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RESEARCH ARTICLE OPEN ACCESS

DESIGN AND FABRICATION OF ELECTRIC MUFFLE FURNACE AND MONITORING PARAMETERS USING IoT

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Abstract:

This project work provides an overview of electric muffle furnace, which are used in a variety of high-temperature processes in industries such as metallurgy, glassmaking, ceramics, and chemical production. Electrically-powered furnace, and discusses their advantages and disadvantages for specific applications. Safety considerations also discussed, as well as their potential negative environmental impacts. The report highlights the importance of proper design, installation, and operation of muffle furnace in compliance with relevant regulations to ensure safety and minimize environmental harm. Finally, the project work discusses advancements in electric muffle furnace technology

***Keywords* — real time temperature monitoring of electric muffle furnace using IoT platform**

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I. INTRODUCTION

An electric muffle furnace is a laboratory heating device designed to achieve high temperatures while isolating the material being processed from combustion by products. This isolation ensures a clean and controlled environment, making muffle furnaces essential for applications requiring precise thermal conditions.

This overview of laboratory furnaces, which are used in a variety of high-temperature processes in industries such as metallurgy, glassmaking, ceramics, and chemical production. Laboratory Electrically-powered furnace, and discusses their advantages and disadvantages for specific applications. Safety considerations also discussed, as well as their potential negative environmental impacts. The report highlights the importance of proper design, installation, and operation of laboratory furnace in compliance with relevant regulations to ensure safety and minimize environmental harm. Finally, the report discusses advancements in furnace technology.

Their major applications include general laboratory testing, annealing, ash determination, coal analysis, leaves carbonization and lime calcinations etc. The other applications include Ignition tests, Heat treating steel parts and Gears, Coal sampling, Organic and inorganic Chemical analysis, soils aggregate cement Testing, Glass blowing lab, Plastic tensile strength test, Gravimetric analysis, Heat treating Gears, Quench testing, Research facilities in chemistry, Annealing Oss determination, Development of coatings and ceramics, Rice laboratory, Stoneware samples firing etc.

II. PROPOSED SYSTEM

The aim of this project is to integrate an Internet of Things (IoT) system with an electric muffle furnace to enable remote monitoring, real-time data logging, and automated monitoring control for temperature management. The proposed method leverages sensors, a microcontroller, and cloud-based platforms to ensure efficient and smart operation of the furnace.

III. SYSTEM DESCRIPTION

We know that the proposed system is designed to enable intelligent and remote control of an **electric muffle furnace** using **IoT-based technologies**. The system combines sensing, data transmission, cloud processing, and user interaction to optimize furnace operation while ensuring safety and efficiency.

IV. Technical Specifications:

Hardware:

Component Specifications

Muffle Furnace	Max Temp: 1000–1200°C, Power: 230V AC, Insulation: Ceramic fiber, Heater: Kanthal
Temperature Sensor	K-Type Thermocouple with MAX6675 Module, Range: 0–1300°C, Accuracy: ±2.5°C
Microcontroller	ESP32/ESP8266, Wi-Fi enabled, Dual-core (ESP32), 3.3V logic, SPI/UART/GPIO support
Power Supply	5V DC for microcontroller, 230V AC for furnace, opt-isolated relay control
Display (optional)	OLED Display (SSD1306), 128x64 pixels, I2C Interface
Enclosure	Heat-resistant ABS or metal casing for electronics
Additional Sensors	DHT11 (optional for ambient conditions)

Software:

Software Component Specifications

Firmware	Developed in Arduino IDE
IoT Communication	MQTT (Mosquitto Broker) or HTTP
Cloud Platform	ThingsBoard / Node-RED for data visualization and control
Mobile App Interface	Blynk (iOS/Android) or custom app via MIT App Inventor/Flutter
Web Dashboard (Optional)	ThingsBoard, real-time graphs, controls, alert system
Data Logging	Cloud-based (ThingsBoard)
Safety Features	Over-temp alerts
OTA Updates	Over-The-Air firmware updates via Wi-Fi (ESP32 feature)

Integration Overview

Sensor to Microcontroller: Thermocouple reads furnace temperature, MAX6675 converts analog signal to digital (SPI), read by ESP32.

Microcontroller to Cloud: ESP32 sends temperature data via Wi-Fi to selected cloud platform using MQTT or HTTP.

User to System: Users interact via mobile app or dashboard to monitor temperature, change set points, and receive alerts.

V.WORKING PRINCIPLE

The working principle of the IoT-enabled electric muffle furnace system is based on real-time temperature sensing, automated control, and remote monitoring through cloud connectivity. The system is designed to enhance the safety, precision, and efficiency of furnace operations.

