



RIFLING BY FLOW FORMING

A NEW DEVELOPED METHOD FOR RIFLING BARRELS

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BARIŞ GÜN
MECHANICAL ENG. BSc.
DESIGN AND MANUFACTURING ENG. MSc.

ILHAN GÜVELİ
NAVAL ARCHITECTURE
AND MARINE ENG. BSc.

INTRODUCTION OF FLOW FORMING

Flow forming is a chipless cold forming method which is used to manufacture dimensionally precise, round seamless hollow components.

In flow forming; a hollow axisymmetric preform is fitted to a mandrel. After both are made to rotate, compression forces are applied to the outside diameter of the preform by hydraulically-driven or ballscrew-driven CNC-controlled rollers. For most applications three rollers are used.

By a precalculated amount of wall thickness reduction, in one or more passes, the material is compressed above its yield strength, plastically deformed and made to flow. The desired geometry of the workpiece is achieved when the outer diameter and the wall of the preform are decreased and the available material volume is forced to flow longitudinally over the mandrel.

Cross-sectional wall reductions for most materials are in excess of 90% of the starting wall thickness. Typically, the preform can be flowformed up to six times its starting length before a need for reannealing of the metal is required.

The inside surface quality of the finished workpiece is almost same with the outside surface quality of the mandrel.

Flow forming process has two typical types which have been appeared due to fixing necessities of preform shapes.

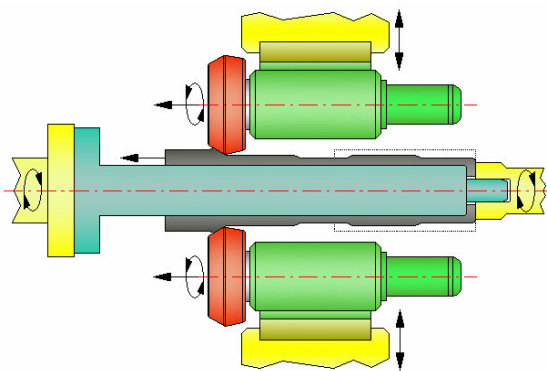


Figure-1 Forward Flow Forming

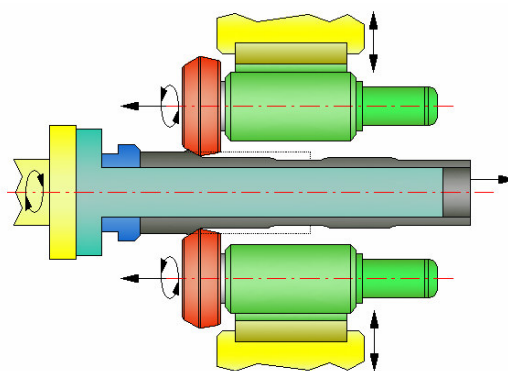


Figure-2 Backward Flow Forming

First type is **forward flow forming** (Figure-1) and it is used to form preforms which have a shape with one side is partially closed or fully closed. In forward flow forming, a tailstock is used to fix the preform to the mandrel. The elongation of the workpiece during forward flow forming is at the same direction with the relative axial movement of the rollers.

Second type of flow forming is **backward flow forming** (Figure-2) and it is used to form preforms with a continuous hole inside. In backward flow forming, a toothed ring is used to fix the preform to the mandrel and it is also used for reloading of the finished workpiece. The elongation of the workpiece during backward flow forming is at the opposite direction to the relative axial movement of the rollers.

For precision long flow forming operations, typically three rollers placed with 120° design is used. These rollers have precalculated radial and axial offsets between each other to achieve necessary forming conditions.

