2017

Formula SAE Intake System

Esa Mahmood
Virginia Commonwealth University

Arman Sarwar
Virginia Commonwealth University

Michael R. Smith
Virginia Commonwealth University

Formula SAE Intake System

MNE504 | **Team members:** Esa Mahmood, Arman Sarwar, Michael R. Smith | **Faculty adviser:** Charles Cartin, Ph.D.

CAPSTONE DESIGN EXPO 2017

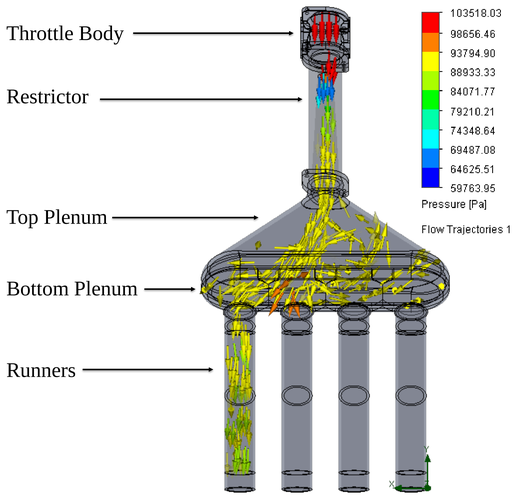
Purpose

Production Intake System:

- Guide air into the engine
- Allow sensor placement to measure airflow
- Minimize unnecessary restriction in the form of pressure drop

For the Formula SAE at VCU race team, this task is very much the same, however:

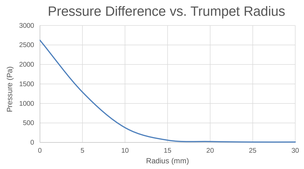
1. All air going into the engine must pass through a 20mm hole (nickel-sized)
2. The FSAE Intake is designed for use at 8,000 to 12,000 RPM
3. The engine is from a CBR600 F4i motorcycle
4. The part only needs to be produced in 250 units



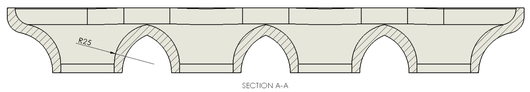
Design

Velocity Stacks:

Intended to smoothly funnel flow into a single tube, the velocity stacks (or trumpets) are critical in reducing pressure losses in the intake system. A radius of 25mm was chosen.

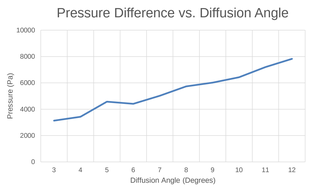


Trumpet Radius	Pressure (Pa)	Iterations
0 mm	2623.63	107
5 mm	1292.66	128
10 mm	374.34	182
15 mm	56.70	164
20 mm	21.98	238
25 mm	8.98	329
30 mm	9.32	297

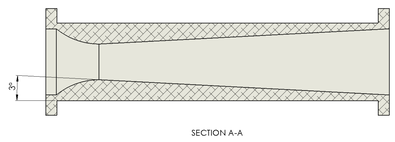


Restrictor (Venturi):

Required by the Society of Automotive Engineers (SAE), the 20mm restrictor is meant to bring the peak power output down from 110hp to 75-85hp. Various diffusion angles were tested for pressure loss, and the 3 degree variation was chosen.



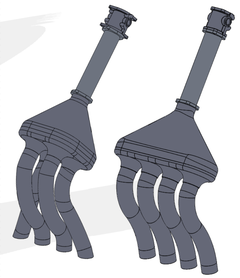
Diffusion Angle	Pressure (Pa)	Iterations
3 Degrees	3129.6	211
4 Degrees	3425.9	211
5 Degrees	4571.7	204
6 Degrees	4409.8	185
7 Degrees	5018.1	194
8 Degrees	5736.1	179
9 Degrees	6018.1	183
10 Degrees	6426.5	251
11 Degrees	7197.7	208
12 Degrees	7824.6	195



Design

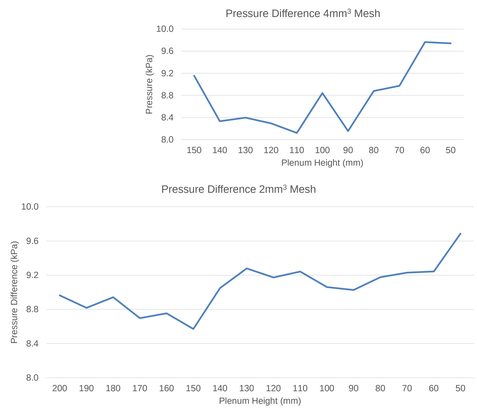
Plenum:

The plenum plays a major role in determining maximum power output and throttle response time, affecting drivability. Two geometries and 16 heights were tested as a full assembly for pressure loss, and the inline 150mm high plenum was chosen for its easiness of construction and similar performance.



Plenum Height (mm)	Square Pressure Drop (kPa)	Percent Difference	Inline Pressure Drop (kPa)
50mm	10.67	-0.12%	10.66
60mm	9.09	0.17%	9.10
70mm	9.41	-0.53%	9.36
80mm	10.16	0.95%	10.26
90mm	9.79	1.10%	9.89
100mm	10.41	-0.77%	10.33
110mm	10.14	3.52%	10.51
120mm	9.63	1.65%	9.79
130mm	10.18	-1.97%	9.98
140mm	10.56	-3.06%	10.25
150mm	10.91	-0.59%	10.84

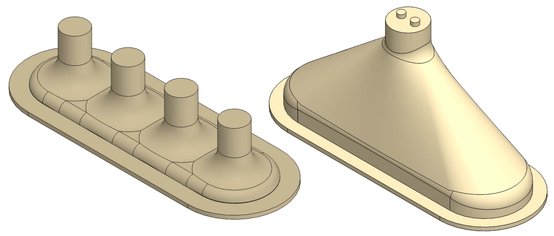
It was decided that a denser calculation mesh and a larger array of heights were needed to find a better relationship between plenum height & pressure drop.



Fabrication

The Mold:

The ABS mold was 3D printed using Fused-Deposition Modeling, and formed the interior volume of the plenum normally occupied by air.



Fiberglass:

10 oz. fiberglass cloth and System 3000 High-Temp Epoxy Resin were used to form 8 total layers of composite, resulting in 0.25” wall thickness and structural stability in continuous temperatures of up to 250°F.

CNC Lathe:

The venturi was made at BGB Technology using 6061 aluminum stock and a CNC lathe based on drawings provided by the senior design team.

Carbon Fiber:

3k carbon fiber construction was pursued for the alternative plenum. Vacuum bagging techniques were used for a smoother finish and allow for more effective resin saturation.

VCU School of Engineering