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Study and Implementation of Automation in Corex Plant

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Abstract: Automation and control of Corex process in steel plant is presently adopted through cables. The parameters like temperature, pressure, flow, level etc are to be measured using sensors and transmitted these analog signals to main control room by compensating wires and special cables through a long distance, Due to excessive heat and dust around the corex furnace results in burning and damage of cables which brings severe problems such as high cost, low reliability and maintenance difficulty.

The automation will incorporate advance monitoring and control that improve operations and system reliability. The concept present in this paper includes the study and implementation of wireless monitoring and control system for Corex plant through Radio Frequency (RF) signals and Bluetooth device.

The automation process Test module was designed and used for testing practical existing system of Corex process of JSW steels, Toranagallu, Karnataka, India. The proposed algorithm was designed for automation of Corex plant in NI LabVIEW simulator and Ardinuo, then same to be interfaced with field instruments using My DAQ device and Radio Frequency (RF) and Bluetooth wireless modules.

Key Words: Wireless; RF module; temperature sensors; Corex plant; automation; ardinuo:, Bluetooth; LabVIEW.

I. INTRODUCTION

Automation is a very important section in the steel industries and plays a major role in the growth of production and services. In order to extend the life span of Corex process of steel plant and ensure safety, it is essential to monitor the parameters of major procces or part of the Corex plant.

At present the Jindal South West (JSW) steels ltd, corex plant is using the Distributed Control system (DCS) for automation in Iron production. Automation system mainly carried out through wires or cables from furnace to control room and vice versa for communication, data acquisition and to control the field devices. To monitor various parameters of Corex, thousands of field instruments are used.

In such Plant measurements of process parameters is very essential to prolong the life of the furnace and to improve the production qality, reliability. Measurement parameters may be such as level, flow, temperature, pressure around the Corex plant. The main control room collects the analog and digital signals of each instruments distributed in the furnace by using large amount of special cables or compensating wires. The complicated wires near the corex process would be damaged inevitably by heat and corrosive dust around the corex plant [1].

Employing wireless automation modules instead of wires or cables for transmission and reception of both analog and digital signals which controls the entire process or part of corex process will results in reliable and secured operations and it also keeps away from the abnormal conditions.

An enormous development in wireless technology will helps in selection of suitable wireless communication system which ever capable of operating effectively, withstanding and adjusting for the operating conditions in Industries/factory environment with improved quality and reliability of the system. Depending upon the exact application requirements wireless system has to be considered carefully. Some of the wireless modules which can be adopted for wireless technology includes IEEE802.15.1/Bluetooth, IEEE802.15.4/Zigbee,IEEE802.11,Radio frequency modules etc. Extensive use of wireless technologies have some benefits in process automation, such as saving in cost, Resiliency and safety, improved reliability, improved in quality of production etc.

This paper presents the development and application of such wireless system for Test type module and also attempts to explain how effectively wireless technology can be adopted to industries like corex plant. Test module employs Bluetooth and Radio frequency wireless modules, interfaced with ardinuo and LabVIEW simulator 2012. The Test module is tested for both wired and wireless modules; Results are tabulated to make an discussion. Separate programming modules will be developed for each cases i.e., wired and wireless systems with the help of LabVIEW simulator. References data's are collected to design the Test module by means of Case study of particular part or process of the corex plant.

Test module analog and digital signals such as water level, temperature, motor On/off, valve open/closed etc are displayed on the LabVIEW simulator, continuously monitored and controlled to get an desired operation of the experimental module.

II. SYSTEM UNDER TEST

For experimental test, one of the subsystems of corex plant called TG scrubber has been consider and Test type module designed as shown in fig.1 below. The required data's gathered through a case study from Jsw steels, corex plant, Toranagallu. , All the system operation and controls are simulated using LabVIEW simulator 2012 and wireless signals communication established with the help of 433Mhz Radio frequency and Bluetooth module. The test module consist of scrubber, cold water pond, clarifier, flare stack, Gas holder and cooling tower with suitable hardware and software components. The Real system case study details are attached in the appendix-1.

