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MECHANICAL ENGINEERING DEPARTMENT
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ቁ.ር Ref.No: ME/JIT/ 026/2004

ቀን Date: 07/10/2011

To:

AJ Simony Merchandise

Addis Ababa

Subject: SI (Petrol) Engine Performance Test with FUEL-STICK (Fuel Conditioner) Result

As per your request to test a fuel with fuel additive called Fuel-Stick, department of mechanical engineering has performed the following two experiments.

1. Performance test for pure petrol and petrol with fuel-stick
2. Emission analysis test for pure petrol and petrol with fuel-stick

Therefore, here within we send the compiled experimental results report. This report is prepared in good faith under standard test conditions. The report or part thereof must not be used for any legal matter

Kind Regards,

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ቀን Date: 07/10/2011

SI (Petrol) Engine Performance Test with FUEL-STICK (Fuel Conditioner)

The performance test has been performed on SI Engine to determine the overall effect of Fuel Stick Conditioner on fuel consumption, engine performance and emissions released. The summary of the results are presented below;

a. Efficiency results (Fuel saving) when Petrol with Fuel Stick is used on Spark Ignition (SI) Engine at Compression Ratio of 9(nine).

Engine Speed (RPM)	1000	1250	1500	1750	2000
Petrol with Fuel Stick	16.4%	11.2%	6.42%	2.91%	2.07%

b. Calorific Value Test(Obtained from AAiT Chemical Engineering Lab result)

Type	Calorific Value [Cal/gram]	Calorific Value [kJ/kg]	Net Difference In Calorific Value (Cal/Gram)	Net Difference In Calorific Value (kJ/kg)
Petrol with Fuel Stick	10,237.20	42,861.17	210.99	882.44
Pure Petrol	10,026.21	41,978.73		

c. Emission Analysis

Type	HC (Unburned Hydrocarbon) [ppm]	CO (Carbon monoxide) [%Vol]
Petrol with Fuel Stick	within the range of 8ppm to 28ppm	within the range of 0.01%vol to 0.03%Vol
Pure Petrol	within the range of 10ppm to 33ppm	within the range of 0.03%vol to 0.46%Vol
Net Difference	2ppm to 5ppm	0.02%Vol to 0.43%Vol

Result Summary

- Generally there is a significant fuel saving at all engine RPM when the engine uses Petrol with Fuel Stick, and in particular the saving in fuel consumption is high during lower engine speeds.
- The fuel consumption to generate the same amount of power decreases in the case of Petrol with Fuel Stick as compared to that of Pure Petrol at the same engine speed.
- The amount of emission gases namely HC- Unburned Hydro Carbon and CO- Carbon Monoxide decreases while using Petrol with Fuel Stick at different Air to Fuel ratios (A/F).

Other Observations

- The engine running using Petrol with Fuel Stick run smoothly (without vibration) at low engine speeds, while moderate vibration was observed during engine running on Pure Petrol.
- Engine cleaning effects was observed in engine components, like spark plugs in SI Engine while using Petrol with Fuel Stick.
- The above performance results may change based on the quality of fuel used (fuel grade).

N.B: This report is prepared in good faith under standard test conditions. The report or part thereof must not be used for any legal matter.

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Department of Mechanical Engineering

- The performance test has been carried out on a '***Variable Compression Test Rig***' manufactured by TQ ENGLAND with engine specification: Model: TD 43F, Swept volume: 582cm^3, Cylinder Bore diameter: 95mm, Stroke: 82mm. Ignition Timing: 20^{o}BTDC: Chock Size: 19mm.
- Emission Analysis test has been carried out on an instrument manufactured by KAY model 5000 EMISSION ANALYSER.

