Ramaiah Institute of Technology

Product Design Report (EEL-48)

Accelerated Weathering Chamber

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Abstract:

The Accelerated Weathering Chamber (AWC) is a crucial tool for simulating environmental conditions to predict the longterm effects of weathering on materials. This project report delves into the necessity of an AWC with precise and accurate parameters. As industries increasingly rely on material durability for product longevity and reliability, the ability to replicate and accelerate environmental stressors such as UV radiation, temperature, humidity, and other climatic conditions becomes essential. This report highlights the limitations of existing weathering chambers and underscores the significance of advanced technologies to achieve more accurate and consistent results. Through comprehensive analysis and case studies, we illustrate how an AWC with enhanced accuracy can lead to better material selection, improved product performance, and reduced costs associated with premature material failure. The findings emphasize the role of precise parameter control in enhancing the predictive capabilities of weathering simulations, ultimately contributing to more robust and durable materials in various industries.

Introduction and Review:

a. Introduction to the product

A weathering chamber is a type of environmental or climate device that simulates accelerated weathering conditions on a material or object in order to test its ability to withstand weathering conditions. Tests may include a variety of weathering cycles while introducing ultraviolet light, water, heat and often corrosive conditions contributing to material deterioration. These chambers are useful when developing materials that will be exposed to external conditions [2]. The capability of a material to retain its desired properties after continued exposure to weathering provides an estimate of the service life of a material. Research and development help determine the factors necessary to engineer more reliable materials that can handle harsh conditions.

The natural weathering of materials exposed to the several exposure conditions may take many years, which is impractical for expeditiously testing and developing products. As such, weathering chambers provide a space where artificial weather conditions [3] can be created in an accelerated and controlled manner. Various properties may be tested often, mechanical properties such as tensile strength, elasticity or visible characteristics such as discoloration and cracking are evaluated. Other materials might be tested for their ability to resist corrosive salt sprays. ASTM G154 testing uses fluorescent light sources that can simulate UVA or UVB and evaluate the impact of UV exposure on a product's mechanical properties. This method is used for evaluating accelerated weathering on plastics, adhesives and sealants, printing inks, coatings and roofing materials and insulating materials like silica.

b. Market for the Product

Accelerated weathering chambers are vital instruments used across various industries to simulate environmental conditions and test the durability of materials. These chambers reproduce factors such as UV radiation, temperature, humidity, and other weatherrelated elements in a controlled environment, allowing manufacturers to predict the longevity and performance of their products. This report delves into the current market landscape of accelerated weathering chambers, exploring key trends, driving factors, challenges, and future prospects. The accelerated weathering chamber market is poised for substantial growth, driven by technological advancements, stringent regulatory standards, and expanding applications. While challenges such as high initial costs and the need for technical expertise persist, the market's future remains bright with opportunities for innovation and expansion.

Wheatering tests for the highest demands

The global market for accelerated weathering chambers has witnessed steady growth over the past decade. As of 2023, the market size is estimated to be valued at approximately USD 600 million, with a projected compound annual growth rate (CAGR) of 5.8% over the next five years. The rising demand for highquality, durable products across various industries is a significant driving force behind this growth.

Competitors and their Market share

Key players in the Accelerated weathering chamber global market market are –

1. Q-Lab Corporation

Overview: A leader with over 60 years of experience, Q-Lab is known for its high-quality weathering and corrosion testing products.

Key Products: QUV Accelerated Weathering Tester, Q-SUN Xenon Test Chamber.

Strategy: Focus on innovation, customer support, and extensive R&D.

Future Outlook: Strong market position with continuous product enhancements and global expansion.

2. Atlas Material Testing Solutions

Overview: A subsidiary of AMETEK, Inc., Atlas has over 100 years of experience in advanced testing technology.

Key Products: CI 4000 Weather-Ometer, Xenotest Beta+.

Strategy: Emphasis on technological innovation and tailored customer solutions.

Future Outlook: Growth driven by strong brand reputation, sustainability focus, and expanding product portfolio.

3. Weiss Technik

Overview: Part of the Schunk Group, Weiss Technik is a major global player in environmental simulation systems.

Key Products: SunEvent, SolarSimulation weathering chambers.

Strategy: Innovation, quality, sustainability, and a strong global service network.

Future Outlook: Poised for growth with a focus on energyefficient and environmentally friendly solutions.

4. Suga Test Instruments

Overview: A Japanese company with over 70 years of experience in high-quality testing equipment.

Key Products: U-48H Xenon Weather Meter, C-UV Accelerated Weathering Tester.

Strategy: Precision engineering, customer satisfaction, and continuous product enhancement.

Future Outlook: Strong growth potential with ongoing R&D investments and a focus on quality.

Presto Stantest

Overview: An Indian company known for affordable, highquality testing solutions.

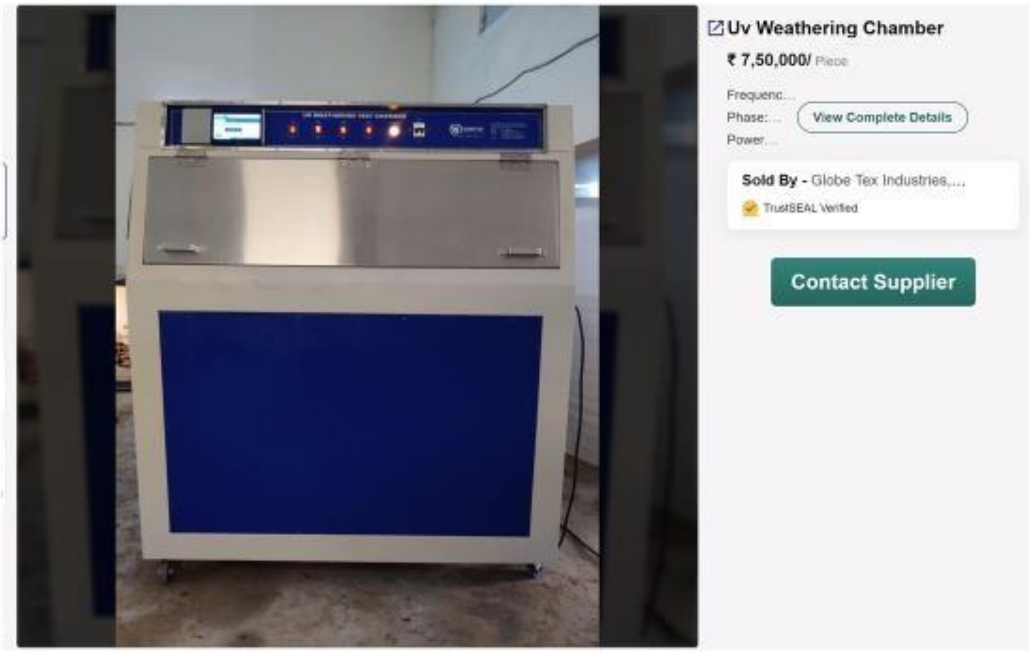
Key Products: UV Accelerated Weathering Tester, Xenon Weathering Chamber.