Fig.1: Test system

III. SYSTEM DESCRIPTION

A. Proposed Automation

The experimental module deigned is tested for the two cases are as follows.

1) For Wireless system an

2) For Wired system.

Both cases are explained briefly in the below

B. For Wireless System

Fig.2 shows the experimental module block diagram for wireless communication. It consists of Field instruments such as valves, motors, temperature sensor and level sensors etc, wireless network, data acquisition kit and LabVIEW simulator to monitor and control the parameters of the Test module . Wireless network used in this project are RF and Bluetooth modules. RF module has been installed to communicate with field instruments by means of LabVIEW simulator through an NI MY DAQ kit. Similarly, for some analog sensors, ardinuo uno R3, Bluetooth and LabVIEW simulator are used. Ardinuo Sketches for temperature sensor and level sensors are written and uploaded to an ardinuo uno R3 kit.

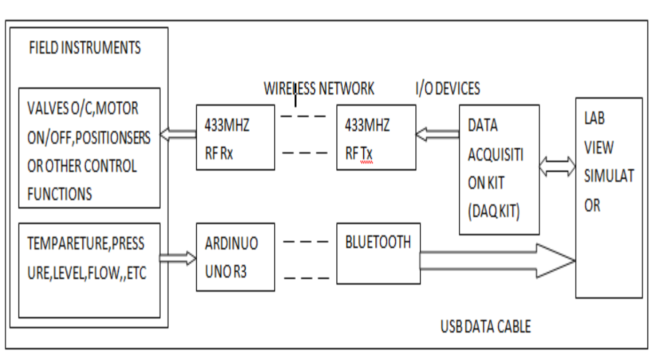


Fig. 2: Test system block diagram for wireless communication.

Wireless modules have interfaced with LabVIEW simulator to communicate and monitor field instruments with computer

C. For Wired System

Test module has been checked under wired condition for same algorithm, all the instruments in the Test module are connected directly to an My DAQ system as shown in below figure.3 and communicated both analog and digitals to an LabVIEW, all the operations checked such as acquired measurement data like temperature and level for different values, motor on/off, valve open/close, buzzer operation during level abnormality has been checked according to flow chart figure.3, all the conditions are working perfectly, temperature and level data's are tabulated during that particular time to compare those with wireless data transmission.

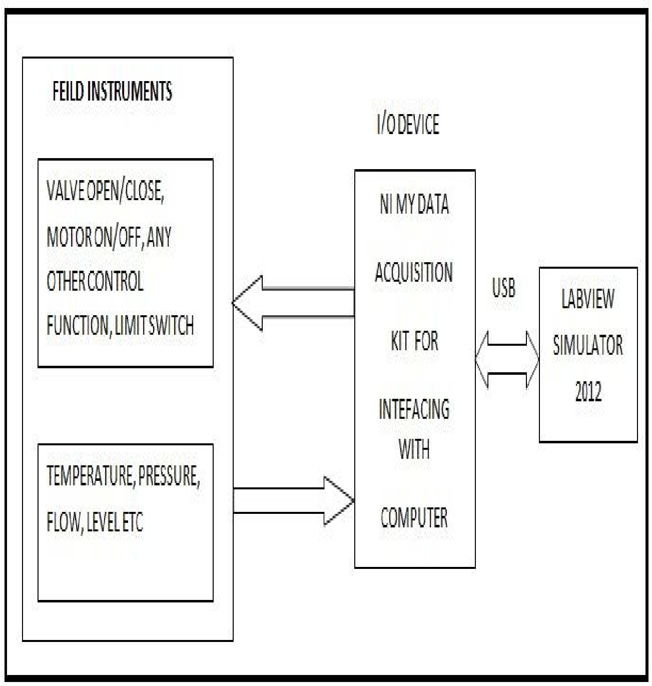


Fig. 3: Test module block diagram for wired communication.

