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IoT Based Smart Sand Reclamation System with Online Monitoring and Data Acquisition

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Abstract - *Indian mechanical sector is much dependent of foundry industry. In India, the available foundries produce approximately 7 million metric tonnes of casting. Nearly same or double amount of foundry sand is required to produce the same casting. Currently the foundry sand are preliminarily extracted from natural resources and remains unused after casting has been produced. This research work emphasis on reuse of foundry sand and control the sources of natural resources by using of sand reclamation system. But currently, cost of recycling of the waste sand is more than naturally available foundry sand. To reduce cost of sand reclamation power consumption of the system should have to be lower and that can be achieved by effective power utilisation. As compared to non-automated sand reclamation system, the current IoT based smart sand reclamation system uses cyclic start and cut off in air supply for fluidisation. This technique is economical and cost effective and it is accessible to most of the large even small scale foundries after use of IoT for sand reclamation system. This research work emphasis on online management of sand reclamation system to monitor as well as control from remotely placed electronic smart gadget and to store the data available of the system to predict the problems by use of previous collected data. This research utilises data acquisition tool, Microcontroller, programming software, IoT tool and smart android app. Overall the IoT based smart sand reclamation system is superior over the same Non-automated system.*

Key Words*: *Internet of things, Sand Reclamation, Automation, Arduino, Data Acquisition

1. INTRODUCTION

In Indiaapprox.7 million metric tonnes of Casting is produced and nearly 2 million people are dependent of the foundry industry directly and indirectly [1]. The foundry produces waste sand from the casting process in the form of used moulds. There is need for a system that can recycle waste sand into reusable sand. Govt. of India is focusing to solve this problem and hence under guidance of department of science and technology a smart sand reclamation system is constructed. This system utilizes waste foundry sand to convert it into reusable foundry sand. Foundry sand reclamation is the techniques by which reuse of moulding sand is possible with minimum use of fresh sand. Existing foundry technologies consume huge quantity of fresh moulding and core sand. Nearby two tons of fresh sand requires per ton of the castings produced. It generates waste foundry sand, it contain chemically bonded sand. This waste sand required to recycle and reuse for casting applications [2].

With the existence of the smart computational and internet age, a reliable controlling and smart monitoring system over the non-automated system is mostly appreciable, that can be gained by utilising the IoT.Internet of Things is the connection of hardware attachedto sensors, network, actuators, electronics and software connectivity which enables to recognise, gather and transfer the data [3].In case of emergency of vehicle accidents IoT can connect to cloud and provide actual biomedical data through the wearable devices [4].

An Internet of Things now a days utilised for the application of 3D object recognition system, robots are being built by use of such excellent technologies [5].A huge number of devices like sensors in addition to computers are interconnected in the IoT (Internet of Things). In the cloud computing model, sensor data is transmitted to servers in networks and processed on the servers in a cloud [6]. Now a days IoT structure used in pre-detection of infection in leaves. If any infections are detected, auto-medicining is provided by switching on the valve and required chemical is splashed through sprinkler to the rural ranch. Embedded structure for controlled system to a field offers a great solution for help site particular drip system administration that ensures manufacturers to maximize their profit by identifying the problems at earliest possible time[7].The unique IoT based automatic washing system for the street lighting surfaces was designed, constructed in one of the cities in Iran. The system is an alternative method for the available methods of cleaning systems [8].

In case of smart control, some challenges present within the deployment blockchain for the Internet of things systems and for smart home applications in particular. Thus, in most cases of domestic automation, a potential place to start the block chain is in the home gateway that supports the processing and computing required to in-network-pre-process or aggregate the information transfers from the different devices[9].

IoT has greater importance in the agricultural sector, this industry is subjected to complex challenges that affects civilization of human being. Considering the increasing population and the non-predictable environmental changes, the agriculture sector has been forced to change the path from commercial ways to info-centred control and automation in order to produce more ingredients by using lesser quantity of materials. Such a fresh pattern is feasible with the acceptance of applications and solutions that are driven by the included with some basic technologies including the robotics, artificial intelligence, and Internet of Things. Overall these methods increases productivity and profit by gathering and analysing information to assist people to control their inputs generate good quality crops and animals products with optimization of energy and chemical use and eliminate risk [10].

