Research Paper Engineering

Experimental Investigation of Viscosity – Temperature Behavior in 4-Stroke Engine

*Ajinkya Patil ** Somnath Avhad *** Vijay Nakrani **** Amit Sharma ***** Sudarshan Jadhao ****** Sanjay Shekhawat

* Students of Mechanical Engineering SSBT, COET, Bambhori,Jalgaon

** Students of Mechanical Engineering SSBT, COET, Bambhori,Jalgaon

*** Students of Mechanical Engineering SSBT, COET, Bambhori,Jalgaon

**** Students of Mechanical Engineering SSBT, COET, Bambhori,Jalgaon

***** Students of Mechanical Engineering SSBT, COET, Bambhori,Jalgaon

****** Associate Professor, Mechanical Engineering, SSBT, COET, Bambhori, Jalgaon

ABSTRACT

In many bikes, we often observe that when bike goes over a longer distance there occur problems of engine overheating which led to adverse effect over the lubricant oil in engine i.e. problem of lubrication. Viscosity of engine oil is inversely proportional to engine temperature due to the rise in temperature of engine block while going over a certain distance leads to reduction in viscosity of engine oil. Reduction in oil viscosity creates problems like vibrations, overheating, noise and detonations in bikes. In this paper we have analyze the relationship of viscosity with temperature and temperature with distance travelled. It discusses the need to maintain viscosity of engine oil to reduce frictional losses and vibrations to improve heat dissipation rate.

Keywords : Lubrication, Viscosity of oil, Engine temperature

INTRODUCTION

The engine lubrication system is designed to deliver clean oil at the correct temperature and pressure to every part of the engine. To be effective, an engine lubricating system must successfully perform the functions of minimizing friction between the surfaces of moving parts, dissipating heat, and keeping the engine parts clean by removing carbon and other foreign matter. From the previous study of the lubrication oil system in the four strokes engine, it is noticed that reliability and performance of the engines are directly dependent on the effectiveness of their lubricating systems. To be effective, an engine lubricating system must successfully perform the functions.[1]

Engine friction is defined as the difference between indicated power and brake power.

Frictional power, F.P.= I.P.-B.P.

It is impossible to remove all the frictional loss but it can be reduce by using lubrication between the parts which have relative motion with each other. Increase in friction is ultimately dissipated as heat to the cooling water and it further increases the pump and fan power requirement also.[2]

The lubrication system used in Royal Enfield is 'wet sump lubrication system'. The general arrangement of wet sump lubrication system is shown in fig.

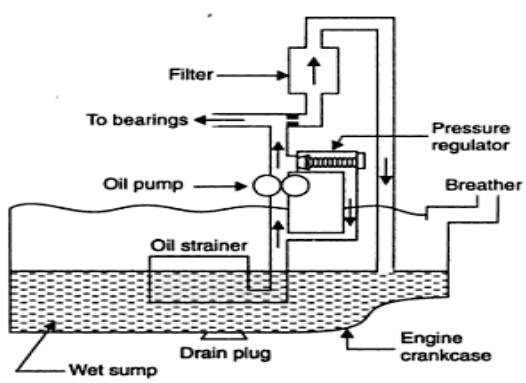


Fig.1. Wet sump lubrication system

A key to understanding why viscosity is critical to lubrication in the second definition:"….resistance to flow….".If lubricating oil had zero resistance to flow , it would not stay in the gap of a bearing under the load, and would immediately flow away from the point of loading.It is the viscosity property of oil which keeps it in a film, allowing it to lubricate and separate surfaces that may otherwise rub or contract each other.[3]

The viscosity of lubricating oils is extremely sensitive to the operating temperature.With increasing temperature the viscosity of oils falls quite rapidly. In some cases the viscosity of oil can fall by about 80% with temperature increase of 25^0C. From the engineering viewpoint it is important to know the viscosity at the operating temperature since it influences the

lubricant film thickness separating two surfaces.The oil viscosity at specific temperature can be either calculated from the viscosity temperature equation or obtained from the viscosity-temperature ASTM chart.[4]

Higher the viscosity of oil greater is the frictional loss. As the oil temperature increases, the viscosity decreases and friction losses are reduced during a certain temperature range as shown in fig. If the temperature exceeds local film is destroyed causing metal to metal contact.

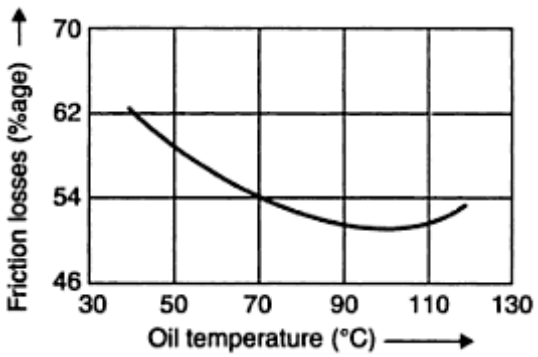


Fig.2. Effect of oil temperature on friction

In this paper we have discussed by maintaining the viscosity of engine oil, how it affects the lubrication system, heat dissipation rate and frictional performance of 4- stroke engine.

