

CROSS ROLLING





Process

Cross wedge rolling (CWR), or briefly cross rolling, is a forming operation using wedge-shaped tools. Billets with a circular cross-section are placed between the two tool halves which are working in opposite directions. The tools contain the negative contour of the final workpiece shape. The radial penetration of the wedges into the billet is followed by the redistribution of the material in the axial direction. This causes a reduction of the initial diameter. The rolling process can be applied in the temperature range of cold, warm or hot forming.

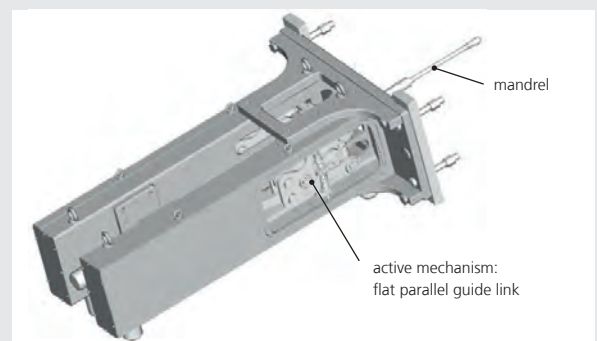
Machines

Two types of cross rolling machines are commonly used in industry, machines with flat tool holders and with round holders. The flat cross rolling machine features hydraulically driven tools with infinitely variable control of the rolling speed and a maximum speed of the return stroke. The design of the round holder cross rolling machine is characterized by an electromotively driven system using clutch and brake. The automatic operation mode of both machine types guarantees high productivity and stable process conditions. Usually an automatic heating system is attached.

Application

Cross rolling processes allow for economic manufacturing of intermediate shapes with accurately defined mass distribution for subsequent forming operations such as forging. Besides the rolling of intermediate pieces, final components can also be manufactured in near-net-shape quality. They can be made for final machining, or they can be left without further processing. The cross rolling process ensures high surface quality, constant processing allowances and low tolerances.

Basic design of a mandrel unit for a flat cross rolling machine to form hollow cross sections



Materials

Basically any metal alloys can be rolled. Alloys especially suitable for cross rolling include materials with high ductility and high necking capacity. Increased requirements on homogeneity or purity of the material structure of steels are needed, depending on the application. Due to the partial forming zone cross rolling can be used for forming alloys, which are usually hard to form, such as high temperature resistant materials.

Precise mass distribution

In forging the quality of complex part geometries is tremendously enhanced if preforms with precise mass distribution are used. Cross rolling is perfectly suitable to produce such preforms. Exact mass distribution along the main axis of parts with longitudinal shape leads to significantly better results in die forging. The cross rolling shape is developed from the final forging shape and the appropriate mass distribution chart. At first, the starting diameter of the cross rolling blank and the maximum reduction have to be specified. Based on the geometry of the cross rolling part, the tool geometry needs to be developed. The cross rolling tools are segmented, which makes it easier to manufacture and subsequently rework them. This enables uncomplicated mounting and easier maintenance.



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Manufacturing of structured parts

Cross rolling can be used for a large variety of components. A major application is the manufacture of gear shafts. The process is widely used in automated, highly productive large volume production. Cross rolling can substitute manufacturing chains, which utilize machining operations only. The method can be applied in combination with various forming technologies and in connection with other production processes.

Lightweight construction

Lightweight construction in the automotive industry focuses on components manufactured with an optimized weight. This poses high demands on manufacturing technologies in order to design the required manufacturing processes in a manner that is economic and technologically safe. As an example of the innovative potential of cross rolling, the manufacture of a hollow gear shaft has been realized at Fraunhofer IWU. Based on a prototype of a formerly massive part without bore, the feasibility of manufacturing a hollow part using forming technologies has been demonstrated. A special auxiliary device developed for a flat cross rolling machine opened up the possibility for controlled forming of the inner contour of hollow shafts. Technological parameters of the forming process, the tool geometry and the mandrel design were optimized. The technological and economic feasibility has been demonstrated.

Cross rolling with axial feed

The benefits of cross rolling can be extended and utilized in small and medium-sized series by using the technology of cross rolling with axial feed. In this process variant the two wedges are replaced by two disc-shaped tools in order to perform the main forming operation. The discs rotate and penetrate radially into the material of the billet. The clamped billet is concurrently fed in the longitudinal direction. The major advantage of the cross rolling with axial feed is the manufacture of different axial geometries without changing

tools. The variety of geometries is achieved by changing machine control parameters only. Long set-up times are not required.

Core competencies

- Research and development
 - Materials – basics – FE-simulation
- Engineering services
 - Process design – tool design
 - Tool manufacturing – tryout
- Prototyping, pilot series, small batch production
- Trainings

Special machinery

- Flat tool holder cross rolling machine FBQ 100/1600 with additional equipment for manufacturing of hollow parts (max. diameter of rolled part 100 mm, max. tool length 1,600 mm)
- Round tool holder cross rolling machine RBQ 1000 (max. diameter of rolled part 200 mm, roll diameter 1,000 mm)
- Cross rolling machine AVQ 630 with axial feed (max. diameter of rolled part 63 mm, roll diameter 630 mm)

Software

- 3d-CAD-software: Pro/ENGINEER
- Finite-elements-software: Forge/Simufact forming

- 1 *Intermediate forms of aluminum and titanium for die forging processes*
- 2 *Flat tool holder cross rolling machine FBQ 100/1600*
- 3 *Process chain for manufacturing a hollow, lightweight gear shaft*
- 4 *Cross rolling machine AVQ 630 with axial feed*

Editor

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