



## A Step towards a New Horizon of Industry 4.0 with an Artificial Intelligent Refractory Failure Detection System Using IoT Technology

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**Abstract :** The world is stepping fast towards the industrial revolution of Industry 4.0. Artificial Intelligence (AI) and machine Learning based systems change the way of interaction with information and system with us. In the small scale industrial sector the information regarding refractory including furnace, operating parameters, process and maintenance supplied through human experience and knowledge so it is necessary that you have to be on that field to know exact condition and proper working of refractory. This can be change in future by implementing artificial intelligence based fault detection system which equipped with cyber physical system which enable the communication between humans, furnace and refractory at any place and anywhere.

**Index Terms – industry 4.0, smart factory, IoT, Refractory failure, IoT based cyber physical system**

### I. INTRODUCTION

In chemical industry the thermax boiler furnace is the major equipment that requires maintenance on periodically time interval and need to inspect once in a year which takes one or two days total shutdown of plant. Although furnaces can exist for centuries, it is still some hotspot area where the maintenance requires specially to inner refractory lining system. It is nearly impossible to predict or detect the wear of inner refractory without shutting down the furnace and get manual inspection throughout the furnace. By implementing the new concept of industry 4.0 an artificial intelligent refractory failure detection system can overcome the problem of complete shutdown of furnace for routine inspection.

### II. CHARACTERISTICS TO ACHIEVE REMOTE REFRACTORY FAULT DETECTION AND TEMPERATURE MONITORING SYSTEM

For the IoT Platform we required some characteristics for the system like Technology heterogeneity and evolution, Network heterogeneity latency mobility object and data security etc. which is shown in fig-1 bellow.



Figure-1

III. OVERVIEW ON MAIN IOT ISSUES

The Issues like confidentiality, integrity, authentication, authorization unlink-ability, anonymity, traceability and no repudiation arise with different layer of development phase of remote refractory fault detection system which is shown in table 1.

IoT Layers	Issues	confidentiality	Integrity	Authentication	Authorization	Unlink ability	Anonymity	Traceability	Non-Repudiation
Application Layer	Application Issues	X	X	X	X	X	X	X	X
	Storage Issues	X	X	X	X		X		
	Key Management Issues	X	X	X			X	X	X
	Trust Management Issues		X	X	X	X			X
	Middleware Issues	X	X	X	X		X	X	X
	Data Integrity Issues		X	X					
	Data confidentiality Issues	X	X						X
	Data authentication Issues		X	X					X
Transportation Layer	Wifi Issues	X	X	X	X	X	X	X	X
	Thinkfree cloud platform Issues	X	X	X	X	X	X	X	X
	GPRS Issues	X	X	X	X	X	X	X	X
	Network access Issues		X	X	X	X	X	X	
	Routing protocols Issues		X	X					
	Encoding Issues		X				X		
	Heterogeneity Issues		X	X			X	X	X
Perception Layer	RFID Issues	X	X	X	X	X	X	X	X
	WSN Issues	X	X	X	X	X	X	X	X
	RSN Issues	X	X	X	X	X	X	X	X
	GPS Issues	X	X	X	X	X	X	X	X
	Platform Issues	X	X	X	X	X	X	X	X

Table-1

IV. CROSS THEMATIC DATA MANAGEMENT, MACHINE LEARNING AND ANALYSIS FOR A REMOTE REFRACTORY FAULT DETECTION AND TEMPERATURE MONITORING SYSTEM A CLOUD COMPUTING ENVIRONMENT

Some of the parameters are co-dependent with each other and can be identified by detail perusal of the cross thematic data management, Machine Learning and analysis for Data acquisition, information processing and decision making using machine learning for AI based system.

