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Improving volumetric flow and efficiency

Research Methods & Project M6X02206

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## Abstract

This report is looking at how we can improve air flow going into the engine via intake and exhaust valves. For this to be improved, FVVA (Fully variable valve actuation) will be used this allows more control over the valves and operation. Being able to shut of cylinder is an advantage for fuel consumption and emission also at idle.

## Technical Abstract

The report is looking at enhancement of volumetric flow and efficiency, by getting more air in from atmosphere and into the engine via FVVA this will increase volumetric flow by being able to have more adaptive control over the lift, timing and duration over a load range. There many advantages to this system such as fuel consumption, emission, weight, and size. Deactivation is an advantage being able to run on two cylinder instead of 4, this means improvement on emission and fuel consumption.

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## Introduction

This project is going to look at volumetric flow and efficiency, how it can be improved, the project is going to look at FVVA (Fully Variable Valve Actuation) to improve the volumetric flow and efficiency on turbocharged and naturally aspirated (non-turbocharged) engines. Volumetric flow and efficiency is basically how much clean air can be sucked in from the atmosphere and into the engine, there are many ways to improve this for example, intake manifolds, turbos, high lift camshafts and ported cylinder head etc. Why not combine any of these with FVVA. In this report it will discuss many advantages of FVVA and will talk about what's involved and how it works. There are many benefits to this system such as low end torque, fuel economy and lower emissions (V.Picron et al, (2008)). It will look at why the industry would consider this system and what are the impacts on the environment are. This system has no camshafts in the engine which will reduce the overall size and weight, it will talk about how the valves can open earlier and deeper and these can control the timing, lift and duration (P.K. Wong 2008). Here are some advantages, reduction in valve overlap, being able to open a valve once or twice on the same stroke, able to shut off cylinders, the valve can open much quicker compared to a traditional camshaft due to not having the lobe, piston don't need cut outs in the piston crown and won't have piston to valve collision (G.Babbitt et al, 2017).

## Research/literature review

The FVVA is a new system which has an impact on improving the volumetric flow and efficiency, not only does it improve the volumetric flow it also improves many other things such as fuel economy, emission and the impact on the environment. This system has no camshafts, not having camshafts will reduce the overall weight and size of the engine. This new system has electromagnetic valve actuators which replaces the conventional camshaft, the VCU (Valve Control Unit) operates the actuators. The actuators work by using the information received from the ECU (Engine Control Unit) through a CAN bus (controller area network) (V.Picron et al, 2008). CAN is a system which connects sensors and individual systems instead of having multi-wire looms, it uses single or dual wire to communicate to different components this was developed by Robert Bosch. The bus is transportation of data through a set of wires. Dual wires is better as when the dual wires are entwined it produces alternating magnetic fields which stop interference from other wires. The actuators are operated by the VCU to control open and close of the valves, one of the main function of this system is being able to control the valves independently. The FVVA can improve fuel consumption by deleting the throttle this will have more load control over load range and wide speed, this is including idle. Being able to have more control over the valves such as timing, lift and duration means can improve volumetric efficiency which in turn will improve fuel consumption (J.Stephen et al, 2017). Being able to close exhaust and intake valves means can shut off cylinders by disabling fuel injection and ignition, shutting off cylinders is an effective way to enhance fuel economy via pumping work and heat transfer loss reduction. Every operation condition may have a different load the number of cylinder that work depends on the load, uses the least amount of cylinder for each load that is needed. This will also improve fuel consumption as minimum amount of cylinder used. NOX, HC and CO are divided by a factor of 3 to 4 which overall will improve the emissions (R, Nate et al, 2008), the reduction in emission would mean this should appeal to industry as this will help with the environment. There are different designs of this system one of the designs will not have the risk of piston and valve collision and doesn't require cut outs for the piston crown (G,Babbitt et al 2017). There are many advantages to having actuation system means can open the valve more than once on same stroke if wanted to, reduction in overlap which can be used to scavenge combustion residuals.

## Proposed methodology

As part of this project some testing will be done, to be able to test the first thing is using CAD (computer aided design) to make the relative components once these components are made it then can be put into CFD. CFD is Computational Fluid Dynamics this can be used to see in cylinder flow pattern (H, Dembinski et al, 2013) and how much air flow can be passed through the valves compared to the camshaft design. This will also show how much clean air passes and the way it passes. It will show if it will swirl or if it will just flow perfect. Using this means it can show where the components need to be improved. The other testing that can be done is using flow bench, flow bench is basically a big vacuum that can flow air through a cylinder head. The flow of direction can be changed, this will show how well the valves will flow with FVVA and this will prove if this system is better the same or worse.

## Conclusion

This report has looked at FVVA and its improvements of volumetric flow and efficiency, how it effects fuel consumption and emission, further tests will be done to prove some of these facts are correct. There are many things discussed such as cylinder deactivation, operation of FVVA and components used, further research will done to show some facts and figures. The overall report has showed that FVVA has many advantages and that it has a big impact on volumetric flow and efficiency. Testing will be done using CFD and Flow Bench to see the improvement differences of this system.

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