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Engine Type = Diesel Engine; Compression ratio = 16; Fuel Type = Pure Diesel																Emmission Analysis			
Engine Speed, [RPM]	Brake Torque, Pure Diesel [Nm]	Friction Torque, [Nm]	Volume of Fuel Consumed [m3]	Time Taken [s]	Air Pressure Drop, [InWC]	Fuel Consumption [kg/h]	Air Consuption [kg/h]	A/F	BP [kW]	FP [kW]	IP [kW]	sfc, Pure Diesel [g/kWh]	Mechanical Efficiencey [%]	Brake Thermal Efficiency [%]	Volumetric Efficiency [%]	HC	CO	CO2	Average Vehecle Speed [km/hr]
1000	26.00	9	2.40E-05	112.3	0.95	0.57	21.85	38.33	2.72	0.94	3.66	209.47	74.29	40.92	131.40	11.00	0.01	0.06	65.94
1250	26.00	9	2.40E-05	103.5	1.20	0.62	27.60	44.61	3.40	1.18	4.58	181.86	74.29	47.13	132.78	19.00	0.02	0.08	82.43
1500	26.00	9	2.40E-05	49.35	1.40	1.30	32.20	24.82	4.08	1.41	5.50	317.81	74.29	26.97	129.10	9.00	0.01	0.04	98.91
1750	25.25	9	2.40E-05	40.92	1.60	1.56	36.80	23.52	4.62	1.65	6.27	338.29	73.72	25.34	126.46	11.00	0.01	0.06	115.40
2000	26.00	9	2.40E-05	35.37	1.90	1.81	43.70	24.14	5.44	1.88	7.33	332.57	74.29	25.77	131.40	12.00	0.01	0.07	131.88
2250	26.00	9	2.40E-05	31.26	2.15	2.05	49.45	24.14	6.12	2.12	8.24	334.49	74.29	25.63	132.17	13.00	0.02	0.08	148.37
2500	25.00	9	2.40E-05	27.37	2.35	2.34	54.05	23.11	6.54	2.36	8.90	357.58	73.53	23.97	130.02	8.00	0.01	0.03	164.85

Cv_Pure_Diesel= 10671 Cal/gram

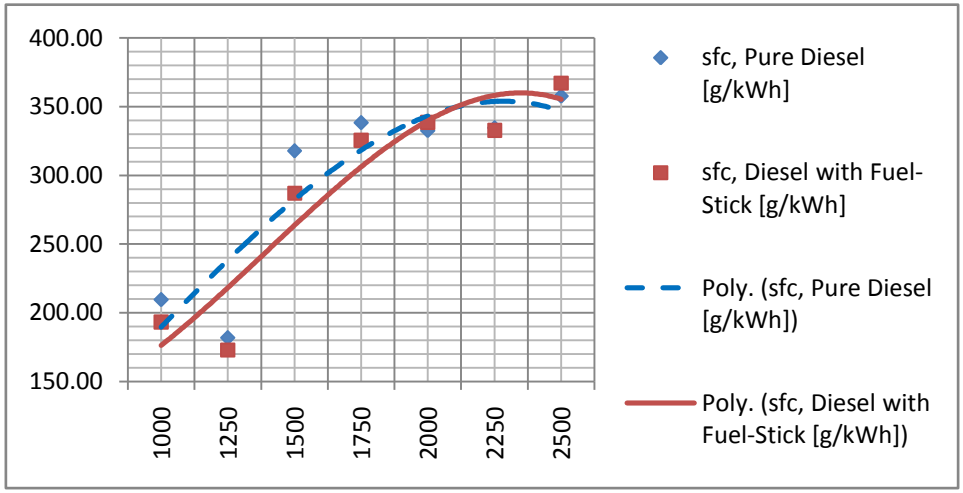


Figure a: Reprsenting Specific fuel consumption(sfc) of CI engine running on pure Diesel and Dielsel with fuel-stick.

Explanation: The result indicates that the fuel consumption to generate the same amount of power decreases in the case of petrol with Fuel-Stick. The save in fuel consumption is high during lower engine speeds (i.e. less than 1500RPM equal to vehicle speed of 80 km/hr.)

