

TO STUDY PERFORMANCE OF TWO STROKE ENGINE WITH MODIFIED INTAKE SYSTEM

Deepak Bharadwaj

Assistant Professor, Mechanical Engineering Department
University Of Petroleum And Energy Studies,Energy Acres,PO Bidholi(via Prem Nagar)
Dehradun,248007, India Email id: dbharadwaj@ddn.upes.ac.in

NAVPRABHAT BISHT

Student. B-Tech Automotive Design Engineering,
University Of Petroleum And Energy Studies,Energy Acres,PO Bidholi(via Prem Nagar)
Dehradun,248007, India
Email id: nuv.0907@hotmail.com

ASHISH SINGH

Student B-Tech Automotive Design Engineering,
University Of Petroleum And Energy Studies,Energy Acres,PO Bidholi(via Prem Nagar)
Dehradun,248007, India
Email id:ashishsingh13@gmail.com

PULKIT BHARGAV

Student B-Tech Automotive Design Engineering,
University Of Petroleum And Energy Studies,Energy Acres,PO Bidholi(via Prem Nagar)
Dehradun,248007, India
Email id:pbhargv28@gmail.com

BISHAKHA

Student B-Tech Automotive Design Engineering,
University Of Petroleum And Energy Studies,Energy Acres,PO Bidholi(via Prem Nagar)
Dehradun,248007, India
Email id: bullu.upes@gmail.com

TARUN KABADWAL

Student B-Tech Automotive Design Engineering,
University Of Petroleum And Energy Studies,Energy Acres,PO Bidholi(via Prem Nagar)
Dehradun,248007, India
Email id:coolkabdwal06@gmail.com

ABSTRACT

The two stroke engine was developed to obtain a greater output from the same size of engine. The engine mechanism eliminates the valve arrangement making it mechanically simpler. Theoretically a two stroke engine develops twice the power of a comparable four stroke engine, thus making it more compact. Getting air into an engine is the key to making power and there are many ways to increase the air flow into the engine. There are such forced induction, nitrous system, better port and valve shapes to improve flow. But for this study the technique that has been selected were the better port size. The claims that this where the harnessing the inertia of the air velocity to better fill the cylinders. Modification in intake port is made. Also use of different fuel metering jets is used for different A/F mixtures. At various throttle positions and with torque and speed as input, performance parameters of engine are calculated. Based on the results various performance curves are plotted. The objective of the project is to determine how much power improvement with the modification in intake system in compared to the original intake system. Modification to the engine without additional system attach to the engine operation were the best solution to have an optimum engine operation in term of torque and horsepower. To optimize the power and intake port flow produce by the engine modification were through a very limited value. The value is limited due to the restricted area of the engine production by the manufacturer.

Hence modification must be planned carefully as over modification of the inlet port can end up with a device slower than its stock counterpart.

Keywords: A/F mixtures, power improvement, intake port, engine modification

1. Introduction

A two stroke engine is one which completes its cycle of operation in one revolution of crankshaft or in two stroke of the piston. In this engine the function of intake and exhaust processes of the 4-stroke engine are taken care of by the incoming fresh charge which is compressed either in the crankcase or by a separate blower while the piston is near the BDC. The combustible A/F mixture is obtained from simple carburetor. The conventional, carburetted, two-stroke SI engine has a number of potential advantages over the equivalent four stroke engine; these include higher specific power output, compactness, simple construction, lower production and maintenance costs, lower brake-specific NO_x emissions, lower engine friction, and reduced part-load pumping losses. As a result of these advantages, the two stroke.SI engine is widely used in mopeds, motorcycles, three wheeled auto rickshaws, chainsaws, snowmobiles, lawn mowers, and outboard marine applications. In India, the *two* wheeled vehicles powered by two-stroke SI engines are numbered around 17 million, compared to only 2.8 million.Modification to the engine without additional system attach to the engine operation was the best solution to have an optimum engine operation in term of torque and horsepower. To optimize the power and intake port flow produce by the engine modification were through a very limited value. The value is limited due to the restricted area of the engine production by the manufacturer. Hence modification must be planned carefully as over modification of the inlet port can end up with a device slower than its stock counterpart.

