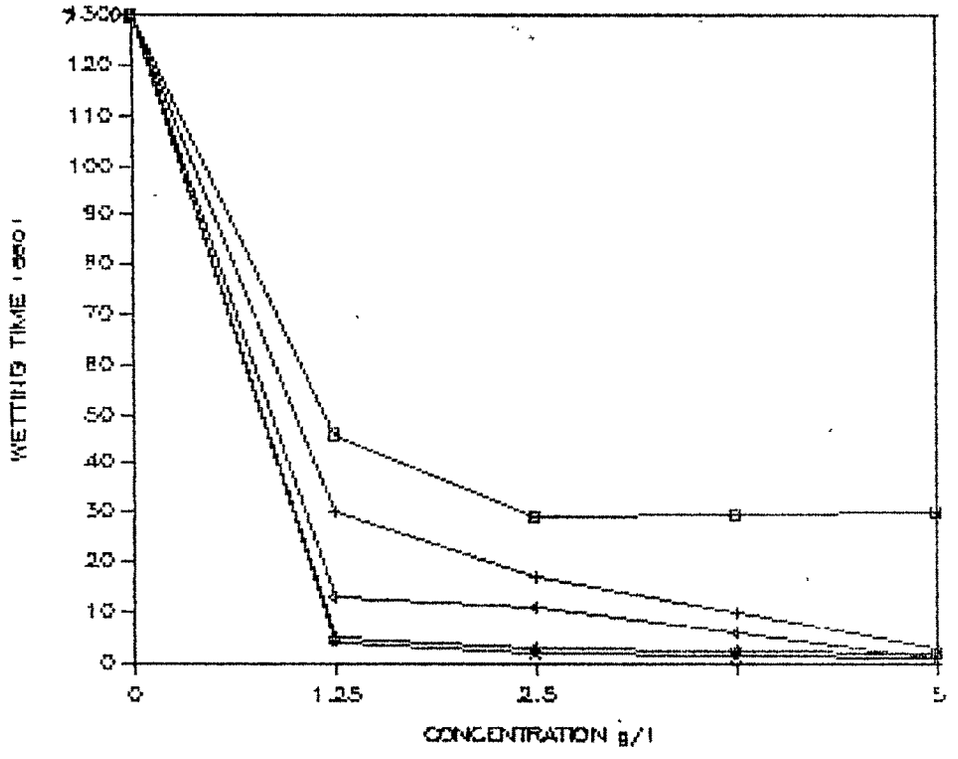
GRAPH 15- RATE OF WETTING OF COMBINATION OF I (501 BAR SOAP & TEEPOL) VERSUS CONCENTRATIO



Combination I

501 Bar Soap	:	Teepol
100	:	0 (□)
75	:	25 (+)
50	:	50 (◇)
25	:	75 (△)
0	:	100 (✳)

GRAPH 16- RATE OF WETTING ON COMBINATION II (SODIUM OLEATE & TEEPOL) VERSUS CONCENTRATION



Combination II

Sodium Oleate	:	Puried Teepol
100	:	0 (□)
75	:	25 (+)
50	:	50 (◇)
25	:	75 (△)
0	:	100 (✳)

Table 24 Rate of wetting for combination III (501 bar soap and sodium lauryl sulphate) at varying concentration

Combination III Per cent ratio S_1 : d_2	Wetting time (sec)		
	1.25 g/l	2.5 g/l	5.0 g/l
100 : 0	113	60	18
75 : 25	54	18	2
50 : 50	21	15	2
25 : 75	10	6	2
0 : 100	4	3	1

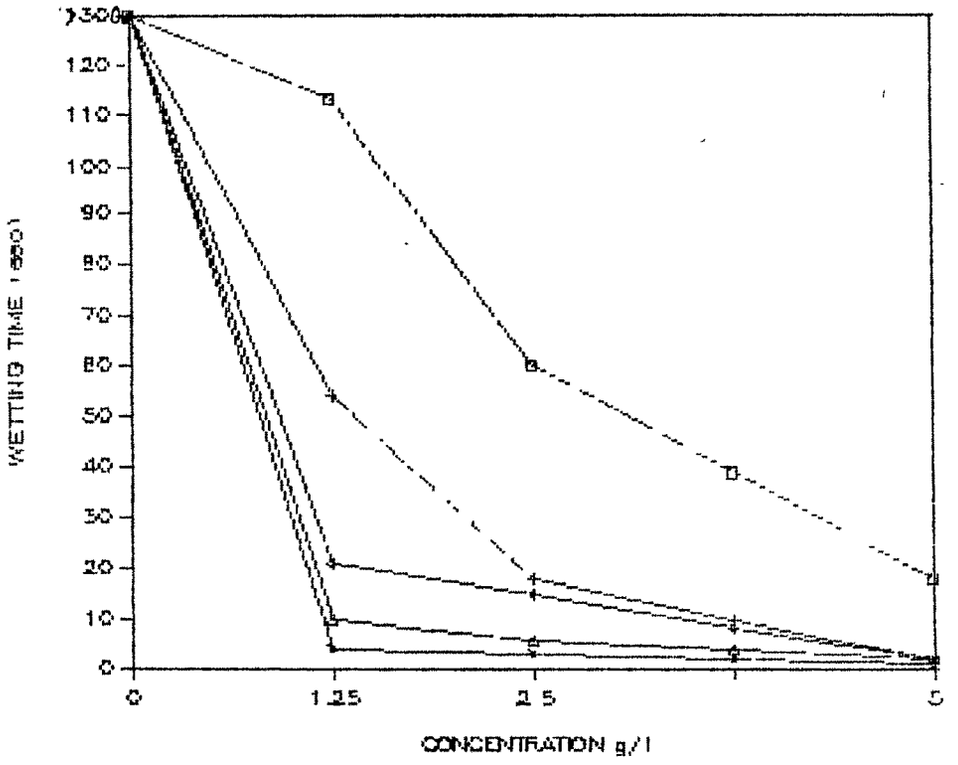
Water > 5 mins
S_1 - Purified 501 bar soap
d_2 - Sodium lauryl sulphate

Table 25 Rate of wetting for combination IV (501 bar soap and Lissapol-N) at varying concentration

Combination IV per cent ratio S_1 : d_3	Wetting time (sec)		
	1.25 g/l	2.5 g/l	5.0 g/l
100 : 0	113	60	18
75 : 25	69	28	2
50 : 50	40	12	1
25 : 75	18	5	1
0 : 100	7	4	2

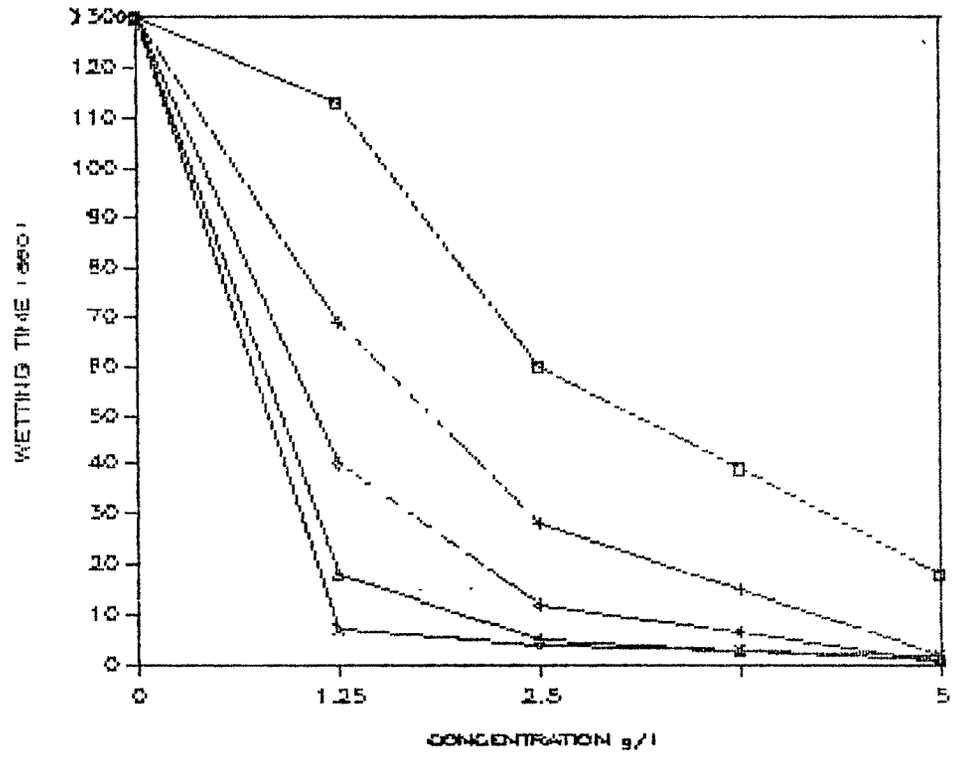
Water > 5 mins
S_1 - Purified 501 bar soap
d_3 - Lissapol-N

GRAPH 17- RATE OF WETTING OF COMBINATION III (501 BAR SOAP & SODIUM LAURYL SULPHATE) VERSUS CONCENTRATION



Combination III
Purified : Sodium
501 Bar : Laury1
Soap : Sulphat
100 : 0 (□)
75 : 25 (+)
50 : 50 (◊)
25 : 75 (△)
0 : 100 (✳)

GRAPH 18- RATE OF WETTING OF COMBINATION IV (501 BAR SOAP & LISSAPOL N) VERSUS CONCENTRATION



Combination IV
501 Bar : Lissapc
Soap : -N
100 : 0 (□)
75 : 25 (+)
50 : 50 (◊)
25 : 75 (△)
0 : 100 (✳)

Emulsifying ability

The emulsifying power was studied for the combination of soap and synthetic detergents. The data for the above has been given in Tables 26 - 29 and illustrated in Graphs 19 - 22.

It can be seen from the graphs that at the lower concentration the combinations tend to lie inbetween the two individual readings but as the concentration is increased the combination readings are lower than the individual readings. Exception was seen in the last combination IV of anionic soap and nonionic synthetic detergent where even at a high concentration of 5.0 g/l the addition of a soap improves the emulsifying ability of the nonionic detergent when in combination.

Foaming power

The foaming power was also studied for the various combinations. The data for these has been given in Tables 30 - 33 and illustrated in Graphs 23 - 26. Graphs 27 - 30 gives the stability of the foam for the various combinations at different ratios and concentration.

Table 26a Emulsifying ability (cms) of combination I (501 bar soap and Teepol) at varying ratios and concentration

Combination I Per cent ratio S_1 : d_1	Emulsifying ability (cms) 1.25 g/l 2 mins	1.25 g/l 5 mins	1.25 g/l 10 mins	2.5 g/l 2 mins	2.5 g/l 5 mins	2.5 g/l 10 mins	5.0 g/l 2 mins	5.0 g/l 5 mins	5.0 g/l 10 mins
100 : 0	3.6	3.5	3.5	3.7	3.6	3.6	4.1	4.1	3.9
75 : 25	3.5	3.5	3.5	3.7	3.6	3.5	3.7	3.7	3.7
50 : 50	3.5	3.5	3.5	3.5	3.5	3.5	3.6	3.6	3.6
25 : 75	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
0 : 100	3.5	3.5	3.5	3.5	3.5	3.5	3.8	3.7	3.7

S_1 - Purified 501 bar soap
d_1 - Purified Teepol

Table 26b Emulsifying ability (%) of combination I (501 bar soap and Teepol) at varying ratios and concentration

Combination I Per cent ratio S_1 : d_1	Emulsifying ability (%) 1.25 g/l 2 mins	1.25 g/l 5 mins	1.25 g/l 10 mins	2.5 g/l 2 mins	2.5 g/l 5 mins	2.5 g/l 10 mins	5.0 g/l 2 mins	5.0 g/l 5 mins	5.0 g/l 10 mins
100 : 0	4.3	0	0	22.9	18.6	14.3	85.7	80	65.7
75 : 25	4.3	4.3	4.3	8.6	8.6	4.3	28.6	22.9	22.9
50 : 50	0	0	0	4.3	4.3	4.3	18.6	14.3	14.3
25 : 75	0	0	0	4.3	0	0	4.3	4.3	0
0 : 100	0	0	0	4.3	0	0	37.1	22.9	22.9

S_1 - Purified 501 bar soap
d_1 - Purified Teepol

Table 27a Emulsifying ability (cms) of combination II (sodium oleate and Teepol) at varying ratios and concentration

Combination II Per cent ratio		Emulsifying ability (cms)								
		1.25 g/l			2.5 g/l			5.0 g/l		
S_2 :	d_1	2 mins	5 mins	10 mins	2 mins	5 mins	10 mins	2 mins	5 mins	10 mins
100 :	0	3.6	3.5	3.5	3.7	3.6	3.6	4.2	4.1	4.1
75 :	25	3.6	3.6	3.5	3.6	3.6	3.6	3.9	3.8	3.8
50 :	50	3.7	3.5	3.5	3.5	3.5	3.5	3.8	3.8	3.8
25 :	75	3.5	3.5	3.5	3.5	3.5	3.5	3.6	3.6	3.6
0 :	100	3.5	3.5	3.5	3.5	3.5	3.5	3.8	3.7	3.7

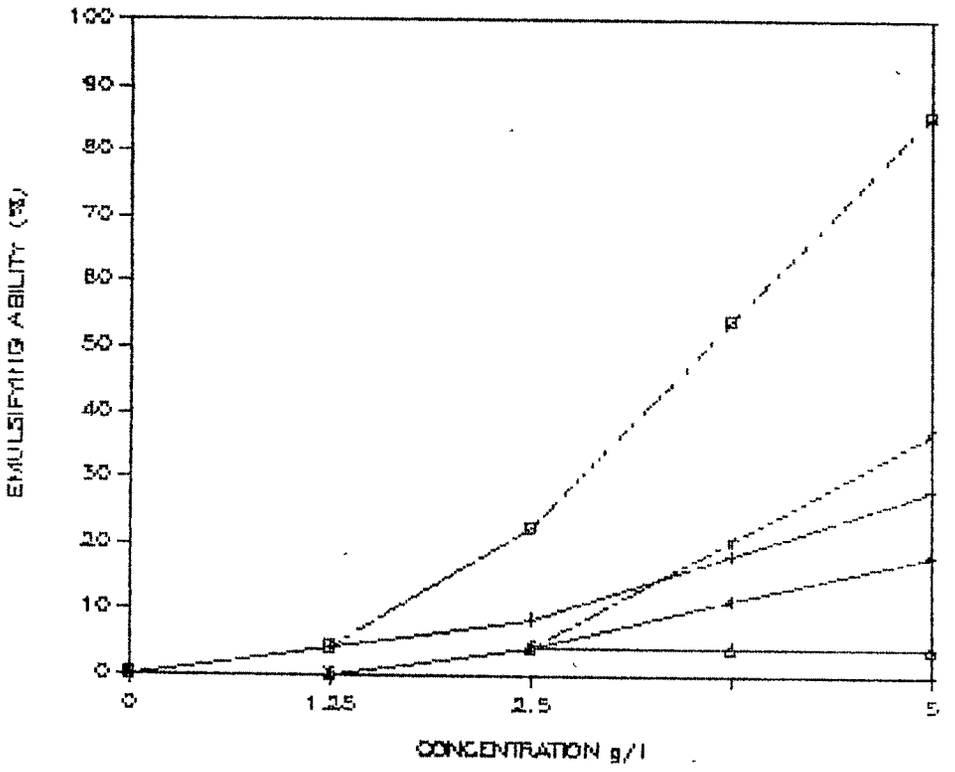
S_2 - Sodium oleate
d_1 - Purified Teepol

Table 27b Emulsifying ability (%) of combination II (sodium oleate and Teepol) at varying ratios and concentration

Combination II Per cent ratio		Emulsifying ability (%)								
		1.25 g/l			2.5 g/l			5.0 g/l		
S_2 :	d_1	2 mins	5 mins	10 mins	2 mins	5 mins	10 mins	2 mins	5 mins	10 mins
100 :	0	14.3	4.3	0	22.9	18.6	14.3	94.3	90	85.7
75 :	25	8.6	8.8	4.3	14.3	14.3	8.6	57.1	47.2	47.1
50 :	50	8.6	4.3	0	4.3	4.3	4.3	37.1	37.1	28.9
25 :	75	0	0	0	4.3	0	0	18.6	18.6	18.6
0 :	100	0	0	0	4.3	0	0	37.1	22.9	22.9

S_2 - Sodium oleate
d_1 - Purified Teepol

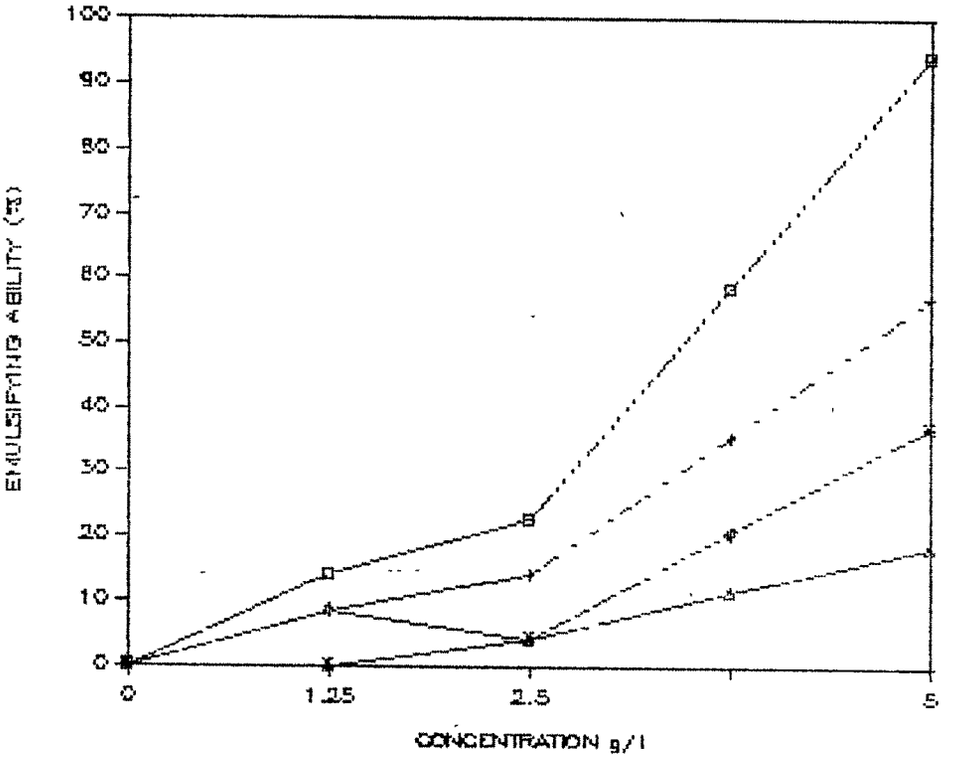
GRAPH 19- EMULSIFYING ABILITY OF COMBINATION I (501 BAR SOAP & TEEPOL) VERSUS CONCENTRATION



Combination I

501 Bar Soap	: Teepol
100	: 0 (□)
75	: 25 (+)
50	: 50 (◇)
25	: 75 (△)
0	: 100 (✳)

GRAPH 20- EMULSIFYING ABILITY OF COMBINATION II (SODIUM OLEATE & TEEPOL) VERSUS CONCENTRATION



Combination II

Sodium Oleate	: Puried Teepol
100	: 0 (□)
75	: 25 (+)
50	: 50 (◇)
25	: 75 (△)
0	: 100 (✳)

Table 28a Emulsifying power (cms) of combination III (501 bar soap and sodium lauryl sulphate) at varying ratios and concentration

Combination III			Emulsifying ability (cms)								
Per cent ratio			1.25 g/l			2.5 g/l			5.0 g/l		
S_1	:	d_2	2 mins	5 mins	10 mins	2 mins	5 mins	10 mins	2 mins	5 mins	10 mins
100	:	0	3.5	3.5	3.5	3.7	3.6	3.6	4.1	4.1	3.9
75	:	25	3.5	3.5	3.5	3.6	3.5	3.5	3.6	3.6	3.6
50	:	50	3.5	3.5	3.5	3.6	3.5	3.5	3.6	3.6	3.6
25	:	75	3.5	3.5	3.5	3.6	3.6	3.5	3.7	3.6	3.6
0	:	100	3.5	3.5	3.5	3.8	3.7	3.7	4.2	4.2	4.2

S_1 - Purified 501 bar soap
d_2 - Sodium lauryl sulphate

Table 28b Emulsifying power (%) of combination III (501 bar soap and sodium lauryl sulphate) at varying ratios and concentration

Combination III			Emulsifying ability(%)								
Per cent ratio			1.25 g/l			2.5 g/l			5.0 g/l		
S_1	:	d_2	2 mins	5 mins	10 mins	2 mins	5 mins	10 mins	2 mins	5 mins	10 mins
100	:	0	4.3	0	0	22.9	18.6	14.3	85.7	80	65.7
75	:	25	0	0	0	8.6	4.3	0	18.6	18.6	8.6
50	:	50	0	0	0	8.6	4.3	4.3	18.6	14.3	8.6
25	:	75	4.3	4.3	0	8.6	8.6	4.3	22.9	18.6	18.6
0	:	100	4.3	0	0	37.1	28.6	26.6	100	100	100

S_1 - Purified 501 bar soap
d_2 - Sodium lauryl sulphate

Table 29a Emulsifying power (cms) of combination IV (501 bar soap and Lissapol N) at varying ratios and concentration

Combination IV Per cent ratio		Emulsifying ability (cms)								
		1.25 g/l			2.5 g/l			5.0 g/l		
S_1 :	d_3	2 mins	5 mins	10 mins	2 mins	5 mins	10 mins	2 mins	5 mins	10 mins
100 :	0	3.5	3.5	3.5	3.7	3.6	3.6	4.1	4.1	3.9
75 :	25	3.6	3.5	3.5	3.6	3.5	3.5	3.9	3.8	3.8
50 :	50	3.5	3.5	3.5	3.5	3.5	3.5	3.7	3.7	3.7
25 :	75	3.5	3.5	3.5	3.5	3.5	3.7	3.7	3.6	3.6
0 :	100	3.5	3.5	3.5	3.5	3.5	3.5	3.6	3.6	3.6

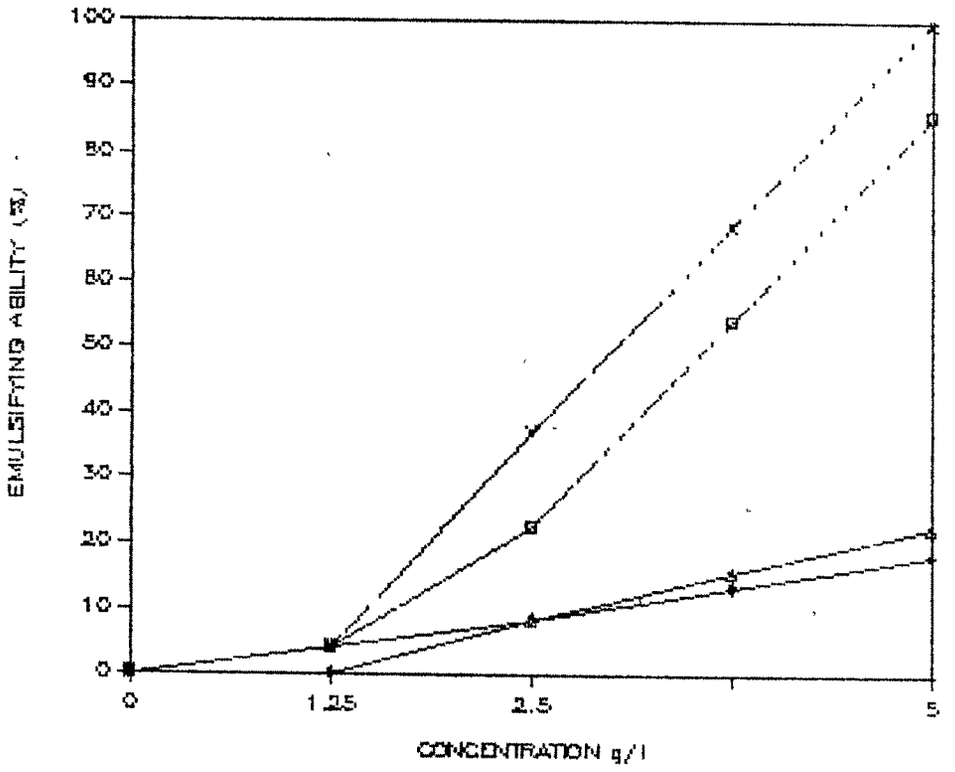
S_1 - Purified 501 bar soap
d_3 - Lissapol N

Table 29b Emulsifying power (%) of combination IV (501 bar soap and Lissapol N) at varying ratios and concentration

Combination IV Per cent ratio		Emulsifying ability (%)								
		1.25 g/l			2.5 g/l			5.0 g/l		
S_1 :	d_3	2 mins	5 mins	10 mins	2 mins	5 mins	10 mins	2 mins	5 mins	10 mins
100 :	0	4.3	0	0	22.9	18.6	14.3	85.7	80.0	65.7
75 :	25	8.6	0	0	8.6	4.3	0	51.4	42.9	37.1
50 :	50	4.3	0	0	4.3	4.3	0	32.9	22.9	22.9
25 :	75	0	0	0	0	0	0	22.9	18.6	8.6
0 :	100	0	0	0	4.3	0	0	14.3	8.6	8.6

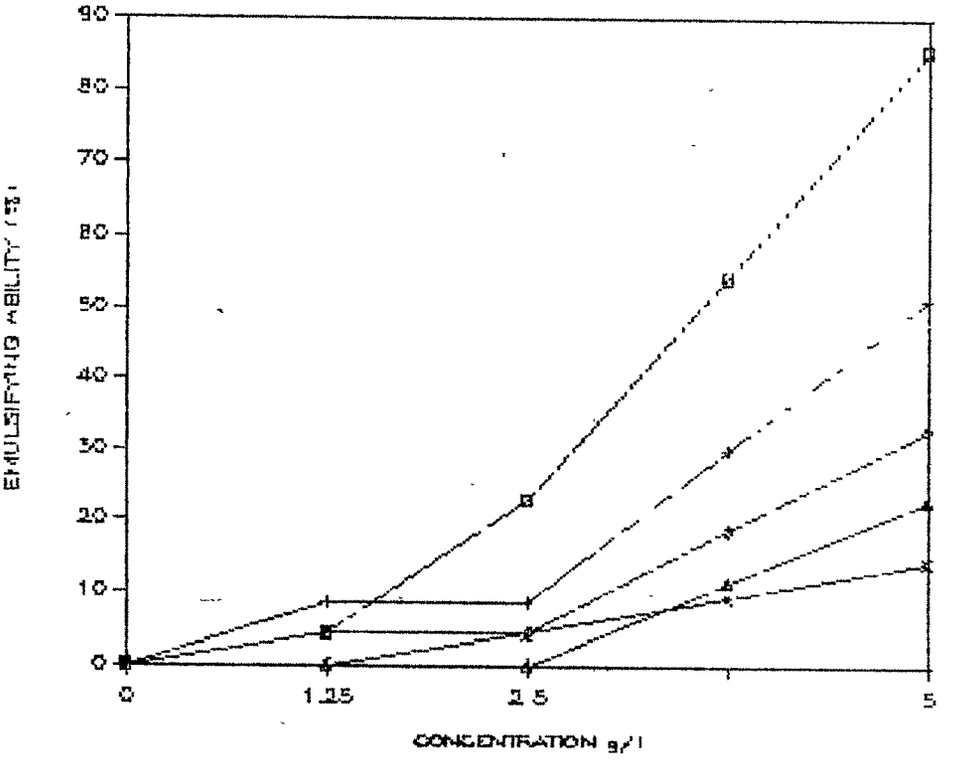
S_1 - Purified 501 bar soap
d_3 - Lissapol N

GRAPH 21- EMULSIFYING ABILITY OF COMBINATION III (501 BAR SOAP & SODIUM LAURYL SULPHATE) VERSUS CONCENTRATION



Combination III
Purified : Sodium
501 Bar : Lauryl
Soap : Sulphate
100 : 0 (□)
75 : 25 (+)
50 : 50 (◇)
25 : 75 (△)
0 : 100 (✳)

GRAPH 22- EMULSIFYING ABILITY OF COMBINATION IV (501 BAR SOAP & LISSAPOL N) VERSUS CONCENTRATION



Combination IV
501 Bar : Lissapol
Soap : -N
100 : 0 (□)
75 : 25 (+)
50 : 50 (◇)
25 : 75 (△)
0 : 100 (✳)

Table 30 Foaming power of combination I (501 bar soap and Teepol) at varying ratios and concentration

Combination I	Foaming power (cms)											
Per cent ratio	1.25 g/l				2.5 g/l				5.0 g/l			
S_1 : d_1	30 secs	2 mins	5 mins	10 mins	30 secs	2 mins	5 mins	10 mins	30 secs	2 mins	5 mins	10 mins
100 : 0	2.4	2.2	2.0	1.5	7.6	6.6	6.4	6.2	8.6	8.1	7.8	7.6
75 : 25	0	0	0	0	6.7	6.4	6.0	5.6	6.5	5.9	5.4	4.4
50 : 50	0	0	0	0	5.1	4.4	4.0	3.7	8.5	6.8	6.6	5.8
25 : 75	0.7	0.4	0.2	0.2	3.8	1.6	0.4	0.3	8.5	6.1	5.3	4.2
0 : 100	9.4	8.9	8.6	8.4	13.8	13.4	13.2	12.4	19.2	18.1	17.9	17.6

