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Automated Engine Leak Detection with Advance Data Logging, Marking and Push-Up Mechanism

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Abstract

In this paper the automated application for detection of leak in 4-Stroke engine using air pressure, augmented by the direct data logging of the relevant data in system is discussed. Leak detection is a routine test performed on an engine before it is mounted onto the frame of a vehicle being built. However, the earlier procedure of conducting leak test suffers several demerits, depends on human capability and consumes much of the factory's productive time. To overcome these demerits we propose the application of absolute automation that would raise reliability of the process while speeding up data logging and retrieval of logged data significantly. The methodology for testing the engine leakage used is air pressure and the Visual basic software is used for logging the test results and other information like engine no., date of testing, employee ID, etc. Simultaneously at the end of shift all data will be automatically uploaded on the SAP and other database, which is then followed by operating the marking machine for the engines which are passed in the leak test or by operating the push-up mechanism for the engine which are failed in the leak test.

Keywords: Automated testing, bar code scanner, Data logging Software, Leak detection, marking machine, Pushup mechanism.

1. Introduction

Leak detection is a routine test performed on an engine [2] before it is mounted onto the frame of a vehicle being built. However, the earlier procedure of conducting leak test [1] [2] suffers several demerits, depends on human capability and consumes much of the factory's productive time. Also this makes it operationally hard to find at what time and in what shift the operator tested a certain engine and to quickly assess, for instance, the proportion of engines found defective. Conventionally, in most factories,

manual testing and data logging into SAP system requires designating a separate person for the task. This paper suggests the application of appropriate automation to overcome many of these demerits that affect test reliability as well as productivity. We propose suitable automation that would raise reliability of the process while speeding up data logging and retrieval significantly and pushing the defected engine back to the engine room. It cuts out the human operator while producing convenient, digitized, reliable and easily retrievable record of the engine leak testing step. This record would include engine identification, test results as well as operational productivity data also after the shift end the test data will automatically uploaded into the SAP system, company's data base and at the same time the hard copy of the test results of the shift will be automatically printed on the desk of the shift/floor manager.

2. System Model

This whole setup includes a conveyor belt, air pipe, a computer, a bar code scanner and a marking machine [1][2] and a push-up cylinder. Conveyor belt carry the engine on which the leak test is to be conducted, as soon as the belt carry the engines on a predefined position, an air pipe is placed at one of the point of engine i.e. inlet point from where we supply input air to the engine (an engine has two point one is for inlet and one is for outlet, as per its standard architecture) [3][4][5][6][7].Soon the air pipe is connected to the engine a predefined amount of air is supplied to the engine, this air will travel through engine's complete internal structure and comes out from the other point of engine i.e. outlet point. This out coming air again measured with help of measuring instruments. If the amount of supplied air and out coming air is same then it is declared that the engine has passed the leak test. Otherwise the engine is declared as faulty and sent back to the manufacturing unit for further inspection.

Once the test result is positive the software initiate the marking machine which put's a mark on tested engine and conveyor belt forward it for further processing of the vehicle frame, and if the test result is negative the software initiate the controller for pushing the engine back to the engine manufacturing department.

3. Working Principle

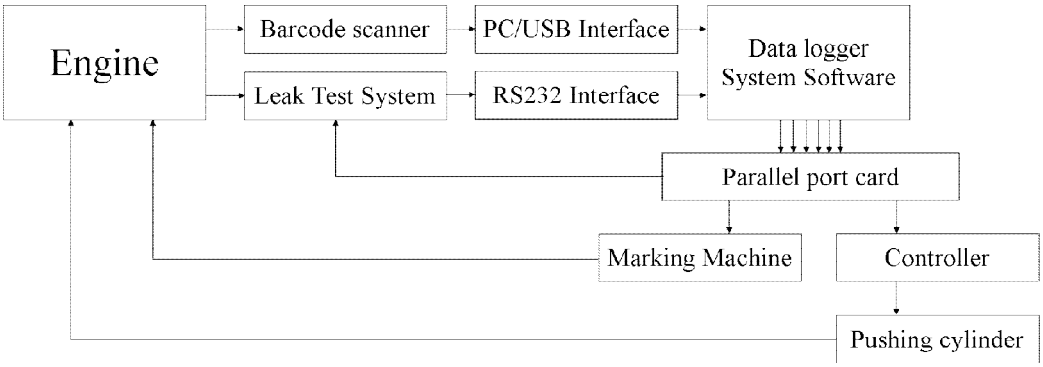


Fig. 1: Block Diagram of the System.