In this work modification in intake port is done , also with the use of two jets (0.85mm & 0.70mm) and readings are taken at a particular rpm(580).It was found that mechanical thermal efficiency was and Fuel economy was improved after modification in intake port.

2. Modification in Two Strokes Engines

Technical modifications are basically made in order to increase the overall efficiency. Similarly modifications in a two stroke petrol engine are made to increase the power output of the engine.

Getting air into an engine is the key to making power and there are many ways to increase the air flow into the engine. There are such forced induction, nitrous system, better port and valve shapes to improve flow. But for this study the technique that has been selected were the better port size. The claims that this where the harnessing the inertia of the airs velocity to better fill the cylinders. Modifications are done in the intake port by enlarging the intake port area. Higher air flow rate enters the intake port resulting higher air-fuel rate burn thus increased the performance of the engine. Modifying the intake port has many types and rules. It is such as porting and polishing. All modifiers, modified cylinder head to have an increasing increment of horsepower and air-flow and thus the engine efficiency will be increase too. This porting process to the cylinder heads and intake ensures that the flow mixture enters the cylinder head chamber with the maximum amount of velocity. The higher flow restriction in any engines is within the cylinder head. Porting is needed for reducing the flow restriction at the particular area to increase performance of the engine compare with the same engine with same displacement. Higher the flow entered will causing increasing velocity of the air-flow and at the same time the performance in case of horsepower will also affected. File off (2-3) mm off of the bottom floor and then file away 1 mm off of each side giving it a more oval appearance. Next, modifications in metering jet were done. We can use two types of fuel metering jet for the experiment

- 0.85mm diameter orifice.
- 0.7mm diameter orifice.

A small diameter carburetor will have high velocity and a good flow characteristic for a low to mid rpm power band. A large diameter carburetor works better for high rpm power bands. The results after modification show increase in the overall efficiency of the engine. Hence modification must be planned carefully as over modification of the inlet port can end up with a device slower than its stock counterpart. In our project modification in intake port is done , also with the use of two jets (0.85mm & 0.70mm) and readings are taken at a particular rpm(580).It was found that mechanical thermal efficiency was and Fuel economy was improved after modification in intake port.

3. Design Method

3.1 Modification In Intake Port

Modification in intake port flow by enlarging the intake port area can increase engine performance. Higher air flow rate entered the intake port resulting higher air-fuel rate burn thus increased the performance of the engine. Modifying the intake port has many types and rules. It is such as porting and polishing. All modifiers, modified cylinder head to have an increasing increment of horsepower and air-flow and thus the engine efficiency will be increase too. This porting process to the cylinder heads and intake ensures that the flow mixture enters the cylinder head chamber with the maximum amount of velocity. The higher flow restriction in any engines is within the cylinder head. Porting is needed for reducing the flow restriction at the particular area to increase performance of the engine compare with the same engine with same displacement. Higher the flow entered will causing increasing velocity of the air-flow and at the same time the performance in case of horsepower will also affected. File off (2-3) mm off of the bottom floor and then file away 1 mm off of each side giving it a more oval appearance.

3.2. Using Different Type of Fuel Metering Jet

In this work, two types of fuel metering jet are used for the experiment

- 0.85mm diameter orifice.
- 0.7mm diameter orifice.

A small diameter carburetor will have high velocity and a good flow characteristic for a low to mid rpm power band. A large diameter carburetor works better for high rpm power bands.