The foundries need to reclaim the sand to minimise fresh sand utilisation in foundries and to avoid disposal costs. The sand reclamation processing can be done by using either cold or hot reclamation process. To assess the energy efficient of reclamation process, the detailed analysis of sand reclamation system is needed. Selection of thermal sand reclamation system depends on fuel availability, innovation spill over and competing technologies. Each sand reclamation technique has its own characteristics, but the selection of reclamation technique is absolutely influenced by the type of binders on sand grains [11].

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2. SYSTEM MODEL

The system model consist of various components as shown in fig , This research utilises data acquisition tool, Microcontroller, programming software, IoT tool and smart android app to execute the sand reclamation process.

2.1 Sand Reclamation System

Sand Reclamation system utilised for converting waste foundry sand to the recycled useful sand. It is consist of fluidised bed combustor, Sand Cooler, Sand Siever, Cooling Unit and Air Flow Generator (compressor). The fluidised bed combustor needs air supply, heating supply and Sand storage space. Also time need to provide for absorption of heat from source to get proper heating to the sand. The increasing sand temperature to 550-600°C breaks burnt binders and sand will be ready to reuse. The air blown to sand confirms uniform heating of the sand and ensures uniform size of sand too.

For the purpose of fluidisation, Compressor is used and essentially required to control this fluidisation after equal interval of time. 10 seconds of time interval with no air flow is provided between consecutive 5 second air flow. This way of fluidisation starts after heated sand reaches 300 °C. The fluidisation with time interval is energy efficient as compared to continuous fluidisation. Sand cooler is also subjected to fluidisation. This fluidisation helps to cool down the heated sand uniformly. This fluidisation takes place in same manner as fluidised bed combustor.

The fluidised bed combustor and sand cooler are subjected heat, Normal temperature of these element is 200-250°C in working condition. In such scenario manual operation of sand unloading is difficult. So there is need of remotely operated element which will assist sand transfer among respective units of sand reclamation system. The sand unloading valves are placed in the system for transfer of sand from fluidised bed combustor to the sand cooler after heating process and transfer of sand from sand cooler to the sand siever after cooling process. Sand siever separates sands according to its GFN. After opening of sand cooler valve the sand siever starts and the process ends after 10 minutes.

Sand cooler are embedded with cooling lines of water. The water lifting pump starts as soon as the sand from fluidised bed combustor startto flow in the sand cooler and stops as the sand from sand cooler flows to the sand siever. The heater and compressor works on 3 phase AC supply and other equipment work on single phase AC supply. Only one line of pressurised air is used to distribute air to various points in the system.

2.2 Micro Controller

The sand reclamation system requires a microcontroller in sense of controlling all the processes mentioned above. There is need for automation of all processes and a microcontroller used for controlling all the operations. Verity of microcontrollers are available in market but Arduino are easy to program and operable. Arduino Mega 2560 is used to data transfer to system and electronic devices.

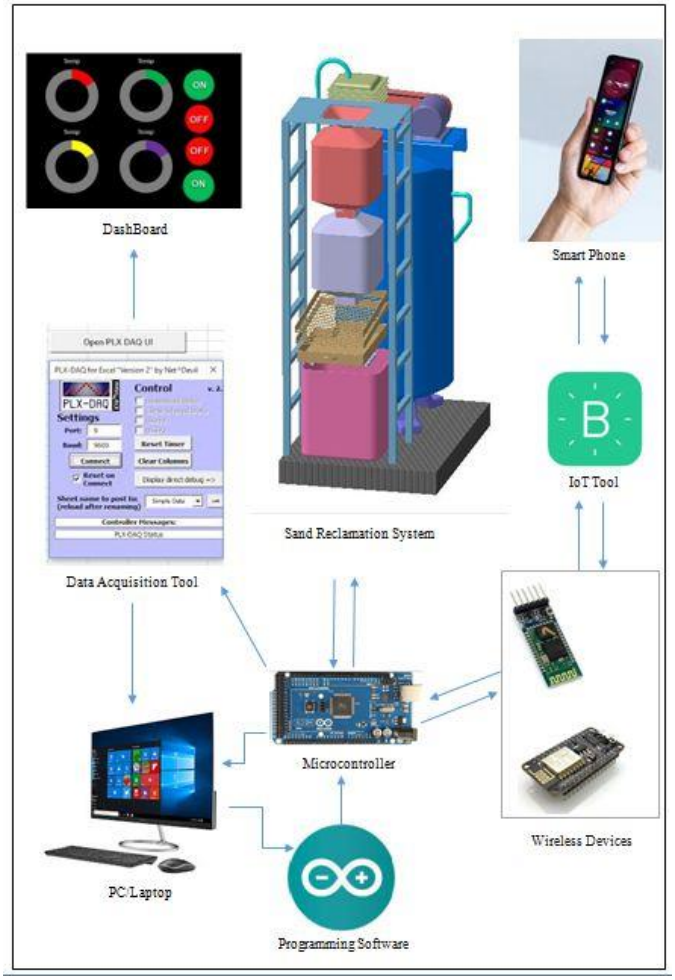

Fig -1: **Smart Sand Reclamation System with Online Monitoring and Data Acquisition**

