I J C T A, 9(9), 2016, pp. 4081-4091

An Automated Data Flow Monitoring Scheme for Electro Static Precipitators

G. Saravana Kumar[1], S. Sudhakar[2], S. Sivaranjani[3] and P. V. Sandhiya[4]

ABSTRACT

Electro Static Precipitators are percolation systems to confiscate miniscule pollutant particles, from a streaming gas by inducing electrical charges. The efficacy of the ESP depends upon continuous monitoring of field data and it shall be accomplished byestablishing an effective communication link establishment between ESP and Control section. This paper, aspires to design and implement an automateddata flow monitoring scheme for electrostatic precipitator controller fields. The proposed scheme develops a third device or monitoring system, which checks and analyzes the data in ESP controller. The ESP controller transmits the data (i.e., frames) via RF transmitter in the form of commands and response is received by the RF receiver. In the receiver section the transmitted frame is split in to packets. The packets are stored in a data base system This paper implementsa monitoring system to check and analyze whether the ESP transmitted data reaches the receiver correctly through RS232 serial port and also to design a page which shows the status of each ESP field in pc base system.

Keywords: ESP controller; RS232/RS485 Serial Port; Database; Data

1. INTRODUCTION

Electrostatic Precipitator [7] is a filtration device that removes fine particles, like dust and smoke, from a flowing gas using the force of an induced electrostatic charge minimally impeding the flow of gases through the unit. The smoke which comes out is purified by the ESP before leaving it to the atmosphere via long chimneys. Now days, pollution has become a serious issue in the world, particularly Air pollution. Smoke, dust from industries, power plants is very harmful to the environment. It is important to purify the smoke before leaving it to the atmosphere. Electrostatic Precipitator serves this purpose well. ESP has many controllers and fields. It is important to monitor that field's working. For this purpose, we are using the radio frequency i.e., wireless network analyzer for transmitting and receiving the data. Radio frequency (RF) [10] is any of the electromagnetic wave frequencies that lie in the range extending from around 3 kHz to 300 GHz, which include those frequencies used for communications or radar signals. RF usually refers to electrical rather than mechanical oscillations. RF is the wireless transmission of data by digital radio signals at a particular frequency. RF communication works by creating electromagnetic waves at a source and being able to send the electromagnetic waves at a particular destination. These electromagnetic waves travel through the air at near the speed of light. The advantages of a RF communication is it is wireless, you don't have to use cable. Cable is expensive, less flexible than RF coverage and is prone to damage. It provides extensive hardware support for packet handling, data buffering, burst transmissions, clear channel assessment, and link quality. A packet analyzer (also known as a network analyzer, protocol analyzer or packet sniffer or, for particular types of networks, an Ethernet sniffer or wireless sniffer) is a computer program or piece of computer hardware that can intercept and log traffic that passes over a digital network or part of a network [13]. As data [18] streams flow across the network, the sniffer captures

[1] Dean & Professor, *Email: g.saravanakumar@velhightech.com*

[2] Assistant Professor, *Email: sudhakars106@gmail.com*

[3, 4] Student, Department of Electronics and Communication Engineering, Vel Tech High Tech Dr. Rangarajan Dr. Sakunthala Engineering College, Chennai. India, *Emails: ranjaniteena@gmail.com, pvsandhaya1994@gmail.com*

each packet and, if needed, decodes the packet's raw data, showing the values of various fields in the packet, and analyzes its content according to the appropriate RFC or other specifications. Packet capture is the process of intercepting and logging traffic.

2. SYSTEM DESIGN

The aim of this system is to transform manual management system to automatic system with the help of Microsoft visual studio 2010 software [15].Vb.Net is the implementation language for this system. ESP Controller have many fields, each field have frame of binary data like command and response which is nothing but its temperature, pressure changes etc,. which is transmitted in radio frequency (2.4 GHZ, ISM).ESP transmitter transmits frames to RF Receiver by wireless or air medium. RF [11]receiver receives binary data, then convert binary data into ASCII (American Standard Code For Information Interchange) codes using ADR112 serial data acquisition interface, because ASCII code represent text in computer and any communication equipment. This ASCII code is converted into PC understandable language via RS232/ RS485 serial port and also serial port split transmitting frames into packets. Microsoft visual studio 2010 professional is used to develop the third device to check and analyze whether the ESP transmitted data reaches the receiver correctly through RS232 serial port and also to design a page which shows the status of each ESP field in PC base system.

3. SYSTEM ARCHITECTURE

3.1. Electrostatic Precipitator Controller

Electrostatic Precipitator [8] is a filtration device that removes fine particles, like dust and smoke, from a flowing gas using the force of an induced electrostatic charge minimally impeding the flow of gases through the unit.

