



DEVELOPMENT OF LOW-COST OIL BATH HEATER”



**BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY
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DEVELOPMENT OF LOW-COST OIL BATH HEATER”

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Bachelor of Mechanical Engineering Technology (Maintenance) with Honours

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DEVELOPMENT OF LOW-COST OIL BATH HEATER”

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**A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Mechanical Engineering Technology (Maintenance) with Honours**



Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this project entitled “ DEVELOPMENT OF LOW-COST OIL BATH HEATER” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature

:



Name

:

SHAH RANKUMAR SIVA KUMAR

Date

:



APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology with Honours.

Signature : 

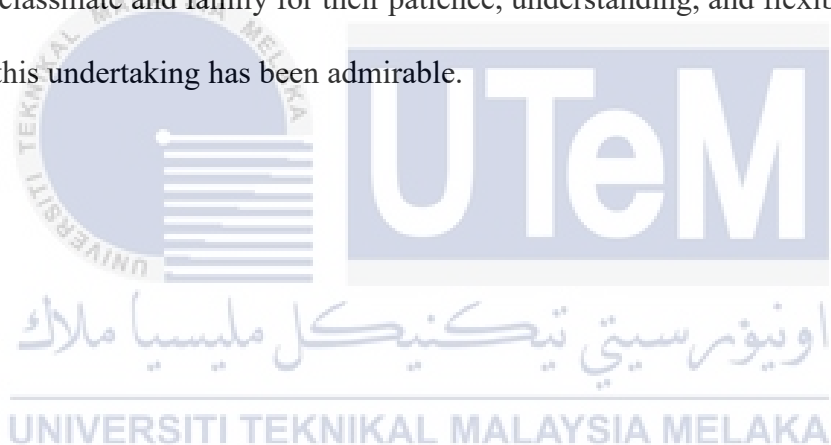
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DEDICATION

I would like to acknowledge and thank my Project Supervisor, Mr Hairul Bin Bakri, for his guidance. As an expert in mechanical systems theory and practice, his advice was invaluable and contributed extensively to the learning experience and also have been guiding me to finish this project successfully. Finally, my deepest appreciation will go to my friends, classmate and family for their patience, understanding, and flexibility throughout this undertaking has been admirable.



ABSTRACT

The oil bath is initially used for heating of specimen in immersion test. The oil is able to sustain temperatures based on specifications, volume and space.

However the existing products in the market seem to vary in features and costing. The most basic model is costing up to RM 4000 which is costly for the testing that is set to carry out. Besides the additional features that are attached along with the bath are not usable for the basic immersion test hence it would be a waste to simply purchase it. Then in terms of the volume issue, whereby the volume that is offered in the market is either too much or too less. Finally, based on the ASTM standard, the temperature requirement for basic immersion test is fixed to 50°C but most available products consist of higher temperatures which are an unnecessary advantage. Hence by designing and fabricating a desired specification model is required. The designing was made based on desired volume and temperature. Simple glass and wooden boxes were utilized as the main structure. Some electronic components were also included such as switching power supply, temperature thermostat, heating element and waterproof temperature sensor. These components made it possible to enhance the heating in the device. The tank is able to contain the volume of 2 liters successfully. The tank could possibly withstand more if any modification is made and since the material of the tank is glass, its reactivity with the content is indifferent. The temperature was also able to increase and sustain outstandingly. The approximate time taken to reach the desired temperature was almost 10 hours. The heater was kept to start up in a short span from the initial stage which eases and fastens the heating process.