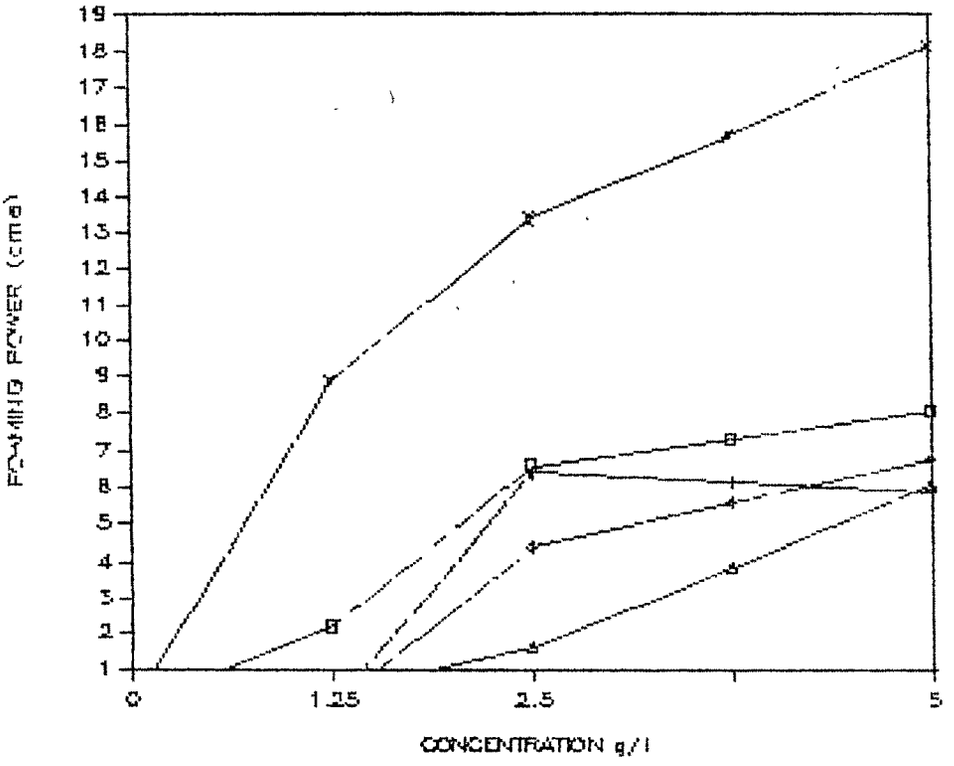
S_1 - Purified 501 bar soap
d_1 - Purified Teepol

Table 31 Foaming power of combination II (sodium oleate and Teepol) at varying ratios and concentration

Combination II	Foaming power (cms)											
Per cent ratio	1.25 g/l				2.5 g/l				5.0 g/l			
S_2 : d_1	30 secs	2 mins	5 mins	10 mins	30 secs	2 mins	5 mins	10 mins	30 secs	2 mins	5 mins	10 mins
100 : 00	7.0	6.7	5.7	5.5	9.2	7.9	7.6	7.1	8.7	8.2	7.7	7.3
75 : 25	5.5	4.8	4.6	3.9	11.2	9.2	8.4	7.6	8.3	6.9	6.7	6.1
50 : 50	1.6	1.4	0.9	0.8	10.2	9.3	8.4	8.1	10.3	9.8	9.2	9.1
25 : 75	0	0	0	0	5.9	5.8	5.5	5.4	11.4	10.7	9.3	7.6
0 : 100	9.4	8.9	8.6	8.4	13.8	13.4	13.2	12.4	19.2	18.1	17.9	17.6

S_2 - Sodium oleate
d_1 - Purified Teepol

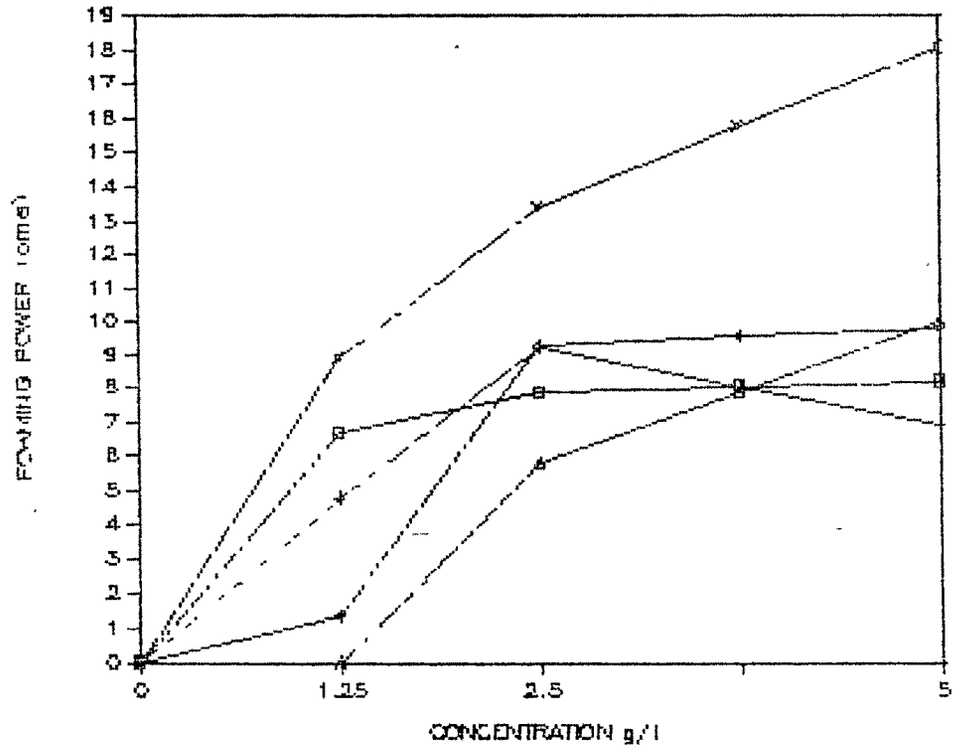
GRAPH 23- FOAMING POWER OF COMBINATION I (501 BAR SOAP & TEEPOL) VERSUS CONCENTRATION



Combination I

501 Bar Soap	: Teepol
100	: 0 (□)
75	: 25 (+)
50	: 50 (◇)
25	: 75 (△)
0	: 100 (✳)

GRAPH 24- FOAMING POWER OF COMBINATION II (SODIUM OLEATE & TEEPOL) VERSUS CONCENTRATION



Combination II

Sodium Oleate	: Purified Teepol
100	: 0 (□)
75	: 25 (+)
50	: 50 (◇)
25	: 75 (△)
0	: 100 (✳)

Table 32 Foaming power of combination III (501 bar soap and sodium lauryl sulphate) at varying ratios and concentration

Combination III Per cent ration S_1 : d_2	Foaming power (cms)											
	1.25 g/l				2.5 g/l				5.0 g/l			
	30 secs	2 mins	5 mins	10 mins	30 secs	2 mins	5 mins	10 mins	30 secs	2 mins	5 mins	10 mins
100 : 0	2.4	2.2	2.0	1.5	7.6	6.6	6.4	6.2	8.6	8.1	7.8	7.6
75 : 25	0.6	0.3	0.3	0.2	9.0	8.6	7.9	7.4	9.4	8.2	7.6	7.3
50 : 50	0.8	0.7	0.4	0.2	11.3	8.7	7.3	5.4	11.2	10.1	9.5	8.6
25 : 75	8.6	7.1	3.3	2.2	13.0	11.5	10.0	8.2	13.1	12.0	11.2	11.0
0 : 100	12.2	11.6	11.1	10.9	19.0	18.2	17.4	16.9	19.6	18.5	17.5	16.9

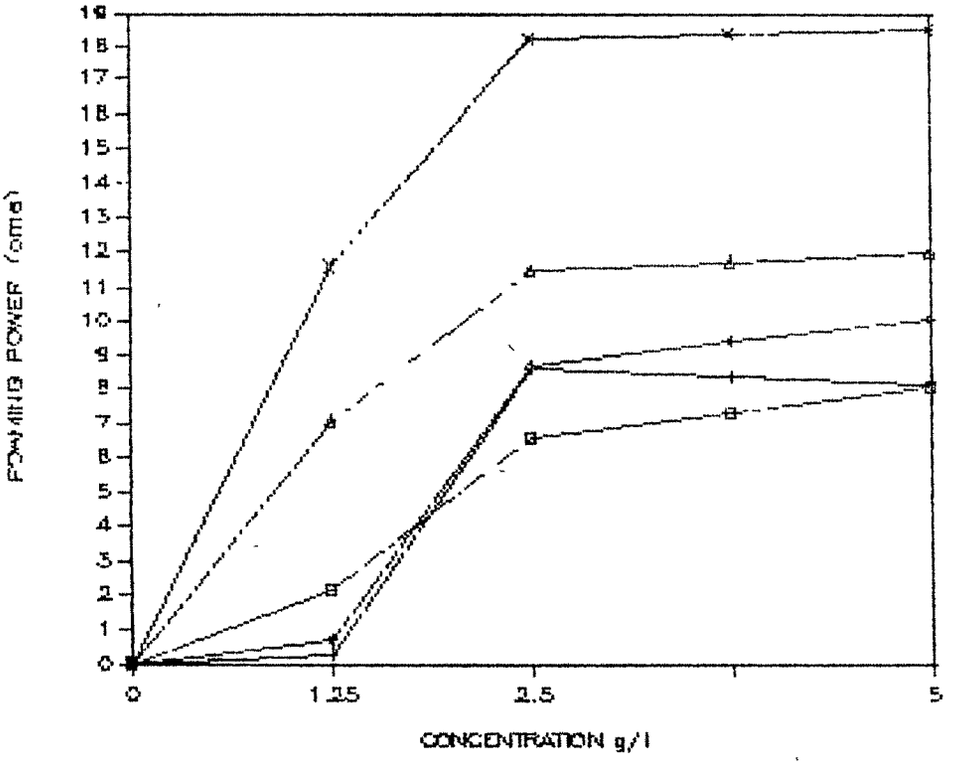
S_1 - Purified 501 bar soap
d_2 - Sodium lauryl sulphate

Table 33 Foaming power of combination IV (501 bar soap and Lissapol N) at varying ratios and concentration

Combination IV Per cent ratio S_1 : d_3	Foaming power (cms)											
	1.25 g/l				2.5 g/l				5.0 g/l			
	30 secs	2 mins	5 mins	10 mins	30 secs	2 mins	5 mins	10 mins	30 secs	2 mins	5 mins	10 mins
100 : 0	2.4	2.2	2.0	1.5	7.6	6.6	6.4	6.2	8.6	8.1	7.8	7.6
75 : 25	0.4	0.3	0.2	0.1	1.1	0.9	0.8	0.7	9.5	8.8	8.3	5.5
50 : 50	0.5	0.3	0.2	0.2	1.7	1.4	1.0	0.7	7.6	6.0	4.1	3.7
25 : 75	1.1	0.6	0.3	0.2	1.8	1.2	1.1	1.0	3.5	2.7	2.1	2.2
0 : 100	5.4	5.2	4.5	4.1	6.6	6.3	5.8	5.3	7.5	7.2	6.7	6.1

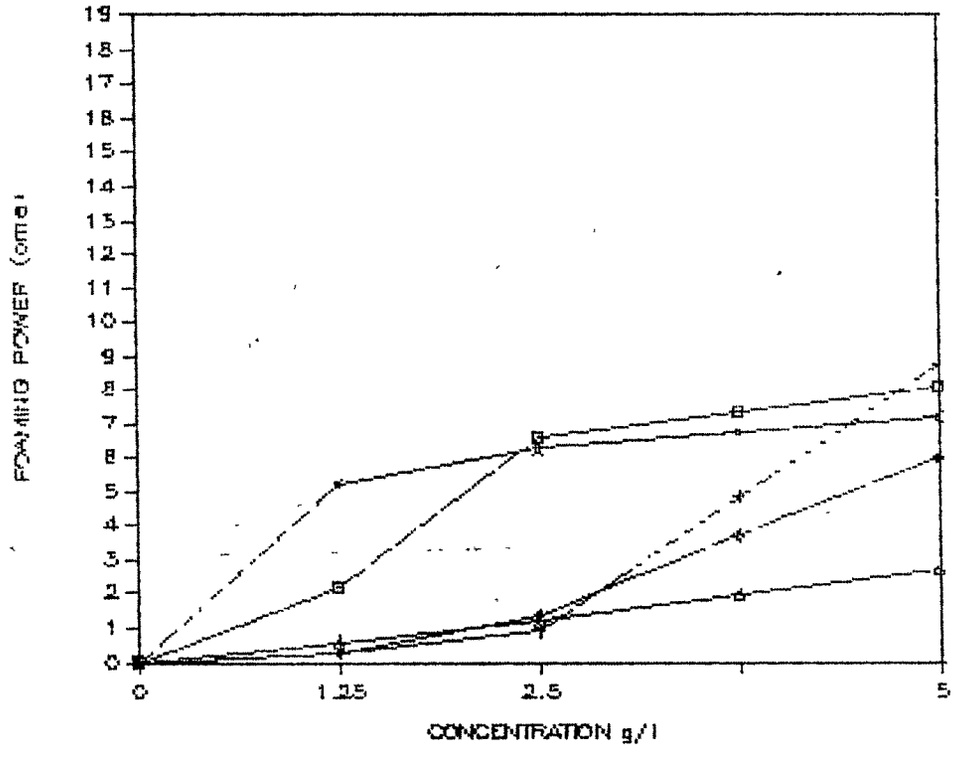
S_1 - Purified 501 bar soap
d_3 - Lissapol N

GRAPH 25- FOAMING POWER OF COMBINATION III (501 BAR SOAP & SODIUM LAURYL SULPHATE) VERSUS CONCENTRATION



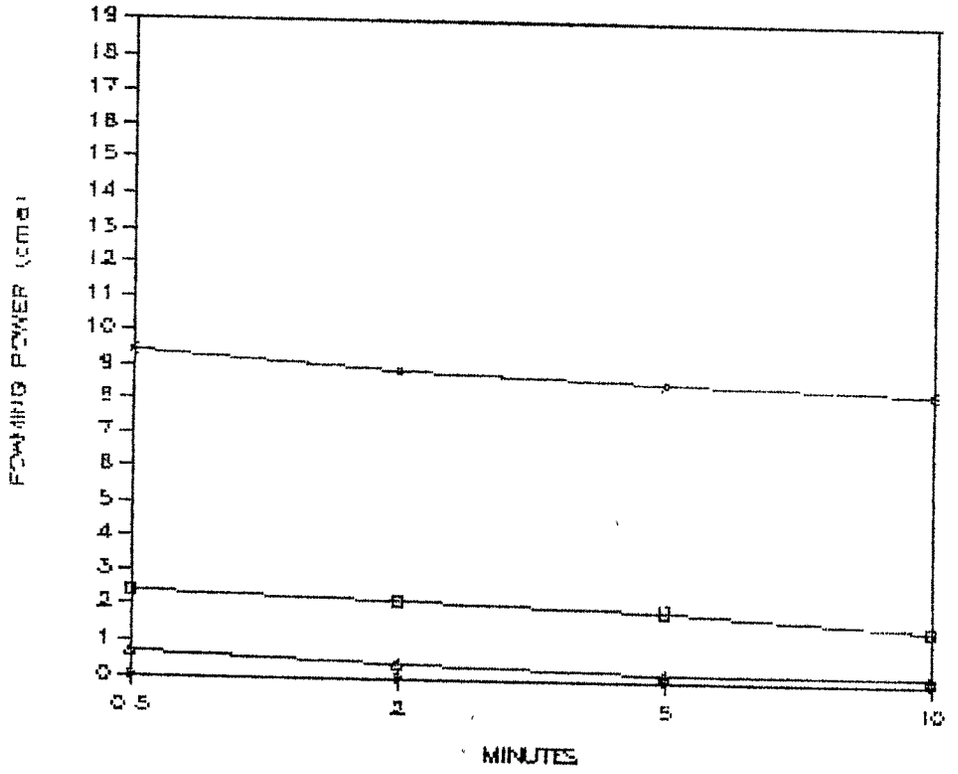
Combination III
Purified : Sodium
501 Bar : Lauryl
Soap : Sulphat
100 : 0 (□)
75 : 25 (+)
50 : 50 (◇)
25 : 75 (△)
0 : 100(✳)

GRAPH 26- FOAMING POWER OF COMBINATION IV (501 SOAP & LISSAPOL-N) VERSUS CONCENTRATION

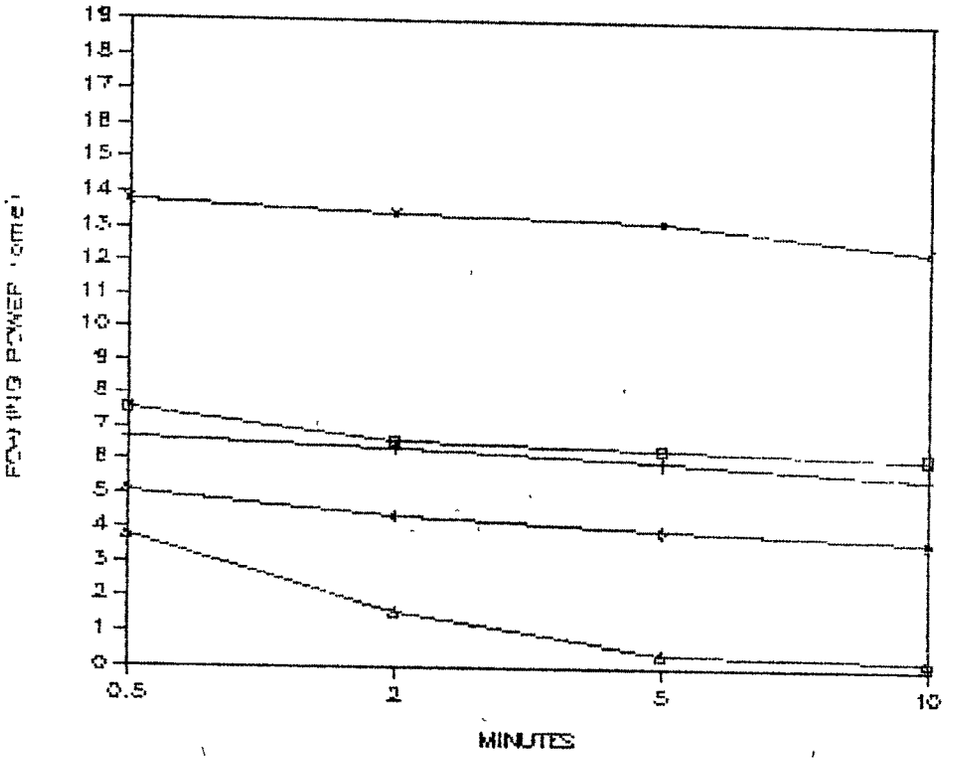


Combination IV
501 Bar : Lissapo
Soap : -N
100 : 0 (□)
75 : 25 (+)
50 : 50 (◇)
25 : 75 (△)
0 : 100(✳)

GRAPH 27a- STABILITY OF FOAM OF COMBINATION I (501 BAR SOAP & TEEPOL) AT 1.25 g/l CONCENTRATION

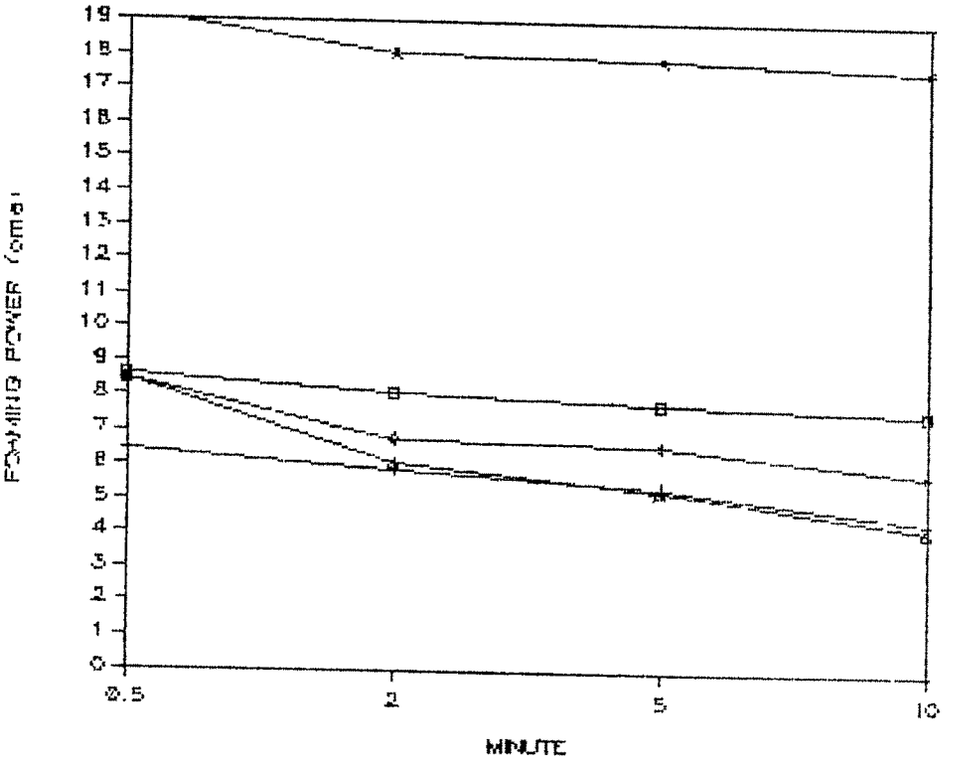


GRAPH 27b- STABILITY OF FOAM OF COMBINATION I (501 BAR SOAP & TEEPOL) AT 2.5 g/l CONCENTRATION



Combination I		
501 Bar Soap	:	Teepol
100	:	0 (□)
75	:	25 (†)
50	:	50 (◇)
25	:	75 (△)
0	:	100 (*)

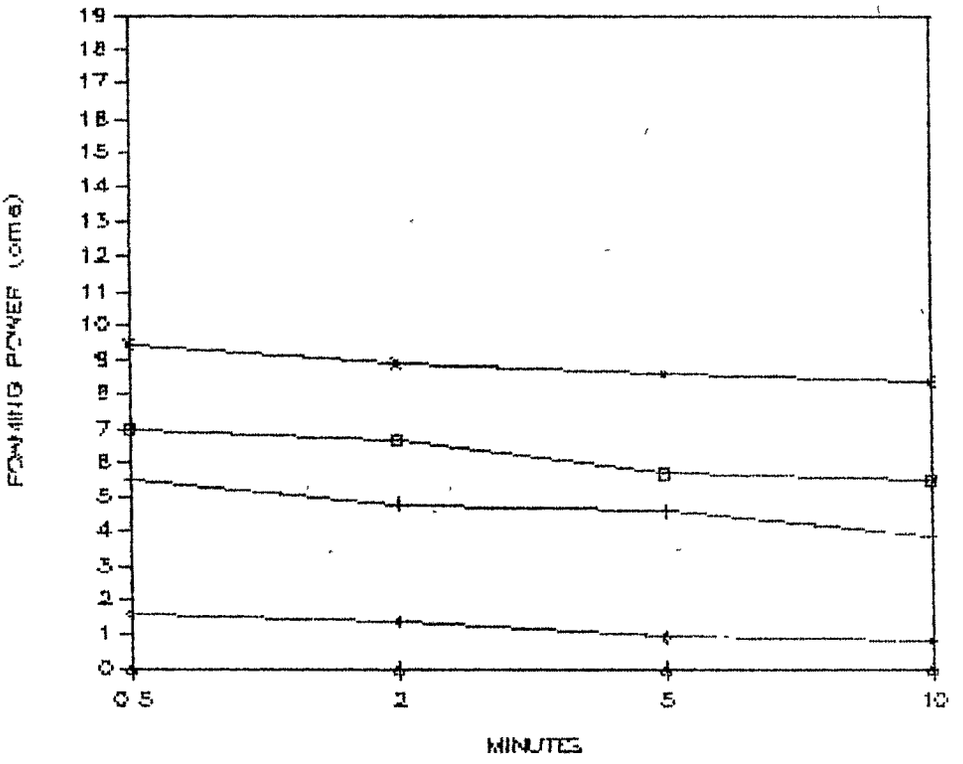
GRAPH 27c- STABILITY OF FOAM OF COMBINATION LI (501 BAR SOAP & TEEPOL) AT g/l CONCENTRATION



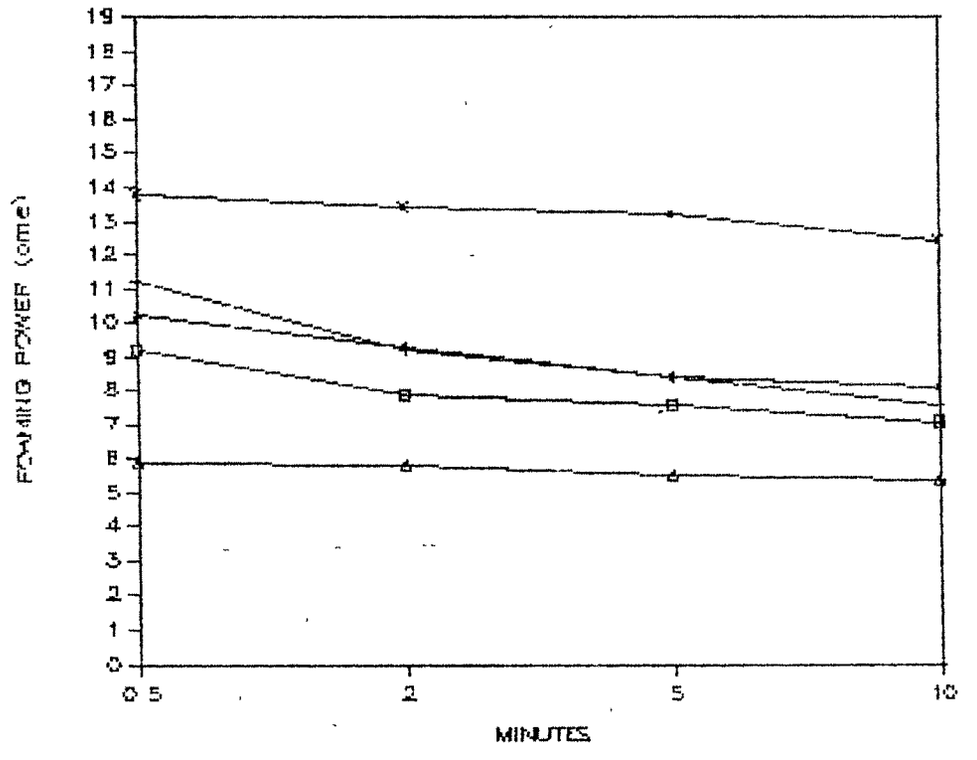
Combination I

501 Bar Soap	: Teepol
100	: 0 (□)
75	: 25 (+)
50	: 50 (◇)
25	: 75 (△)
0	: 100 (✱)

GRAPH 28a- STABILITY OF FOAM OF COMBINATION II (SODIUM OLEATE & TEEPOL) AT 1.25 g/l CONCENTRATION

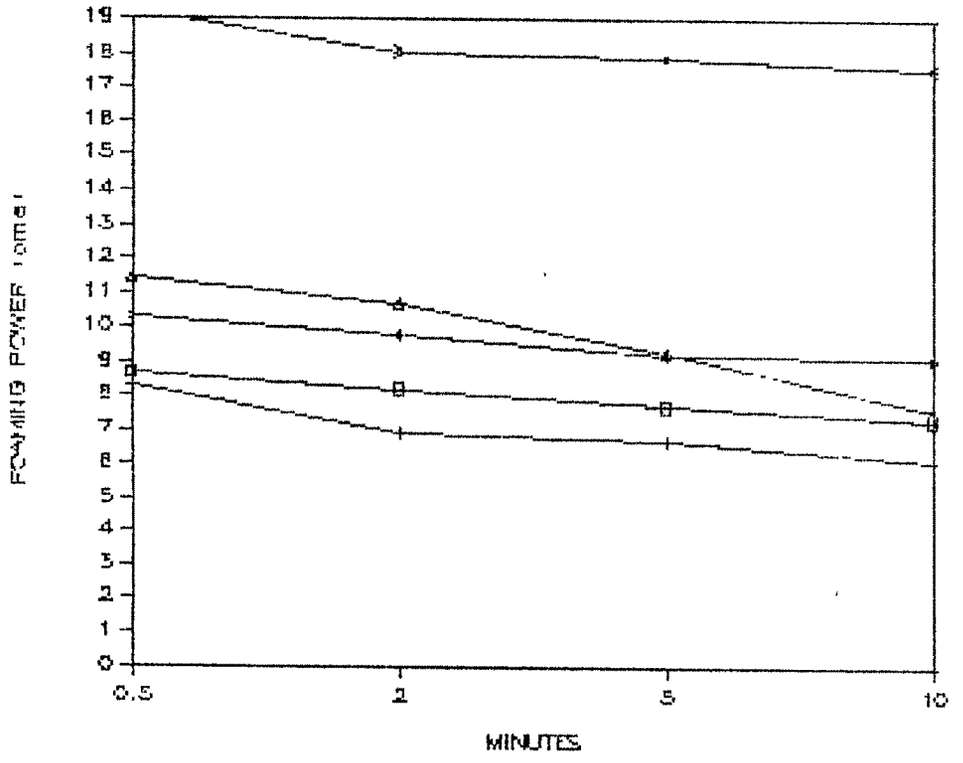


GRAPH 28b- STABILITY OF FOAM OF COMBINATION II (SODIUM OLEATE & TEEPOL) AT 2.5 g/l CONCENTRATION



Combination II Sodium Oleate	:	Purified Teepol
100	:	0 (□)
75	:	25 (+)
50	:	50 (◇)
25	:	75 (△)
0	:	100 (✳)

