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Effect of Passenger Car Oil Usage in a Motorcycle Engine

Hasan Muhamad Abid, Eida Nadirah Roslin, Rifqi Irzuan Bin Abdul Jalal, Ahmad Shahril Daut, Mohd Zaki Bahrom

Abstract: ***The aim of this research is to investigate the usage of passenger car engine oil into a motorcycle engine by determining the after effect of the lubricant to the engine. The difference between engine oil of passenger car and motorcycle is the friction modifier that is in the formulation of cars engine lubricant. A motorcycle engine has a wet clutch system in the crank case, such engine oil with a friction modifier will decrease the clutch capacity of the system. In this study, three types of methodology tests have been conducted such as endurance test which combined with the fuel efficiency test at the same time, drag test and Ferrography tests that were conducted to determine the amount of contamination in both types of engine oil. The results showed that using a passenger car lubricant on motorcycle engine did not affect the engine compartment and parts. The numbers of metal wear in the used oil of both types of cars and motorcycle were slightly different.***

Keywords: cars engine oil; motorcycle engine oil; additive, Endurance test; drag test, oil contamination.

I. INTRODUCTION

Engine oil or motor oil is any about different substances including build oils improved with additives, especially anti-wear added substance also detergents, dispersants and, for multi-grade oils viscosity list improvers. Furthermore, the sum lubricating oils hold numerous erosion and oxidation inhibitors. The primary importance of engine oil is to decrease the rubbing of moving parts. Also to clean those motor from ooze (one of the capacities of dispersants) and varnish (detergents). It additionally cools the engine and eventually carrying heat out from moving parts [1][2]. Motorcycle oils and passenger car oils are very similar, with the exception of a couple of areas that are keys to motorcycle operation. The first area concerns common sumps, or the use of motor oil, to lubricate and cool the transmission. However, in a passenger car, the transmission is lubricated by different oil which has frictional properties required for transmission operation; therefore motorcycle engine oil does not contain the friction modifiers of passenger car engine oil [3]. The second area of concern for motorcycle engine oils is that they tend to shear more quickly than typical passenger car engine oil due to high temperature level.

There were claims that cars lubricant can be used in motorcycle engine because it's just oil [4]. Both oil function the same way which to lubricate the component and carries heat away from it. With differences of lubricant price more bikers out there have started using cars engine oil in their motorcycles engine rather than the lubricant that the motorcycle maker recommended best for their engines. Studies have been made in 2005 by the Lubrizol Corporation Wickliffe, in Ohio USA, stated that even 10W-30 oils developed for passenger cars application may cause gear pitting issues when motorcycle are run under heavy load. This is proof that private firm engineers also carry their own research concerning this matter.

Car engine oil has been classified as A, B, C, and D. Based from the viscosities blend oil B is classified as SAE 10W-40 and all the other were SAE 15W-40. For engine oil B and D, both were added with Shear Unstable Polymerthacrylate and for engine oil A and C they were both are Shear Stable Polymerthacrylate. The vehicle test was run for 80,000 km with 12,000 km oil interval change on a three lane paved road and 8 km oval shaped track. The vehicle speed was maintained from 112 to 120 km/h and oil sump temperature is between 143 and 149°C [5]. The cylinder bore wear and tear results were also taken to show the difference for each type of engine oil usage in each engine. For the engines A, B, and C, the result for wear and tear were in the average level but for engine D the reading was a bit extreme. The cylinder wear for this engine was higher than the other engines. The most obvious reading is from cylinder number 2 and 3 which increased in diameter by 427 µm and 518µm [5][6]. On the other hand, in France, most motorcycle user didn't use the viscosity type set by the manufactures 10W-40. They would use a more viscous lubricant for their engine which are 10W-50, 20W-40 or 20W-50. Researches selected few types of motorcycle engine such as motocross engine, racing engine and city engine. The results showed that 10W-50 type could make the engine run longer in high RPM before the piston ring jammed and the engine piston burned and scuffed [7]. Furthermore, a research was conducted by four major contributors in motorcycle industry in Japan in the case of friction coefficient and viscosity studies for motorcycle engine [8].