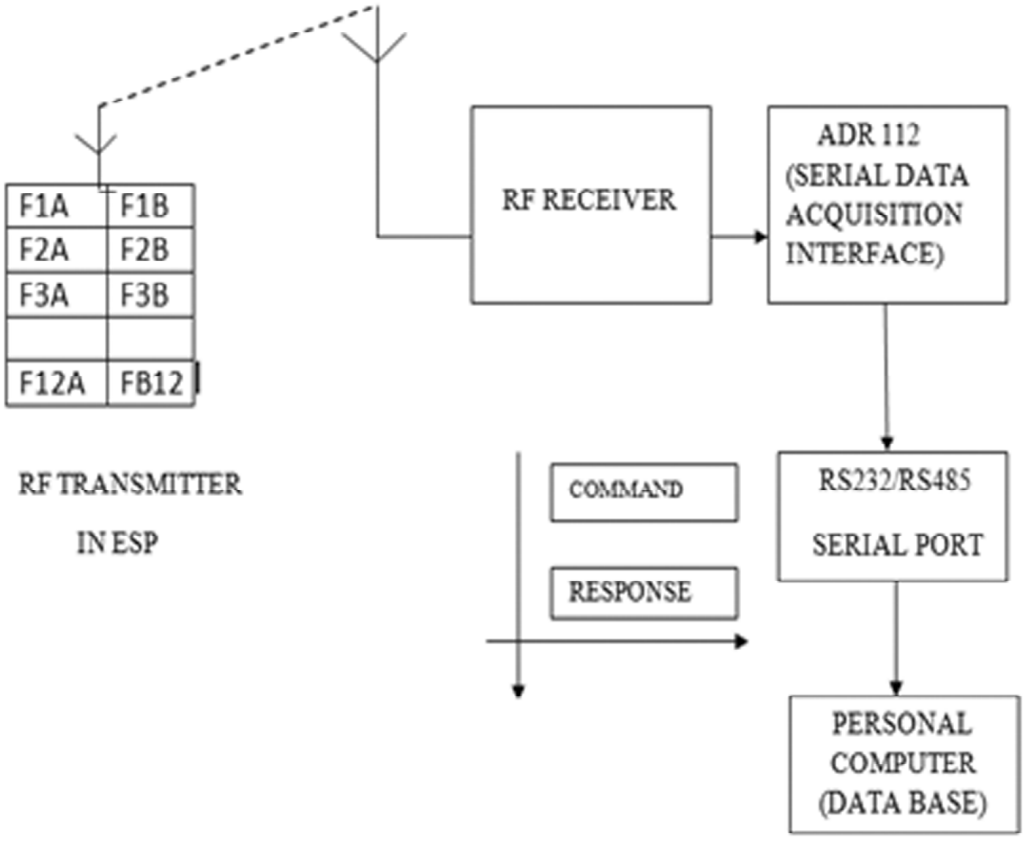

Figure 1: Block diagram of the ESP Controller Data Transmission and Reception.

The principle components of an electrostatic precipitator (ESP) are two sets of electrodes insulated from insulated from each other. The first set is composed of row of electrodes. Between which the dust-laden gas flows.

The second set of electrodes consists of wires, called the discharge or emitting electrodes that are centrally located between each pair of parallel plates. The wires carry unidirectional negatively charged high-voltage (between 20 and 100 KV) current from an external dc source. The applied high voltage generates a unidirectional, non-uniform electrical field whose magnitude is greatest near the discharge electrodes. When the voltage is high enough, a blue luminous glow, called corona, is produced around them. Electrically forces in the corona accelerate the free electrons present in the gas so that they ions. The new electrons create again more free electrons and ions, which results in a chain reaction.

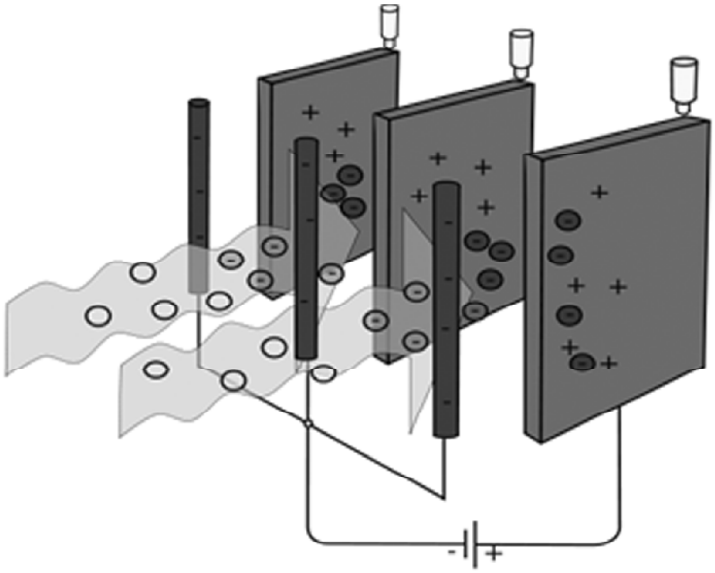

Figure 2: Conceptual Diagram of an ESP.