2.3 Arduino IDE Software

The Arduino Mega 2560 is programmable in Arduino IDE software for various operations. Arduino IDE software enable programming, program compiling and execution of program for required processes. As number of devices are controlled at a time, the multitasking programming is used as a powerful tool in the relative software.

2.4 Hardware and wireless devices

The overall system requires temperature sensors, relays, ultrasonic sensors, flow sensor, pressure sensor, Bluetooth module, WiFi module and programmable NodeMCU Board. The temperature sensors required at atmosphere, fluidised bed combustor, sand cooler and water cooler. For the temperature measurement Max6675 module is used. The flow and pressure sensor is used to measure flow at the beginning of pressurised air-line. Bluetooth module HC-05 is used for serial communication between microcontroller and sensors and control devices. Data acquisition and data storage is processed by NodeMCU (another Microcontroller). 3 phase supply controlling is done by AC contactors. Single phase supply are controlled by 5VDC-230VAC, 10 Amp 8 channel Relay Module.

Fig -2: **Online Monitoring of Smart Sand Reclamation System by use of BLYNK**

2.5 IoT Dashboard, Data Acquisition and Storage Tools

Internet of things is not possible without a smart built in applications interface. Blynk, Ubidots, Virtuino, freeboard and other similar IoT based interface are available in market. Blynk IoT based interface is used in this research work. The blynk library and android application were installed in the respective devices. Blynk provides tools that enables ease of programming for the Arduino IDE software. Serial communication between Arduino Mega 2560

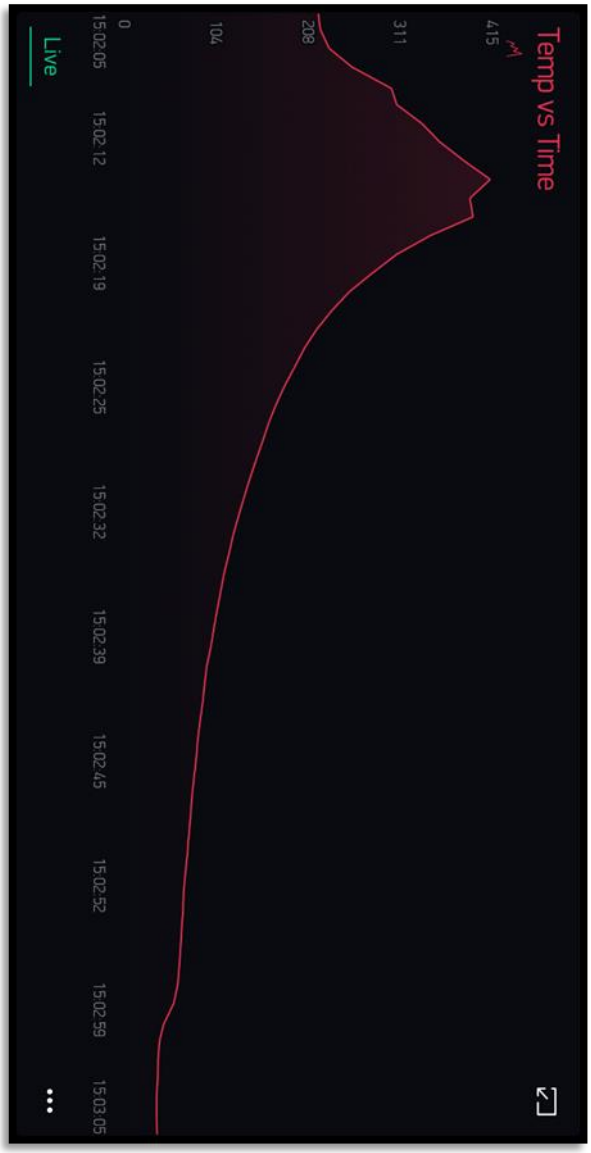

Fig-3: **Temperature vs Time graph plotted with IoT data acquisition tool – BLYNK**

microcontroller and android smart phone is held by the Bluetooth/ESP8266 WiFi Module or Node-MCU microcontroller. The Blynk enables controlling widgets such as Buttons, Sliders, Timer, Joystick, step controls and display widget such as LED, Gauge, Labeled Value, Value Display, LCD etc. specially Blynk enables us to plot graphs and data monitoring in table form. The fig 2 shows online monitoring by use of Blynk IoT android interface. At the other hand the fig 3 shows Temperature Vs Time graph by Blynk IoT android interface.