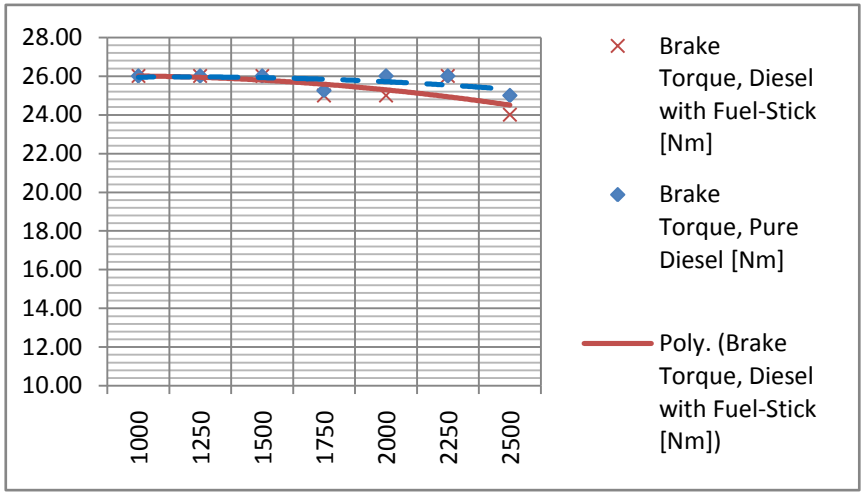


Figure b: Reprsenting Brake Torque Out put of CI engine running on pure Diesel and Diesel with fuel-stick.

Explanation: The result indicates that the brake torque generated is the same in both cases.(i.e. SI engine running on 'petrol with fuel-stick' generates the same torque as in the pure petrol by consuming less amount of fuel as in figure a.)

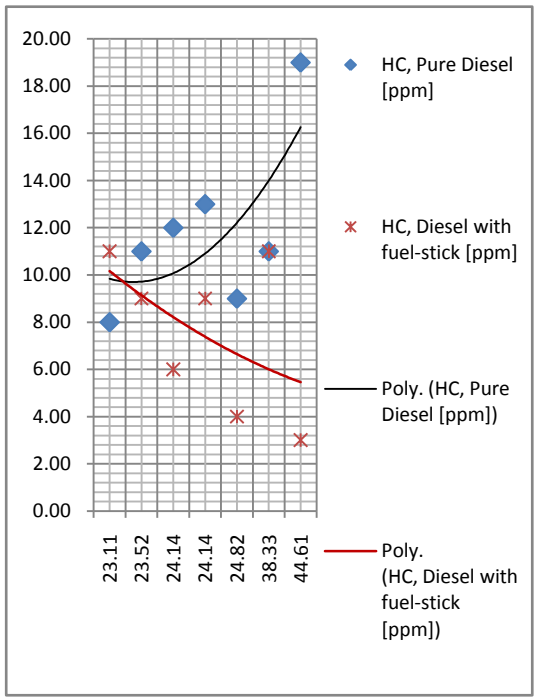
Engine Type = Diesel Engine; Compression ratio = 16; Fuel Type = Diesel with Fuel-Stick																Emmission Analysis			
Engine Speed, [RPM]	Brake Torque, Diesel with Fuel-Stick [Nm]	Friction Torque, [Nm]	Volume of Fuel Consumed [m3]	Time Taken, [s]	Air Pressure Drop, [InWC]	Fuel Consumption [kg/h]	Air Consuption [kg/h]	A/F	BP [kW]	FP [kW]	IP [kW]	sfc, Diesel with Fuel-Stick [g/kWh]	Mechanical Efficiencey [%]	Brake Thermal Efficiency [%]	Volumetric Efficiency [%]	HC	CO	CO_2	Save in Fuel, %
1000	26.00	9	2.40E-05	121.75	0.95	0.53	21.85	41.55	2.72	0.94	3.66	193.23	74.29	44.36	131.40	11.00	0.01	0.05	7.75
1250	26.00	9	2.40E-05	108.76	1.20	0.59	27.60	46.89	3.40	1.18	4.58	173.05	74.29	49.53	132.78	3.00	0.01	0.01	4.85
1500	26.00	9	2.40E-05	54.62	1.35	1.17	31.05	26.49	4.08	1.41	5.50	287.15	74.29	29.85	124.48	4.00	0.01	0.02	9.65
1750	25.00	9	2.40E-05	42.97	1.55	1.49	35.65	23.93	4.58	1.65	6.23	325.37	73.53	26.34	122.51	6.00	0.01	0.03	3.82
2000	25.00	9	2.40E-05	36.14	1.85	1.77	42.55	24.02	5.23	1.88	7.12	338.51	73.53	25.32	127.94	9.00	0.01	0.04	-1.78
2250	26.00	9	2.40E-05	31.43	2.05	2.04	47.15	23.15	6.12	2.12	8.24	332.68	74.29	25.76	126.02	9.00	0.01	0.04	0.54
2500	24.00	9	2.40E-05	27.76	2.30	2.31	52.90	22.94	6.28	2.36	8.64	367.24	72.73	23.34	127.25	11.00	0.01	0.04	-2.70