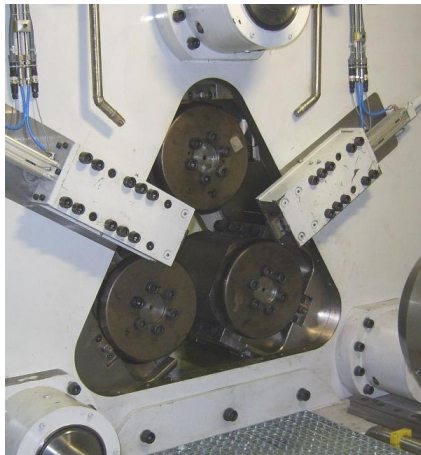


Figure-3 Typical 3-Roller Design

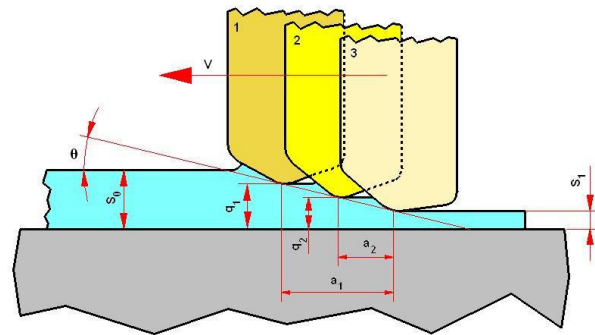
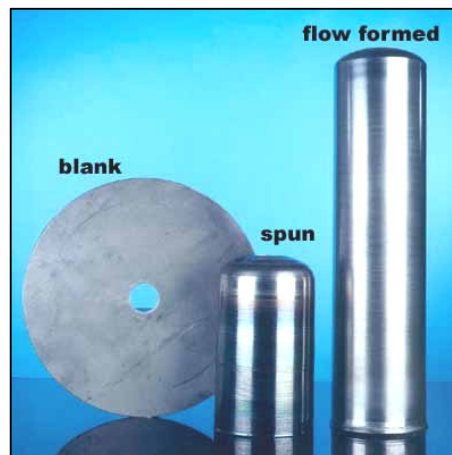


Figure-4 Offsets of 3-rollers

Main advantages of flow forming method :

- Chipless, seamless and cold manufacturing.
- Improved material properties such as yield strength, fatigue life, etc.
- Manufacturing capability of very accurate long hollow parts.
- Preventing secondary operations such as turning, grinding, etc.
- Fast and economical production rates compared to other methods.



As a result of the cold work (strain hardening) that occurs during the process cycle, a flow formed component will have considerably higher mechanical properties than the ones of the starting material. Typically, the preform material is plastically deformed with wall reductions in excess of 90% of the starting wall thickness, causing a substantial refinement of the grain structure and a total realignment of the grain's microstructure in a very uniform, axial direction. The greater the wall reduction, the finer the grain's microstructure of the finished component. If necessary, the grain structure can be recrystallized by a post forming annealing cycle.

Flow forming offers the unique possibility of forming to size a pre-hardened workpiece, thus eliminating the difficulties and high costs associated with final machining, grinding and honing of a hardened and distorted hollow component. Flow forming method also allows to achieve high dimensional accuracies and at the same time guarantee conformance to required mechanical properties.

Figure-5 shows an illustration of the grain's microstructure of a preform to flow formed zone and Figure-6 shows the improvement of mechanical properties for an AISI 316 workpiece.