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* Correspondence Author
Hasan Muhamad Abid*, Automotive Engineering Section, University Kuala Lumpur Malaysia France Institute, Bangi, Selangor, Malaysia.
Eida Nadirah Roslin, Automotive Engineering Section, University Kuala Lumpur Malaysia France Institute, Bangi, Selangor, Malaysia.
Rifqi Irzuan Bin Abdul Jalal, Automotive Engineering Section, University Kuala Lumpur Malaysia France Institute, Bangi, Selangor, Malaysia.
Ahmad Shahril Daud Automotive Engineering Section, University Kuala Lumpur Malaysia France Institute, Bangi, Selangor, Malaysia.
Mohd Zaki Bahrom, Automotive Engineering Section, University Kuala Lumpur Malaysia France Institute, Bangi, Selangor, Malaysia

Manufacturers have been considering on introducing a lower friction and lower viscosity engine oils for automotive industry. The test was conducted on 10W-30 lubricant type for passenger cars. The results demonstrated difference between motorcycle engine and car engine was the power output from motorcycle engine was 1.5-1.8 more than automotive engines and the revolutions per minute were 1.3 times more than cars engines. This was due to engine oil temperature of a motorcycle reached to 160°C that was less than the one of car engine. Also in Japan, a study on car engine oil used in a motorcycle engine that resulted in clutch slipping when using low viscosity engine oil [9].

On the other hand, a study that has been conducted using a Honda CBR1000RR. The test was done both on race track and engine dynamometer. The purpose of this research was to observe the cleanliness of the engine, wear protection performance, clutch performance, and lubricant durability. During the test, 10W-40 type were used with additives specifically formulated for motorcycle application. The results demonstrated good clutch performance with 0.017mm of average wear. Also there was no deterioration in performance and slight clutch slip recorded [10] [11]. A similar study was conducted on lubricant base oil effect on motorcycle engine using SAE 10W-40 blended with different properties. Sample A was all mineral base stocks, for sample B are hydroisomerized mineral stocks and ester and for sample C a combination of ester and polyalphaolefin blend. The observation showed that for motorcycle A which was an off-road category at 9000 RPM it produced 20.0 kW. For sample A and B the result showed at RPM 9500 the power dropped while sample C maintained its power. For the sport motorcycle, the power output was produced by the engine for all three types of samples were almost the same with slight difference in power output [12]. Moreover, there was a research on motorcycle engine oil performance using engine oil containing high mineral base oil. Samples of oils were classified as S1, S2, S3, R1, R2 and, R3 for SAE grade of 5W-20, 10W-20, 10W-30, 10W-30, 10W-40 and, single grade 30 respectively. R1 was the commercially used for motorcycle engine. S1, S2, and S3 were the trials oil that had been made with high quality mineral base oil. S3 was a mixed of olefin co-oligomer and olefin co-polymers but R1 only had olefin co-polymers as it viscosity index improver. Results from evaporation loss by all six type of oil, S3 showed a low volatility from the other five test samples, it also had a low shear rate. This showed that a combination of both viscosity index improvers enabled to achieve a good performance in volatility and shear stability. In the fatigue test, S3 also provided high rate of fatigue durability as compared to R1 [13].

Moreover, Polymethacrylate was used in 5W-30 oil grade as a viscosity modifier to improve engine oil efficiency and due its high rate shearing stability. The result showed that the new formulated oil has met the criteria set for JASO MA2 which was the highest JASO performance level for motorcycle oil. The engine oil also was tested on FZG test rig for a load carrying capacity in the case for gearbox and gear protection performance. The candidate oil had an equivalent performance to 10W-30 engine oil. A fatigue life performance was also evaluated using a needle roller bearing pitting test on a uni-steel bearing tester. This was used to stimulate gear fatigue conditions. The oil sample demonstrated an equivalent result if compare to 10W-30 fatigue performance result [14] [15].

In 2008, A. Mitarai, M. Kasai from Idemitsu Kosan Co. Ltd. and M. Akagi from Honda R&D Co. Ltd. conducted a performance test on motorcycle engine oil with sulfur based additive as substitute Zn-DTP [16]. Zinc dialkyldithiophosphate or Zn-DTP was type of additives that widely used in the engine oil formulations. The purpose of this research was to find suitable replacement for Zn-DTP by using sulfur based additive. For the first test they were using oil sample A and B for the friction test. The test was done on a motor for dynamic friction test. This is to test friction of the clutch on a steel plate with drops of the engine oil sample. The observation showed that engine oil sample B had higher friction coefficient than oil sample A. It was considered that sulfur element in the oil sample B could increase friction coefficient of the clutch plate to the metal plate [17].

