Chapter - 1

INTRODUCTION

"To do successful research you do not need to know everything. You just need to know of one thing that is not known"

.... AL Schawlov

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Technological research and development in the last three decades or so has recorded an impressive growth and spectacular improvement in various branches of engineering industry. Rapid technological progress, particularly in the fields of automobile, gas turbine engine, aeronautics, atomic and space research together with phenomenal advancement in armament technology, has necessitated many vital components to be produced to a very high degree of dimensional accuracy, precision and surface finish with greatly improved mechanical properties in order to meet highly stringent design specifications and extreme service requirements. Manufacturing industry has found that in many cases the traditional manufacturing processes are unable to cope with these requirements. Further, the rapid increase in the cost of raw materials and the increasing awareness of their limited availability have caused manufacturing industry to critically examine various chipless metal forming techniques replacing wherever possible the conventional machining operations with the aim of making a more economical use of available materials.

This situation, i.e. the ever increasing stringent design specifications and service requirements combined with economy in raw materials has stimulated the development of new metal forming processes with a view to increase accuracy, reliability and ease of production operating within the envelope of reasonable economics. One of such modern metal forming techniques introduced within last three decades is that referred to here as "Flow forming' which may effectively meet today's challenge to industry.

1.1 Flow Forming Process

Flow forming is also known by a variety of names according to the various machine makers or the countries practising the technique, such as, power shear spinning, hydrospinning, shear forming, roll forming, spin forging, flow turning, etc. The author personally feels that the name "Flow Forming" is the best suited to the process defining adequately the method of plastic deformation and flow of a metal into a new form.

Flow forming is a method of rotary metal forming in which the work metal is forced to take the shape of a rotating mandrel by the action of one or more power assisted rollers. It is a high energy rate and point deformation metal forming process and the most severe method of metal deformation even in high tensile strength and heat resisting materials.

The process is capable of producing rotationally symmetric hollow parts of any desired contour. Tolerances and finishes are comparable with high class machining. Unique advantages are claimed for this process which include the improvement in part quality and mechanical properties, low tooling cost, less finished scrap etc. Important applications include satellite nose cone, many critical armament components, various parts of nuclear reactors, aerospace, automobile and gas turbine engine besides many general industrial applications.

Now-a-days, flow forming is replacing in many cases, the fabrication, casting and conventional machining processes. Press-working or deep drawings which require several operations are also being replaced by single operation flow forming and shapes are being made by this technique that would be practically impossible to make by any other method.

1.2 Reasons for choosing the Present Work

Because of the advantages of the flow forming process over other methods of manufacturing the same part, and also because of the success obtained so far in many applications with materials of widely varying properties it becomes evident that flow forming is a very promising process.

In order to achieve efficient techno-economic utilisation of the flow forming process, i.e. to facilitate further development and improvement of both the process as well as the machine for employing flow forming technique more widely in large scale production applications, it is absolutely essential to have more specific informations on the flow forming parameters with regard to their interactions and individual effects on the end results or performance characteristics. Unfortunately, work done so far in this field is too inadequate, as indicated by lack of published literature, to draw definite inferences.

Theoretical study and analytical work hitherto carried in the field of flow forming technology employed only approximate methods based on certain assumptions because of the difficulty of applying exact mathematical methods to the problems of importance. The precise state of stress and mechanics of plastic deformation in flow forming is still ill-defined. As such solutions obtained by different theoretical methods do not generally lead to identical answers and as far as possible the theoretical predictions need to be verified and compared with practical experimental evidences.

In view of the above, successful solutions to the flow forming problems would be a function of the experience gained through practical experimental work. But because of the very different properties of materials used in flow formed parts and because of great expense involved, a trial and error type experience will be neither economical nor efficient way to handle the problem. There is, therefore, an urgent need for systematic experimentation and scientific analysis of experimental results with a view to assess the influence of various controlling parameters (factors) determining the process on the objective performance parameters or end results characterising the process and finally to arrive at the optimum working or operating conditions.

1.3 Scope of the Present Work

The present work aims at experimental attainment of the parametric optimum conditions in flow forming of sheet metal cones, i.e. to evaluate experimentally the optimum parametric values for achieving certain specific end results while flow forming sheet metal cones of different materials.

Keeping this aim in view, suitable experiments are designed, run and the experimental results processed to fulfill the following objectives :

(a) to assess quantitatively the degree of significance of the interactions and individual effects of various important controlling variables (factors) on certain specific objective parameters or end results characterising the process performances.

(b) to establish the functional relationships among associated process parameters.

(c) to determine the optimum values of relevant controlling factors defining the effective regime of working conditions.

For achieving the above objectives of the present work, use has been made of some well known as well as lesser known methods and techniques of the Statistics, the Design of Experiments and the Operation Research such as factorial experiments and analysis of variance, multiple regression analysis, optimisation methods, etc.

In the belief that one appropriate figure is worth a thousand words, emphasis is given on schematic sketches, line diagrams, graphical representations, pictorial views, etc., for better illustrations.

It is hoped that the useful practical data and informations, generated from the systematic design and scientific analysis of a large number of experiments carried out for the present work, will help in providing the practical designers and the production engineers with necessary tools to design and operate efficiently the flow forming machine, in order to get better techno-economic utilisation of the flow forming process and thereby to control effectively the desired quality of the flow formed products.