DESIGN, MANUFACTURE AND EXPERIMENTAL TESTING WITH SIMULATION OF ARDUINO CONTROLLED BRAKE SHOE BONDING OVEN

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ABSTRACT

Due to irregular road condition and unbalanced force applied on the brake shoe by the driver it is common in developing countries to replace the lining either in corrective maintenance or before accident occurred for the sake of ensuring life of automobiles and human beings. For the sake of safety the need arises for design and manufactured of ARDUINO controlled brake shoe bonding oven. Temperature control of systems has become vital in especially, in industrial Applications where their operations are at wide range of temperatures. In different garages, the brake bonding ovens are scarce of controller and have lack of safety. The goal of this work is to build compact and affordable system that can relatively easily programmed to control the oven using ARDUINO. The oven is controlled the temperature by switching circuit or relay which is connected with magnetic contactor. The magnetic contactors are controlled the over loading of power supply and the heating element that does received from the power source. By communicating the heating elements from the programmed language to interpreted the result in the LCD display. Proteus software is used to simulate the result in microcontroller by uploading the programmed in hex file from Arduino and shoed the brake bonding temperature in LCD with heating duration of the brake shoe. ANSYS fluent software is used to simulate the transient process, but also some stationary conditions are evaluated in order to optimize the oven design with required parameters. The performance test gave oven efficiency of 86% with including loss of heat during opening and closing of the door during inserting the brake shoe. Finally, the temperature is displayed in the LCD and when the temperature is reached to maximum limit then the buzzer will sound to count the time by pressing timer in the LCD in 20 minutes then when this time ended the brake shoe has to be remove from the oven.

Key words: Arduino, Temperature control, Control systems, heating Element, Performance, LCD, Relay, Magnetic Contactor, Microcontroller

INTRODUCTION

Most types of friction brakes operate on the principle that friction can be used to convert the mechanical energy of a moving object into heat energy, which is absorbed by the brake. The essential elements of a friction brake are a revolving component, such as a wheel, axle, disk, or brake drum and a stationary part that is pushed against the rotating part to slow or stop, and it takes in a liner over the stationary part which can generate high amount of friction and causes long wear life. Eventhogh, all brake lining friction material for a brake system were deliberate to preserve stable and reliable friction coefficient at an extensive range of pedal pressure, vehicle speed and temperature the enactment of the brake declines through time. For this case to achieve brake efficiency the brake shoe should have got new brake lining during corrective maintenance. Heating system practice equipment play a great role in automotive industry especially in our country Ethiopia due to the road condition and environmental factors the brake shoe are maintained for preventive maintenance and corrective maintenance before failure of brakes occurred. Heat treatment is usually accompanying with increasing the strength of the materials and in forming their properties in to different shapes and used to bond lining with brake shoe material. These tasks are performed in industrial ovens for heat treatment, stress releasing, tempering and pre- heating.

MATERIALS AND METHODS

Generally, it consists of the heating element, controller (microcontroller) thermal sensor and power supply. The heating element which is going to be heated at the given temperature which produces a current flow by receiving heat from the source is used to heat up the brake shoe in the given oven. The heating element temperature is controlled by microcontroller so called ARDUINO UNO which is the latest technologies now a days used in different researches. These arduino have wide range of features integrated and capable of developing programming or coding for the given design. The coding is loaded in this microcontroller and the temperature is measured by the temperature sensor and the temperature is set to give the right heating sense to the oven by sequentially sends the required current in to the base of the supply by the transistors until it achieves the required value. Otherwise, the temperature should be resetting and flows as in its optimal value. Likewise, the temperature is controlled. As a result, the heat loss due to controlled temperature is minimized when

compared to the problem stated in statement of problem. And the timer is also used for knowing the timing for heating of the brake shoe in the oven. [5] discussed a project, Proton Exchange Membrane (PEM) energy unit are progressively being refered to by governments as a conceivable pathway to the decrease of ozone depleting substance outflow. It is one of the forthcoming force hotspots for car applications, prepare machines, stationary cogeneration frameworks, and portable electronic gadgets. Be that as it may, the dryness of the film of a PEM power device diminishes the ionic conductivity, bringing about execution decrease. In this work, a two-dimensional model is utilized to examine the fundamental and collaboration impacts of five outline factors, at three levels in a proton trade layer (PEM) energy unit. Investigation is directed for working possibilities of 0.7 and 0.6V and a scope of current densities. An engine that picks up its energy from a hydrogen tank and a power device Stored in a tank. The substance vitality from the hydrogen will be changed over into electrical vitality by the power device to push the prepare at up to most extreme speed of 80km/hr. Prepare apparatuses like Fans, lighting may likewise keep running on PEM energy unit. This new hydrogen prepare is along these lines ideal for shorter, calmer extends of the system that jolt hasn't yet come to.