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ABSTRAK

“Oil Bath” pada mulanya digunakan untuk memanaskan spesimen dalam ujian rendaman. Minyak ini mampu mengekalkan suhu berdasarkan spesifikasi, isipadu dan ruang. Walau bagaimanapun, produk sedia ada di pasaran kelihatan berbeza dari segi ciri dan kos. Model paling asas berharga sehingga RM 4000 yang mahal untuk ujian yang ditetapkan untuk dijalankan. Selain itu, ciri tambahan yang disertakan bersama tab mandi tidak boleh digunakan untuk ujian rendaman asas oleh itu adalah membazir untuk membelinya sahaja. Kemudian dari segi isu volum, di mana volum yang ditawarkan di pasaran sama ada terlalu banyak atau terlalu kurang. Akhir sekali, berdasarkan piawaian ASTM, keperluan suhu untuk ujian rendaman asas ditetapkan kepada 50 °C tetapi kebanyakan produk yang tersedia terdiri daripada suhu yang lebih tinggi merupakan kelebihan yang tidak perlu. Oleh itu dengan mereka bentuk dan membuat model spesifikasi yang diingini diperlukan. Reka bentuk dibuat berdasarkan isipadu dan suhu yang dikehendaki. Kaca ringkas dan kotak kayu digunakan sebagai struktur utama. Beberapa komponen elektronik turut disertakan seperti bekalan kuasa pensuisan, termostat suhu, elemen pemanas dan penderia suhu kalis air. Komponen ini memungkinkan untuk meningkatkan pemanasan dalam peranti. Tangki itu mampu memuatkan isipadu 2 liter dengan jayanya. Tangki itu mungkin boleh bertahan lebih lama jika sebarang pengubahsuaian dibuat dan kerana bahan tangki adalah kaca, kereaktifan dengan kandungannya adalah acuh tak acuh. Suhu juga dapat meningkat dan mengekalkan dengan cemerlang. Anggaran masa yang diambil untuk mencapai suhu yang dikehendaki ialah hampir 10 jam. Pemanas berminat untuk dihidupkan dalam jangka masa yang singkat dari peringkat awal yang memudahkan dan mempercepatkan proses pemanasan.

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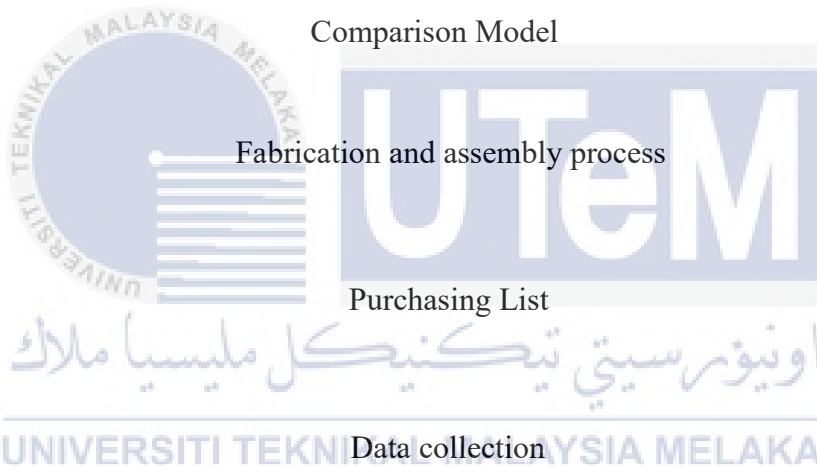
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CHAPTER 1

INTRODUCTION

1.1 Background

A laboratory oil bath heater is a common tool for heating chemical reactions. It is widely utilized in research laboratories for reactions that require the temperature up to 300 degrees Celsius. The uniqueness about an oil bath is that, it can sustain the temperature. Most oil bath heaters are made up of aluminum or stainless-steel mold thus making the structure rigid.

The interiors however are also made of aluminum, which allows heat transfer to happen quickly and sustain the heat. Some other features that can be spoken for are, the capacity of the chamber. The standard version of the oil bath consists of 4 liters however there are many other options to be considered as well such as a 7 liters bath, 12 liters bath and more up to 20 liters. This opens up the branch of opportunity to choose the desired capacity. Some heater however is equipped with an additional feature which is a stirrer. The stirrer is responsible for the heat distribution. It comes in various quantities which solely depends on the size of the heater. They are placed in distinct positions. Most immersion test are conducted in the oil bath as it can provide uniform heating. The sample or specimen handling method varies in shape and sizes. Some are vast as a bowl shape while some consist of pots for individual specimen immersion.

1.2 Problem Statement

Oil bath heater is an essential laboratory tool for any heating process that involves oil. However, the costing for a standard oil bath heater is relatively high. The mini version itself starts off with at least RM1600.00. The modified versions however are more expensive. In order to orderly regulate a lab session with the utilization of oil bath heater, the education faculty need to own at least 4 or 5 sets of the heater. This will indeed be a challenge for the institute as they have to invest on multiple expensive equipment. If needed for a modified version, the faculty may have to spend further for it. Apart from the costing issue, the essential oil bath heaters in the market exceeds the specification based on our need. The available oil bath heaters usually consist the range of 50 degree to 350 degree. Hence it is necessary to own an oil bath within the temperature and volume range.