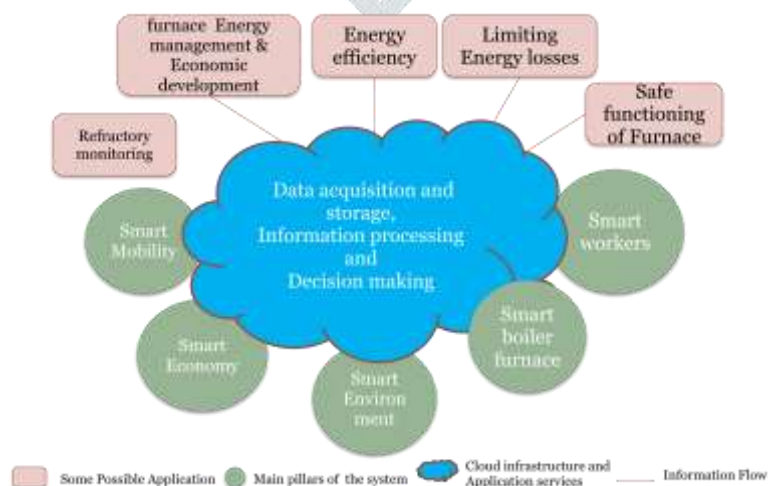


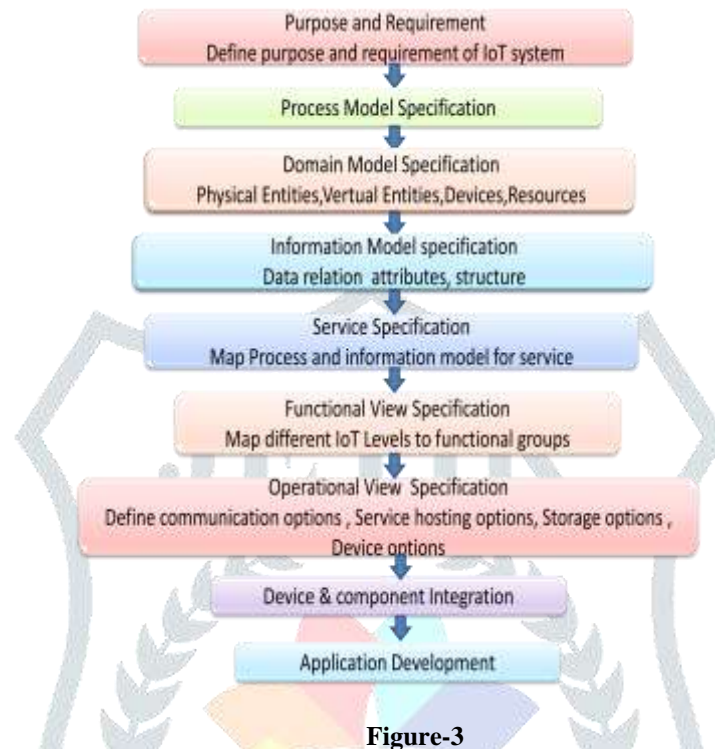
Figure-2

## V. ARTIFICIAL INTELLIGENCE BASED REMOTE REFRACTORY FAULT DETECTION AND TEMPERATURE PRESSURE MONITORING SYSTEM

The term refers to the new generation of systems with integrated computational capabilities that can interact with humans via different modalities in the future. RRFDTMPS will improve furnace productivity through smart prediction and diagnostic using informative data from different sensor connected through network and furnace body.

This system can predict and prevent failure of refractory at early stage of potential failure of refractory by self awareness and self prediction using collected data from the sensors and take self decision and prediction using machine learning algorithm for prediction of failure at different stage at different zone at surface of furnace.

### V.1. IoT Design Methodology



### V.2. Experimental setup Methodology

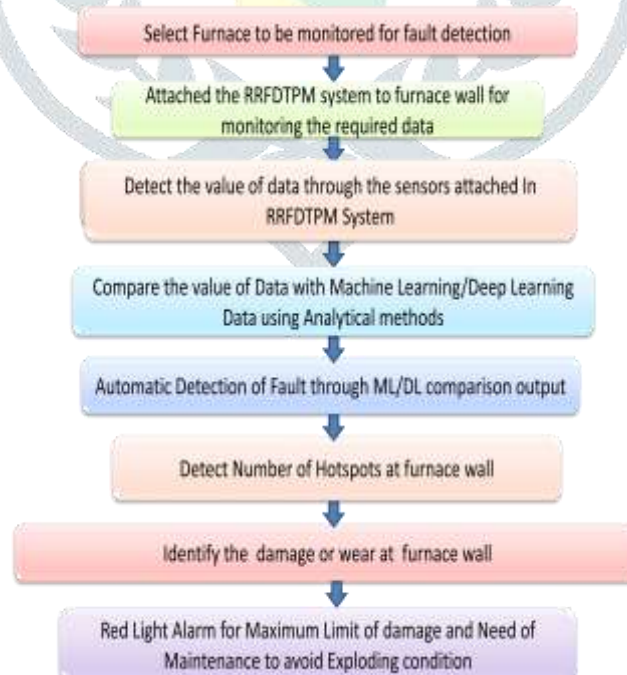


Figure-4

## V.3. Flow chart for Remote Refractory fault detection and Temperature- Pressure monitoring system

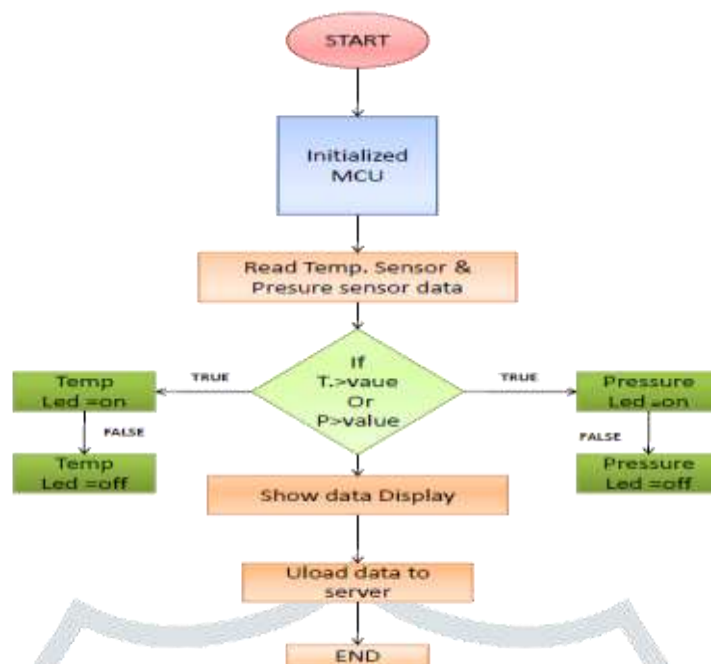


Figure-5

## VI. CONCLUSIONS

The artificial intelligence based Remote Refractory fault detection and Temperature Pressure monitoring system can predict through early detection technique using machine learning any fault in refractory which can help to reduce energy loss due to faulty refractory and the system can save time to find out that fault by manual inspection which can take one or two days total shout down of furnace in a plant of small scale industries.

## VII. ACKNOWLEDGMENT

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