

CONTENTS

	page
ACKNOWLEDGEMENTS.	IV
LIST OF PLATES	V
LIST OF TABLES	V
LIST OF FIGURE	V
NOMENCLATURE	VIII
ABBREVIATION	VIII
SUMMARY.	IX
CHAPTER (1) INTRODUCTION.	1
CHAPTER (2) REVIEW OF PREVIOUS WORK.	7
2.1 INTRODUCTION.	7
2.2 LITERATURE REVIEW	7
Modelling of filtration	7
Performance of oil filters.	7
Test methods for automotive filtration	8
Engine oil pumpability	9
Engine wear	10
Effect of by pass filters	14
Service interval	19
Disposal of filter elements	20
New trends in oil filters	21
2.3 AIM OF THE PRESENT WORK	24
CHAPTER (3) EXPERIMENTAL WORK	25
3.1 INTRODUCTION	25
3.2 PARTS OF THE TEST RIG	25
Oil feeding system	28
Oil flow meters	33
Oil delivery pipelines	33
Measurments facilities	38
Measurment of oil flow rat	38
Measurment of pressure drop	41
Measurment of the concentration of the contaminant	41

Measurment of oil temperature	41
The Assembling chassis	44
3.3 CALIBRATION OF THE OIL FLOW METERS	47
Procedure of calibration of first / main flow meter	47
Procedure calibration of second/by-pass flow meter	49
3.4 MEASUREMENT ACCURACY	51
3.5 GENERAL SPECIFICATION OF TEST RIG	51
3.6 MAIN OUTSTANDING FEATURES OF THE TEST RIG	51
3.7 ESTIMATION OF FILTERS NOMINAL FLOW RATE	52
3.8 AIM OF THE DIFFERENT TESTS	53
3.9 TEST PROCEDURE	56
Test conducted at constant flow rate and a constant temperature	56
Test conducted at constant flow rate and a variable temperature.	56
Test conducted at constant temperature and a variable flow rate.	56
Test conducted simultaneously at low flow rate	57
Test conducted at variable flow rate	57
Test conducted at variable temperature	57
3.10 CALCULATION OF THE PERFORMANCE CHARACTERISTICS OF FILTERS:	58
Calculation of pressure drop	58
Calculation contaminant concentration	58
Calculation of dust retained	59
Calculation of efficiency of the filter	59
Calculation of dust retained and efficiency of filters for tests conducted simultaneously at very low flow rate	59
3.11 TEST RESULT	60
Result of tests conducted for effect of operating condition:	61
Result of tests conducted at a constant flow rate and constant temperature	62
Result of tests conducted at a constant flow rate and a variable temperature	62
Result of tests conducted at a constant temperature and a variable flow rate	64
Result of tests conducted simultaneously at low flow rate	66

CHAPTER (4) DISCUSSION AND ANALYSIS OF THE RESULTS	67
4.1 INTRODUCTION	67
4.2 EFFECT OF FLOW RATE	67
4.3 EFFECT OF TEMPERATURE	71
4.4 EFFECT OF INGRESSION RATE	75
4.5 COMPARISON BETWEEN PERFORMANCES OF FILTERS:	79
Tests conducted at constant flow rate and constant temperature	80
Tests conducted at different temperatures	90
Tests conducted at different flow rates	93
Tests conducted at low flow rates	97
CHAPTER (5) CONCLUSIONS AND RECOMMENDATIONS	101
5.1 CONCLUSIONS	101
5.2 RECOMMENDATIONS	102
5.3 RECOMMENDATIONS FOR FUTURE WORK	103
REFERENCES	104
APPENDIX(A) Specification of the test oil	108
APPENDIX(B) Specification of the test dust	110
APPENDIX(C) Specification of the test FILTERS	113
SUMMARY	115

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LIST OF PLATES

Plate. 3.1	The test rig.	27
Plate. 3.2	The feeding system.	29
Plate. 3.3	The stirrer .	31
Plate 3.4	The main pipeline	34
Plate. 3.5	Filter connection	36
Plate. 3.6	The orifice	40
Plate. 3.7	Precipitating device.	42
Plate. 3.8	The temperature regulator.	42
Plate. 3.9	Control panel.	45

LIST OF TABLES

Table. 3.1	Matrix of test.	54
Table. 3.2	Specification test conditions for lubricating oil filter element capacity tests S.A.E HSJ 806 OCT 93 [1.	55

