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Development of SCADA System for Turbocharger Testing

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ABSTRACT: With expanding weight on the need to lessen CO2 emanations and fuel utilization, engine producers and vehicle integrators are searching for more radical approaches to build engine proficiency. One strategy is to draw vitality from various waste warmth sources. A turbocharger is a minimal and effective method for accomplishing this end and Cummins Turbo Technologies is working with various clients to create turbocharger items for particular applications. Testing of turbocharger becomes very essential to verify that vehicle equipped with turbocharger reduces engine emission and also increases engine efficiency. This paper gives insights on lab development for testing of Turbocharger wherein SCADA system will be developed for testing. This work is all about developing signal conditioning system, installing cyflex software and finally hardware software integration.

KEYWORDS: SCADA System, Turbocharger, CO2 emanation, Engine proficiency, cyflex software.

I. INTRODUCTION

CIL is India's managing producer of diesel engines alongside a scope from 15 kVA to 2000 kVA and worth packages assisting the power generation, manufacturing and automotive Markets. CIL's produce contain diesel and usual gas engines in the scope of 65 HP to 3,500 HP. It manufactures above 35,000 engines and gensets each annum and is amid India's biggest exporters of engineering products.

With expanding weight on the need to lessen CO2 emanations and fuel utilization, engine producers and vehicle integrators are searching for more radical approaches to build engine proficiency. One strategy is to join an auxiliary warmth recuperation framework to the engine, drawing vitality from various waste warmth sources. A turbocharger is a minimal and effective method for accomplishing this end and Cummins Turbo Technologies is working with various clients to create turbocharger items for particular applications. Turbochargers are one of numerous items produced in the war against contamination. Car makers, government offices, and ecological associations worried with contamination from car and truck fumes depend on turbochargers to diminish destructive discharges by expanding air admission to a vehicle's motor. To confirm that vehicles outfitted alongside turbochargers encounter these necessities, on and off road assessing is required. To empower far reaching item test and plan approval Cummins is going to outline and constructed a devoted test office. The establishment of this test cell speaks to a venture of over $1.5M and gives the ability to assess the thermodynamic execution and solidness of these fast small scale turbine gadgets. Outline of the office has brought various difficulties which incorporate the sheltered taking care of and dealing with the natural effect of utilizing natural liquids, estimation of force from little rapid turbines, dynamic control and operational security.

Initially in cummins OPTO 22 and Advantech's Data Acquisition System is used. Opto 22 delivers an expansive cluster of dependable, adaptable equipment and programming items for mechanical mechanization, remote checking, venture information securing, and machine-to-machine (M2M) applications [1]. The PAC Project Software Suite from Opto 22 gives the product that we requirement for modern computerization, remote observing, and information securing applications in any field. The PAC Project Software Suite from Opto 22 gives the product that we requirement for modern computerization, remote observing, and information securing applications in any field. PAC Control is a natural, flowchart-based programming and troubleshooting instrument for mechanical computerization, remote observing, and information

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procurement applications. Using PAC Control, can create, download, and run control programs on a SNAP PAC stand alone or on-the-rack controller [2].

Advantech proposals a expansive scope of I/O mechanisms alongside assorted interfaces and purposes established on PC knowledge, from ISA to USB, from gesture conditioning to graphical multimedia tools. Advantech's manufacturing I/O produce are affordable, and suitable for automation requests, such as T and M (Test and Measurement) and workshop requests like monitoring, domination, contraption automation and creation testing. Advantech furnish prop for Windows 7, Windows XP, Windows CE, and Linux and proposals graphic instruments to aid to use sketches in shorter time. ADAM-3000 Sequence encompass of the most cost-efficient, earth configurable, isolation-based, gesture conditioners. The modules can be installed to protect your instruments and procedure signals from the harmful results of earth loops, motor sound, and supplementary mechanical interferences [3].

But there are some parameters which were very critical for turbo charger test cell such as, maximum input frequency, frequency update rate, frequency resolution, data transfer rate, sensor failure notification. OPTO 22 and Advantech's DAS are not suitable for use. Because, High turbo speed update rate is required for safety and transient testing Accuracy of Turbo speed is very critical parameter of Turbocharger performance test cell, Inaccurate turbo speed will impact on wrong calculations and wrong information shared with Customer, High data transfer rate is required to store data on Hard drive and take safety actions fast to control emergency situation and sensor failure notification is required for Troubleshooting. This will directly give indication on failure of Sensor. So, new Data Acquisition System (DAS) is developed at Cummins Turbo Technologies which will fulfil these needs. This work deals with setting up a lab for testing of Turbocharger wherein SCADA system will be developed for testing. This project is about developing Enclosure boxes, installing cyflex software and finally hardware software integration.

