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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	Egyption 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 filtes 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 ingression 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 increase 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 the M.Sc. degree in Mechanical Engineering (Automotive)

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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).