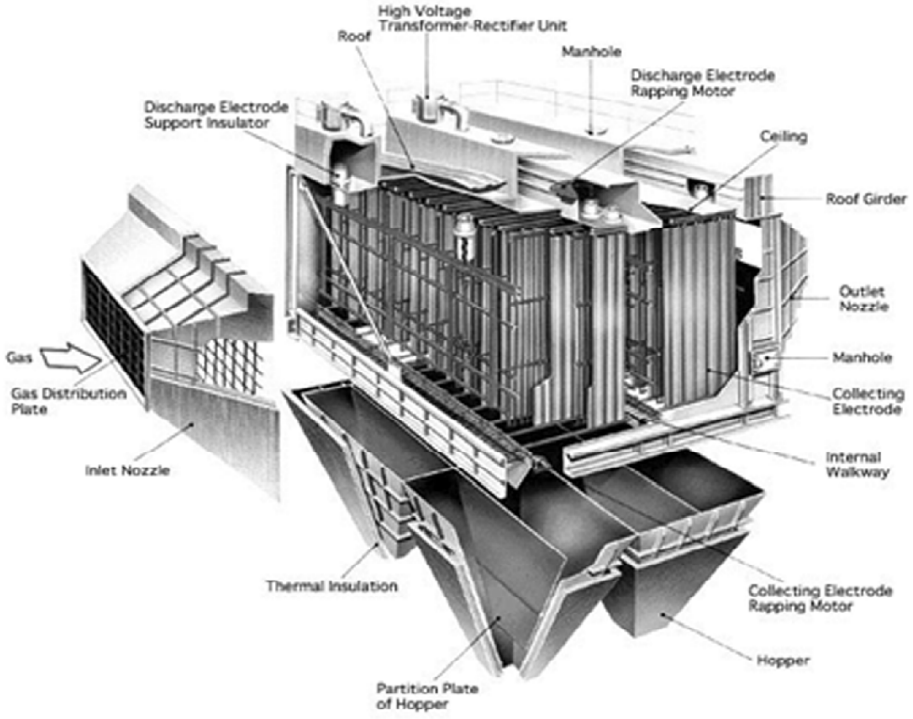

Figure 3: Internal Structure of ESP Controller.

The positive ions travel to the negatively charged wire electrodes [9]. The electron follow the electrical field toward the grounded electrodes, but their velocity decreases as they move way from the corona region around the wire electrodes towards the grounded plates. Gas molecules capture the low velocity electrons and become negative ions. As these ions move to the collecting electrodes, they collide with the fly ash particles [21] are driven to the collecting plate by the force, which is proportional to the product of this charge and the strength of the electric field.

When the particles collect on the grounded plates, they lose their charge on the ground [19]. The electrical resistivity of the particles however causes only the partial discharge and the retained charge tends to hold the particles to the plate. High resistivity causes retention of most of the charge, which increases the force holding the particles to the plates and makes the removal more difficult. This can rectified either by operating a high gas temperature (before APH) or by superimposing a high voltage pulse on the base voltage to enhances ESP performance during operating under high resistivity conditions.

Collected particulate matter must be removed from the collecting plates on a regular schedule to ensure efficient [20] collector operation. Removal is usually accomplished by a mechanical hammer scrapping system. The vibration knocks the particulate matter off the collecting plates and into a hopper at the bottom of the precipitator.

3.2. RF Transmitter and RF Receiver

ESP controller have many fields, each fields have one transmitter which transmits frame of binary data like commands and response which is nothing but temperature and pressure changes in radio frequency (2.4GHZ, ISM). The radio frequency transmitted [10] frames are received by radio frequency receiver in wireless or air medium.

3.3. ADR112 Serial Data Acquisition System

The received binary data is converting into ASCII (American Standard Code For Information Interchange) codes using ADR112 [16] Serial data acquisition interface.

3.4. Serial Port RS232/RS485

These ASCII codes are converting into PC understandable language via RS232/RS485 serial port. This serial port RS232/RS485[17] splits the transmitting frames into packets.