D. Design Of Corex Process Module

1) *Front panel design:* This LabVIEW VI is designed to support interfacing to the RF module and Bluetooth by taking the case study data as reference. Various data's are obtained from the real system to design Test module. Fig.4 shows the front panel of proposed project, called as TG scrubber, it is one of the sub system of corex process. The graphics are designed with the help of LabVIEW front panels tools such as decorative functions, lines, numeric control and indicators ,graphs, LED's, Push buttons etc. On this front panel each and every operation Test system are monitored and controlled as per set point given in the LabVIEW VI program.

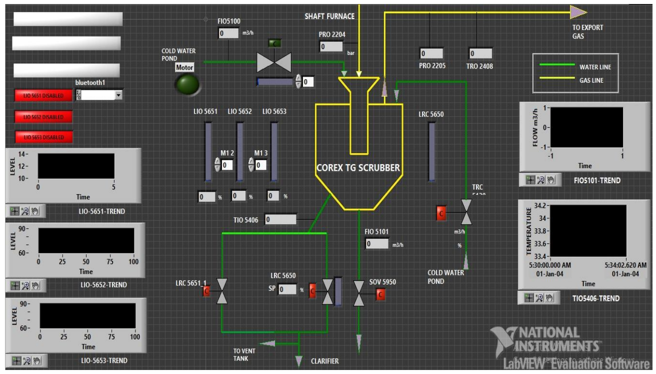


Fig.4: Front panel design

2) *Block diagram panel design:* Block diagram panel is the most essential and very important tool in the LabVIEW, this is because all the control actions such as arithmetic operations, logic operations, conditional loops, interfacing and any set points are programmed to simulator through this block diagram panel. Figure 5& figure 6 shows the block diagram panel for the Test module for both wireless and wired communication respectively. It consists of 3 level indicators labeled as LIO 5651 , LIO 5652& LIO 5653, temperature indicators such as TRO 2408 & TIO 5406, some on/off and control valves , flow indicators ,motor, buzzer and pressure indicators.

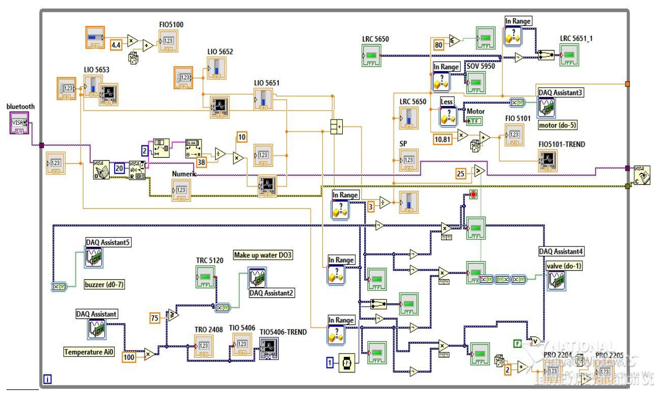


Fig.5:Programming diagram for wireless module

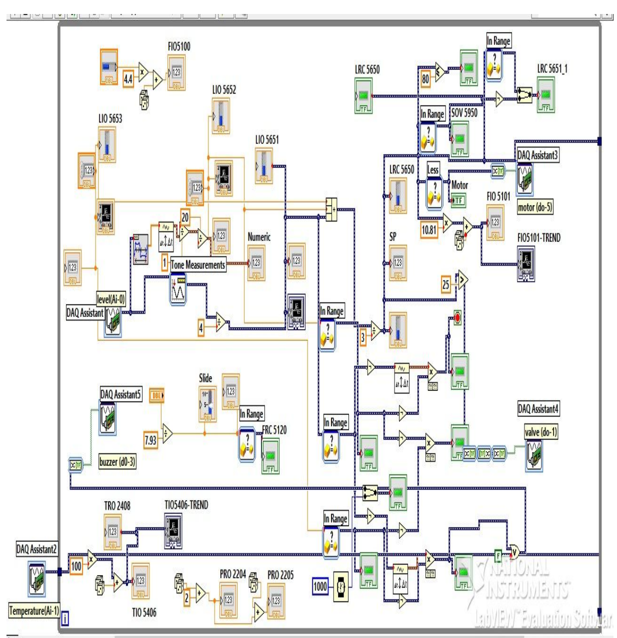


Fig.6: Programming diagram for wired module

IV. PROPOSED ALGORITHM

This section illustrates the development procedure of methodology. The overall concept has been represented in Figure 7. It gives the algorithm for wireless based monitoring and control of automation in corex plant