Another method of Data Acquisition is used in the system, the data received from sensor is processed by the microcontroller and displayed to the serial monitor. PLX DAQ is a specialised tool applicable for data acquisition purpose, use serial monitor of the Arduino IDE software and captures data in to excel. A special decoding method is required for data storage using Arduino IDE software and PLX DAQ tool. Also Excel provides special graph tools to create display dashboard in excel only. Both methods are used in this research work.

3. EXPERIMENTAL SETUP

A pressurised fluid line is connected to the Double Solenoid Direction Control Valve 1 and 2 as shown in fig 4. This direction control valve is capable of transferring air to either fluidised bed combustor or to sand unloading valve or both will be disconnect. The Arduino Mega 2560 controls this valve on the basis of provided time interval. The fluid line to the sand cooler is also provided with direction control valve 2 which controls air for sand cooler fluidisation and sand removal during sand unloading.

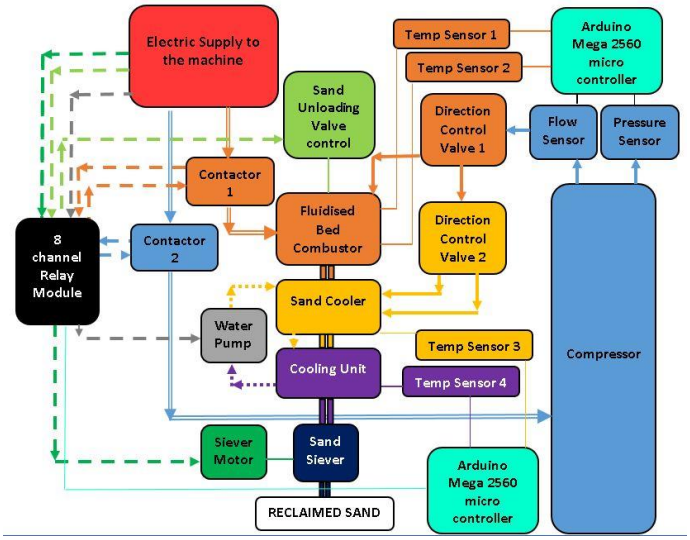

Fig- 4: **Experimental Setup of IoT based sand reclamation system.**

Air flow measurement is achieved by flow sensor device connected to the line earlier to first direction control valve. The fluidised bed combustor provided with K-type

thermocouple. One of the thermocouple is inserted in the sand. Other is inserted at exhaust of fluidised bed combustor. The sand cooler and water cooling unit are provided with K-type thermocouple each.

The overall system starts first, the fluidised bed heater starts after 5 seconds. Compressor starts sequentially after fixed interval of time. The direction control valve 1 remains closed at initial condition, compressor generates enough pressure inside the tank during this initial condition. As soon as, the temperature sensor 1 reaches 300°C, the direction control valve 1 is activated to first condition i.e. pressurised air is sent to the fluidised bed combustor with 5 seconds activated and 10 seconds deactivated condition. Temperature sensor 1 reaches set cut off temperature then a timer starts in the program for 15 minutes. After this time the heater is off andthe sand unloading valve of fluidised bed combustor opens after predetermined time interval has passed. The fluidised bed combustor with the help of sand unloading valve eliminates processed sand, then the direction control valve 1changes its position and sends pressurized air to the direction controlled valve 2.