3.5. Host Computer

Host Computer[4] or PC provides an interface between serial port RS232/RS485 and application based system, which is the brain of database system. In PC using Microsoft visual studio 2010 professional we

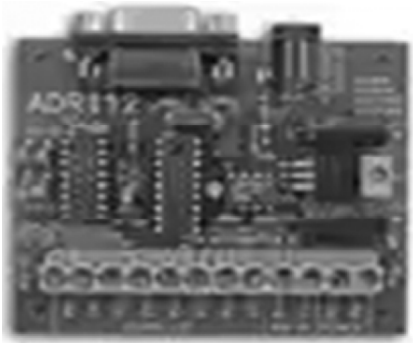

Figure 4: ADR112 Serial Data Acquisition System.

Figure 5: Serial Port RS232.

develop the third device or monitoring system to check and analyze whether the ESP transmitted data reaches the receiver correctly through RS232 serial port and also to design a page which shows the status of each ESP field in PC base system.

4. SOFTWARE DESIGN

This system is used to transform manual management system to automatic system with the help of Microsoft visual studio 2010 software.Vb.Net is the implementation language for this system.

4.1. Microsoft Visual Studio

Microsoft Visual Studio[17] is an integrated development environment (IDE) from Microsoft. It is used to develop computer programs for Microsoft Windows super family of operating systems, as well as web sites, web applications and web services. Visual Studio uses Microsoft software development platforms such as Windows API, Windows Forms applications, Windows Presentation Foundation and Windows Store. This IDE can connect with database by using query language. The. Net language is used to write the program.

4.2. Flow Chart of the System

The system can be recognized easily by seeing the flow chart of the overall system shown in figure 6 and 7.

The first flow chart consists of a serial port connection for which the settings are made as mentioned Baud rate = 9.6, Number of bits =1, parity = none, stop bits = 1. Based on the serial port settings the

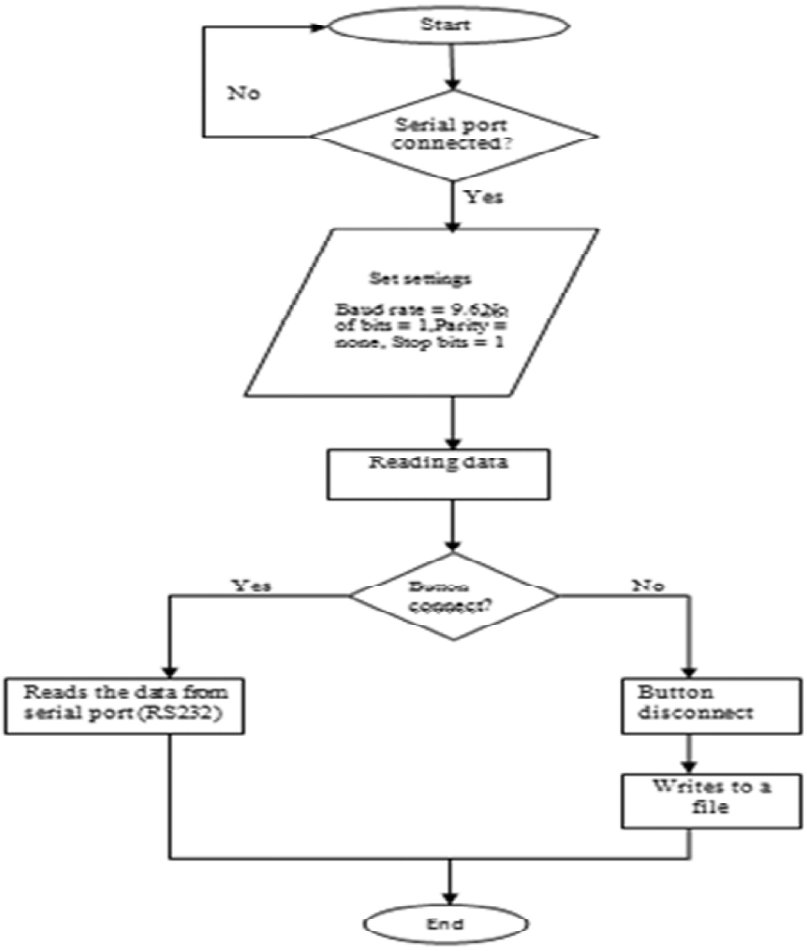

Figure 6: Flowchart Representing Reading Data from Serial Port

corresponding comport is selected and the data is read from particular comport. When the button is connected then the data is read from RS232 serial port. When the button is disconnected, serial port stop reading the data and store those data in particular file.