4. Experimental Setup

A single cylinder 2 strokes, force air cooled 150cc engine, carburetted loop scavenged manufactured by BAJAJ Auto Ltd. used in a BAJAJ SUPER motor scooter has been used for testing, modification and the experimental study. This engine has been coupled to a Rope Brake Dynamometer for speed and torque measurements. Calibrated standard instrumentation has been made use of to measure fuel and air flow rates. The lubricating oil used is SAE 30 mixed in a proportion of 35cc to 1000cc of gasoline. Carburettor jet sizes of 0.84mm were used in the SPACO Dell'Orto 17/20 Carburettor fitted on the engine. The engine is retrofitted with a 12V Magneto coil system and Ignition coil using a MICO (BOSCH) W175Z1/ W7A Single Electrode Spark Plug. The twin spark plug head is ready with the two plugs, the default one being the same BOSCH W175Z1/ W7A plug and the secondary plug being the BOSCHW8DC spark plug. Apart from the regular performance check we also intend to carry out an exhaust gas analyser test for checking the HC Emissions.

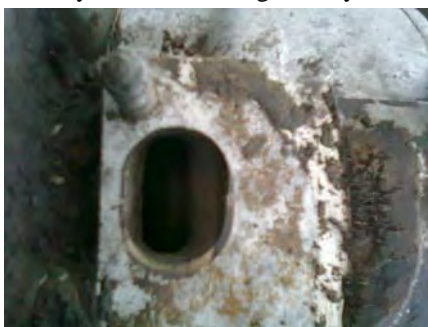


Fig1.Before Porting



Figure2. After Porting

5. Calculations

5.1. Intake Port:

The surface area of elliptical port of intake port:

$$\begin{aligned}
 &= (\pi * length * width) / 4 & (1) \\
 &= (\pi * 2.6 * 1.9) / 4 \\
 &= 3.84 \text{ square cm}
 \end{aligned}$$

After file off 3 mm from each side and 1 mm from bottom floor

The surface area of elliptical port of intake port:

$$\begin{aligned}
 &= \pi * length * width / 4 \\
 &= \pi * 2.8 * 2 / 4 \\
 &= 4.39 \text{ square cm}
 \end{aligned}
 \tag{2}$$

Which make the opening of intake port more oval in shape and the surface area will increase and ultimately more air – fuel get intake in the crankcase.

5.2 .Amount Of Discharge

In the carburetor of Bajaj scooter engine we have two types of fuel metering jet

- 0.85 mm diameter orifice.
- 0.7 mm diameter orifice.

So the discharge of fuel during carburation will be different depending on orifice area of the metering jet.

The discharge is given by:

$$Q = (\pi * d * b * n / 4) * v * (\theta * 60 / (360 * N)) \tag{3}$$

Without modification:

$$\begin{aligned}
 Q &= ((\pi * 0.026 * 0.019) / 4) * v * (\theta * 60 / (360 * N)) \\
 &= 0.387 * 10^{-3} * (v * (\theta * 60 / (360 * N)))
 \end{aligned}$$

After modification

$$\begin{aligned}
 Q &= ((\pi * 0.028 * 0.020) / 4) * v * (\theta * 60 / (360 * N)) \\
 &= 0.455 * 10^{-3} * (v * (\theta * 60 / (360 * N)))
 \end{aligned}$$

Percentage increment in discharge=

$$\frac{[(0.455 * 10^{-3} - 0.387 * 10^{-3}) * (v * (\theta * 60 / (360 * N)))] * 100}{(0.455 * 10^{-3} * (v * (\theta * 60 / (360 * N))))} = 14.94\% \tag{4}$$

Where

d = diameter of the orifice

b = width of the orifice

v = velocity of the fuel coming (same for both at same engine speed)

θ = crank angle rotation in degree

After this we conduct the test for both metering jets and study the variation b/w two graph of performance.