Strategy: Affordability, quality, and comprehensive customer support.

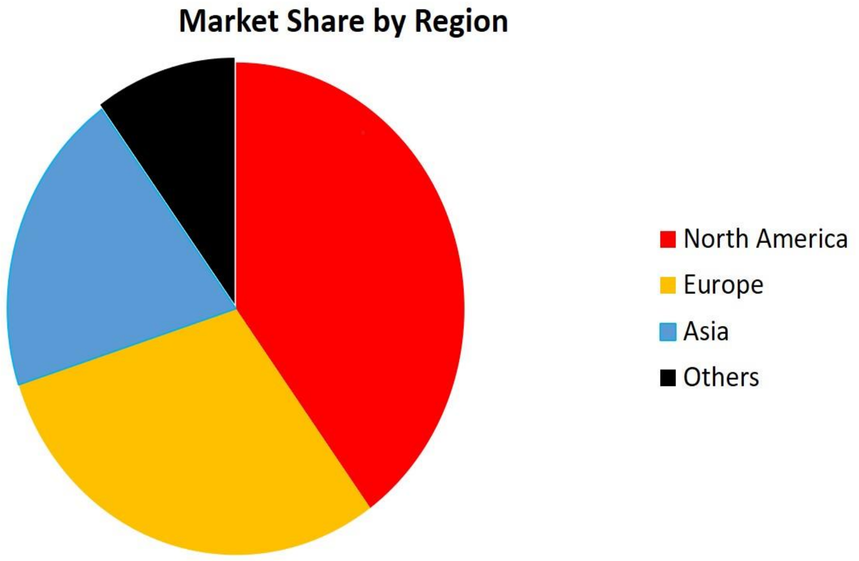
Future Outlook: Positioned for growth in emerging markets with a focus on cost-effective, reliable solutions.

c. Existing Product Survey

The market for accelerated weathering chambers faces several significant challenges, including high initial costs, maintenance and calibration needs, technical expertise requirements, standardization issues, limited simulation accuracy, environmental concerns, technological obsolescence, supply chain disruptions, and usability issues. Addressing these problems is crucial for the continued growth and effectiveness of accelerated weathering chambers. Innovations in technology, improved standardization, and a focus on sustainability and usability will be key to overcoming these challenges and ensuring that weathering chambers remain essential tools for material testing and quality assurance.



Market Share by Region

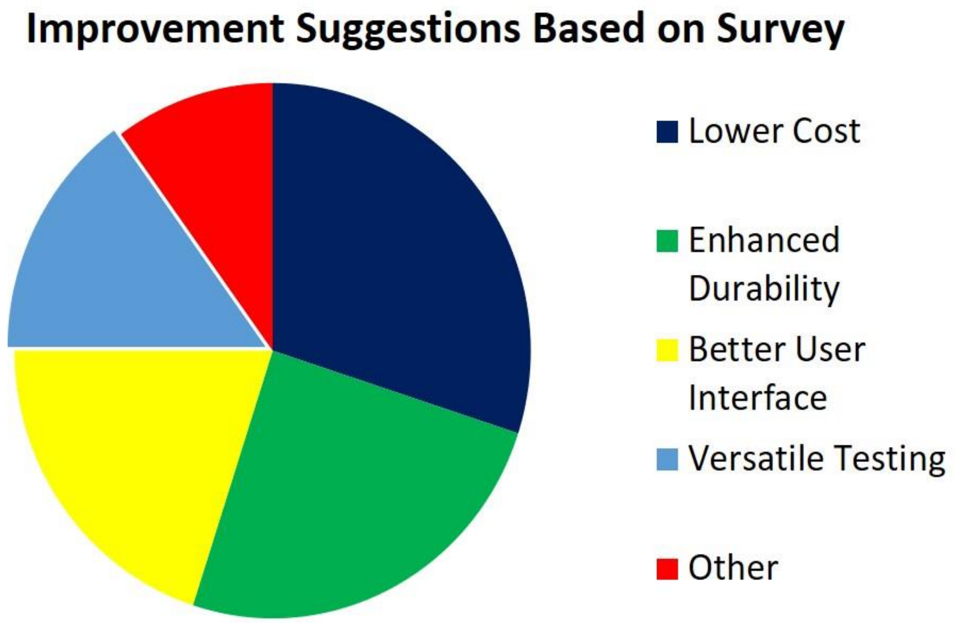


d. Market Survey

We conducted a survey of 40 participants through Google Forms. The questions covered general opinions on weathering chambers, potential improvements, and customer requirements.

- 1. Majority of respondents find the current weathering chambers effective but costly.
- 2. Suggested improvements include enhanced durability and lower costs.
- 3. Common requirements are better user interfaces and more versatile testing options.

