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A Critical Analysis of Springback defect in Cold Drawing Process of Seamless Tube Manufacturing

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Abstract : Cold drawing is one of the most important semi-finished process used in the steel industry and cold drawing of seamless tube technology is therefore an important engineering discipline within the area of mechanical engineering. The major problem associated with cold drawing of seamless tubes is the springback, the geometric difference between the loaded condition and unloaded configuration and is affected by many factors such as die angle, land width, drawing speed, tube material etc.

IndexTerms – Springback, cold drawing

I. INTRODUCTION

Metal forming is the large group of manufacturing processes in which plastic deformation is used to change the shape of metal work pieces. The factors that determine the choice of the forming or any other process are maximum utilization of resources with high quality output. Both extrusion and drawing are net shape metal forming processes which have high material utilization and produces parts with superior metallurgical and material properties. Due to the ever increasing competition with the advent of globalization it has become highly important to keep on improving the process efficiency in terms of product quality and optimized use of resources. The demands in the automobile sector, energy sector and mining sector have led to several modifications in different manufacturing processes. Good quality and high precision products can be produced by several metal forming methods such as extrusion, drawing, rolling etc. Cold drawing is widely used metal forming process with inherent advantages like closer dimensional tolerances, better surface finish and improved mechanical properties as compared to hot forming processes.

II. Springback in Cold Drawing

Though the cold drawing industries faces various problems like dimensional variation, scores on tubes, chattering, bending of tubes etc., but springback is severe one. Research conducted over last decades has indicated that springback has an important role in industry and studied how this permanent variation can be avoided.

Springback is a phenomenon that occurs in many cold working processes. When a metal is deformed into the plastic region, the total strain is made up of two parts, the elastic part and the plastic part. When removing the deformation load, a stress reduction will occur and accordingly the total strain will decrease by the amount of the elastic part, which results in springback. Since all materials have limited elastic modulus, when load acting on plastic deformation is relieved from the material, it is followed by several elastic improving. Elastic limits of materials are exceeded, but flow limit thereof cannot be exceeded, therefore, the material still keeps a portion of its original flexibility character. When the load is released, the material on forcing compression side tries to enlarge, whereas the material on tensile side tries to shrink. As a result, the material tries to springback. We name this nature of material as a springback.

III. Company Profile

The research work has to conduct in Yashashree tubes Private limited, F-48, M.I.D.C., Ahmednagar, Maharashtra, India 414001 which is specialized in production of the seamless tubes.

It manufactures tubes for most diversified applications like domestic and export applications, e.g. Automobile axles, structural systems, Commercial Vehicles, Two-Three Wheelers, Bearings, Oil industry, Petrochemical Industry,

Refineries, Fertilizer plant, Boilers, Heat Exchangers, Pressure vessel, Hydraulic and Pneumatic Cylinders, etc. It also exports the seamless tubes to U.S.A., Europe, Gulf countries etc.

IV. Importance and Significance of the Study:

Towards the end of the nineteenth century, various processes became available for the manufacture of seamless tube and pipe, with production volumes rapidly increasing over a relatively short period. As the requirements imposed on tubular products continued to increase, not only were the associated manufacturing processes constantly improved, but also appropriate systems for effective production control and quality assurance were introduced. Nowadays, tube and pipe manufacturers all have a system in their place enabling the production process from the steelworks to the finished tube to be continuously monitored and documented for total traceability, and effectively controlled on the basis of quality criteria. The mechanical and non-destructive tests stipulated in the relevant technical specifications are carried out by personnel operating independently from the production control department so as to guarantee product of a constantly high quality.

Research conducted over last decade indicated important role of springback in industry and studied how this permanent variation can be avoided.

- It varies with composition, material properties and dimensional range of outer diameter and thickness. However, required to control Springback to achieve closer dimensions.
- Springback causes deviation from designed target shape, downstream quality problems and assembly difficulties.
- Determination of Springback by trial and error technique not only increases the cost of manufacture and repair of tool but also waste of time causing delay in the development of the product.
- The solution yields improved dimensional consistency, tighter size and tolerances, improved quality, straightness, productivity, formability, longer tool life resulting cost effectiveness.

V. Cold Drawing

Seamless precision steel tube has been standardized in DIN 2391 for the diameter range from 4 to 120 mm and wall thicknesses from 0.5 to 10 mm. In addition, however, non-standardized intermediate sizes, and tube up to 380 mm outside diameter with wall thicknesses up to 35 mm, can also be manufactured by cold drawing. There are three processes employed for the cold drawing of tube: hollow drawing, stationary or floating plug drawing, and drawing over a mandrel (also known as drawing on the bar).