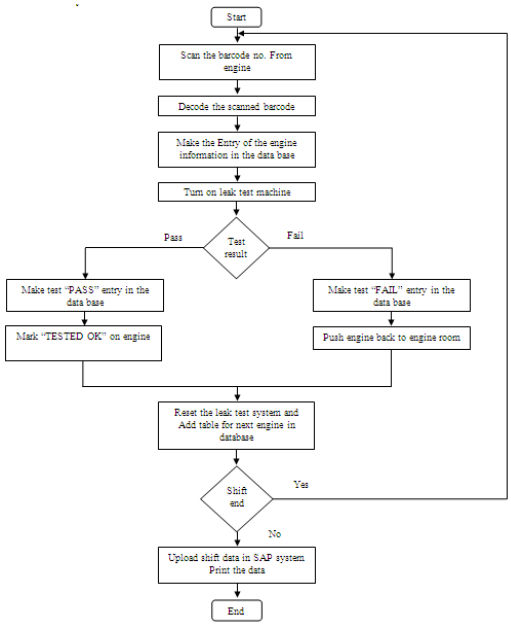
Engines which are to be tested are placed on engine assembly line (conveyor) which brings all engines at a predefined location where the leak test is to be performed. As the engine is arrived, bar code scanner will be activated and scanner will scan the barcode and transmit data to PC through USB interface. The database software Visual Basic® will decode the scanned information which consists of parameters like model number of engine, plant code, year code, month of manufacturing and serial number, etc. This will store this data in a data base. This data base also consists of parameters like engine data, identity of line man, shift number, time of testing and date of testing.

After scanning and decoding barcode, PC will send a signal to parallel port logic card to start leak test. Meanwhile, operator will place two air pipes on engine. Out of these two pipes one will carry predefined amount of pressurized air towards the engine. This pressurized air will travel through all sections of engine and come out from other end (as per standard design of engine it has two points, one is inlet and another is outlet), another pipe which is connected on outlet side will pass all the air to leak test machine, this system will compare the incoming and outgoing amount of air. If both amounts are same, then it will show a result indicating that test result is positive, otherwise test result is negative i.e. engine has a leak. Leak test system is connected to personal computer through the serial port RS232 to PC at the baud rate of 9600, using the pins- receive data, transmit data and ground of serial port which allow the transmission of 8-bit and which contains the result of leak test machine.

Data logger software i.e. Visual Basic® [9] [10] [11] will fetch the received data from hyper-terminal and store result into data base. With this data, it will update the engine test result, identity of line man, shift number, time of testing and date of testing.

Then PC will again send a signal to parallel port logic card to start the marking machine if the engine has passed in leak test or to start the push-up operation to push the defected engine back to engine room if the engine has failed in the leak test.

4. System Flow Chart



5. Process Cycle

The process cycle includes the actions such as

1. Clamp: Attaching the inlet and outlet pipes to the engine which takes the time of 5 seconds.
2. Fill: After clamping the 2 bar air is filled in the engine which takes the time of 5 seconds.
3. Stabilization: After filling the air into the engine it takes 2 seconds for stabilization.
4. Test: The engine testing takes the time of 5 seconds.
5. Dump: After testing operation the air of the engine is to be dumped i.e. removed it takes 5 seconds.
6. Marking or push-up operation: Final marking or pushup operation takes 5 seconds.

This total process of Engine Leak Detection and other operation is completed in 27 seconds.

The complete process cycle with respect to time and pressure is shown below.

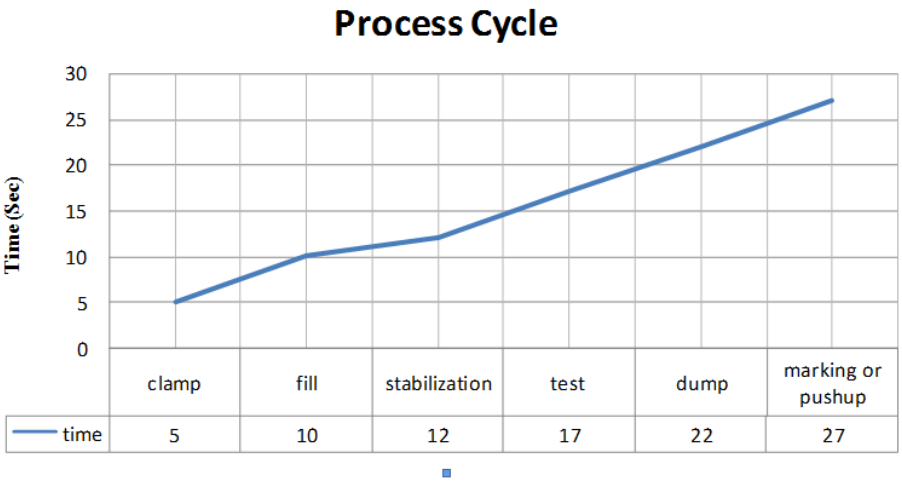


Fig. 3: Process cycle of engine leak detection system with respect to Time.

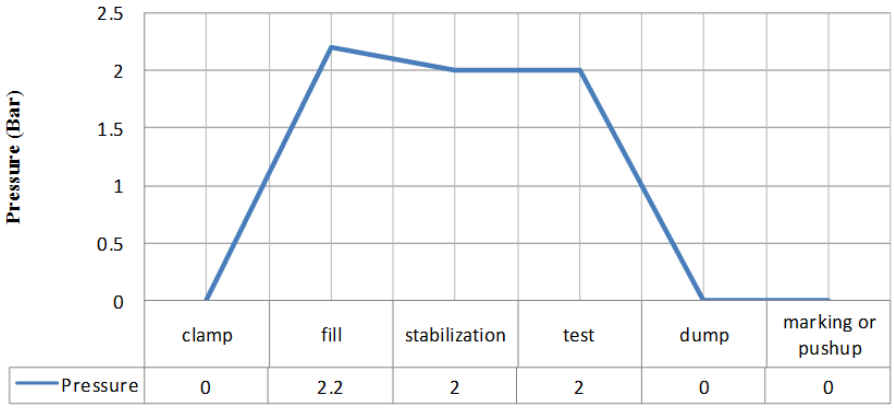


Fig. 4: Process cycle of engine leak detection system with respect to Pressure.

