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A STUDY ON THE APPLICATION OF FILTER-AIDS IN ZDDP FILTRATION

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Abstract

ZDDP(Zinc dialkyldithiophosphate) is used in engine oil as an anti-corrosion, anti-oxidant and anti-erosion. Using of filter-aids in ZDDP filtration process is very important.
In this project 19 different filter-aids (17 kinds are Iran made and the remain belong to the foreign producer) have been applied and their performance specified. These experiments were accomplished in a 2 liters stainless steel jacketed laboratory filter, and optimum amount of filter-aid and solvent (heptane) were obtained. Also operating pressure for various type of feed (ZDDP) and base-oil (SAE-10 and SAE-30) have been achieved. All experiments were run at 80˚c and filter-aids consumed as Precoat and Body feed.
All conclusions were based on Filtrate Volume-Time curves.

Key words: filter-aid, filtration system, laboratory filter

DESCRIPTION OF FILTRATION SYSTEM AND THE PROCEDURE

This system has consisted made of the stainless steel jacketed vessel with the capacity of 2 liters. The max. operation pressure of this system is 3 bar. The nitrogen gas cylinder provides this pressure. In order to conduct the filtration under the desired temperature, we can use of circulator and heat transfer oil. The filtrate is transferred into the scaled cylinder. The procedures in the laboratory are as follow:

1) At first, we put a piece of cloth as well as a layer of paper on the surface of filtration system. Then, it is coated by filter-aid. For this purpose, we mix filter-aid with base oil (SAE 30) and pour them into the filtration system.
2) The circulator turns on in order to reach to the 80ºC.
3) Mix 386 gr. ZDDP(Zinc dialkyldithiophosphate) with 166.2 gr. of base oil and heat them to the 80ºC.
4) The Nitrogen gas injects to the system for having the suitable pressure.
5) Volume of filtrate vs. the time is recorded.
6) By using a suitable software (such as; excel) the curve of filtrate volume vs. time is drawn.

RESULTS

In this regard, we studied about 19 types of filter-aids which 17 of them are local supply and have been specified by the letters *G,H,I,J,K,L,M,N,O,P,Q,R,S,T,U,V,W*. The other filter-aids, *X* and *Y* are belonging to the foreign companies.

In this project, about 61 experiments have been done in 6 series. Temperature, pressure, weight and type of filter-aid (precoat), weight and type of filter-aid (body feed), type of base oil, thickness of cake on the surface of filter media and the final volume of filtrate were all point out in all procedures. The curve of each experiment result has been drawn based on the filtrate vol-

ume vs. time. In all experiments operating temperature is about 80ºC.

EXPERIMENTS SERIES 1:

In this series, about 19 experiments have been done by 19 types of filter-aids. The suitable feed contains of 70% ZDDP, 30% base oil. In all experiments, we used 7gr. of filter-aids as the precoat and 20gr. as the body feed (admix). These quantities are due to the good results in the previous project regarding the filter-aid named Y[1] (Pictures No.1a and 1b). The best results are related to the filter-aids of J,M,O,X. Of course the filter-aid of L can compete with M and O, but as these filter-aids are all belong to one supplier , we just use O and M for further investigation.

EXPERIMENTS SERIES 2:

In this series, 4 types of filter-aids J,M,O,X have been studied . The final result shows that optimum amount of filter-aid is about 5-7gr. for the precoat and 15gr. for the body feed (Fig.2-5).

EXPERIMENTS SERIES 3:

In this series***,*** the effect of pressure on the rate of filtration was studied. Increasing the pressure developed the rate of filtration regarding all types of filter-aids. In all experiments, increasing the pressure up to the 2 bar has no incredible impression on filtrate turbidity (Fig.6-9).

EXPERIMENTS SERIES 4:

In this series, the effect of viscosity on filtration rate was studied. By increasing the amount of solvent (Heptane) the feed viscosity decreases and the rate of filtration increases. But it should be mentioned that separation the Heptane from the final product needs recovery unit that should be carefully studied on technical and economic aspects. The best result was obtained at 50ºC with 25% of Heptane (Fig.10).

EXPERIMENTS SERIES 5:

We studied on the effect of kind of feeds (type of products in pilot plant) on the filtration rate. These experiments confirmed that changing the filter feed has no impression on filter-aid optimum quantities because of difference conditions in pilot plant. The rate of filtration just change (Fig.11-14).

EXPERIMENTS SERIES 6:

These experiments confirmed that using of oil type SAE-10 increase the rate of filtration just a little (Fig.15-16).

EFFECT OF FILTER-AID ON CHEMICAL COMPOSITION OF ZDDP

In regard with the chemical effect of filter-aids on ZDDP, the elements Zn, Fe, Ca, Mg, Na, K, and Al in filtrate measured by atomic absorption. As there was no incredible alteration on these quantities of these element, before and after filtration, therefore the elements interchange from filter-aid to ZDDP has been negligible.

CONCLUSION

Through 19 types of filter-aids, just 4 of them named J, M, O, X were chosen and the optimum quantity of each one was obtained. In each case, the optimum quantity of filter-aid is 5-7gr. as the precoat and 15gr as the body feed. As you can see in Fig.17, the filter-aid type X has the most efficiency and incredibly increases the filtration rate. Also the filter-aid named M (local supply) has also good results.

References:

1. Sadraei Nouri S., Khaleghi Nasab A., April 2000, Filtration of Zinc dialkyldithiophosphate (ZDDP), Proceeding of World Filtration Congress, 8, Vol. 2 PP.1138 –1141
2. Butts T.J., 1997. In Advances in Filtration and Separation Technology, Vol.4, Fine Particle Filtration and Separation, K.L.Rubow (Ed.). American Filtration Society, Gulf, Houston, pp. 276-280
3. Dickenson T.C., 1997. Filters and Filtration Handbook. Elsevier Advanced Technology, Oxford

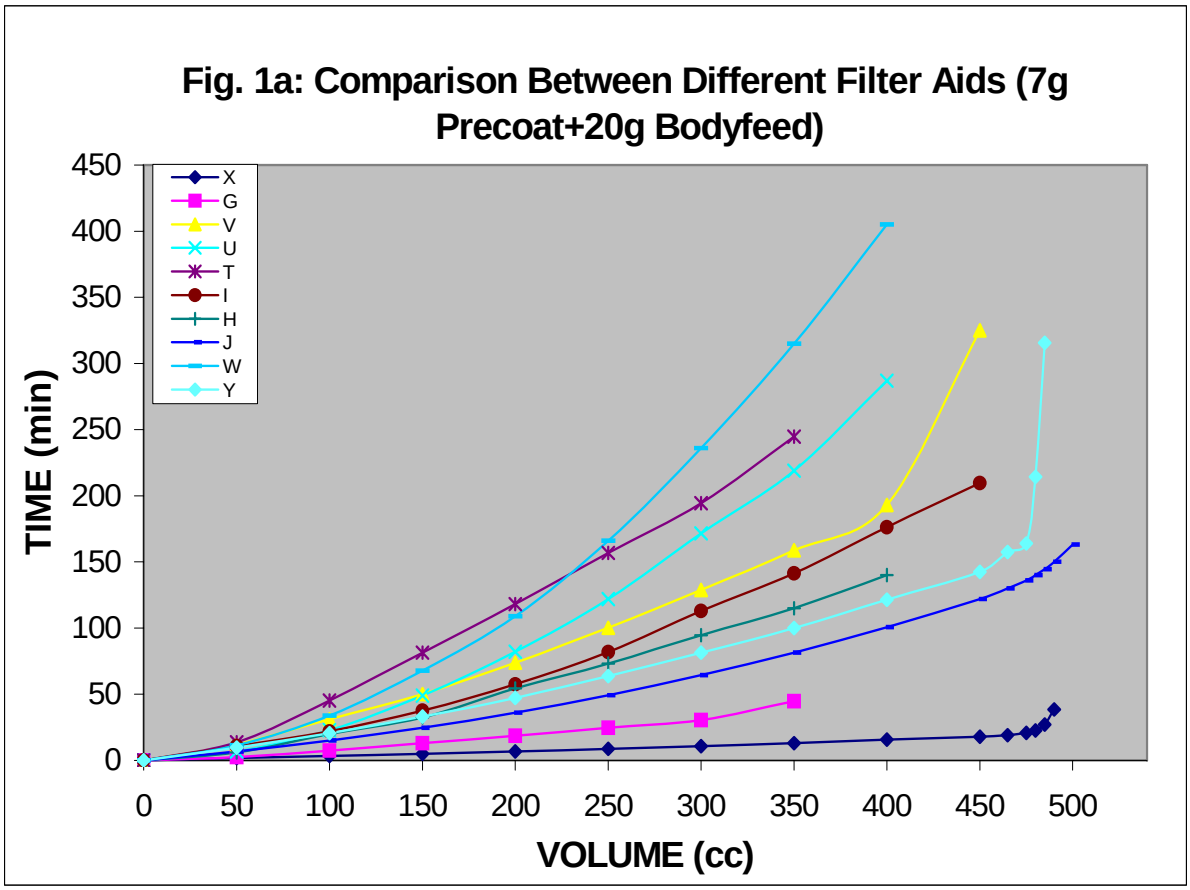


Fig. 1a: Comparison Between Different Filter Aids (7g Precoat+20g Bodyfeed)
TIME (min)
VOLUME (cc)
X
G
V
U
T
I
H
J
W
Y
0
50
100
150
200
250
300
350
400
450
500