LIST OF FIGURES

Fig. 3.1	Schematic diagram of test rig.	26
Fig. 3.2	The feeding system.	30
Fig. 3.3	The stirrer and oil tank	32
Fig. 3.4	Pipeline diagram of test rig	35
Fig. 3.5	Filter connection	37
Fig. 3.6	Oil flow meter	39
Fig. 3.8	Assembling chassis.	43
Fig. 3.9	Control diagram.	46
Fig. 3.10	Calibration curve of oil by-pass flow meter.	48
Fig. 3.11	Calibration curve of oil full flow meter.	50
Fig. 4.1	Variation of pressure drop with time at different flow rates.	68
Fig. 4.2	Variation of dust remove with time at different flow rates.	69
Fig. 4.3	Variation of efficiency with time at different flow rates.	70
Fig. 4.4	Variation of containant cocentration with time at different flow rates.	71
Fig. 4.5	Variation of pressure drop with time at different temperature.	75
Fig. 4.6	Variation of amount of dust remove with time at different temperature	73
Fig. 4.7	Variation of pressure drop with time at diffrent temperature.	74
Fig. 4.8	Variation of containant concentration with time at different temperature.	75
Fig. 4.9	Variation of pressure drop with time at different value of ingressin rate.	76
Fig. 4.10	Variation of amount of dust remove with time at diffrent value of ingressin rate.	77
Fig. 4.11	Variation of efficiency with time at diffrent value of ingressin rate.	78
Fig. 4.12	Variation of contaminant cocentration with time at diffrent value of ingressin rate.	79
Fig. 4.13	Variation of pressure drop with time	80
Fig. 4.14	Variation of amount of dust remove with time.	81
Fig. 4.15	Variation of pressure drop with amount of dust	82

	remove.	
Fig. 4.16	Variation of specific dust loading with time	83
Fig. 4.17	Variation of filters efficiency with time	84
Fig. 4.18	Variation of containant cocentration with time	85
Fig. 4.19	Variation of percentage decrease in pressure drop with time with respect to F1	87
Fig. 4.20	Variation of percentage decrease in containant cocentration with time with respect to F1	88
Fig. 4.21	Variation of percentage increase in efficiency with time with respect to F1	89
Fig. 4.22	Variation of pressure drop with temperature for the three tested filters	90
Fig. 4.23	Variation of amount of dust remove with time for the three tested filters	91
Fig. 4.24	Variation of specific dust loading with time at for the three tested filters	92
Fig. 4.25	Variation of efficiency with time for the three tested filters	92
Fig. 4.26	Variation of pressure drop with time for the three tested filters	94
Fig. 4.27	Variation of amount of dust remove with time for the three tested filters	95
Fig. 4.28	Variation of efficiency with time for the three tested filters.	96
Fig. 4.29	Variation of specific dust loading with time for the three tested filters	96
Fig. 4.30	Variation of pressure drop with time for the two tested filters	97
Fig. 4.31	Variation of dust remove with time for the two tested filters	98
Fig. 4.32	Variation of efficiency with time for the two tested filters	99
Fig. 4.33	Variation of specific dust loading with time for the two tested filters	100

NOMENCLATURES

Symbol

A	Filtration area , cm^2
A*	Specific area=A/P, cm^2/Kw
C ₀	The original concentration ,g/l
C _u	The measured concentration ,g/l
C _n	The net concentration ,g/l
C _{df}	The concentration down stream full flow ,g/l
C _{db}	The concentration down stream by pass flow ,g/l
C _{rf}	The removed concentration full flow ,g/l
C _{rb}	The removed concentration by pass flow ,g/l
c.c	Contaminant concentration , ,g/l
c.w	Weight of Contaminant in sampe,g
d.r	Dust removed by filter
η	Efficiency of the filter, %
η_{ff}	Efficiency of the full flow filter, %
η_{bp}	Efficiency of the by pass flow filter, %
F	Filter
m _a	Contaminant added , gm
m _r	Contaminant removed , gm
m _n	Net Contaminant , gm
Ni	Ingression rate added to the system ,g/hr
p.d	Pressure drop across filter, (cm hg)
P	Engine max.power in [KW]
Q	oil flow rate , [l/hr]
q	specific oil flow rate , [l/hr/ cm^2]
Sp.d.l	The specific dust loading of filter, gm/ m^2
t	Oil temperature in sump ,oC

ABBREVIATIONS AND PREFIXES

ASME	American Society of mechanical Engineers
ASTM	American Society of testing Materials
ANSI	American National Standard Institute.
BSI	International British Standard
ES	Egyptian Standard
ISO	International Standard Organization
JIS	Japanese International Standard
SAE	Society of Automotive Engineers, an organization serving the automotive industry.

SUMMARY

Engine life is mainly limited by the contaminant resulting from adhesive particles in fuel, lube oil and intake air which accumulate with time. These can influence to a large degree the rate of the engine wear.

The selection of filters and a well designed oil filter will reduce engine wear and directly influence engine life, reduce maintenance costs and oil usage.

