

# Smart Chemical Plant Control System

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**Abstract:** The paper presents a control system to prevent the explosion of chemical plants by measuring parameters and alert the personnel in case of emergency. The proposed system uses raspberry Pi to collaborate the values of parameters such as temperature, pressure and air quality and checks whether the values crosses the threshold value set. In case, if the values cross the value determined then the alert is given as message. Thus, this method shows that the explosion in chemical plants can be controlled thereby preventing the huge damage to the people and the environment around.

**Index terms:** MQTT (Message queuing telemetry transport).

## I. INTRODUCTION

Due to urbanisation and the increased use of power in each and every place the requirement of power also increases subsequently which makes the industries to grow up in a large extent to meet the requirements. It is forecasted that the growth of generation of power by renewable and non-renewable energy sources will increase in the near future. The developed nation uses less polluting sources to generate power and thus the disaster occurrence probability is less compared to the developing and underdeveloped nation. The developing nation find it difficult to generate the power with less pollution due to various reasons like over-population, necessity of more power.

In present plants different techniques are employed to measure the parameters like temperature, pressure, air quality, gas released, etc.,. But they use devices to measure these above mentioned parameters individually and more man power is required to check the values. Due to carelessness and ignorance of the persons working there, explosion occurs. There are also other reasons for the explosion such as improper maintenance, uneducated, not fully aware of the machineries used, etc.,.

The balance control strategy can be done using batteries. The different batteries used are thermal power batteries, hydropower batteries, flow batteries, etc..[1],

But these batteries' implementation cost is high and requires implementing again after the life is over.

Protocols can be used for the communication. But very deep implementation of the model is required to get the higher efficiency [2]. Data consistency must be maintained throughout the plant.

## II. EXISTING METHOD

Some of the devices used for measuring the parameters in present plants are explained below. The Omnigrad TST is a compact resistance thermometer to check temperature. This checks the temperature of the surrounding in which it

is placed. This consists of the measurement insert, thermo well and connecting head. Variety of transmitters for different standard output signals are available. For gas measurement devices such as Zirconia. True Peak Tunable Diode Laser Analyzers are used. Though various devices are used to check the parameters value, they do not monitor continuously and display it. Even if not monitored they do not alert during emergency.

Since the explosion causes major damage and the recovery is hard, it is important to monitor and control the plant in emergency time. Every parameters that contribute to the high power output but also responsible for damage has to be monitored and displayed continuously.

In the current existing methods, there are many systems which will monitor the various parameters but not trigger the alarm to alert everyone in case of any unexpected events. Various parameters like temperature, pressure, air quality and gas constituents are measured using various sensors. Commonly used sensors for temperature is Omnigrad TST which is an compact resistance thermometer. For measuring gas constituents the commonly used sensor are True peak Tunable Diode Laser Analyser and Zirconia are being currently used.

### Conventional Governors

There are three types of conventional governors. They are mechanical-hydraulic governors, mechanical governors and hydraulic governors.

### 1. Proposed Method

The temperature, pressure and air quality are checked continuously and monitored. After the continuous monitoring of the various parameters is done, there is an alerting system in case of occurrence of an unexpected event. If such an event arises then the respective people are alerted through their mobile or desktops.

### DRAWBACKS OF EXISTING METHOD

- There is no continuous monitoring and the values of the parameters are merely displayed.

- There is no alert system. Even in the event of an emergency no action would be taken by the system.

In this proposed method in addition to monitoring of the various parameters like temperature, pressure and gas constituents the proposed system will alert the respective people through their mobiles and desktops in the event of an emergency.

ADVANTAGES

- Low cost equipments are used
- Alert messages are received soon and hence precautionary steps can be taken

The raspberry Pi is a small board size computer that is used here as a microcontroller. This is supported by an Analogue to Digital converter which converts the analogue data into serial bits of digital data. This conversion is done by the process of successive approximation. The serial bits of data is supplied to the Raspberry Pi which then processes the data and checks whether it is above the critical value and if the situation is an emergency. If that is the case then the alert message is sent to the subscriber.

The sensor used for the measurement of gas is MQ 7. The LM 35 is used here as a sensor to measure the temperature. Number of sensors are placed in various places for the measurement of the parameter.

The message is sent using the MQTT protocol which can be subscribed by the required personals. MQTT is a machine to machine communication protocol which is used here to transmit the alert message.

The required parameters are continuously monitored using the sensors and a threshold value is set. If the observed value crosses the threshold value then an alert message is created and it is sent by using the MQTT protocol. The MQTT protocol acts as a broker between the system and the subscribers.

It is always better to subscribe before the entire process as subscription after publication will result in the loss of some data. So it is advisable to subscribe first and then publish.