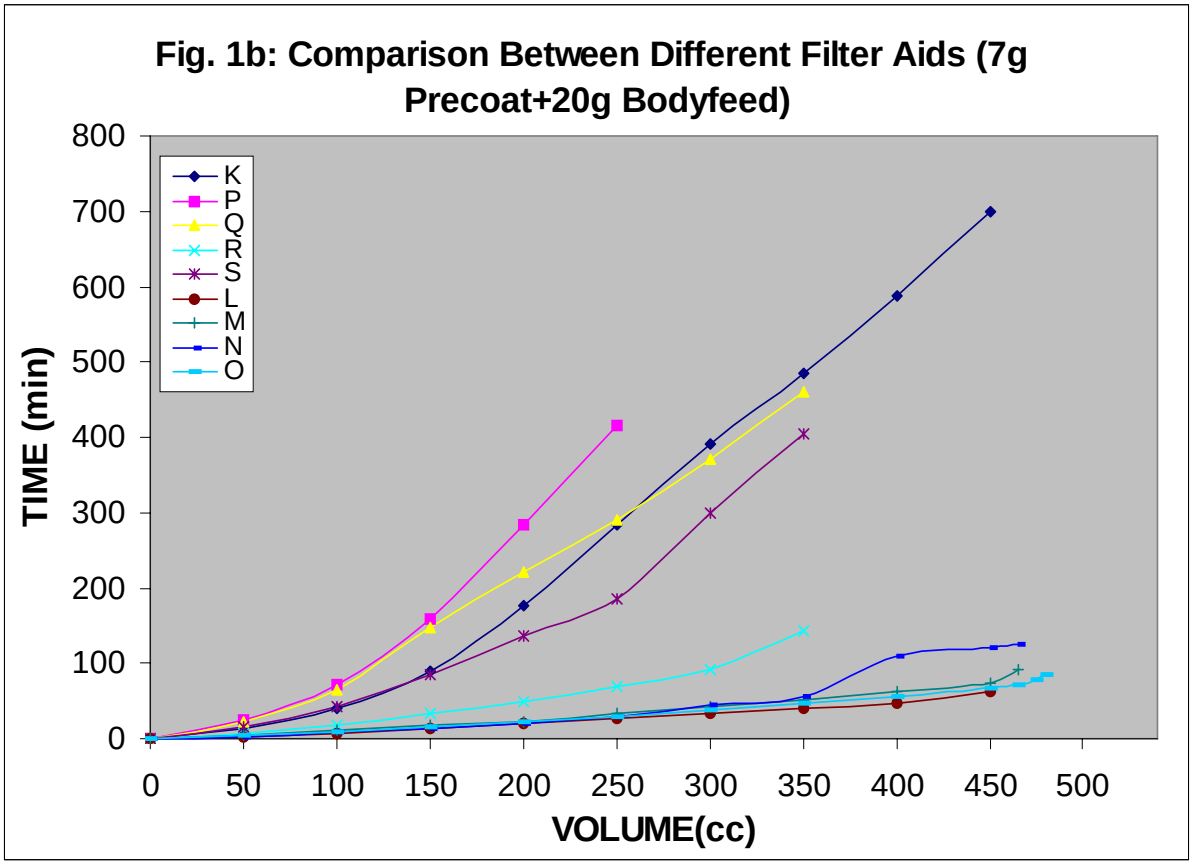


Fig. 1b: Comparison Between Different Filter Aids (7g Precoat+20g Bodyfeed)
TIME (min)
VOLUME(cc)
K
P
Q
R
S
L
M
N
O
0
50
100
150
200
250
300
350
400
450
500
600
700
800

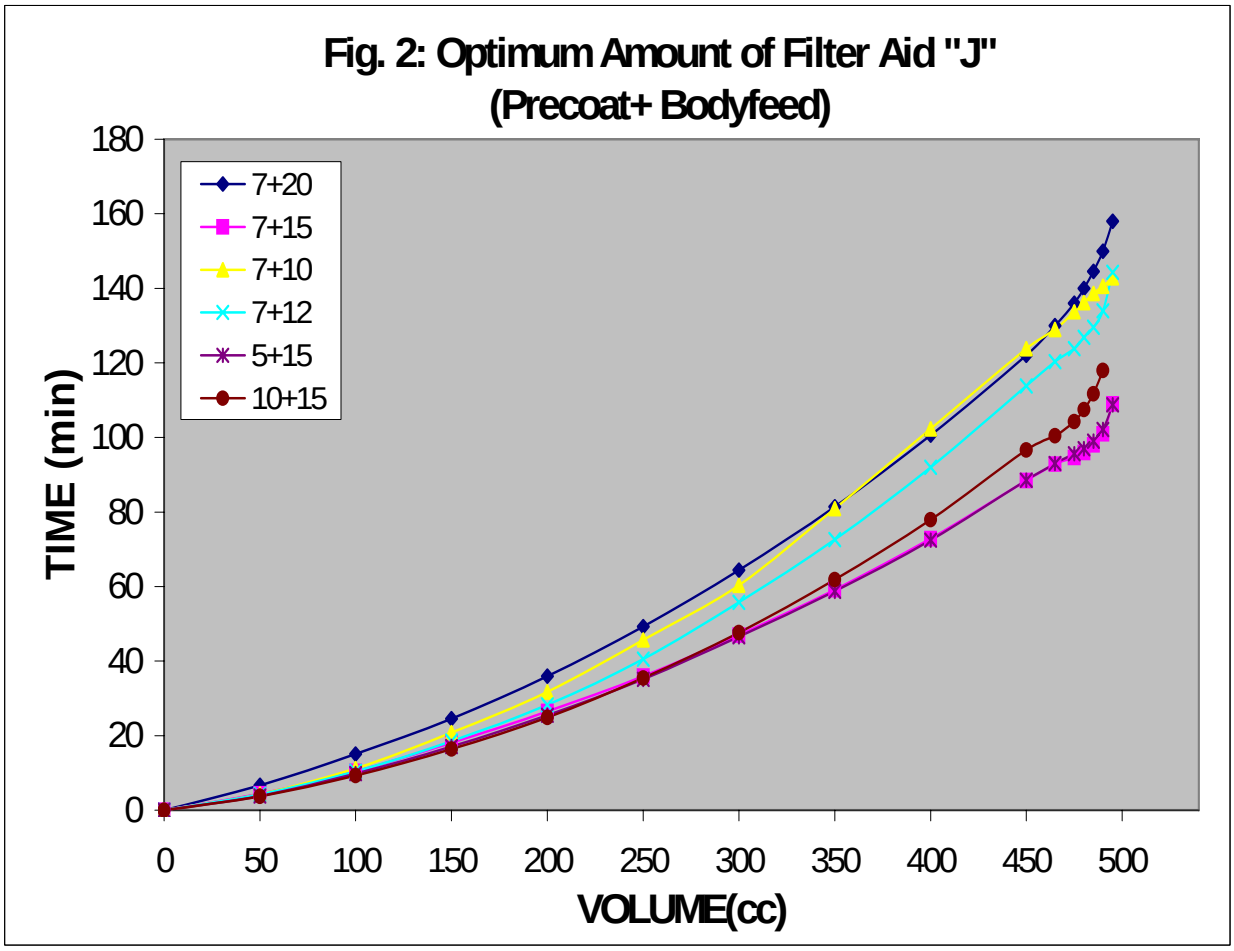


Fig. 2: Optimum Amount of Filter Aid "J"
(Precoat+ Bodyfeed)
TIME (min)
VOLUME(cc)
7+20
7+15
7+10
7+12
5+15
10+15
0
20
40
60
80
100
120
140
160
180
0
50
100
150
200
250
300
350
400
450
500

