© 2020 IJSRST | Volume 5 | Issue 7 | Print ISSN : 2395-6011 | Online ISSN: 2395-602X

4th National Conference on Advances in Engineering and Applied Science
Organized by : Anjuman College of Engineering and Technology (ACET) Nagpur, Maharashtra, India, In association with
International Journal of Scientific Research in Science and Technology

Performance Analysis of Four Stroke Four Cylinder Petrol Engine Using PLC and SCADA Program

Sanket Bodele*, Taufique Khan, Danish Raza, Dr. Kirti Khandelwal

Department of Mechanical Engineering, Rashtrasant Tukdoji Maharaj Nagpur University,Nagpur, Maharashtra, India

ABSTRACT

As we know that now a day's research is going on engines to reduce pollution and emissions of harmful gas like carbon monoxide and to find alternative petroleum product this requires regular monitoring and control of automobile engine. So we need to calculate various parameters like brake power, torque, engine speed, indicated power etc. Manually which takes too much time and effort if we integrate PLC (Programmable Logic Control) and SCADA (Supervisory Control and Data Acquisition) with our test rig? The PLC will calculate all this parameter and convert it into digital signals and SCADA shows all this on a single screen and also compare results with previous results. This paper present information on PLC and SCADA.

Keywords : SCADA, PLC

I. INTRODUCTION

INTERNAL COMBUSTION ENGINE

The internal combustion engine (IC Engine) is a reciprocating heat engine in which fuel mixed with correct amount of air is burnt inside a cylinder. The spark-ignition engine usually runs on a liquid fuel. The fuel must be highly volatile so that it vaporizes quickly. The fuel vapour mixes with air before entering the engine cylinders. This forms the highly combustible air-fuel mixture that burns easily. The mixture then enters the cylinders and is compressed. Heat from an electric spark produced by the ignition system sets fire to, or ignites, the fuel mixture. As the mixture burns (combustion), high temperature and pressure are produced in the cylinder. This high pressure, applied to the top of the piston, forces it to move down the cylinder. The motion is carried by gears and shafts to the wheels that drive the automobile.

We are using the engine with the following specifications:

Ambassador (Engine No. 6EHHA10842)

Max. Power	72. 5 hp @ 5000 rpm
Max. Torque	65 n-m @ 1500 rpm
Cylinder	04
Displacementnt	1489 cc
Bore	79. 00 mm
Stroke	89.00 mm
Compression Ratio	8: 3: 1
Cooling	Water cooled
Ignition	Battery
Fuel	Petrol

II. COMPONENT

MEASUREMENT OF AIR FLOW

Air box method

An airbox is an empty chamber on the inlet of most combustion engines. It collects air from outside and feeds it to the intake hoses of each cylinder. Also instruments that measures airflow such as an airflow meter. Anemometers are also used to measure wind speed and indoor airflow

VANE ANEMOMETER

A vane anemometer thus combines a propeller and a tail on the same axis to obtain accurate and precise wind speed and direction measurements from the same instrument. The speed of the fan is measured by a rev counter and converted to a windspeed by an electronic chip. Hence, volumetric flow rate may be calculated if the cross-sectional area is known.

In cases where the direction of the air motion is always the same, as in ventilating shafts of mines and buildings, wind vanes known as air meters are employed, and give satisfactory results.

Fuel level measurement:

Types of way use for level measurement

- Glass Level Gauge
- Floats
- Displacers
- Bubblers
- Differential Pressure Transmitters
- Magnetic Level Gauges
- Capacitance Transmitters
- Photocells

Photocells

Photocells act as light sensors. In-like infrared sensors that are good for line followers or detecting the presence of an object, photocells are good when you just want to detect light. For example, you might want a sensor that detects when a flashlight is on, or when the sun is out. Photocells are used in automatic night lights and in street lamps that turn themselves on at night. Sometimes known as photoresistors, photocells are available from a number of sources. They look like a small (0.5 to 2 inch) disk with two leads out the back. Radio Shack sells a multi-pak of cells for about $2.50 under part number 276-1657. A picture of one of the cells in this pack is shown below.