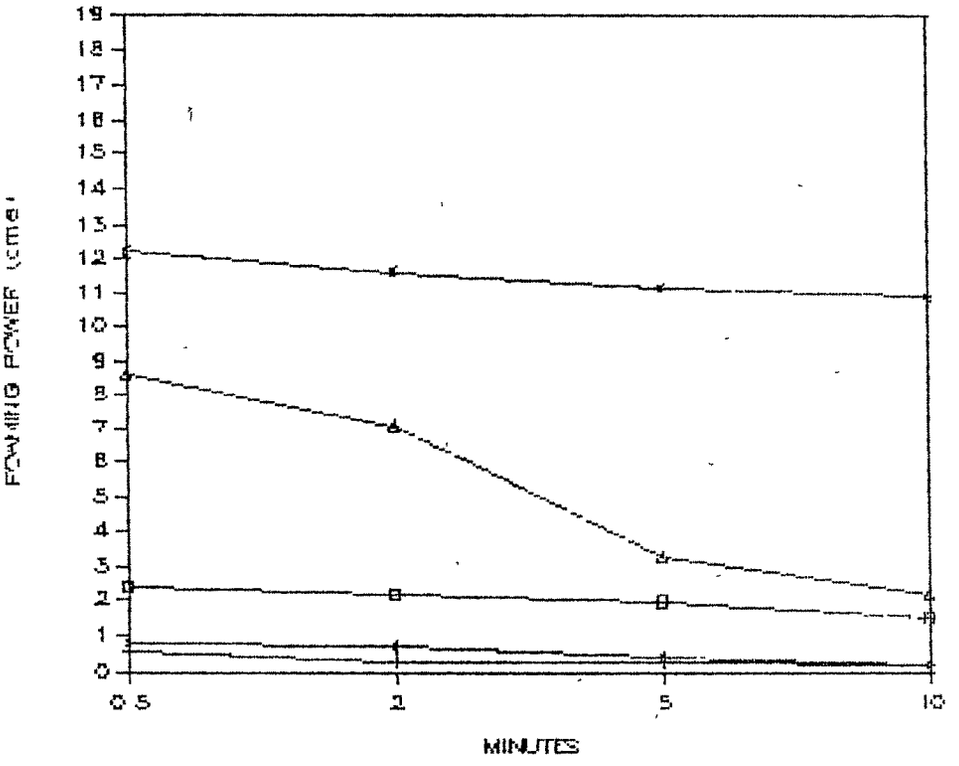
GRAPH 28c- STABILITY OF FOAM OF COMBINATION II (SODIUM OLE & TEEPOL) AT 5 g/l CONCENTRATION



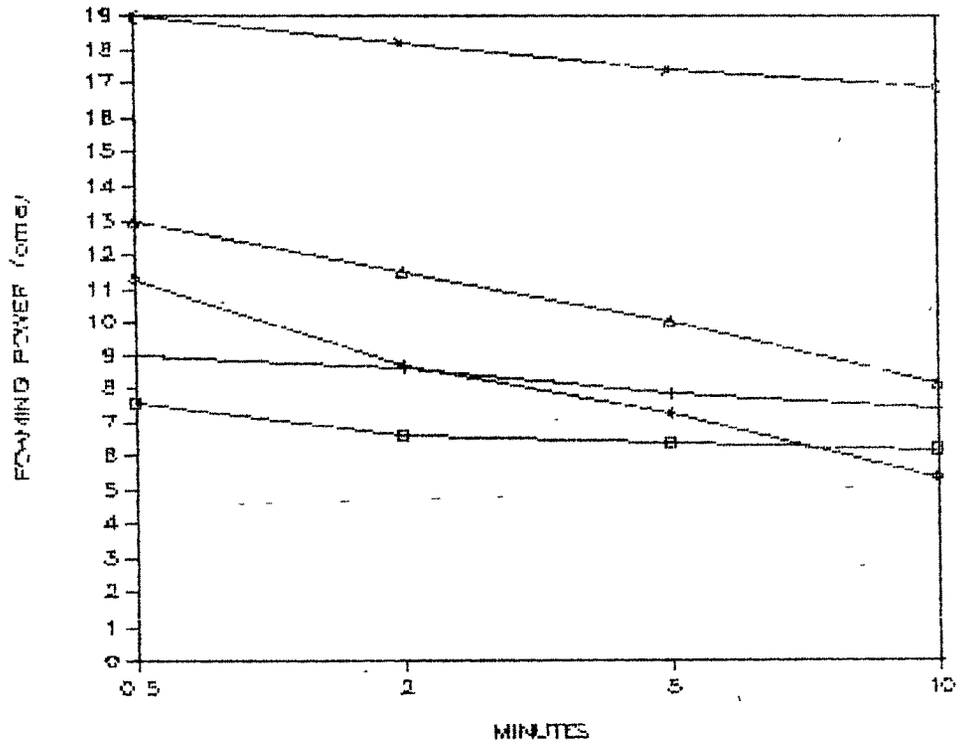
Combination II

Sodium Oleate		Purified Teepol
100	:	0 (□)
75	:	25 (+)
50	:	50 (◇)
25	:	75 (△)
0	:	100 (*)

GRAPH 29a- STABILITY OF FOAM OF COMBINATION III (501 BAR SOAP & SODIUM LAURYL SULPHATE) AT 1.25 g/l CONCENTRATION

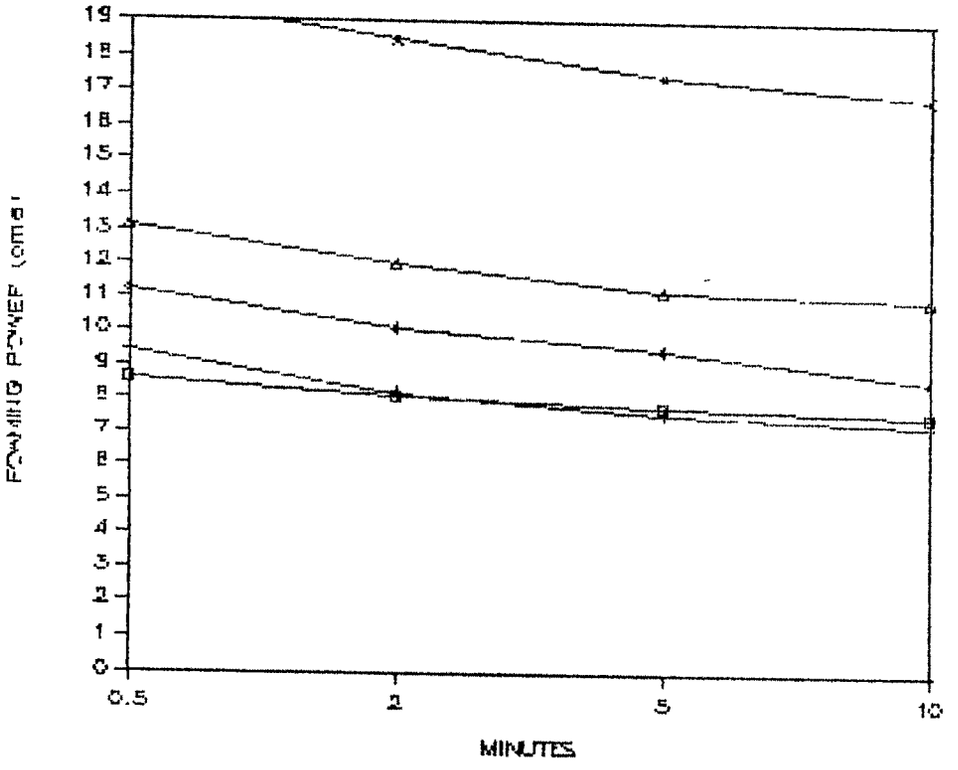


GRAPH 29b- STABILITY OF FOAM COMBINATION III (501 BAR SOAP & SODIUM LAURYL SULPHATE) AT 2.5 g/l CONCENTRATION



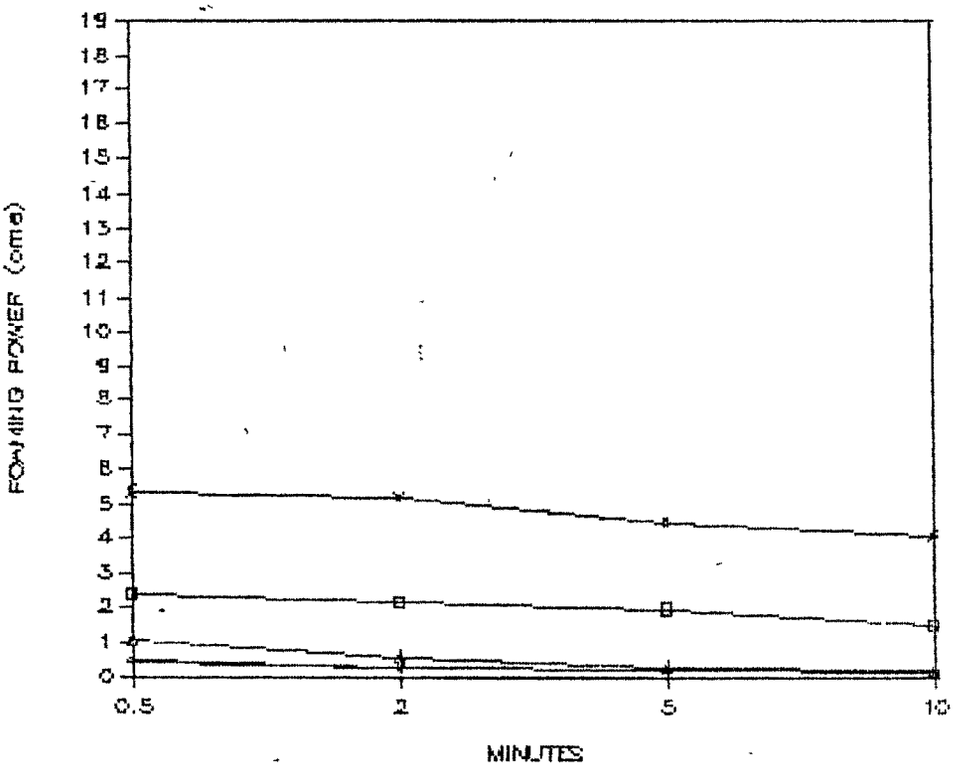
Combination III
Purified : Sodium
501 Bar : Lauryl
Soap : Sulpha
100 : 0 (□)
75 : 25 (+)
50 : 50 (◇)
25 : 75 (△)
0 : 100 (✕)

GRAPH 29c- STABILITY OF FOAM OF COMBINATION III (501 BAR SOAP & SODIUM LAURYL SULPHATE) AT 5 g/l CONCENTRATION

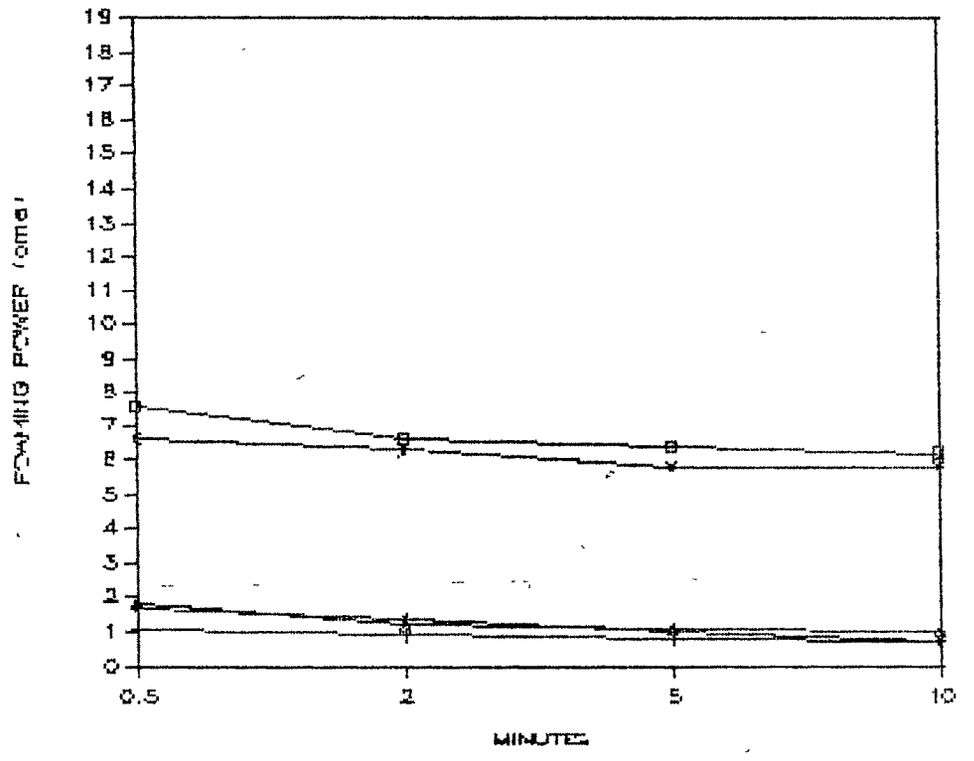


Combination III
Purified : Sodium
501 Bar : Lauryl
Soap : Sulphate
100 : 0 (□)
75 : 25 (+)
50 : 50 (◇)
25 : 75 (△)
0 : 100(✱)

GRAPH 30a- STABILITY OF FOAM OF COMBINATION IV (501 BAR SOAP & LISSAPOL-N) AT 1.25 *g/l CONCENTRATION



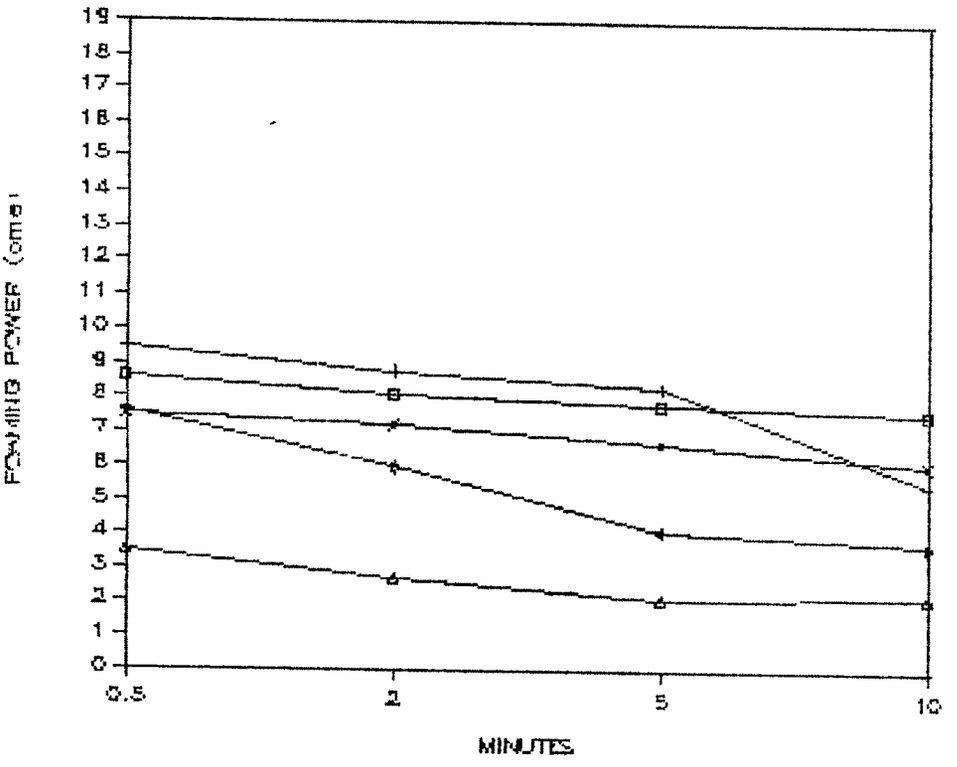
GRAPH 30b- STABILITY OF FOAM OF COMBINATION IV (501 BAR SOAP & LISSAPOL-N) AT 2.5 g/l CONCENTRATION



Combination IV

501 Bar Soap	:	Lissapol -N
100	:	0 (□)
75	:	25 (+)
50	:	50 (◇)
25	:	75 (△)
0	:	100 (*)

GRAPH 30c- STABILITY OF COMBINATION OF IV (501 BAR SOAP & LISSAPOL -N) AT 5 g/l CONCENTRATION



Combination IV
501 Bar : Lissapol
Soap : -N
100 : 0 (□)
75 : 25 (+)
50 : 50 (◇)
25 : 75 (△)
0 : 100(✳)

It was seen from the data and graphs that a low concentration of 1.25 g/l there was no foam formed except in the combination III of purified 501 bar soap and sodium laurỳl sulphate where the latter was in higher amount. This could be due to the high foaming power of sodium lauryl sulphate. It could be concluded that by combining a soap and a synthetic detergent the foaming power does not improve but is lowered.

When the soap and synthetic detergents were combined and then the general properties studied it was seen that when in combination the surface tension at the lower concentration tends to lie in between the individual readings. The surface tension is reduced to half and the range of the readings for all combinations at various ratios and concentration. Percentage wettability at lower concentration of the combinations showed improvement when combined but at the higher concentration the wettability reduced. Wetting time showed improvement when in combination. Even a small quantity of a synthetic detergent improved the wetting time of the soaps. Emulsification and foaming power did not show any improvement when they were used in combinations.

A detergent is good if it gives good cleaning. This can be tested by determining the soil removal characteristics of the detergent. After the study of the characteristics of soaps and synthetic detergents, alone and in combination, these were studied for their cleaning efficiency.

5.4 Reflectance characteristics of scoured, soiled and washed samples

The three fabrics used for the present study were 100% cotton, 67/33 polyester/cotton blend fabric and 100% polyester. The reflectance characteristics were determined for these scoured fabrics (i.e. before soiling), after soiling (by solvent and emulsion soil) and after washing with different cleansing agents at 5.0 g/l. The data for the reflectance measurements for the above has been given in Tables 34 - 36.

Table 34 Reflectance measurement of scoured, soiled and washed cotton fabric

	Agent:	Reflectance readings				
		Scoured sample	a		b	
			Soiled sample	Washed sample	Soiled sample	Washed sample
1	501 bar soap			64.0		58.5
2	Sodium oleate			56.0		60.0
3	Teepol	72.2	23.6	45.6	19.6	53.0
4	Sodium lauryl sulphate			56.3		62.4
5	Lissapol-N			42.0		48.5

a Solvent soiling
b Emulsion soiling

Table 35 Reflectance measurements of scoured, soiled and washed polyester/cotton blend fabrics

	Agent:	Reflectance readings				
		Scoured sample	a		b	
			Soiled sample	Washed sample	Soiled sample	Washed sample
1	501 bar soap			58.3		58.6
2	Sodium oleate			62.3		60.0
3	Teepol	66.2	20.3	49.6	18.5	56.2
4	Sodium lauryl sulphate			59.0		63.1
5	Lissapol-N			50.3		54.0

a Solvent soiling
b Emulsion soiling

Table 36 Reflectance measurements of scoured, soiled and washed polyester fabric

	Agent;	Reflectance readings				
		Scoured sample	a		b	
			Soiled sample	Washed sample	Soiled sample	Washed sample
1	501 bar soap			64.3		64.6
2	Sodium oleate			63.0		64.3
3	Teepol	66.5	23.26	58.6	18.5	62.1
4	Sodium lauryl sulphate			63.6		63.0
5	Lissapol-N			57.3		59.0

a Solvent soiling
b Emulsion soiling

Note: The white tile of the instrument was adjusted at 75.

From the above tables it was seen that the soiling (solvent and emulsion) was approximately the same for all the three fabrics although emulsion soiling was a little more as compared to solvent soiling but it was seen that it was more easily removed than solvent soiled samples during laundering. The scoured cotton sample gave the maximum reflectance reading and hence was the closest to the white tile.

From the readings it was also seen that maximum soil was removed from polyester fabric and minimum from cotton fabric by both methods of soiling and by all cleaning agents.

The soaps (purified 501 bar soap and sodium oleate) and anionic synthetic detergent (sodium lauryl sulphate) were more efficient cleaning agents as compared with Teepol and nonionic synthetic detergent Lissapol N.

5.5.1 Cleaning efficiency (% soil removed) of soaps and synthetic detergents at different concentrations

The efficiency of a soap or a synthetic detergent is judged by the way it brings about the cleaning of garments. The characteristics like rate of wetting, foaming ability along with emulsifying properties are general indicators; however its ability to remove sufficient soil so as to make garments look new or cleaned can make it a good detergent for laundry. To see the effect of these properties of detergents ~~have~~ on soil removal or to what extent these general properties of detergent are related to actual cleaning, the soil removal properties of detergents were studied.

The detergent properties of cleaning agents were evaluated on the basis of the percentage soil removed. Reflectance readings for soiled samples (before and after washing) were taken on photovolt reflectance meter. The per cent soil removed was calculated by the formula given below:

$$\% \text{ soil removed} = \frac{Rw - Rs}{Ro - Rs} \times 100$$

where Rw - Reflectance of washed sample

Rs - Reflectance of soiled sample

Ro - Reflectance of original sample

If the soil is thoroughly removed in washing then per cent soil removed will come to 100 but this is only theoretically expected. In practice if the readings are lower they are still acceptable.

The cleaning efficiency of the soaps (501 bar soap and sodium oleate) and the synthetic detergents (Teepol, sodium lauryl sulphate, Lissapol N) were tested on three test fabrics as given below :

(a) Cotton fabric

(b) Polyester/cotton (67/33) blend fabric

(c) Polyester fabric.

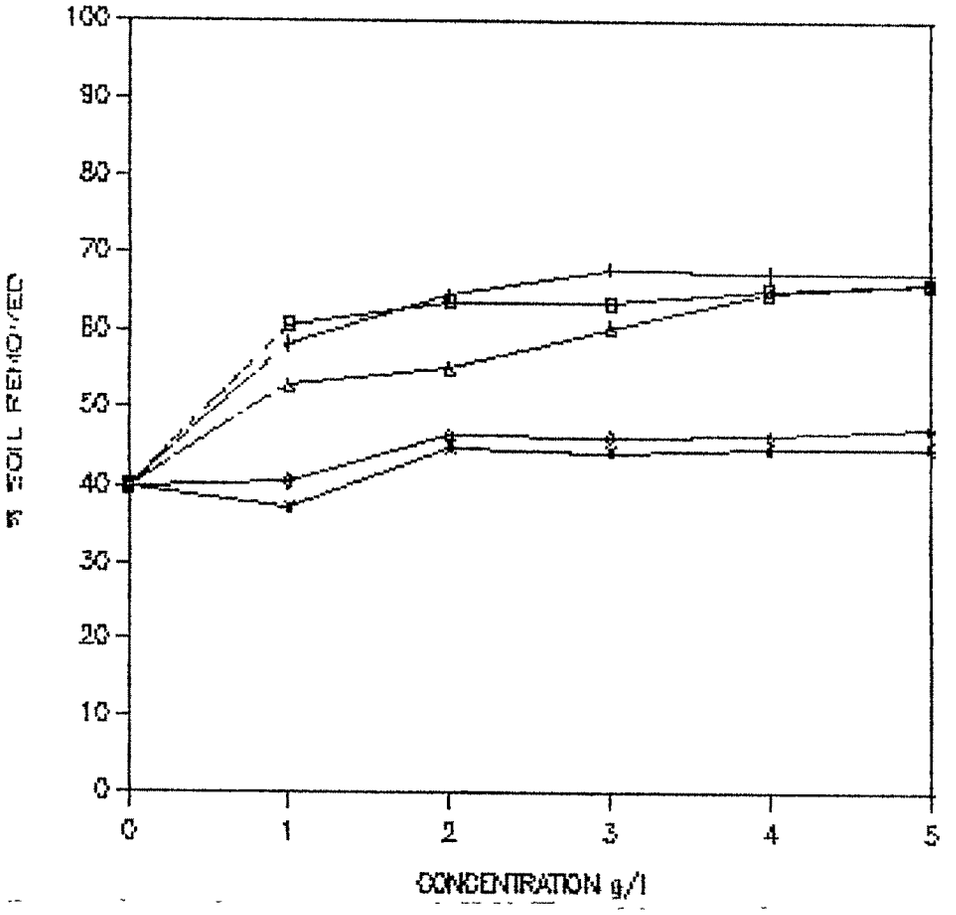
(a) Cotton fabric

Data on soil removal for cotton fabric has been given in Table 37 and shown in Graph 31.

Table 37 Data on % solvent soil removed for cotton fabric by soaps and synthetic detergent at varying concentration

Agents: / Conc. g/l	Soil removal (%)				
	Purified 501 bar soap (S_1)	Sodium oleate (S_2)	Purified Teepol (d_1)	Sodium lauryl sulphate (d_2)	Lissapol N (d_3)
1.0	60.73	58.27	40.75	53.05	37.32
2.0	63.64	64.40	46.51	55.27	44.91
3.0	63.54	67.86	46.32	60.36	44.29
4.0	65.19	67.55	46.51	64.66	44.89
5.0	65.92	67.62	47.53	66.35	44.92

GRAPH3⊢ RELATION BETWEEN % SOLVENT SOIL REMOVED & CONCENTRATION WITH SOAPS & SYNTHETIC DETERGENTS (COTTON FABRIC)



(□) Purified 501 Bar Soap (+) Sodium Oleate
(◇) Purified Teepol (△) Sodium Lauryl Sulphate
(*) Lissapol-N

From the data in Table 37 (also shown in Graph 31) it was observed that there was a gradual increase in soil removal in beginning upto 2.0 to 3.0 g/l concentration after which there was no further removal of soil (indicating that not all of the soil was removed as it was artificial (41).

Soaps (purified 501 bar soap and sodium oleate) were more efficient in removing soil, so also the detergent sodium lauryl sulphate. The synthetic detergent Teepol gave poor efficiency. The least effective was the nonionic one namely Lissapol N.

The soaps even at low concentrations showed good cleaning efficiency. Several researchers have reported that an anionic detergent was more effective than a nonionic detergent in removing oily soil from cellulosic fabrics (27). Soaps are also considered as better detergents for cotton than sulphate and sulphonated detergents as soaps when prepared in soft water with no salt builders of other solutes have shown higher soil suspending power than sulphates and sulphonated anionics or cationics (58).

In a study by Furry and Mclendon (22) the synthetic detergents in different concentrations removed less soil from cotton fabric as compared to soaps.

(b) Polyester/cotton (67/33) blend fabric

The data for the removal of soil for this fabric has been given in Table 38 and has been illustrated in Graph 32.

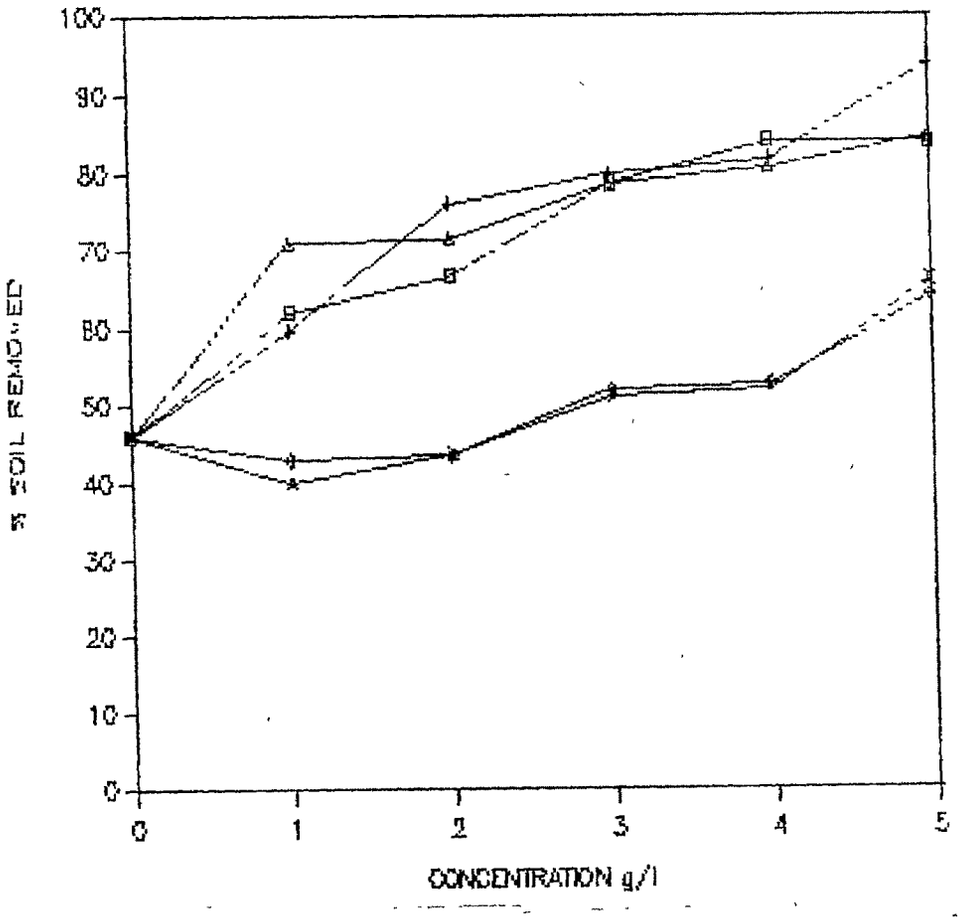
Table 38 Data on % solvent soil removal for polyester/cotton blend fabric by soaps and synthetic detergents at varying concentration

Agents: / Conc. g/l	Soil removal (%) Purified 501 bar soap (S_1)	Sodium oleate (S_2)	Purified Teepol (d_1)	Sodium lauryl sulphate (d_2)	Lissapol N (d_3)
1.0	61.92	59.78	42.97	71.27	40.11
2.0	66.92	75.99	43.59	71.59	43.76
3.0	78.75	79.78	51.97	78.37	51.20
4.0	83.91	81.71	52.85	80.57	52.20
5.0	83.68	93.81	64.09	84.52	66.01

The data in Table 38 and Graph 32 indicate that this equillibrium in soil removal (as noted above for cotton) no longer truly exist as such or can be disturbed.