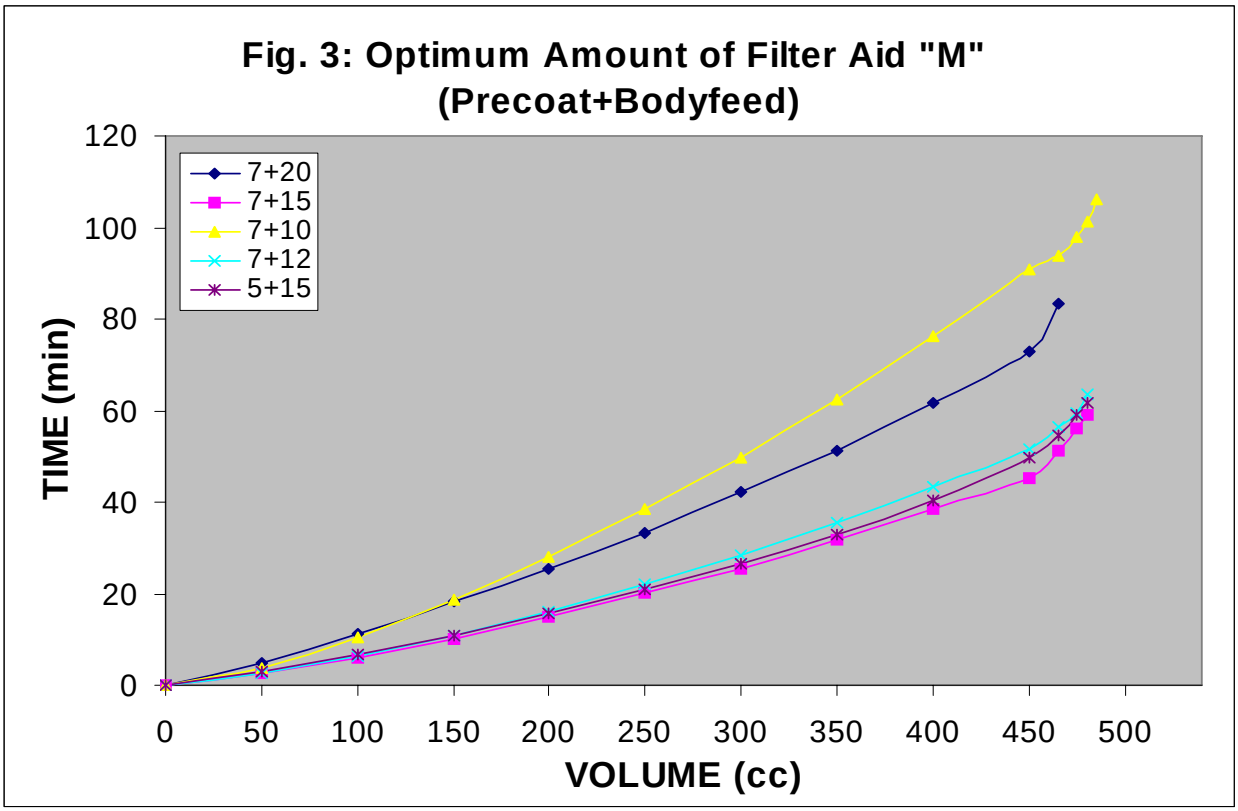


Fig. 3: Optimum Amount of Filter Aid "M"
(Precoat+Bodyfeed)
TIME (min)
VOLUME (cc)
7+20
7+15
7+10
7+12
5+15
0
20
40
60
80
100
120
0
50
100
150
200
250
300
350
400
450
500

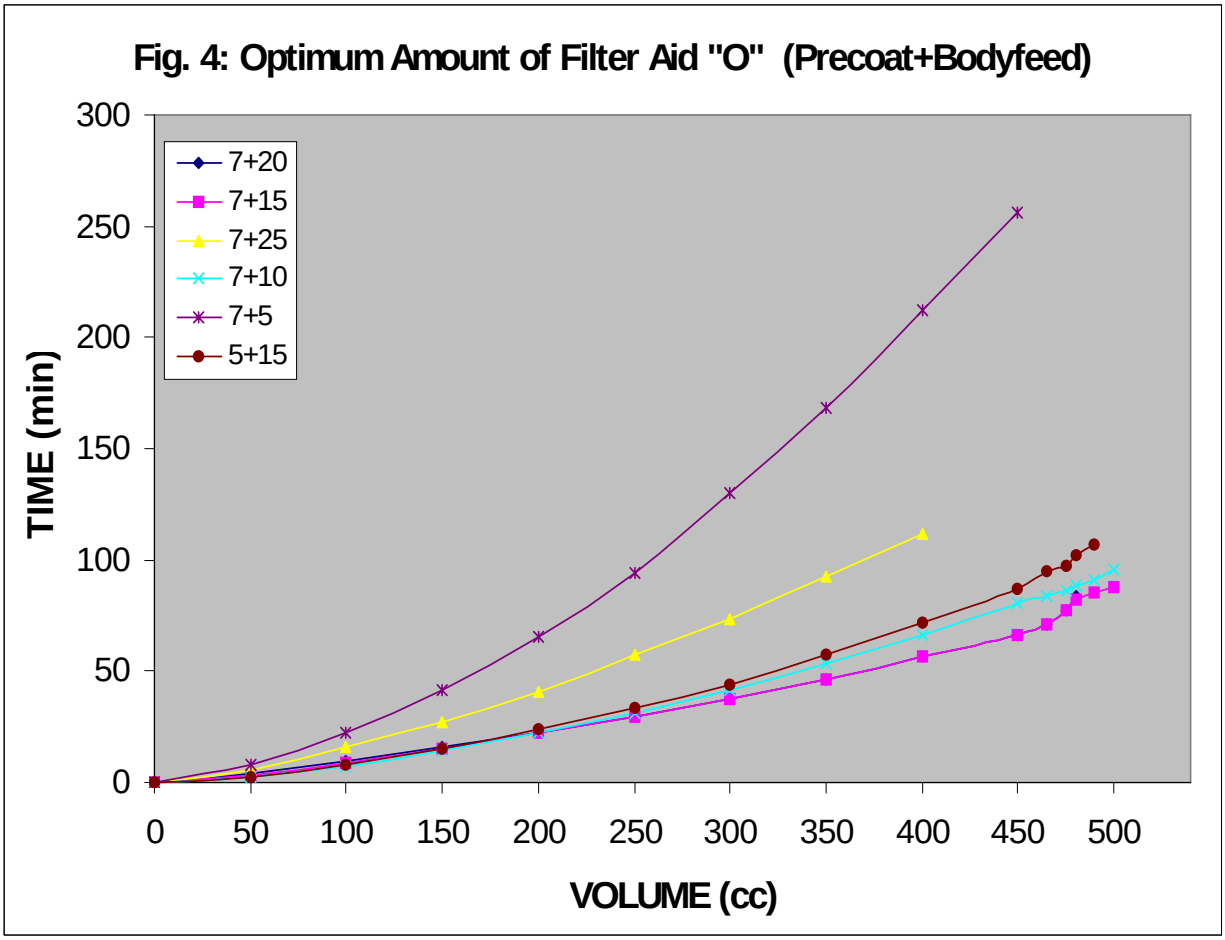


Fig. 4: Optimum Amount of Filter Aid "O" (Precoat+Bodyfeed)
TIME (min)
VOLUME (cc)
7+20
7+15
7+25
7+10
7+5
5+15
0
50
100
150
200
250
300
350
400
450
500

