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Comparative Analysis of Fuel Consumption Between Engine Idling and Engine Stop Restart in Traffic Conditions

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INTRODUCTION & AIM

In urban areas, traffic jams cause a lot of vehicles to come to a halt and cause the engines to idle for long periods, contributing to high fuel use and emissions. These emissions are responsible for air pollution and environmental degradation, especially in urban areas. Most of today's cars have automatic stop/start systems designed to conserve fuel when the car is idle, but there are many gasoline-powered cars that don't have them. This leads to uncertainty for drivers about whether it's more efficient to keep the engine running or to turn it off and restart the engine during a brief traffic stop. The objective of this study is to compare the fuel consumption of engine idling and engine stop-restart conditions for a conventional gasoline engine under real operating conditions. The study compares fuel consumption for starting and idling using Mass Air Flow (MAF) sensor data analysis. The results are meant to give practical suggestions for fuel saving and decreasing emissions in urban driving conditions.

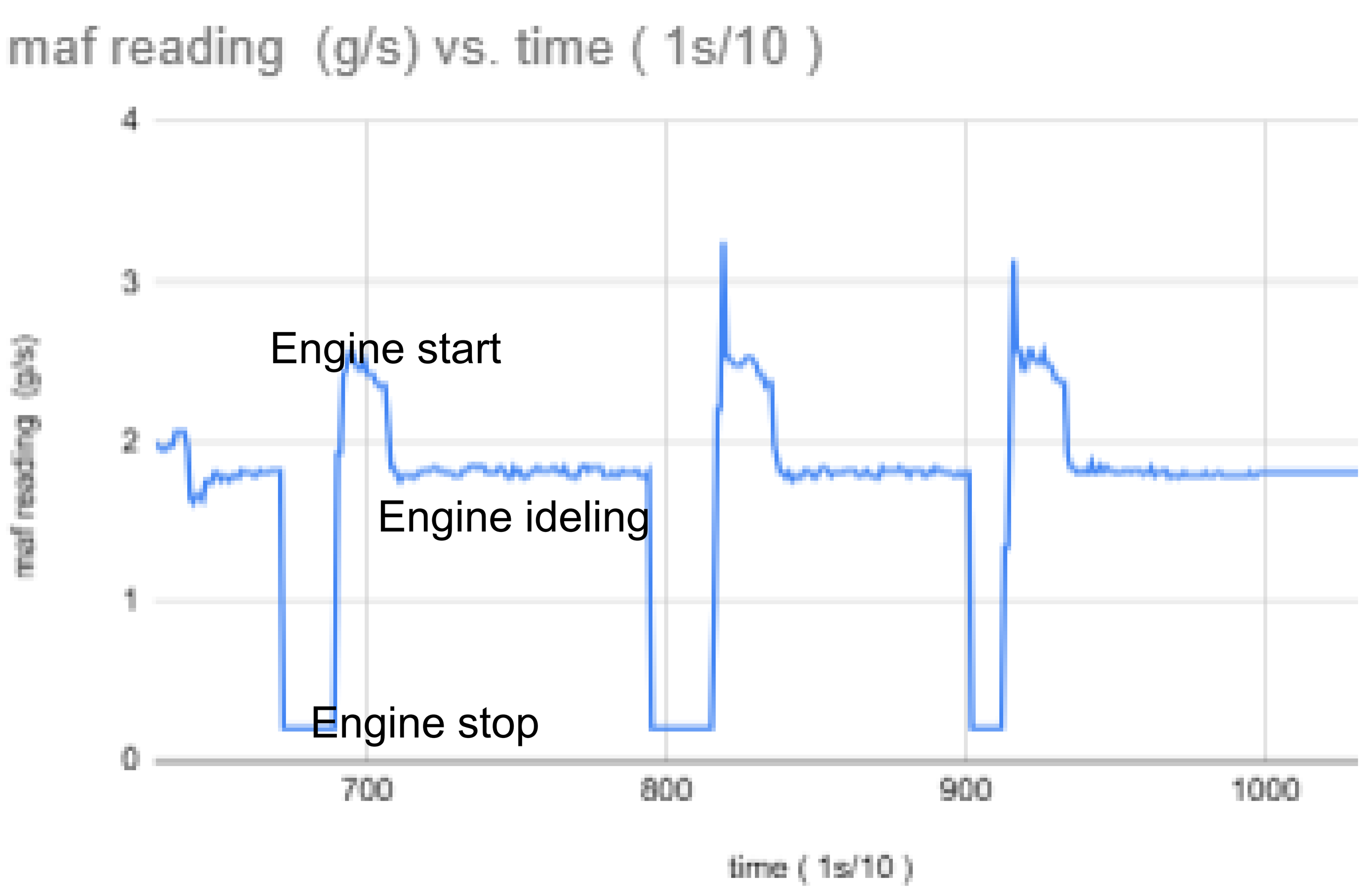
METHOD

- An 1500 cc, four-cylinder, inline, liquid-cooled Toyota 1NZ - FE gasoline engine was used for the experiment.
- The LAUNCH OBD-II diagnostic scanner was connected to the vehicle to record real - time Mass Air Flow (MAF) sensor data.
- To assure consistent test conditions the engine was operated at its normal working temperature range of 85 – 95°C.
- Several start/idle/stop cycles were conducted to mimic real city traffic.
- The values of MAF were recorded continuously during the engine starting and idling and plotted against time.
- The total air mass needed to start the engine was calculated by integrating the area under the MAF - time curve.
- Air-fuel ratios of 13:1 and 14.7:1, respectively, were used for estimating fuel consumption during engine starting and idling.
- The mean number of fuel consumption per start and the fuel consumption rate while idling were computed and compared.
- The break - even idling duration was calculated to find out which idling and restart fuel consumption is more economical during traffic stops.

RESULTS & DISCUSSION

- The experimental analysis revealed that the difference in the fuel consumption was apparent when the engine was started and when the engine was idled. The fuel consumption of one start of the engine was computed as 0.380 g and the idling fuel consumption rate was determined as 0.123 g/s. This means that the amount of fuel needed to start the engine is quite a bit larger than is needed for idling, but can be significant over time.
- A comparison of both conditions resulted in a break even point of around 3.07 seconds. This translates to a period of 3.1 seconds or more, during which the engine stops and is started from a standstill, is more fuel efficient than it is to idle. If it's less than this amount of time, the idle is using less fuel than restart.
- The results also show that unnecessary fuel combustion causes higher emissions of CO, CO_2 and NOx and thus has an impact on the environment due to extended idling. Thus, the mitigation of idling time in traffic is an important measure to be taken to decrease urban air pollution.
- It should be noted, however, that this study only takes into consideration fuel consumption, but not factors such as starter motor wear, battery load or usage of the pars such as auxiliary systems, which may affect real-life decisions.

Sample of area calculation graph



Calculations

Calculate the area under the MAF graph to obtain total air mass:

$$m_{air} = \int MAF(t)\,dt$$

Calculate Air fuel ratio

$$AFR = \frac{m_{air}}{m_{fuel}}$$

CONCLUSIONS

- Stopping and restarting the engine is more fuel-efficient when a vehicle remains stationary for more than 3.1 seconds.
- Engine stop-start operation can provide environmental benefits by reducing emissions.
- The study indicates that keeping the engine idling for periods longer than 3.1 seconds leads to unnecessary fuel consumption.
- The findings support the implementation of idle stop (start-stop) systems in conventional vehicles.
- Idle stop systems can help improve fuel economy in vehicles.
- These systems can also contribute to reducing urban air pollution.

REFERENCES & ACKNOWLEDGMENT

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