The efficiency of soaps and sodium lauryl sulphate was much higher than that of Teepol and Lissapol N. The soil removed from the blend fabric was higher than that from cotton fabric.

GRAPH 32- RELATION BETWEEN % SOLVENT SOIL REMOVED & CONCENTRATION WITH SOAP & SYNTHETIC DETERGENTS (POLYESTER COTTON BLEND)



(□) Purified 501 Bar Soap (+) Sodium Oleate
(◇) Purified Teepol (△) Sodium Lauryl Sulphate
(*) Lissapol-N

This indicated the influences of polyester in the fabric. One can note that both the substrate and the cleaning agent have their independent influence on soil removal.

(c) Polyester fabric

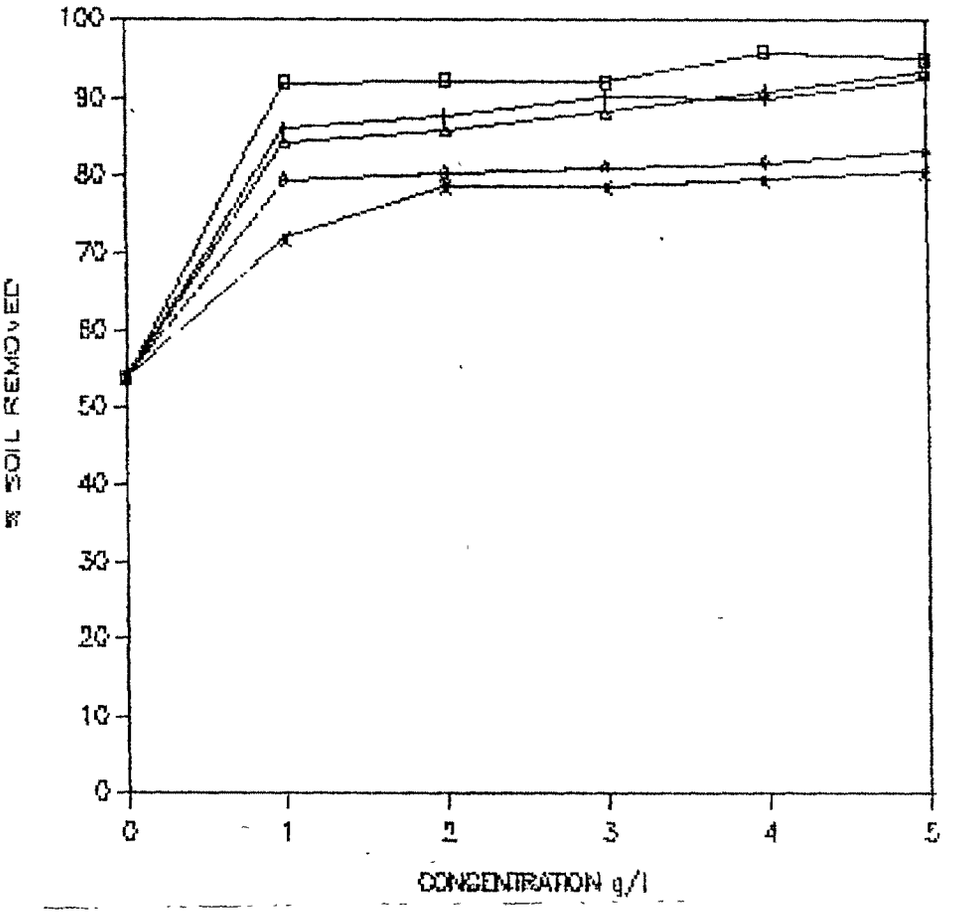
The data on percentage soil removed for the polyester fabric is given in Table 39 and illustrated in Graph 33.

Table 39 Data on % solvent soil removal for polyester fabric by soaps and synthetic detergents at varying concentration

Agents:	Soil removal (%)				
Conc. g/l	Purified 501 bar soap (S_1)	Sodium oleate (S_2)	Purified Teepol (d_1)	Sodium lauryl sulphate (d_2)	Lissapol N (d_3)
1.0	91.87	86.02	79.36	84.24	71.99
2.0	92.42	87.82	80.28	85.91	78.39
3.0	92.24	90.32	81.01	88.32	78.54
4.0	95.9	90.17	81.58	91.11	79.55
5.0	95.17	92.53	83.11	93.75	80.42

The cleaning efficiency by the agents for soil removal from polyester indicated further improvement in soil removal. Though Teepol and Lissapol N removed slightly less soil as compared to

GRAPH 33- RELATION BETWEEN % SOLVENT SOIL REMOVED & CONCENTRATION WITH SOAPS & SYNTHETICS DETERGENTS (POLYESTER FABRIC)



(□) Purified 501 Bar Soap (+) Sodium Oleate
(◇) Purified Teepol (△) Sodium Lauryl Sulphate
(*) Lissapol-N

the other three, their cleaning efficiency was also high (about 80%) while that of the other three (namely purified 501 bar soap, sodium oleate and sodium lauryl sulphate) just higher (above 90%). This is in agreement with the results of Lewis (40) who found that after one laundering a greater percentage of oily soil was removed from polyester fabric than from cotton fabric, and that this was because the soil tends to lie on the surface because of the smoothness and high crystallinity of the fabric.

In these results on soil removal given above it was also seen that after 2.0 g/l there was no further increase in per cent soil removed. In a study by Furry and Mclenden (22) for anionic and nonionic detergents the washing efficiency was generally greater at 1.5 g/l than at 0.5 g/l, the efficiency increased up to 2.5 g/l and remained unchanged thereafter. How to improve the results at higher concentration has been of interest to study. One can use increased agitation, but at the cost of some damage or additional alkaline substances so as to cause swelling but here too there is a tendency to cause damage. Hence the researcher has attempted to improve the cleaning by combinations of a soap and a detergent. These results follow in subsequent sections.

Per cent solvent soil removed by commercial 501 bar soap

To see the comparison in the cleaning efficiency of a built soap with an unbuilt the comparisons were made between the commercial 501 bar soap with purified 501 bar soap. It was seen after purification that the commercial bar soap (501) had 40% pure soap and 60% builders and impurities.

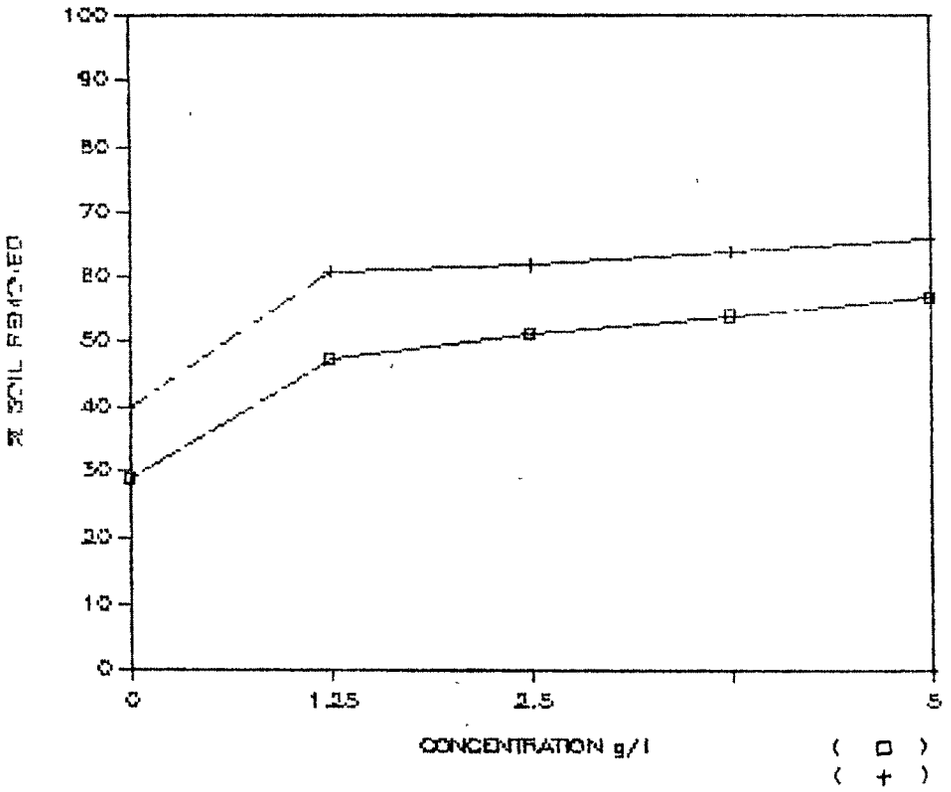
The cleaning efficiency of the commercial 501 bar soap has been given in Table 40 and has been compared with purified 501 bar soap in the Graphs 34 - 36.

Table 40. Data on % solvent soil removal by commercial 501 bar soap at varying concentration on different fabrics

Concentration g/l	Soil removal (%)					
	A		B		C	
	Commercial 501 bar soap	Purified 501 bar soap	Commercial 501 bar soap	Purified 501 bar soap	Commercial 501 bar soap	Purified 501 bar soap
1.25	47.32	60.80	58.45	66.33	66.6	88.88
2.5	51.17	61.92	61.38	66.80	75.59	92.30
5.0	56.9	65.90	74.17	83.68	89.59	95.17

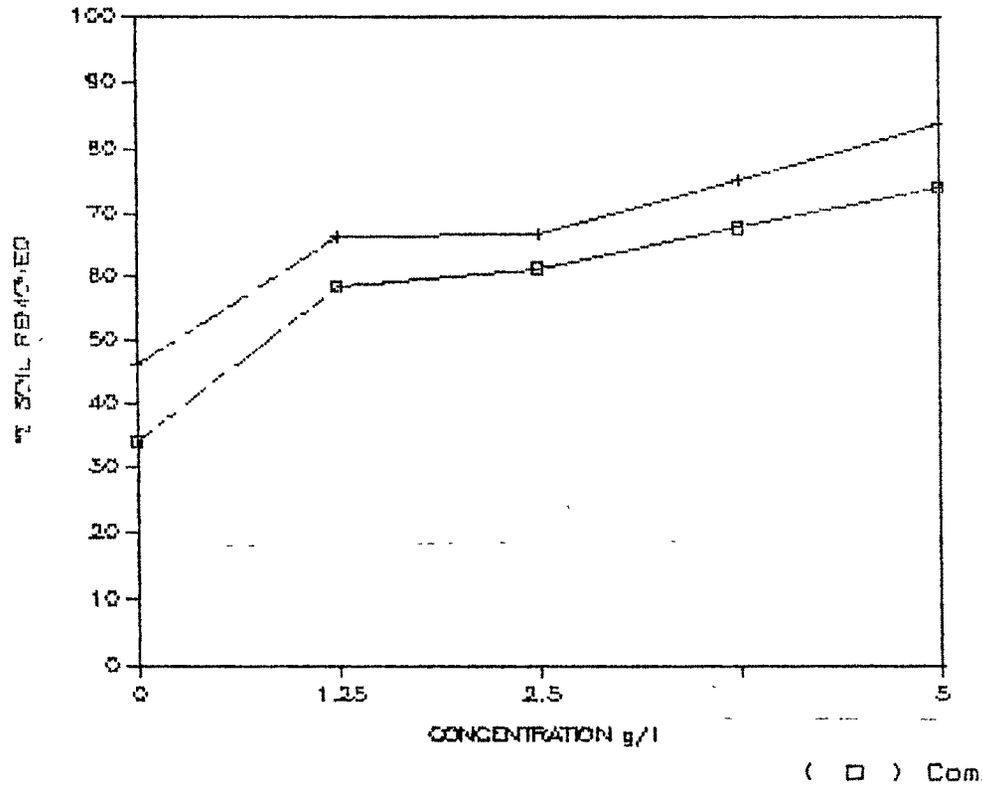
Fabric A - 100% cotton
Fabric B - 67/33 polyester/cotton
Fabric C - 100% polyester

GRAPH 34- RELATION BETWEEN % SOLVENT SOIL REMOVED & CONCENTRATION WITH COMMERCIAL 501 BAR SOAP (COTTON FABRIC)



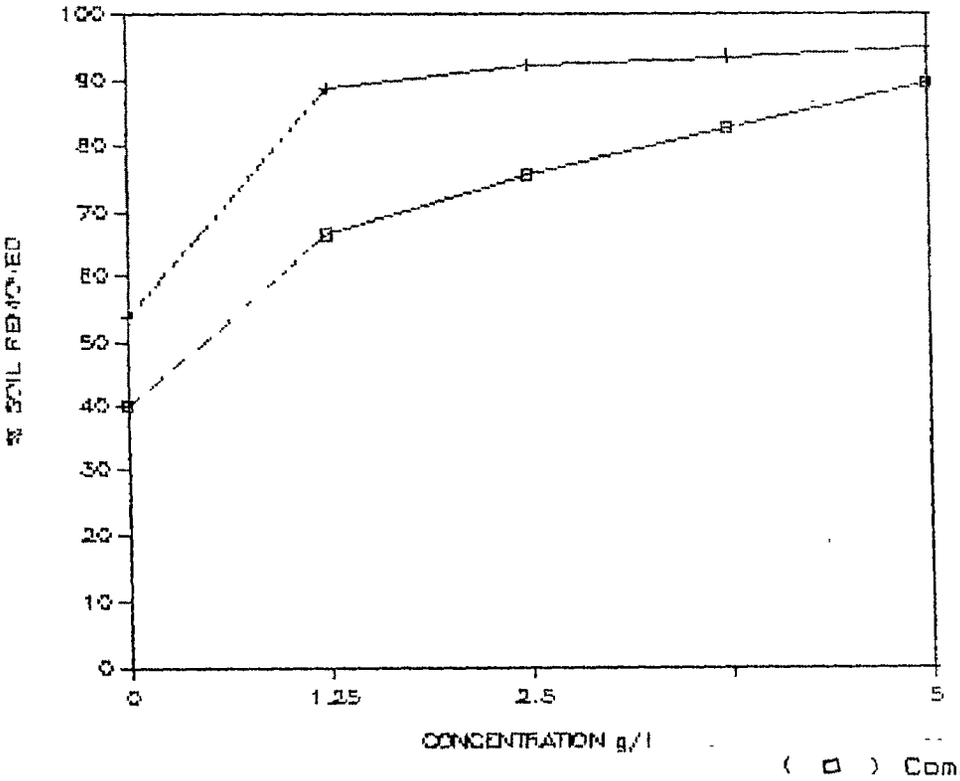
(□) Commercial 501 Bar Soap
(+) Purified 501 Bar Soap

GRAPH 35- RELATION BETWEEN % SOLVENT SOIL REMOVED & CONCENTRATION WITH COMMERCIAL 501 BAR SOAP (POLYESTER COTTON BLEND)



(□) Commercial 501 Bar Soap
(+) Purified 501 Bar Soap

GRAPH 36- RELATION BETWEEN % SOLVENT SOIL REMOVED & CONCENRATION WITH COMMERCIAL 501 BAR SOAPS (POLYESTER FABRIC)



(□) Commercial 501 Bar Soap
(+) Purified 501 Bar Soap

When commercial and purified 501 bar soap were compared for their cleaning efficiency purified 501 bar soap had better cleaning efficiency. Therefore it could be concluded that using a pure soap at a low concentration gives the same cleaning as using a commercial soap at a higher concentration.

Cleaning efficiency of samples soiled by emulsion soil using different soaps and synthetic detergents

Another variation in this study has been the use of emulsion soil for soiling of fabric samples. In the washing of garments, soil or stains from one part of a garment (especially the heavily soiled parts like collars, cuffs, hemlines) have a tendency to pass on to other parts either by direct contact or via emulsion-redeposition. Hence in studies on detergency it is useful to try emulsion soiling technique. This technique is receiving an attention in studies on cleaning agents.

Emulsion soil was thus used as another method of soiling mainly as a comparison to the conventional method of solvent soiling. Emulsion soil can help to assess the redeposition tendency during laundering of samples.

Samples were soiled with emulsion soil and then washed in the Launder-Ometer with the solutions of soaps and synthetic detergents at 2.5 g/l and 5.0 g/l concentration for 15 minutes at room temperature. From the reflectance data of emulsion samples before and after washing, % soil removed was calculated.

The data on the % soil (emulsion) removed has been given in Table 41 and illustrated in Graphs 37 - 39. The % emulsion soil removed has been compared with % solvent soil removed by plotting an histogram (Graphs 40 - 42).

It was seen from the histogram that emulsion soiled samples showed higher percentage soil removed than solvent soiled samples. Emulsion soil was more easily removed from cotton fabric as compared to solvent soil. From polyester fabric and the blend fabric also more emulsion soil was removed but the difference was not much. The anionic and nonionic synthetic detergents were more efficient in removing emulsion soil than solvent soil.

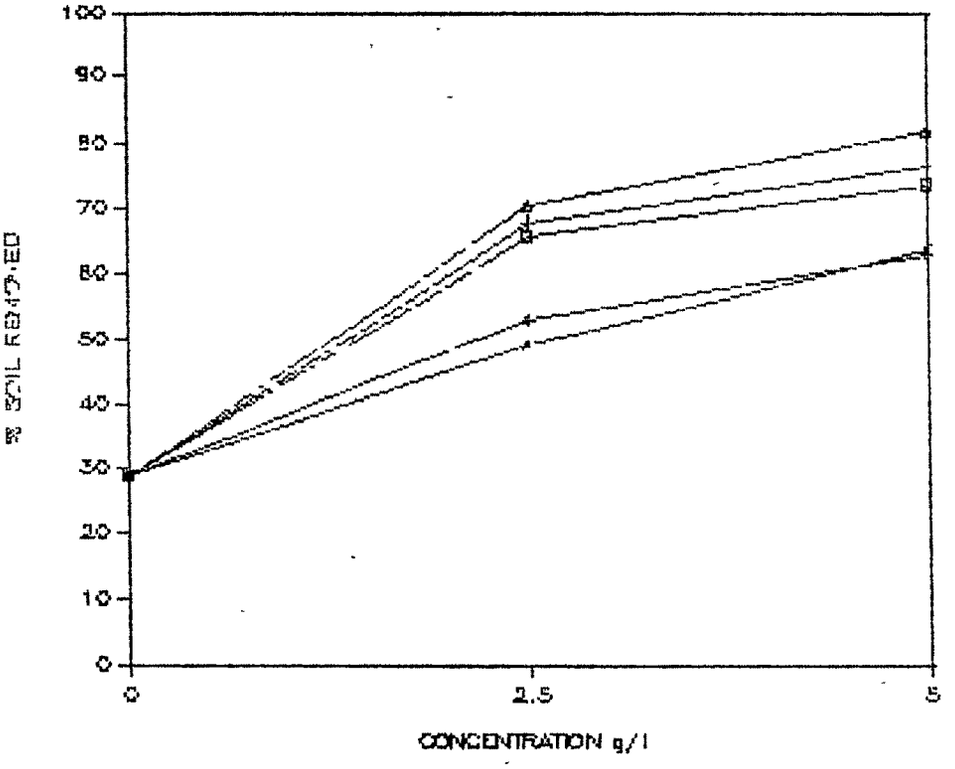
From the Graphs 37 - 39 of per cent emulsion soil removed from the three test fabrics at 2.5 g/l and 5.0 g/l concentration it was seen that emulsion soil was very easily removed from polyester and most difficult to remove from cotton which gave the poorest results. These results were similar to the solvent soil results.

Table 41. Data on % emulsion soil removal for the various fabrics by soaps and synthetic detergents at different concentrations

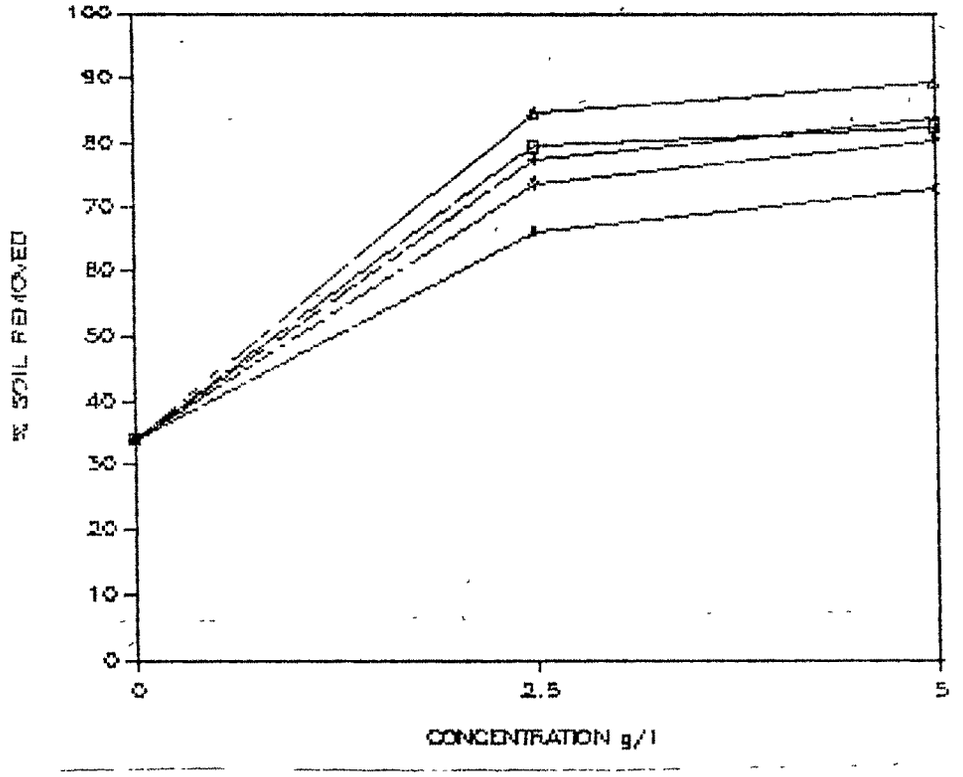
Detergent	Emulsion soil removal (%)					
	A		B		C	
	2.5 g/l	5.0 g/l	2.5 g/l	5.0 g/l	2.5 g/l	5.0 g/l
Purified 501 bar soap	65.57	73.5	79.40	82.4	88.56	95.3
Sodium oleate	67.66	76.6	77.28	83.9	88.51	93.9
Purified Teepol	53.23	62.9	73.46	80.5	80.15	92.9
Sodium lauryl sulphate	70.19	82.0	84.48	89.4	87.11	90.6
Lissapol N	49.19	63.7	66.11	72.5	79.03	83.4
Water						

Fabric A - 100% cotton
Fabric B - 67/33 polyester/cotton blend
Fabric C - 100% polyester

GRAPH 37- RELATION BETWEEN % EMULSION SOIL REMOVED & CONCENTRATION WITH SOAPS & SYNTHETIC DETERGENTS (COTTON FABRIC)

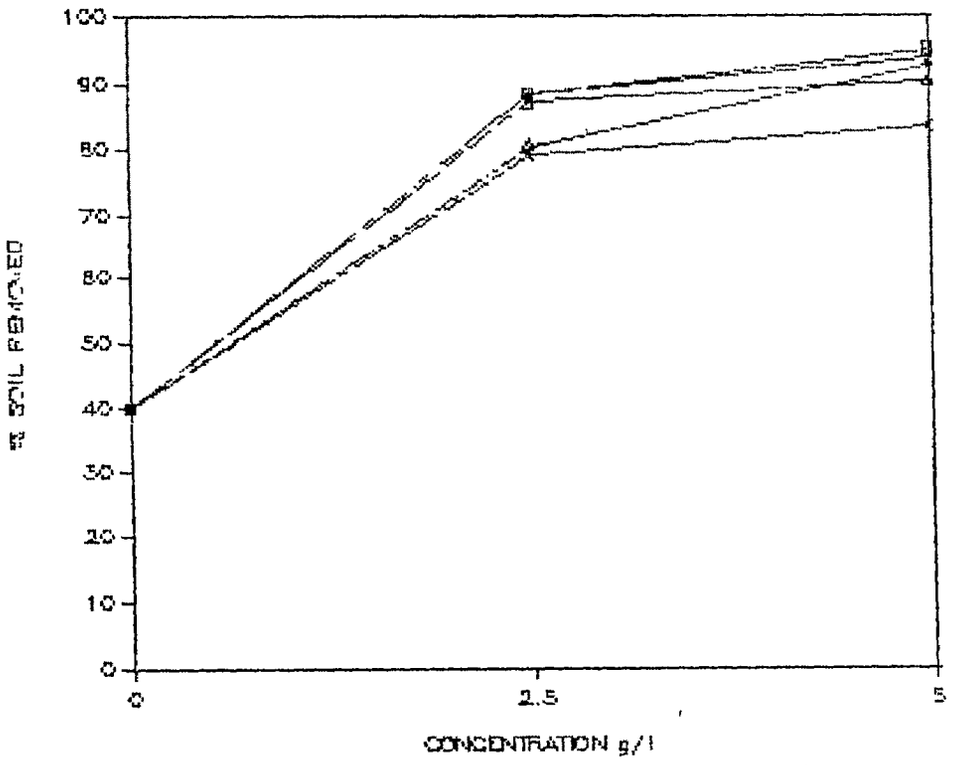


GRAPH 38- RELATION BETWEEN % EMULSION SOIL REMOVED & CONCENTRATION WITH SOAPS & SYNTHETIC DETERGENTS (POLYESTER COTTON BLEND)

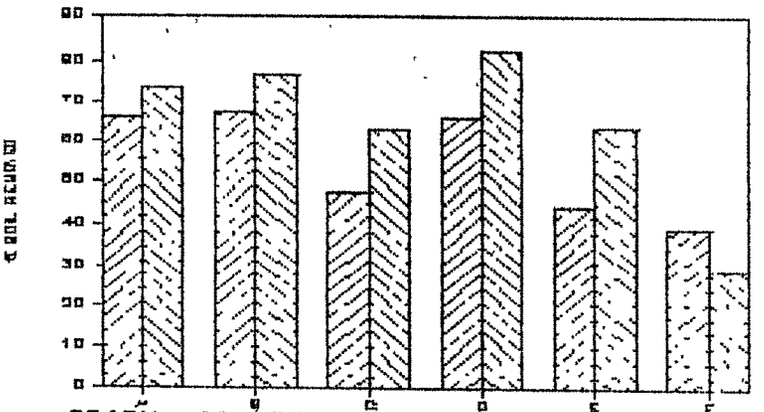


(□) Purified 501 Bar Soap (+) Sodium Oleate
(◇) Purified Teepol (△) Sodium Lauryl Sulphate

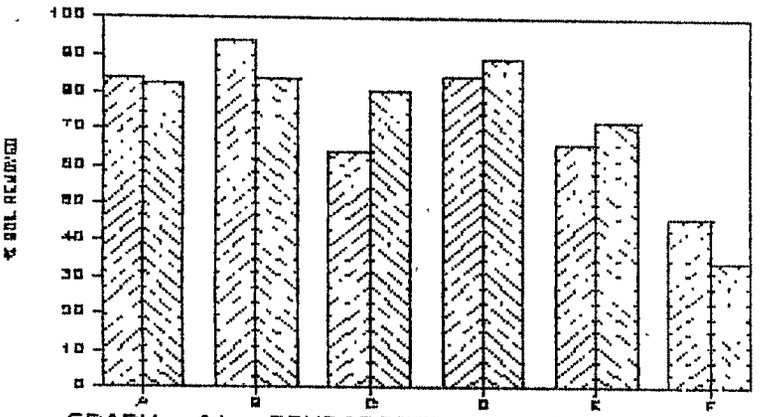
GRAPH 39- RELATION BETWEEN % EMULSION SOIL REMOVED & CONCENTRATION WITH SOAPS & SYNTHETICS (POLYESTER FABRIC)



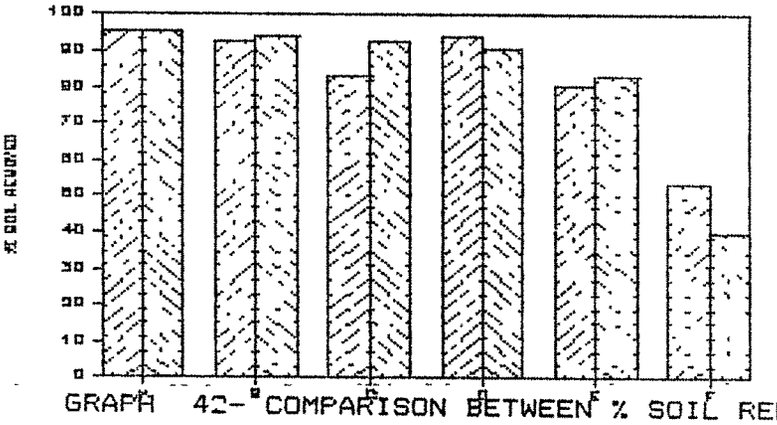
(□) Purified 501 Bar Soap (+) Sodium Oleate
(◇) Purified Teepol (△) Sodium Lauryl Sulphate
(✱) Lissapol-N



GRAPH 40- COMPARISON BETWEEN % SOIL REMOVED FROM SOLVENT & EMULSION SOILED SAMPLES WITH SOAPS & SYNTHETIC DETERGENTS T 5 g/l CONCENTRATION (COTTON FABRIC)



GRAPH 41- COMPARISON BETWEEN % SOIL REMOVED FROM SOLVENT & EMULSION SOIL SAMPLES WITH SOAPS & SYNTHETICS DETERGENTS AT 5 g/l CONCENTRATION (POLYESTER COTTON BLEND)



GRAPH 42- COMPARISON BETWEEN % SOIL REMOVED FROM SOLVENT & EMULSION SOILED SAMPLES WITH SOAPS & SYNTHETICS DETERGENTS AT 5 g/l CONCENTRATION (POLYESTER FABRIC)

Solvent Soiled Sample

Emulsion Soiled Sample

A Purified 501 Bar Soap
B Sodium Oleate
C Purified Teepol
D Sodium Lauryl Sulphate
E LIssapol-N
F Water

5.5.2 Cleaning efficiency (i.e. percentage soil removed) of soaps and synthetic detergents in combination at varying ratios and concentration

The combinations of a soap and a synthetic detergent were studied for the cleaning efficiency, as it is normally expected that in combination the properties of each component will supplement so as to improve the performances in washing. It was noted in the earlier section (page 47) on the cleaning efficiency of individual soaps and synthetic detergents that the soaps and sodium lauryl sulphate gave better cleaning efficiency as compared to Teepol and Lissapol N. From the results noted (page 123) on the general properties of the combinations of soaps and synthetic detergents it was also seen that even with the addition of a small amount of synthetic detergent to the soap the wetting is improved. This could be useful in improving the washing efficiency of the combinations.