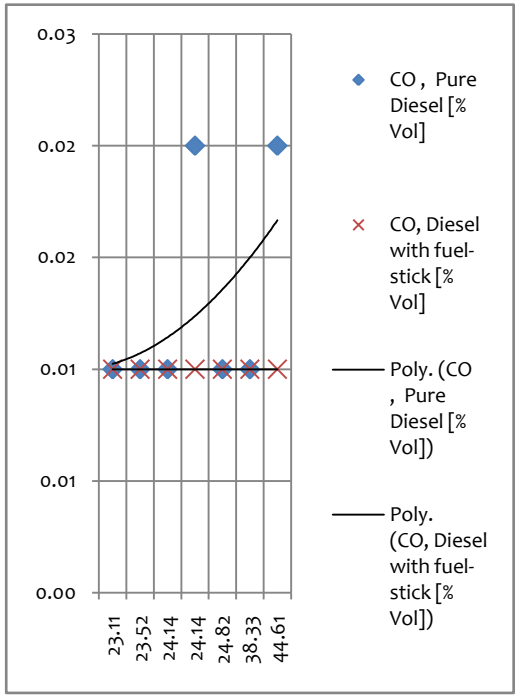
Cv_Diesel_with_fuel-Stick= 10957 Cal/gram

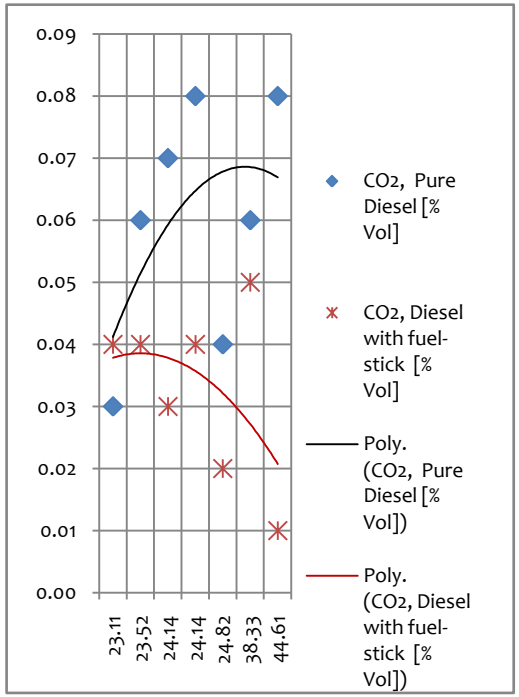
Emission Analysis for Diesel engines running on Pure diesel and with Fuel-Stick