5.3 Percentage increase in A/F ratio of 0.70mm to 0.85mm jet

$$(m_a / m_f) = (c_{da} / c_{df}) * (A_t / A_f) * \sqrt{(P_a / P_f)} \tag{5}$$

Where

m_a = mass of air flow

m_f = mas of fuel

c_{da} = coefficient of discharge for venturi

c_{df} = coefficient of discharge of fuel nozzle

A_t = area of throat

A_f = area of jet

P_a = pressure inside the cylinder

P_f = pressure depression at throat

- For 0.70 mm

$$(m_a / m_f) = 1 / (\pi * 0.7^2 * 10^{-6} / 4) * (c_{da} / c_{df}) * (A_t) * \sqrt{(P_a / P_f)}$$

$$(m_a / m_f) = 2598448.05 * [(c_{da} / c_{df}) * (A_t) * \sqrt{(P_a / P_f)}]$$

- For 0.85 mm

$$(m_a / m_f) = 1 / (\pi * 0.85^2 * 10^{-6} / 4) * (c_{da} / c_{df}) * (A_t) * \sqrt{(P_a / P_f)}$$

$$(m_a / m_f) = 1762269.266 * [(c_{da} / c_{df}) * (A_t) * \sqrt{(P_a / P_f)}]$$

Percentage increment in mixture formation

$$\frac{[2598448.05 - 1762269.266] * [(c_{da} / c_{df}) * (A_t) * \sqrt{(P_a / P_f)}] * 100}{2598448.05 * [(c_{da} / c_{df}) * (A_t) * \sqrt{(P_a / P_f)}]} = 32\%$$

5.4 Indicated Power

Calculated from the graph b/w Brake Power vs TFC from Appendix A in Table1

5.5 Brake Power

It is the actual power which is coming on crankshaft after friction power losses. This is calculated with the help of mechanical dynamometer.

First the torque can be calculated by dynamometer and it is given by.

$$T = r * f$$

Where

r = radius of the rotating wheel in rope dynamometer

f = weight coming on wheel of rope dynamometer.

Then.

$$\text{Work done one revolution} = 2\pi * r * f$$

$$\text{Power} = \text{work/time} = (2\pi * r * f * N) / 60$$

Where N = revolution per minute of the drive shaft.

$$\text{Therefore, } Bp = (2\pi * T * N) / (60 * 1000) \text{ KW} \tag{6}$$

Calculated in the Table 1 and Table2 in Appendix A

5.6. Frictional Power

It is the power used by the engine to overcome the friction loose.