In another study, a new type of engine oil has been developed with high fuel efficiency and viscosity that improved fuel economy. The test was conducted by using two motorcycles of 125cc engines, single cylinder and air cooled. The type of lubricant used was 20W-40 and 10W-30. The result showed, for field of durability test, a positive result which presented engine wear in terms of iron, copper and aluminum were normal and only a higher level of silicon dust which came from a lower efficiency of air filtration system. The conditions of the engine parts were also satisfactory which considered that both motorcycle have endured 30,000 km of test. For fuel economy test there was slightly of 2.9% of benefit for the low viscosity oil compare to the 20W-40 engine oil [18] [19].

Furthermore, a ferrography test was conducted to monitor the conditions of engine oil. Size and concentration of engine oil were important in the experiment. A Spectroscopic analysis could not detect an element or measured particle that is larger than 10μm. However, in Ferrography test, a small sample of engine oil was allowed to across an incline microscope in a high gradient magnetic field. Therefore, it detected contaminant particles and generating size distribution. Ferrography test results presented detailed study of scuffed particles leading towards the identification of origins of the detected components in the engine oil. Ferrography test was also used to show particular factor of bearing failure in the engine [20] [21].

II. METHODOLOGY

In this study, two types of lubricants are used motorcycle engine oil and car engine oil for data collection ranged from fuel consumption, endurance and drag tests. After all the tests of each type of engine oil, the motorcycle engine will be overhauled and retrieving data for engine parts tear and wear. Moreover, samples of new and used oil of both will be sent for oil contamination test under microscopic view. Oil grade of 10W-40 of both type, motorcycle and car lubricants, will be used as test lubricant in the motorcycle engine. The motorcycle used in the test is a four-stroke engine of 97.1cc. The motorcycle engine will be overhauled and all parts will be replaced with new ones for each type of oil used in the experimental tests.

The endurance test will be done in the urban and highway area which consists of 1000 kilometer of distance. During the test, a tracking device is used to track the motorcycle movement. The tracking device is known as STRAVA that uses a direct GPS signal to track speed and location. The drag test will be conducted for a straight 100 meter of distance with no inclination. Also the study includes a particle test for the new and used engine oil using a rotating disc electrode-optical emission spectroscopy or RDE-OES. The result of the test is in PPM value which means parts per million. Furthermore, a microstructure test is conducted on the engine piston to detect the properties of the part.

III. RESULTS

A. Motorcycle Oil 10W-40 (4T) Test

A. 1 Endurance Test

The lubricant used for the test was 10W-40 and fuel used for the test is RON 95. During the endurance and fuel consumption test, the motorcycle was filled with three liters of fuel in the tank. The distance of traveling was 32 kilometers and the end result shows that balance of fuel left in the tank are 1.63 liter which was 10.67 km/liter. The top speed achieved during the test was 80 km/hr.

A. 2 Drag test

The distance for drag test from start to end was 100 meter for the same type of lubricant was used during the previous test which was 10W-40 and RON 95 fuel. The drag time taken is presented in table 1

Table. 1 Drag time using motorcycle oil

Round	Time taken (second)
1	12
2	13
3	13
4	13.5
5	13.5
6	14
7	13.5
8	14
9	13
10	14

B. Passenger Car Oil 10W-40 test

B. 1 Endurance test

The lubricant used for the test was 10W-40 for passenger car and fuel used for the test is RON 95. During the endurance and fuel consumption test, the motorcycle was filled with RON 95 fuel of three liters in the tank. The distance of travelling was 31.9 kilometer and the end result shows that balance of fuel left in the tank was 2 liters which was10.63 km/liter. The top speed achieved during the test was 80 km/hr.

B. 2 Drag test

The distance for drag test from start to end was 100 meter for the same type of lubricant was used during the previous test which was 10W-40 and RON 95 fuel. The drag time taken is presented in table 2

Table. 2 Drag time using passenger car oil

Round	Time taken (second)
1	15
2	13
3	13
4	13
5	13.5
6	14
7	13.5
8	13.5
9	14
10	14

C. Rotating Disc Electrode test result

After all tests run are completed, the new and used lubricants were sent for the contamination test. The results produced only a slightly difference of particle detected in the engine oil of used and new samples. The results were in the numbers of element base from a periodic table 3. Table 4 shows the numbers contained in the engine oil with attached graph, see Fig. 1.

Table. 3 Chemical elements from periodic table symbol

Mg	Ca	Mo	B	Zn	P
Magnesium	Calium	Molybeletus	Boron	Zinc	Phosphorus

Table 4 Elemental test using Rotating Disc Electrode

Class	Motor-cycle new (ppm)	Motor-cycle used (ppm)	Passenger car new (ppm)	Passenger car used (ppm)
Mg	11.470	18.459	13.613	16.928
Ca	1723.4	1741.5	2191.4	2231.8
Mo	171.13	176.31	36.191	36.904
B	75.829	61.596	0.071	2.323
Zn	851.16	904.28	980.18	956.70
P	856.90	811.22	1061.5	947.82

Table 4 above shows the number of detergent/dispersant additive in Mg and Ca, lubricity modifier in Mo, anti-wear additive in B and Zn, and corrosion inhibitor and anti-wear additive in P. Ppm stands for parts per million.