4. RESULT AND DISCUSSIONS

The sand reclamation system is made up of various controlling and sensing device with complex process to control and monitor manually. The reclaimed sand holds higher temperature during unloading, which is unreachable to operator now being controlled by the IoT based system. Fluidised bed combustor exerts burnt resin and this may hazard human skin, but now the operator is able to control the same system away from15 meters. The smart IoT based sand reclamation system is able to trace the history of machine with the help of data acquisition and data storage, as any change in system deflects graphs plotted from master graphs and now operator is able to compare graphs and find out defect quickly. The smart system enables to read clear indication of data on the smart phones only as well as it enables controls and emergency stops on the smart phones. One of the most important thing achieved in this system is energy utilization. The IoT enabled control over machine per second. So microcontroller can control the system as per energy requirement. Earlier sand reclamation system was utilising continuous fluidisation for both fluidised bed combustor and sand cooler with 5HP compressor for nearly one hour cycle time. Now, smart IoT based sand reclamation system enable cyclic start and cut off in air supplyfor fixed time period and hence 5HP compressor need to work for only 25-30 minutes. This modified procedure saves power required to overall system results ultimately in reducing reclamation cost per kg of sand.

5. CONCLUSION

The foundry industry in India has vital role in global industrial scenario as it is one of the large scale producer of casting. In such situations, it becomes important to use resources with proper care. The foundry sand is generated from natural sources and need to reuse, so as to maintain future backup source. But currently, cost of recycling of the waste sand is more than naturally available foundry sand. To reduce cost of sand reclamation power consumption should have to be lower and that can be achieved by effective power utilisation. As compared to non-automated system, the current IoT based system uses cyclic start and cut off in air supply for fluidisation. The cyclic start and cut off in air supplyassures that 10 seconds cut off between consecutive 5 seconds air flow. This technique is complex to execute in non-automated system. The IoT based sand reclamation process provides smart control of system that assures no physical contact with thermal system of machine and reduces chances of hazard. IoT based sand reclamation system provides data acquisition which helps to maintain quality of process precisely. Further the data gathered from IoT system helps to find out system failure from previous data storage. Overall the IoT based sand reclamation system is superior over the Non-automated system.

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REFERENCES

[1] Subodh Panchal, Indian Foundry Industry, International Foundry Forum, Barcelona (September, 2010)
[2] Vishal J. Savant, Rohitkumar S. Bharamgonda, Utkarsh A. Patil, Vasudev D.Shinde,Testing of Fluidized Bed Combustor for Foundry Sand Reclamation" International Research Journal of Engineering and Technology (IRJET) Volume: 05, Issue: 06 (June -2018),pp- 130-134.
[3] Md. Sanwar Hossain,Mostafizur Rahman, Md. TuhinSarker, Md. ErshadulHaque, Abu Jahid,A smart IoT based system for monitoring and controlling the sub-station equipment, ELSEVIER, Internet of Things 7 (2019).
[4] GiriBabuSinnapolu, ShadiAlawneh, Integrating wearables with cloud-based communication for health monitoring and emergency assistance, ELSEVIER, Internet of Things 1–2 (2018) 40–54.
[5] DidierCoquin, RedaBoukezzoula, Alexandre Benoit, Thanh Long Nguyen,Assistance via IoT networking cameras and evidence theory for 3D object instance recognition: Application for the NAO humanoid robot, ELSEVIER, Internet of Things 9 (2020).

[6] RyujiOma,Shigenari Nakamura, DilawaerDuolikun, TomoyaEnokido, Makoto Takizawa, An energy-efficient model for fog computing in the Internet of Things (IoT), ELSEVIER, Internet of Things 1–2 (2018) 14–26.

[7] ChannamallikarjunaMattihalli,EdemialemGedefaye, FasilEndalamaw, AdugnaNecho,Plant leaf diseases detection and auto-medicine", ELSEVIER,Internet of Things 1–2 (2018) 67–73

[8] MortezaHadipour, JavadFarrokhiDerakhshandeh, Mohsen AghazadehShiran, Reza RezaeiAutomatic washing system of LED street lighting via Internet of Things, ELSEVIER, Internet of Things 1–2 (2018) 74–80.

[9] Daniel Minoli, Positioning of Blockchain Mechanisms in IoT-powered Smart Home Systems: A Gateway-based Approach, ELSEVIER, Internet of Things,https://doi.org/10.1016/j.iot.2019.100147.

[10] ImranCharania, Xinrong Li, Smart Farming: Agriculture's Shift from a Labour Intensive to Technology Native Industry, Internet of Things (2019), doi: https://doi.org/10.1016/j.iot.2019.100142.

[11] Suyog B. Rayjadhav, Digvijay A. Mhamane and Vasudev D. Shinde, Assessment of sand reclamation techniques and sand quality in thermal reclamation,Int. J. Productivity and Quality Management, Vol. X, No. Y, pp -1-11.