ABSTRACT

The Automotive Forged components are Heat Treated and Quenched to achieve desirable mechanical properties and it is a physical process, which consists of various parameters interaction. These variables in quenching process also govern the ability of a part to meet distortion requirement. It is critical to balance the ability of material to achieve properties while at the same time control distortion and consisted a challenging task for heat treatment engineers. Because of the complexity of the heat treating process, it is rather difficult to understand the interaction of fluid flow and its parameters on part distortion and properties. There is less tolerance for “trial and error”, and the emphasis is on “doing it right the first times.” Proper distortion control has become even more important than in previous days. The heat-transfer coefficient has a significant effect on the properties of the finished product, like hardness, strength, residual internal stress and distortion. Optimized distortions after quenching will increase the cost due to post manufacturing processes such as grinding and hot straightening. Therefore, most quenching cases will benefit from reducing distortion. Therefore, to analyzed Heat Transfer coefficient and its effect on the Distortion of the element. To find out the relationship between the Heat transfer Coefficient and Distortion

Keywords: Heat Transfer Coefficient, Distortion, Quenching.

I. INTRODUCTION

Heat treatment is a multiparameters process. The selection of appropriate parameters predicts required behaviours of heat treated components. The type of quenching medium, the selection of quenching medium temperature and the selection of the medium state (unagitated, agitated) are determining factors [1]. In the metal forming processes, heat generation occurs due to plastic deformation energy. In the process of heat generation and heat transfer from material to active tool greatly influences the service life of the tool. The main factors effecting tool life in the elevated temperature forging processes are worn, heat checking, fatigue, and plastic deformation. The different transformation products formed during cooling contribute to the overall formation of transformational stresses. The cooling rate is also vitally important because it contributes to the formation of thermal stresses. Taken together, the sum of the thermal and transformation stresses is a controlling factor involved in the resulting distortion and cracking potential of steel [6]. The quenching process is a transient heat-transfer problem, and the temperature difference between the component and the quenching medium cannot be directly adjusted to control the boundary heat flux. The only way to significantly affect the quenching process is to adjust the heat-transfer coefficient [7].
II. DISTORTION DUE TO HEAT TREATMENT

Distortion can be defined as an irreversible and usually unpredictable dimensional change in the component during the process in from heat treatment and from temperature.

![Diagram](image)

Fig 1. Relationship between heat transfer, deformation and phase transformation during the quenching process[7].

Variation and leading in service. The term dimensional change is used to denote changes in both size and shape. The heat-treatment distortion is therefore a term often used by engineers to describe an uncontrolled movement that has occurred in a component as a result of heat-treating operation. Although it is recognized as one of the most difficult and troublesome problems confronting the heat treated and the heat-treatment industries on a daily basis, it is only in the simplest thermal heat-treatment methods that the mechanism of distortion is understood. [7] Distortion can be defined as an irreversible and usually unpredictable dimensional change in the component during processing of heat treatment and from temperature variations and loading in service. The term dimensional change is used to denote changes in both size and shape. The heat-treatment distortion is therefore a term often used by engineers to describe an uncontrolled movement that has occurred in a component as a result of heat-treating operation. Although it is recognized as one of the most difficult and troublesome problems confronting the heat treated and the heat-treatment industries on a daily basis, it is only in the simplest thermal heat-treatment methods that the mechanism of distortion is understood. [7] Distortion can be defined as an irreversible and usually unpredictable dimensional change in the component during processing of heat treatment and from temperature variations and loading in service. The term dimensional change is used to denote changes in both size and shape. The heat-treatment distortion is therefore a term often used by engineers to describe an uncontrolled movement that has occurred in a component as a result of heat-treating operation. Although it is recognized as one of the most difficult and troublesome problems confronting the heat treated and the heat-treatment industries on a daily basis, it is only in the simplest thermal heat-treatment methods that the mechanism of distortion is understood. Changes in size and shape of tool-steel parts may be either reversible or irreversible. Reversible changes, which are produced by applying stress in the elastic range or by temperature variation, neither induce stresses above the elastic limit nor cause changes in the metallurgical structure. In this situation, the initial dimensional values can be restored to their original state of stress or temperature. [9]

