Factors Affecting The Flow of Metals In Extrusion Process

CAC

Thesis
Submitted to
Faculty of Engineering
Ain Shams University

In The Partial Fulfilment
for the degree of
Master of Science

in

Mechanical Engineering
(Metal Forming)

By

Mohamed Hanafy Mohamed Ahmed
B. Sc. Mechanical Engineering, Production
Engineering Section
Ain Shams University, 1968

1972

"FACTORS AFFECTING THE FLOW OF METALS

IN EXTRUSION PROCESS"

Examiners	Signature	Date
Prof. Hassan Hussin Fahmy	H. Fahmy	7/6/1972
Eng. Mohamed Abdel Baghdady Okasha		
Dr: Mahmoud Mohamed Farag		

Acknowledgements

I wish to express my deepest appreciation to Dr. M. K. Abdel Aziz, professor of production Engineering, Faculty of Engineering, Ain Shams University, whose advice, interest and encouragement were invaluable in carrying out this work.

Deepest gratitude and special thanks are presented to Dr. M. Farag, Assistant professor of production Engineering, Ain Shams University, for his valuable help, advice and supervision throughout the whole course of this work.

Grateful acknowledgement is also due for the staff of production Engineering department at Faculty of Engineering, Ain Shams University , and for the staff of Military Factory 63 for their help in producing the extrusion dies used in the present work.

I am also grateful to all my colleagues for their encouragement during the entire work.

Table Of Contents

Page

Chapter II :

Chapter III:

S U M M A R Y

Factors affecting the flow of metals in extrusion process

The aim of this investigation was to study the effect of the extruded shape geometry on the extrusion process. This was done by comparing the extrusion loads required to extrude various shapes with the loads required for the circular section of the same area.

The effect of both extrusion ratio and extrusion temperature on the extrusion process were also studied.

The extrusion process was discussed in terms of the following parameters:

1- Maximum experimentally obtained extrusion pressure (P_e).

2- Ideal extrusion pressure P_h (pressure to overcome homogeneous deformation without friction).

3- The extrusion pressure at the transition (coring) point (P_o).

4- The extra pressure due to the inhomogeneous or redundant deformation of metal (P_r).

5- The pressure required to overcome frictional work (P_f).

6- The extrusion efficiency $\eta = P_h / P_e$.

7- Redundant work factor $\phi = P_o / P_h$.

8- Redundant work ratio P_r / P_e.

9- Frictional work ratio P_f / P_e.

The flow of the metal was studied using the grid lines on the specimens meridinal planes.

The material tested in the present work was commercial purity aluminium, and the extrusion was carried out in an experimental sub-press 25mm. inside diameter which can be heated to the required test temperature.

The experimental results and discussions led to the main four following conclusions:

- In general the circular sections required the least pressure. The increase of the extrusion pressure of the rectangular sections overthat of the circular sections varied from 2% to 28%. The difference increased as the breadth to width **ratio** (a /b) of the shape increased. This was attributed to the increase in redundant deformation.

- The value of the ideal extrusion pressure (P_h) was found to increase linearly with increasing reduction ratio according to the relation $P_h = \sigma \ln (A_o / A_1)$.

where

σ = The flow stress of the metal kg/mm^2.

A_o = Initial cross section area "before extrusion" mm^2.

A_1 = Final cross section area "after extrusion" mm^2.

- There was no effect of neither reduction nor temperature on the frictional work ratio (P_f/P_e) since the coefficient of friction (μ) was almost constant.

The value of the frictional work ratio was about 16.6 % .

- The extrusion efficiency (η) of the extrusion process was found to be a maximum at an extrusion reduction of 18.5 for all shapes, and increased with increasing temperature. This was attributed to the improved homogeneity of the flow.

The value of the extrusion efficiency (η) ranged between 50 % and 65 % .

List Of Figures

List Of Tables

Chapter I

1-1 Introduction

Progress has been made in understanding the technology of extrusion since the processes was first introduced by Bramah in 1797. Increased insight into the process has been gained, through both experimental and theoretical analysis, in areas such as the pressure of extrusion, temperature rise and distribution during extrusion, and patterns of metal flow under different boundary conditions. Extrusion technology today permits the routine extrusion of tubes, intricate shapes and extrusions of varying cross section (stepped extrusions) .

The theory of extrusion, as in many of the manufacturing fields has lagged considerably behind the know-how of practice. In 1931 Siebel and Fangmeir first presented an analytical method for calculating the extrusion energy. The analysis of extrusion process was based on the so called "total strain theory" untill the appearance of Hill's work in 1948 using the slip line theory. Considerable application of the slip line theory to the extrusion problem and some experimental verification are due to Johnson and his co-workers, later Johnson and Kudo-applied the upper bound method to various extrusion problems.

One of the reasons that caused the slow progress of understanding the extrusion problem was the lack of data on the behaviour of metals under complex working conditions.

However, suitable correlations can now be obtained between the practical behaviour and laboratory tests. But even then, fundamental informations is readily available only for pure metal and solid solution.