UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF O-RING JIG FOR MECHANICAL TESTING

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BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (MAINTENANCE TECHNOLOGY) WITH HONOURS

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Faculty of Mechanical and Manufacturing Engineering Technology

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

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DECLARATION

I declare that this Choose an item. entitled " Development Of O-ring Jig For Mechanical Testing " is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Name : Brynald Anak Geris

Date : 10th January 2023

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 (Maintenance Technology) with Honours.

Signature : 

Supervisor Name : Hairul Bin Bakri

Date : 20/1/2023

DEDICATION

My sincere gratitude and highest appreciation go out to my family and friends for the support and encouragement they have given me throughout the years, particularly to my beoved parents, Geris Anak Kabol and Tity Anak Bagon, who always been there for me. I also would like to give a lot of thanks to my special friend Bivianty Rezia for always giving me a huge moral support, and I also dedicate this dissertation to my brother, Bryan Anak Geris, as he always share his knowledge and word of advice to work on this thesis.

ABSTRACT

O-ring is an important component used in fuel delivery systems (FDS). O-rings are often used on the valve stem of a car engines to keep oil from getting into the combustion chamber. Biodiesel can cause deterioration and swelling of the O-ring as its material is elastomer. In addition, the performance of the O-ring will be affected due to the interaction with biodiesel. Therefore, mechanical test need to be done for O-ring immersed in biodiesel before conducting the tensile test. Tensile test is one of the most typical testing to obtain tensile stress, tensile strain and young modulus. These data are important to predict the life cycle of the O-ring contacted with biodiesel. In this study, jig for tensile test of O-ring was develop. As for this custom jig that was design and been fabricate, this jig can be install to universal testing machine, INSTRON 5585. Thus, it could cut cost from buying a new machine which is specific for O-ring tensile experiment. Therefore, as for the result, the experiment will conduct the dry run test of tensile test, and the results obtain is to analyze the graph pattern and the range of tensile stress value by doing the comparison between theoretical and experimental data.

ABSTRAK

O-ring adalah komponen penting yang digunakan dalam sistem penghantaran bahan api (FDS). O-ring sering digunakan pada batang injap enjin kereta untuk menghalang minyak daripada masuk ke dalam kebuk pembakaran. Biodiesel boleh menyebabkan kemerosotan dan bengkak cincin-O kerana bahannya adalah elastomer. Di samping itu, prestasi cincin-O akan terjejas akibat interaksi dengan biodiesel. Oleh itu, ujian mekanikal perlu dilakukan untuk cincin-O yang direndam dalam biodiesel sebelum menjalankan ujian tegangan. Ujian tegangan adalah salah satu ujian yang paling tipikal untuk mendapatkan tegasan tegangan, terikan tegangan dan modulus muda. Data ini penting untuk meramalkan kitaran hayat cincin-O yang dihubungi dengan biodiesel. Dalam kajian ini, jig untuk ujian tegangan O-ring telah dibangunkan. Bagi jig tersuai ini yang telah mereka bentuk dan telah dibuat, jig ini boleh dipasang pada mesin ujian universal, INSTRON 5585. Oleh itu, ia boleh mengurangkan kos daripada membeli mesin baharu yang khusus untuk eksperimen tegangan gelang-O. Oleh itu, bagi keputusan, eksperimen akan menjalankan ujian larian kering ujian tegangan, dan keputusan yang diperoleh adalah menganalisis corak graf dan julat nilai tegasan tegangan dengan melakukan perbandingan antara data teori dan eksperimen.

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I would like to use this opportunity to offer my most sincere thanks to my respected supervisor, Hairul Bin Bakri, who has taken me under his supervision and given me the chance to do research with his guidance. The real gratitude I feel for his patience and passionate support is hard to put into words.

A special thanks to my family and friends who always encouraged me to keep on with this research. I'm using it to thank everyone who has helped me with this project, especially my housemates, who are always willing to support me no matter what.

Last but not least, I would like to thank to the Lab Assistant for guiding me to handle the machine that I used for this whole research purpose. I really appreciate to those who have giving me an endless support and motivation to never give up for this long journey of study life. May God Bless to all those who have been there with me especially during my hardest time.