The second flow chart represents the status of ESP controller, in this the serial port starts reading the data from each ESP controller fields. Totally it have three status, base on this status the color of the field is changed automatically. Those statuses are

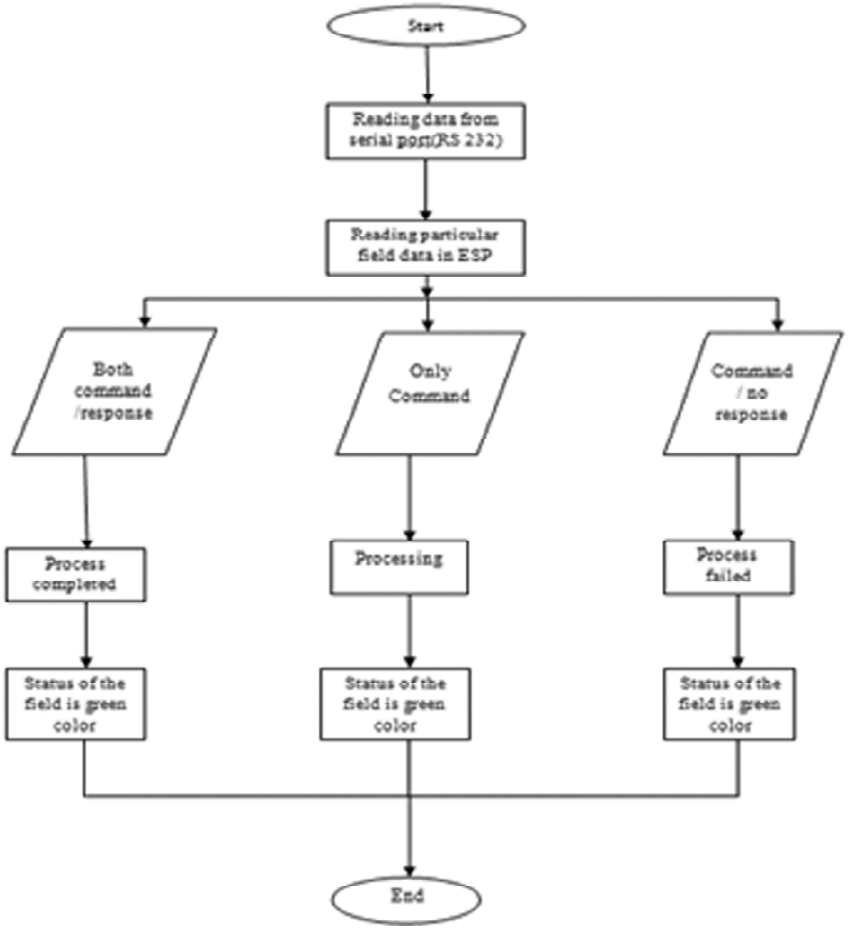

Figure 7: Flowchart representing the status of ESP fields.

5. EXPERIMENTAL RESULT

In this experimental result, ADR112 serial data acquisition system and RS232 serial port are used for reading data. The host computer with Microsoft Visual Studio is needed

The figure 8 is the form structure where we set port setting. Based on the serial port settings the corresponding comport is selected and the data are read from particular comport. When the button is connect then serial port start reading the data from RS232 serial port. When the button is disconnected serial port stop reading the data from serial port and store those data in particular file.

Fig 9 shown is the form structure for reading data from serial port, where particular comport and baud rate is selected, then button is clicked, all the serial port date are shown in received data's rich text box, when button disconnect is clicked the received date will copy to file that is shown in fig. 9.

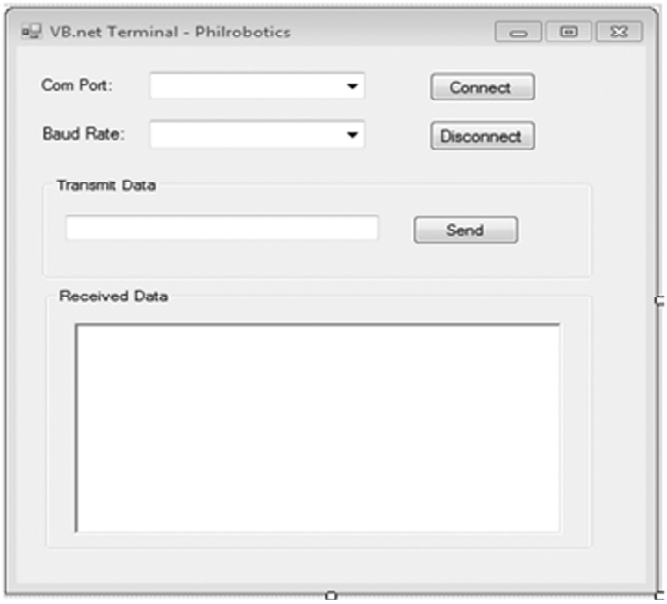

Figure 8: Form Structure for Reading Data from serial port.