Arduino controlled brake bonding oven

In order to provide faster heating a fan oven which has fan with the heating element around provides the heat or a fan assisted oven that was a small fan to circulate the air in the heat treatment chamber of the heating element can be used. And the heat is transferred to heating element through convection heat transfer. And this is controlled by simple programming using Arduino software, and the temperature can be set and adjust as desired value. A timer also used the oven to be turned on off automatically at preset times.

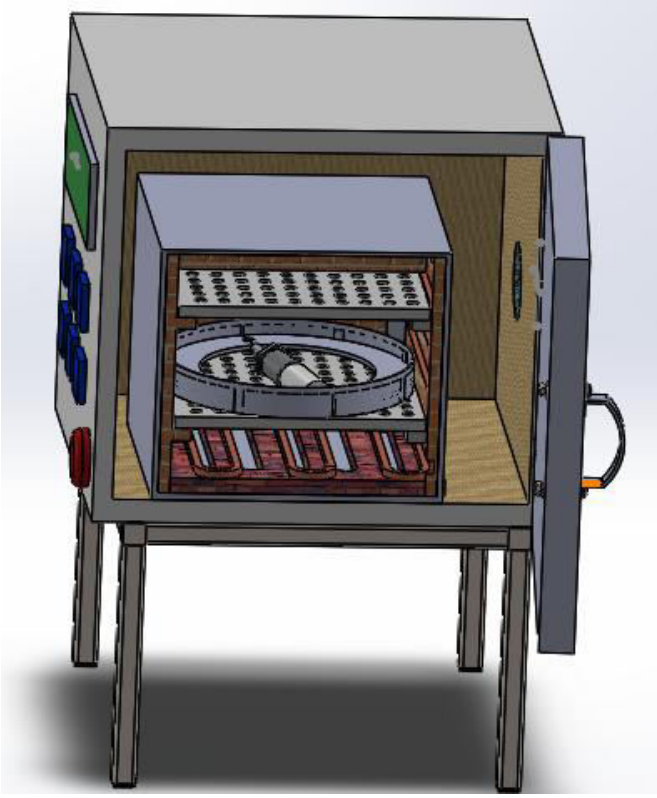

Figure 1. 3D proposed brake shoe bonding oven using solid work

4. RESULT AND DISCUSSION

4.1 Heat transfer analysis of oven using ansys

ANSYS fluent software is used to simulate the transient process, but also some stationary conditions are evaluated in order to optimize the oven design with required parameters. To do the energy transfer rate in the oven property of the materials are very important. The analysis is done in ansys workbench fluid flow or fluent for determining the energy transfer rate in the oven by considering convection and radiation transfer. To analyses the result the properties of the materials in the oven considering and the values are tabulated in the table below. Based on the design specification starting from size of the brake shoe, the capacity of the oven were designed and based on that the model is done using solid works software. Then the model is imported in to ansys software for analysis. The energy equation and surface to surface heat transfer should be activated in the general model list. In the radiation mode of the surface to surface heat transfer method and the energy iteration per radiation should be specified to get accurate value in each step. The energy iteration per radiation giving in the ansys is 10 with maximum number of iterations 50 and residual convergence 0.001 to get accurate result. After setting the values the software computes the result. Then the

materials should be filled their properties that are fed in to the system. Actually there are solid and fluid materials in the oven. The fluid is considered as air which has to be set as an ideal gas and all the properties are considered.