Improvement Suggestions



S.NO	Submit Date	How satisfied are you with the precision control features of the Accelerated Weathering Chamber?	How important is the chamber's ability to simulate complex environmental scenarios, such as cyclic temperature and humidity variations, in your testing protocols?	How effectively does the chamber's automation features, such as automatic test cycle initiation and data logging, streamline your testing processes?	How effective is the integration of advanced sensor technology in the Accelerated Weathering Chamber for real-time monitoring of environmental conditions such as UV radiation, temperature, and humidity?	How important is the energy efficiency of the Accelerated Weathering Chamber in reducing operational costs and environmental impact during polymer insulator testing?	How effective is the chamber's real-time alarm and notification system in alerting users to critical test conditions or equipment malfunctions?	How well does the chamber's advanced data analytics feature support the identification of trends and patterns in polymer insulator degradation and performance?	How important is the ability to access test data and results from the Accelerated Weathering Chamber remotely via cloud services?
1	02-06-2024 16:14:07	Very Satisfied	Very important – It is necessary for most tests but some can be conducted with simpler simulations.	Very effectively – Automation features significantly streamline our processes, reducing manual effor	Extremely effective – Advanced sensors provide precise and real-time data, significantly enhancing	Critically important – Energy efficiency is essential for minimizing costs and environmental impact. | Very important – It is important for cost reduction but not critical.	Effective – The system generally works well but occasionally misses critical alerts. | Moderately effective – The system provides some alerts but often lacks reliability.	Very well – Advanced analytics provide clear insights into trends and patterns, enhancing our under | Moderately well – Analytics provide some insights but often lack depth and accuracy.	Critically important – Remote access to test data is essential for our operations and decision-maki
2	02-06-2024 16:18:27	Satisfied	Very important – It is necessary for most tests but some can be conducted with simpler simulations.	Effectively – Automation features are helpful but sometimes require manual oversight.	Very effective – Sensors generally provide reliable data but occasionally require calibration.	Moderately important – It is somewhat important but other factors are more critical	Moderately effective – The system provides some alerts but often lacks reliability.	Well – Analytics are generally useful but could be improved for better clarity and detail.	Very important – Remote access is important but not critical for all tests.
3	02-06-2024 16:44:08	Very Satisfied	Very important – It is necessary for most tests but some can be conducted with simpler simulations.	Very effectively – Automation features significantly streamline our processes, reducing manual effor	Extremely effective – Advanced sensors provide precise and real-time data, significantly enhancing	Very important – It is important for cost reduction but not critical.	Highly effective – The alarm and notification system is reliable and provides timely alerts.	Very well – Advanced analytics provide clear insights into trends and patterns, enhancing our under	Very important – Remote access is important but not critical for all tests.
4	02-06-2024 18:59:47	Satisfied	Critically important – Simulating complex scenarios is essential for our testing protocols and ensur	Very effectively – Automation features significantly streamline our processes, reducing manual effor	Very effective – Sensors generally provide reliable data but occasionally require calibration.	Critically important – Energy efficiency is essential for minimizing costs and environmental impact.	Highly effective – The alarm and notification system is reliable and provides timely alerts.	Very well – Advanced analytics provide clear insights into trends and patterns, enhancing our under	Very important – Remote access is important but not critical for all tests.

e. Problem Statement

To Redesign and Redevelop an **Accelerated UV weathering chamber(V2.0)** to monitor the change in property of the specimen exposed to certain weathering conditions using IOT interface

f. Objectives

To enhance the performance and accuracy of existing weathering chambers by developing an advanced model that addresses current limitations. This involves incorporating stateof-the-art technologies and design improvements to provide more precise simulation of environmental conditions, reduce operational costs, and increase overall reliability. The upgraded weathering chamber model will aim to:

1. **Improve Simulation Accuracy**: Integrate advanced sensors and control systems to more accurately replicate real-world weathering conditions, ensuring that test results are reflective of actual environmental impacts.
2. **Enhance Durability and Reliability**: Utilize robust materials and engineering practices to increase the durability of weathering chambers, thereby extending their lifespan and reducing maintenance requirements.
3. **Optimize Cost-Effectiveness**: Implement design innovations that lower both initial costs and operational expenses, making advanced weathering chambers more accessible to a broader range of users.
4. **Increase User-Friendliness**: Develop an intuitive user interface and automated features that simplify the operation and monitoring of weathering chambers, reducing the need for specialized training and enabling more efficient testing processes.
5. **Expand Testing Capabilities**: Incorporate versatile testing options that allow for a wider range of environmental simulations, catering to diverse testing needs and enhancing the chamber's applicability for various industries.

Methodology:

a. Features and Specifications

To address the limitations of current weathering chamber models and develop an advanced, reliable product, a comprehensive methodology will be employed. The process begins with a thorough assessment of existing models, including a review of their design, performance metrics, and user feedback. This evaluation is supplemented by benchmarking against industry standards and leading competitors. Data and insights gathered from users, industry experts, and maintenance teams will guide the identification of key areas for improvement, including accuracy, durability, cost-effectiveness, and userfriendliness.

- Precise temperature, UV, humidity control.
- TFT display.
- Enhanced thermal insulation.
- Dedicated programable keys.
- Updated program.
- PCB based circuit design.

SPECIFICATION

1. Temperature Range and Control:

- Range: -20°C to 100°C
- Control Accuracy: ±1°C
- Uniformity: ±2°C throughout the chamber

2. Humidity Range and Control:

Range: 10% to 95%

Control Accuracy= +/- 3% RH

3. Light Source:

Type: Xenon arc lamp or UV lamp

- Wavelength: 290 nm to 800 nm for Xenon; 340 nm for UV
- Intensity: Adjustable, typically 0.35 to 0.80 W/m² at 340 nm

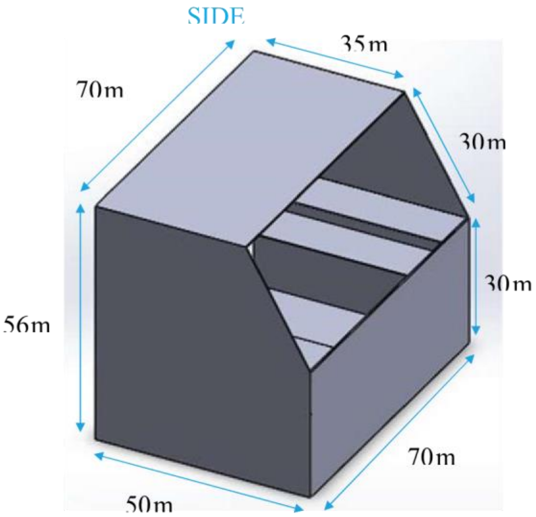
4. Cycle Programming:

