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Performance Enhancements of IC Engines in Real-World Conditions

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Abstract –

Optimizing engine performance of IC Engines is a very shady field. Other than reputed companies & Original Equipment Manufacturers (OEMs), who publish their reports, the rest of the industry does not throw much light into aftermarket modification field. As an end-user, a customer wanting to optimize his vehicle in terms of power, mileage & usability is often mislead into buying products & modifying his automobile that will produce no useful gains.

This mini-project will be done on 2-wheeler motorcycles ranging from 150cc-350cc. It aims at bridging the gap between the products and the end-user's knowledge of it. It will take on many such optimizing/modifying techniques, such as installing air-filters, spark plugs, exhaust systems, engine oils etc., and try to demystify what is actually happening there for the use of the said end-user.

This mini-project will involve testing of various parameters of an engine, such as Brake Horse Power, Torque, Exhaust Emissions, Inlet Manifold Pressure etc., of a completely stock Engine. It is again tested after modifications for the same parameters. The results are then compared to give an outline of the effect of the modification. Each modification is done separately for the results to be completely independent of each other. All of the tests are conducted in real-world conditions, so as to ensure the reliability of the result. The final report (end of the project work) will give a much needed clarity on the modifications; will also comment on the safety of using such techniques and its cost effectiveness for the end-user.

Market Situation –

In a stock motorcycle (factory-made, unmodified), it is so designed that the whole system is as generic as possible. That is, it is supposed to be appropriate for a wide-band of end-users. Taking this line, the manufacturers tune down most of the engine parameters in favour of mileage & fuel efficiency, as these are the two major parameters that an end-user looks while buying the automobile.

As time passes, the user, who now is accustomed to the automobile, might feel the need to enhance and optimize his automobile. He therefore researches about all the modifications that he can do to his automobiles, so as to increase the performance and efficiency.

Parameters for testing –

1. Power produced (at the wheels)
2. Torque produced (at the wheels)
3. Fuel efficiency

These parameters were chosen because of the following reasons –

1. Power produced at the wheel was taken, instead of engine power, because this gives an accurate idea of how the motorcycle will perform in the real world. It also includes the losses that will occur due to external conditions, and therefore will give a realistic feel to the test.

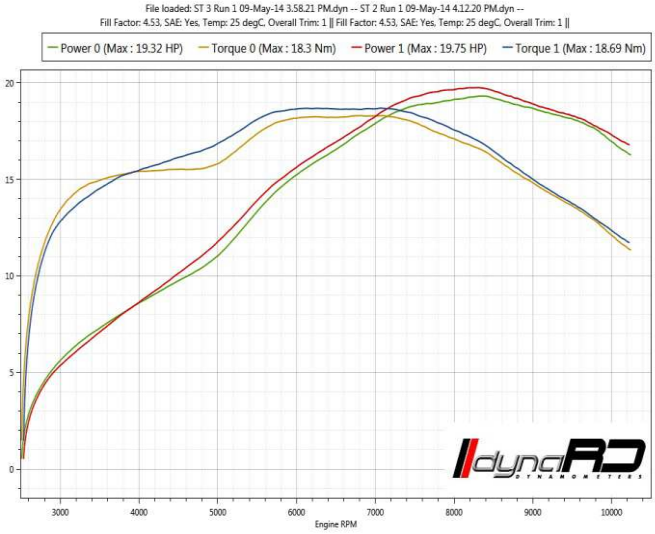
2. Torque produced at the wheel was taken, instead of engine torque, because of the same reasons as above, that is, it will give an accurate idea of performance in the real world.
3. Fuel efficiency is an obvious factor and a parameter to be considered, as most endusers will ultimately look at this for their decisions. It gives an indication of how well the engine is taking the modifications and will also represent whether the modification done is cost-effective or not.

Specifications of modifications used –

Sl. No.	Modification	Stock	Modified
1	Air Filter	Honda Genuine CBR 250R air filter	K & N Air filters, model no. HA-2511
2	Engine Oil	Genuine Yamaha stock Yamalube 20W40 Mineral oil	Motul Fullysynthetic 300V Factory Line 15W-50 Synthetic oil.
3	Exhaust Muffler	Original Royal Enfield Stock exhaust muffler	Free-flow "Goldie" exhaust muffler.

Results –Air filter modification -

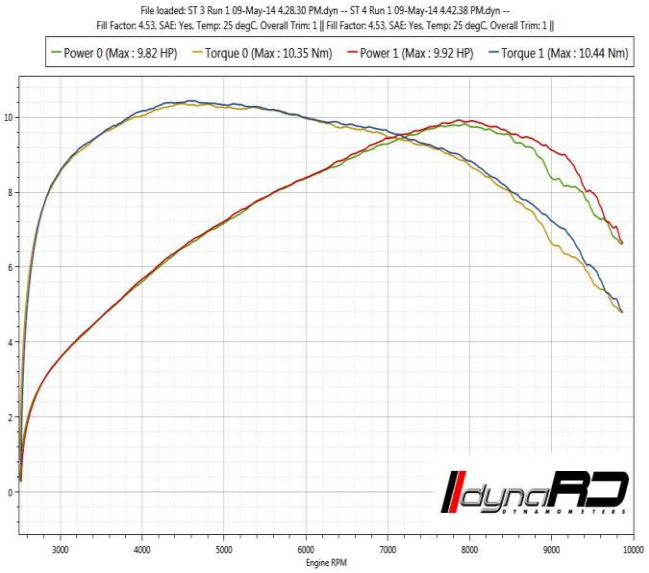
a. For load testing, there is a 1.11sec difference in acceleration timings, in partial load conditions. Whereas, there is a 1.24sec difference in acceleration timings with full load condition. In both cases, the modified motorcycle's timings were better.
b. For the crispness of throttle, it was seen that the modified setup has a better crispness than the stock setup.
c. For initial fuel efficiency, it was seen that the stock setup fared better than the modified setup.
d. For the cold starting test, it was seen that there is no difference between stock and modified setup.
e. Dyno test -