1.3 Research Objective

The objectives of the research are;

- To design a practical low-cost oil bath
- To fabricate a functional oil bath based on desired specification

1.4 Scope of Research

The scope of the entitled project is to;

- Keen to contain specimen volume of 2 liters. This is highly suitable for a lab scale immersion test.
- Produced a heating capacity of 50 °C within 10 hours. The temperature requirement was obtained based on ASTM standard D 471-06
- Temperature can be maintained for at least 1006 hours (6 weeks) which is reference to ASTM D 471-06



CHAPTER 2

LITERATURE REVIEW

2.1 Introduction


The purpose of this literature review is to obtain some aidful insights for the thesis. In order to complete this project many researches relatable to the title was done in order to gain some idea. This chapter examines previous initiatives and studies into topics related to this project which can provide guidance for conducting this project effectively. Varying scopes and strategies associated with the project are also presented in this part. This chapter can also be described as the contextual analysis section, in which bold ideas and plans from previous initiatives are presented. This literature study was completed by revising, websites, papers, conferences, reference books and many other publications akin to this project. It also consist of additional data in order to resolve the optimal strategy for this job.

2.2 Laboratory Oil Bath Heater

The oil bath heater is a sort of heated bath mostly equipped in laboratories. It is a common tool for heating of chemical reactions. Mineral oil or silicone oil are regularly used for reactions that require heating up to 200 degree celcius. Oil baths are essentially used due to their uniform heat transfer competence. In terms of design, the heater is made out of aluminium or stainless steel pan. The container however is made of heavy porcelain dish or thick walled pyrex glass. Beneath the heater is where the coil is present which will be manipulated via variable voltage controller based of designation. (Oil Baths in Laboratories | Environmental Health and Safety, 2022)

2.2.1 Types of oil bath heater

(Table 2.2.1 Types of Oil Bath Heaters)

	<p>4 LITER OIL BATH WITH STIRRER</p> <p>Temperature range (°C): for oil---from Room temp ~ 200 for water--from Room temp ~ 80</p> <p>Temp. stability: ± 1 C</p> <p>Temp. display: keypad input digital display</p> <p>speed-setting: knob setting</p> <p>speed: 0~2000 rpm</p> <p>bath size: 110×Φ220 mm</p> <p>bath volume: 4 L</p> <p>heater wattage: 1500 W</p> <p>The max. flask input: 3000 ml</p> <p>power supply: 220V/50Hz</p> <p>Dimensions: 190Lx200Wx190H mm</p>
	<p>7 LITER CIRCULATING OIL BATH 200DEG C</p> <p>Digital 7 litre circulating oil bath</p>

	<p>Temperature range: up to 200 deg C</p> <p>Digital temperature controller ± 0.1 deg C</p> <p>Includes hood with oil drain</p> <p>Digital temperature setting & readout</p> <p>Heater 1200W</p> <p>Stainless steel bath and lid</p> <p>Inside dimensions: W19.5xD23.5xH15cm</p> <p>External dimensions: W54xD34.5xH38cm</p>
	<p>12 LITER CIRCULATING OIL BATH 300DEG C</p> <p>Digital 24 litre circulating oil bath</p> <p>Temperature range: up to 300 deg C</p> <p>Digital temperature controller ± 0.1 deg C</p> <p>Includes hood with oil drain</p> <p>Digital temperature setting & readout</p> <p>Heater 2250W</p> <p>Optional external circulation</p> <p>Stainless steel bath and lid</p> <p>Inside: W30xD30xH20 cm</p> <p>Outside: W66xD40xH42 cm</p>
	<p>20 LITER OIL BATH WITH 6X MAGNETIC STIRRER</p> <ul style="list-style-type: none"> ● 6 Individually stirring positions. ● Microprocessor based PID controller. ● Stirrer accommodates vessels up to