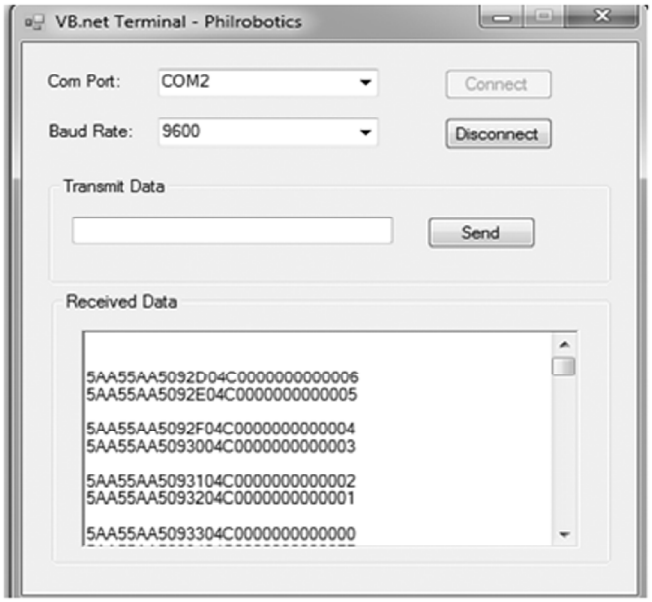

Figure 9: Form structure for button connect

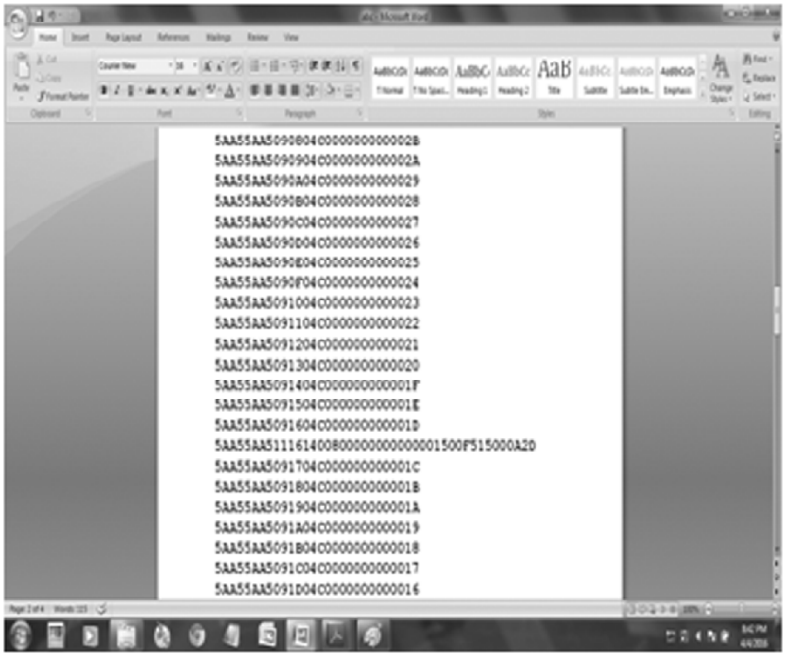

Figure 10: Snop shot of writing data in file

The data details are given below

5AA55AA5091604C000000000001D-Command

5AA55AA5111614008000000000000001500F515000A2D – Reply

Command Description

1-4 Preambles (5AA55AA5)
5 Length (09)
6 Controller Address (16)
7 Frame Code (04)
8 Controller Digital Control 1 (C0)
9 Controller Digital Control 2 (00)
10 Current Limit (00)
11 Charge Ratio (00)
12 Base Charge Set (01)

Reply Description

0-1 Same (5aa55aa51116140080000000000)
13 Optimizer Repeat Time (00)
14 Spare (15)
15 Spare (00)
16 Checksum (F515000A2D)

