The Influence Of Temperature And Lubrication Variation On The Dimension Change In Ring Compression Test Using Ansys Software

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Abstract. The objective of the study is to identify the influence of temperature and lubrication influence on Ring Compression Test. Within the study, a quasi-experiment was conducted using ANSYS software. The simulation of Ring Compression Test was conducted by varying the temperature (200°C, 300°C and 400°C) and the lubrication (0.48, 0.60 and 0.88). The dependent parameters in the simulation of Ring Compression Test were as follows: hot forging job, heat transfer coefficient 5 W/(m²K), collision velocity 0.008333 m/s and top die movement depth 7 mm (50%). From the results of the study, it might be identified that temperature variation does not have significant influence of dimension change while. On the other hand, the results of lubrication variation show that the higher the collision coefficient is the lower the diameter on the Ring Compression Test will be.

Keyword : Ring Compression Test, temperature and lubrication variation, ANSYS

1. Introduction

Ring Compression Test is one of the methods that have been implemented as the process of identifying the deformation on the object (ring) due to the compression load in the object. The Ring Compression Test is considered as the appropriate manner for evaluating the collision in a process related to open die forge [1]. The results of the test might be stated in the form of graphic that displays the collision coefficient from the decreasing in-depth diameter and the height-decreasing diameter so that the difference between the inner diameter and the outer diameter might be identified [2]. Ring Compression Test or RCT is a well-known and well-proven test in comparison to the analytical method [3].

The phenomenon that mostly occurs in the Ring Compression Test on steel material is inter-surface collision. The inter-steel surface collision has important influence in forming the steel object; this type of collision has certain effects in relation to power consumption, steel flow, deformation load and internal structure of the product [4]. The problems of collision are very complex on the process of steel formation due to numerous technological factors that have been involved in the process.
Avitzur, Hawkyard and Johnson performed hollow disk analysis theoretically by means of uniform distortion assumption. From the results of their analysis, it is found that collision coefficient tends to increase in line with the deformation line for the steel with solid lubrication condition [5].

In addition, Male also performed a study in relation to the application of Ring Compression Test on steel formation and the results of his study are similar to those of the study by Avitzur, Hawkyard and Johnson [6]. RCT is considered as a very precise technique for determining the strain curve in the steel formation process. Its accuracy is shown on the high temperature condition and low strain condition [7].

Based on the review toward the existing literatures, it is deemed necessary to perform further study in relation to the application of Ring Compression Test. Therefore, the main objective of the present study is to identify the influence of temperature and lubrication variation on the Ring Compression Test toward the deformation pattern of an object.

2. Methodology
The study was a quasi-experimental research using Finite Element Analysis (FEM)-based ANSYS software. The aim of the study was to predict the results of the experiment, which might serve as a matter of reference for conducting the real experiment. Then, several aspects that should be given attention in the study were as follows:

2.1 The independent variables in the study were the temperature variation (200°C, 300°C and 400°C) and the lubrication variation (0.48, 0.68 and 0.88).

2.2 On the other hand, the dependent variables in the study were the ring dimension and the deformation pattern.

2.3 Furthermore, the control variables were as follows:
- The top die dimension and temperature (100 mm x 100 mm x 30 mm and 250°C)
- The bottom die dimension and temperature (100 mm x 100 mm x 30 mm and 250°C)
- Heat transfer coefficient: 5 W/m²K
- The collision velocity (0.008333 m/s)
- The top die movement in-depth (7 mm / 50% h)

The specimen or the object in the study had the following dimension: 42:21:14 (OD:ID:H) while the material of the specimen was aluminium. The aluminium was formed by means of bubut machine and was trimmed in accordance to the dimension that has been set. In order to ensure the same surface kekasaran, the trimming technique that had been selected was precision.

| Table 1. Material Properties of AL 6082 |
|-----------------------------------------|
| **Properties** | **Value** |
| Density | 2.71 g/cm³ |
| Modulus young | 71 Gpa |
| Ultimate tensile strength | 140 – 330 Mpa |
| Yield strength | 90 – 280 Mpa |
| Termal expansion | 23.1 µm/m-K |
| Solidus | 575°C |
3. Results and Discussions
From the results of simulation using ANSYS, the difference on the deformation pattern and the dimension change within the Ring Compression Test might be identified. The temperature in the Ring Compression Test might influence the deformation pattern and the dimension change on the specimen. The influence of temperature variation itself might be consulted in Table 2 below.

Table 2. The Influence of Temperature Variation within Ring Compression Test

| Temperature | Deformation Pattern | Dimension Change |
|-------------|---------------------|------------------|
| 200°C       |                     |                  |
| 300°C       |                     |                  |
Table 2 displays the results of Ring Compression Test simulation using the ANSYS software. From the results of the simulation, dimension difference that has been resulted by each temperature variation on the specimen might be identified. Within the Ring Compression Test, the specimen that has been exposed to 200°C temperature results in the following diameter: 53,298 mm Do, 12,31219 mm D1 and 7 mm H. Then, the specimen that has been exposed to 300°C temperature results in the following diameter: 52,9259 mm Do, 12,32362 mm D1 and 7 mm H. Next, the specimen that has been exposed to 400°C results in the following diameter: 53,9184 mm Do, 12,30446 mm D1 and 7 mm H.

The conduct of Ring Compression Test with 300°C temperature has the biggest outer diameter (Do) and inner diameter (D1) in comparison to the conduct of Ring Compression Test with 200°C temperature and the conduct of Ring Compression Test with 400°C temperature respectively. This result is similar to that of a study by Andersson, Kivivuori&Korhonen, which shows that the heat transfer coefficient does not heavily influence the dimension change because the dimension change is influenced more by collision coefficient [8].

In addition to temperature variation, the deformation pattern and dimension change within the Ring Compression Test might be influenced by lubrication [9]. The influence of the lubrication on the specimen might be consulted in Table 3.
Table 3. The Influence of Lubrication on Specimen

| Lubrication Treatment | Dimension Change |
|-----------------------|------------------|
| Lubrikasi 0.48        | ![Graph 1]       |
| Lubrikasi 0.60        | ![Graph 2]       |
| Lubrication 0.88      | ![Graph 3]       |

Table 3 displays the dimension change that has been resulted by each lubrication variation on the specimen. The Ring Compression Test with 0.48 lubrication results in the following diameter: 53.9094 mm Do, 12.3366 mm D1 and 7 mm H. Then, the Ring Compression Test with 0.60 lubrication results in the following diameter: 53.8138 mm Do, 11.83074 mm D1 and 7 mm H. Next, the Ring...
Compression Test with 0.88 lubrication results in the following diameter: 53.9741 mm Do, 11.59244 D1 and 7 mm H.

The conduct of the Ring Compression Test with 0.48 lubrication has the biggest outer diameter (Do) and inner diameter (D1) in comparison to the conduct of Ring Compression Test with 0.60 lubrication and 0.88 lubrication. This result is similar to that of a study by E. Rajesh & M. Shiva Prakash, which shows that the smaller the collision coefficient is the bigger the deformation in the Ring Compression Test will be [10].

4. Conclusions
Based on the results of Ring Compression Test with temperature and lubrication variation, it might be concluded that temperature and lubrication variation might influence the deformation and dimension change of the specimen within the Ring Compression Test. The biggest dimension change in the Ring Compression Test is found in 300°C temperature with 0.48 lubrication, while the smallest dimension change in the Ring Compression Test is found in 400°C with lubrication 0.88.

5. References
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