Rest of the paper is organised as follows section II provides overview of basics of turbocharger and different types of test used for testing of turbocharger at Cummins. In section III, methodology is given. In section IV, use of PLC and its algorithm is given. And lastly in section V, results for hardware simulation is given.

II. TURBOCHARGER TESTING

I Basics of Turbocharger:

At the point when individuals discuss race autos or superior games autos, the theme of turbochargers more often than not comes up. Turbochargers likewise show up on vast diesel motors. A turbo can essentially help a motor's pull without altogether expanding its weight, which is the colossal advantage that makes turbos so mainstream.

- The air channel (not appeared) through which surrounding air goes before entering the compressor (1).
- The air is then compacted which raises the air's thickness (mass/unit volume) (2).
- Many turbocharged motors have a charge air cooler (otherwise known as intercooler) (3) that cools the compacted air to further expand its thickness and to build imperviousness to explosion.
- After going through the admission complex (4), the air enters the motor's chambers, which contain a settled volume. Since the air is at raised thickness, every chamber can attract an expanded mass stream rate of air. Higher air mass stream rate permits a higher fuel stream rate (with comparative air/fuel proportion). Combusting more fuel results in more power being created for a given size or relocation.
- Once fuel is burned, exhaust gases are passed from exhaust line (5).
- The high temperature gas then proceeds to the turbine (6). The turbine makes backpressure on the motor which implies motor fumes weight is higher than barometrical weight.
- At turbine, pressure and temperature drop is formed, which uses gases from exhaust to provide necessary energy to drive compressor (7).

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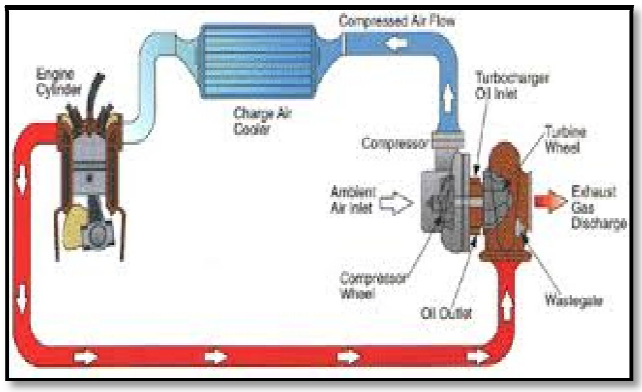

Figure 1. Working of Turbocharger

II Turbocharger Testing:

i) Endurance Test

Endurance test is carried out to check behavior of turbo when speed is continuously increasing and decreasing. This situation is seen when vehicle is traveled on road which has continuous up and down movement. In this test turbo is run at maximum speed for 5 min, then speed is decreased to lowest in just 3 min, again at low speed turbo is run for 5 min. This cycle is repeated 6 times. This test is done generally for few number of turbos to check lifetime of turbocharger in case of speed variation.

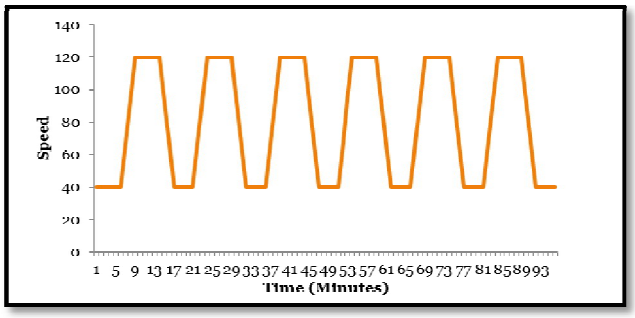

Figure 2. Endurance Test

ii) Hot Test

This test is called as production pass off testing or assembly testing. In this test turbo speed is increased to maximum and it is run at max speed for 3 min, then fuel supply for turbo is stopped and then turbo is allowed to cool down naturally. Each turbocharger has to pass this test before its use.

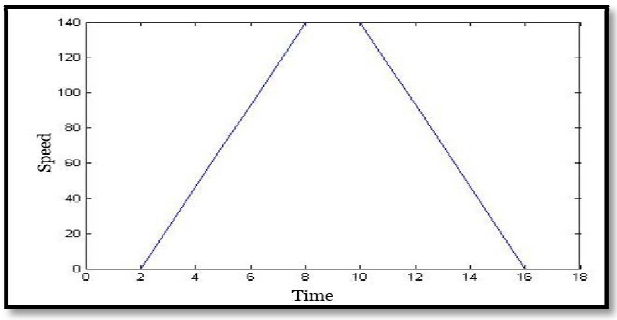

Figure 3. Hot Test

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iii) Hot Shut Down Test

This test is resembles to hot test with only one change. In hot test, fuel supply is turned off for turbocharger and it is allowed to cool down naturally. In hot shut down test, turbo is run at maximum speed for 3 min and after 3 min immediately, lube oil, fuel and air supply is stopped, even at that time turbo is running due to its inertia, which creates pressure on turbine housing. And also in this test, it is checked at what time turbo will stop after stopping it's all supplies.