**Program for Subscribing:**

```
import paho.mqtt.client as paho
# Function Definition for subscribe
def on_subscribe(client, userdata, mid, granted_qos):
    print("Subscribed: "+str(mid)+" "+str(granted_qos))
# Function Definition
# Function Definition for message
def on_message(client, userdata, msg):
    print(msg.topic+" "+str(msg.qos)+" "+str(msg.payload))
#client = paho.Client()
# Function Calling for Subscribe
client.on_subscribe = on_subscribe
#Function Calling for Message
client.on_message = on_message
```

```
client.connect("iot.eclipse.org", 1883,60)
#client.subscribe("SR/Temp"Á,qos=1)
#client.loop_forever()
# Ssubscribe data
client.subscribe("SR/Temp", qos=1)
# Call this function always client.loop_forever()
```

**Program for Publishing**

```
import paho.mqtt.client as paho
import time
import random
def on_publish(client, userdata, mid):
    print("mid: "+str(mid))
client = paho.Client()
client.on_publish = on_publish
client.connect("iot.eclipse.org", 1883,60)
client.loop_start()
Temp = str(random.randrange(0,20))
Pressure =str(random.randrange(20,40))
while 1: # Sending Data for ever
    Temp = str(random.randrange(0,20))
    Pressure =str(random.randrange(20,40))
    x, y=client.publish("SR",Temp,qos=1)
    x1,y1=client.publish("SR",Pressure,qos=1)
    time.sleep(2)
```

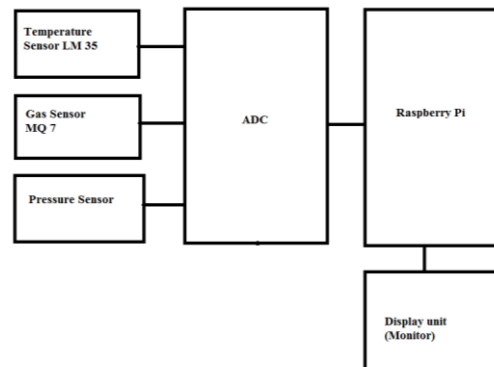


Fig 3.1 Block diagram of transmitting unit

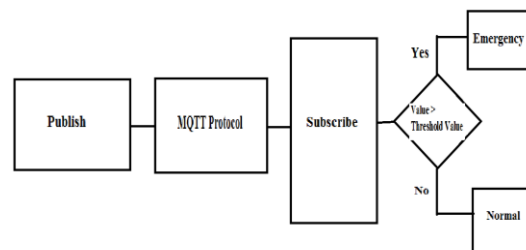


Fig 3.2 Block diagram of Receiving unit

**2. Results and Discussions**

The proposed system is found to send the alert message when the observed value reaches above the critical value, the alert message is sent and received by two process.

The sending and receiving the alert message is done by two processes called as subscription and publishing. The subscriber first initiates the subscription and the system will publish the message to the subscribers. The MQTT protocol acts as a broker.

**Subscription**

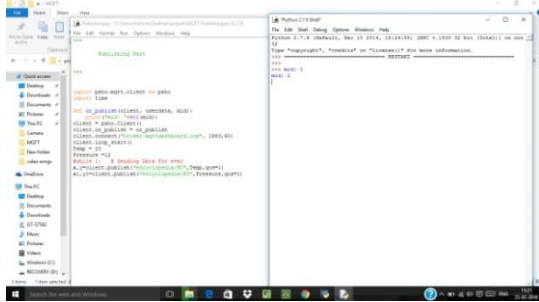


Fig 4.1 Subscription

People who are to be alerted should subscribe to receive the alert message. The above screenshot shows the subscription.

**Publishing**

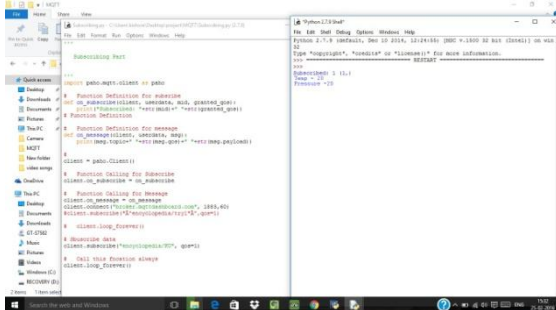


Fig 4.2 Publishing

The alert message is published and the subscribers will receive the messages. In the above screenshot two parameters temperature and pressure is received along with their values.

**III. CONCLUSION**

The proposed Smart Chemical Plant Control System using MQTT and Raspberry Pi, presented positive results in controlling the system. Control system concepts have to consider that today and in near future, there are and will be no common communication standards for the overall power plant. Hence, automatic control of the plant is necessary in present and near future. The sensors that are applicable in plants are placed and thus precise value of the parameters were noted.

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