EXPERIMENTAL METHODOLOGY

The experimental setup as shown in fig.3 & details of its components are as follows:-

1.Copper tube

1. Diameter = 8mm .
2. Length =2000mm
2. Engine oil specifications-Castrol: 20w40 oil
   kinematicViscosity: 130 mm^2/s (130 cSt) at 40°C
   : 14.5 mm^2/s (14.5 cSt) at 100°C

Fire point: Closed cup 180^0c (356F)

Density:880 kg/m^3

3. Radiator :
   number of tubes=11Diameter of tube=8mm.
   Length of tube=200mm\
4. Temperature sensors=4
5. Temperature controller =1
6. Pump:

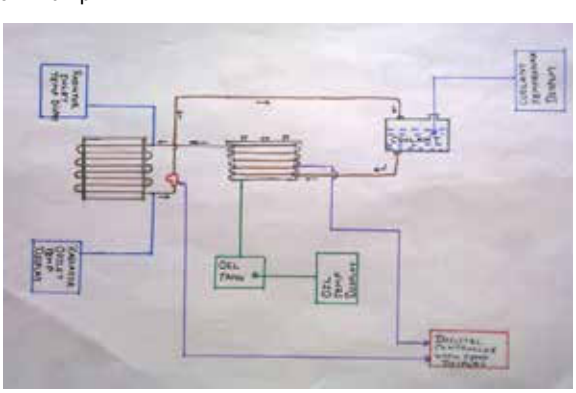


Fig.3.line diagram

The readings of temperatures of engine block, radiator in, radiator out, oil temperature, coolant temperature after every 5 km up to 40 km. These readings are tabulated as below,

Observation table 1: Without cooling system

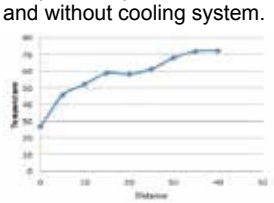
Sr.No.	Distance (km)	Engine temp (°c)	Oil temp (°c)	Viscosity at engine temp μ (poise)	Time (pm)
1	0	27.1	21.3	2.1	1:40
2	5	67.1	31.5	0.4	2:04
3	10	83.6	49.7	0.2	2:18
4	15	85.9	56.1	0.2	2:29
5	20	102.4	60.9	0.1	2:40
6	25	118.4	64.1	0.1	2:53
7	30	142.5	66.4	0.09	3:05
8	35	153.2	70.2	0.07	3:20
9	40	165.1	72.5	0.05	3:35

Observation table 2: With cooling system

Sr.No.	Distance (km)	Engine temp (°c)	Radiator in temp (°c)	Radiator Out temp (°c)	Oil temp (°c)	Coolant temp (°c)	Viscosity at engine temp μ (poise)	Time (pm)
1	0	26.6	25.4	26.1	25.6	21	2.2	1.00
2	5	45.7	44.5	40.3	34.6	22.7	0.9	1.15
3	10	52.1	51.7	47.1	40.0	24.5	0.7	1.25
4	15	56.9	56.1	50.7	53.7	26.3	0.6	1.35
5	20	58.3	58.2	51.7	57.6	28.8	0.5	1.45
6	25	61.3	58.3	53.7	58.3	31.2	0.5	1.54
7	30	67.9	64.9	59.1	60.5	34.5	0.4	2.03
8	35	71.9	68.1	63.6	63.0	37.8	0.3	2.17
9	40	72.3	70.7	64.8	67.7	40.2	0.3	2.30

Results And Discussion:

Graphical representation of Distance Vs Temperature with and without cooling system.



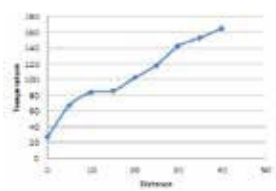
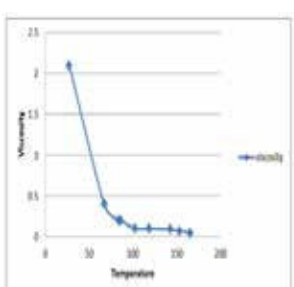


Fig.4.Without cooling system
Fig.5.With cooling system

Graph shows that after 40 km distance the temperature of engine block goes to 165.1^0c for without system and for with system the temperature is 72.8^0c.

The graphs of Viscosity Vs Temperature for the system and without our system is shown below:



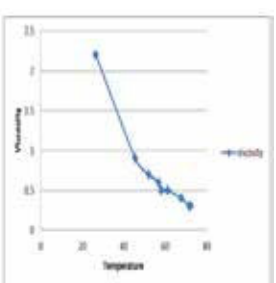


Fig.6 Without cooling system
Fig.7 With cooling system

From the above graphs we can see that for without system ,after 40 km distance the temperature is 165.1^0c and viscosity is 0.05 poise. And for the system after 40 km distance the temperature is 72.8^0c and viscosity is 0.3 poise.

Conclusion :

After analysing the relationship of viscosity with temperature and temperature with 40 km distance travelled the temperature of engine block goes up to 165.1^{0}c for without cooling system and calculated viscosity is 0.05 poise whereas, on applying the system the temperature of engine block reaches up to 72.8 ^{0}c almost less then the half that of without cooling system and visosity for this point is 0.3 poise.

Thus it helps to reduces the overheating, noise ,vibration and detonation in the engine and also reduces the maintance in the bike.

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