Emission Analysis for SI Engine Running on pure petrol			
A/F	HC, Pure Diesel [ppm]	CO , Pure Diesel [% Vol]	CO_2, Pure Diesel [% Vol]
23.11	8.00	0.01	0.03
23.52	11.00	0.01	0.06
24.14	12.00	0.01	0.07
24.14	13.00	0.02	0.08
24.82	9.00	0.01	0.04
38.33	11.00	0.01	0.06
44.61	19.00	0.02	0.08

Emission Analysis for SI Engine Running on petrol with fuel-stick			
A/F	HC, Diesel with fuel-stick [ppm]	CO, Diesel with fuel-stick [% Vol]	CO_2, Diesel with fuel-stick [% Vol]
22.94	11.00	0.01	0.04
23.15	9.00	0.01	0.04
23.93	6.00	0.01	0.03
24.02	9.00	0.01	0.04
26.49	4.00	0.01	0.02
41.55	11.00	0.01	0.05
46.89	3.00	0.01	0.01



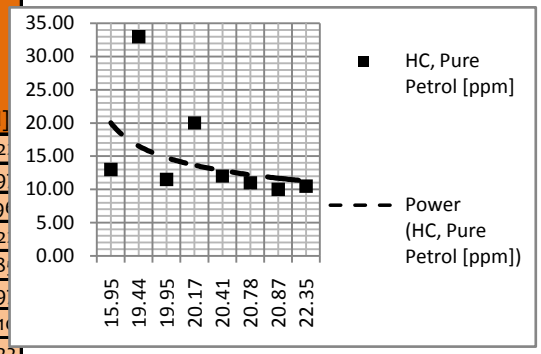


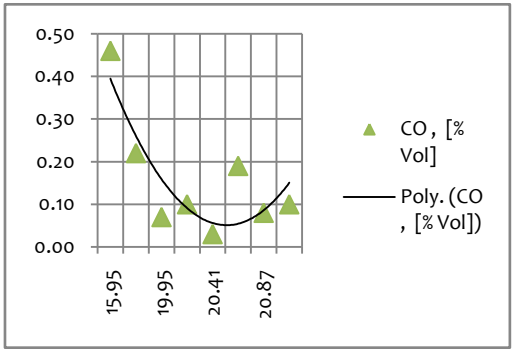


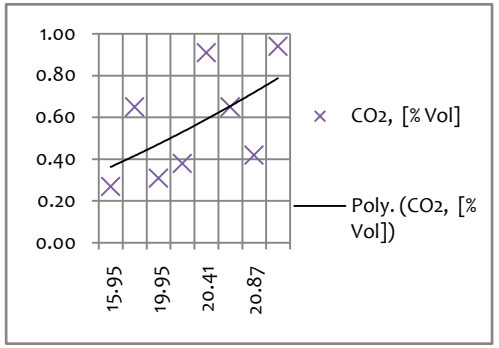
Conclusions: The above Three Compiled figures indicate that the amout of emission gases namely HC(Unburned Hydro Carbon), CO(Carbon monoxide) and green house gase CO_2(carbondioxide). The amout of HC and CO decreased in case of Diesel with fuel-stick specially when the engine speeds increases.

Emission Analysis for SI Engine Running on pure petrol

A/F	HC, Pure Petrol [ppm]	CO , [% Vol]	CO2, [% Vol]	O2, [% Vol]
15.95	13.00	0.46	0.27	1.2
19.44	33.00	0.22	0.65	0.9
19.95	11.50	0.07	0.31	0.9
20.17	20.00	0.10	0.38	1.2
20.41	12.00	0.03	0.91	0.8
20.78	11.00	0.19	0.65	0.9
20.87	10.00	0.08	0.42	1.1
22.35	10.50	0.10	0.94	1.22