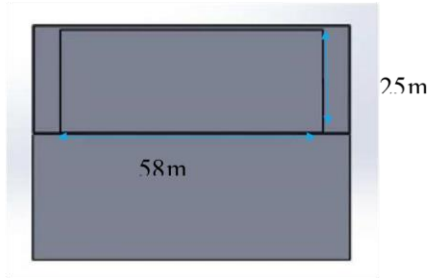
- Light/Dark Cycles: Programmable, typically 4 hours light / 4 hours dark
- Temperature Cycles: Programmable to simulate day/night or seasonal variations
- Humidity Cycles: Programmable to simulate varying humidity conditions

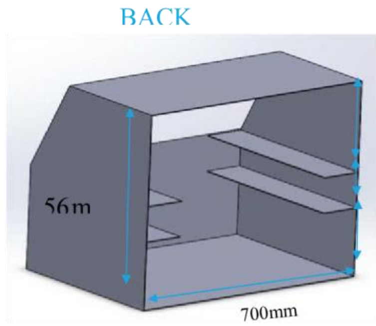
5. Safety Features:

- Over-temperature protection
- Humidity overflow prevention
- Automatic shutoff in case of malfunction

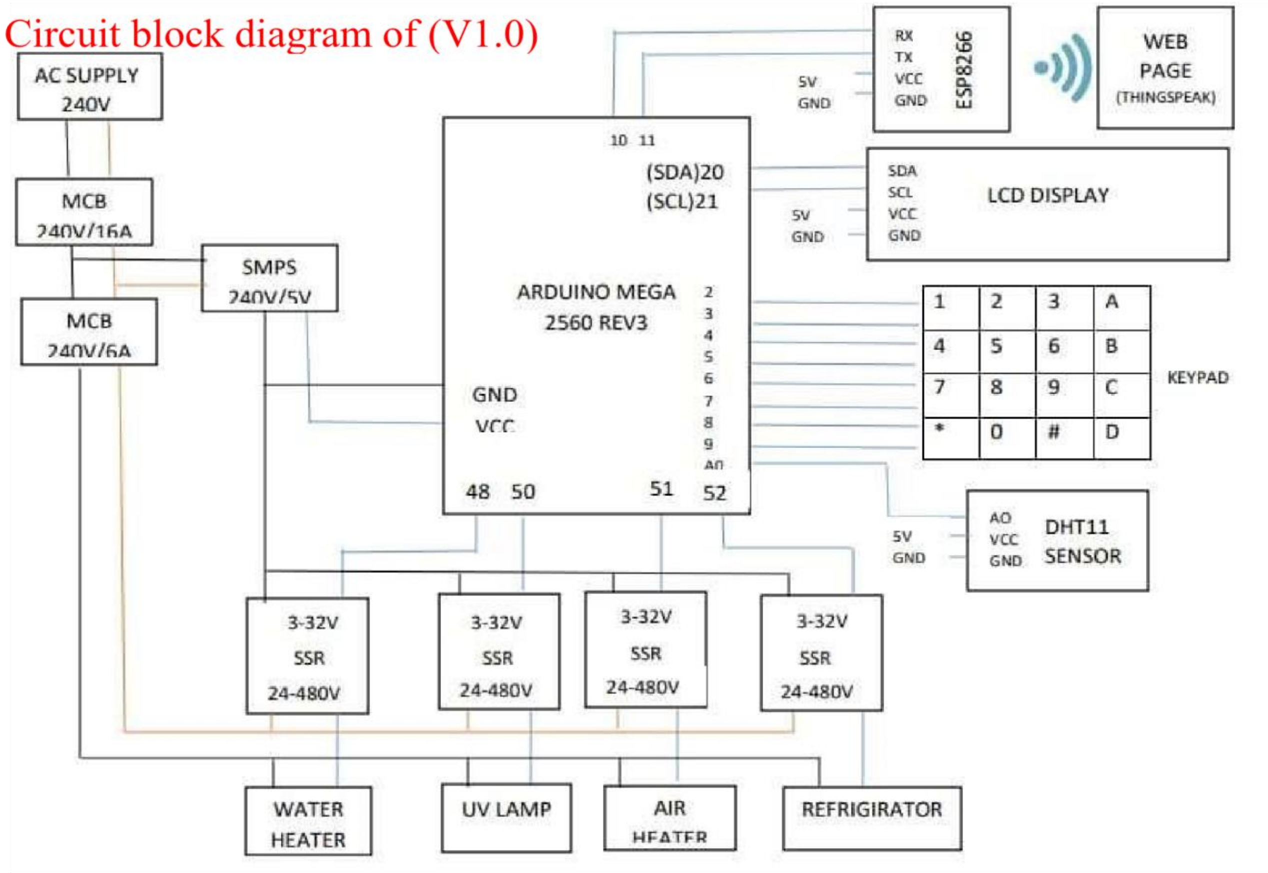
b. CAD Model







c. Block Diagram



