How changing the shape of the combustion geometry in a small two-stroke engine affects performance

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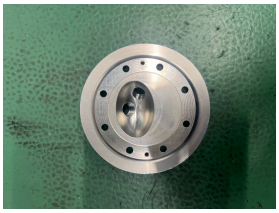

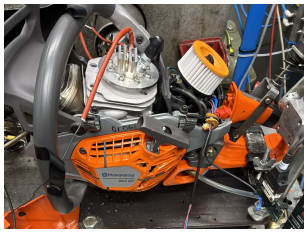

Figure 1: The Offset Oval Design and the Chainsaw used for testing

Did you know that a two-stroke engine needs less than 5 % total efficiency to have more power per kilogram than electric alternatives? In many applications, such as the chainsaw used in this thesis or long distance drones, the power to weight ratio is one of the most important things for choosing the power source. In this thesis we looked into how changing the combustion chamber, where the spark-plug sits, can improve performance. We discovered that having an oval shape that is offset to the intake side showed great promise for future development and significantly decreased emissions.

In a two stroke, the burnt gasses from the previous cycle are expelled at the same time as new gasses enter the cylinder. This process is called scavenging. The experiments indicated that moving the combustion chamber towards the intake side improved this scavenging effect, and reduced emissions. The same was true for increasing the squish area, which is a flat area around the dome in which the spark-plug sits. We also noted that this increase in squish was bad for combustion. However, scavenging is such an important part of the two-stroke engine that the increased scavenging efficiency from increasing the squish area lead to overall lower emissions. We however believe the negative effects on the combustion performance can be relived by for example changing the angle of the squish to make it less aggressive.

1 What did we test

A few alternatives were first tested in a simulation program which showed that some designs improved the performance of the engine. After this, 4 designs along with the standard design used in current chainsaws were tested in a engine test bench. A specially designed engine was used, where the top of the engine was cut of and a removable head attached to change the combustion chamber geometry while still having the same engine. The offset oval discussed in the introduction as well as the engine is shown in Figure 1.

How we did the experiments

To test the performance of the different combustion chambers, each of them were placed in an engine testing bench. The engine testing bench is a system where everything is controlled by a computer, so instead of physically pressing the gas you set a desired engine speed on the computer. Once the engine reaches the desired speed, measurements are taken. For the purposes of this study the measurements of interest were mostly those that related to the efficiency and emissions of the engine. These measurements are most important in order to determine how well the engine, or more specifically for this study, the combustion chamber transforms fuel into energy.

What results did we find

The results showed that a combustion chamber with an offset towards the intake was better at converting fuel into energy than the standard combustion chamber. An oval shaped chamber with an offset was even better at it! We noticed a significantly better scavenging efficiency, but the power for all chambers were comparable. If we are after more power, we can always increase it at the expense of more emissions. Having lower emissions therefore allows for more power, and vice-versa. More power baby!

Why is this important

Since the world is constantly looking for cleaner energy sources to address the issues of pollution and global warming, all types of energy producers must follow that path in order to remain usable. The two-stroke engine has been flying under the radar compared to the enormous amount of emission regulations that has been put on the four-stroke engine, and as a result the two-stroke engine has not seen the same progress in terms of reducing emissions. While there exists a much greater number of four-stroke engines in the world, the two-stroke is still very prevalent, and this study aims to shine a light on what could be done in the future to make the two-stroke engine more efficient, and as such better for the environment.

Thesis: Effects on Scavenging and Hydrocarbon Emissions: Altering the Combustion Chamber of a Small Two-Stroke Engine

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