Four combinations of a soap and a synthetic detergent were studied at varying per cent ratios and concentrations. These combinations were tried on the three test fabrics as mentioned below :

(a) Cotton fabric

(b) Polyester/cotton 67/33 blend

(c) Polyester fabric.

(a) Cotton fabric

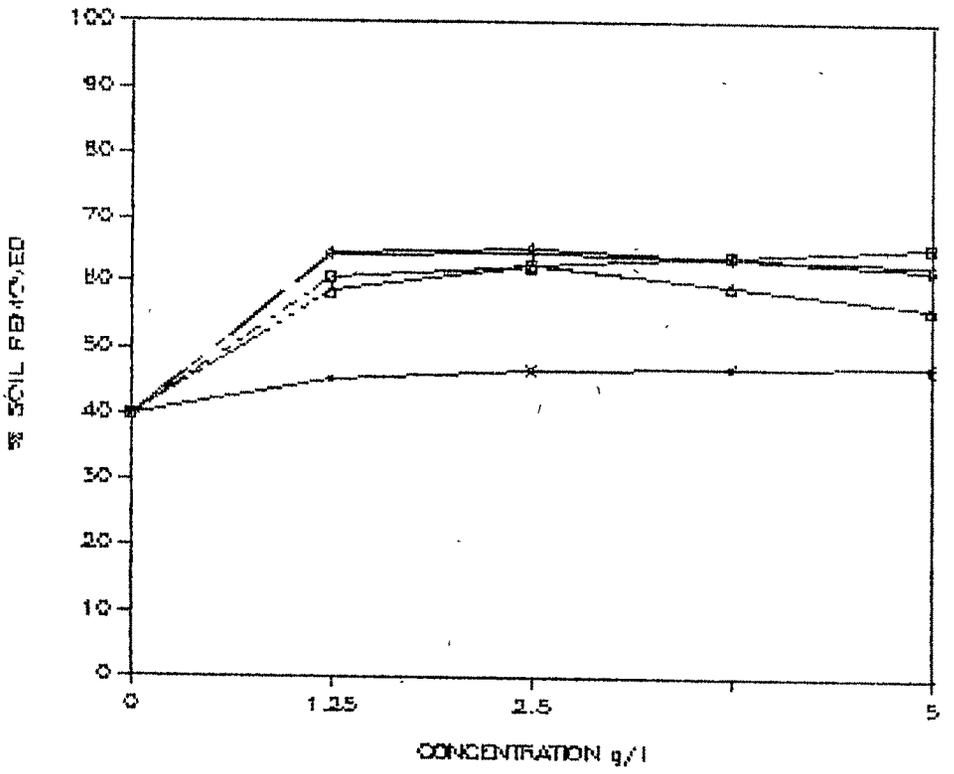
The per cent soil removed for the cotton fabric for these combinations has been given in Tables 42 - 45 and illustrated in Graphs 43 - 46.

Table 42 Per cent soil removed from cotton fabric by the combination I (501 bar soap and Teepol) at varying ratios and concentration

Combination I Per cent ratio S_1 : d_1	Soil removal (%) Conc. (g/l) 1.25	2.5	5.0
100 : 0	60.80	62.92	65.92
75 : 25	64.47	64.83	63.17
50 : 50	64.76	65.52	62.33
25 : 75	58.78	62.71	56.72
0 : 100	45.35	46.86	47.53

S_1 - Purified 501 bar soap
d_1 - Purified Teepol

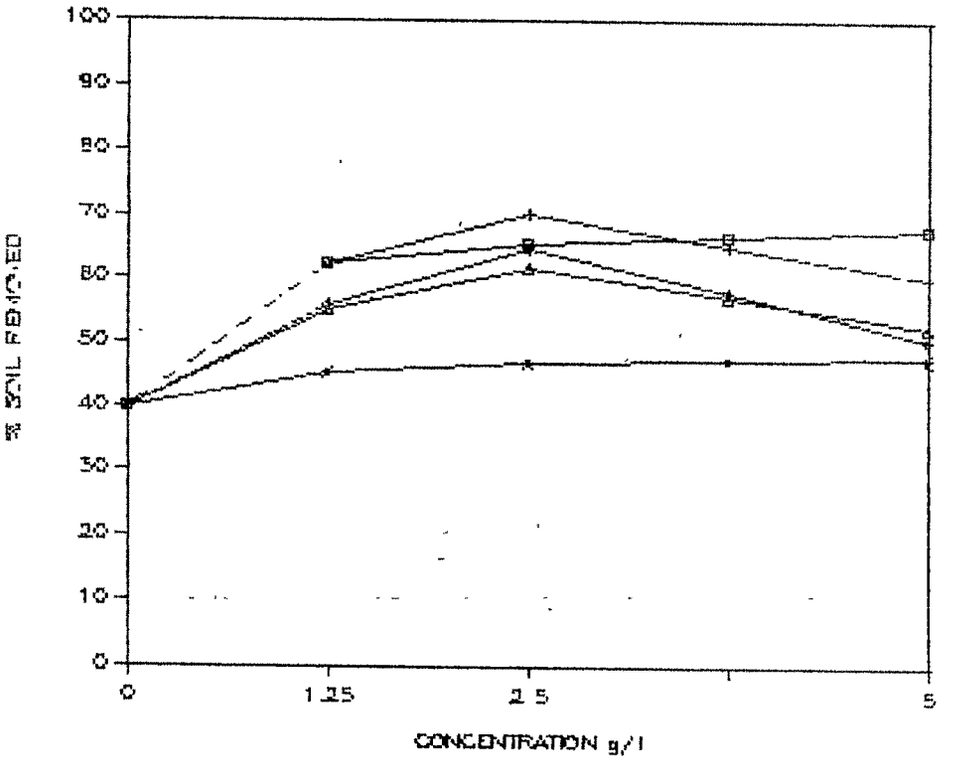
GRAPH 43- RELATION BETWEEN % SOLVENT SOIL REMOVED & CONCENTRATION WITH COMBINATION I, 501 BAR SOAP & TEEPOL (COTTON FABRIC)



Combination I

501 Bar Soap	: Teepol
100	: 0 (□)
75	: 25 (+)
50	: 50 (◇)
25	: 75 (△)
0	: 100 (✳)

GRAPH 44- RELATION BETWEEN % SOLVENT SOIL REMOVED & CONCENTRATION WITH COMBINATION II, SODIUM OLEATE & TEEPOL (COTTON FABRIC)



Combination II

Sodium Oleate	: Purified Teepol
100	: 0 (□)
75	: 25 (+)
50	: 50 (◇)
25	: 75 (△)
0	: 100 (✳)

Table 43 Per cent soil removed from cotton fabric by combination II (sodium oleate and Teepol) at varying ratio and concentration

Combination II Per cent ratio S_2 : d_1	Soil removal (%) Conc. (g/l) 1.25	2.5	5.0
100 : 0	62.49	65.54	67.82
75 : 25	62.42	70.30	60.01
50 : 50	55.77	64.89	50.45
25 : 75	55.08	61.59	52.22
0 : 100	45.35	46.86	47.53

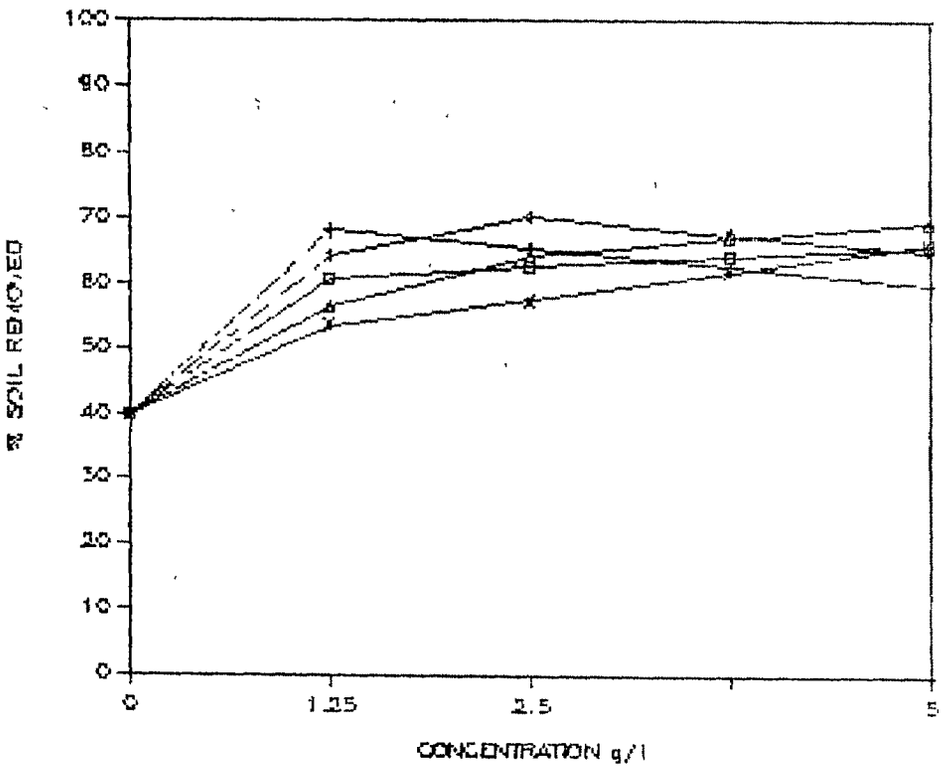
S_2 - Sodium oleate
d_1 - Purified Teepol

Table 44 Per cent soil removed from cotton fabric by combination III (501 bar soap and sodium lauryl sulphate) at varying ratios and concentration

Combination III Per cent ratio S_1 : d_2	Soil removal (%) Conc. (g/l) 1.25	2.5	5.0
100 : 0	60.80	62.92	65.92
75 : 25	68.07	65.50	60.22
50 : 50	64.42	70.21	65.12
25 : 75	56.66	64.44	69.62
0 : 100	53.65	57.65	66.35

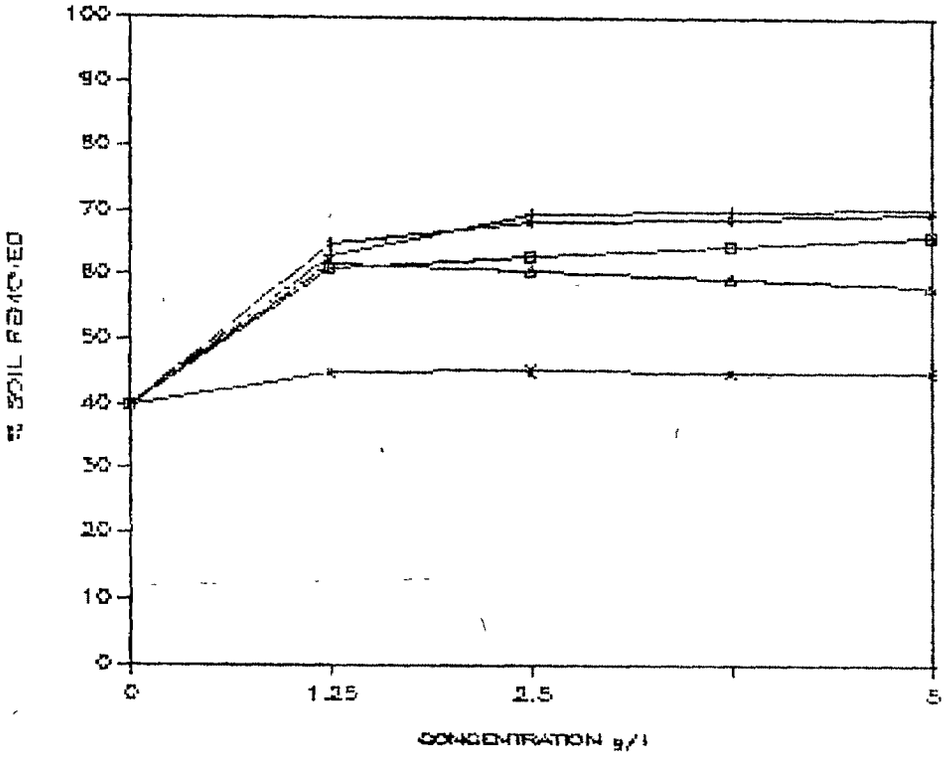
S_1 - Purified 501 bar soap
d_2 - Sodium lauryl sulphate

GRAPH 45- RELATION BETWEEN % SOLVENT SOIL REMOVED & CONCENTRATION WITH COMBINATION III, 501 BAR SOAP & SODIUM LAURYL SULPHATE (COTTON FABRIC)



Combination III
Purified : Sodium
501 Bar : Lauryl
Soap : Sulphate
100 : 0 (□)
75 : 25 (+)
50 : 50 (◊)
25 : 75 (△)
0 : 100(✳)

GRAPH 46- RELATION BETWEEN % SOLVENT SOIL REMOVED & CONCENTRATION WITH COMBINATION IV, 501 BAR SOAP & LISSAPOL-N (COTTON FABRIC)



Combination IV
501 Bar : Lissapol
Soap : -N
100 : 0 (□)
75 : 25 (+)
50 : 50 (◊)
25 : 75 (△)
0 : 100(✳)

Table 45 Per cent soil removed from cotton fabric by combination IV (501 bar soap and Lissapol N) at varying ratios and concentration

Combination IV Per cent ratio S_1 : d_3	Soil removal (%) Conc. (g/l) 1.25	2.5	5.0
100 : 0	60.80	62.92	65.92
75 : 25	62.65	69.44	70.29
50 : 50	64.85	68.26	69.32
25 : 75	61.56	60.63	58.30
0 : 100	44.82	45.18	44.92

S_1 - Purified 501 bar soap
d_3 - Lissapol N

It was seen from the data in Tables 42 - 45 that the combination I (purified 501 bar soap : purified Teepol) at the lower concentration of 1.25 g/l and 2.5 g/l, in the per cent ratio 75:25 and 50:50 removed more soil than when the two cleaning agents were used individually at 5.0 g/l. In combination II (sodium oleate and purified Teepol), all the three ratios at 2.5 g/l gave good results especially the per cent ratio 75:25 (sodium oleate : Teepol). In combination III (purified 501 bar soap and sodium lauryl sulphate), both the cleaning agents had good detergency properties all throughout. The best results were seen for the per cent ratio 25:75 (purified 501 bar soap : sodium lauryl sulphate) at all concentrations. In combination IV (purified 501 bar soap and nonionic synthetic detergent Lissapol N) very encouraging results were seen. The combinations

in the two per cent ratios of 75:25 and 50:50. The best results were seen at 2.5 g/l and it stayed constant till 5.0 g/l with no increase or decrease in per cent soil removed.

It was thus concluded that the overall performance of the combinations in soil removal was better than the individual ones. These could be arranged in the following order of performance : First purified 501 bar soap and Lissapol N, second purified 501 bar soap and sodium lauryl sulphate. Purified 501 bar soap and sodium oleate with purified Teepol were equivalent and third in the order of cleaning efficiency.

The optimum combination noted for cotton fabric has been of purified 501 bar soap and nonionic synthetic detergent Lissapol N (Combination IV).

Teepol in combination did not give good cleaning even though it has the property of quick wetting. Its insufficient emulsification ability could explain this. At 5.0 g/l, the final soil removal was less as compared to that at 2.5 g/l with combinations. When the general properties were studied in combination the same trend has been noted earlier. When used in combination the lower concentration of 2.5 g/l was seen to be more efficient than at 5.0 g/l. Overall it was seen that in combination a higher percentage of soap is more effective.

(b) Polyester/cotton (67/33) blend fabric

The data for per cent soil removed for the above fabric has been given in Tables 46 - 49 and illustrated in Graphs 47 - 50.

Table 46 Per cent soil removed from blend fabric by combination I (501 bar soap and Teepol) at varying ratios and concentration

Combination I Per cent ratio S_1 : d_1	Soil removal (%) Conc. (g/l) 1.25	2.5	5.0
100 : 0	66.33	66.80	83.68
75 : 25	65.37	66.84	83.23
50 : 50	71.20	67.31	78.69
25 : 75	62.38	64.25	76.48
0 : 100	44.22	48.22	64.09

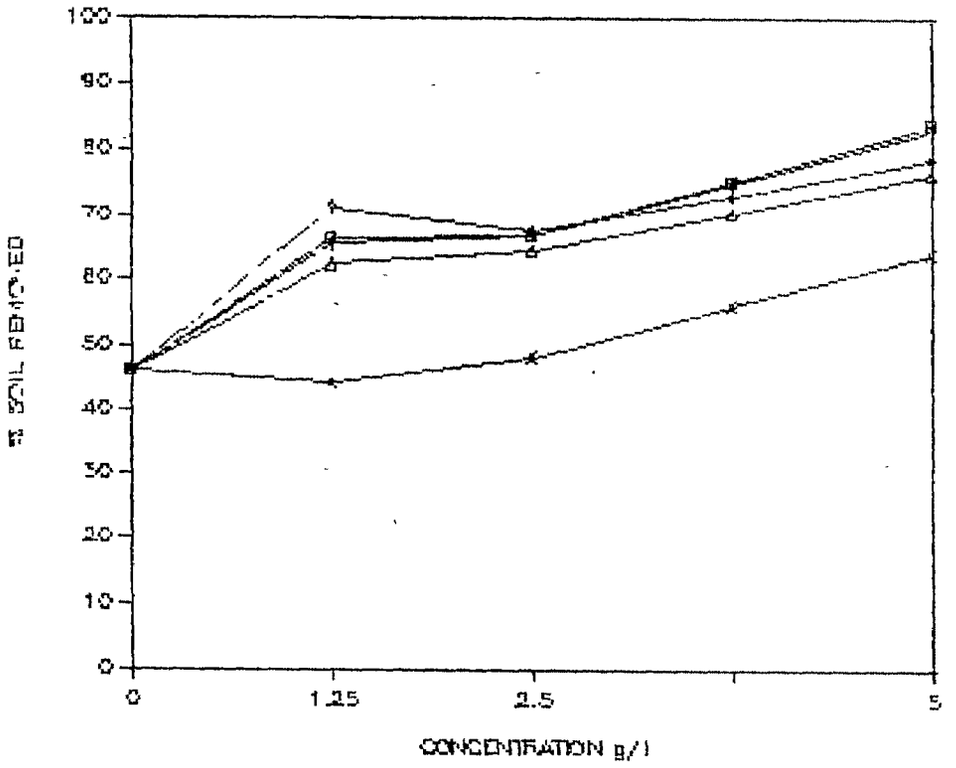
S_1 - Purified 501 bar soap
d_1 - Purified Teepol

Table 47 Per cent soil removed from blend fabric by combination II (sodium oleate and Teepol) at varying ratios and concentration

Combination II Per cent ratio S_2 : d_1	Soil removal (%) Conc. (g/l) 1.25	2.5	5.0
100 : 0	73.36	79.42	93.81
75 : 25	59.67	78.10	70.05
50 : 50	51.83	82.59	79.77
25 : 75	63.33	66.61	61.23
0 : 100	44.22	48.22	64.09

S_2 - Sodium oleate
d_1 - Purified Teepol

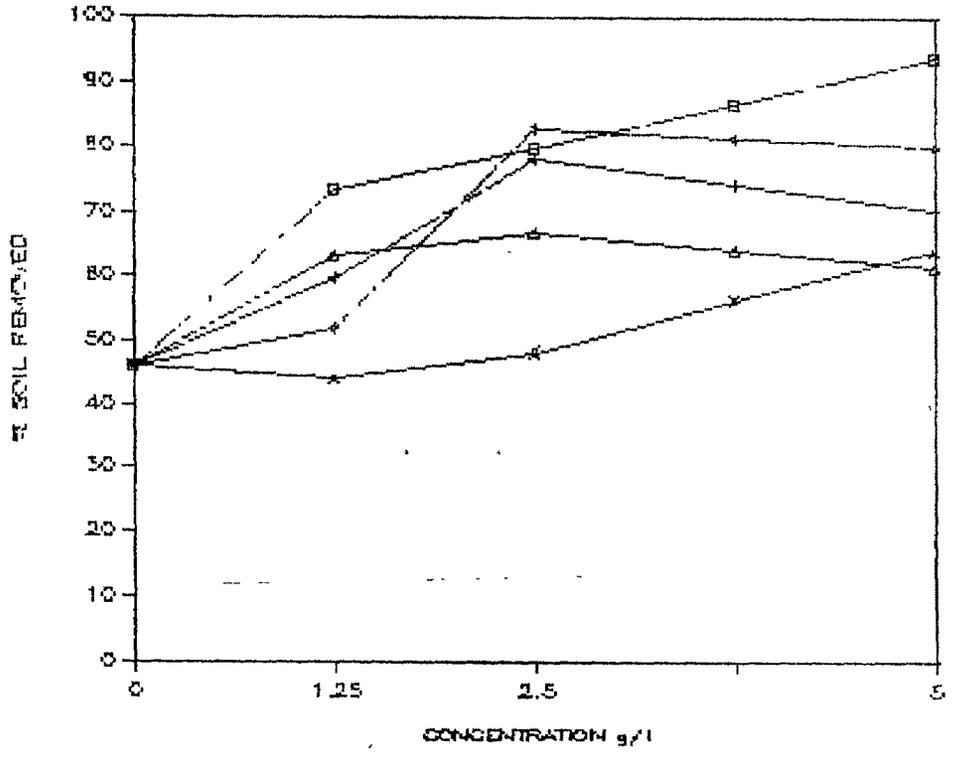
GRAPH 47- RELATION BETWEEN % SOLVENT SOIL REMOVED & CONCENTRATION WITH COMBINATION I, 501 BAR SOAP & TEEPOL (POLYESTER COTTON BLEND)



Combination I

501 Bar Soap	: Teepol
100	: 0 (□)
75	: 25 (+)
50	: 50 (◇)
25	: 75 (△)
0	: 100 (✱)

GRAPH 48- RELATION BETWEEN % SOLVENT SOIL REMOVED & CONCENTRATION WITH COMBINATION II, SODIUM OLEATE & TEEPOL (POLYESTER COTTON BLEND)



Combination II

Sodium Oleate	: Purified Teepol
100	: 0 (□)
75	: 25 (+)
50	: 50 (◇)
25	: 75 (△)
0	: 100 (✱)

Table 48 Per cent soil removed from blend fabric by combination III (501 bar soap and sodium lauryl sulphate) at varying ratios and concentration

Combination III Per cent ratio S_1 : d_2	Soil removal (%) Conc. (g/l) 1.25	2.5	5.0
100 : 0	66.13	66.80	83.68
75 : 25	64.42	77.53	87.13
50 : 50	67.55	75.24	89.60
25 : 75	62.92	72.46	79.12
0 : 100	71.26	77.14	84.52

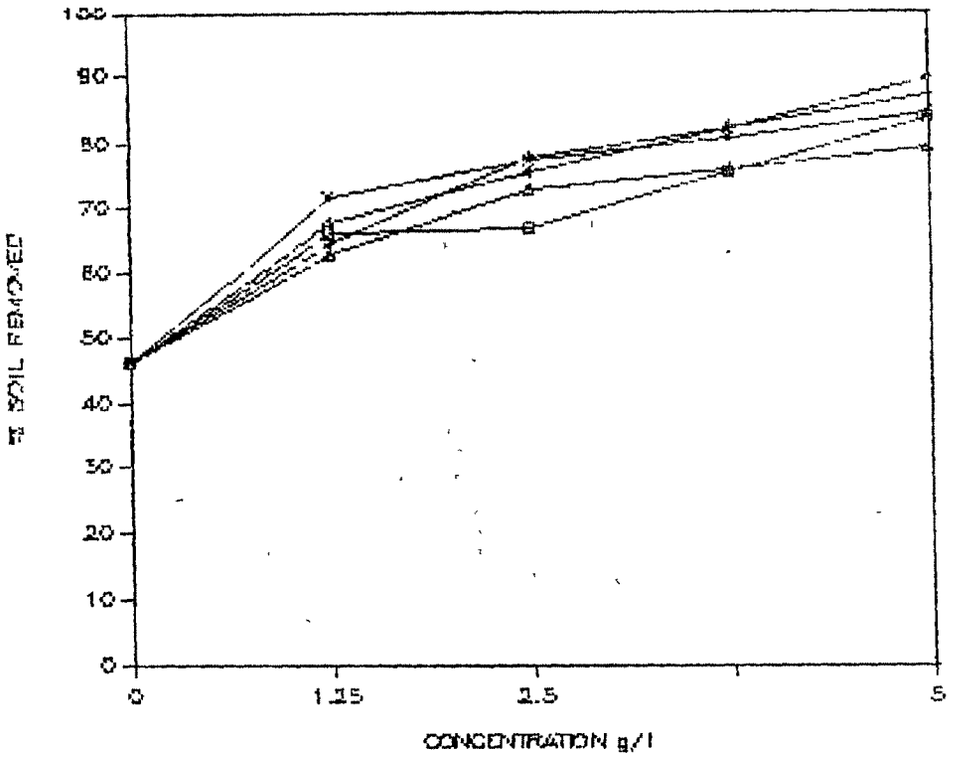
S_1 - Purified 501 bar soap
d_2 - Sodium lauryl sulphate

Table 49 Per cent soil removed from blend fabric by combination IV (501 bar soap and Lissapol N) at varying ratios and concentration

Combination IV Per cent ratio S_1 : d_3	Soil removal (%) Conc. (g/l) 1.25	2.5	5.0
100 : 0	66.13	66.80	83.68
75 : 25	71.16	72.67	79.60
50 : 50	62.65	62.1	69.20
25 : 75	63.43	58.41	65.45
0 : 100	41.14	46.75	66.1

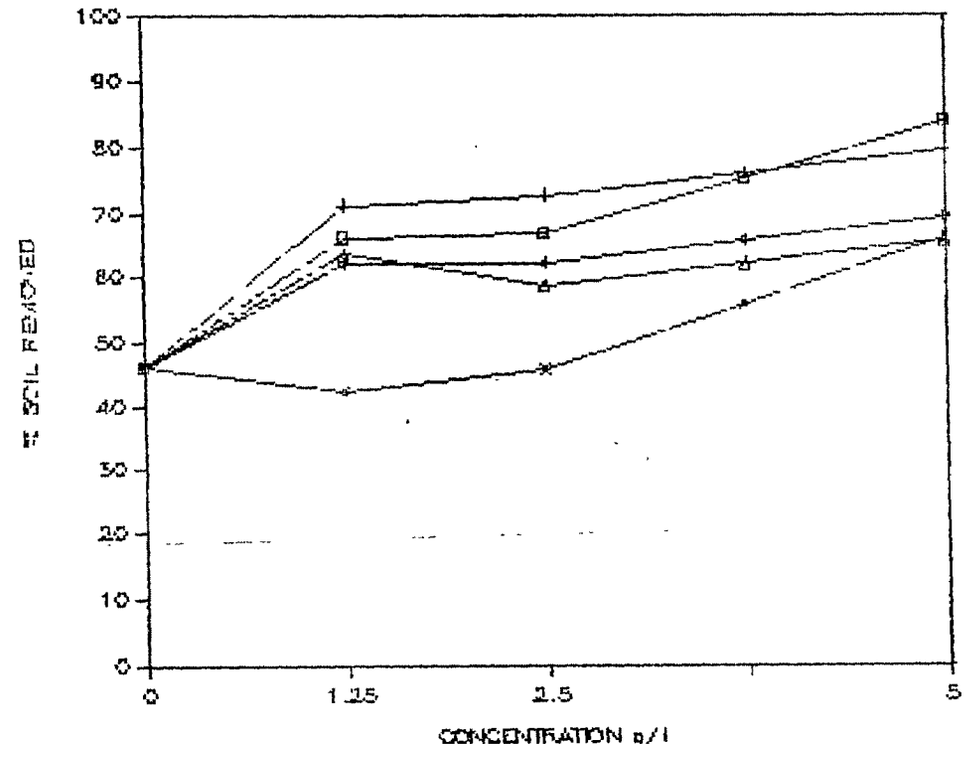
S_1 - Purified 501 bar soap
d_3 - Lissapol N

GRAPH 49- RELATION BETWEEN % SOLVENT SOIL REMOVED & CONCENTRATION WITH COMBINATION III, 501 BAR SOAP & SODIUM LAURYL SULPHATE (POLYESTER COTTON BLEND)



Combination III
Purified : Sodium
501 Bar : Lauryl
Soap : Sulphate
100 : 0 (□)
75 : 25 (+)
50 : 50 (◇)
25 : 75 (△)
0 : 100(*)

GRAPH 50- RELATION BETWEEN % SOLVENT SOIL REMOVED & CONCENTRATION WITH COMBINATION IV, 501 BAR SOAP & LISSAPOL N (POLYESTER COTTON BLEND)



Combination IV
501 Bar : Lissapol
Soap : -N
100 : 0 (□)
75 : 25 (+)
50 : 50 (◇)
25 : 75 (△)
0 : 100(*)

For combination I (purified 501 bar soap and purified Teepol) it was seen that the per cent ratio 50:50 gave good results. With increase in concentration the percentage soil removed also increased. The 50:50 per cent ratio of combination II (sodium oleate and purified Teepol) also give good results specially at 2.5 g/l. For the combination III (purified 501 bar soap and sodium lauryl sulphate) the per cent ratio 50:50 gave good results. In the combination IV (purified 501 bar soap and nonionic synthetic detergent Lissapol N) the per cent ratio of 75:25 gave high percentage soil removal.