V.I. Defects in Cold drawing process

Following defects are found during cold drawing

- Eccentricity
- Bending
- Internal cracks.
- External cracks.
- Ovality.
- Dimensional Variations Larger and smaller inside / outer diameter.
- Wavy surface.
- Tube thickness oversize.
- ID and OD scores
- Springback

The cause of each defect is known which can easily detected, but the reasons for springback are many and needed to study in depth.

VI. Springback

Since all materials have limited elastic modulus, when load acting on plastic deformation is relieved from the material, it is followed by several elastic improving. Elastic limits of materials are exceeded, but flow limit thereof cannot be exceeded. Therefore, the material still keeps a portion of its original flexibility character. When the load is released, the material on forcing compress side tries to enlarge, whereas the material on tensile side tries to shrink. As a result, the material tries to springback.

VII. Research Objectives

- To design and develop die and plug for cold drawing of circular and sectional (square and rectangular) seamless tubes for minimization of springback.
- To optimize the reduction ratio and process parameters for least springback with developing mathematical model of springback during cold drawing under the influence of various parameters.
- To present an approach to minimize springback by comprehensive study of microstructural evaluations, characterizations using metallurgical aspects.
- To reduce the cost of expensive trials required for new product/process development by providing an appropriate solution to minimize springback.

VIII. Hypothesis:

Hypothesis is a proposed explanation for a phenomenon. In cold drawing many things need to be considered.

1. High starting load during cold drawing has to be considered.
2. The material used for tube and die-plug are fixed during this research.
3. Friction conditions and lubrication are used as a standard practice of the cold drawing industry.
4. Heat treatment procedure used is only annealing.

IX. Methodology

An extensive literature survey has to be carried out to identify the process parameters influencing cold drawing process and springback. This study will consider different parameters to reduce springback. The first objective of the research will be to design die and plugs for seamless tubes especially die semi angle for optimized performance. Experimentation will be carried out then to optimize reduction ratio. Further the process parameters such as die semi angle, land width and drawing speed will be optimized for circular seamless tubes. The primary data collected through experimentation on draw bench machine using digital micrometer and CMM is taken for data analysis in Minitab software. Various tests like Kruskal-Wallis test, One sample test, ANOVA test, Post Hoc test, Micro Structural Changes, XRD Plots, Cold Draw Load,% Elastic Recovery, Mechanical Properties, Hardness Properties will be studied to optimize the reduction ratio and process parameters.

X. Expected Conclusions

In this research the springback effect of seamless tube that undergoes cold drawing has to be handled with the aim of reducing it. This work firstly aims at predicting die semi angle for optimized performance. Different multi attribute decision making methods like AHP, TOPSIS etc. has to be used to finalize die semi angle. Experiments will to be conducted under three reduction ratios viz.10-15 %, 15-20 % and 20-25 % with working conditions of die semi angles of 10 and 15 degree, land width of 5 and 10 mm as well as drawing speed of 4, 6 and 8 m/min.The purpose of this work is to present optimized reduction ratio and process parameters such as die semi angle, land width and drawing speed which results in minimum springback. The factors influencing springback effect of C-45 material is identified and then reduction ratio has to be finalized using Statistical Package for Social Science (SPSS) software of data analysis. Metallurgical and Mechanical properties for different reduction ratios are also to be studied. This can be used to help design of tools in the metal forming industry to minimize springback and improve the quality of the product.

Further the study is to be carried out to optimize process parameters. Minitab software is used for data analysis. From the results of ANOVA, the major controllable parameter affecting the springback is to be found. The optimal combination is to be predicted for cold drawing of seamless tubes of EN 8 D(C-45) material for die semi angle, land width and drawing speed.

XI. Chapterization

The report will presents details of research study carried out pertaining to springback phenomenon in case of cold drawing of seamless tubes with an objective to minimize it. As springback cannot be nullified, it has minimized through optimization in this study. A brief outline of proposed chapters is given as follows:

Chapter 1-Represents the introductory background of the research undertaken. It will also provide an identification of problems, objectives of the research, brief outline of methodology and organization of research work.

Chapter 2-Provides an overview of the company profile and literature in the area of cold drawing and springback analysis. The literature covers the major database till 2018.The literature review will be represented into two sections viz. cold drawing and springback.

Chapter 3- Deals with the research methodology including experimental design framework, experimental set up, machines with their specifications and materials used. It will also deal with sample preparation for testing in accordance with ASTM standards.

Chapter 4- Provides the details of experimentation carried out on draw bench in seamless tube manufacturing industry. The purpose of experimentation is to optimize Die Semi Angle, Reduction Ratio and process parameters. This chapter will be associated with data collection and data analysis

Chapter 5-Provides major findings, recommendations, conclusions, practical implications and significant contribution of research. Finally, the limitation of research and scope for future research will be elaborated in details.

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