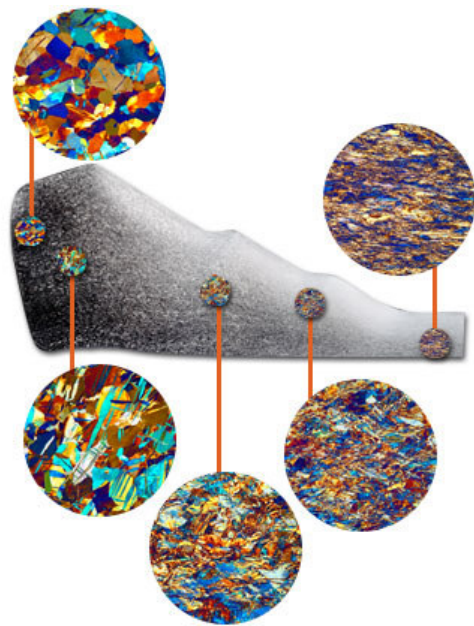


Figure-5 Grain's Microstructure

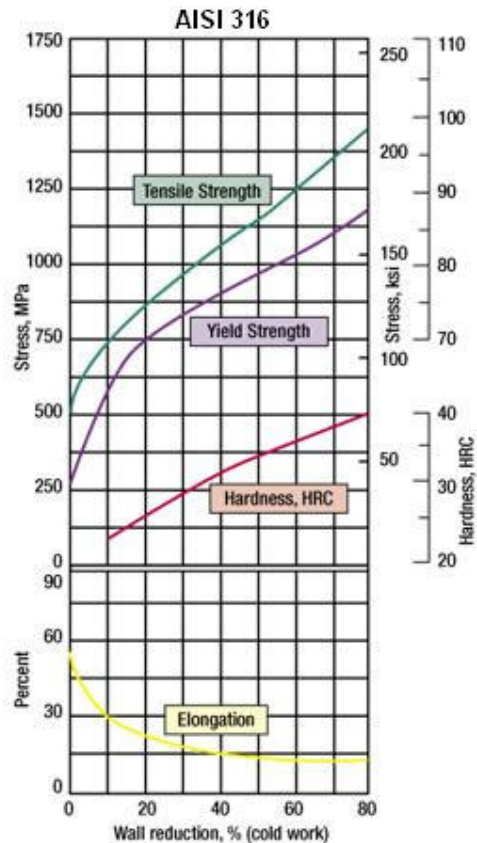


Figure-6

RIFLING BY FLOW FORMING

Flow forming of a barrel can be described as a special application of forward flow forming which is used to form grooves and lands inside the barrel while also forming outside of the barrel.

In rifling by flow forming, a barrel preform over a special mandrel containing reverse image of desired grooves and lands are flow formed by rollers. During the process, the barrel material flows in axial and radial directions. Axial flow elongates the barrel and radial flow forms the rifling.