$$Fp = Ip - Bp$$

see from graph Fig3, Fig4, Fig5, Fig6

$$tfc = (\text{Fuel consumed} * 0.72 * 1000) / (1000000 * \text{time}) \tag{7}$$

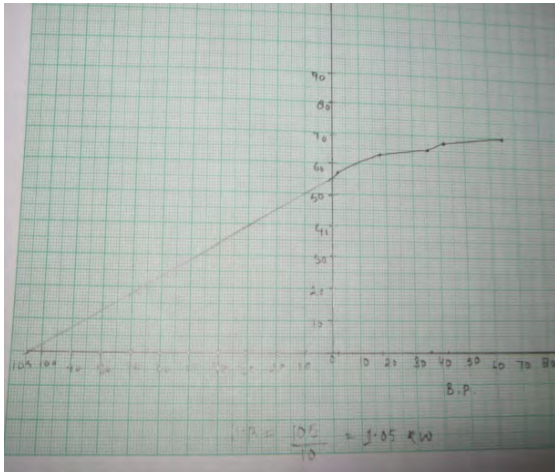


Fig3. Frictional Power. @ 0.85 mm with porting

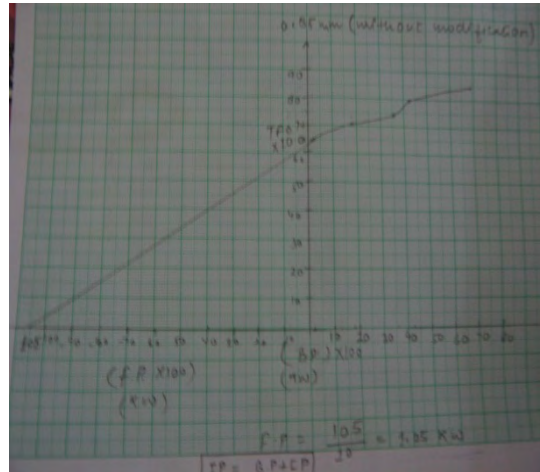


Fig4. Frictional Power. @ 0.85 mm without porting

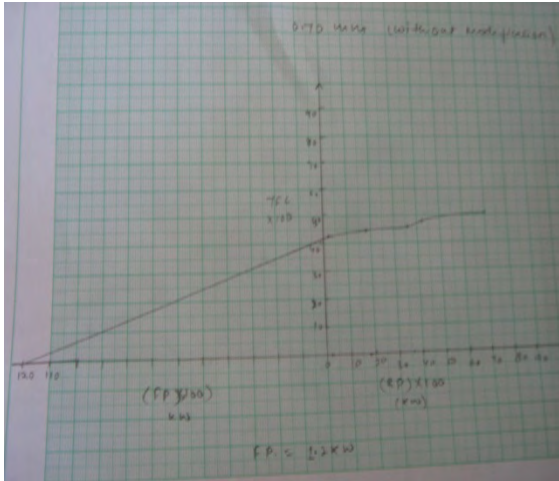


Fig5. Frictional Power. @ 0.70 mm without porting

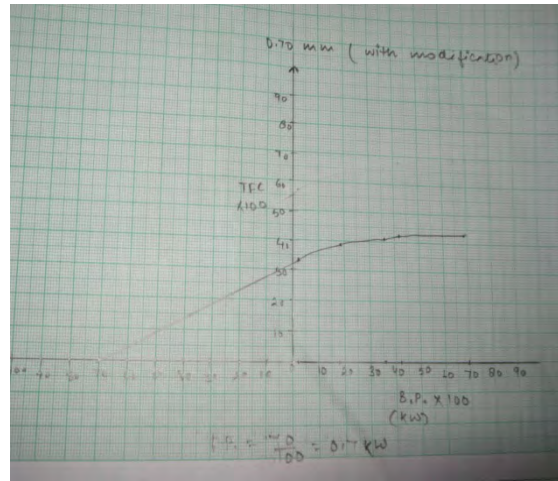


Fig6. Frictional Power. @ 0.70 mm with porting

5.7. Brake Thermal Efficiency

Brake thermal , $th = (BP/HS) * 100$ 8)
 $th = 0.6913/8.48 * 100 = 8.144 \%$
 calculated in Table1 and Table2

5.8 Total Fuel Consumed (TFC)(Kg/hr)

$$= (\text{vol of fuel consumed(cc)} * \text{sp gravity of fuel} * 10^3 * 3600) / [10^6 * t (\text{sec})] \quad (9)$$

5.9. Heat Input (Q)(KW)

$$Q_{\text{supplied}} = (\text{specific heat of fuel(MJ)} * 10^3 * \text{TFC(kg/sec)}) \quad (10)$$

6.Result

1. Brake thermal efficiency increased after modification.
 like @580 rpm, 8kg load=
 a.) for 0.85mm jet
 Brake thermal efficiency , $th = 6.74\%$ (before modification)
 and after modification = 8.14%
 b.) for 0.70mm jet
 Brake thermal efficiency , $th = 11.06\%$ (before modification)
 and after modification = 12.95%
 referring Table1 and Table2
2. Fuel economy also improved after modification.
 like @580 rpm, 8kg load=
 a.) for 0.85mm jet
 time for consumption of 10 cc fuel=**30.56sec(before modification)**
37.29sec (after modification)
 b.) for 0.70 mm jet
 Time for consumption of 10 cc fuel=**50.66sec(before modification)**
59.30sec (after modification)
 referring Table1 and Table2
3. Also 0.70mm fuel jet made 32% leaner mixture than 0.85mm fuel jet.
4. Graphical representation of Brake power VS Tfc

