STUDY OF MICRO PITS ON BILLET EXPERIMENTAL SURFACE IN EXTRUSION PROCESS

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STUDY OF MICRO PITS ON BILLET EXPERIMENTAL SURFACE IN EXTRUSION PROCESS

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Dedicated to my loving parents, brother and sister

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ABSTRACT

Lubrication is very important in cold extrusion of aluminium to reduce the extrusion load and friction. The purpose of this research is to investigate the effects of micro-pits arrays formed on work piece experimental surface and capability of palm oil as a lubricant in cold work extrusion process. Size of pit is 4mm in diameter, 0.4µm in depth and in spherical shape. The pits are separated by 4mm in column and 1mm in row. One palm oil and two additive free mineral oil are used in this experimental work. Two amounts of lubricant are used: 8mg and 15mg.The experimental results are compared to the results obtained from experimental work with work piece without micro-pits. Experimental work with a plain strain extrusion apparatus with a symmetrical work piece is conducted at room temperature. The material of the piece is pure aluminium A1100. The results focused on the extrusion load, surface roughness of work piece experimental surface, flow angle, and flow line. The extrusion load required to extrude work piece with micro-pits lubricated by RBD palm stearin at amount of 8mg was reduced by 11.1 kN compared to work piece without micro-pits. The extrusion load was reduced from 57.7kN to 46.6kN.The results obtained from the experimental work demonstrated that the micro-pits formed on the work piece experimental surface are able to control the friction and palm oil has fulfilled the lubrication performance in paraffin mineral oil. The experimental results also showed that greater amount of lubricant has better performance.

ABSTRAK

Pelinciran adalah sangat penting dalam penyemperitan sejuk aluminium untuk mengurangkan beban penyemperitan dan geseran. Tujuan kajian ini adalah untuk menyiasat kesan susunan lubang mikro susunan yang dibentukkan pada permukaan benda kerja eksperimen dan keupayaan minyak sawit sebagai minyak pelincir dalam proses penyemperitan sejuk. Saiz lubang adalah berdiameter 4mm, kedalaman 0.4µm dan berbentuk sfera. Lubang dijarakkan sebanyak 4mm pada susunan lajur dan 1mm pada susunan baris. Satu minyak sawit dan dua minyak mineral bebas tambahan digunakan dalam kerja eksperimen ini. Dua jumlah pelincir digunakan: 8mg dan 15mg.Keputusan eksperimen dibandingkan dengan keputusan yang diperolehi daripada kerja eksperimen dengan benda kerja tanpa lubang mikro. Kerja eksperimen dengan peralatan penyemperitan terikan satah dengan benda kerja yang simetri dijalankan pada suhu bilik. Bahan benda kerja adalah aluminium A1100 tulen. Keputusan memberi tumpuan kepada beban penyemperitan, kekasaran permukaan pada permukaan benda kerja eksperimen, sudut aliran, dan garis aliran. Beban penyemperitan diperlukan untuk menyemperit benda kerja dengan lubang mikro yang dilincirkan oleh RBD stearin sawit pada jumlah 8mg telah dikurangkan sebanyak 11.1kN berbanding dengan benda kerja tanpa lubang mikro. Beban penyemperitan dikurangkan daripada 57.7kN kepada 46.6kN. Keputusan yang diperolehi daripada kerja eksperimen menunjukkan bahawa lubang mikro yang dibentukkan pada permukaan benda kerja eksperimen dapat mengawal geseran dan kelapa minyak telah memenuhi prestasi pelinciran dalam minyak mineral parafin. Keputusan eksperimen menunjukkan bahawa jumlah pelincir yang lebih besar mempunyai prestasi yang lebih baik.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Metal Forming processes such as extrusion, forging, sheet stamping, rolling, casting, and drawing become more important in the industry field nowadays. Extrusion is an important type of metal forming process in industry. An extrusion process is done by pressing a solid material such as aluminum under pressure through a die.

Extrusion can be dividing to three methods which are direct extrusion, indirect extrusion, and impact extrusion. There are two type of extrusion process: cold extrusion and hot extrusion. Cold extrusion is the process that the material made to flow in the cold flow under high pressure application. The application of high pressure force the material through a hole enclosed between a die and a punch. Cold extrusion is become more important in manufacturing industries nowadays because the press and tool design becoming more advanced. The major advantages of this process are the products produced have improvement in mechanical property, high dimension accuracy, and smooth surface.

Friction and lubrication play an important role in metal forming process such as extrusion forging, stretch forming, and deep drawing. The exits of lubricant film with effective thickness between contact surfaces reduces the tool wear, increases the forming limit and improves the product quality in the metal forming process.