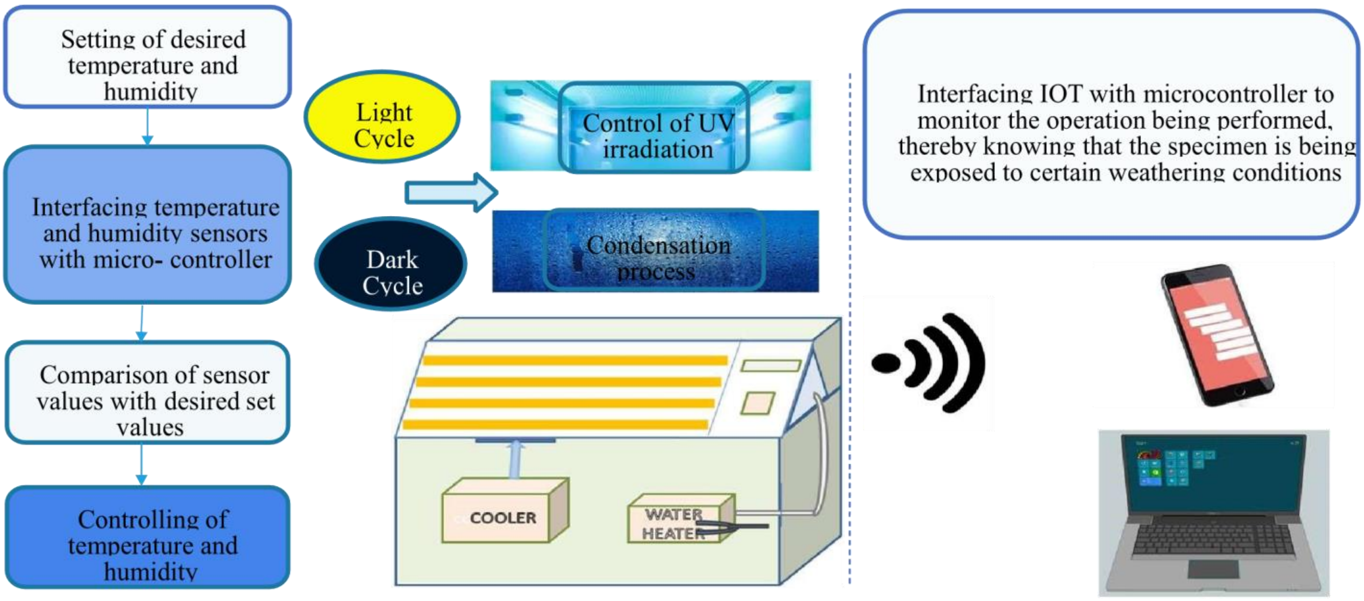
d. IMPROVED FEATURES OF WEATHERING CHAMBER (V2.0)

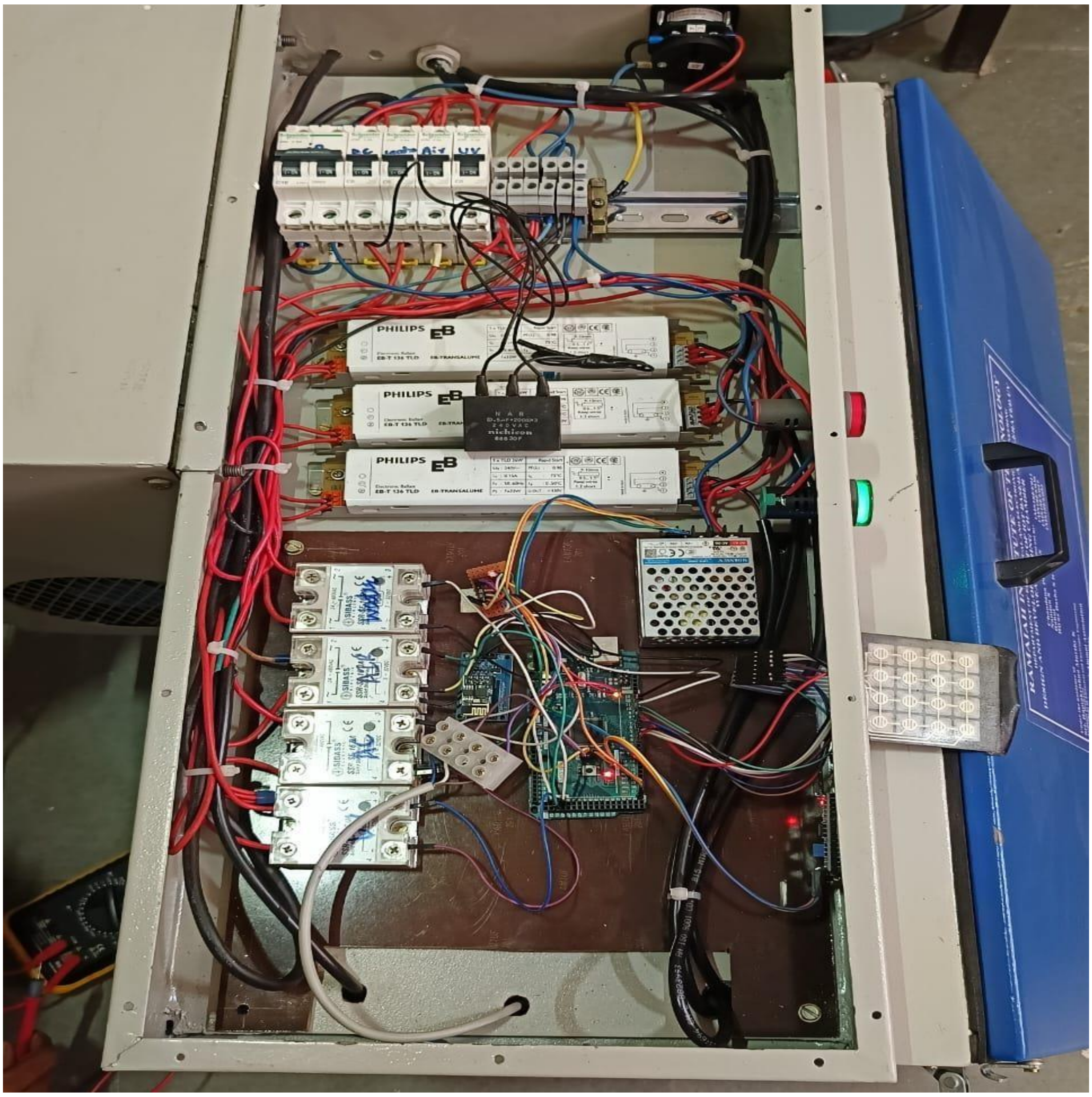
- Precise temperature, UV, humidity control
- Enhanced thermal insulation
- Dedicated programable keys
- Updated program
- PCB based circuit design
- Cable management

- We are eliminating LCD display and implementing new TFT display that is touch screen display
- TFT touch screen displays offer the perfect blend of high-quality visuals and interactivity, making them suitable for a wide range of applications.