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LIST OF SYMBOLS AND ABBREVIATIONS

D,d	-	Diameter
cm	-	Centimeter
mm	-	Milimeter
δ	-	Delta
CS	-	Cross-Sectional Diameter
ID	-	Inside Diameter
OD	-	Outside Diameter
°C	-	Degree Celcius
FDS	-	Fuel Delivery Systems
ULSD	-	Ultra Low Sulphur Diesel
%	-	Percentage
N	-	Newton
MPa	-	Megapascal Pressure Unit
E	-	Young's modulus
σ	-	Tensile stress
ϵ	-	Tensile strain

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CHAPTER 1

INTRODUCTION

1.1 Background

O-ring is one of the important components used in fuel delivery systems (FDS). The fuel delivery system includes all of the components that supply fuel to the engine. The tank, all the lines, one or more fuel filters, a fuel pump and the fuel metering components are all included. As for the diesel engine fuel system, it is known that the fuel flow divided to three subsystems, which is fuel feed, combustion and exhaust sub-system. Presently, in modern industrial engine machine application with the principle of rotation, compression and using liquid fuels, mechanical seals play a key role in sealing process fluids in, keeping contamiants out and prevent the machine from failure caused by leakage (L N Komariah, 2019).

Elastomers undergo degradation to a greater extent in biodiesel (L N Komariah, 2019). This mechanical properties can be seen after the O-ring has been exposed to biodiesel. Aside from swelling, biodiesel also can cause the structural volume and mass changes, as well as changes in mechanical properties in polymers which including hardness, and tensile stress and tensil stain.

1.2 Problem Statement

Tensile test is a common way to test something mechanically. It is used to find out how strong a material is and how far it can be stretched before it breaks. This method will

provide important information such as yield strength, ultimate tensile strength, ductility, strain hardening characteristics, Young's modulus, and Poisson's ratio. As for this experiment, most specimens have a standard cross section that is either round or square with two shoulders and a shorter section gauge length in the middle.

The use of biodiesel in FDS will corrode the polymeric O-ring. O-rings tend to degrade after exposure to fuel in certain operating condition and periods (L N Komariah, 2019). Therefore, mechanical test need to be done for O-ring immersed in biodiesel before conducting the tensile test. However, there is some problem in this project which is tensile test cannot be performed at lab since there is no tensile test jig that is special for O-ring is available. This will lead to the difficulty to conducting the experiment of the tensile test.

Therefore, the aim of this project is to design the O-ring jig and to fabricate the O-ring jig so that the O-ring jig can be used to conduct the tensile test experiment.

1.3 Research Objective

i. To design the O-ring jig for the tensile test.

ii. To fabricate the O-ring jig for the tensile test.

1.4 Scope of Research

By following the objectives of this research, the scope of this project is:

1) The size of the O-ring use for the tensile test were limited to one size only for this research, which the size of O-ring is 28 x 3mm.

2) The jig will only can be install to universal Testing machine, INSTRON 5585.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

O-rings are normally found in pumps, cylinders, connectors, and valves, where it helps to seal joints between different parts to prevent fluid and gas leakage. They were applied with static, dynamic, hydraulic, and pneumatic components, giving them a very effective solution to a common engineering problem. Therefore, the used of O-ring in fuel delivery systems (FDS) however can cause it to degrade after been expose to biodiesel.

Recently, there are numerous studies and research of the mechanism biodiesel effect polymer, which by doing the test of O-rings material contacted with biodiesel. Therefore, further investigation need to be done focusing on this component. The first step is by performing mechanical testing for O-ring immersed in biodiesel.

2.2 O-ring

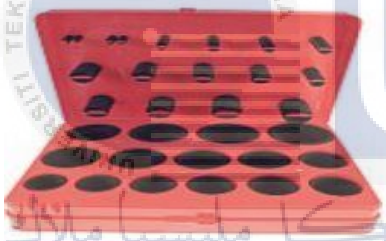
Seals are essential to the majority of mechanical systems. O-rings are absolutely necessary to the operation of machinery because they prevent leakage while also helping to join mechanisms together. In addition, a seal that is compressed in the space that exits between two surfaces is known as a gasket. O-rings are a type of gasket that has the form of a donut and may be utilized in either static or dynamic settings.

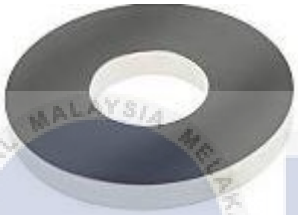
Besides that, O-rings are one of the most often used seals in equipment. This is due to the process to produce O-ring are simple, economical, and it is durable as for the fact that O-rings have a low barrier to entry.

2.2.1 Types of Orings

As for the O-ring, there a various type of O-ring can be found in an engineering Industry. Every each type of the O-ring has their own function. Table 2.1 shows every each type of the O-ring that are commonly found in the industry.