In this algorithm the focus is maintain the level in the scrubber system and also monitor the temperature inside scrubber, according to these two measurements remaining control actions like motor On/off, valve open/close, Plant trip alarm etc will works

The algorithm is as follows,

Step 1: Measure the level and temperature.

Step 2: If the any one level is below 20%, then disable the level (Red light), else display Level enabled (green light).

Step 3: If the temperature is above 75 degree, Switch on Add Make up water LED indication on Test module or else continue to measure an temperature.

Step 4: If the average level is below 20% , activate buzzer , Indicate plant trip indication on the monitor and switch ON the supply to the motor , continue to measure.

Step 5: If the average value of Level is above 25% , then give open command to an solenoid Valve, indicate valve open indication on display and continue to monitor the level.

Step 6: If the average level is above 80%, buzzer an plant trip alarm and switch OFF the motor or else continue to measure the level

Step 7: If the condition is true then stop the program but continue to measure level and temperature.

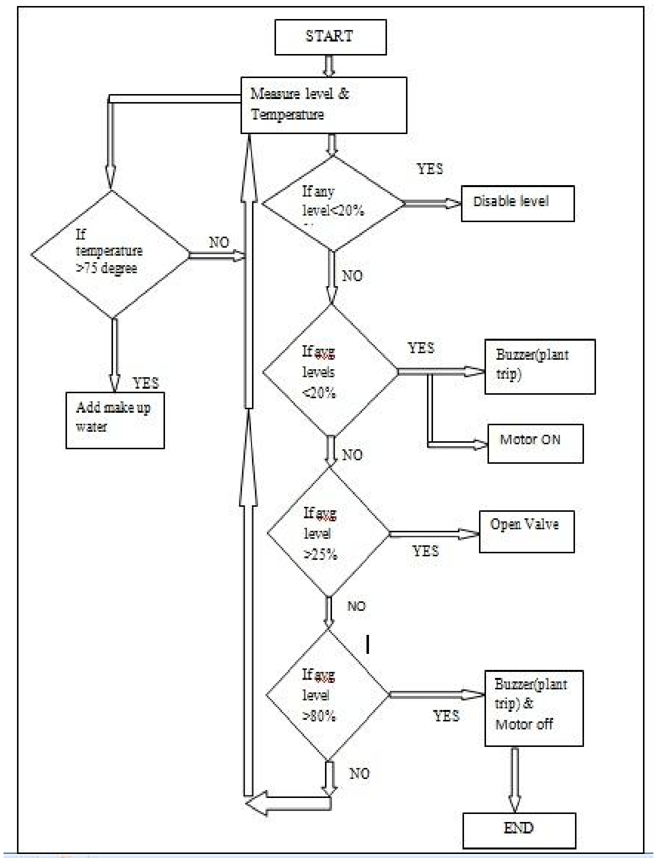


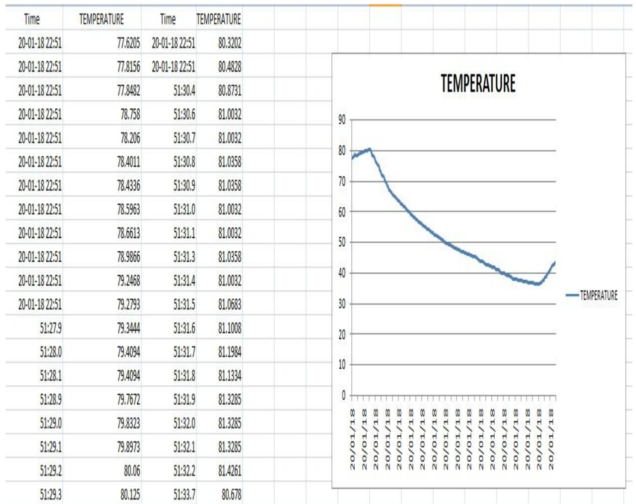
Fig.7: Proposed control algorithm

V.RESULTS AND DISCUSSIONS