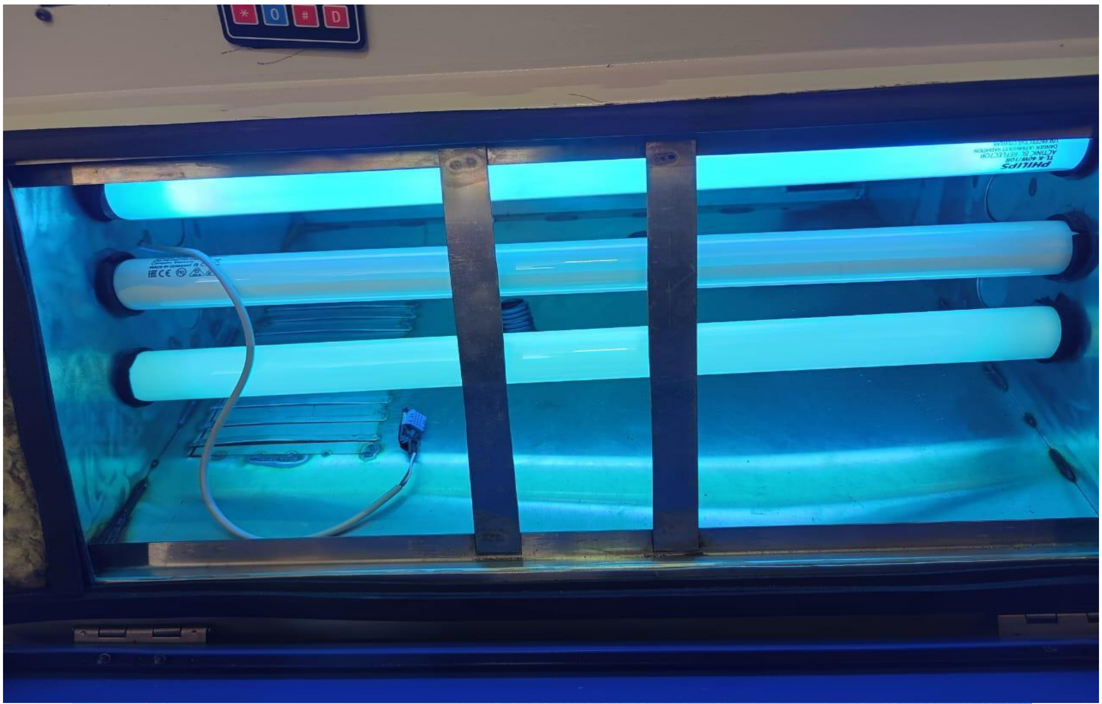
- the different touch technologies and their respective advantages and limitations can help in selecting the right type of touch screen for specific needs.

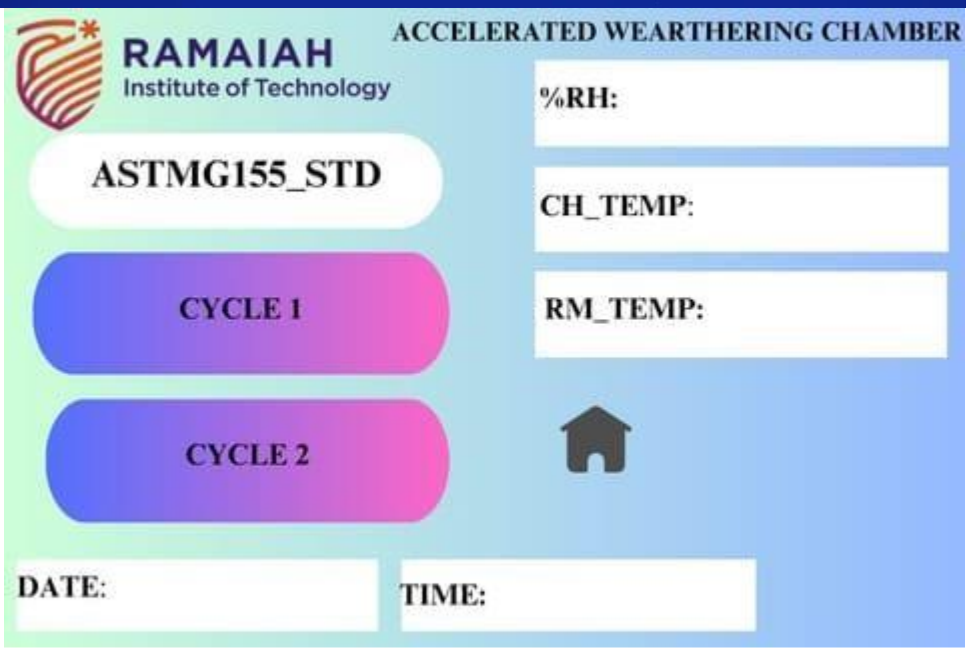
e. Flow Chart





f. Picture of the product





g. Components Used

Components list

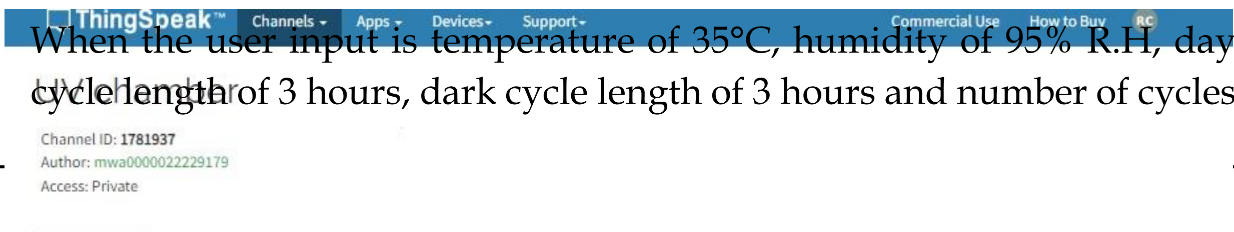
SLNO	COMPONENTS	SPECIFICATIONS	COST IN (RS)	QTY
1	ARDIUNO MEGA	N/A	IN USE	1
2	TFT DISPLAY	N/A	450	1
3	ELECTRONIC CHOKE	240V 36W	IN USE	4
4	SOLID STATE DRIVE (SSR)	12V/6A	IN USE	4
5	SMPS	240V 50HZ AC INPUT 5V 1A DC	IN USE	1
6	MINIATURE CIRCUIT BREAKER	240V/16A	IN USE	1
7	MINIATURE CIRCUIT BREAKER	240V/16A	IN USE	1
8	INDICATOR	240V 50HZ AC	IN USE	1
9	HUMIDITY SENSOR	3 to 5v power and i/o, 2.5ma	750	1