Table 2. 1 Types of O-rings

NO.	Types of O-rings	
1.		Viton O-ring seals
2.		Nitrile O-ring seals
3		Rubber O-ring seals

4.		Silicone O-ring seals
5.		Fluorocarbon elastomer O-ring seals
6.		Metal O-ring seals
7.		Stainless steel O-ring seals
8.		NBR O-ring seals

9.		NBR 70 O-ring seals
10.		Buna-N O-ring seals

2.2.2 O-ring size

Standard and metric measurement systems are the two primary types of O-ring sizes. Standard is a unit of measurement that was desgined for usage in the United States, whereas metric is the standard that is used internationally. The metric sizes are further separated by area, with Europe and Japan being the most prominent examples.

O - RINGS KIT

BNR70° 、30 SIZES=391PCS

NO	JAPANESE STANDARD SIZE LIST/P. G ERIES		QUANTITY	NO	JAPANESE STANDARD SIZE LIST/P.G ERIES		QUANTITY
001	P-003	2.8 x 1.9	18	016	G-22	22 x 3	11
002	P-004	3.8 x 1.9	18	017	P-022.4	22.1 x 3.5	10
003	P-005	4.8 x 1.9	18	018	G-025	24.4 x 3.1	11
004	P-006	5.8 x 1.9	18	019	P-025	24.7 x 3.5	10
005	P-007	6.8 x 1.9	18	020	P-026	25.7 x 3.5	10
006	P-008	7.8 x 1.9	18	021	G-030	29.4 x 3.1	11
007	P-009	8.8 x 1.9	18	022	P-030	29.7 x 3.5	10
008	P-010A	9.8 x 2.4	14	023	P-032	31.7 x 3.5	10
009	P-011	10.8 x 2.4	14	024	P-034	33.7 x 3.5	10
010	P-012	11.8 x 2.4	14	025	G-035	34.4 x 3.1	11
011	P-014	13.8 x 2.4	14	026	P-036	35.7 x 3.5	10
012	P-016	15.8 x 2.4	14	027	G-040	39.4 x 3.1	11
013	P-018	17.8 x 2.4	14	028	P-040	39.7 x 3.5	10
014	P-020	19.8 x 2.4	14	029	G-045	44.4 x 3.1	11
015	G-020	20 x 3	11	030	P-048	47.7 x 3.5	10

Figure 2. 1 List of Japanese Standard O-rings size

2.2.3 Application of the O-ring

One of the crucial elements utilised in fuel delivery systems is an O-ring (FDS). the versatility and dependability of the O-ring make it one of the most important components utilised in today's industry. This is because of the materials that are used to create O-rings have been developed and refined over the years, there is now a wide selection of elastomers that are used in the manufracture of O-rings to suit the requirements of a number of different application.

Viton O-rings, for instance, have the capacity to withstand temperatures ranging from -40°C to 250°C, have a low gas permeability, excellent mechanical qualities, and a low compression set. They are excellent choices for usage with acids, halogenated hydrocarbons, petroleum, and silicone fluids or gases because to their heigh degree of compatibility with these substances. Because of their remarkable adaptability, they are widely used in a diverse variety of sectors, including the aviation industry, the automotive sector, chemical processing, and mechanical engineering plants.

2.2.4 Drawbacks

Rubber sealing elements are frequently utilised as sealing elements during reservoir restoration because of their great resistance to heat and media as well as their strong mechanical qualities. Rubber also has excellent mechanical properties. But under the conditions of high temperature, high pressure and high acid content during the acid fracturing process, rubber sealing elements are easily eroded by acids and the sealing performance declined, thus leading to thefailure of seal elements and influencing the production of oil and gas wells (D. Zeng, 2021).

Intial resistance to friction is significant when an O-ring is utilised for dynamic sealing compression because of this characteristic. In addition, it is very difficult to avoid leakage while shifting the seal, and it is even more difficult to monitor the leakage to ensure that is does not exceed the value that is tolerated. Besides that, it is imperative that the processing dimensions and accuracy of the dual coupling components to be adhered to.

2.3 Biodiesel

As mentioned in previous chapter, biodiesel is an alternative selection to replace diesel. Biodiesel release less toxic emissions into the atmosphere from combustion. Biodiesel is a fuel which is a mixture between a diesel and natural elements. At first, biodiesel was made out of used cooking oil which has been recycled alot. Beside than that, biodiesel can be applied to existing diesel engines without any modification need to be done. (S R Parthiban, 2021) stated that, the usage of biofuels which are oils made from wood that are 100% organic is one of the most significant developments. It can be used as pure (B100) or in various concentrations of gasoline.