A. Results

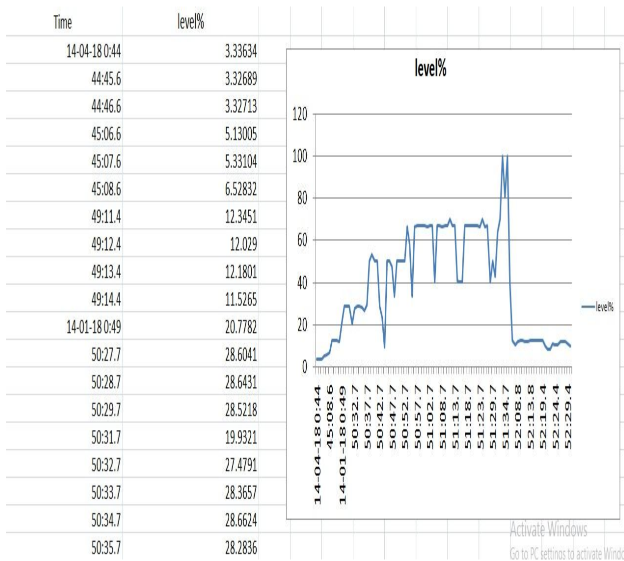
These Test module results are very essential to analyze the above two cases, by these results conclusion for both wired and wireless modules are made and differentiated in the further process. Measurements and charts for both the cases are mentioned below

1) For wired test module: Corresponding results of temperature and level for wired test module are as show in fig.8 and fig.9 respectively.



Time	TEMPERATURE	Time	TEMPERATURE
20-01-18 22:51	77.6205	20-01-18 22:51	80.3202
20-01-18 22:51	77.8156	20-01-18 22:51	80.4828
20-01-18 22:51	77.8482	51:30.4	80.8731
20-01-18 22:51	78.758	51:30.6	81.0032
20-01-18 22:51	78.206	51:30.7	81.0032
20-01-18 22:51	78.4011	51:30.8	81.0358
20-01-18 22:51	78.4336	51:30.9	81.0358
20-01-18 22:51	78.5963	51:31.0	81.0032
20-01-18 22:51	78.6613	51:31.1	81.0032
20-01-18 22:51	78.9866	51:31.3	81.0358
20-01-18 22:51	79.2468	51:31.4	81.0032
20-01-18 22:51	79.2793	51:31.5	81.0683
51:27.9	79.3444	51:31.6	81.1008
51:28.0	79.4094	51:31.7	81.1984
51:28.1	79.4094	51:31.8	81.1334
51:28.9	79.7672	51:31.9	81.3285
51:29.0	79.8323	51:32.0	81.3285
51:29.1	79.8973	51:32.1	81.3285
51:29.2	80.06	51:32.2	81.4261
51:29.3	80.125	51:33.7	80.678

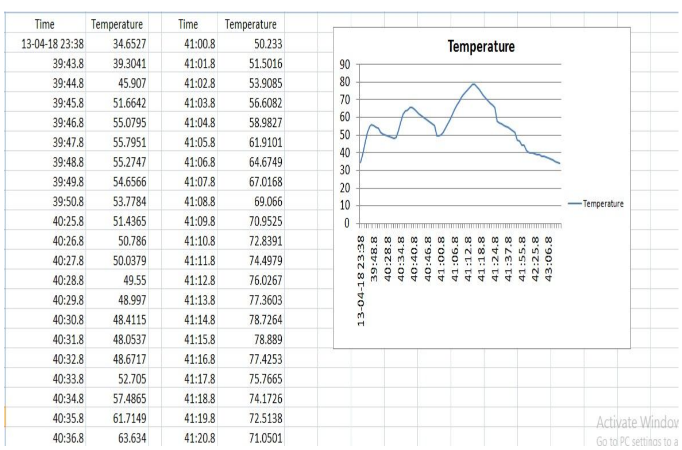
fig.8: temperature measurement with chart