6. Leak Test Machine

Leak test system is heart of this project. Leak test system is designed using AT89C51 Microcontroller [13] [14] [15]. It is programmed in such a way that, when it receives positive/negative test result it will transmit a pass and fail signal respectively towards PC using serial communication. AT89C51, 8 bit micro controller is used for this purpose. The engine output pressure is sensed by the pressure switch. This pressure switch is set on a pressure of 2 bar [16][17]. Pressurized air is supplied to switch as soon as the range equal to 2 bar the switch will change position from normally closed [NC] to normally open [NO], hence a signal will transmit to microcontroller indicating that test result is positive.

When performing the test over an engine, pressurized air of 2 bar is supplied through inlet valve and this will travel through entire engine and comes out from outlet valve, then these inlet and outlet pressures are compared and when both are same, it is to be declare that engine has no leak and allowed for further processing.

When a pressure of less than 2 bar is supplied to pressure switch then switch will not change its contact position from NC to NO. Hence a signal will transmit to microcontroller indicating that test result is negative.

Operating Principle:-

The principle of operation is based on thermodynamics law of BOYLE-CHARLES stated in equation.1

$$\boldsymbol{P\,V\ =\ n\,R\,T} \text{ --------- (1)}$$

Where,

P: Test pressure

V: Test volume

n: Number of moles

R: Constant of air

T: Temperature

At a constant pressure and at a constant temperature volume of gas is constant.

7. Marking Machine

When the leak test machine delivers result i.e. the engine is pass or fail,it is stored in the data table of the software. The data table consists of date and time at which engine was tested as well as the engine prefix and engine result. We propose the use of a marking machine for marking the “TESTED OK” mark on the passed engine. A marking machine is a small temporary marker placed on a pneumatic cylinder’s rod which carries the marker towards the engine to put a mark. If the test result is positive the marking machine will mark “Tested OK” stamp on the engine and if the test result is negative the marking machine will not be operated.

8. Data Logger

In the existing leak detection and data logging system, the data is just produced in an excel sheet [1] and the floor assistant has to manually upload the data in SAP system

and take printout for maintaining the paper based record for office use. We propose some improvement in data logging technique in such a way that at the end of each shift, the produced excel sheet with all information i.e. test result, time of testing, identity of line man (employee code), shift number and date will be immediately uploaded in SAP system of the company so that the top level management will have an easy access to all these records, as well as at the same time a hard copy will be printed on the desk of floor manager for maintaining paper based record automatically. All these software is developed in Visual Basic® 6.0[9] [10] [11]. It shares the system data in terms of numeric data types as it is an event driven programming language.

9. Parallel Port and Serial Port Interface

A Parallel Port [12] of a desktop computer is used to communicate between desktop computer, marking machine, pushup controller and leak test system. As soon as scanning of bar code is complete the programmed software signals leak test system to perform the test by sending signal through the parallel port. Also if the test is successful then a signal to start marking machine is sent on the different port of parallel interface and if the test is failed then a signal to start pushup controller is sent on the different port of parallel interface. The result of leak test system i.e. pass or fail is given to software via serial port [12] of the computer by establishing a serial communication between the microcontroller used in leak test machine and computer at the baud rate of 9600 bauds/sec [13] [14] [15].

10.Pushup Mechanism

Existing system does not pull out the defected engine from the main conveyor if the leak test of the engine is negative then the system generates an alert that the engine has a leak and the line man has to monitor that alert continuously and take the defected engine out of the line manually [1]. We propose the automated technique to push the defected engine back to the engine for testing the nature of leak and removing it. For this push-up operation, a pneumatic cylinder is used. When the leak test machine generates a negative output the computer will send the signal to the push-up controller to push the respective engine back to the engine room conveyor. When the push-up controller gets the signal from the computer, the push-up cylinder will fire a stroke and the respective engine will be automatically removed from main line which is moving towards the assembly line.

11.Conclusion

After implementation of this set we observed that whole above stated process is completed within 27 seconds. And due to the advancement in data logging software, data regarding the engine which is available instantly also can be monitored centrally. Also use of Visual Basic® ensures data maintenance and retrieval is easy. This data easily get connected with SAP system and at the end of each shift, how many engines were tested, how much have passed the test, identity of lineman and other parameters will be easily retrieved. At the same time the hard copy will also be maintained which will be helpful for analysis of results to increase the production rate . Also a single

person is able to perform the entire task which ends in cost saving of two people, which in turn reduces production cost and the defected engines are also able to be send back to the engine room at the same time for repairing which ensures the increase in productivity.

12. Acknowledgment

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