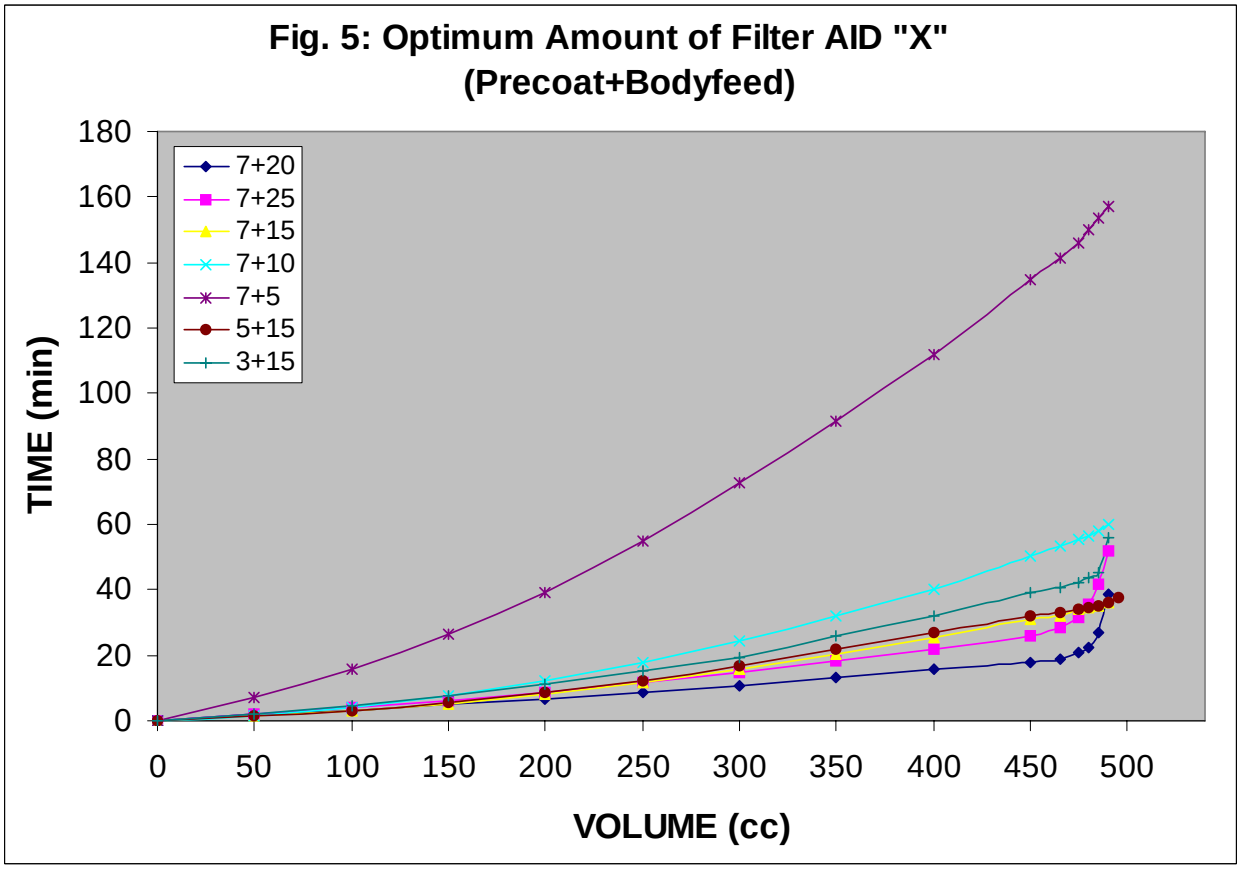


Fig. 5: Optimum Amount of Filter AID "X"
(Precoat+Bodyfeed)
TIME (min)
VOLUME (cc)
7+20
7+25
7+15
7+10
7+5
5+15
3+15
0
20
40
60
80
100
120
140
160
180
0
50
100
150
200
250
300
350
400
450
500

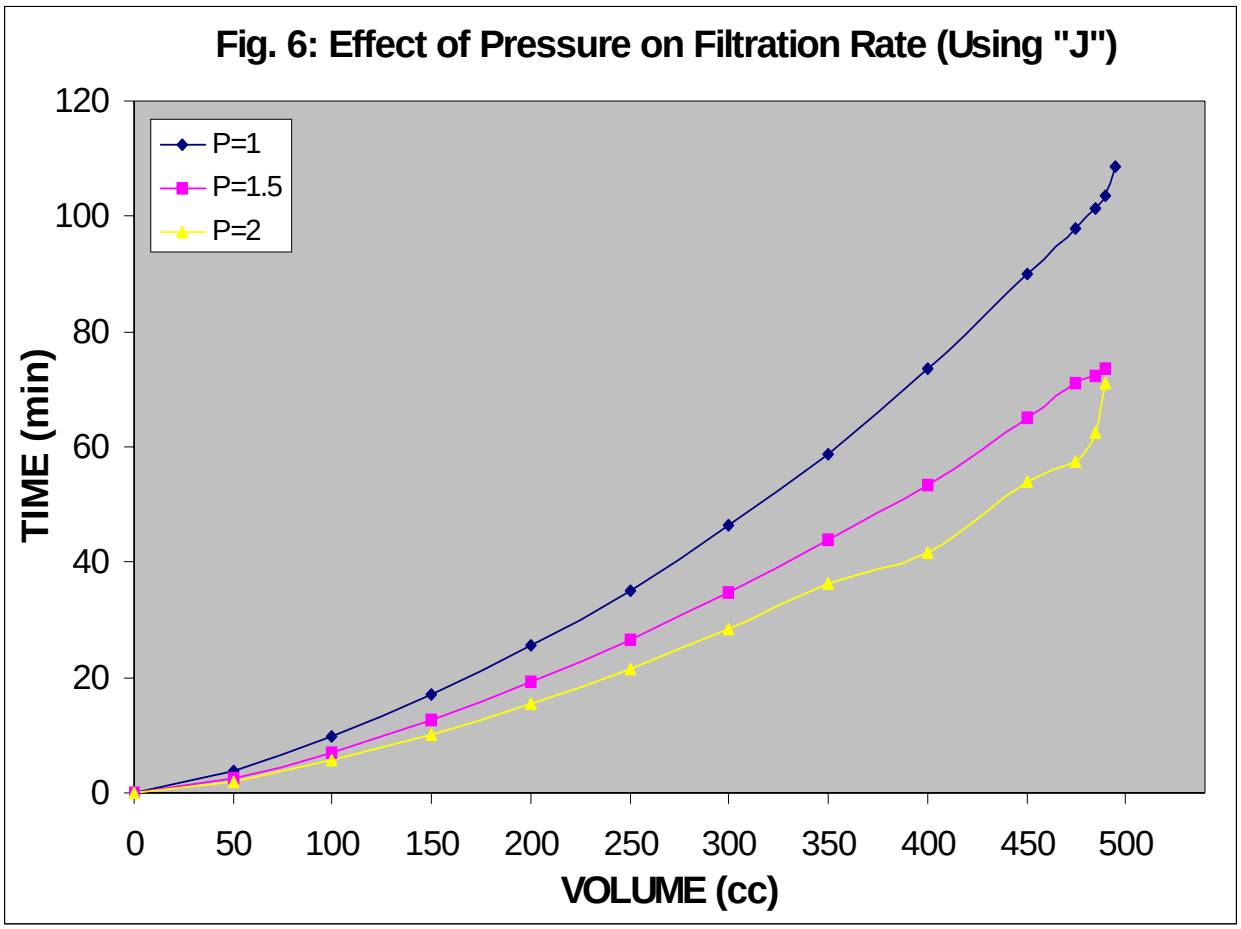


Fig. 6: Effect of Pressure on Filtration Rate (Using "J")
TIME (min)
VOLUME (cc)
P=1
P=1.5
P=2
0
20
40
60
80
100
120
0
50
100
150
200
250
300
350
400
450
500

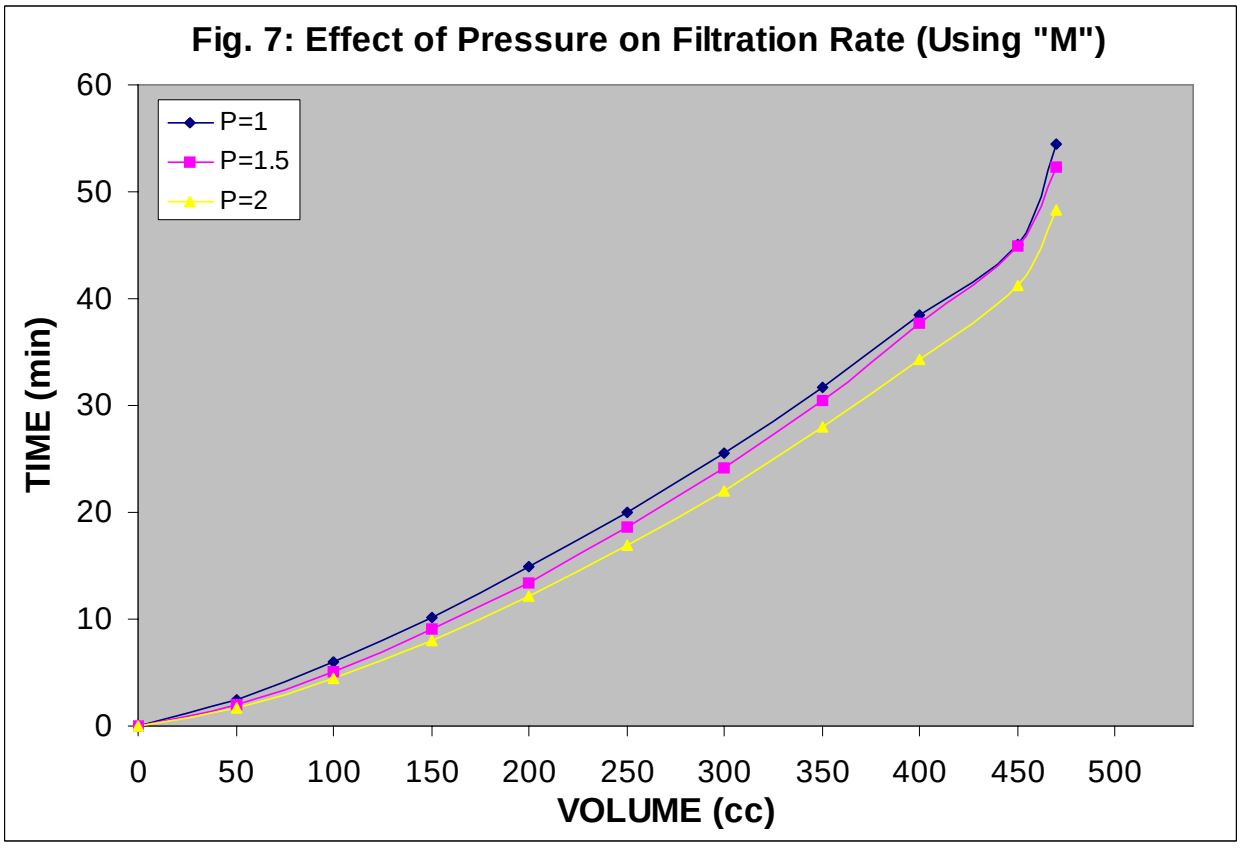


Fig. 7: Effect of Pressure on Filtration Rate (Using "M")
TIME (min)
VOLUME (cc)
P=1
P=1.5
P=2
0
10
20
30
40
50
60
0
50
100
150
200
250
300
350
400
450
500