Time	level%
14-04-18 0:44	3.33634
44:45.6	3.32689
44:46.6	3.32713
45:06.6	5.13005
45:07.6	5.33104
45:08.6	6.52832
49:11.4	12.3451
49:12.4	12.029
49:13.4	12.1801
49:14.4	11.5265
14-01-18 0:49	20.7782
50:27.7	28.6041
50:28.7	28.6431
50:29.7	28.5218
50:31.7	19.9321
50:32.7	27.4791
50:33.7	28.3657
50:34.7	28.6624
50:35.7	28.2836

fig.9: Level measurement with chart

2) For wireless test module: Similarly corresponding results of temperature and level for wireless test module are as show in figure.10 and figure.11 respectively. Also checked motor, valve and buzzers operation and remaining simulation values worked accordingly predetermined set points.



Time	Temperature	Time	Temperature
13-04-18 23:38	34.6527	41:00.8	50.233
39:43.8	39.3041	41:01.8	51.5016
39:44.8	45.907	41:02.8	53.9085
39:45.8	51.6642	41:03.8	56.6082
39:46.8	55.0795	41:04.8	58.9827
39:47.8	55.7951	41:05.8	61.9101
39:48.8	55.2747	41:06.8	64.6749
39:49.8	54.6566	41:07.8	67.0168
39:50.8	53.7784	41:08.8	69.066
40:25.8	51.4365	41:09.8	70.9525
40:26.8	50.786	41:10.8	72.8391
40:27.8	50.0379	41:11.8	74.4979
40:28.8	49.55	41:12.8	76.0267
40:29.8	48.997	41:13.8	77.3603
40:30.8	48.4115	41:14.8	78.7264
40:31.8	48.0537	41:15.8	78.889
40:32.8	48.6717	41:16.8	77.4253
40:33.8	52.705	41:17.8	75.7665
40:34.8	57.4865	41:18.8	74.1726
40:35.8	61.7149	41:19.8	72.5138
40:36.8	63.634	41:20.8	71.0501

Fig.10: temperature measurement with chart

Time	level%
14-04-18 0:44	3.33634
44:45.6	3.32689
44:46.6	3.32713
45:06.6	5.13005
45:07.6	5.33104
45:08.6	6.52832
49:11.4	12.3451
49:12.4	12.029
49:13.4	12.1801
49:14.4	11.5265
14-01-18 0:49	20.7782
50:27.7	28.6041
50:28.7	28.6431
50:29.7	28.5218
50:31.7	19.9321
50:32.7	27.4791
50:33.7	28.3657
50:34.7	28.6624
50:35.7	28.2836

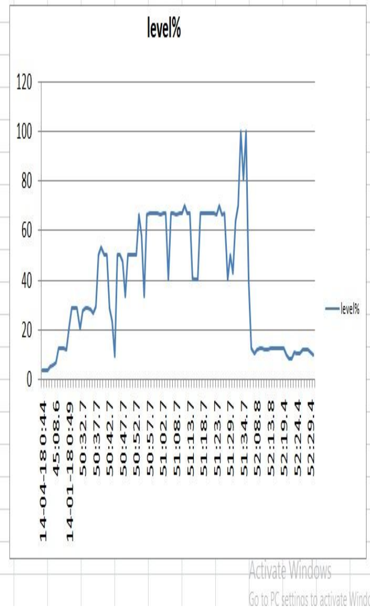


Fig.11 Level measurement with chart

B. Discussions

The Test module result shows measurements level and temperature for different cases on display and depending upon these two measurements remaining control actions are performed such as operation of motor, valve, buzzer &LED indication etc.