Table 4.1: Description of nichrome alloy

Nichrome Material property	Value	Units
Melting point	1400	°C
Electrical resistivity at room temperature	1.0 × 10−6 to 1.5 × 10−6	Ωm
Specific heat	450	Jkg−1°C−1
Thermal conductivity	11.3	Wm−1°C−1
Specific gravity	8.4	none
Modulus of elasticity	2224.2	pa
Thermal expansion 14 × 10−6	14 × 10−6	°C−1
Density	8400	Kg/m3

Thermal conductivity is the quantity of heat transmitted through a unit thickness in direct normal to the surface. Thermal conductivity of gases, insulating products like fiber glass, aluminum, brass, copper and other common materials of clay should be defined from the engineering tool box thermal conductivity properties before executing the analysis. The heat transfer coefficient for different mediums should be stated before feeding the values in the ansys software and it is included in heat transfer book.

Thermal conductivity is the quantity of heat transmitted through a unit thickness in direction normal to surface. Clay have the value of thermal conductivity of 0.15 to 1.8 w/m.k. but fiber glass have 0.04 w/m.

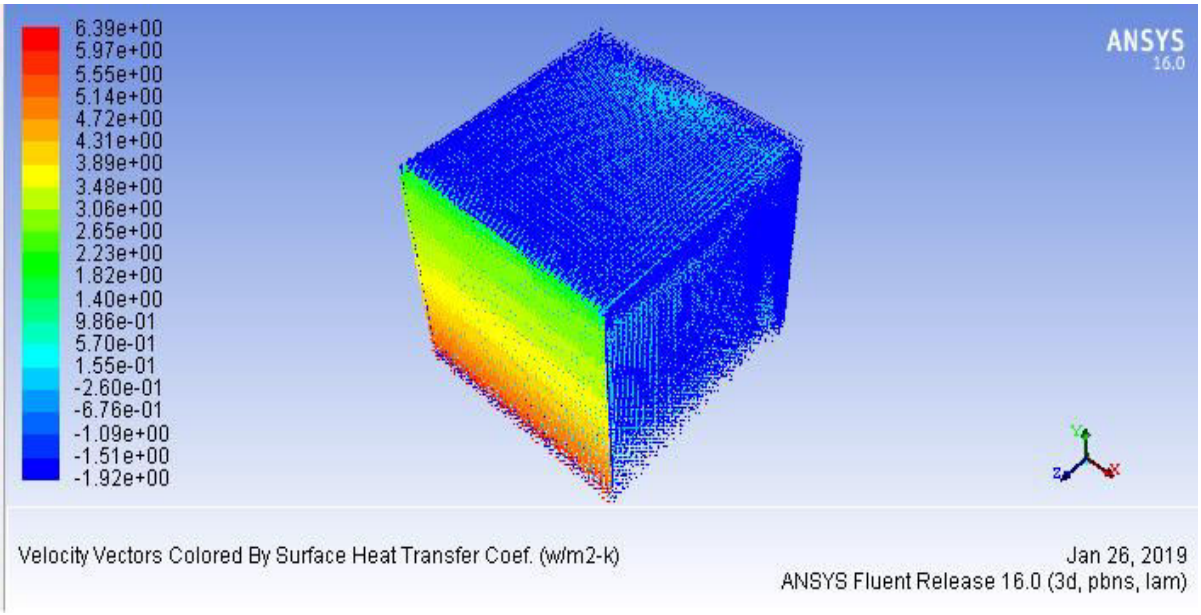

Figure 4.1: Surface heat transfer coefficient analysis result

As shown in the figure the heat transfer coefficient in the oven which is displayed in velocity vectors colored and the maximum value is 6.39 W/M^2.K.