Results and Discussions:

Once the chamber is turned ON , parameters such as number of cycles, temperature, humidity, dark cycle duration, light cycle duration have been inputed. Consider the user set number of cycles is 1000, temperature is 35°C, humidity is 95% R.H, dark cycle duration is 5 hours, light cycle duration is 6 hours, then based on this and sensor output, the chamber heater or cooler will be ON. Assume sensor output temperature of 30°C and sensor output humidity as 70% R.H. In this case the chamber heater is ON as the user set temperature (35°C) is more than the sensor output temperature (30°C) of the chamber. Also, water heater is ON as the user set humidity (95% R.H) is more than the sensor output humidity (70% R.H) of the chamber. The cooler and cooler fan will be OFF. This process goes on for 1000 cycles where one cycle is equal to one light cycle and one dark cycle.

The IOT intergration using ThingSpeak is done resulting in temperature, humidity and the present cycle which appears under the UV chamber module created.

When the user input is temperature of 35°C, humidity of 95% R.H, day cycle length of 3 hours, dark cycle length of 3 hours and number of cycles



of 100 cycles, the IOT output on ThingSpeak were monitored and captured. Initially the temperature and humidity in the chamber

Since the temperature is lower than the user set temperature, the chamber heater turns on and starts to heat up the chamber air. As the temperature increases initially the humidity dropped drop to a value as shown in the figure 4.2. This behaviour inside the chamber is observed due to the inversely proportional characteristics of temperature and humidity

Conclusion:

To select the appropriate material, as an important essential of its selection and research for various applications, its properties, ageing knowledge, performance, durability and reliability when prone to weathering are to be assessed. To assess these in a shorter duration,

an accelerated weathering chamber is best to be used. In this project information has been gathered to design and develop an accelerated UV weathering chamber with the basic exposures in artificial weathering conditions, to test the material degradation and property change. UV irradiance, temperature and moisture are the minimum basic conditions considered in the device and designed keeping in mind the industrial ASTM G154 standards. There will be control of the temperature and humidity in the chamber with the help of sensor, heaters and cooler interfaced with the microcontroller. The user gets the flexibility to set the requirements of exposure duration and number of cycles using the trivial user interface method. The user can even view the real time parameter and condition values inside the chamber over IOT using Thing Speak platform. The device is aimed to have only the basic principles and operating exposures keeping up to the standards of industrial requirement. The methodology and implementation of the entire device has precise control with the combination of a simple design. The results are showed by running the chamber for required number of cycles and also by 3D modelling the chamber according to the design details. Challenges and complexities were handled to make it a suitable effective industry standard product to serve the testing in materials assessment criteria.

Future scope:

The proposed chamber can have effective user interface by integrating human machine interface. Have controlling option in the IOT itself for the entity who owns the chamber . however the user should only be given the privilege to monitor. Can have separate cloud database where all the information like No. of cycles, time left, the present weathering conditions, etc. will be sent to the user using Google Firebase. As the work has been done only on three parameters (Temperature, Humidity and UV Irradiance), further additional conditions like rain, optical filters, thermal shock, high voltage stress, leakage current, etc. can be incorporated with advanced features available in the Industrial UV Weathering Chamber like Irradiation control (voltage controlled), UV sensor, Gas-discharge lamps, HMI, etc. can be added. Can be implemented using STM microcontroller and finally turn this UV weathering Chamber into an industrial device according to ASTM G154 standards.

References:

- "Technological Advancements in Weathering Chambers" - Journal of Material Science and Testing"Global Accelerated Weathering Testing Chamber Market Analysis 2023" - Market Research Future
- ASTM G155 - "Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials"

- ISO 4892-2 - "Plastics - Methods of Exposure to Laboratory Light Sources - Part 2: Xenon-Arc Lamps"
- **"Accelerated Weathering of Polymers: Methods, Characterization,andApplications"**
  Authors: R.J. C. van der Meer, J.J. H. van der Meer
  Journal: Journal of Materials Science

Appendix A:

Here is the complete code for the interfacing of difference cycles and processes in the Weathering chamber –

```
//#include <LiquidCrystal.h>

// initialize the library with the numbers of the interface pins

//LiquidCrystal lcd(21, 20, 19, 18, 17, 16);// RS EN D4 D5 D6
D7

Keypad customKeypad = Keypad(makeKeymap(hexaKeys),
rowPins, colPins, ROWS, COLS);


short day_dur=1;

short no_cyc=1,tor_dur=1,op_dur=1,cyc_count=0;

bool cyc_flag=0; unsigned int t1; void setup() {

        delay(100);

  Serial.begin(9600);   lcd.init();

lcd.backlight();   lcd.begin(16,

2);   lcd.setCursor(0, 0);

lcd.print("Env Cycle MSRIT");

lcd.setCursor(0, 1);

lcd.print("Version 1.1 ");
```

```
  pinMode(hum1_pin, OUTPUT);//hum pin
pinMode(hum2_pin, OUTPUT);//hum pin
pinMode(uv_pin, OUTPUT);//uv pin   pinMode(htr_pin,
OUTPUT);//htr pin   pinMode(cool_pin,
OUTPUT);//cooler pin   digitalWrite(hum1_pin, LOW);
digitalWrite(hum2_pin, LOW);   digitalWrite(uv_pin,
LOW);   digitalWrite(htr_pin, LOW);
digitalWrite(cool_pin, LOW);

  delay(2000);
}

short sec_10;
short t_min;
bool day_flag;
bool tor_flag;
char key; short
set_hum; short
set_temp; short
cur_hum; short
cur_temp;

void loop() {

            if(cyc_flag)
```

```
-t1)>10000)

sec over

rint("."); if(sec_10==6)

//1min over t_min++;
sec_10=0;
lcd.setCursor(0, 1);
{        if((millis()        lcd.print(String(t_min));
         {                   DHT.read11(dht_dpin);
                               Serial.print("Current humidity = ");
                               Serial.print(DHT.humidity);
                               Serial.print("%  ");
                               Serial.print("temperature = ");

                             Serial.print(DHT.temperature);
                   sec_10++; Serial.println("C                    ");
                             lcd.setCursor(5, 1);
                   {         lcd.print(String(DHT.temperature));
```

```
lcd.setCursor(10, 1);
lcd.print(String(DHT.humidity));

}//1min over

DHT.read11(dht_dpin);
cur_temp=DHT.temperature;
cur_hum=DHT.humidity;

if(day_flag)
{
	if(cur_temp>set_temp)
	{
digitalWrite(uv_pin, HIGH);
		digitalWrite(htr_pin, LOW);
digitalWrite(cool_pin, HIGH);


}
	else
	{
digitalWrite(uv_pin, HIGH);
```

```
digitalWrite(htr_pin, HIGH);
        digitalWrite(cool_pin, LOW);
 }
if(cur_hum>set_hum)
{
  digitalWrite(hum1_pin, LOW);
digitalWrite(hum2_pin, LOW);          digitalWrite(uv_pin,
HIGH);
 }
else
 {
  digitalWrite(hum1_pin, HIGH);
digitalWrite(hum2_pin, HIGH);
digitalWrite(uv_pin,HIGH);
 }
}
if(tor_flag)
{
if(cur_temp>set_temp)
 {
```

```
}
        digitalWrite(uv_pin, LOW);
digitalWrite(htr_pin, LOW);
digitalWrite(cool_pin, HIGH);        }        else
      {
        digitalWrite(uv_pin, LOW);
digitalWrite(htr_pin, HIGH);
digitalWrite(cool_pin, LOW);
      }
                    if(cur_hum>set_hum)
                    {
                        digitalWrite(hum1_pin,
LOW);                         digitalWrite(hum2_pin,
LOW);                        digitalWrite(uv_pin, LOW);
                    }
                    else
                    {
                            digitalWrite(hum1_pin,
  HIGH);                        digitalWrite(hum2_pin,
                     HIGH);
        digitalWrite(uv_pin, LOW);
                    }
```

```
                    }
                }//10 sec over
                if(day_flag)
                {

                    if(t_min>=day_dur)
                    {
                        digitalWrite(htr_pin, LOW);
            digitalWrite(cool_pin, LOW);
                        day_flag=0;
                tor_flag=1;
        t_min=0;
                        lcd.clear();
                        lcd.print("Day Cycle over");
            delay(1000);    //later make it 5000
        //lcd.setCursor(0, 1);
lcd.clear();
                        lcd.print("Dark Cycle-");
        lcd.print(String(no_cyc));

                        lcd.setCursor(0, 1);
                    }
```

```
        }
        if(tor_flag)
        {

            if(t_min>=day_dur)
            {

                lcd.clear();
                lcd.print("Dark Cycle ovr");
delay(1000);
                lcd.setCursor(0, 1);
lcd.clear();
                lcd.print("Day Cycle-");
                lcd.print(String(no_cyc));

                day_flag=0;
                tor_flag=0;
                t_min=0;
                delay(500);      //later make it 5000

                if(no_cyc>1)
                {
```

```
no_cyc--;
day_flag=1;
tor_flag=1;
lcd.clear();
}
else
{
cyc_flag=0;
lcd.clear();
digitalWrite(htr_pin, LOW);
digitalWrite(cool_pin, LOW);      digitalWrite(uv_pin,
LOW);      digitalWrite(hum1_pin, LOW);
digitalWrite(hum2_pin, LOW);
lcd.print("ALL Cycle over");
lcd.setCursor(0, 1);
lcd.print("Pres * for Start");

}


}
}
```

```
                }
                //cycle flag   key =
customKeypad.getKey();

  if (key) {
Serial.println(key);
lcd.print(String(key));

        if (key == 'A')
        {
                DHT.read11(dht_dpin);
                Serial.print("Current humidity = ");
  Serial.print(DHT.humidity);
  Serial.print("%  ");
  Serial.print("temperature = ");
  Serial.print(DHT.temperature);
  Serial.println("C  ");

    }
        if (key == '*')
    {
```

```
lcd.clear();        lcd.print("Enter
Day Dur:");
    Serial.println("New Cycle configuration\n");
    Serial.println("Enter duration for Day Cycle in min: ");
 lcd.setCursor(0, 1);      day_dur = getNum();
delay(500);

        lcd.clear();
lcd.print("Set Tmp:");
Serial.println("Set Temp:");
set_temp=getNum();
delay(500);


        lcd.clear();
        lcd.print("Enter Dark Dur:");
    Serial.println("Enter duration for Dark Cycle in min: ");
lcd.setCursor(0, 1);   tor_dur = getNum();   delay(500);

        lcd.clear();
lcd.print("Set Hum:");
Serial.println("Set Hum:");
```

```
set_hum=getNum();
delay(500);


          lcd.clear();
lcd.print("Enter Cycs:");
     Serial.println("Enter no of cycle");
  lcd.setCursor(0, 1);      no_cyc =
getNum();          delay(500);

                lcd.clear();
lcd.print("Enter No Cyc:");
     Serial.println("Cycle Configuration");
     Serial.println(day_dur);
     Serial.println(tor_dur);
     Serial.println(no_cyc);
        lcd.clear();
```

```
                                        "+String(tor_dur)+"


  lcd.print(String(day_dur)+"
ing(no_cyc));

delay(2000);

lcd.clear();

  lcd.print("Day Cycle-");

lcd.print(String(no_cyc));

                    cyc_flag=1;

  t1=millis();

sec_10=0;

       t_min=0;
       day_flag=1;
       tor_flag=0;
```

```
    }
  }
  delay(100);
}


unsigned int getNum()
{
  char key;
short len = 0;
char num[4];


 short n1 = 0;
while (1)
 {
   key = customKeypad.getKey();
lcd.print(String(key));
   if (key)
   {
     Serial.println(key);

     if (key == 'D')
```

```
{        if
(len > 0)
  {
    num[max_num] = 0;
n1 = atoi(num);
  }
  return n1;

}
num[len] = key;
len++;      if (len ==
max_num)
```

```
      {
        num[max_num] = 0;
n1 = atoi(num);
return n1;
      }
    }
  }
}
```