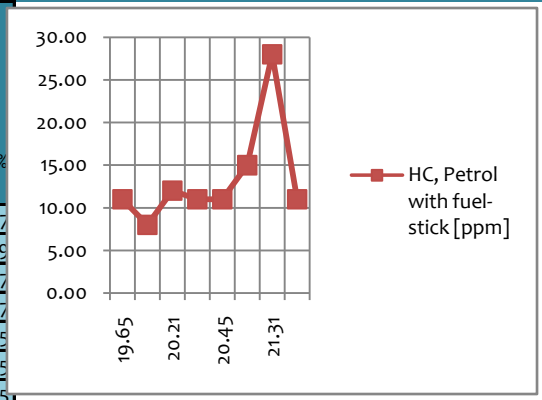


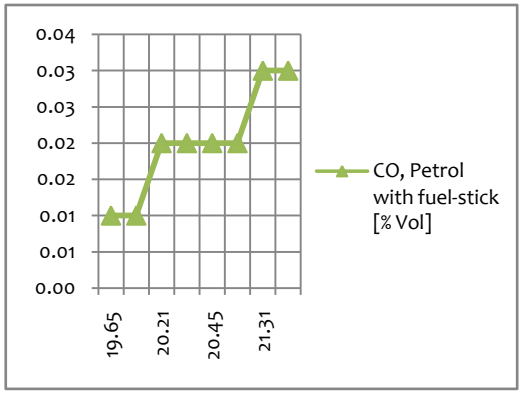


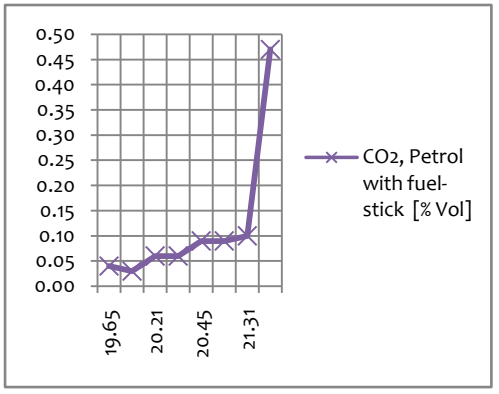


Emission Analysis for SI Engine Running on petrol with fuel-stick

A/F	HC, Petrol with fuel-stick [ppm]	CO, Petrol with fuel-stick [% Vol]	CO2, Petrol with fuel-stick [% Vol]	O2, Petrol with fuel-stick [% Vol]
19.65	11.00	0.01	0.04	0.97
19.95	8.00	0.01	0.03	0.79
20.21	12.00	0.02	0.06	0.97
20.41	11.00	0.02	0.06	0.97
20.45	11.00	0.02	0.09	0.85
20.48	15.00	0.02	0.09	0.85
21.31	28.00	0.03	0.10	0.85
23.14	11.00	0.03	0.47	1.10







The above SIX figures indicate the amout of emission gases namely HC(Unburned Hydro Carbon), CO(Carbon monoxide) and green house gase CO2(carbondioxide). The amout of HC and CO decreased in case of petrol with fuel-stick specially during the lower engine speeds.