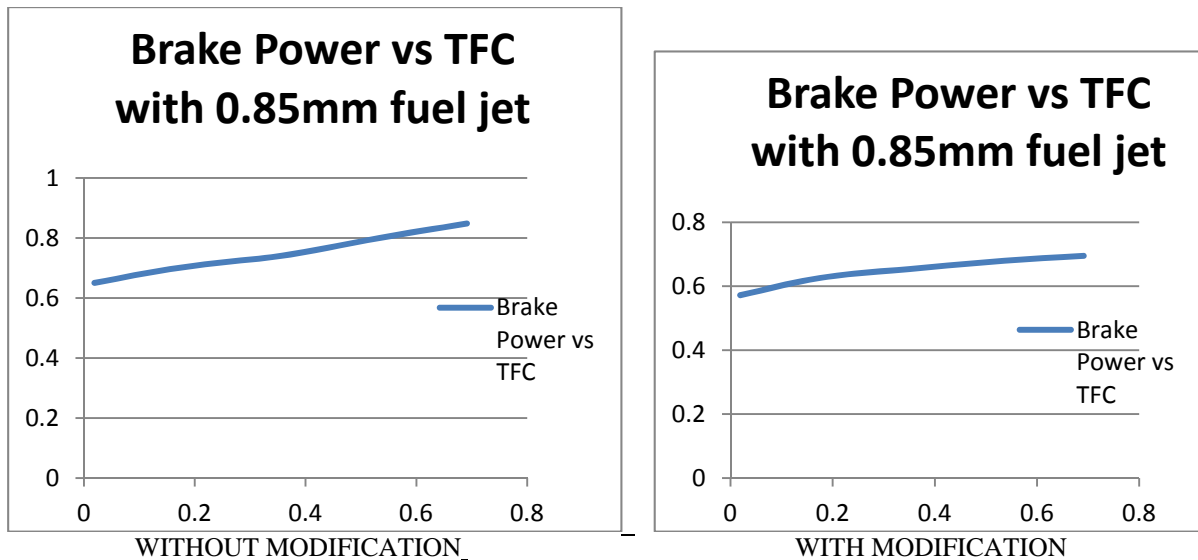


Figure7: TFC vs Brake Power for jet (0.85mm) with and without modification

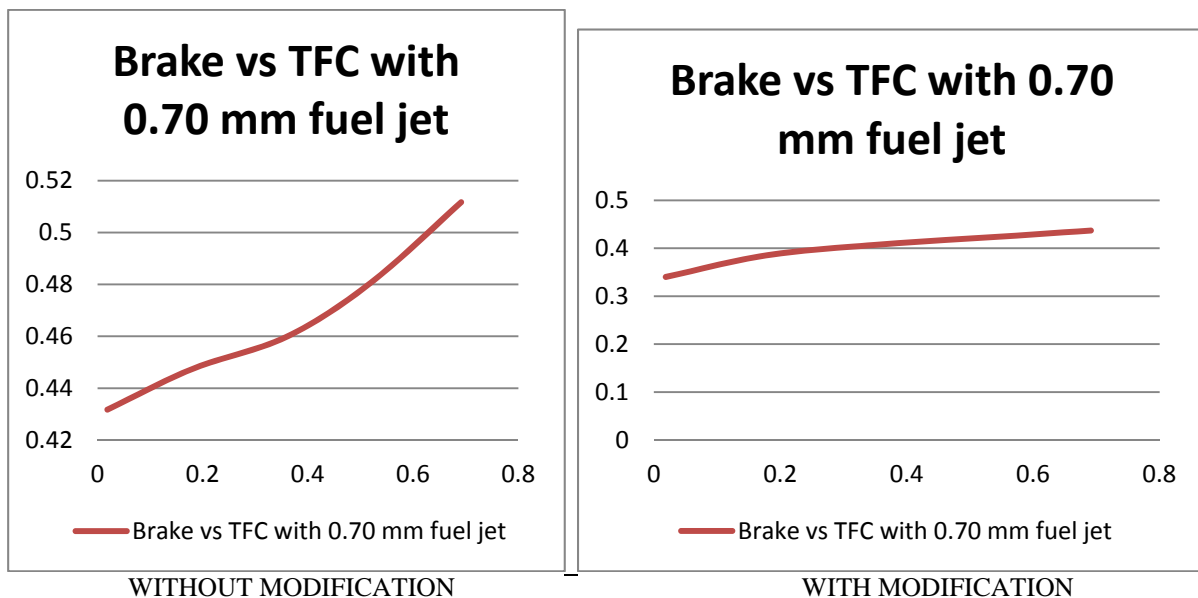


Figure 8: TFC vs Brake Power for jet (0.70mm) with and without modification

7. Conclusion

The modification should be planned carefully in such a way that no engine components get affected. This study also concern about the improvement in the fuel economy and brake thermal efficiency. Based on calculation and graphs plotted, an optimum value of fuel and efficiency is taken into consideration. The 0.70 jet gave 32% more leaner mixture than 0.85mm. Due to which brake thermal efficiency was improved 11.06% to 12.95 % in 0.70 mm jet and 6.74% to 8.14% in .85mm jet. @ (580rpm, 8kgload).The intake port area is increased by porting ,thereby increasing the mass flow rate by 15%, due to which brake thermal efficiency improved or in other words fuel economy increased .Hence modification must be planned carefully as over modification of the inlet port can end up with a device slower than its stock counterpart. Probably the simplest and best modifications have been made in our project to modify the intake system.

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Appendix A

Table1

Reading With 0.85 mm fuel jet