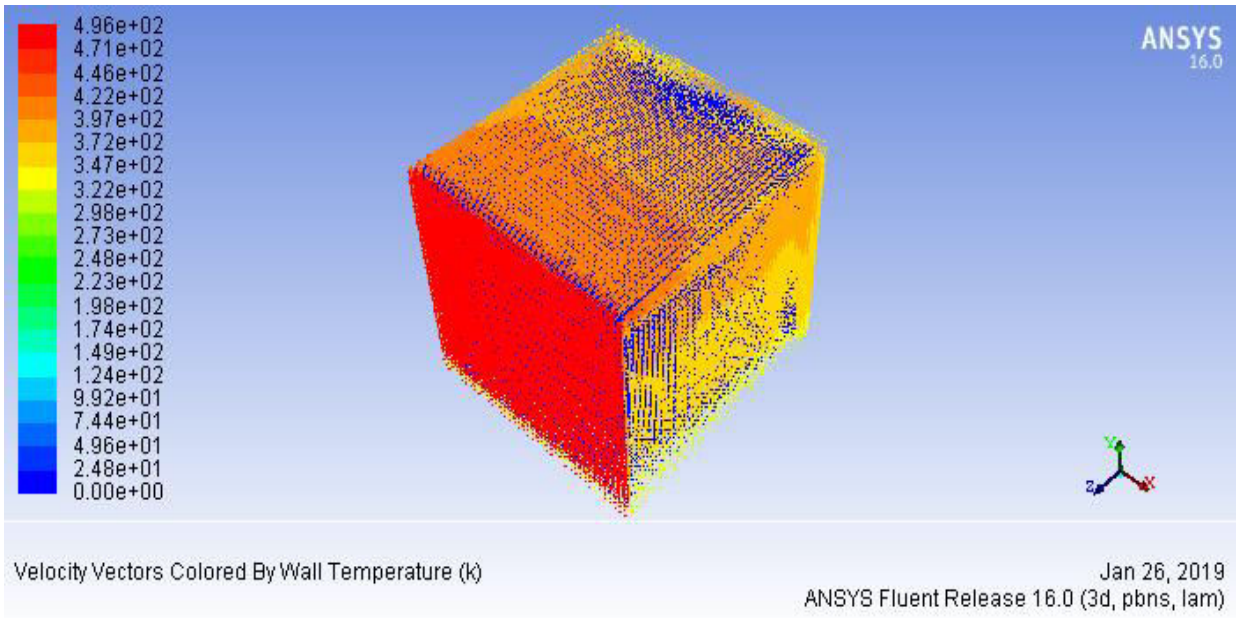

Figure 4.2: Temperature distribution in the oven result by ansys

The temperature in the oven with varying time had shown in the simulation and the maximum value is 498K. But, the theoretical temperature determined from the lumped system in the body or in which the lining have bonded with brake shoe at a temperature of 480K which is almost similar with the value which is found from the analysis of oven by ansys.

5. CONCLUSION

Under this study a lot of activities has been done from starting to end to achieve functionality which includes design, manufacturing, developing Algorithm for controlling the oven, simulation using proteus software to show the brake shoe bonding temperature and time using Arduino Uno, which is the latest instrument now a days in different researches. Also, different experimental tests has been done in the result and discussion using thermometer, Thermocouple and LM35 for temperature sensing inside the oven. In the experiment, a lot of problems are occurred during the experiment for displaying the brake shoe bonding temperature and time. After different experimental tests the result is achieved.

From each experiment the following conclusions were formulated.

- From experiment 1, using thermometer the temperature is measured inside the oven and the resistance is recorded in the digital multimeter and when the resistance value is achieved at 38 KΩ the temperature is 160℃ which is measured using thermometer.
- By using putting thermocouple inside the oven and giving heat supply from the source where the heat is measured in terms of resistance in the digital multimeter, the temperature is achieved 170℃ at 40 KΩ with 3minutes pre-heating time.
- Experiment 2, using thermocouple temperature sensor; when the electrical component are installed, there was a problem in the display unit due to absence of thermocouple module sensor and the result was an intermittent result when power is on the brake shoe bonding temperature becomes large i.e.500℃ and 400℃ again goes to 0℃ which is not continuous reading in the display unit. In this experiment there was a problem happening in the display unit.
- Experiment 3, using LM35 temperature sensor; in this experiment the result of brake shoe bonding temperature and time which is displayed in the LCD is more accurate and it reads continuous counting.

Therefore, it can be concluded that, the LCD needs thermocouple module sensor to have uniform reading temperature display in the display unit. And the result displaying using LM35 is better than thermocouple temperature sensing result displaying in the LCD in operational work.

Generally, the brake shoe was tested in the oven and the lining have bonded at a temperature of 170℃ which was displayed in the display unit and waits for 20 minutes. But, theoretical value of bonding temperature is 197℃ under 37minutes.

The efficiency of the oven under normal operating condition with heat losses due to opening of door when brake shoe put inside it as well loss through walls of the oven is almost 86%. But, to prevent loss of heat through walls of the oven fiber glass is surrounded.

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