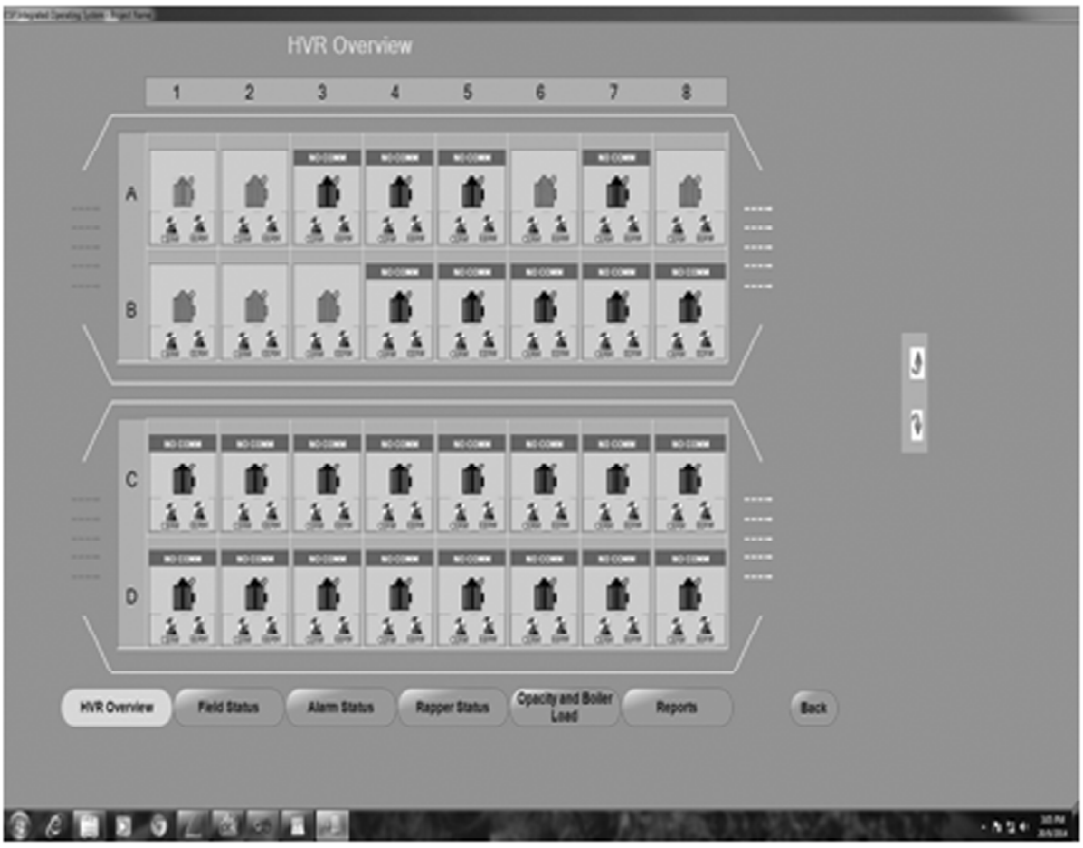

Figure 11: Status of the each ESP Controller

Fig. 11 shown is the status of the each ESP Controller, in this each field have some particular binary data like command and response, based on this data status of the field is of three types

- **First**-Both command and response state-In this command is transmitted and response is received by ESP field which is called as process completed state
- **Second**-only command-In this command is transmitted and waiting for response by receiver in the ESP Field which is called as processing state
- **Third**-command and no response state-In this command is transmitted and no response is received by ESP Field which is called as process failed state

