

DESIGN AND DEVELOPMENT OF A FLOW FORMING MACHINE

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To my beloved wife **Syazwin binti Ahmad @ Ahmad Sowi**  
To my beloved little princess **Arfah Al Ulya binti Mohd Shamsulizan**

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## **ABSTRACT**

Flow forming is an advanced version of metal spinning process which is used to manufacture sheet metal products having symmetrically axial geometry and also to produce long thin-wall tubes with precision dimensions and desired mechanical property. In flow forming of tubes, the workpiece is held onto the mandrel as the forming roller moves along the workpiece axially to reduce the diameter. Author has developed a few concepts of flow forming tool that built to accommodate the lathe tool post. One of the concept consists of two rollers set has been fabricated. This tool is rigid enough to perform flow forming at lathe machine and can flow-form tubes with a diameter up to 100mm. This tooling assembly is attached at Pinacho SP/165 conventional lathe machine to perform flow forming process. The selected work material is aluminium alloy 6061 that widely applied at light-weighted industries. The main objectives of this research is to analyse the influences of major process parameters such as feed rate, spindle speed and depth of cut on wall thickness changes, internal diameter growth and roundness of the finished products. The dimensions of the finish products are measured using Carl Zeiss Coordinate Measuring Machine. It is found that wall thickness changes decreases and external diameter increases as the roller travels along the tube. It is also found that higher feed rate of rollers and lower thickness reductions have advantages for obtaining smaller internal diameter growth. The tube with good roundness also can be obtained by flow-form the tube using lower thickness reductions. Material structure test also has been conducted to confirm the direction of the flow of material during the process.

## ABSTRAK

Proses pemutaran tiub adalah proses memutar logam termaju yang digunakan untuk menghasilkan produk berasaskan kepingan logam yang mempunyai geometri paksi bersimetri dan juga untuk menghasilkan tiub yang panjang dan berketebalan nipis di samping mempunyai dimensi yang tepat dan sifat mekanikal dikehendaki. Dalam proses pemutaran tiub, bahan kerja dipasang pada mandrel dan roda pembentuk bergerak pada arah yang sama dengan paksi bahan kerja untuk mengurangkan garis pusat. Pengarang telah membangunkan beberapa konsep alat pembentuk yang dibina untuk disesuaikan pada pos alat pada mesin pelarik. Salah satu konsep yang terdiri daripada dua set roda pembentuk telah dihasilkan. Alat ini cukup tegar untuk melaksanakan proses pemutaran tiub di mesin larik dan boleh membentuk tiub dengan diameter sehingga 100mm. Alat ini dipasang pada mesin melarik konvensional berjenama Pinacho SP / 165 bagi melaksanakan proses pemutaran tiub. Bahan kerja yang dipilih adalah Aluminium alloy 6061 yang digunakan secara meluas di industri-industri ringan. Objektif utama kajian ini adalah untuk menganalisis pengaruh parameter proses yang utama seperti kadar suapan, kelajuan gelendong dan kedalaman pemotongan ke atas perubahan ketebalan dinding, pengembangan diameter dalam dan kebulatan produk yang telah dihasilkan. Dimensi produk akhir diukur menggunakan Mesin Pengukur Koordinat Carl Zeiss. Ia didapati bahawa perbezaan diantara bahagian awal dan akhir tiub yang diproses ialah perubahan ketebalan dinding berkurang dan diameter luar membesar. Ia juga mendapati bahawa kadar suapan penggelek yang lebih laju dan pengurangan ketebalan yang lebih nipis mempunyai kelebihan untuk mendapatkan pertumbuhan diameter dalaman yang lebih kecil. Tiub yang mempunyai kebulatan yang baik juga boleh dihasilkan dengan menggunakan pengurangan ketebalan lebih nipis. Ujikaji struktur bahan juga telah dijalankan untuk mengesahkan arah aliran bahan semasa proses tersebut berjalan.

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## **LIST OF ABBREVIATION AND SYMBOLS**

CNC	Computer Numerical Controlled
% D	Percentage of Reduction Thickness
FPM	Feed per Minute
RPM	Revolution per Minute
CAD	Computer Aided Design
kW	Kilowatt
g	gram
mm	millimetre
F	Fahrenheit
ml	millilitre
%	Percentage
Rev	Revolution

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Background of Study**

Flow forming is one of the rotary-type incremental sheet metal forming processes other than manual spinning and shear spinning. Flow Forming is an incremental metal forming technique in which a disk or tube of metal is formed over a mandrel by one or more rollers using tremendous pressure. The roller deforms the work piece, forcing it against the mandrel, both axially lengthening and radially thinning it.

This process become popular alternative to deep drawing and ironing process due to the inherent advantages and flexibility of the process such as low tooling cost and low tooling loads, plus the rapid emerging trend in modern industries towards near net shape manufacturing of thin sectioned lightweight parts. The usage of tubular parts is increasing in many manufacturing fields due to the demands of lightweight product in order to reduce energy waste and to save resources in the background of environment problems.

The application of the flow forming technique range from the manufacture of rocket motor casings, warhead casings, nozzle, cartridge cases, critical items for jet

engines, exhaust pipe for motorcycles, automotive component and household appliances.

## **1.2 Statement of Problem**

- Recently, the flow forming process only can be done at CNC flow forming machine.
- Flow forming process and turning process have the similarity; produce the product using rotational mechanism. So, lathe machine can be utilized in running the flow forming process. A development of flow forming tool needed to be done so it can be attached to the lathe machine.
- An analysis also needed to be done so it can meets the capability with the current flow forming machine.

## **1.3 Objective of Study**

- To perform flow forming operation at manual turning machine.
- To design and fabricate a flow forming tooling assembly.
- To analyze the capability of the developed forming tool compare to the current flow forming machine.

## **1.4 Scope of Study**

- In-depth study of a flow forming of sheet metal.
- In-depth study of a manual turning machine structure and related modification requirement.
- To fabricate tooling assembly.
- To perform basic performance of the modified machine.

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