S. No	Weight (kg)	S1	S2	S=S2-S1	Force=(W-S)*g (N)	Torque (N-m)	Speed N(rpm)	Time (sec)	F. C (cc)	Brake power (kW)	TFC (kg/s)	TFC=TFC*3600 (kg/hr)	bsfc=TFC/BP (kg/kW-hr)	Heat supplied (kW)	$\eta_{th}=(BP/HS)*100$ (in %)	F.P. (KW)	I.P.
1	0	0.2	0	-0.2	2	0.312	580	39.87	10	0.01894048	0.000180587	0.650112867	34.32399109	7.939142212	0.238570862	1.05	1.06894048
2	2	0.2	0.3	0.1	19	2.964	580	36.87	10	0.17993456	0.000195281	0.703010578	3.907034745	8.585126119	2.095887207	1.05	1.22993456
3	4	0.2	0.4	0.2	38	5.928	580	34.97	10	0.35986912	0.000205891	0.741206749	2.059656435	9.051575636	3.975762171	1.05	1.40986912
4	6	0.2	0.7	0.5	55	8.58	580	32.57	10	0.5208632	0.000221062	0.795824378	1.527895191	9.718563095	5.359467186	1.05	1.5708632
5	8	0.2	0.9	0.7	73	11.388	580	30.56	10	0.69132752	0.000235602	0.848167539	1.226867895	10.35777487	6.674479111	1.05	1.74132752

radius=0.156

Reading With 0.70 mm fuel jet

1	0	0.2	0	-0.2	2	0.312	580	60.04	10	0.01894048	0.00011992	0.431712192	22.79309668	5.272045303	0.359262467	1.2	1.21894048
2	2	0.2	0.3	0.1	19	2.964	580	57.94	10	0.17993456	0.000124266	0.447359337	2.486233535	5.463127373	3.293618247	1.2	1.37993456
3	4	0.2	0.4	0.2	38	5.928	580	56.37	10	0.35986912	0.000127728	0.459819053	1.277739676	5.615284726	6.408742167	1.2	1.55986912
4	6	0.2	0.7	0.5	55	8.58	580	53.91	10	0.5208632	0.000133556	0.480801336	0.923085631	5.871519199	8.871012465	1.2	1.7208632
5	8	0.2	0.9	0.7	73	11.388	580	50.66	10	0.69132752	0.000142124	0.511646269	0.740092437	6.248195815	11.06443429	1.2	1.89132752