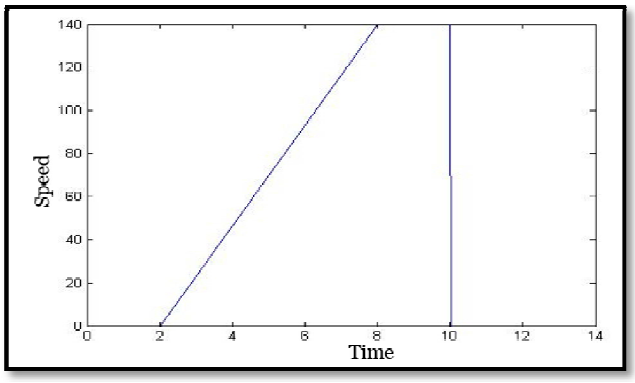

Figure 4. Hot Shut down Test

III. METHODOLOGY

In previous section, different types of testing used for turbocharger is given. we are going to develop SCADA system for testing of turbocharger. Figure 6 shows block diagram of proposed system. The principle cell control is a time critical system and information obtaining framework which can control all the running parameters of ongoing tests and log information. In addition to this, there is a safety PLC that observes for safety critical channels such as inlet, outlet temperatures, pressures and shaft speed as well as a gas leakage system. If any of these parameters goes beyond there safe limit then safety PLC shuts down the overall test cell. Secondary power supply is provided to ventilation system so that it will function continuously in case of leak even if test cell is shut down. In addition with the test cell safety, there is a Cyflex program running on a separate computer, which is used to show different pressure temperature plots for different items. This visual representation helps us to easily understand status of all parameters at a glance.

Here, Gantner modules are used for signal conditioning. These Gantner modules communicate to Cyflex system using Ethernet module i.e E-gate Dp. Cyflex system has scripts written for different tests given above and overall system is controlled using Safety PLC system. Safety PLC is responsible for initialization of test cell, then control is handed over to cyflex system. Cyflex system perform tests. Meanwhile, safety PLC is continuously monitoring safety critical parameters and shuts down test cell in case of any emergency.

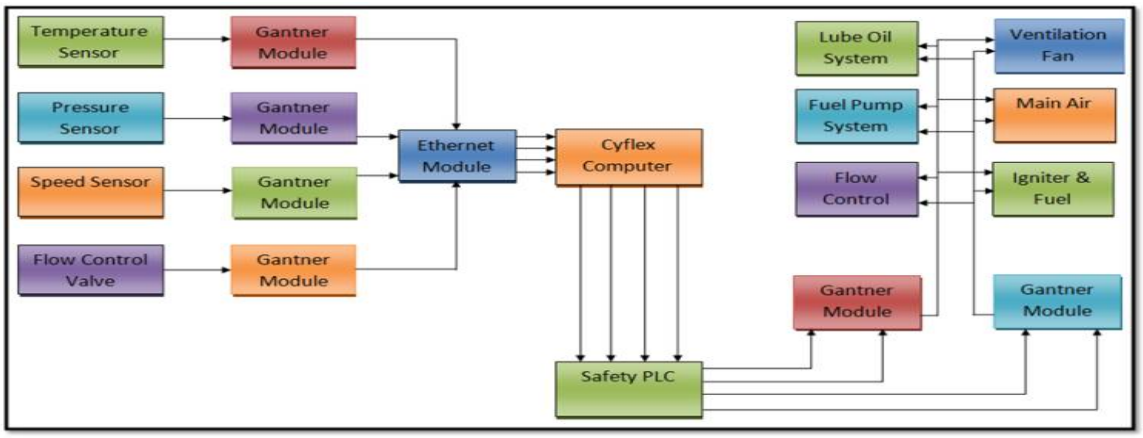

Figure 5. Block Diagram of Proposed System

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IV. SYSTEM WORKING

As seen in previous section, it is explained that PLC is used as a safety partner. It gets input from watch dog timer, Door Lock system and Power reset system. Depending upon input, it takes decision to run or stop system. Whole system works as follows:

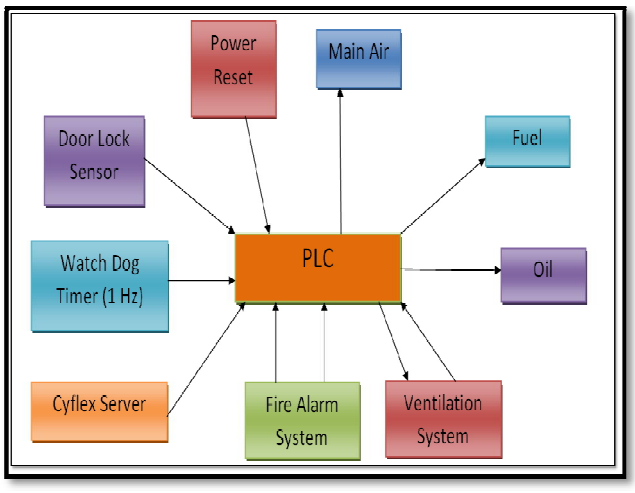

Figure 6. System Inputs and Outputs

1. PLC continuously gets 1 Hz clock pulse from watch dog timer when system is normally operating. It first check if pulse is coming or not. If yes then it checks for Doorlock system.