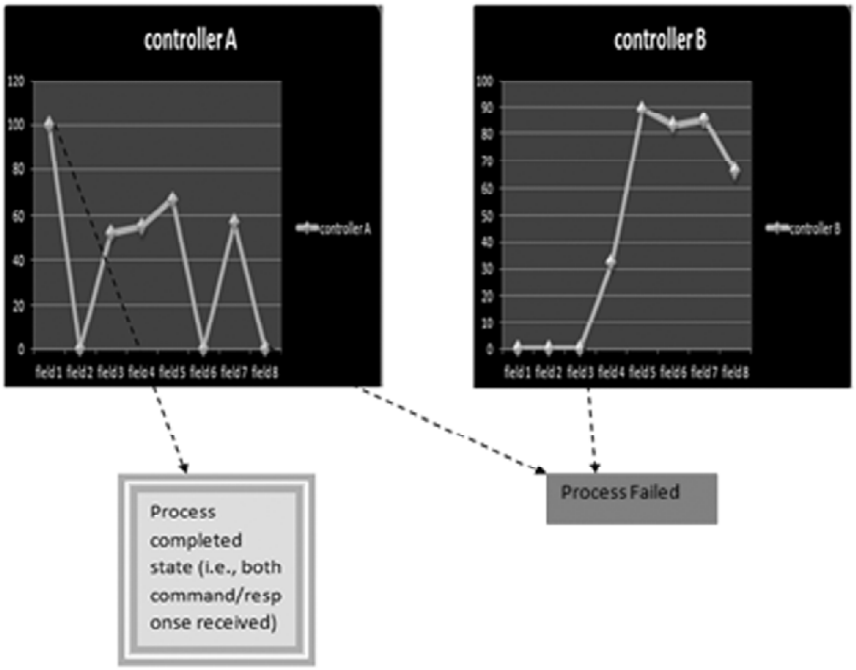

Figure 12: Graph representing status of ESP Controller A, B

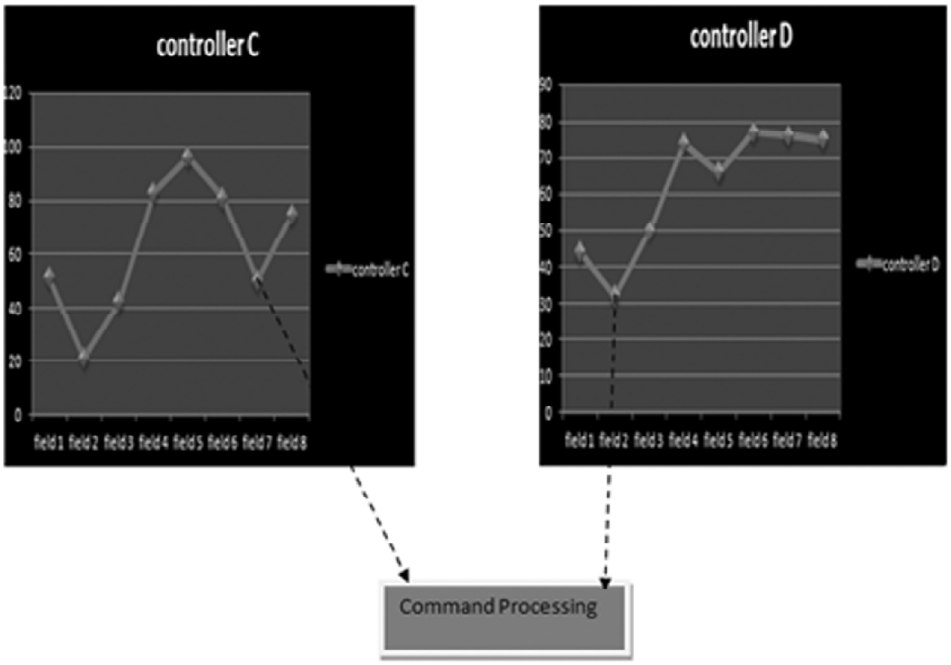

Figure 13: Graph representing status of ESP Controller C, D

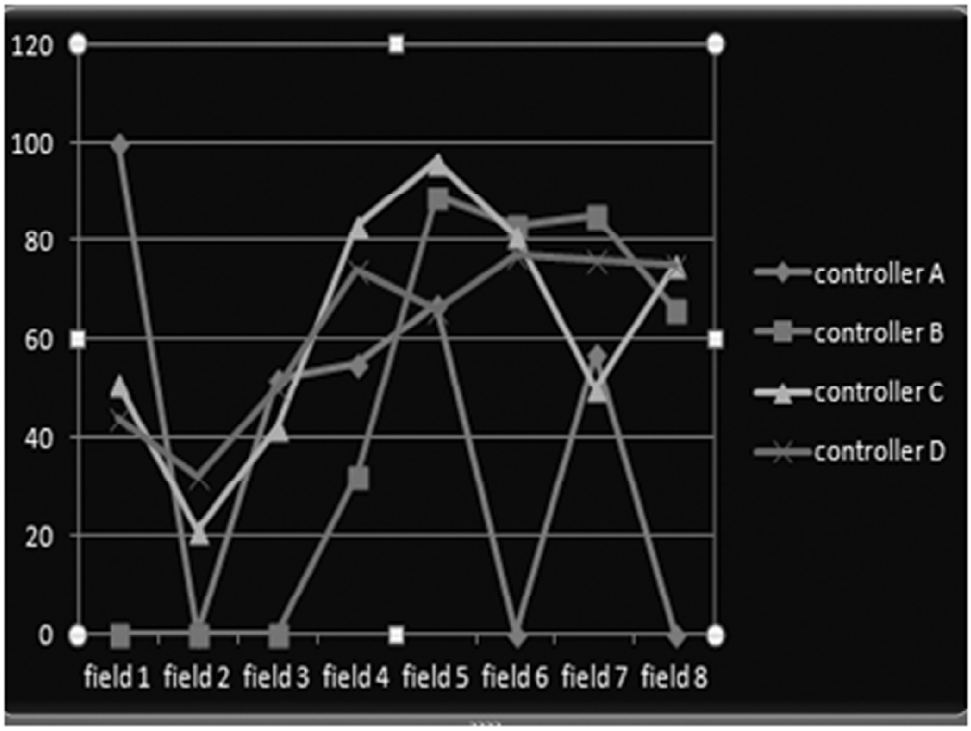

Figure 14: Graph representing status of overall ESP Controller

6. CONCLUSION

In conclusion, this system mainly reviewed the research and development work with the help of ESP, ADR112 Serial Data Acquisition Interface and RS232 Serial Port. By developing this monitoring system, the knowledge of ESP Controller, RS232 Serial Port and the database construction using. Net language are realized. In terms of performance and efficiency, this system has provided a convenient method of data base monitoring system. By using databases, the data is more organized. For this system, thus we developed the third device to check and analyze whether the ESP transmitted data reaches the receiver correctly through RS232 serial port and designed a page which shows the status of each ESP field in PC base system.

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