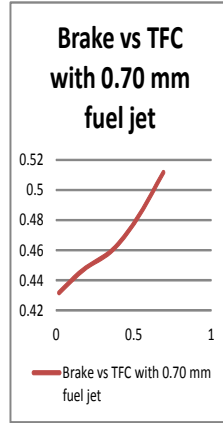
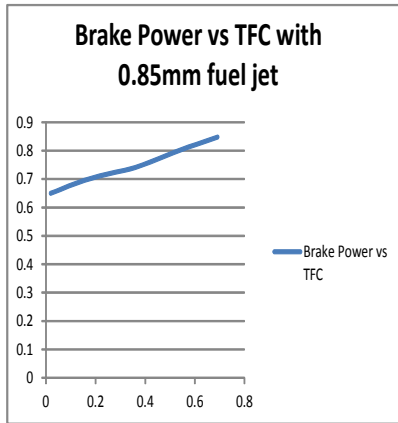


Table2

Reading With 0.85 mm fuel jet (after modification)																	
S. No	Weight (kg)	Weight on Spring			Force=(W-S)*g	Torque=F*0.156	Speed	Time	FC	Brake power	TFC	TFC	bsfc	HS	$\eta_{th}=(BP/HS)*100$	FP	IP
(kg)	S1	S2	S=S2-S1	(N)	(N-m)	N(rpm)	(sec)	(cc)	(kW)	(kg/s)	(kg/hr)	(kg/kW-hr)	(kW)	(in %)			
1	0	0.2	0	-0.2	2	0.312	580	45.34	10	0.01894048	0.0001588	0.571680635	30.18300672	6.981332157	0.271301803	1.05	1.06894
2	2	0.2	0.3	0.1	19	2.964	580	41.33	10	0.17993456	0.000174208	0.627147351	3.485419091	7.658688604	2.349417365	1.05	1.22993
3	4	0.2	0.4	0.2	38	5.928	580	39.57	10	0.35986912	0.000181956	0.655041698	1.820222025	7.999332828	4.498739179	1.05	1.40987
4	6	0.2	0.7	0.5	55	8.58	580	38.23	10	0.5208632	0.000188334	0.678001569	1.301688369	8.279717499	6.290832991	1.05	1.57086
5	8	0.2	0.9	0.7	73	11.388	580	37.29	10	0.69132752	0.000193081	0.695092518	1.005446041	8.488431215	8.144349674	1.05	1.74133
radius=0.156																	
Reading With 0.70 mm fuel jet (after modification)																	
1	0	0.2	0	-0.2	2	0.312	580	76.17	10	0.01894048	9.45254E-05	0.340291453	17.96635847	4.155620323	0.455779848	0.7	0.71894
2	2	0.2	0.3	0.1	19	2.964	580	67.2	10	0.17993456	0.000107143	0.385714286	2.143636474	4.710321429	3.820005975	0.7	0.87993
3	4	0.2	0.4	0.2	38	5.928	580	63.5	10	0.35986912	0.000113386	0.408188976	1.134270638	4.984781102	7.21935653	0.7	1.05987
4	6	0.2	0.7	0.5	55	8.58	580	61.4	10	0.5208632	0.000117264	0.422149837	0.810481211	5.155270358	10.10350891	0.7	1.22086
5	8	0.2	0.9	0.7	73	11.388	580	59.3	10	0.69132752	0.000121417	0.437099494	0.632261094	5.337834739	12.95145979	0.7	1.39133