For the blend fabric, performancewise combination III (purified 501 bar soap and sodium lauryl sulphate) was first. The second was combination IV (soap and nonionic synthetic detergent Lissapol N).

It was also noted that the cleaning was more on the blend fabric than on cotton (that is, more percentage soil was removed from the polyester cotton blend than from cotton fabric A certain amount of irregularities in soil removal was however observed.

(c) Polyester fabric

The data has been given in Tables 50 - 53 and illustrated in Graphs 51 - 54.

Table 50 Per cent soil removed from polyester by combination I (501 bar soap and Teepol) at varying ratios and concentration

Combination I Per cent ratio S_1 : d_1	Soil removal (%) Conc. (g/l) 1.25	2.5	5.0
100 : 0	88.88	92.30	95.17
75 : 25	92.96	93.72	92.54
50 : 50	93.65	91.55	94.02
25 : 75	90.52	92.03	93.26
0 : 100	80.44	80.12	83.11

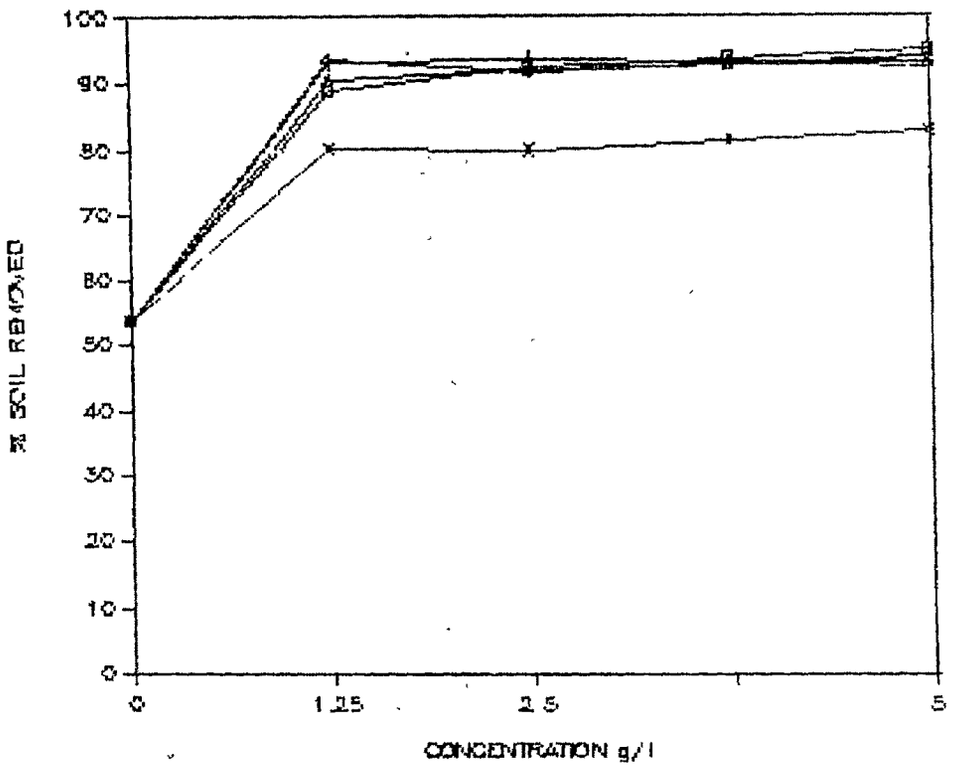
S_1 - Purified 501 bar soap
d_1 - Purified Teepol

Table 51 Per cent soil removed from polyester by combination II (sodium oleate and Teepol) at varying ratios and concentration

Combination II Per cent ratio S_2 : d_1	Soil removal (%) Conc. (g/l) 1.25	2.5	5.0
100 : 0	87.05	89.32	92.53
75 : 25	90.38	90.6	93.29
50 : 50	90.70	88.76	90.72
25 : 75	90.13	89.82	93.86
0 : 100	80.44	80.12	83.11

S_2 - Sodium oleate
d_1 - Purified Teepol

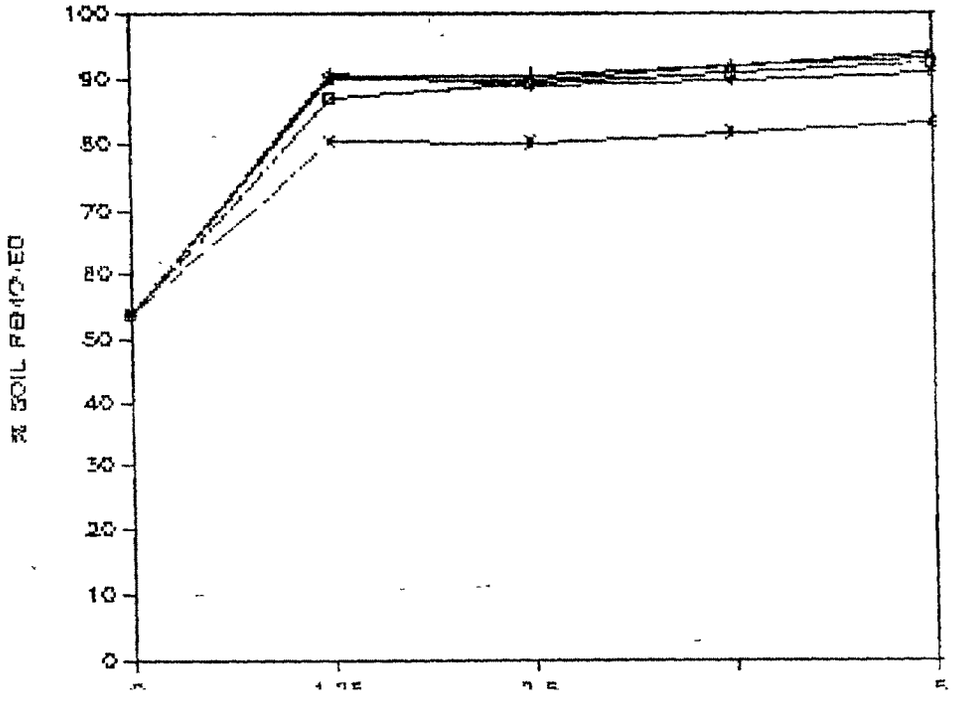
GRAPH 51- RELATION BETWEEN % SOLVENT SOIL REMOVED & CONCENTRATION WITH COMBINATION I, 501 BAR SOAP & TEEPOL (POLYESTER FABRIC)



Combination I

501 Bar Soap	: Teepol
100	: 0 (□)
75	: 25 (+)
50	: 50 (◊)
25	: 75 (Δ)
0	: 100 (*)

GRAPH 52- RELATION BETWEEN % SOLVENT SOIL REMOVED & CONCENTRATION WITH COMBINATION II, SODIUM OLEATE & TEEPOL (POLYESTER FABRIC)



Combination II

Sodium Oleate	: Purified Teepol
100	: 0 (□)
75	: 25 (+)
50	: 50 (◊)
25	: 75 (Δ)
0	: 100 (*)

Table 52 Per cent soil removed from polyester by combination III (501 bar soap and sodium lauryl sulphate) at varying ratios and concentration

Combination III Per cent ratio S_1 : d_2	Soil removal (%) Conc. (g/l) 1.25	2.5	5.0
100 : 0	88.88	92.30	95.17
75 : 25	92.01	91.87	93.21
50 : 50	92.94	91.55	90.94
25 : 75	88.58	86.66	90.71
0 : 100	83.67	85.33	93.75

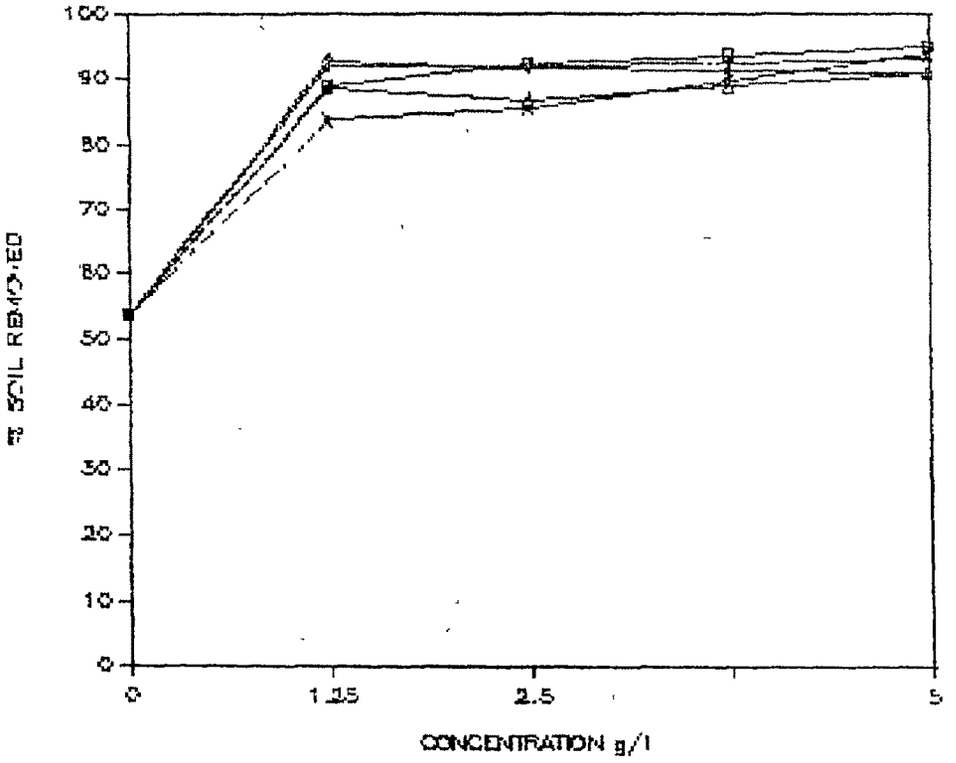
S_1 - Purified 501 bar soap
d_2 - Sodium lauryl sulphate

Table 53 Per cent soil removed from polyester by combination IV (501 bar soap and Lissapol N) at varying ratios and concentration

Combination IV Per cent ratio S_1 : d_3	Soil removal (%) Conc. (g/l) 1.25	2.5	5.0
100 : 0	88.88	92.30	95.17
75 : 25	88.23	90.16	92.26
50 : 50	88.87	91.13	93.23
25 : 75	90.15	90.93	91.69
0 : 100	75.59	78.53	80.42

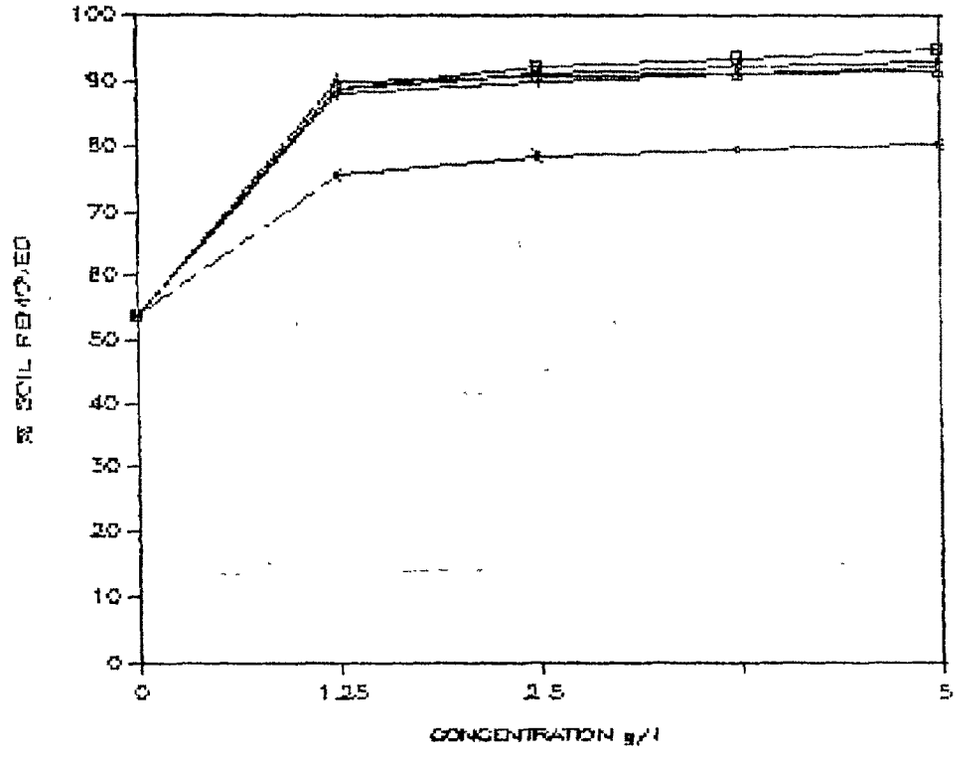
S_1 - Purified 501 bar soap
d_3 - Lissapol N

GRAPH 53- RELATION BETWEEN % SOLVENT SOIL REMOVED & CONCENTRATION WITH COMBINATION III, 501 BAR SOAP & SODIUM LAURYL SULPHATE (POLYESTER FABRIC)



Combination III
Purified : Sodium
501 Bar : Lauryl
Soap : Sulphate
100 : 0 (□)
75 : 25 (+)
50 : 50 (◇)
25 : 75 (△)
0 : 100 (✳)

GRAPH 54- RELATION BETWEEN SOLVENT SOIL REMOVED & CONCENTRATION WITH COMBINATION IV, 501 BAR SOAP & LISSAPOL N (POLYESTER FABRIC)



Combination IV
501 Bar : Lissapol
Soap : -N
100 : 0 (□)
75 : 25 (+)
50 : 50 (◇)
25 : 75 (△)
0 : 100 (✳)

Here it was seen that all the combinations gave good cleaning efficiency, in all ratios and concentration. Further increase in cleaning efficiency with the increase in concentration is marginal or nil. Even with a small amount of addition of a better cleaning agent (soap) the poor cleaning efficiency of purified Teepol and Lissapol N is increased tremendously. Here the combination II (sodium oleate and purified Teepol) was above the other combinations which were equivalent.

It was thus noted that the maximum amount of soil more than 85% was removed from polyester fabric. As noted earlier, polyester fibre substrate characteristics, like smoothness, hydrophobicity, played their part in the ease of soil removal.

Cleaning efficiency of samples soiled by emulsion soil using the optimum combinations of soaps and synthetic detergents

Samples soiled with emulsion soil were washed with the optimum combinations for the different fabrics 100% cotton, 67/33 polyester cotton blend and 100% polyester at 5.0 g/l concentration using a Launder-Ometer for 15 minutes at room temperature. The data for the above has been given in Table 54 and illustrated by histograms (55 - 57) along with per cent soil removed by the individual detergents.

Table 54 Data on the per cent emulsion soil removed by the four optimum combinations at different concentration from the three fabrics

100% cotton			67/33 polyester cotton			100% polyester		
Combination and per cent ratio	% soil removed 2.5 g/l	5.0 g/l	Combination and percent ratio	% soil removed 2.5 g/l	5.0 g/l	Combination and percent ratio	% soil removed 2.5 g/l	5.0 g/l
I 75:25	64.75	64.48	I 50:50	81.09	80.51	I 50:50	85.01	86.82
II 75:25	66.20	65.53	II 50:50	81.46	83.96	II 25:75	83.51	88.09
III 25:75	66.61	69.92	III 50:50	82.98	86.91	III 20:75	84.66	84.50
IV 75:25	60.66	68.75	IV 75:25	74.48	80.15	IV 50:50	79.56	85.91

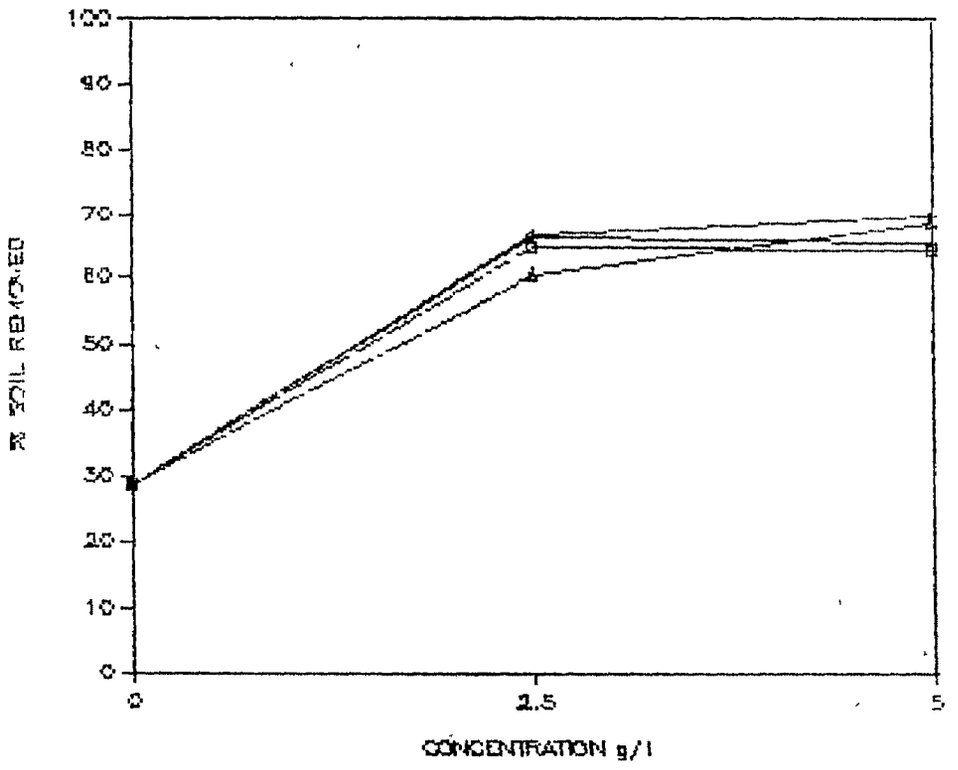
I - Purified 501 bar soap + purified Teepol

II - Sodium oleate + purified Teepol

III - Purified 501 bar soap + sodium lauryl sulphate

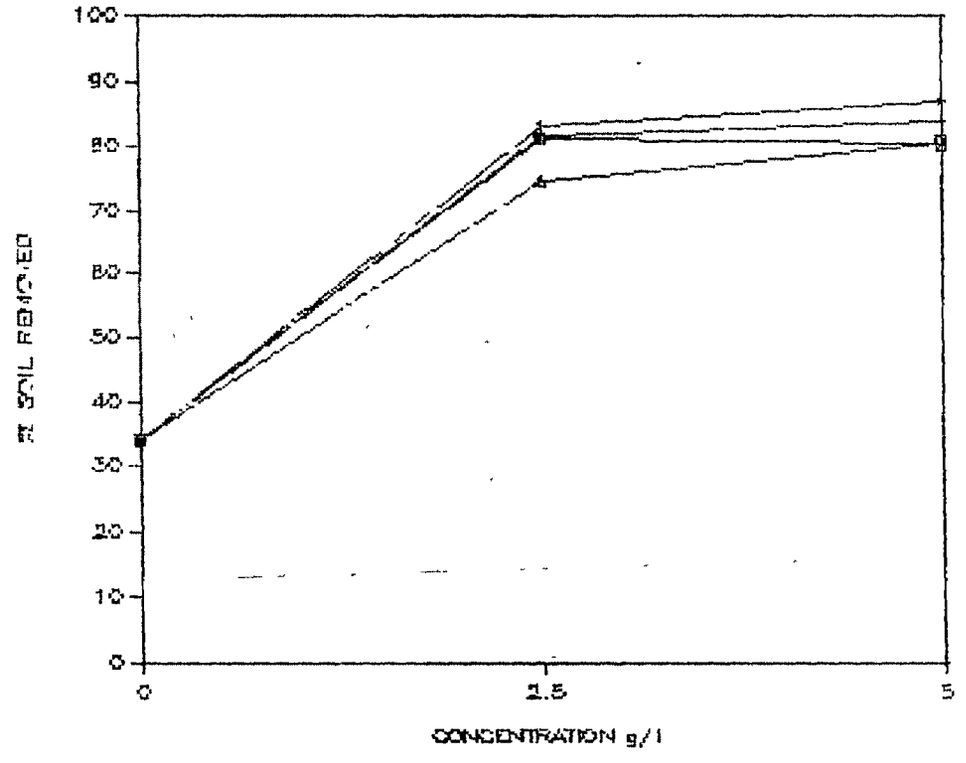
IV - Purified 501 bar soap + Lissapol N

GRAPH 55-RELATION BETWEEN % EMULSION SOIL REMOVED & CONCENTRATION WITH OPTIMUM COMBINATIONS (COTTON FABRIC)



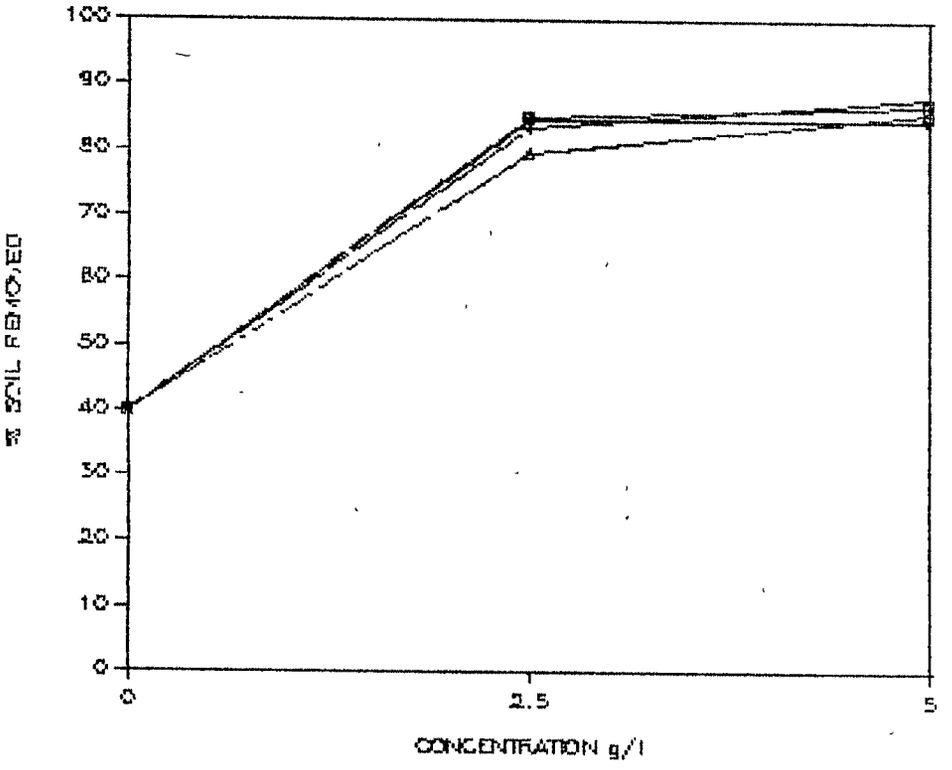
(□) Combination I 75 : 25
(+) Combination II 75 : 25
(◇) Combination III 25 : 75
(△) Combination IV 75 : 25

GRAPH 56- RELATION BETWEEN % EMULSION SOIL REMOVED & CONCENTRATION WITH THE OPTIMUM COMBINATIONS (POLYESTER COTTON FABRIC BLEND)



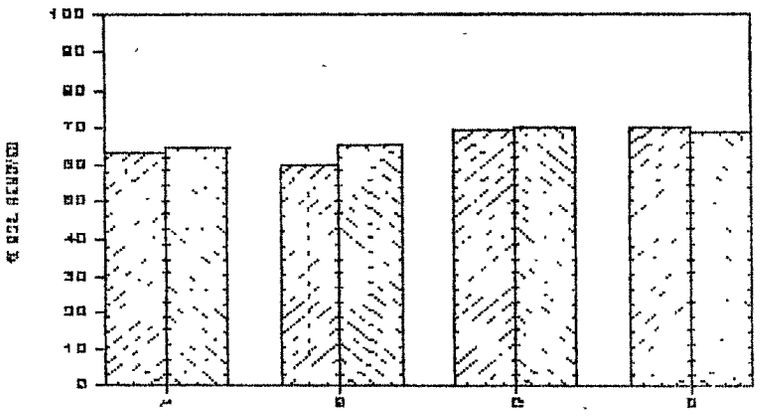
(□) Combination I 50 : 50
(+) Combination II 50 : 50
(◇) Combination III 50 : 50
(△) Combination IV 75 : 25

GRAPH 57- RELATION BETWEEN % EMULSION SOIL REMOVED & CONCENTRATION WITH OPTIMUM COMBINATIONS (POLYESTER FABRIC)



(□) Combination I
50 : 50
(+) Combination II
25 : 75
(◇) Combination III
25 : 75
(△) Combination IV
50 : 50

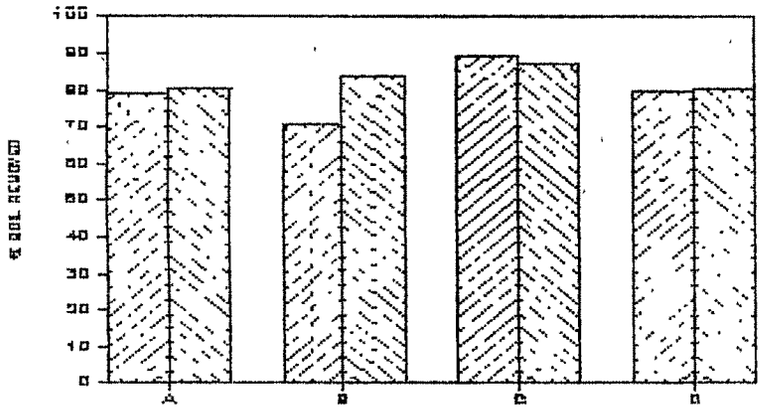
GRAPHS 58- COMPARISON BETWEEN % SOIL REMOVED FROM SOLVENT & EMULSION SOIL SAMPLES WITH THE OPTIMUM COMBINATIONS AT 5 g/l CONCENTRATION (COTTON FABRIC)



Solvent Soiled Sample

Emulsion Soiled Sample

A Combination I (75:25)
B Combination II (75:25)
C Combination III (25:75)
D Combination IV (75:25)

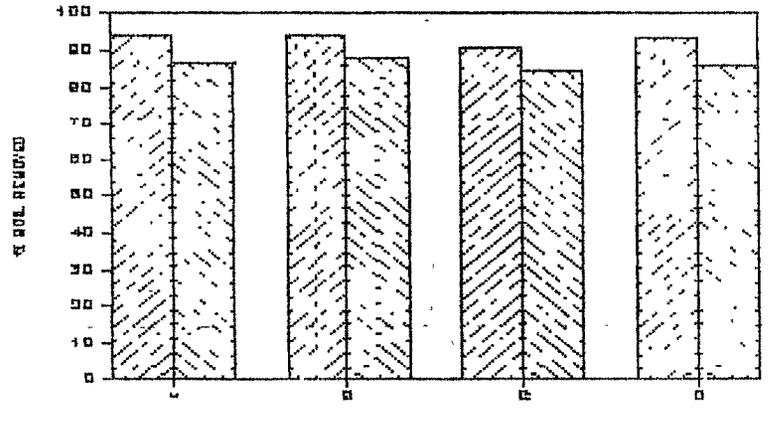


Solvent Soiled Sample

Emulsion Soiled Sample

A Combination I (50:50)
B Combination II (50:50)
C Combination III (50:50)
D Combination IV (75:25)

GRAPH 59- COMPARISON BETWEEN % SOIL REMOVED FROM SONT & EMULSION SOILED SAMPLES WITH THE OPTIMUM COMBINATIONS AT 5 g/l CONCENTRATION (POLYESTER COTTON BLEND)



Solvent Soiled Sample

Emulsion Soiled Sample

A Combination I (50:50)
B Combination II (25:75)
C Combination III (25:75)
D Combination IV (50:50)

GRAPH 60- COMPARISON BETWEEN % SOIL REMOVED ROM SOLVENT % EMULSION SAMPLES WITH THE OPTIMUM COMBINATIONS AT 5 g/l CONCENTRATION (POLYESTER FABRIC)

It was seen from the histogram that the optimum combination for the removal of emulsion soil from the three fabrics was the combination of a soap and a nonionic synthetic detergent. When the percentage soil removed of emulsion soil was compared with that of solvent soiled samples (Graphs 58 - 60) not much difference was seen in the removal of soil.

5.6 Relationship between soil removal and properties of soaps and synthetic detergents

An effort has been made in this section to see the relationship between the detergency property (% soil removed) and general properties (surface tension, wettability, wetting time, emulsification and foaming) of soaps and synthetic detergents. For this, graphs of detergency versus other properties have been plotted. These have been given in Graphs 61 - 75.

From the graphs (61 - 63) it was evident that a relationship of detergency with surface tension. Wetting time showed a relationship with surface tension, that is lower the surface tension lower the wetting time.