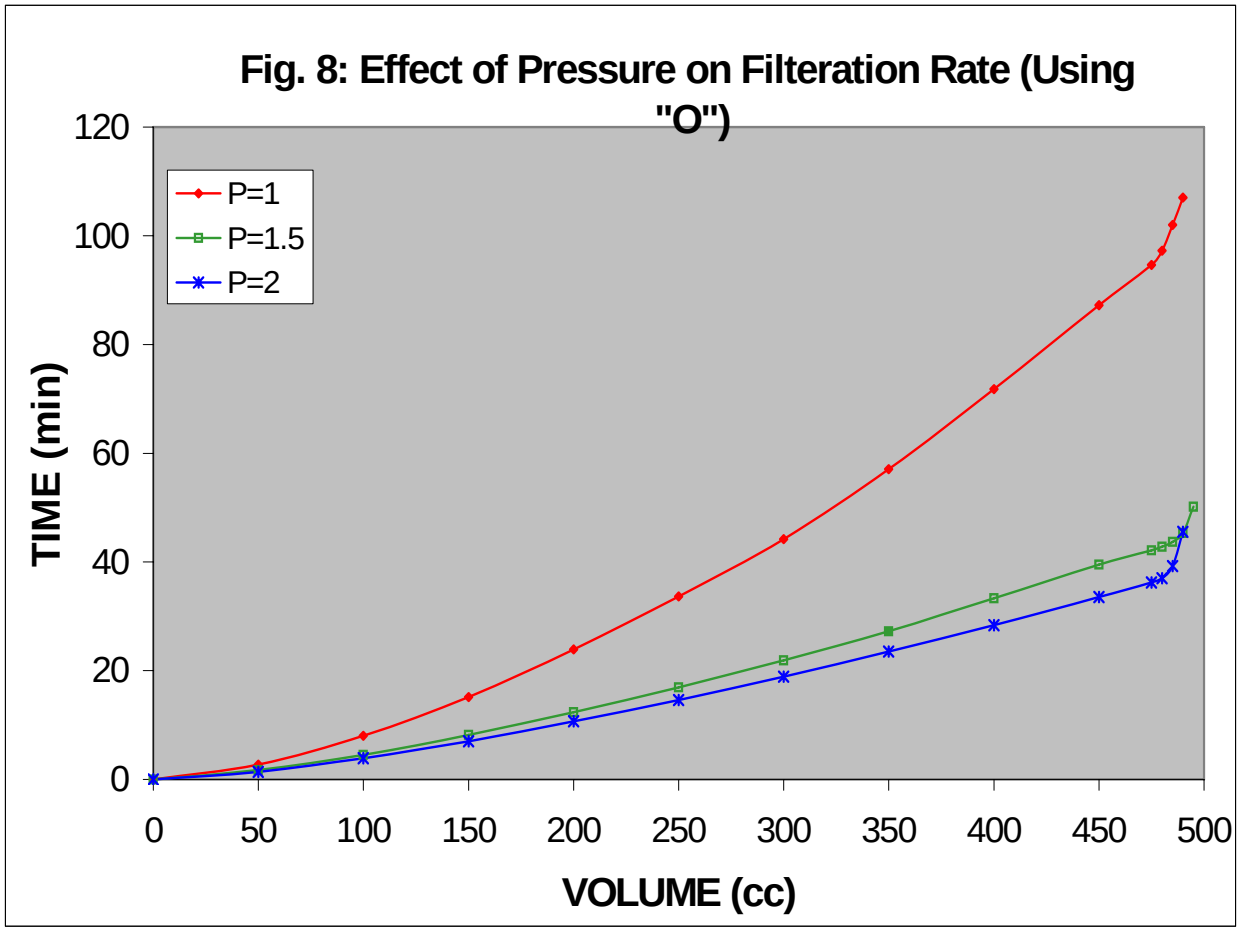


Fig. 8: Effect of Pressure on Filteration Rate (Using "O")
P=1
P=1.5
P=2
TIME (min)
VOLUME (cc)
0
20
40
60
80
100
120
0
50
100
150
200
250
300
350
400
450
500

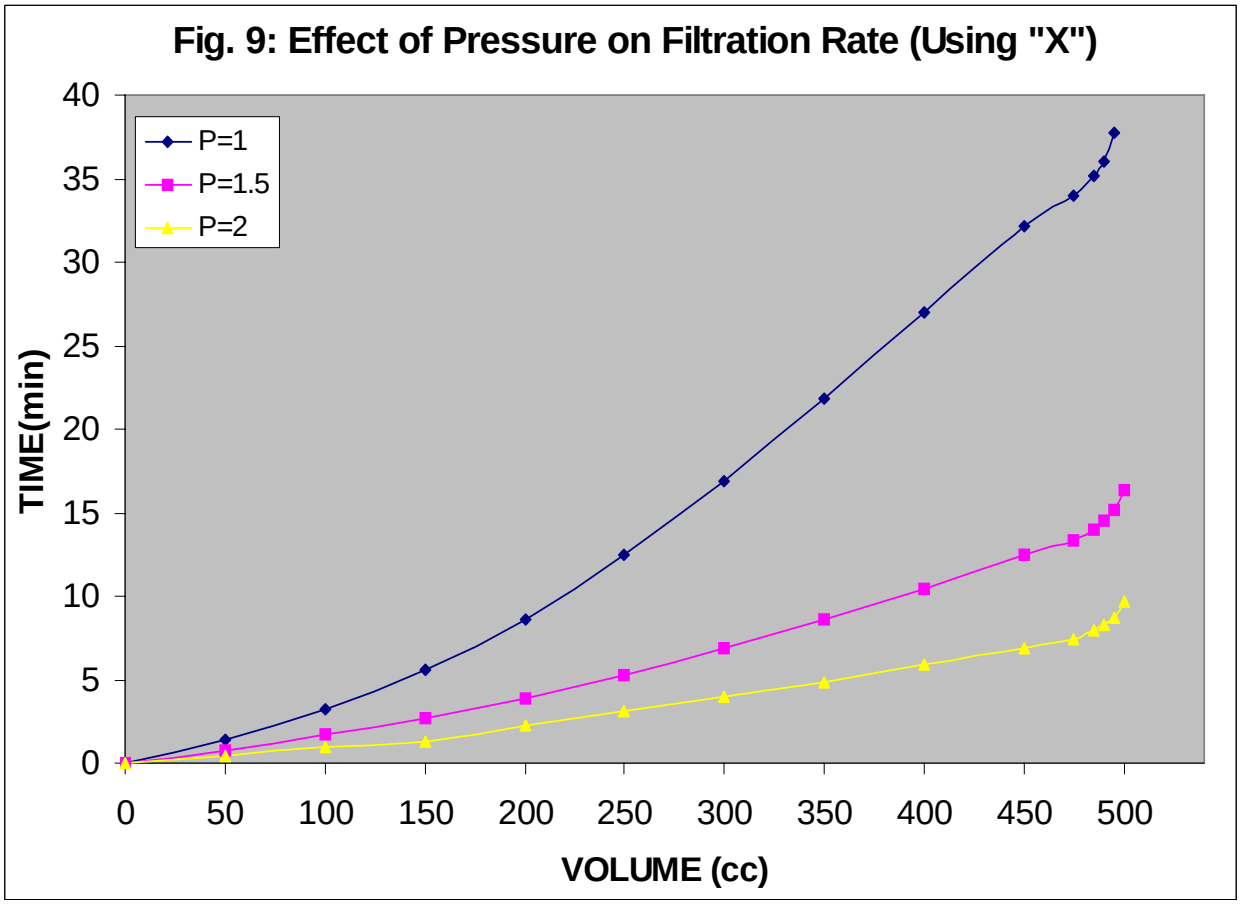


Fig. 9: Effect of Pressure on Filtration Rate (Using "X")
P=1
P=1.5
P=2
TIME(min)
VOLUME (cc)
0
5
10
15
20
25
30
35
40
0
50
100
150
200
250
300
350
400
450
500