Engine Type = Petrol Engine; Compression ratio = 9; Fuel Type = Pure Petrol																Emmission Analysis				
Engine Speed, [RPM]	Brake Torque, Pure Petrol [Nm]	Friction Torque, [Nm]	Volume of Fuel Consumed [m3]	Time Taken [s]	Air Pressure Drop, [InWC]	Fuel Consumption [kg/h]	Air Consuption [kg/h]	A/F	BP [kW]	FP [kW]	IP [kW]	sfc, Pure Petrol [g/kWh]	Mechanical Efficiencey [%]	Brake Thermal Efficiency [%]	Volumetric Efficiency [%]	HC, Pure Petrol [ppm]	CO , [% Vol]	CO2, [% Vol]	O2, [% Vol]	Average Vehecle Speed [km/hr]
1000	35.50	9	2.40E-05	44.41	1.00	1.44	23.00	15.95	3.72	0.94	4.66	387.98	79.78	22.09	138.32	13.00	0.46	0.27	1.22	66
1250	37.25	9	2.40E-05	46.27	1.25	1.38	28.75	20.78	4.87	1.18	6.05	283.91	80.54	30.19	138.32	11.00	0.19	0.65	0.97	82
1500	37.00	9	2.40E-05	37.43	1.50	1.71	34.50	20.17	5.81	1.41	7.22	294.45	80.43	29.11	138.32	20.00	0.10	0.38	1.22	99
1750	36.50	9	2.40E-05	32.67	1.70	1.96	39.10	19.95	6.69	1.65	8.33	293.12	80.22	29.24	134.36	11.50	0.07	0.31	0.96	115
2000	35.50	9	2.40E-05	29.79	1.95	2.15	44.85	20.87	7.43	1.88	9.32	289.20	79.78	29.64	134.86	10.00	0.08	0.42	1.10	132
2250	33.00	9	2.40E-05	25.77	2.10	2.48	48.30	19.44	7.77	2.12	9.89	319.68	78.57	26.81	129.10	33.00	0.22	0.65	0.97	148
2500	30.00	9	2.40E-05	25.83	2.20	2.48	50.60	20.41	7.85	2.36	10.21	315.75	76.92	27.15	121.72	12.00	0.03	0.91	0.85	165
2750	25.00	9	2.40E-05	27.65	2.25	2.32	51.75	22.35	7.20	2.59	9.79	321.78	73.53	26.64	113.17	10.50	0.10	0.94	1.22	181

Cv_Pure_Petrol= 10026.21 Cal/gram

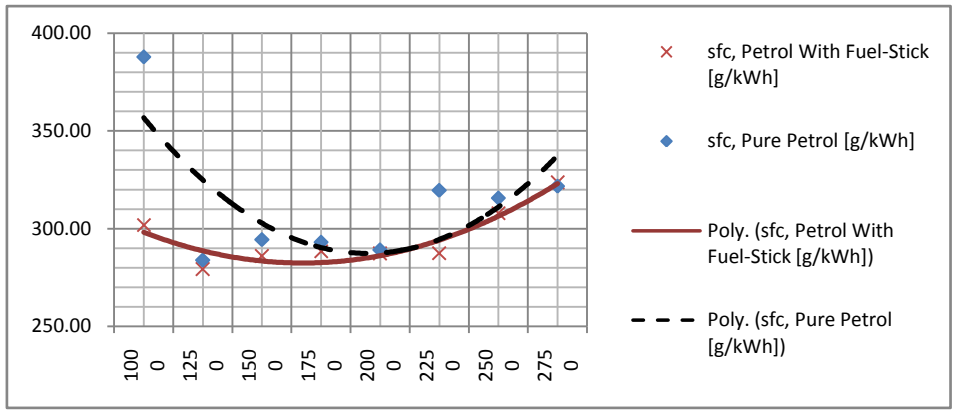


Figure 1: Reprsenting Specific fuel consumption(sfc) of SI engine running on pure petrol and petrol with fuel-stick.

Explanation: The result indicates that the fuel consumption to generate the same amount of power decreases in the case of petrol with Fuel-Stick. The save in fuel consumption is high during lower engine speeds (i.e. less than 1500RPM equal to vehicle speed of 80 km/hr.)