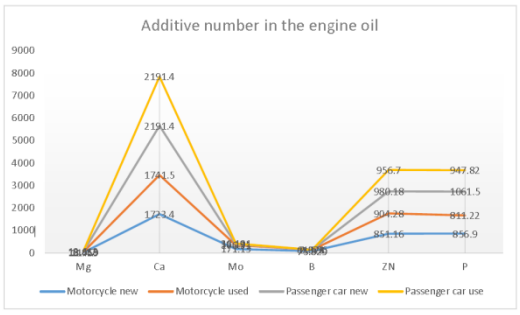

Fig. 1 Additive element collected result

In the test result of the engine oil, there were a few elements that were not in the first reading of the new engine oil then came out after the project were conducted and contain in the used engine oil. The number of elements and type of elements were show in Table 6. Differences in the number are presented in the graph of Fig. 2.

Table. 5 Chemical element from periodic table symbol

BP	Al	TI	Cu	Cr
Lead	Aluminum	Titanium	Copper	Chromium

Table. 6 Wear metals number in the used and new

Class	Motor-cycle new (ppm)	Motor-cycle used (ppm)	Passenger car new (ppm)	Passenger car used (ppm)
BP	0.000	0.739	1.410	2.184
Al	0.000	22.783	0.714	26.071
Ti	0.000	0.208	0.000	0.000
Cu	0.024	9.253	0.002	5.208
Cr	0.000	1.211	0.000	1.024

From Table 6, wear metals that has been collected by the machine may come from various source for example number of aluminum that were collected in the sample for used engine oil were high to compare from other elements. Aluminum may contain in several of compartment in the engine such as piston, bearings, housing, etc.

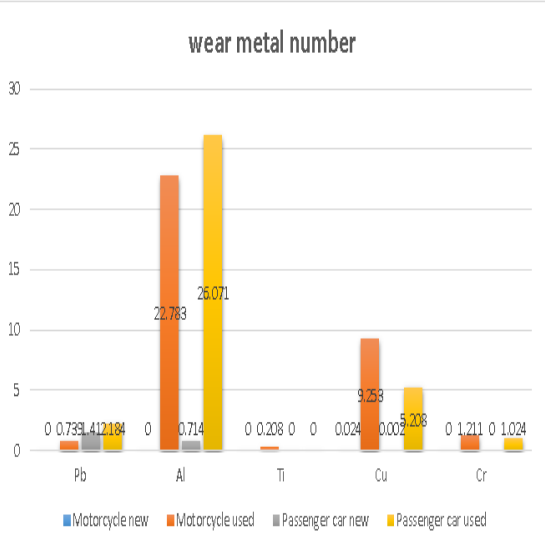

Fig. 2 Wear metal number

D. Viscosity test result

Both of the used engine oil sample has been tested for 1000 kilometer in mileage.

Table. 7 Viscosity test according to SAE grade

Test sample	Test result (cost)
Motorcycle new	13.93
Motorcycle used	9.83
Passenger car new	13.56
Passenger car used	9.46

IV. DISCUSSION

Based on the table 8, the observation demonstrated that using car oil in a motorcycle engine did not produce any differences in terms of fuel consumption except 0.04 km/l of slight difference. The speed of the motorcycle during the endurance test of 32 kilometer distance was kept for 80 km/h for both tests. The result also can be stated that by using a car lubricant in motorcycle engine, viscosity of the engine fluid is still in the same range of 4.1 cSt which presents no changes of viscosity in the passenger car oil if used in motorcycle engine.

Table. 8 Average time for drag test and fuel used in endurance test

Case/Parameter	Motorcycle lubricant	Car lubricant
Endurance test (km/l)	10.67	10.63
Drag test average (second)	13.35	13.65
Viscosity test (cSt)	4.1	4.1

As for Table 9 the high increase of boron (B) in the passenger car lubricant may came from the anti-wear agents in the lubricant additive or antioxidants of the engine oil due to the formation of tribofilm. Other than number of Boron element in the result, the rest of the data is normal to compare from the existing result of motorcycle engine oil. Based on the measurement of parts that were tested during the project progress, the clutch plate original thickness are 3mm, the end result of thickness for the clutch using motorcycle engine are 2.96mm and with using passenger car oil are 2.94mm. This shows that by using passenger car lubricant on a motorcycle engine gave no effect for the engine.