1) *Case 1:* It refers to the system to be under wired module condition, the measurement of required data is normal without any errors but only problem is opening of cable results in miss error data to an simulator or data will not change, continuously shows constant data. Measurements like temperature results in maximum value if the cable is opened, that will cost more quantity of water to a system operation.
2) *Case 2:* It refers to the system to be under wireless module condition, Once the wireless modules are synchronised to an LabVIEW simualtor 2012, the measurement of required data is perfect with errors are in within accecptable limits. operation motor, valve,buzzer, and LED indication found normal according to the delay time given in the LabVIEW and ardinuo alogrithms. checked working of module for different time delays and by that concluded that for an accurate measurement of parameters the best suitable time delay is 1 or 10ms.

VI. CONCLUSION

After continuous study of Corex automation, the field instruments data acquisition and control signals failure are because of the damage of cable due to excessive heat & dust around furnace and due to miss manhandling , There is an enormous development in wireless technology and so many wireless instruments are already available in the market with flexible and very effective specifications which are suitable for industrial applications so this project illustrates an wireless network Testtype module used for transferring and receiving of analog and digital signals. Results Compared on both wired and wireless modules by using algorithms on LabVIEW 2012, almost found same accuracy of signal transfer without having too much error signals. By employing wireless network there are several advantages such as i) Increased production quality by eliminating damage of cables and timely and accurate reading of field instruments. ii) Reduced maintenance cost, iii) Low cost, without extensive use of compensating wire and expensive PLC equipment, can significantly reduce hardware costs. iv) High reliability, eliminating the failure factors such as cable aging, bad contact, and cable damage and so on.

In this project, for Testtype module RF and Bluetooth modules are has been tested successfully and establish wireless network with cheap cost, 433Mhz RF module test about 20mtr distance in closed area found no problems in signals transfer, similarly Bluetooth module also test for a distance about 5mtr, no problem found while receiving the analog signals.

By this project concluded that Wireless technologies can be easily adopted in industrial areas , which are suitable for operating conditions, parameters and can eliminate repeated problems on major part of the corex process to achieve an better production with best quality and reliability.

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APPENDIX I

INPUT DATA OF CASE STUDY

COREX 1&2 PLANT, JSW STEELS, TORANAGALLU, KARNATAKA-583123

Table 1: Details of analog Field instruments taken as reference to the Test module