In operation, a photocell acts like a light sensitive resistor with a high resistance when dark and a low resistance when in the light. Photocell properties vary widely from model to model so you may have to do a lot of experimenting. You can test sensitivity to light by measuring the photocell resistance as you subject it to light and dark.

When using with a Arduino, the photocell is wired up in series with a fixed resistor so that the Arduino can read its output as a voltage. The schematic below shows the basic photocell circuit, except rather than digital I/O pin 1, connect to one of the analog input pins, for example analog pin 1 as shown, on the Arduino. The analog input pins are located on the other side of the board from the digital I/O pins.

Speed Measurement:

Tachometers for Engine Speed measurement:

Tachometers measure the engine speed in revolutions per minute (rpm). This instrument determines the rotational speed (how fast it's spinning) of a shaft or disk in the engine and displays the reading on a calibrated analog dial display on the dashboard of a car, aircraft or other vehicle. The display indicates a safe rpm range, which is meant to help the driver determine the best gear and throttle settings, and correct traveling speeds. Extended periods of high-speed travel, with excessive engine speeds, can lead to insufficient lubrication, an overheated engine because the cooling system can't keep up, and wear-and-tear on engine parts from going beyond their speed capacity.

The crankshaft, sometimes casually abbreviated to crank, is the part of an engine which translates reciprocating linear piston motion into rotation.

Torque measurement:

The device which are used for the measurement of torque are known as dynamometer.

The type of dynamometer which is used in our system is known as an electric dynamometer.

An electric dynamometer consists of three main components they are as follows.

1. Generator
2. Transformer/variac
3. Power absorbing device

The torque is applied by the engine in order to rotate the rotor of the generator. under off condition of the generator no power is supplied to the rotor winding's which no force or resistance to the rotation of the generator rotor.

In order to apply load on the engine shaft power is supplied to the input winding of the generator via variac/transformer which uses the electrical resistance property of its winding material to control the voltage and current which is being supplied to the input of the generator. the current and voltage which is being supplied is used to induce magnetism in the rotor winding which leads to production of ac current in the stator winding which is supplied to the power absorbing device or to the grid. The more the value of current and voltage is increased the more torque will be required to turn the rotor. The formula which can be derive for the above definition and concerned principle is

4. $$Torque = \frac{V * I}{1000}$$
5. Where,
6. V = DC voltage applied(voltmeter)(volts)
7. I = DC current applied(ammeter)(amperes)
8. Torque in N*M

Alternator Specification:

Kirloskar made AC Generator
Output: 10 KVA
Voltage: 230 volts A/C
Max. Current: 43.5 amps
Unity Power Factor
Frequency: 50 Hz
Rated Speed: 1500 Rpm

Variac (Continually Variable Single-Phase Auto Transformer)

Max. Voltage Input: 240 Volts A/C

Temperature measurement:

RTD (Resistance Temperature Detector)

RTDs work on a basic correlation between metals and temperature. As the temperature of a metal increases, the metal's resistance to the flow of electricity increases. Similarly, as the temperature of the RTD resistance element increases, the electrical resistance, measured in ohms (Ω), increases. RTD elements are commonly specified according to their resistance in ohms at zero degrees Celsius (0° C). The most common RTD specification is 100 Ω, which means that at 0° C the RTD element should demonstrate 100 Ω of resistance.

Water flow measurement:

Burette method: -

In order to measure the mass flow rate of water, a specific amount of water is measure in a container known as burette. The time for this collection is measured to find out the mass rate in lit/sec or lit/ min which can be converted into kg/ sec 0r kg/ min.