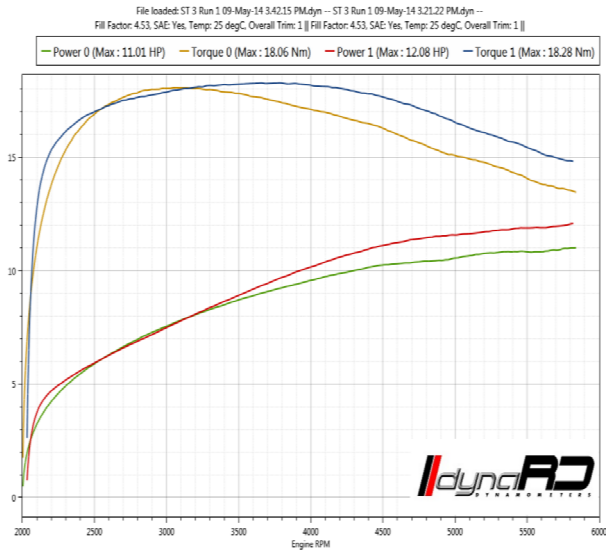


Synthetic Oil modification –

a. For load testing, there is a 2.25sec difference in acceleration timings, in partial load conditions. Whereas, there is a 2.17sec difference in acceleration timings with full load condition. In both cases, the modified motorcycle's timings were better.
b. For the crispness of throttle, it was seen that the modified setup has a relatively better crispness than the stock setup.
c. For initial fuel efficiency, it was seen that the stock setup fared better than the modified setup.
d. For the cold starting test, the stock setup fared badly, whereas the modified setup.

e. Dyno Test –





Exhaust Muffler modification -

a. For load testing, there is a 2.1sec difference in acceleration timings, in partial load conditions. Whereas, there is a 1.65sec difference in acceleration timings with full load condition. In both cases, the modified motorcycle's timings were better.
b. For the crispness of throttle, it was seen that the modified setup has an extremely good crispness when compared to the stock setup.
c. For initial fuel efficiency, it was seen that the stock setup fared better than the modified setup.
d. For the cold starting test, it was seen that there is no difference between stock and modified setup.
e. Dyno Test –

Discussions –Air Filter –

1. The modified setup performed better than the stock setup, because of the extra amount of air going into the engine cylinder. This allowed the fuelinjected to calibrate and add more fuel to the air-fuel mixture, thereby gaining power.
2. In the modified setup, as there is no restriction, aside from the filter material, the engine was free to suck air to its maximum capabilities, allowing the fuel-injection system to inject more fuel, thereby increasing power and torque. This is seen as the constant increase throughout the power-band.
3. The crispness of throttle was better in modified setup because the lesser obstruction in the intake system, which allowed air to be sucked in freely.
4. Cold-starting was not affected because of the fuel-injected system, which automatically calibrates the appropriate amount of fuel to be injected in all conditions.

Synthetic Oil –

1. The modified setup performed better than the stock setup, as the synthetic oil gives better lubrication than the stock setup.
2. This is due to the inherent nature of the synthetic oil, which provides better lubrication and wear-resistance throughout all temperatures with respect to stock mineral oil.
3. The crispness of throttle was better in modified setup because the lesser friction, which allowed that engine to rev freely and quickly.
4. Due to greater lubrication, lesser friction was present, thus minimizing friction losses, which attributed to the higher power and torque output in the modified setup.
5. Cold-starting was better in modified setup, as the inherent nature of the oil made less viscous allowing it to start freely and quickly, compared to stock setup.
6. The synthetic oil also kept the engine temperature lower than the stock setup, thus further helping it to work efficiently.

Exhaust Muffler –

1. The modified setup performed better than the stock setup, as the free-flow exhaust muffler allowed the exhaust gases to flow out more freely than the stock setup.
2. This allowed the piston to have lesser load on it to push the gases out, therefore giving a higher power and torque output.
3. This can be seen in the consistent increase in power and torque from 3500rpm.
4. As the load on the piston decreased, the engine was allowed rotate freely, thus giving it a more free nature, whereas the stock setup constricted the engine very much.
5. The crispness of throttle was better in modified setup, because of the free flowing gases in the exhaust system, which allowed that engine to push more and more gases out for the same rpm.
6. Cold-starting was not much different compared to stock setup, as the starting depended on initial air-fuel mixture temperature, which doesn't get affected by this modification.

Final Conclusion –

It depends on the end-user on whether he wants to do certain modifications. From the results and discussions, we can see a general increase in performance for all the modifications used, provided those are done under correct procedures. These results were fairly satisfying, and also laid to rest some of the general misconceptions that were attached to such modifications.

Apart from power enhancing, the mini-project also tried to bridge the gap between the aftermarket modifications and the customer's knowledge of it. Dealing with how the actual results of how a modification might work-out and whether their claims were correct. It is concluded that the manufacturer's claims of increasing power and performance which are indeed true, But the manufacturer also claims increase in mileage which is not true since it comes with of a small drop of mileage. If the end-user can adjust with the drop, then they can find the modifications useful.