Piston of the engine were supposed to be run under a microstructure test by using a microscope but because the shape of the piston is round the equipment unable to get the reading of the microstructure in the piston and also because of there were no diamond sand paper left in the lab therefore the microstructure machine can't detect the surface grain structure of the piston.

Table. 9 Increase/Decrease number of additive/modifier

Case/Parameter	Motorcycle lubricant (ppm)	Comment	Percentage of additive %	Car lubricant (ppm)	Comment	Percentage of additive %
Mg	6.989	Increase	60.9	3.315	Increase	24.4
Ca	18.1	Increase	1	40.4	Increase	1.8
Mo	5.18	Increase	3	0.713	Increase	2.8
B	14.23	Decrease	18.76	2.252	Increase	3171.83
Zn	53.12	Increase	6.2	23.48	Increase	2.4
P	45.68	Decrease	0.53	113.68	Decrease	10.7

V. CONCLUSION

The results of this study conclude that the lubricant of passenger car engine gave no effect to the engine parts and compartment of the motorcycle. This is based from data achieved in the electrodes test. Number of elements collected from both sample in terms of additive number decreasing or increasing has shown that by using a passenger car lubricant on motorcycle engine wouldn't causes the engine to break down or fail if continuous usage of the lubricant to the engine.

It also shows that during the fuel consumption test for 32 kilometer mileage and 3 liter of fuel had demonstrated that differences of fuel usage are in the same range which is 10.67 km/l for motorcycle engine lubricant and 10.63 km/l for passenger car lubricant. The differences of result may came from several of parameter such as how the driver of the motorcycle open the throttle during the test, idling hours and braking time. Other than that the results showed by using passenger car lubricant in terms of fuel consumption are normal.

Comparison of oil consumption and contamination result also showed a bit of differences in the number of elements but for viscosity test for both engine oil gave the same result which is 4.1cSt. This shows that, motorcyclist who wanted to change the type of engine oil from motorcycle engine lubricant to passenger car lubricant won't make any changes to the motorcycle engine parts and its performance.

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AUTHORS PROFILE

Hasan Muhamad Abid Hasan is currently working as a lecturer in the department of Automotive Engineering Section, University Kuala Lumpur Malaysia France Institute, Malaysia. He graduated from International Islamic University Malaysia. His specialization is finite element analysis and internal combustion engine. His research area is vehicle crashworthiness and internal combustion engine.

Eida Nadirah Roslin is a Senior Lecturer at Universiti Kuala Lumpur, Malaysia France Institute. She obtained her Bach. Of Engineering in Manufacturing from International Islamic University Malaysia, Master of Engineering in Manufacturing System from Universiti Putra Malaysia and PhD in Engineering (Manufacturing System) from University of Malaya, Malaysia. She is currently a Research Principle for Advanced Manufacturing, Mechanical, and Innovation Research Lab. Her research interests include Manufacturing System, Operation Management, Lean System, Sustainable Engineering and Renewable System.

Rifqi Irzuan Abdul Jalal received B.Eng. degree in mechanical engineering from Okayama University, Japan, in 2008. He worked for an automotive company, Proton Holding as an engine development engineer from 2008 to 2012. He was a resident development engineer at Lotus Engineering, United Kingdom in 2009 as one of the team to develop Proton first turbocharged engine. In 2012, he went to Loughborough University, United Kingdom where he received the Ph.D. degree in automotive engineering in December 2016. In 2017, he joined the automotive engineering section, Universiti Kuala Lumpur (Malaysia France Institute), where he currently holds the position as a senior lecturer. His research interests are thermal management, design optimization, engine cooling system, advance control strategy, component durability, model-based calibration, engine performance and aerodynamic.

Ahmad Shahril is a Lecturer at Universiti Kuala Lumpur,Malaysia France Institute.He obtained Bachelor of Mechanical Engineering From Universitaire Aix Marseille 2,France.Master of Engineering in Manufacturing system from Universiti Putra Malaysia.His research interest are finite element analysis, Material, machining and automotive.

Mohd Zaki Bahrom is a lecturer in the Automotive Engineering Section at Universiti Kuala Lumpur Malaysia France Institute Malaysia. He graduates from Universiti Teknologi MARA. His research interests include friction materials, engine performance, tribology and renewable energy.