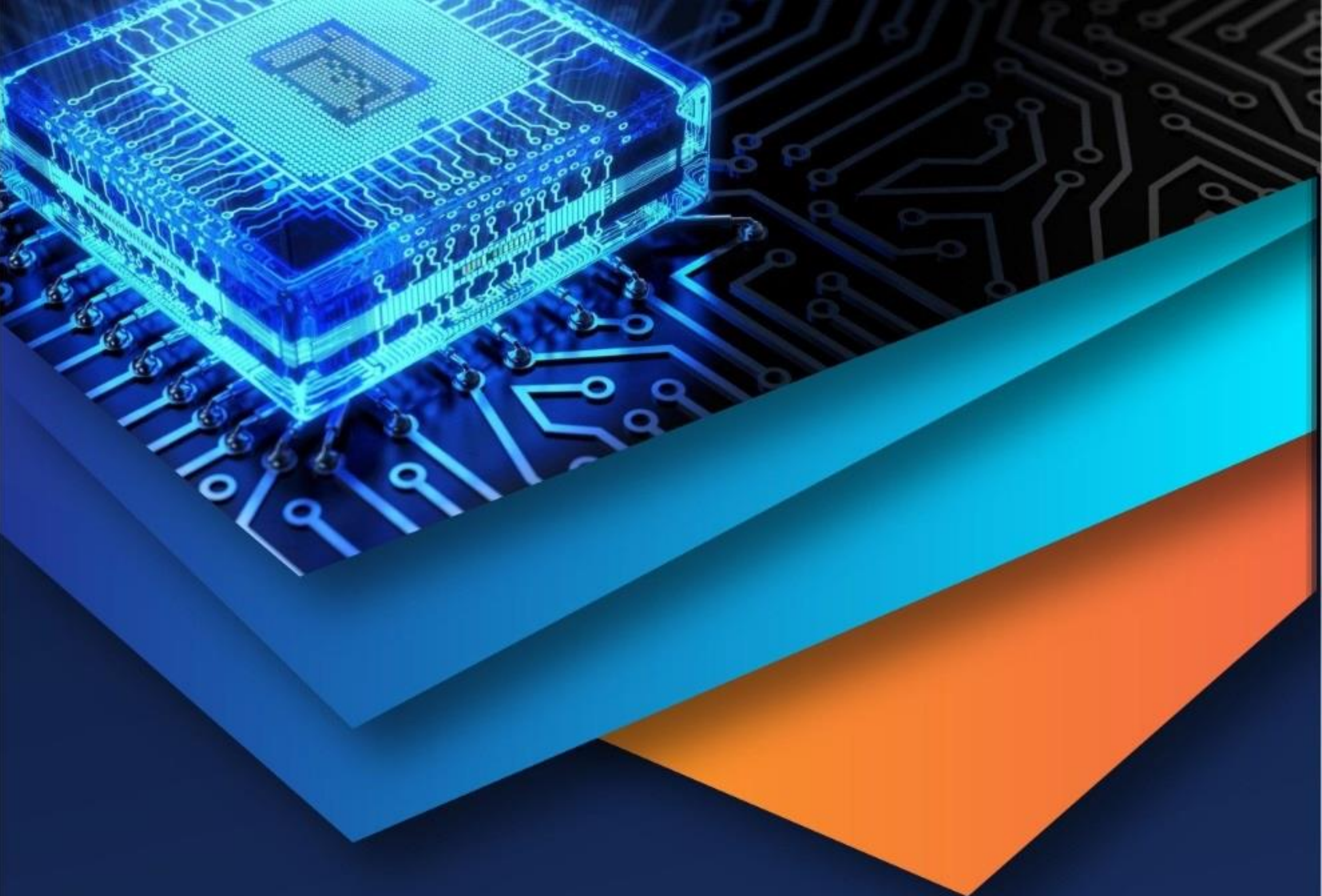
Sl. No	Tag no	Transmitter		Process point Elevation angle(HP)		Process point Elevation angle(LP)		Calibrated	Tx Range	Isolation valve size	PCD in mm	Length in mm
		Location	Angle	Location	Angle	Location	Angle					
1	LIO 5651	27 mtr	320	19mtr	360	21mtr	270	0-0.2bar	16-1600mbar	DN 50/25	125/85	175/25
2	LIO 5652	27 mtr	320	19mtr	180	21mtr	300	0-0.2bar	16-1600mbar	DN 50/25	125/85	175/25
3	LIO 5653	27 mtr	320	19mtr	330	21mtr	290	0-0.2bar	16-1600mbar	DN 50/25	125/85	175/25
4	PRO 2204	32 mtr	300	31mtr	300	NA	NA	0-5.3bar	0.16-16bar	DN 25	85	125
5	PRO 2205	32 mtr	270	32mtr	270	NA	NA	0-5.3bar	0.16-16bar	DN 25	85	125
6	FIO 5100	32 mtr	270	27mtr	270	27mtr	270	0-250mbar	0-600mbar	DN 15	65	135
7	FIO 5101	37mtr	220	32mtr	250	27mtr	250	0-50mbar	1-60mbar	DN 15	65	125

Table 2: Details of temperature sensor taken as reference to the Test module

Sl. No	Tag no	Transmitter		Thermocouple Elevation angle		Type of T/c or RTD	Calibrated	Tx Range	Length in mm	
		Location	Angle	Location	Angle				Inersion	Nominal
1	TIO 5406	32mtr	320	27mtr	220	PT100	0-200 dgree	0-300 dgree	400	520
2	TRO 2408	32 mtr	270	32mtr	270	PT100	0-250 dgree	0-500 dgree	570	670

Table 3: Details of motor taken as reference to Test module

SL.NO.	TAG NO.	FEEDER NO.	DISCRIPTION	KW	FLA	RPM	FRAME SIZE	DE	NDE
1	821P01	5F-0A	SCRUBBER PUMP - 01	250	415	1485	QU355M4E	NU322	6316



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