SETUP CONFIGURATION:

- **Float Switch**

  Hall Effect Transducer

- **Solenoid Valves**

  A} Fuel Control,
  Excitation Voltage: 12 V, DC, 8 Watt
  pressure: 10 bar

  B}. Water Control
  Excitation Voltage: 23. 0 V AC, 5 Watt
  Pressure: 12bar
  Input and Output Diameter: 1/4"

  C} Pneumatic Valves
  Excitation Voltage :230 V AC, 5 Watt
  Pressure: 6bar

- **Electro-mechanical Relays**

  Eexcitation voltage: 12 V @250 ma
  Output: 230 V AC @ 10 Amps

- **Transducers**

  Voltage Transducer
  Input: 0-300 V AC, 50 Hz
  Output: O-V DC
  Current Transducer
  Input: 0-5 Amps A/C, 50 Hz
  Output: O-S V. DC
  Current Transformer
  Ratio: 100 / 5 Amps, 50 Hz
  Anemometer
  Vane Type.
  Diameter: 65 mm
  Range: 0. 1 m/s - 10 m/s
  Opto Slot Sensor
  Type: Open Emitter
  Input: 15 V DC
  Output: 15 V DC

  Max. Voltage Output: 300 volts A/C
  Max. Input Current: 50 amps

- **SMPS**

  24 V 2A2
  12 V 3Amp

- **Relay Card**

  8 output *2 relay cards

- **Input Out Module**

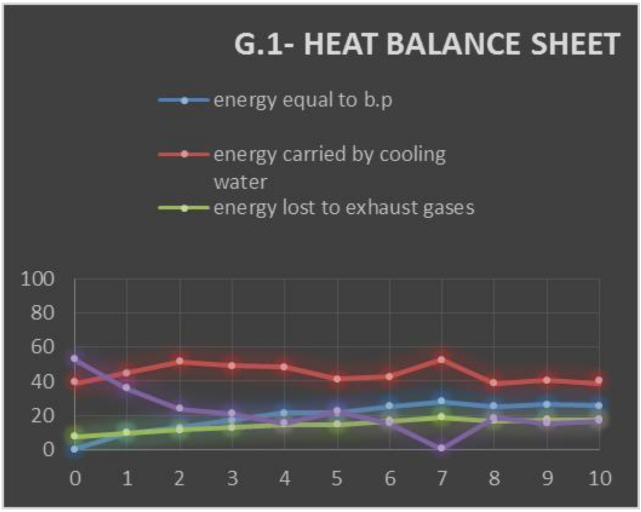
  MODEL: DVP16SP11R
  Provide Extended Input Output PLC CPU Model

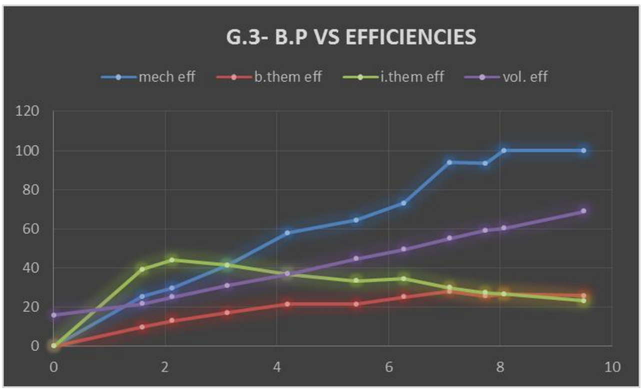
- **PLC**:

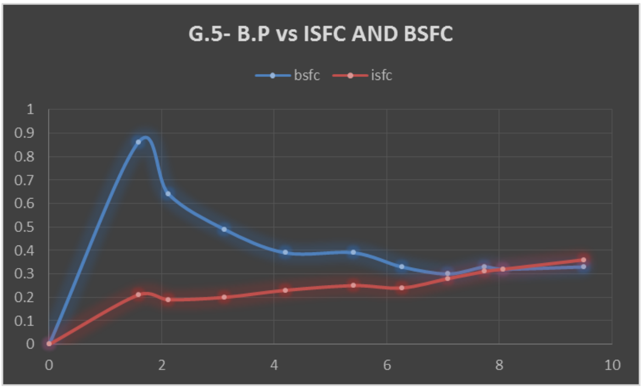
  14 SS2
  8 INPUT 8 OUTPUT
  8 INPUT 6 OUTPUT

