

Major Project Questions

Project Title: Cylinder Head Flow Optimisation of a Spark Ignition Multi-Point Injection Engine for Motorsport Application.

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Question 1

Can you discuss how your flow bench data relates to your actual camshaft profile, you may refer to some of your data where necessary?

Question 1 Response (maximum 200 words)

Yes the camshafts profile determines how much valve lift and how long the duration of the valve opening to when it closes again can be measured by the degrees of the cam profiles. So our cams used in the project were 264 deg duration cams with 10.8mm of valve lift for both the inlet and the exhaust cams. When I dismantled the cylinder head I noticed the cams had "CatCams" (A company that makes performance cams) engraved on them, then I researched the product number on the cams and the specs of the cams were found on the CatCams catalogue. This relates to my flowbench data because I needed to know how much to open the inlet and exhaust valves when testing the heads to have max lift. For instance in figure 21 of the intake port at max valve lift the ported head has 148cfm whereas the stock head has 131cfm of mass air flow. The standard cam that I didn't use had just 254 deg duration with 9mm of valve lift therefore with the valve wide open the mass air flow would only be 140cfm for the ported head and 129cfm for the stock head. Since this is only looking at full open lift, the duration of the cam would make a significant difference as the 264deg cam leaves the valves open for much longer therefore air can get into the engine for a greater length of time than the 254deg cam.

Question 2

Can you provide further discussion that tumble and swirl at wide open throttle has no adverse effect on the flow into the chamber?

Question 2 Response (maximum 200 words)

Since swirl and tumble are air flow characteristics that are designed to meter air/fuel mixture better for efficient combustion, race engine builders just increase the area in the ports to allow more air to flow due to the bigger capacity. I have seen first hand on Yousouf Boukra's paper that when he changed the angle of the port by lowering the entry of the port to direct flow across the top of the piston to increase tumble rather than a downdraft design, he increased the tumble effect to allow a more efficient combustion and increased the tumble by 15%. But this had a worse effect on airflow even though the port geometry was greater. When he lowered the entry of the port and changed the angle to be near level with the piston at TDC, the mass of air that the more efficient port design could flow was much less than the standard port which he modelled from. This was due to the entry angle where the air cant flow as good because he changed the geometry to increase tumble compared to the port design where it was situated before or just like a downdraft port that I studied in my paper. My paper was improving a cylinder head port for greater power output and many of my sited sources state that improving the mass of air flow increases horsepower and I have done that by porting the cylinder head whereas Yousouf's port design had worse mass air flow when he went about increasing the tumble effect for a more efficient combustion on a road engine for less emissions and not for greater power output.

Question 3

How was the measurements e.g. diameter and internal angles within the ports derived for your modification head?

Question 3 Response (maximum 200 words)

In general the most critical areas when porting are those which pass the most air at highest speed and for the longest duration. Since the highest speed and longest duration airflow within the port is at or around the valve seat, optimising airflow in this area is especially important. In most cases according to (Baechtel ,J .2015) approximately 50% of gains that you are likely to see from head work comes from this area around the valve seat and back of the valve. That's why westward engineering that carried out the headwork use a serdi, valve guide and seat cutter (a precise tool for three angle valve jobs). So the first angle in a high performance valve job is the cut throat which is where the port gets thinner to meet the back of the valve. This is typically 60-70 degrees according to (Baechtel ,J .2015). The second cut is generally done at 45 degrees and is the surface that the valve actually seals against. The Third cut is normally 20-30 degrees and is immediately after the valve seat and this cut helps reduce valve shrouding of the airflow past the valve as the valve starts to lift off the seat. As you can see in figure 17. In my project of the stock head and ported head where the difference in the bowl area after the port entry in the area exactly at the roof until the floor of the port is much greater on the ported head, this was because the short turn radius on the port floor is critical to airflow. (Baechtel, J .2015) States that he has witnessed 30-40% of an improvement to airflow has come from work done in this area.

Question 4

What makes your work original?

Question 4 Response (maximum 200 words)

The simple fact that I carried out all the work on the project myself and completed it with no help compared to other students makes this work original whereas most people when doing a task are very unsure on how to structure their project and go to the next step. The rally car that the engine was being modified for is going to compete in a brand new homologated class that was only set up this year so the engine modifications were restricted around that which therefore makes my work original as the regs for this class were only put in place early 2020. The addition of all the extra work that I carried out in calculating the VE of the both stock and modified heads and getting the engines assembled and then analysing the dyno sheets was an extra task which really makes the work original as you can see the difference that the porting process had by examples shown in the excel graphs comparison for both heads and then how that influences the horsepower and VE in the real life results of running the engine on a dyno.

Question 5

Was there any substantial issues that Covid-19 played in the completion of your project? If not what aspects of the project had taken longer than planned and why?

What do you see yourself doing when you finish, do you have a job lined up?

Question 5 Response (maximum 200 words)

No in terms of completing my project but the pandemic closed all businesses including the AP Performance business (engine dyno specialists) which had me thinking i wasn't going to finish the project but then he opened up a few days later and I was able to get the jobs done for example mount the stock engine in the car and bringing the car on the trailer to them in Galway and then repeating this only days later to get the results for the modified engine. On what job do I see myself doing, would be really any engineering job in Ireland as there were plenty of job opportunities in Dublin for engineers, for example HVAC (heating, ventilation and air-conditioning) with the PM Group and on mechanical engineer graduated schemes with ESB both in which I have applied for. I also know a person high up in the PM Group in Dublin and they were looking to get some engineering graduates prior to the pandemic and they were very interested in the BSc motorsport degree that I was doing because they liked the modules as part of the course.