THE EFFECT OF DIFFERENT LUBRICATING OIL ON BILLET IN COLD WORK EXTRUSION PROCESS

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TO MY BELOVED

Mother
Father
&
Family Members

Thank You for Your Endless Support!

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ABSTRACT

In metal extrusion, lubrication is crucial to reduce load and friction. The indication for good lubrication is based on how it affects the quality of product. This main purpose of this research is to investigate the effect different lubrication oil on billet in cold work extrusion. The billet material that used in the extrusion process is pure aluminum A1100 and it is milled and annealed before extrusion process for material treatment. Three amount of lubricants are applied on biller that are one palm oil and two additive free mineral oils. The types of lubrication that are used in cold work extrusion are RBD PS (Palm Stearin), VG460 and VG95. The quantity of lubricant that is used was 15mg for every extrusion run and every different lubricant. The experimental results are obtained and compared between extruded billet products of different lubricating oil used. The experiment is conducted at the room temperature with symmetrical paired billets in the rig. The result concentrated on extrusion load, surface roughness of extruded billet and flow angle. The difference of extrusion load required to extrude billet lubricated by RBD PS is in between the extrusion load lubricated by VG460 and VG95 that are 3.58kN and 10.59kN correspondingly. The result also showed that surface roughness Ra of billet lubricated by RBD PS has constant and lowest surface roughness Ra on product area compared to billet lubricated by VG360 and VG95.Based on the result, the lubrication by using RBD PS can be useful to minimize the load significantly by the advantage of better surface roughness compared to mineral oil of VG 460 and VG95.The experiment also demonstrated that RBD PS is able to produce the extrusion load almost as low as VG460 with similar steady load pattern. The performance of RBD PS has produced important lubricating requirement the same par as other mineral oils used.

ABSTRAK

Dalam penyemperitan sejuk, pelinciran adalah sangat penting untuk mengurangkan beban dan geseran. Penentu untuk pelinciran yang bagus adalah berdasarkan kualiti sesuatu produk. Tujuan kajian ini adalah untuk menyiasat kesan pengunaan minyak pelincir yang berbeza pada bilet melalui penyemperitan sejuk. Jenis material yang digunakan dalam proses penyemperitan ialah aluminium A1100 dan dipotong serta dilakukan penyepuhlindapan untuk rawatan haba sebelum proses penyemperitan. Tiga pelincir yang telah digunakan pada bilet iaitu satu minyak kelapa sawit dan dua minyak mineral bebas tambahan. Jenis-jenis pelincir yang digunakan dalam penyemperitan sejuk ialah RBD PS (Palm Stearin), VG460 dan VG95.Jumlah berat yang digunakan untuk setiap penyemperitan dan setiap satu pelincir yang berbeza ialah 15mg. Eksperimen telah dijalankan pada suhu bilik dengan penggunaan bilet yang simetri yang dipasangankan didalam rig. Keputusan diberikan tumpuan pada beban penyemperitan, kekasaran permukaan pada bilet dan sudut aliran. Perbezaan perbandingan beban penyemperitan maksimum diperlukan untuk menekan bilet yang dilincirkan dengan RBD PS adalah terletak antara beban penyemperitan yang dilincirkan dengan VG 460 dan VG95 iaitu 3.58kN dan 10.5kN mengikut turutan. Keputusan juga menunjukkan kekasaran permukaan Ra bilet yang dilincirkan dengan RBD PS adalah sekata dan paling rendah antara kekasaran permukaan Ra bilet lain yang dilincirkan dengan VG460 dan VG95.Berdasarkan keputusan, pelinciran menggunakan RBD PS sangat berguna untuk mengurangkan beban dengan banyak disamping kekasaran permukaan yang lebih baik berbanding minyak mineral VG460 dan VG95. Eksperimen juga menunjukkan RBD PS mampu menghasilkan beban penyemperitan serendah VG460 dengn corak beban sekata yang sama. Prestasi RBD PS telah menghasilkan keperluan penting untuk pelinciran setaraf dengan minyak mineral lain yang digunakan.