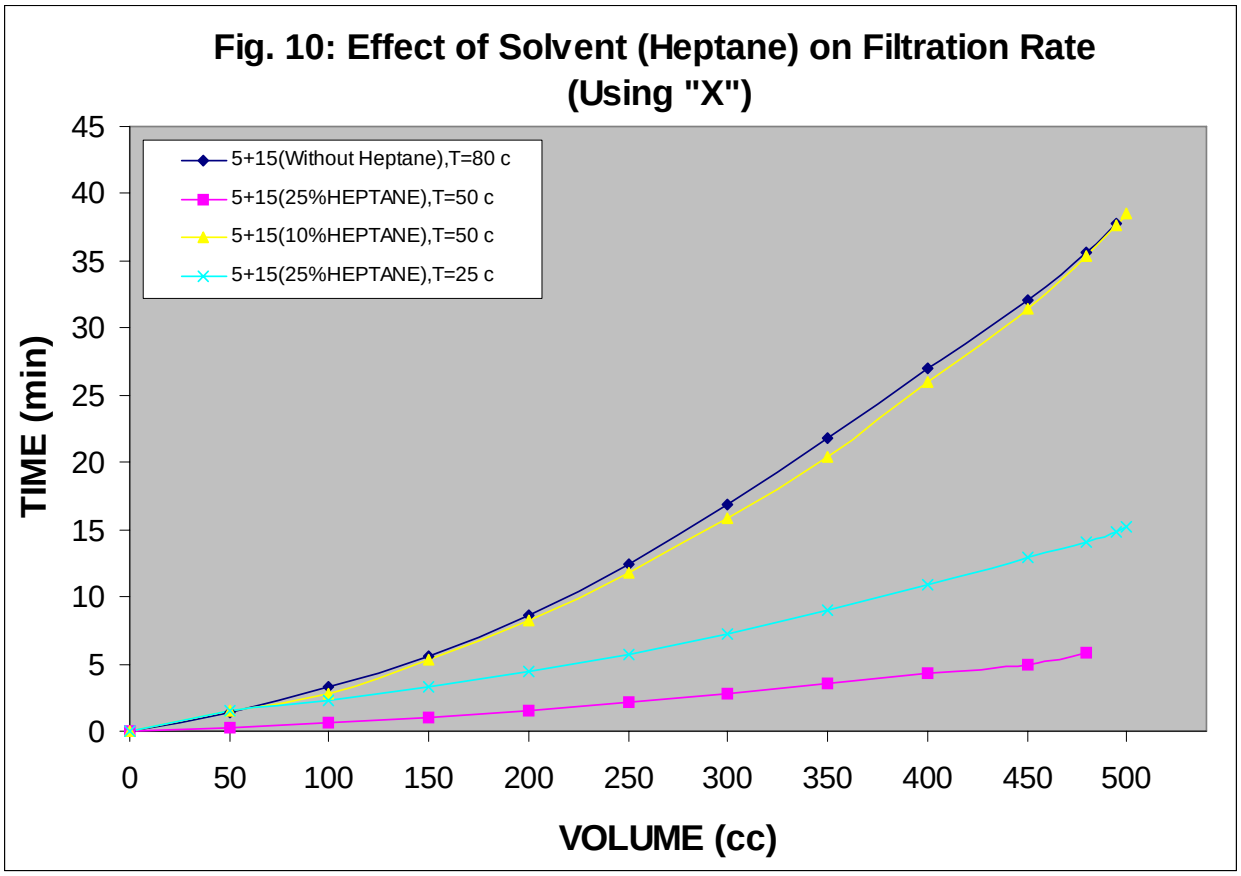


Fig. 10: Effect of Solvent (Heptane) on Filtration Rate (Using "X")
5+15(Without Heptane),T=80 c
5+15(25%HEPTANE),T=50 c
5+15(10%HEPTANE),T=50 c
5+15(25%HEPTANE),T=25 c
TIME (min)
VOLUME (cc)
0
5
10
15
20
25
30
35
40
45
0
50
100
150
200
250
300
350
400
450
500

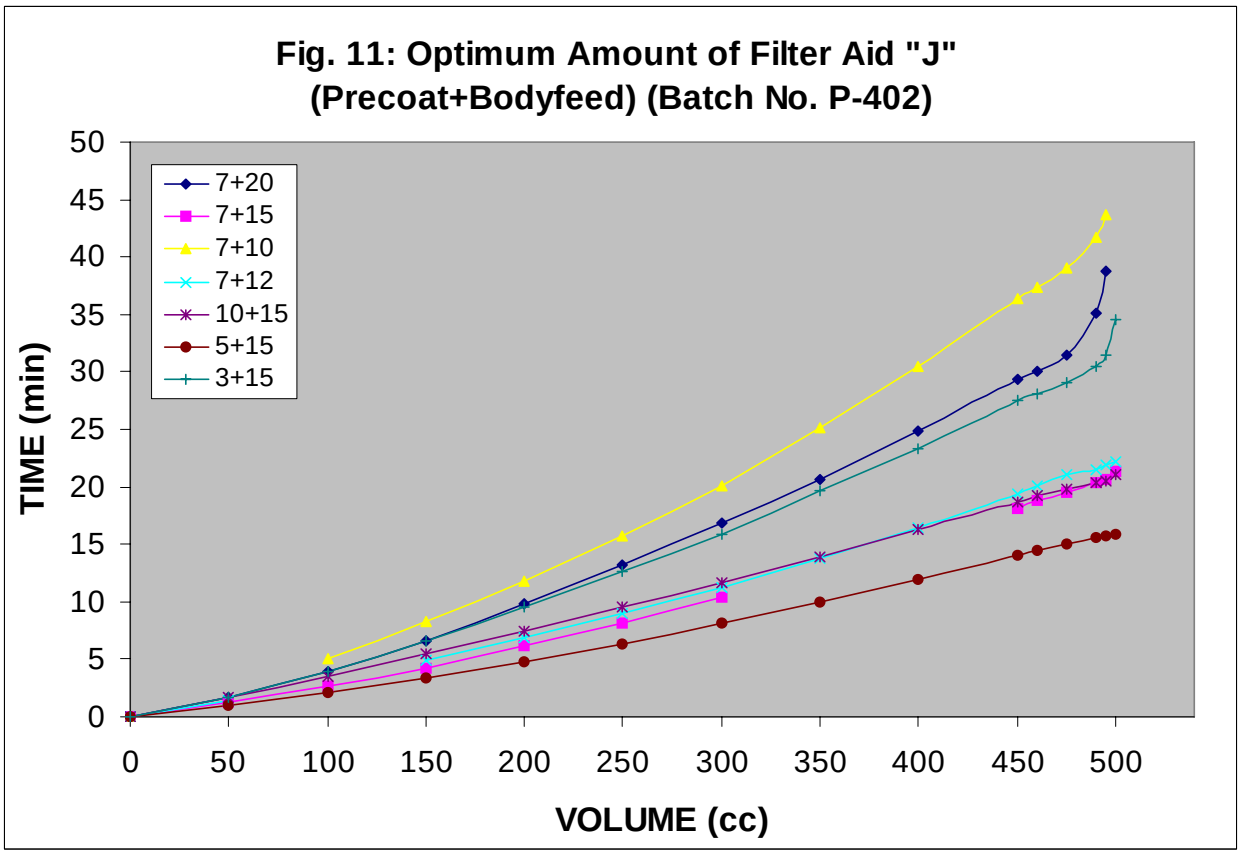


Fig. 11: Optimum Amount of Filter Aid "J" (Precoat+Bodyfeed) (Batch No. P-402)
7+20
7+15
7+10
7+12
10+15
5+15
3+15
TIME (min)
VOLUME (cc)
0
5
10
15
20
25
30
35
40
45
50
0
50
100
150
200
250
300
350
400
450
500

Fig. 12: Comparison Between Different Feeds (Filter Aid 'J")

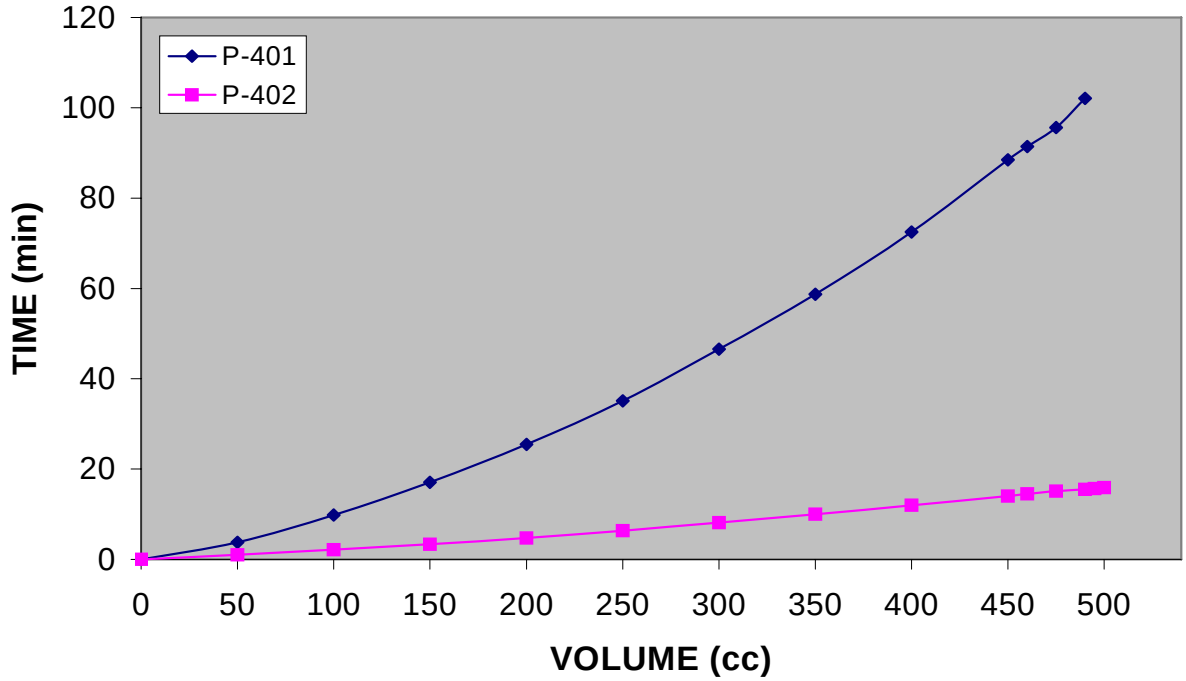


Fig. 13: Comparison Between Different Feeds (Filter Aid "O")