Temperature Sensing and Data Acquisition

A **K-type thermocouple** is placed inside the muffle furnace chamber to sense the internal temperature. This sensor produces a small voltage proportional to the temperature, which is amplified and digitized using the **MAX6675 thermocouple amplifier module**. The processed temperature data is read by the **ESP32 microcontroller** through the SPI interface.

IoT Communication and Cloud Monitoring

The ESP32 is connected to a **Wi-Fi network**, enabling it to send live temperature data to an **IoT platform** (e.g., Blynk, Firebase, or ThingsBoard) using protocols like **MQTT or HTTP**. The data can be accessed remotely via a **mobile app or web dashboard**, allowing the user to:

- Monitor current temperature in real time
- Set or update the temperature threshold
- Manually turn the furnace ON or OFF
- Receive alerts if the temperature exceeds safe limits

Safety and User Interaction

Over-temperature Protection: The system sends alerts and shuts down the furnace if a critical temperature is detected.

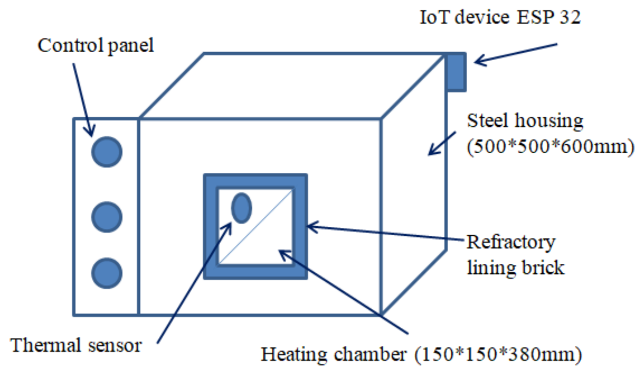
Manual Override: The user can manually control the furnace remotely, overriding the automatic logic when needed.

Data Logging: Temperature data can be logged on the cloud for historical analysis and quality control.

CONSTRUCTION:

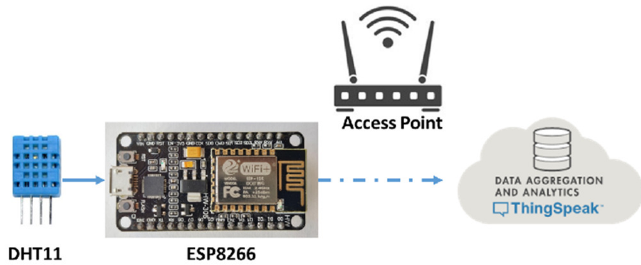
DESIGN DIAGRAM

ELECTRIC MUFFLE FURNACE



Front view of electric muffle furnace

IoT components and feedback devices



Thing speak:

Thing Speak is an open-source IoT analytics platform service which allows users to communicate with internet enabled devices. It facilitates data access, retrieval and logging of data by providing an API to both the devices and social network websites. It allows users to aggregate, visualize, and analyse live data streams in the cloud. The user can send data to Thing Speak from any device (ESP8266), create instant visualizations of live data, and send alerts using web services like Twitter and Twilio. With MATLAB analytics inside Thing Speak, you can write and execute MATLAB code to perform pre-processing, visualizations, and analyses. Thing Speak enables engineers and scientists to prototype and build IoT systems without setting up servers or developing web software.

DHT11 digital temperature and humidity sensor is a composite Sensor contains a calibrated digital signal output of the temperature and humidity. Application of a dedicated digital modules collection technology and the temperature and humidity sensing technology, to ensure that the Product has high reliability and excellent long-term stability. The sensor includes a resistive sense of wet components and an NTC temperature measurement device, and connected with a high-performance 8-bit microcontroller.

Data Format:

DHT11 uses a simplified single-bus communication. Single bus that has only one data line, the system of data exchange, controlled by a single bus to complete. Device (master or slave) through an open-drain or tri-state port connected to the data line to allow the device does not send data to release the bus, while other devices use the bus; single bus usually require an external one about 5.1kΩ pull-up resistor, so that when the bus is idle, its status is high. Because they are the master-slave structure, and only when the host calls the slave, the slave can answer, the host access devices must strictly follow the single-bus sequence, if the chaotic sequence, the device will not respond to the host.