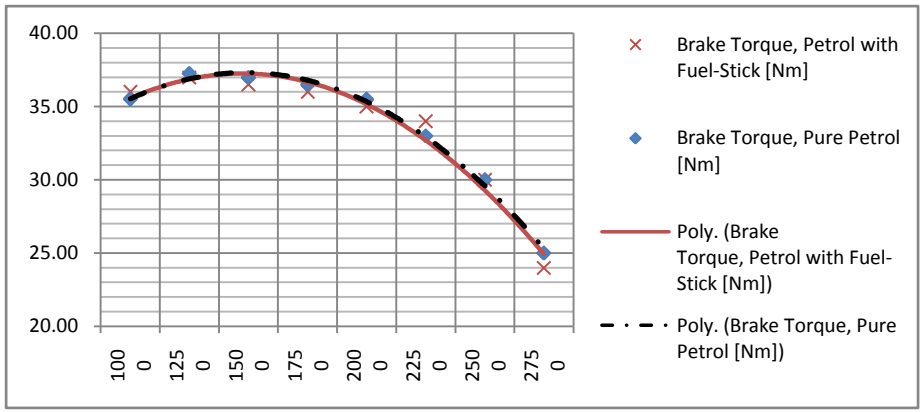


Figure 2: Reprsenting Brake Torque Out put of SI engine running on pure petrol and Petrol with fuel-stick.

Explanation: The result indicates that the brake torque generated is the same in both cases.(i.e. SI engine running on 'petrol with fuel-stick' generates the same torque as in the pure petrol by consuming less amount of fuel as in figure 1)

Engine Type = Petrol Engine; Compression ratio = 9; Fuel Type = Petrol with Fuel-Stick																Emmission Analysis				
Engine Speed, [RPM]	Brake Torque, Petrol with Fuel-Stick [Nm]	Friction Torque, [Nm]	Volume of Fuel Consumed [m3]	Time Taken, [s]	Air Pressure Drop, [InWC]	Fuel Consumption [kg/h]	Air Consuption [kg/h]	A/F	BP [kW]	FP [kW]	IP [kW]	sfc, Petrol With Fuel-Stick [g/kWh]	Mechanical Efficiencey [%]	Brake Thermal Efficiency [%]	Volumetric Efficiency [%]	HC, Petrol with fuel-stick [ppm]	CO, Petrol with fuel-stick [% Vol]	CO2, Petrol with fuel-stick [% Vol]	O2, Petrol with fuel-stick [% Vol]	Save in Fuel, %
1000	36.00	9	2.40E-05	56.27	1.00	1.14	23.00	20.21	3.77	0.94	4.71	301.96	80.00	28.39	138.32	12.00	0.02	0.06	0.97	22.17
1250	37.00	9	2.40E-05	47.35	1.20	1.35	27.60	20.41	4.84	1.18	6.02	279.31	80.43	30.69	132.78	11.00	0.02	0.06	0.97	1.62
1500	36.50	9	2.40E-05	39.06	1.40	1.64	32.20	19.65	5.73	1.41	7.14	286.03	80.22	29.97	129.10	11.00	0.01	0.04	0.97	2.86
1750	36.00	9	2.40E-05	33.65	1.65	1.90	37.95	19.95	6.59	1.65	8.24	288.53	80.00	29.71	130.41	8.00	0.01	0.03	0.79	1.56
2000	35.00	9	2.40E-05	30.42	1.95	2.10	44.85	21.31	7.33	1.88	9.21	287.25	79.55	29.84	134.86	28.00	0.03	0.10	0.85	0.67
2250	34.00	9	2.40E-05	27.81	2.05	2.30	47.15	20.48	8.01	2.12	10.13	287.52	79.07	29.81	126.02	15.00	0.02	0.09	0.85	10.06
2500	30.00	9	2.40E-05	26.48	2.15	2.42	49.45	20.45	7.85	2.36	10.21	308.00	76.92	27.83	118.95	11.00	0.02	0.09	0.85	2.45
2750	24.00	9	2.40E-05	28.63	2.25	2.24	51.75	23.14	6.91	2.59	9.50	323.71	72.73	26.48	113.17	11.00	0.03	0.47	1.10	-0.60

Cv_Petrol_with_fuel-Stick= 10237.2 Cal/gram