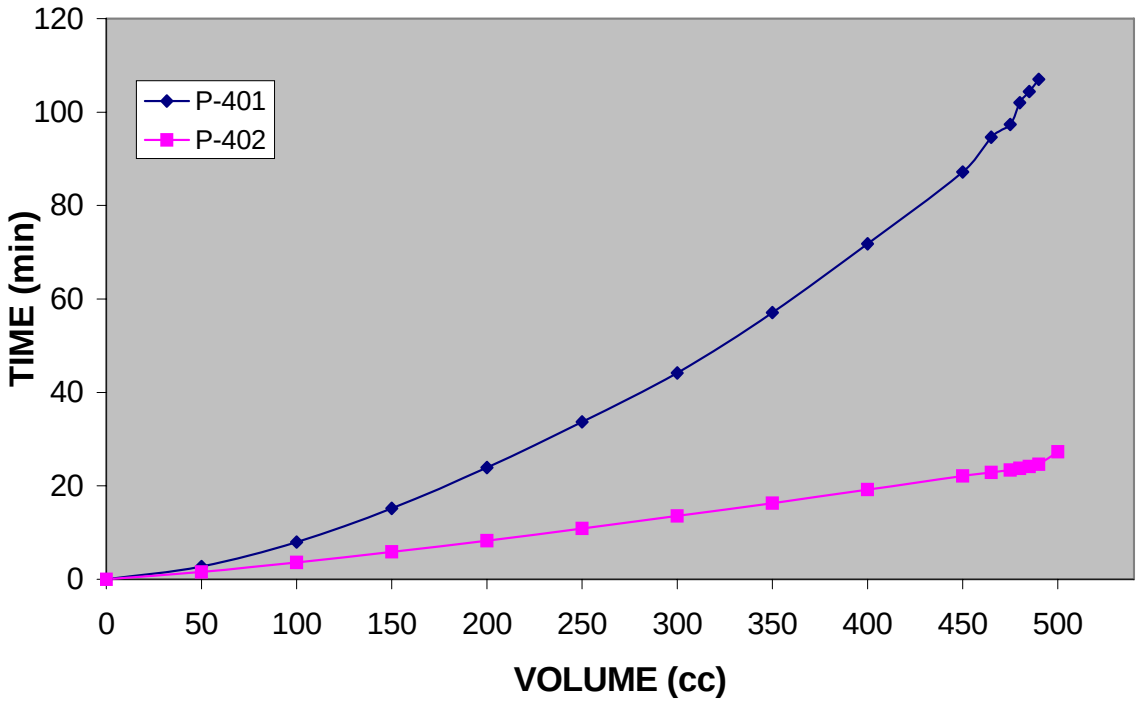


Fig. 14: Comparison Between Different Feeds (Filter Aid "M")

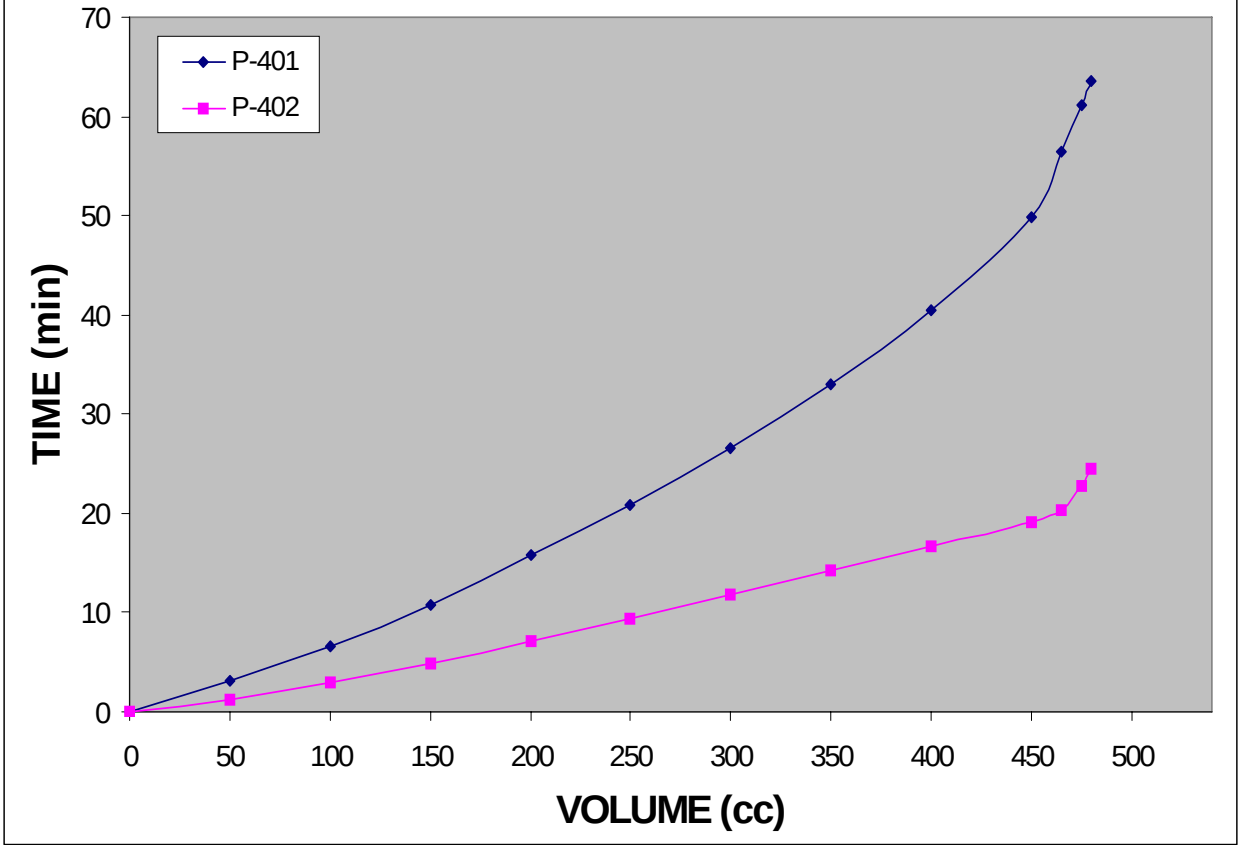
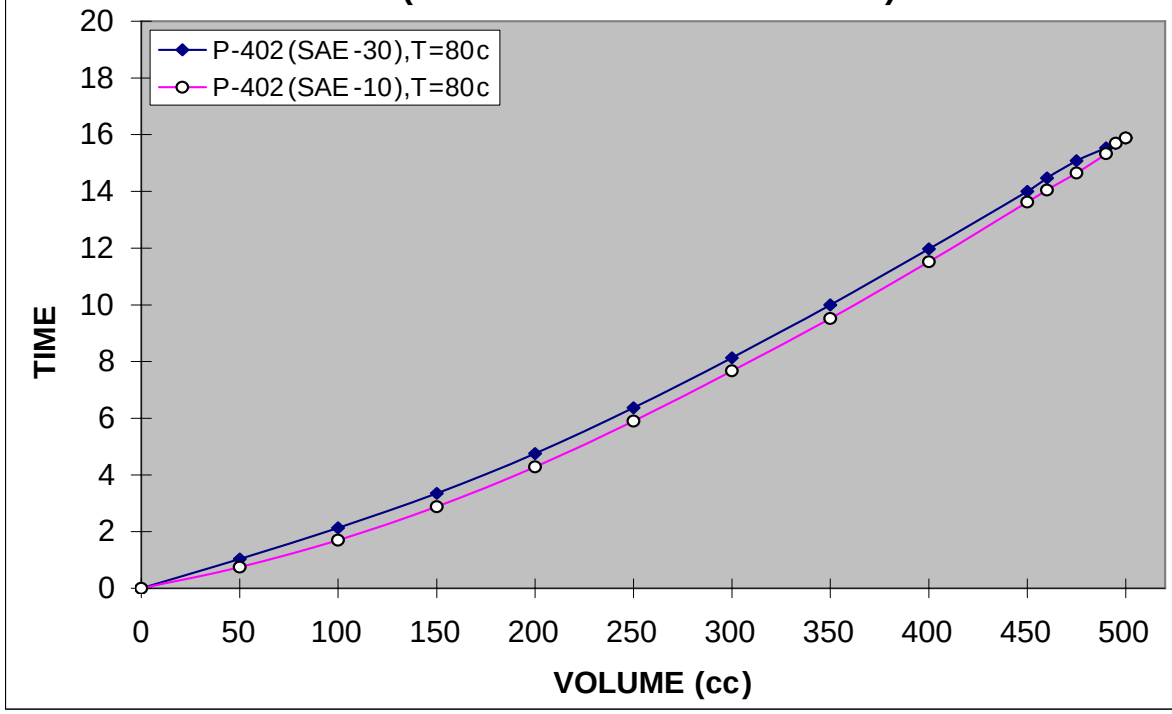