Types of Distortion

Distortion is a general term that involves all irreversible dimensional change produce during heat-treatment operations. This can be classified into two categories: size distortion, which is the net change in specific volume between the parent and transformation product produced by phase transformation without a change in geometrical form, and shape distortion or warpage, which is a change in geometrical form or shape and is revealed by changes of curvature or curving, bending, twisting, and/or non-symmetrical dimensional change without. Any volume change. Usually both types of distortion occur during heat-treatment cycle.

Problem Definition: - Distorted components cause noise in the transmission, affects the life of a component, In extreme cases failure of Component takes place. Therefore distortion control has become more important than ever.

III.OBJECTIVE

A prediction of treated component's behaviour during a cooling process is possible only in the case if the boundary conditions of the process are defined. Before the application of a cooling process numerical simulation, the heat transfer coefficient of the component surface should be defined quantitatively. The experiment, applying the simulation model and numerical solution, is able to test the influence of heat treatment parameters on an immediate and final state of the component.

- The objective of this work is to Study the Heat Transfer Characteristics of Aluminium Forged Component for Quenching Process.
- To find out the relationship between Heat Transfer Coefficient and Distortion in the given Material.
- To design Heat Treatment Process Parameter

IV.METHODOLOGY

In the methodology initially aluminium material workpiece (specimen) is selected and heated up to 250°C temperature and then will be placed in Quenching tank for Heat treatment process. During this operation measure the Temperature with help of thermocouple etc. and after quenching observe the distortion in workpiece. Measuring that distortion with measuring device such as Vernire caliper. By applying the various input and output boundary
condition such as temperature, distortion, length, heat transfer coefficient will be calculated and graph will be plotted correlation between Heat Transfer Coefficient and Distortion is carried out.

**Material required for experiment:**
- Al forged Component
- Quenching Material will using: -Water, Oil
- Measuring instruments or tester for reading a parameter is Thermocouples, Verni Caliper Quench Probe.

**V. EQUATIONS**

The following mathematical equations are used to calculate Heat transfer Coefficient for Quenching Process. [8]

1) **Heat Flux for Surface:**

\[
(q/A) = \text{ChfGp}\left(\frac{\rho_g(\rho_1-\rho_g)}{(\rho_1-\rho_g)}\right)
\]

2) **Film Boiling Heat Transfer Coefficient**

:(Bromley Co-relation)

3) **Heat Transfer Coefficient along the Surface.**

\[
h_b = 0.62\left(\frac{kG^2 \rho G g(p_1-\gamma G) hfg + 0.4 CGG \left(T_w - T_{sat}\right)}{D_g G(T_w - T_{sat})}\right)^{1/4}
\]

4) **Average Heat Transfer Coefficient**

\[
h_b = 0.943 \left(\frac{kG^3 \rho G (p_1-\gamma G) hfg \rho_1 g \lambda}{L \mu_G \Delta T}\right)
\]

Also along with that we have to study Time-Temperature Graph, HTC graph, Hardness graph. Also analysis of TEM and SEM of Component under testing.

**VI. CONCLUSION**

Many experimental and computational investigations indicate that the heat-transfer coefficient during the quenching processes has a significant influence on the resulting component properties such as the hardness distribution, residual stresses and distortion. Up until now, trial-and-error methods by experiment or computer simulation have been used to determine the heat-transfer coefficient during the quenching process, but this cannot guarantee an optimum heat-transfer coefficient because of the limited number of trials; the cost of trial-and-error methods are also high. Therefore, optimization of the final properties of the component with the least cost will be valuable research work. In this paper, the heat-transfer coefficients between the surface of the component and the circulated quenchants are used as design variables to optimize the process. And try to develop the relationship between Heat Transfer Coefficient and Distortion, Hardness etc.

**REFERENCES**

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