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LIST OF ABBREVIATION

PMO	-	Paraffinic Mineral Oil
VG	-	Viscosity Grade
RBD PS	-	Refined Bleach Deodorized Palm Stearin
LVDT	-	Linear Variable Differential Transformer
SKD	-	Steel Grade
CNC	-	Computer Numerical Control
CCD	-	Charge Coupled Device

LIST OF SYMBOLS

F_c	-	Total friction force in forward extrusion
fc	-	Friction force between billet and wall of container
fd	-	Friction force between die bearing and extruded billet
Fd	-	Force needed for plastic deformation of billet
τ	-	Frictional shear stress between the billet and wall of container
δ	-	Inner diameter of the container
l	-	Residual length of billet in container
Ra	-	Arithmetic average of the roughness profile

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Extrusion process consists of three methods which are indirect extrusion, direct extrusion and impact extrusion. The hot extrusion and cold extrusion are two types of process that divide the application. The cold extrusion is the process in which the material is made to flow respected to high pressure force and it is done at room temperature or near room temperature. The force is applied to the material through the hole where it is confined between a die and a punch. Extrusion is the process of changing geometric shape and deforming the workpiece. Manufacturing industries nowadays are rapidly practicing the cold extrusion since more development of enhanced tool and pressing method making the process cheaper. Besides the cost efficient and advanced technology on cold extrusion process, the product produced can be controlled in terms of properties such as surface finish, strength and tolerances.

Extrusion process also involves the heat that is derived from friction. Therefore, lubrication is important to ensure the desired extruded product. Metal forming like rolling, forging, and deep drawing are dealing with high friction hence the lubrication effect with contact surface between tool and material greatly influences the end product in metal forming. Tool life itself also can be improved since wear effect is reduced from the lubrication.

The major influence in metal forming is the friction. It dictates the final product of how the properties can be affected by the amount of friction occurred. It also indicates the feature of the product by the friction effect. In many application and also metal forming, there are three types of lubrication which are boundary lubrication, mixed lubrication and full film lubrication. The fundamental, lubrication is separation surfaces of protecting them in order to reduce friction, heat generated, wear and energy consumption. In addition, lubrication controls contaminant and within the process to prevent damage to tools and dies.

In metal forming, the extrusion load, wear and friction have correlation between them. Lubrication is crucial in reducing those effects as lowering the load wear and friction can obtain the good product. Some of the material tends to adhere to the tool and die due to shearing effect thus resulting in built-up edge. Lubrication plays important role in reducing that from occur that eventually could damage the end product surfaces.

Traditionally, the mineral oil is used to get the better surface roughness since it is the easiest and resourceful lubricant to obtain. The mineral oil is commonly found in industries where many manufacturing sectors require this as an imperative medium to get the better product. As more advanced technology comes, the useful method to improve the tribology mechanism is created as such as applying the vegetable lubricant that is good to sustain the load and at the same time to produce high quality product. In cases, the industries trying to minimize the application of lubricant during operation as it sometimes could lead the wastage and cost. Since this part of the operation, the mineral oil that is sometimes does not met application is used in order to get the effect of lubrication. By noting the important of lubrication, it is a key factor to reduce the bad impact to the operation and the product in industries. In some example, the overly excessive lubrication can damage the movement of the operation as it suffocates the movement. Therefore, the proper amount that is sufficient to use in the system has to be the list to look at as it also affects how the temperature and wear mechanism to occur. It is the best way to study that the types of application that is suitable to use particular lubricant especially in substitute of existing lubricant.