Fig. 15: Effect of Base -Oil on Filtration Rate (Filter Aid =J & Feed =P-402)



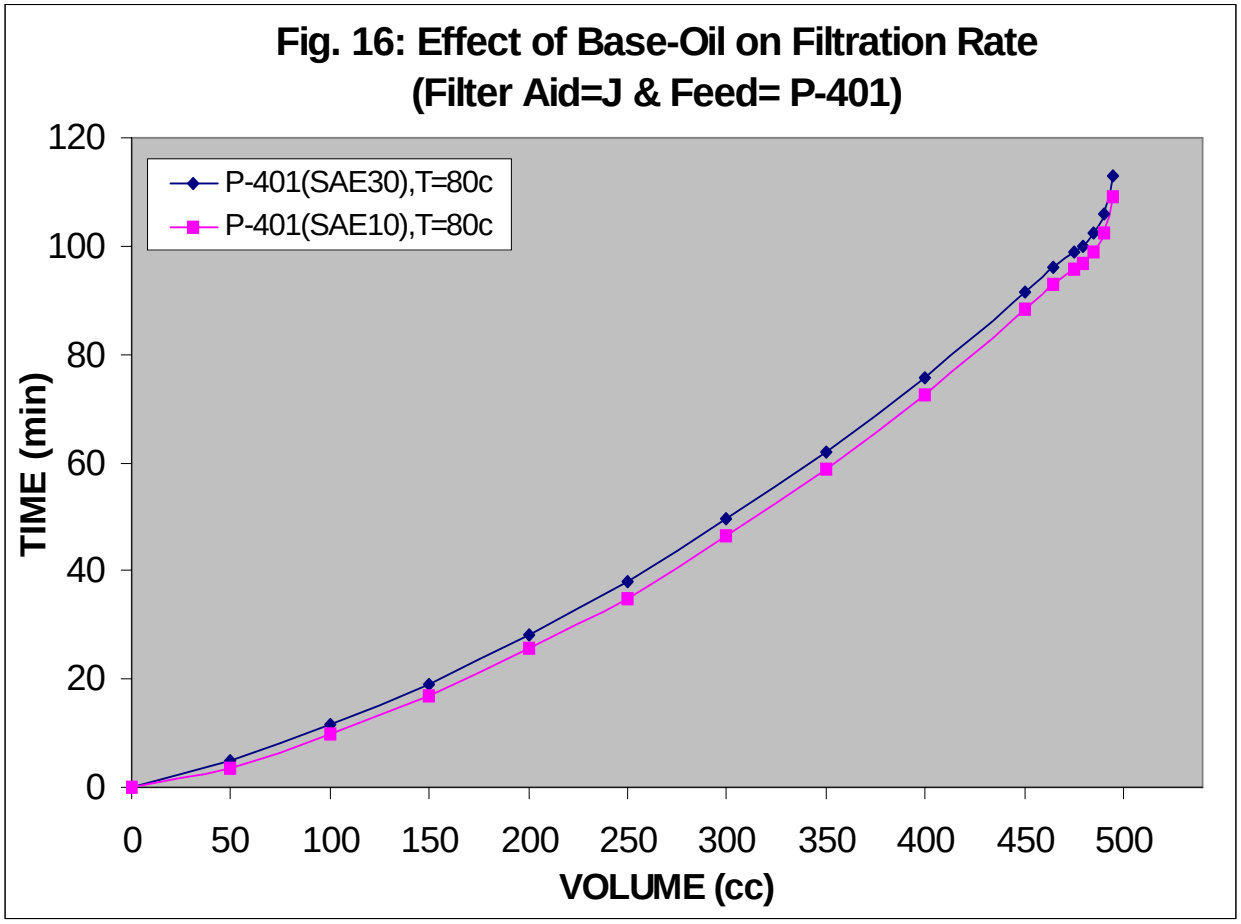


Fig. 16: Effect of Base-Oil on Filtration Rate
(Filter Aid=J & Feed= P-401)
P-401(SAE30),T=80c
P-401(SAE10),T=80c
TIME (min)
VOLUME (cc)
0
20
40
60
80
100
120
0
50
100
150
200
250
300
350
400
450
500

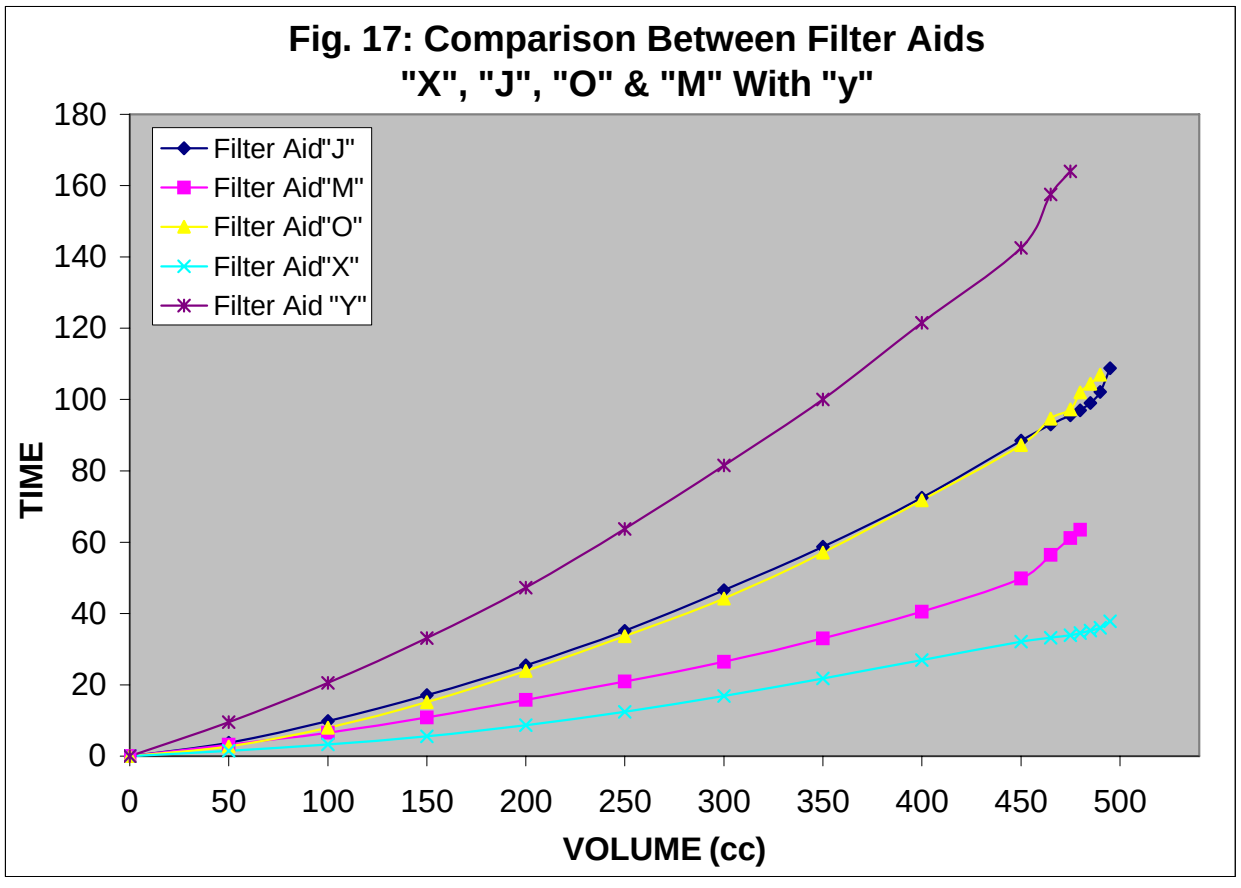


Fig. 17: Comparison Between Filter Aids
"X", "J", "O" & "M" With "y"
Filter Aid"J"
Filter Aid"M"
Filter Aid"O"
Filter Aid"X"
Filter Aid "Y"
TIME
VOLUME (cc)
0
20
40
60
80
100
120
140
160
180
0
50
100
150
200
250
300
350
400
450
500