Friction is the major parameter that affects the metal forming processes which exist between the work pieces and dies. The quality and precision of the product is depending on the friction. During metal forming process, lubricants are selected to reduce and decrease the work piece and taper die wear. The friction coefficient is proportional to the lubrication conditions. There are four important lubrication regimes in reducing friction: thin film regime, thick film regime, boundary regime, and mixed regime. These lubrication regimes are normally used in the metal forming processes.

Lubrication is significant in cold extrusion to reduce the coefficient of friction, extrusion load, and wear. Besides that, lubrication also separate the work piece and tool surfaces and prevent the surfaces of two metal from direct contact, increase the tool lifespan and produce the quality product.

Surface texturing is a branch of surface engineering in purpose to improve load capacity, reduce friction coefficient, and increase wear resistance in metal forming process. The oil pockets such as holes, micro pits, cavities or dimples were used to reduce friction. These oil pockets will act as lubricant reservoir, micro-bearing, and capture wear debris in lubrication. The designers of surface texturing technique have to familiar the relationship between the textured surface and its function. The accuracy of determination surface texturing pattern or array for a specific function is highly affecting the results that expected. For example, the textured surfaces of golf balls are used to reduce drag force and tire treads on vehicle wheel surfaces are intend to increase road grip at our daily life. Furthermore, the surface texturing play a important role in industrial fields such as modify the surfaces of the machine parts in purpose increase the performance of the engine.

1.2 Problem Statement

Friction and wear are the main problems which exist in extrusion process because of direct contact between work pieces and tools. Tribology is one of the significant solutions for these problems and it helps some investor save thousand billion over a year. For this reason, tribology is getting more attention and attraction from the researcher in the mechanical field. Tribology is referring to the type of engineering which is closely related to lubrication, friction and wear. Tribology normally related to the boundary lubrication which is the complex problems between two friction contact surfaces.

Metal forming process such as cold extrusion need high amount of energy to create the product and many tribology problems such as increased of surfaces roughness, friction, and wear occur during the process. During the extrusion process, the metal produce at the exits of the die should be on uniform velocity to prevent it from distortion, twist about their axis, buckle, and curve along the length or separation.

Flow control in an extrusion process is very important to produce the quality product. Example of flow control is optimum lubrication and surface texturing such as micro-pits or microgrooves to reduce the friction coefficient and then decrease the friction and wear.

Lubricants will be applied between the tools and work piece during the cold extrusion process. There are high possibilities that the lubricant applied get dry before the extrusion complete. This condition will damage the product and cause wear on the product due to friction between the tools and work piece. One of the solutions is apply the hot extrusion process. But it is not suitable for small company due to high cost of tools.

Industry manufacturers are required always to make sure the lubricant supply is continuously to produce the quality products. One of the alternative ways is adding the micro-pits on the sliding surfaces of the work piece. These micro-pits will act as lubricant reservoir to hold lubricant and capture wear debris.

Therefore, this research is aim to investigate the effect micro-pits pattern on the work pieces which can act as oil reservoir and ensure the lubricant between tools and work pieces supply continuously. Several micro-pits pattern that never been tested by other researcher will be tested to achieve the aim of this research.

1.3 Objectives of the Study

There are total of three objectives to be achieved upon the completion of this project. The objectives of this study are:-

(i) To compare the extrusion load required to extrude billet with and without micro-pits

(ii) To determine the surface roughness of extruded billet

(iii) To investigate the metal flow of extruded billet.

1.4 Scope of the Study

The research works conducted in this project are limited and concentrated to the following aspects:-

(i) The experiment carried out by cold work plane strain extrusion process.

(ii) Different viscosity of mineral oil and palm oil based lubricant will be applied on die surface

(iii) Amount of lubricant applied are limited to 8mg and 15mg

(iv) Material of billet is pure Aluminum (A1100)

(v) Type of billet is 45-degree die half angle

(vi) Material of taper die is steel (SKD 11)

(vii) The ratio of billet size before and after extrusion process is 1:3

(viii) The micro-pit size is 0.4mm in diameter and 4μm in depth

(ix) The micro-pit is spaced 4mm in column and 1mm in row

1.5 Dissertation Outline

This thesis is organized as follows:-

In Chapter 1, background study of project, problem statement, objectives and scope and limitations are demonstrated.

In Chapter 2, a detailed review of the published journals relating to the micro-pits and plant based oil lubricant are presented. The review examines the effects of micro-pits and bio-lubricant in friction and wear reduction and industrial applications.

In Chapter 3, step by step of the methodology used throughout the process for completing this project is demonstrated. The steps that involve throughout the project development will be explained in detail according to respective sections. Flow chart of the overview methodology will be also presented in this chapter.

In 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.

In Chapter 5, highlights some key conclusions of the thesis and recommendations for further research based on the outcomes of the thesis

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