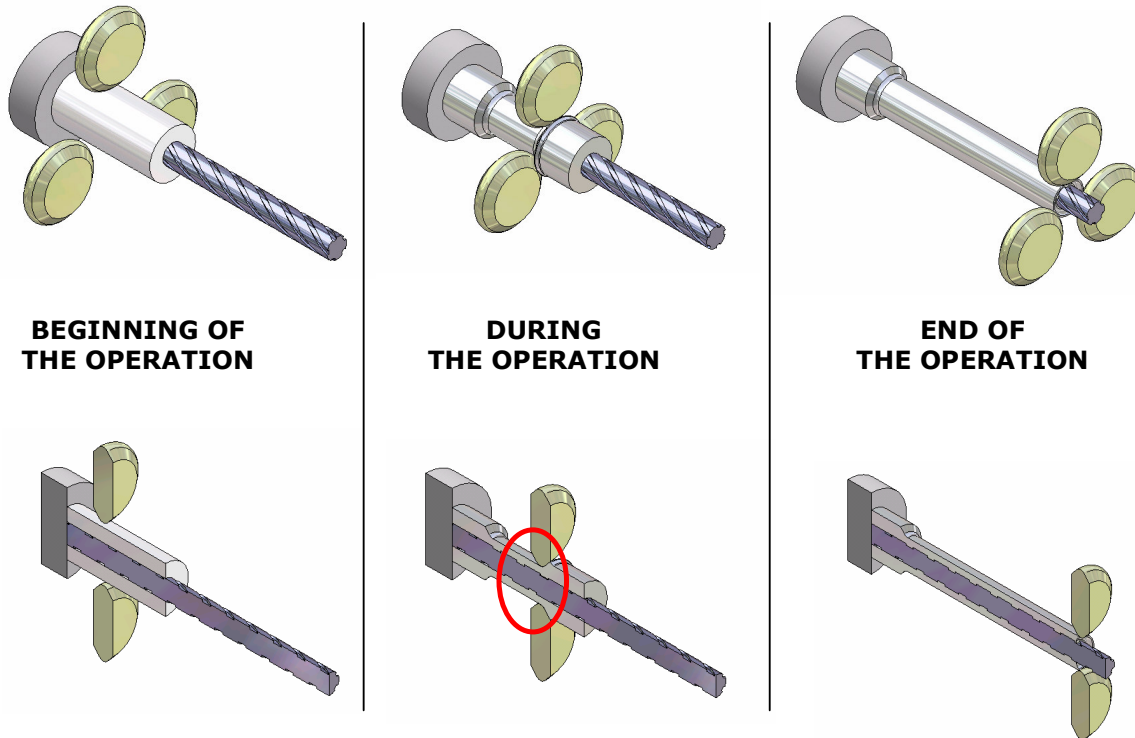


Figure-7 Rifling Process

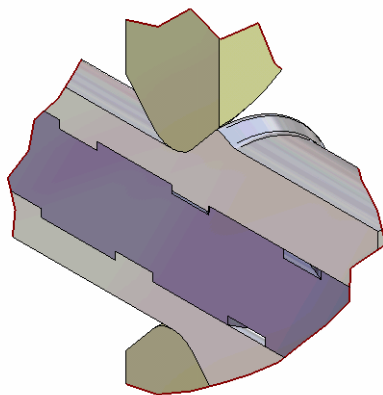


Figure-8 Material Flow

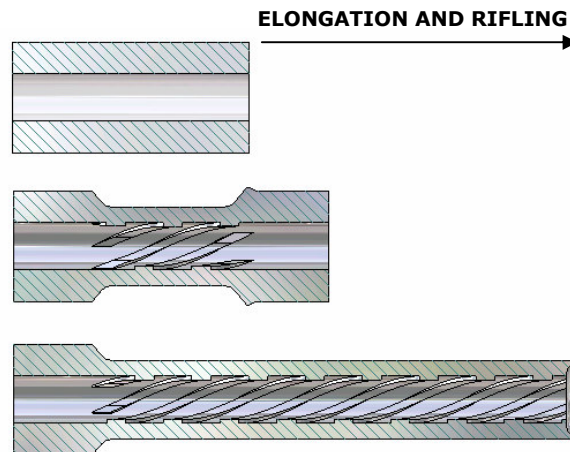


Figure-9

It is also possible to form different outside diameters during flow forming without any stop of the rifling inside unless each point of outer surface of rifled zone must be less than the preform's beginning outer diameter.

Rifling by flow forming method will be the mostly using method for manufacturing tomorrow's barrels. This method has many advantages compared with the conventional methods; cutting (broach rifling), button rifling, forging and electrochemical rifling.

The advantages of rifling by flow forming :

- More accuracy with the precision standards of flow forming technology.
- Stronger and / or lighter barrels with more plastic work and strain hardening.
- Improved fatigue life with flow formed grain structure.
- Prevented / decreased secondary operations like turning, grinding, etc.
- Economical and faster production rates.
- Useful for all light and heavy barrels from pistols to tanks.
- Less mass production investment costs with higher technology.

The photographs below show the Aluminum parts flow formed and rifled for trials of the method in less than 30 seconds with x3 times elongation in length. Grooves and lands have been formed approximately x8 times thicker than real applications.



Please call us for your opinions and questions.

MACDOR Machine Industry And Trade Co. Ltd.

Altiyol Gaziosmanpasa Sok. No:10/13 Kadikoy/Istanbul, TURKEY
Tel: +90216365376 Fax: +902163365381 E-Mail: info@macdor.com
Barış Gün (GSM +905434324720) **İlhan Güveli** (GSM +905423765241)