Single bus to transfer data defined DATA for communication and synchronization between the microprocessor and DHT11, single-bus data format, a transmission of 40 data (The 8bit humidity integer data + 8bit the Humidity decimal data +8 bit temperature integer data + 8bit fractional temperature data +8 bit parity bit)

PROGRAMMEE IN ARDUINO IDE

Displaying Temperature and Humidity in ThingSpeak

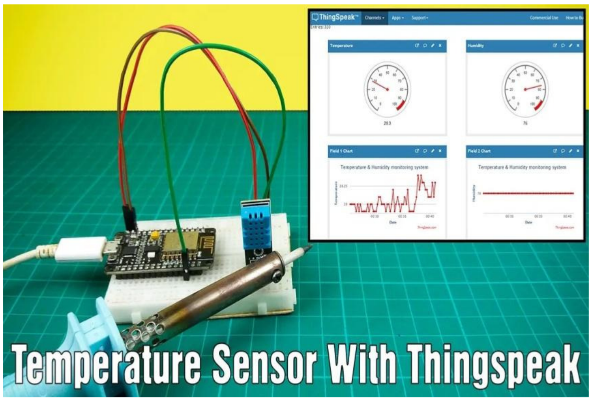
```
#include <ESP8266WiFi.h>
#include "ThingSpeak.h"s
#include <Adafruit_Sensor.h>
#include <DHT.h>
#include <DHT_U.h>
#define DHTPIN 2 // Digital pin connected to the
DHT sensor
#define DHTTYPE DHT11 // DHT 11
const char* ssid = "Hamajidhu"; // your network
SSID (name)
const char* password = "01012020"; // your
network password
int i = 0;
WiFiClient client;
unsigned long myChannelNumber = 2869942;
const char * myWriteAPIKey =
"EK44673MMR4PZI66";
// Timer variables
unsigned long lastTime = 0;
unsigned long timerDelay = 30;
DHT_Unified dht(DHTPIN, DHTTYPE);
uint32_t delayMS;
void setup() {
Serial.begin(115200); //Initialize serial
WiFi.mode(WIFI_STA);
ThingSpeak.begin(client); // Initialize ThingSpeak
dht.begin();
}
void loop() {
int temp,hum;
for (i = 0; i < 50; i++)
{
if ((millis() - lastTime) > timerDelay) {
// Connect or reconnect to WiFi
if (WiFi.status() != WL_CONNECTED) {
Serial.print("Attempting to connect");
while (WiFi.status() != WL_CONNECTED) {
WiFi.begin(ssid, password);
delay(5000);
}
Serial.println("\nConnected.");
}
// Get temperature event and print its value.
sensors_event_t event;
dht.temperature().getEvent(&event);
if (isnan(event.temperature)) {
Serial.println(F("Error reading temperature!"));
```

```
}
else {
Serial.print(F("Temperature: "));
Serial.print(event.temperature);
temp=event.temperature;
Serial.println(F("°C"));
}
// Get humidity event and print its value.
dht.humidity().getEvent(&event);
if (isnan(event.relative_humidity)) {
Serial.println(F("Error reading humidity!"));
}
else {
Serial.print(F("Humidity: "));
Serial.print(event.relative_humidity);
hum=event.temperature;
Serial.println(F("%"));
}
ThingSpeak.setField(1, temp);
ThingSpeak.setField(2, hum);
int x = ThingSpeak.writeFields(myChannelNumber,
myWriteAPIKey);
if (x == 200) {
Serial.println("Channel update successful.");
}
else {
Serial.println("Problem updating channel. HTTP
error code " + String(x));
}
lastTime = millis();
}
}
}
```

Pin Connection:

ESP32	DHT11
GPIO2 (D4)	DATA
3.3V	Vcc
Gnd	Gnd

Temperature appears in graph



CONCLUSION

The integration of Internet of Things (IoT) technology with the electric muffle furnace successfully demonstrates how traditional laboratory or industrial equipment can be modernized for enhanced functionality, efficiency, and safety. Through real-time temperature monitoring, remote access, automated control, and cloud-based data logging, the system provides a smart and user-friendly solution for managing high-temperature operations.

By using a microcontroller (ESP32/ESP8266), a temperature sensing module (K-type thermocouple with MAX6675), and an IoT platform (such as Blynk, Firebase, or MQTT with a custom dashboard), the project enables users to remotely control furnace operations, track historical data, and receive instant alerts for abnormal conditions. The automatic control logic also ensures temperature stability, reduces energy consumption, and minimizes human error.

Overall, this project not only enhances the operational intelligence of the furnace but also opens possibilities for predictive maintenance, process optimization, and integration into larger smart lab or smart factory systems. It serves as a practical implementation of Industry 4.0 concepts in the thermal processing domain.

REFERENCES

- MAX6675 Thermocouple Digital Converter Datasheet. [Online]. Available:

https://datasheets.maximintegrated.com/en/ds/MAX6675.pdf

- ESP32 Technical Reference Manual. Espressif Systems. [Online]. Available: https://www.espressif.com/sites/default/files/documentation/esp32_technical_reference_manual_en.pdf

- K-Type Thermocouple Theory and Application. Omega Engineering. [Online]. Available: https://www.omega.com/en-us/resources/thermocouples

- Blynk IoT Platform Documentation. [Online]. Available: https://docs.blynk.io