TESTING RESULTS

Sr No.	Particulars	No Load	1	2	3	4	5	6	7	8	9	10
1	Speed (RPM)	1508	1505	1505	1500	1496	1508	1505	1507	1502	1496	1500
2	Load KW	0.01	1.56	2.16	3.13	4.09	5.44	6.22	7.15	7.68	8.02	9.47
3	Air Velocity (m/s)	1.32	1.8	2.1	2.58	3.06	3.73	4.12	4.58	4.85	5.01	5.74
4	Time Taken for 30 cc fuel (sec)	62.08	56.8	56.45	50.55	46.06	36.25	36.9	36.33	30.1	30.05	24.39
5	Time Taken for 5 lit. cooling water (sec)	203.81	158.78	140.08	133.14	124.47	113.32	106.66	88.11	98.86	95.41	33.26
6	Current Amp	0.24	18.51	21.83	26.28	29.84	34.19	36.48	39.02	40.44	41.17	40.64
7	Voltage V	0	84.5	98.97	119.02	137.02	159	170.5	183.15	189.87	194.88	212.08
8	Ambient Air Temperature c	27.32	29.04	27.96	28.5	27.01	27.68	27.8	29.04	27.43	28.5	27.22
9	Exhaust gas Temperature c	320.45	340.8	347.44	358.7	371.53	386.7	396.1	406.63	412.99	418.13	434.27
10	Cooling water inlet temperature c	26.29	26.44	25.55	26.12	26.25	26.43	26.01	25.86	25.99	26.37	26.58
11	Cooling water outlet temperature c	82.93	81.42	82.01	82.94	82.63	82.34	80.34	81.86	81.22	82.06	80.98







III. CONCLUSION

A four stroke four cylinder SI engine test rig is developed and experimentation is perform for blends of ethanol (0-10%) in order to determine the performance of engine for each blend. PLC is intergrated with the rig and the resul;t are tabulated.

The results clearly shows that the blend of ethanol with 10% give better engiune performance.

Based on the results it is concluded that increase in ethanol proportion boosted the performance of engine significantly. Further experiment can be carried out to determine the optimum blend of enthanol with the help og PLC and SCADA.

IV. REFERENCES

[1]. J. B.Heywood, Internal Combustion Engine Fundamentals, McGraw-Hill Inc, New York, 1988.

[2]. G. P. S. Kumarappa, "Improving the Performance of Two Stroke Spark Ignition Engine by Direct Electronic CNG Injection," Jordan Journal of Mechanical and Industrial Engineering, vol. 2, no. 4, p. 169 – 174, 2008.

[3]. R. Govindan, M. Govindaraju and Dr. K. Bharathiraja and Dr.K.R.Ramani, "Experimental Investigation of Embedded Controlled DieselEngine," Journal of Asian Scientific Research, vol. 2, no. 9, pp. 524-538.

[4]. M. Mastanaiah, "Performance of Electronic Fuel Injection System Using Compressor and Controller," International Journal of Advanced Engineering Research and Studies, vol. 2, no. 3, pp. 57-59, 2013

[5]. "Quarterly energy prices," March 2015. Online]. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/415778/qep_mar_15.pdf. Accessed 03 June 2015].

[6]. A. T. Ergenc and Deniz Özde Koca, "PLC controlled single cylinder diesel-LPG engine," Fuel, vol. 130, p. 273–278, 2014

[7]. E. Alfieri and Alois Amstutz and Lino Guzzella, "Gain-scheduledmodel-based feedback control of the air/fuel ratio in diesel engines,"Control Engineering Practice, vol. 17, p. 1417–1425, 2009.