	<p>1L.</p> <ul style="list-style-type: none"> ● Stirring speed adjustable from 300 to 1500rpm <p>(Medium solution: water)</p> <p>Tank Capacity 20 Litres</p> <p>Temperature working range Ambient +5°C-200°C</p> <p>Stability (at 37°C) ±0.1°C</p> <p>Stirring By built-in immersion circulating pump</p> <p>Heater 2 KW</p> <p>Standard Accessory Gable cover</p> <ul style="list-style-type: none"> ● Digital timer can be set from 0 to 9999 (min/hr), and power preset On/Off function. <p>Internal Dimension (mm) W495 x D295 x H15</p> <p>Overall Dimension (mm) W770 x D395 x H370</p> <p>Power Source 110V/220V 50Hz/60hz</p>
	<p>OIL BATH CIRCULATOR</p> <p>Hermetic oil cooling high temperature circulator.</p> <p>Over temperature alarm protection ensures safety of the unit</p> <p>Temperature range (°C) Room ~ 250</p> <p>Environment Temperature(°C) 5 ~ 40</p> <p>Function of Circulating pump:</p> <p>Power (W) 750</p> <p>Max. flow (L/min) 75</p> <p>Max.lift (m) 15</p> <p>Power of Heater (kw) 12</p>

	<p>Power Supply 3 PHASE</p> <p>Dimensions (mm) 940L×640W×1585H</p>
	<p>Daihan - Digital High Temperature Oil Bath</p> <p>Capacity 6 Lit.</p> <p>Temp. Range & Accuracy Ambient + 5 °C to 250 °C, ±1.5°C</p> <p>Temp. Uniformity & Probe ±3.0°C, PT100</p> <p>Heating Power 1.5 kW</p> <p>Drain Valve Mounted</p> <p>Dimension (w×d×h) Effective Space - 270×180×h110 mm; Internal - 270×180×h150 mm; External - 425×305×h340 mm</p> <p>Power Supply & Cord/Plug 1 Phase, AC 120 V, 60 Hz or 230 V, 50 / 60 Hz</p>

(Lab Oil Bath, 2022)

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2.3 Working principle of an oil bath heater

An oil bath is a laboratory heating device which uses boiling oil as the temperature regulator. Since different oils have different boiling points, it is possible to obtain a temperature near to the desired temperature by selecting an oil with a boiling point as close as possible to the desired temperature. The procedure to promptly utilize the heater is to begin with ensuring if the bath is sufficiently filled with oil. Always follow the preset level to avoid overflow or insufficient amount. This is an influential factor as both overflowing and insufficient amount could affect the specimen inside. Choosing the appropriate oil is a crucial task as well since there are many types to choose from. Before initiating the process, inspect the clearance space around the heater. Make sure there are no obstacles around the heater, especially any sorts of chemical or easily flammable liquids. Furthermore, the vents of the heater should not be obstructed while working. The vent benefits by ensuring there is enough air flow in and out to sustain the heater from experiencing external heating. The power cord should be aligned neatly and away from any hot objects. Once the environment is clear, pour the sufficient amount of necessary oil in a substantial manner. Then turn the heater on at the control unit. Control the parameters based on designation. Usually the parameters consist of temperature control, delay function and hold function. Some heaters also come with a stir function which initially is built in with one or multiple stirrers. Set the temperature based on designation and set the delay function for the timer. The delay function will maintain the temperature for as long as time is set. Once the set up is done place the specimen in the bath. Make sure to close the cover perfectly. Once the heating is done, let the oil to cool down before draining it. A miniature tap will be preinstalled at the edge of the heater which is where the oil will be depleted. Remove the specimen carefully and drain the oil out. Cleaning is an essential part of the job. The interior tank should be cleaned upon usage.

2.4 Parts of the oil bath heater



Figure 2.4.1 Oil Bath Heater

The oil bath is made up of numerous parts which occupies their own role. The main parts are cover, control unit, tank and drain. These parts are fundamental for the oil bath heater to successfully run its task. The cover is in charge of protecting the oil and its content from being disrupted and also aids in sustaining the temperature while the oil is being heated. The close environment will allow the heat to be distributed evenly. Secondly the control unit. The control unit will manage the activation and deactivation of the heater, mode and parameter setting, temperature manipulation and to display details. Some heaters are equipped with additional features such as stirring option. Without the control unit, the heater will not be able to operate. Then there is the tank. The tank comes in various sizes. They are made of material that can sustain high temperatures. The tanks are not marked with the capacity but as the user, we should acknowledge based on the need for the volume and choose the right one. However the interior of the tank has a level marking which allows user to only fill in oil to the marking level. Hence it is wise to always pour necessary amount for the heating process to complete. Cleaning the tank accordingly is also necessary as leftover oil residue may effect the oil virtue. Next, the drain is as important as any other component. It will be functioned to decently dispose of the used oil.