Percentage wettability gave a certain trend (Graphs 64 - 66) Some quantity of the agent has to be held, and if this is more it enables to release the soil and thereby help in cleaning. It is thus noted that a relationship exists of per cent soil

removed with wettability, that is higher the percentage wettability, better the cleaning efficiency.

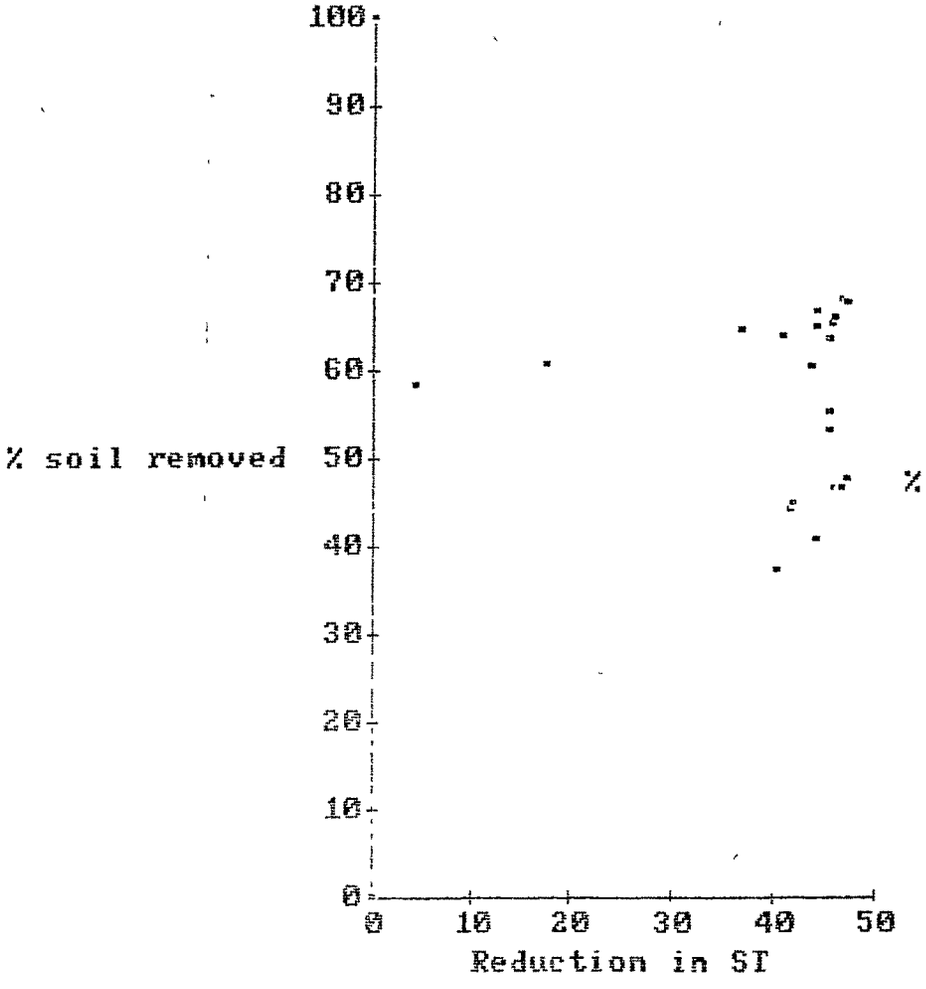
No relationship was observed between per cent soil removed and wetting time, as the points so plotted (Graphs 67 - 69) were scattered.

A relation was seen between per cent soil removed and emulsifying ability of the soaps and synthetic detergents (Graphs 70 - 72). The more the emulsifying ability the better the detergency. But with foaming power no relation was observed (Graphs 73 - 75).

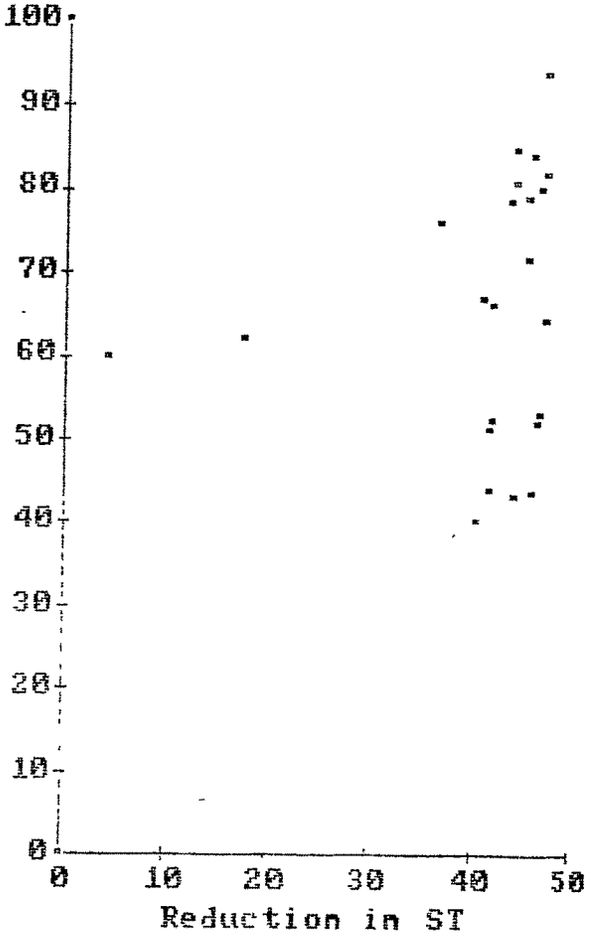
For combination of a soap and a synthetic detergent the per cent soil removed and values for other properties (surface tension and wetting time) did not vary much, they fell in a narrow range. No specific relationship could be drawn, as they indirectly confirm the relation as drawn above, when agents were used alone.

It was therefore concluded that even though Teepol and Lissapol N have good lowering of surface tension and good wetting, these do not lead to improved detergency. Sodium lauryl sulphate showed good results, for general properties as well as cleaning for the three fabrics. The soaps gave good wettability and emulsifying ability and also gave reasonably good cleaning efficiency. Evaluation of a cleaning agent cannot be reduced to a single measurement as it gives little indication as to its real value as a detergent.

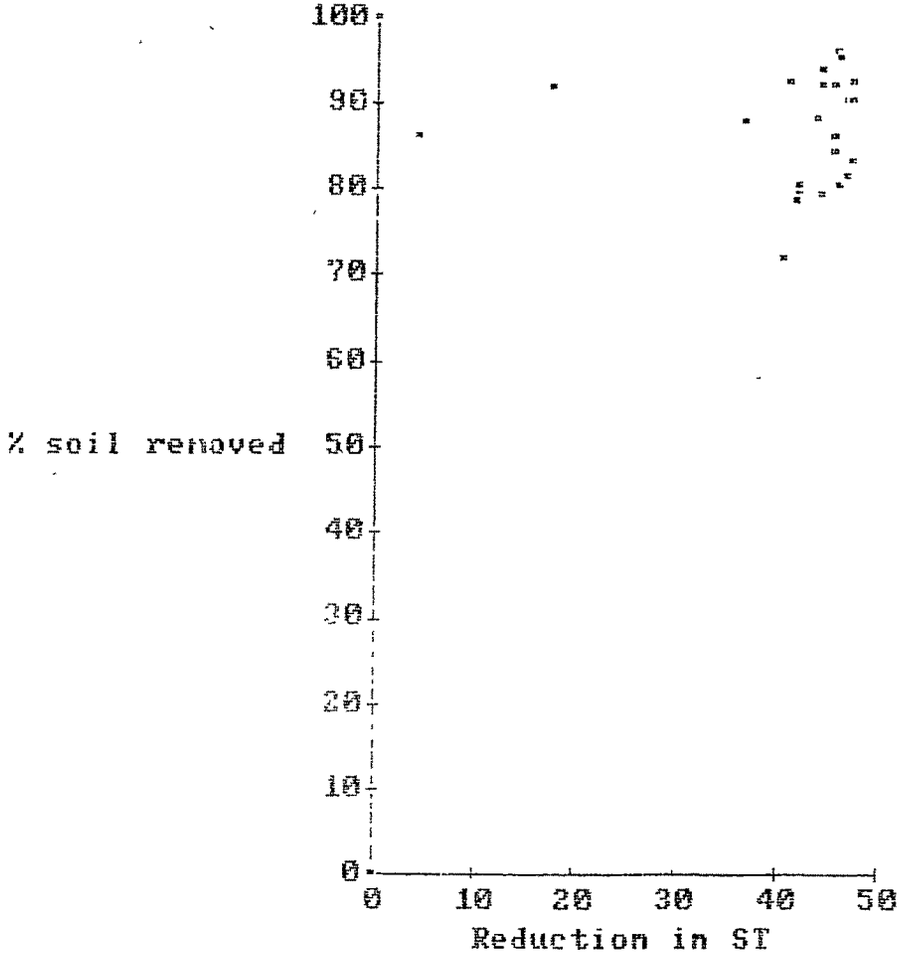
GRAPH 60-Relationship betweer %soil removed &Reduction in surface tension(cotton fabric



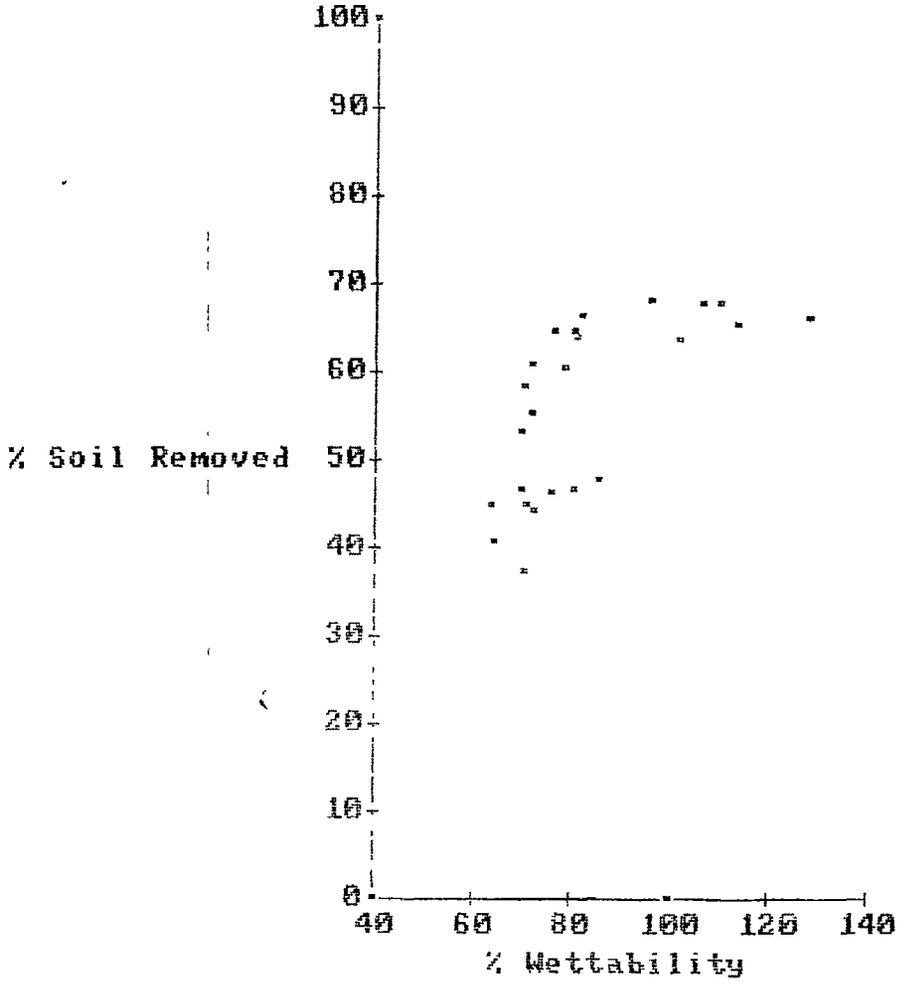
GRAPH 61-Relationship betweer %soil removed &Reduction in Surface Tension(Polyester/cotton blend)



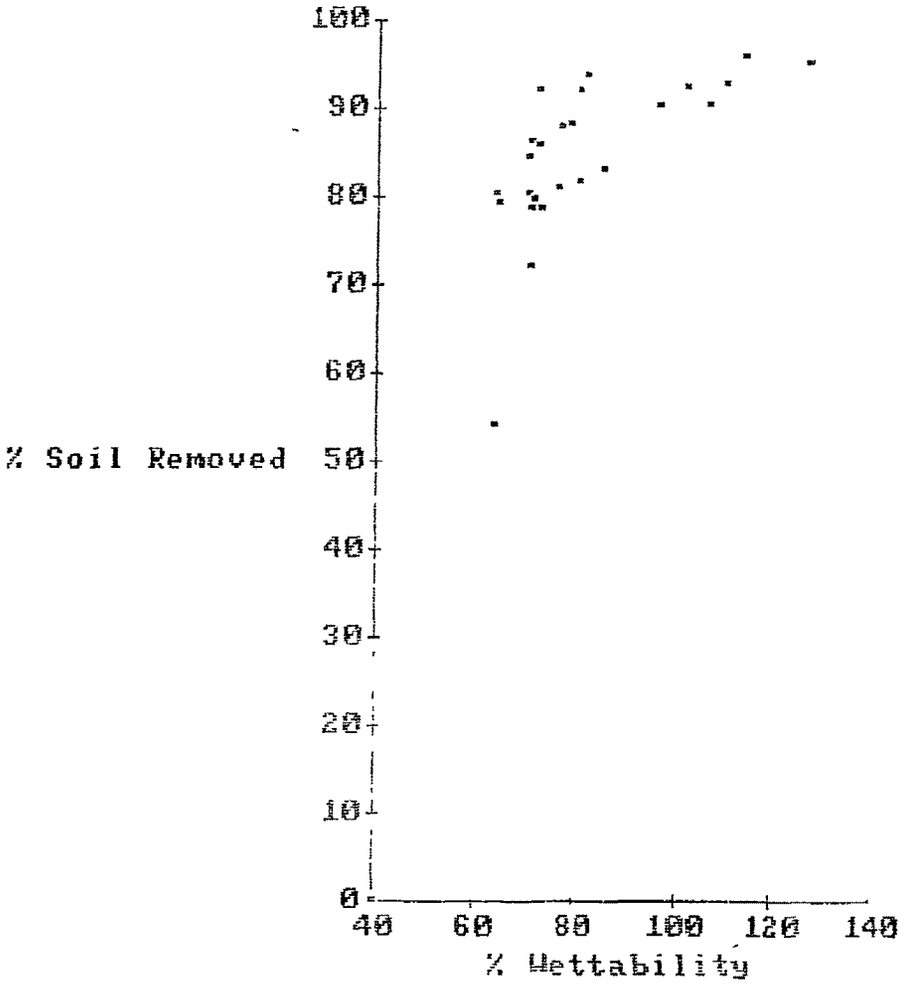
GRAPH 63-Relationship betweer %soil removed &Reduction in Surface Tension(Polyester Fabric)



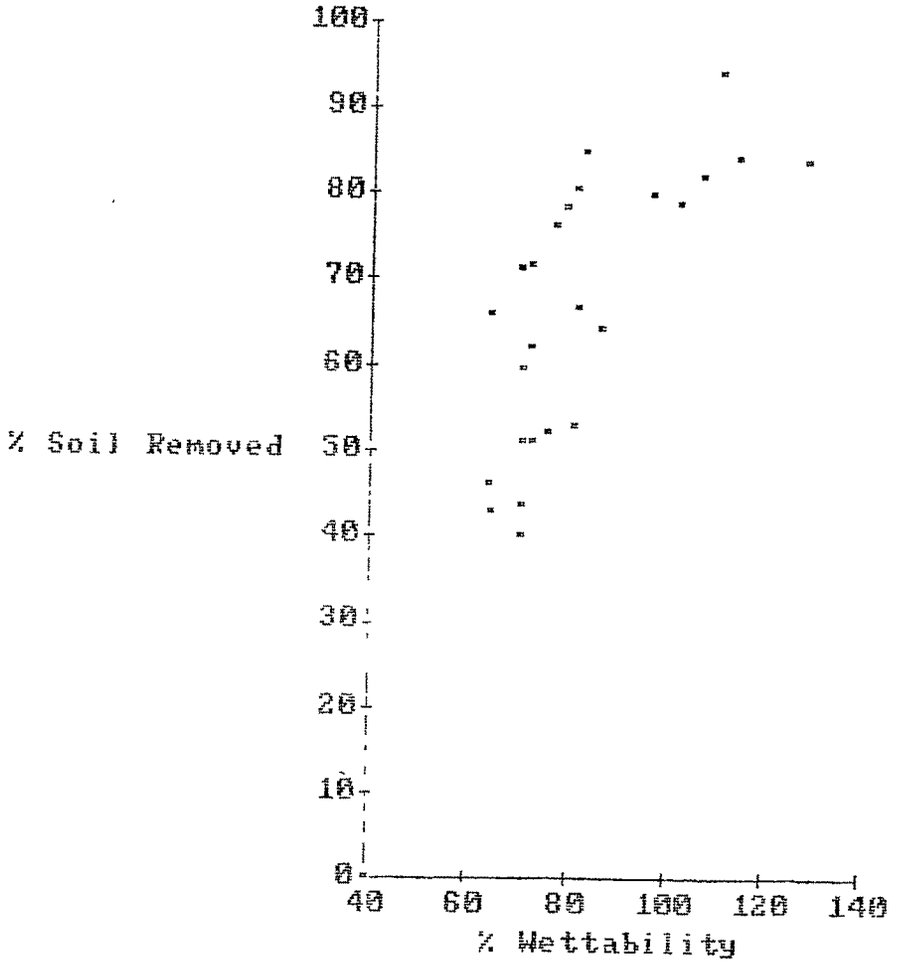
GRAPH 64-Relationship between %Soil Removed &Wettability(Cotton Fabric)



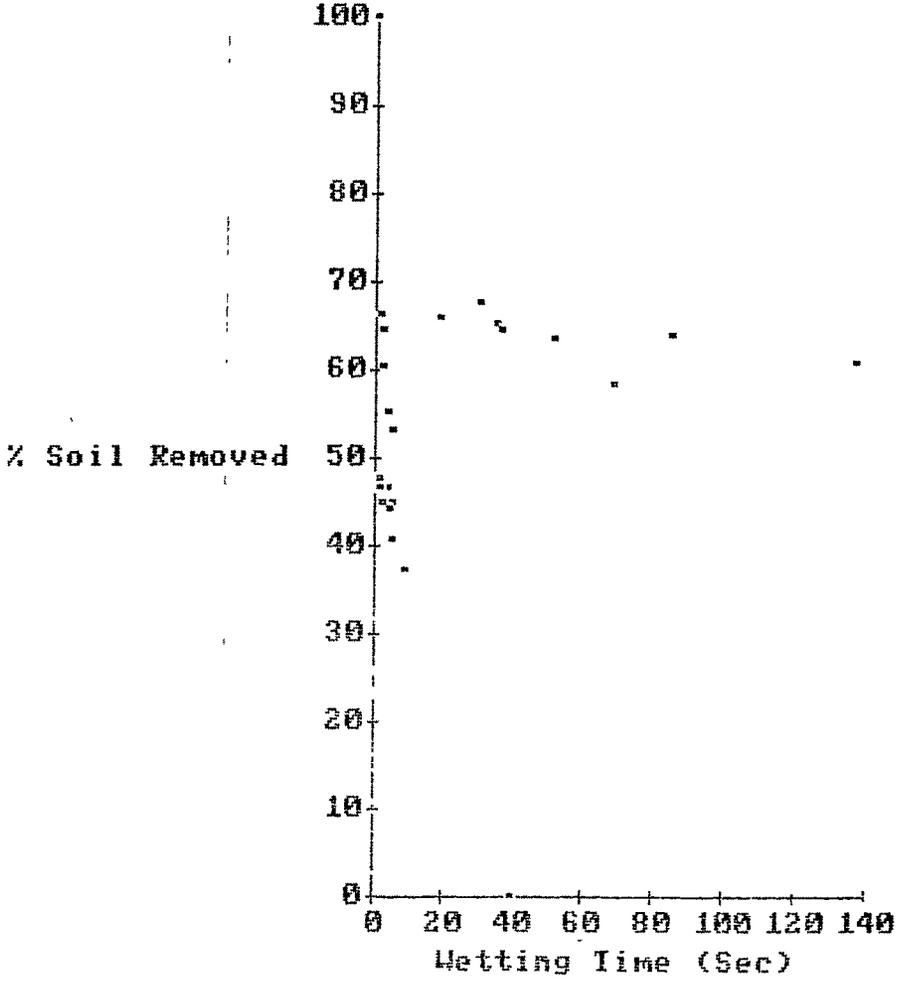
GRAPH 65-Relationship between %Soil Removed & %Wettability (Polyester Cotton)



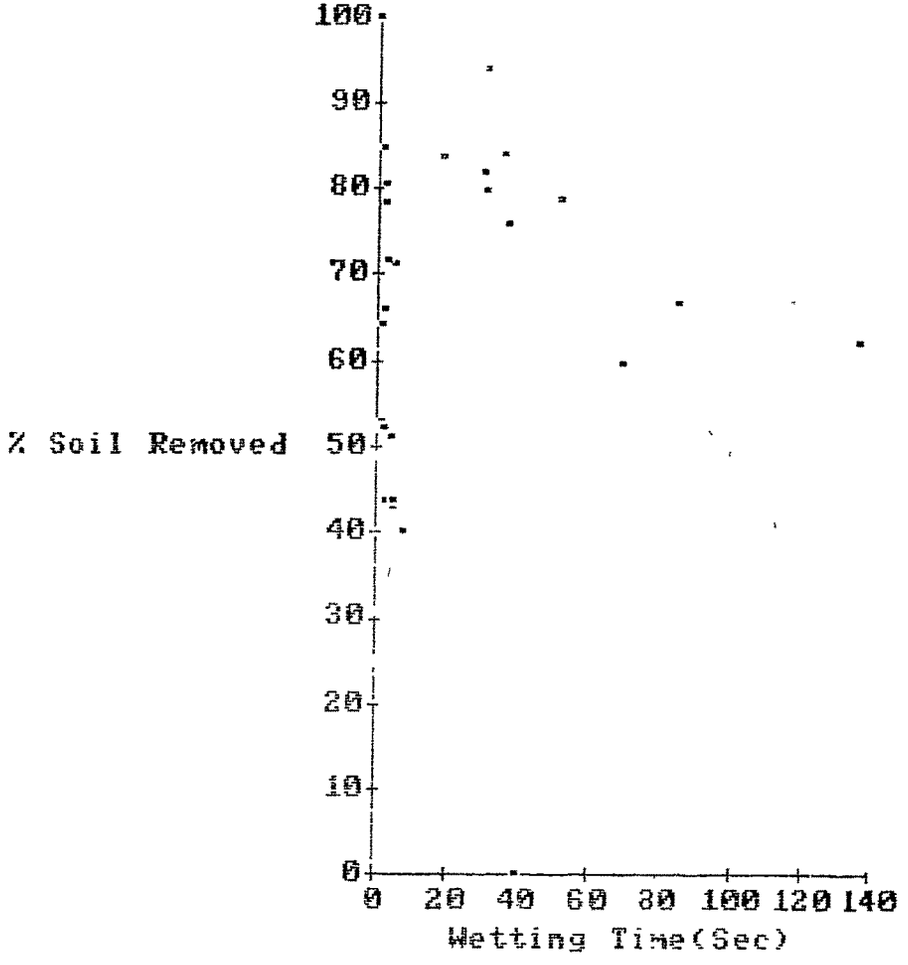
GRAPH 66-Relationship between %Soil Removed & %Wettability(Polyester/Cotton Blend)



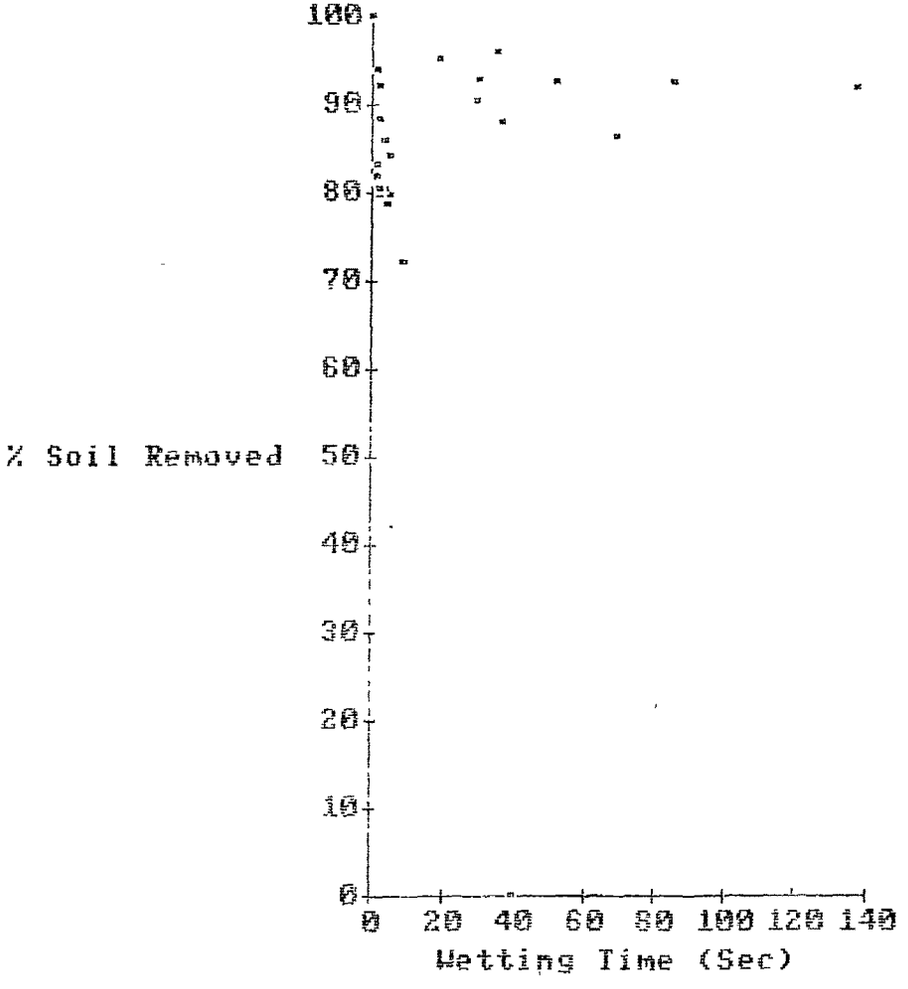
GRAPH 67-Relationship between %Soil Removed & Rate of Wetting (Cotton Fabric)



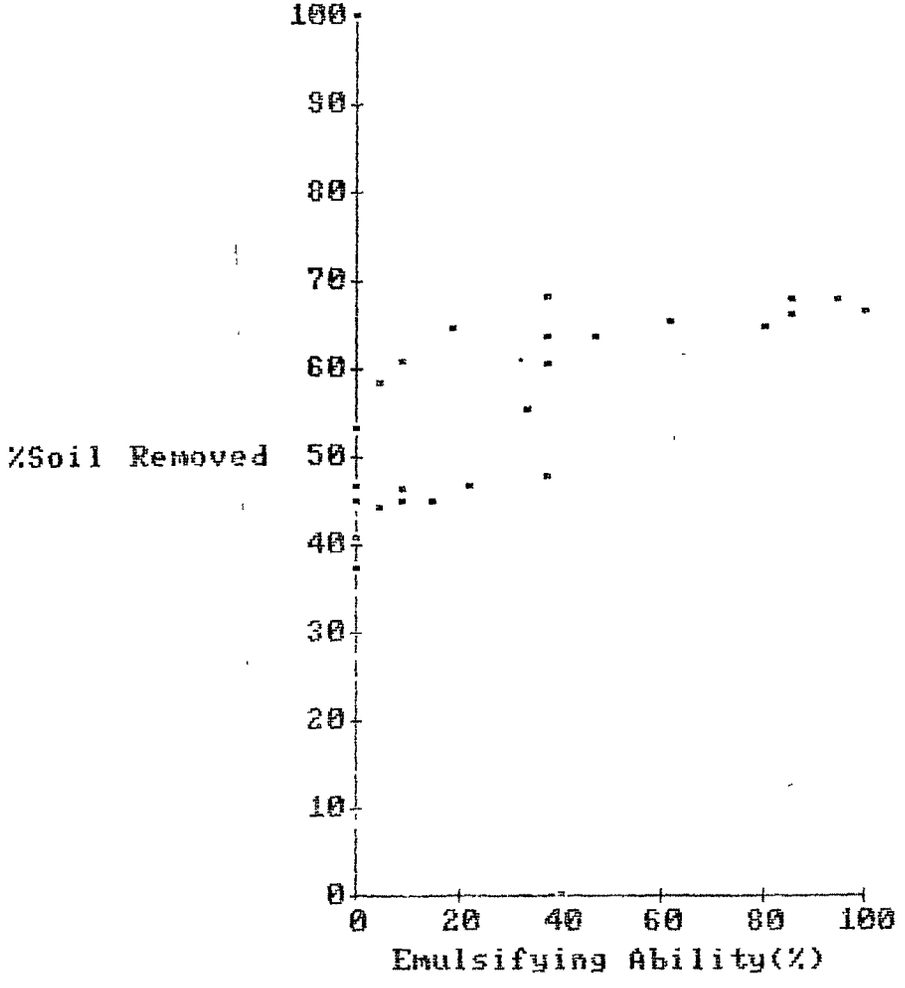
GRAPH 68-Relationship between % Soil Removed & Rate of Wetting (Polyester/Cotton Blend)