1.2 Problem Statement

In general, metal extrusion involves friction and wears that cause problem due to slides over another. It is unavoidable in operation and has negative impact on the main process parameters and product quality. Despite of that, the friction and wear can be greatly reduced using lubrication. This is tribology study that relates the interaction of surfaces relative to the movement. The most important aspect in many forming operations are dimension and surface finish. Due to the fact that customer demand is increasing, forming operation must comply and meet the need of market. It is where the entire product must have both the tolerance specification on dimension and surface finish.

The criticality in metal forming to reduce force load friction and wear has induced the research in tribology to improve the process. Basically, forming comprise three parts where the forming condition excluded the thing that might be changed which are workpiece, tool and lubricant. Since the extrusion process engages a direct contact between surfaces of tool and workpiece, the condition is quite extreme with local high temperature and pressure. As the process is repeated over time, tool die would be worn in different ways and eventually alter the condition of the process. This will affect the end product that needs to be fulfilled to requirement.

The tool die for the forming should be able to be used for a long life span and in stable process. Lubrication potentially extends the effect of tool die short life span as well as good surface finish. The workpiece on the other hand can be manipulated by getting the good initial surface roughness. There are many factors that influence the magnitude of friction such as normal stresses, material flow, velocity, lubrication, forming load, temperature and the significantly in extrusion are billet and tool material.

In industry, there are many ways of searching the alternatives to the mineral oils as the lubricant since the green prospect of the waste material and the less toxic effect to living things especially human. As the need for alternatives of industries toward this aspect is increasing, the product quality also has to be considered as to change the existing common lubricants in industries, the requirement to get the good quality and the same effect of lubricant is crucial as this may affect the productivity of the sector.

The research for this project is to gain the information as the effect of different lubricant used as opposed to mineral oil on the workpiece which is at the side of billet as it goes through the toll die as soon as extrusion load applied. In order to achieve the objectives of the research, different types of oil will be varied to obtain the effect on the result of extruded workpiece.

1.3 Objective of Research

Three objectives that have to be achieved in completing this research project are:

I. To measure the load of extrusion on different type of lubricant
II. To investigate and analyze the effect of lubricant on in extrusion
III. To determine the flow angle pattern on billet after extrusion.

1.4 Scope of Research

The research project focuses on the area of the interest on the following regions

I. Experiment on the extrusion executed under cold working condition with plain strain extrusion
II. Lubrication of billet by three types of lubricant that will be used on extrusion taper die surface area are as follows:

- PMO VG 460 (Paraffinic Mineral Oil VG 460)
- PMO VG 95 (Paraffinic Mineral Oil VG 95)
- RBD PS (Refined Bleach Deodorized Palm Stearin)

III. Material of billet is pure Aluminum A1100
IV. The amount of lubricant used is 15mg for every extrusion process
V. The angel of billet is constant 45 degrees die half angle
VI. Taper die is made of steel (SKD 11) material
VII. Ratio of billet size before and after extrusion is 1:3
VIII. Each one of the billet will be using all three types of lubricant separately

- 10 Billets-PMO VG 460
- 10 Billets-PMO VG 95
- 10 Billets-RBD PS

1.5 Research Outline

The structure of the thesis is arranged in chapters as follows:

Chapter 1: The background of the study, problem statement, objectives and scope and limitation is reviewed.

Chapter 2: A review of published information in journals that relate to the alternative oils and the lubrication effect on the metal extrusion are studied. The literature focuses on the effect of vegetable oil on billet and types of lubricant that influence the key factors in tribology which is important in friction reduction and its impact in the industrial sector.

Chapter 3: Methodology of the research project as a whole process is demonstrated. Every step in the project is discussed as in specific process and the explanation throughout the project development is put in section. In this chapter as simplification of review, the methodology of the project is represented by flow chart.

Chapter 4: Results and discussions for each work done throughout the project will be described. All the results of analysis of work piece are demonstrated in detail according to respective sections.

Chapter 5: Outlining the crucial factor of conclusion for thesis and some recommendations as ideas to improve further research in the same scope of work for better results.

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