To evaluate the performance of oil filters from the contaminant level of the circulating oil, test rig for testing oil filters was designed and constructed conforming to international standards. Comparison between three filters with different area was done at different operating conditions.

The efficiency of the filter having the smallest area did not exceed 83% while that of the filters with an area 220% and 230% greater than the smallest filter reached 90 % and 94 % respectively.

It was also found that when the oil temperature increased, the contaminant concentration decreased.

When the ingress rate was increased (indicating a worn out engine), it was found that the rate of increase in pressure drop with time is more steep than the case of a relatively new engine. When the engine parts get worn out the frequency of oil and filter change must be increased in order not to have an adverse effect on the engine.



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CONTAMINANT LEVEL ESTIMATION BASED I.C.E. OIL FILTER PERFORMANCE EVALUATION

A thesis submitted in partial fulfillment of the requirements for
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CHAPTER 1

INTRODUCTION

Internal combustion engine life is dictated by a number of factors among which are engine design, power output, duty cycle, contamination, lubrication and lube oil. Engine life is mainly limited by the consequences of wear. The level of contamination with abrasive particles in fuel, lube oil and intake air can influence to a large degree the rate of engine wear and consequently engine life. The selection of filters does not only affect an engine's rate of wear and life, but also has an impact on engine's fuel economy. Hence the selection of filters for fuel, lube oil and intake systems becomes an increasingly and a more critical issue for today's modern engines. This is due to increased expectation for an engine's durability, performance and economy, as well as increased requirements in exhaust emission control.

The filtration of contaminants from lubricating oil is an important part of the maintenance of any engine. These contaminants are the result of engine wear, as well as a portion of the impurities imported from air or fuel. A well designed oil filter will reduce engine wear and oil usage, and will play an important role in controlling engine emissions. Thus both economic and environmental benefits are realized. The goal of

filtration system optimization is to obtain the cleanest oil for the longest period of time at the lowest cost.

Considerable engineering effort has been directed towards lengthening the intervals between oil changes. Lengthening the current engine oil changes interval still further, is an important step towards minimizing maintenance cost and decreasing the volume of oil needed to service the car population which is very important due to the shortage of petroleum resources. Another benefit is the reduction of the amounts of oil disposed.

There are environmental implications associated with the design of oil filtration systems. Finer filtration maintains oil cleanliness; hence, oil life can be extended and the amount of waste oil generated reduced. In recent years, the disposal of used oil filters has been identified as an environmental concern. Filter disposal whether by recycling or other means, costs money.

The filtration process may serve in increasing or decreasing maintenance costs. Decreased costs may occur because the reduced level of abrasive material in the lubricant causes a reduced wear rate, which in turn helps to extend component life and reduce costs due to sudden unanticipated breakdown. On the other hand, higher maintenance costs are associated with increasingly finer filtrations. Such filters may be expensive, clog quickly, and require costly downtime for replacement.

The objective of studying filter performance is to decide upon the suitable time for its change. The performance parameters that are measured to evaluate oil filter performance are:

- Pressure drop across filter.
- Efficiency
- Concentration of contaminants in oil sump
- Contaminant holding capacity

When the pressure drop across the filter reaches a certain value, oil will be unable to reach some parts of the engine, the result of which is excessive engine wear.

When the efficiency of the filter is low, this implies that the filter does not trap the majority of dust particles passing through it. This will consequently cause excessive engine wear.

If the concentration of the contaminants in the oil sump exceeds a certain limit this means that the oil has lost its effectiveness in lubricating the different engine parts.

The contaminant holding capacity is the maximum quantity of contaminant that the filter can trap during its life time. No further increase in this value is possible as the filter gets completely clogged, and in the presence of a by pass valve, the oil will circulate without being filtered causing excessive engine wear.

The contaminants present in the lubricating oil of an engine can be classified into 3 groups:

1. Wear particles: iron, chrome, molybdenum, aluminum, lead, tin, copper, nickel, silver, antimony and titanium.
2. Contaminant metals: silicon, sodium, potassium and boron.
3. Additive metals: magnesium, calcium, barium, phosphorous and zinc.

The reasons for the presence of contaminants in the lubricating oil of engines can be summarized in the following:

1. Oil degradation from engine coolant or fuel.
2. The use of an incorrect grade of lubricant
3. Air filter failure allowing sand or dirt to enter the air intake system.
4. Over extended drain intervals.

The viscosity of oil is one of the main parameters that dictate its service life. A decrease in oil viscosity can be a result of either of the following:

1. Contamination of oil with fuel or solvents.
2. Molecular shearing due to heat and pressure from the system
3. Non emulsified water contamination
4. Wrong refill or make-up oil (oil is added with lower viscosity than recommended).