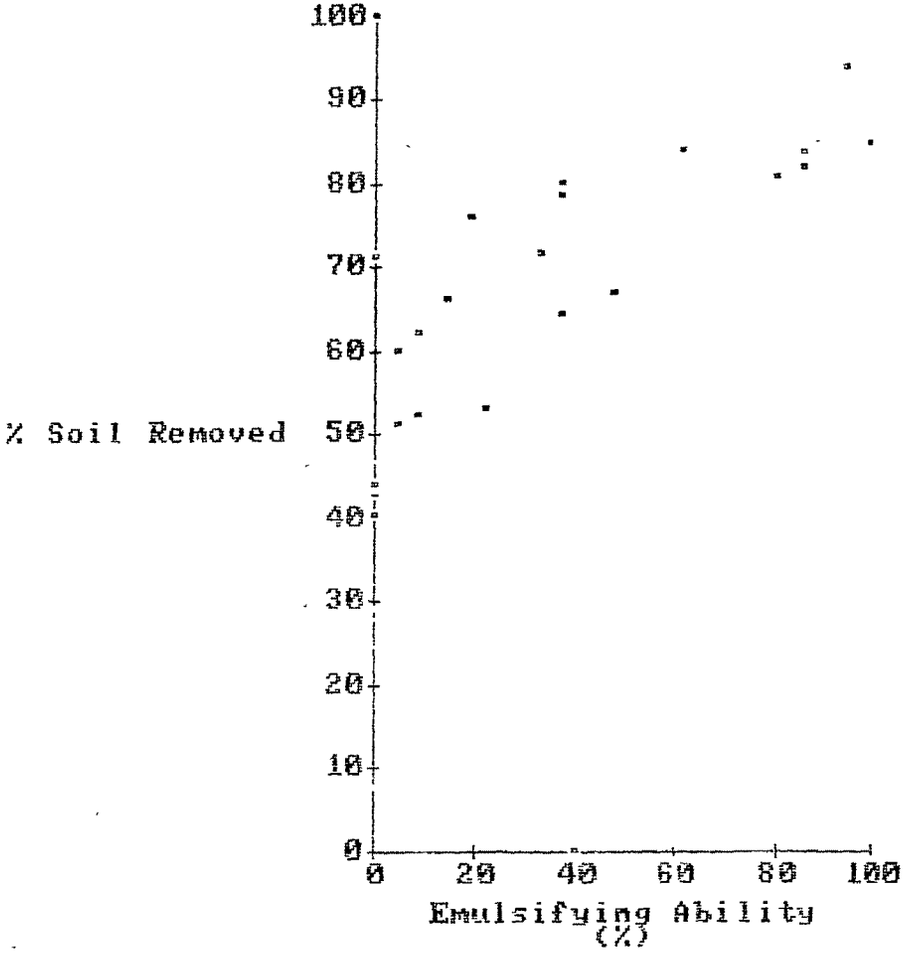
GRAPH 69-Relationship between
% Soil Removed & Rate of
Wetting (Polyester Fabric)



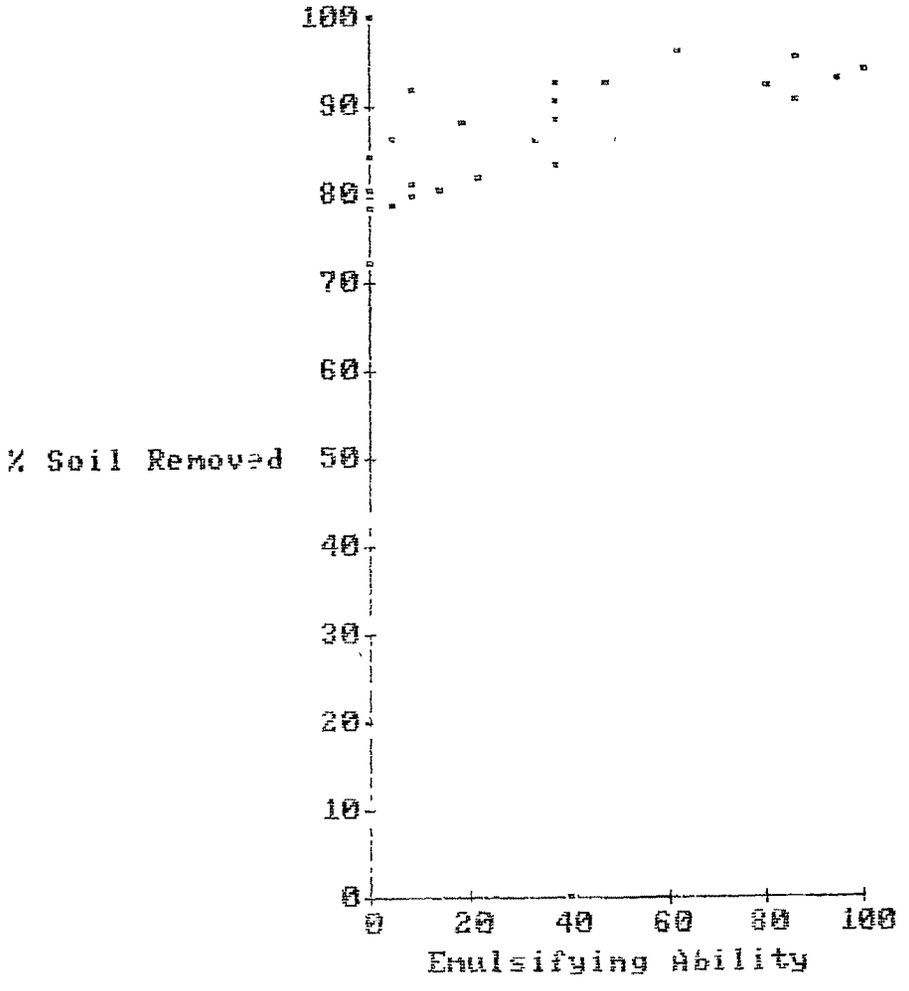
GRAPH 70-Relationship between %Soil Removed &Emulsifying Ability (Cotton Fabric)



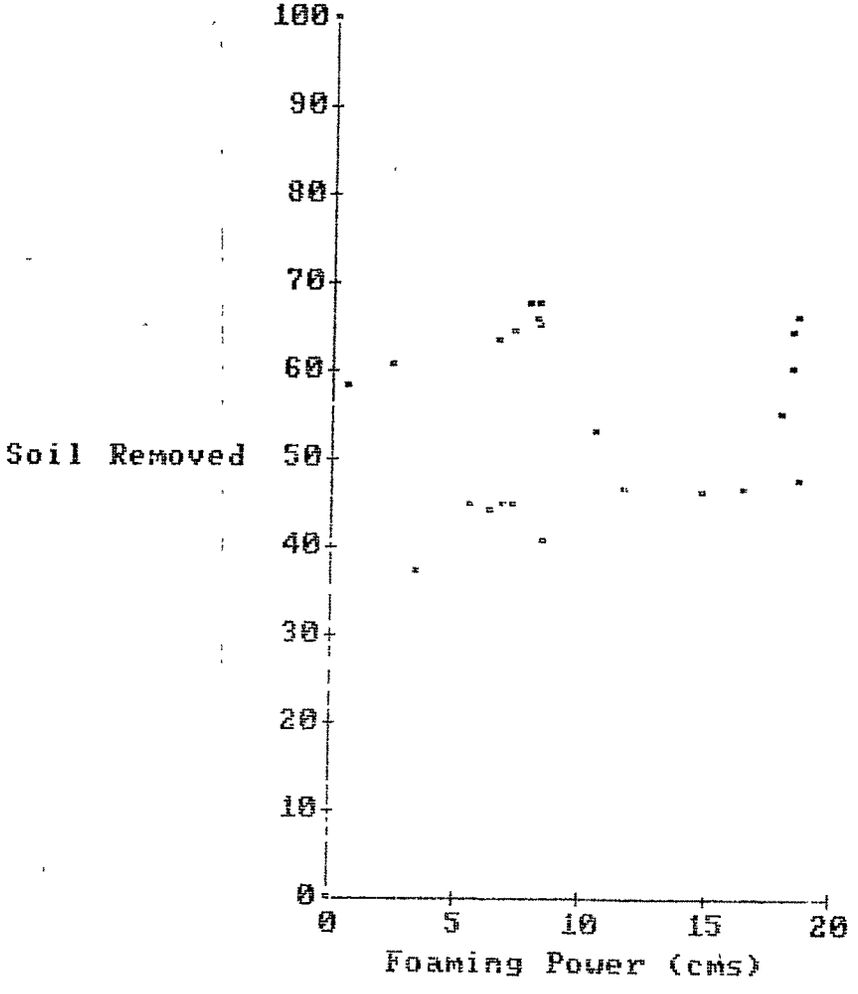
GRAPH 71-Relationship between %Soil Removed & Emulsifying Ability (Polyester/Cotton Blend)



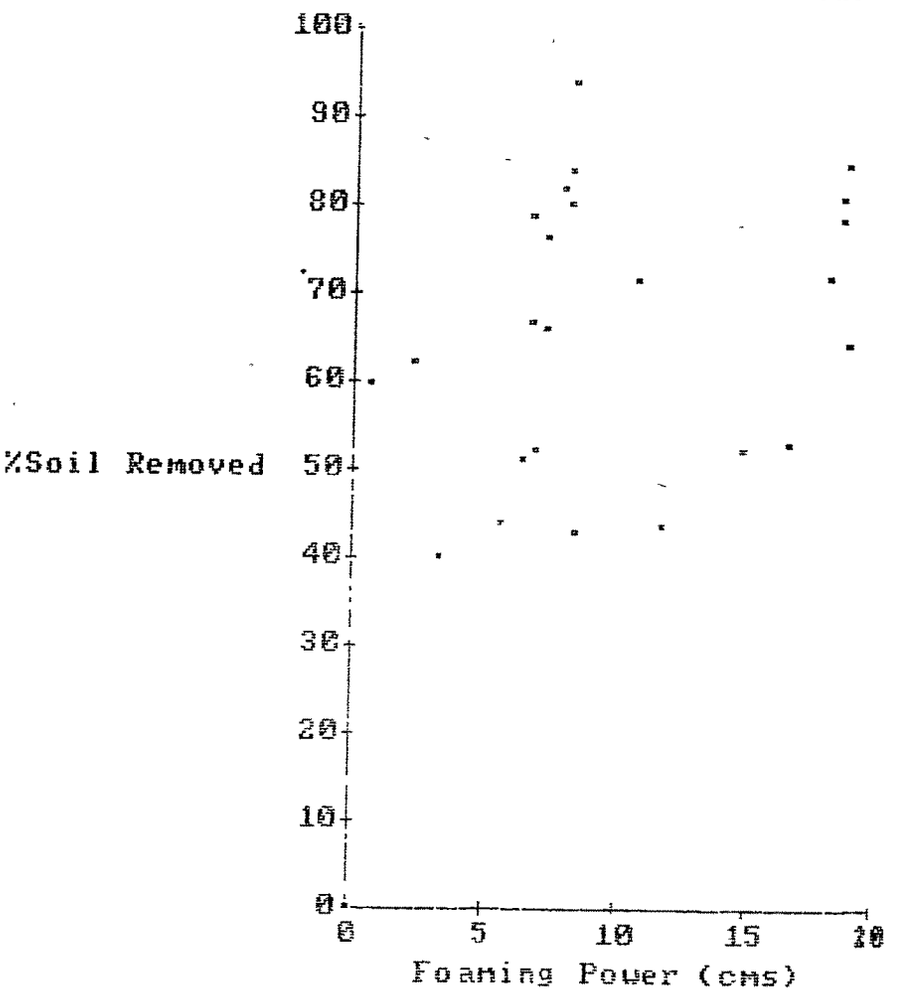
GRAPH 72-Relationship between %Soil Removed & Emulsifying Ability (Polyester Fabric)



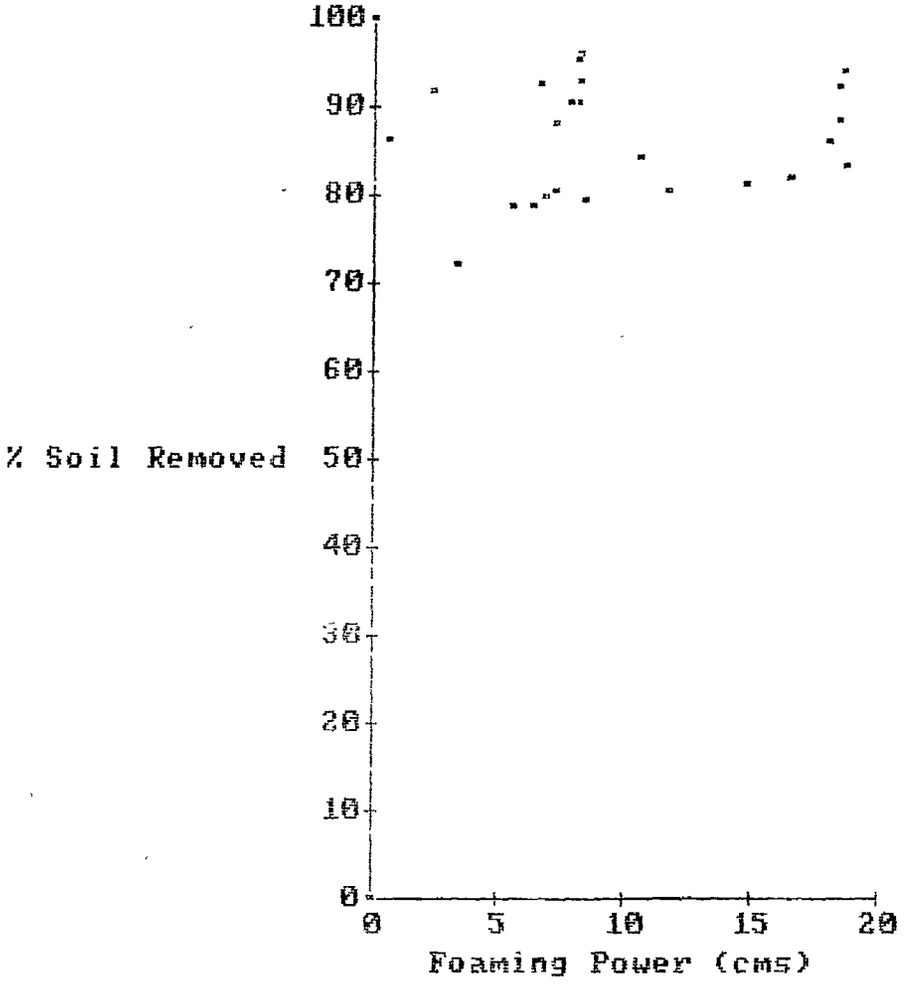
GRAPH 73-Relationship betweer
% Soil Removed & Foaming Powe
(Cotton Fabric)



GRAPH 74-Relationship between
%Soil Removed &Foaming Power
(Polyester/Cotton Blend)



GRAPH 75-Relationship betweer
%Soil Removed & Foaming Powe
(Polyester Fabric)



5.7 Design and fabrication of a small washing machine with a stirrer from above and its application for the washing efficiency of soiled fabrics

A small washing machine with an overhead stirrer was designed and fabricated in metal. The diagram of which is shown in Fig 9.

There is a vast variety of washing machines available in the market. In most machines the principle used for agitation the impeller system or the rotary drum/tumble wash principle. Most commercial washing machines have an aluminium tank with or without heaters. Some of the expensive models also have stainless steel tanks. The capacity usually varies between 2 to 4 kg (dry clothes weight). Most washing machines are semi-automatic. From the literature it was seen that the principle used for washing or the method of agitation was by the impeller, made usually of bakelite or a metal. This impeller helps in giving movement to the water and cleans with the help of the washing liquid. The impeller speed is around 1400 r.p.m. The impeller system of agitation has certain advantages and disadvantages. The advantage being that space is saved and the total capacity of the tank can be utilized. But the main disadvantage of this system is that as the soiled fabrics do not get enough agitation, they require washing agents with excessive builders for soil removal, by doing so the fabrics get damaged due to excessive swelling.

FABRICATED SMALL WASHING MACHINE

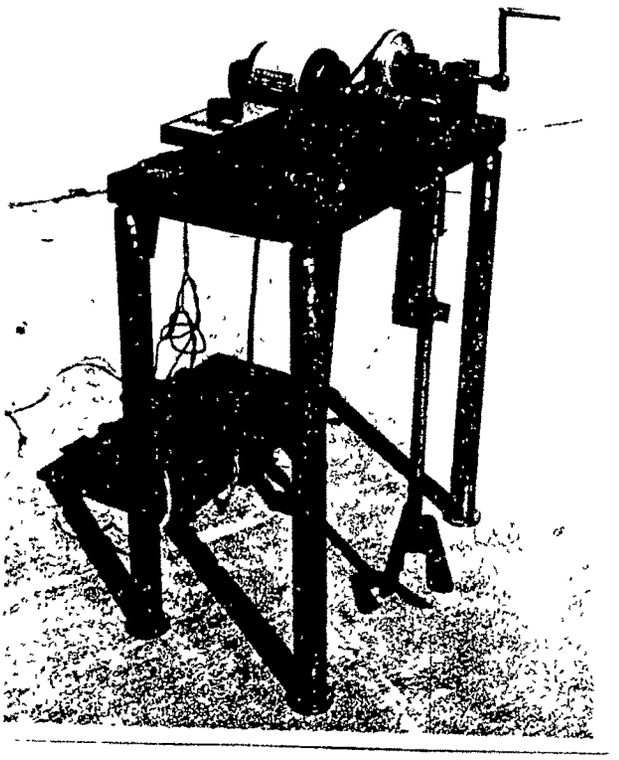


Plate I

SMALL WASHING MACHINE (PACKED)

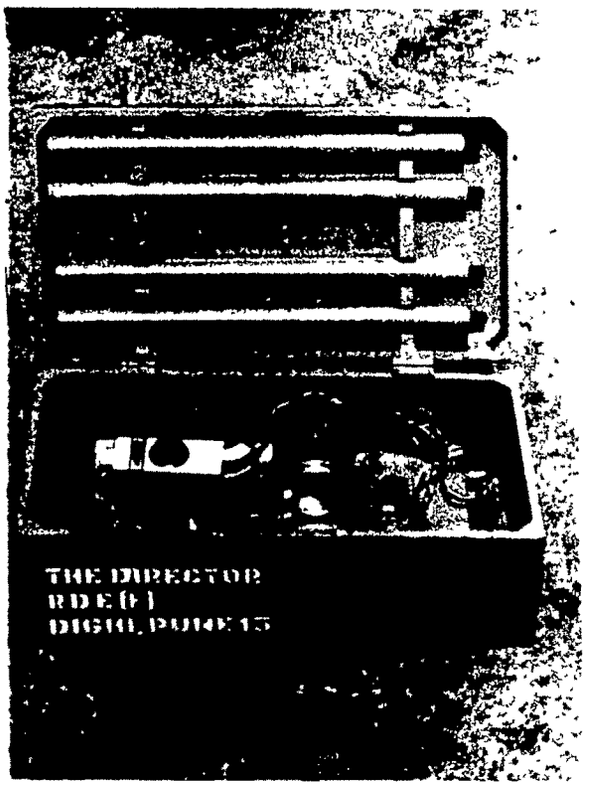


Plate II

The cost also is too much for an average consumer to purchase. Moreover they are so bulky that they are difficult to transport or carry.

Therefore, a model was designed with a stirrer from above for this research. This was economical, small and portable so that it would be easy to transport and the stirrer gives enough agitation to both the liquid and the fabrics.

Three cleaning agents, a soap (501 bar soap), an anionic synthetic detergent (sodium lauryl sulphate) and a nonionic synthetic detergent (Lissapol N), and their two combinations, Combination III of 501 bar soap and sodium lauryl sulphate in the per cent ratio 25:75 and Combination IV of 501 bar soap and Lissapol N in the per cent ratio 75:25 were tried out for their cleaning efficiency. Samples were soiled with solvent soil (refer page 66).

The data for the above has been given in Table 55 and illustrated by a histogram in Graph 76.

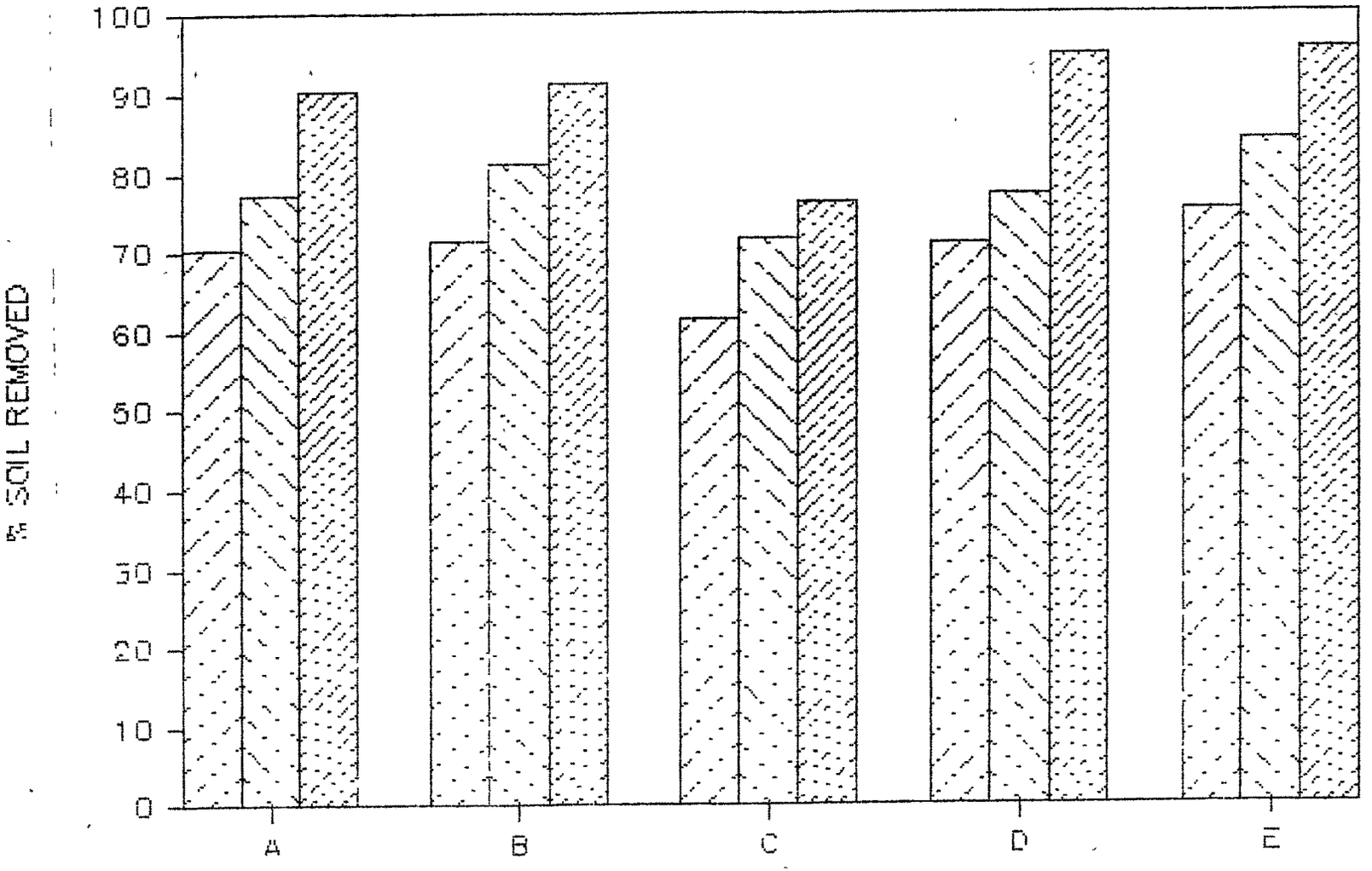
Table 55 Data on % solvent soil removed from the three fabrics by individual and combination of soaps and synthetic detergents in the small washing machine

Cleaning Agents (5.0 g/l)	Fabric A	Fabric B	Fabric C
Purified 501 bar soap	70.32	77.31	90.52
Sodium lauryl sulphate	71.23	81.20	91.25
Lissapol N	61.51	71.63	76.41
Combination III	71.19	77.23	94.87
Combination IV	75.19	84.24	95.50

Fabric A - Cotton fabric
Fabric B - Polyester/cotton 67/33 blend
Fabric C - Polyester fabric
Combination III - 501 bar soap and sodium lauryl sulphate (25:75)
Combination IV - 501 bar soap and Lissapol N (75:25)

It was seen from the above table that the same trend followed that is maximum soil was removed from polyester fabric and minimum from cotton fabric. The combinations gave very encouraging results in the small washing machine. The last combination of a soap and a nonionic synthetic detergent gave the best results. The agitation given by the stirrer was quite sufficient for soil removal.

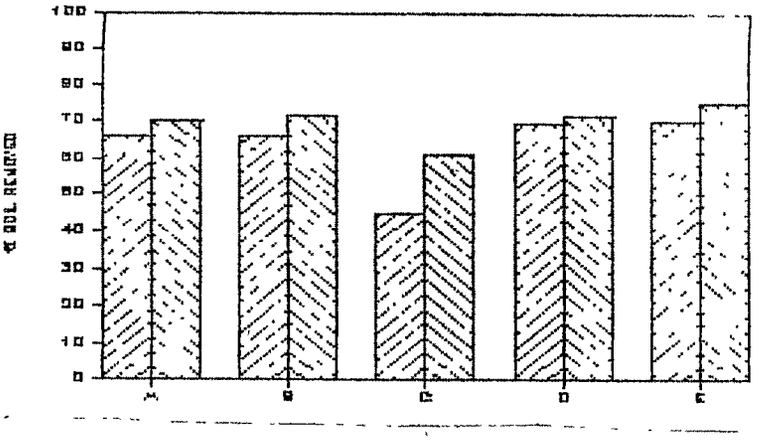
GRAPH 76- COMPARISON BETWEEN % SOIL REMOVED WITH SOAPS & SYNTHETICS DETERGENTS FROM THE THREE TEST FABRICS USED IN SMALL WASHING MACHINE.



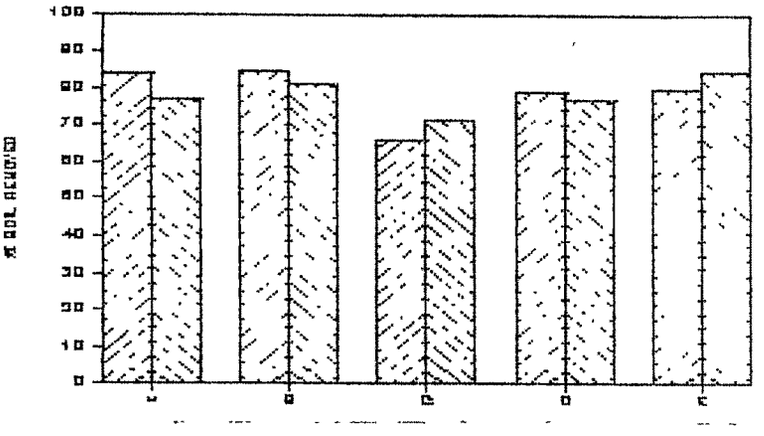
A - Purified 501 Bar Soap B - Sodium Lauryl Sulphate C - Lissapol N
D - Combination III 501 Bar Soap & Sodium Lauryl Sulphate (25:75)
E - Combination IV 501 Bar Soap & Lissapol - N (75:25)

Cotton Fabric Polyester/Cotton Blend Polyester Fabric

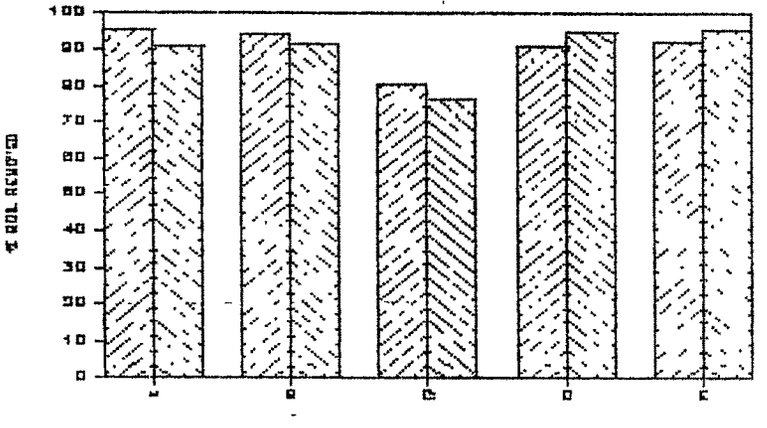
GRAPH 77- COMPARISON BETWEEN % SOIL REMOVED WITH SOAPS & SYNTHETICS DETERGENTS USING A LAUNDER-OMETER & THE SMALL WASHING MACHINE FROM COTTON FABRIC



GRAPH 78- COMPARISON BETWEEN % SOIL REMOVED WITH SOAPS & SYNTHETICS DETERGENTS USING A LAUNDER-OMETER & SMALL WASHING MACHINE FROM POLYESTER COTTON BLEND



GRAPH 79- COMPARISON BETWEEN % SOIL REMOVED WITH SOAPS & SYNTHETIC DETERGENTS USING A LAUNDER-OMETER & THE SMALL WASHING MACHINE FROM POLYESTER FABRIC



A - Purified 501 Bar Soap
B - Sodium Lauryl Sulphate
C - Lissapol N
D - Combination III 501 Bar Soap & Sodium Lauryl Sulphate (25:75)
E - Combination IV 501 Bar Soap & Lissapol - N (75:25)