2. There are two types of interlock system for locking. First, there is door sensor to check for door is open or close. if door is open it checks for another key present at PLC. If both keys are there then only it starts next system, otherwise it waits in that state for key to be present.

3. Then it checks whether all modules are getting required supply voltage or not. If it is getting then only it starts next process, otherwise wait for all modules to get power supply.

4. Then it starts Lubrication oil and after 30 sec it starts main air supply and after that it starts oil supply.

5. Meanwhile it is continuously checks for signals from fire alarm system, There are two types of signal we are getting from fire alarm system, Smoke signal and Fire signal.

6. If smoke signal is there, then it performs soft shut down. It first stops Fuel supply then after 10 mins it stops main air supply and then 30sec later it stops oil supply. And system will be shut down after that.

7. If fire signal is there, then it performs hard shut down, It immediately stops all supplies and system will shut down.

8. PLC is also sending continuous ON/OFF signal to ventilation system and ventilation system sends feedback signal to PLC that it it operating.

V. RESULT AND DISCUSSION

There are total 12 electrical panels needed to build SCADA system. We have tested that hardware using Gantner Software. In results we are showing simulation of only one electrical panel. Figure 6, Shows picture of electrical panel and fig 2. Shows simulation result of that electrical panel.

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Figure 7. Electrical Panel

Figure 7 shows picture of electrical panel, it shows different sensors connected to electrical panel. This panels contains 6 pressure transducers, 14 temperature sensors and 2 speed sensor.

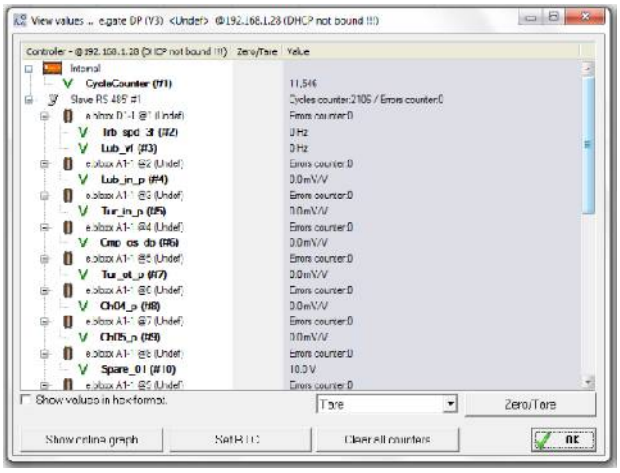

Figure 8a. Simulation result of electrical panel

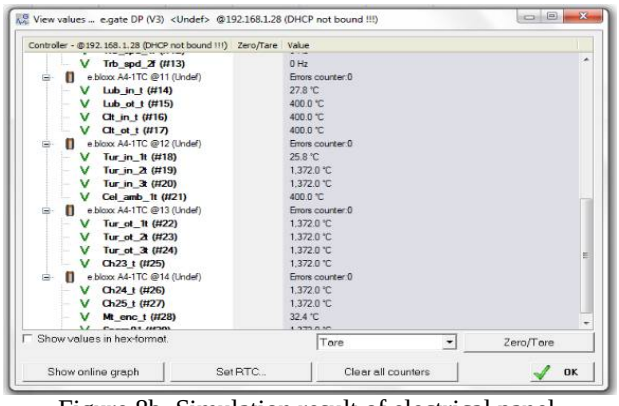

Figure 8b. Simulation result of electrical panel

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Figure 8a and 8b shows simulation result of electrical panel, there is a list of connected sensors and their corresponding values at that time. There is no pressure applied on pressure transducers so its showing value 0.0 mv, only one temperature sensor is connected i.e Tur_in_1t and it is showing room temperature 25.8°. Values of all physical parameters can be checked on this Gantner software. If this values goes beyond safety limit alarm generates and test cell shuts down.

VI. CONCLUSION

The new test facility is able to extract performance data from the turbine expander by controlling the turbine expansion ratio, turbine inlet temperature and shaft speed to predetermined points while logging data, just like a conventional turbine mapping cell for a turbocharger.

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