

“Aluminum Extrusion – Design and Calculation by HyperXtrude”

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Abstract: 2006 was a very gratifying year for the extrusion industry in Europe. The demand increased all over Europe by more than 6% and market volume in EU25 plus EFTA amounted to over 2.9 million tonnes making 2006 a new record year. By far the most dynamic market development in the extrusion sector in 2006 took place in Germany, where market volume increased to over 710,000 tonnes, an absolute maximum, with a growth rate of +17% higher than the previous record year of 2004.

German manufactures, producing profiles, rods and tubes at 31 locations using 84 plants were pleasantly surprised by this development last year. Despite historically high LME prices, in the recent past German producers have achieved good growth. Innovative products, high quality and proximity to their customers have been the key to success in this.

Manufactures of section systems have for some years been very gratified by the development of the mechanical engineering industry in Europe, especially in Germany, which is not only the dynamo of the economy as a whole but is also becoming an increasingly important market for extruded products.

The extrusion branch in Germany is looking to the future with optimism. German extruders are to an increasing extent looking abroad. Whereas in 1996 some 50,000 tonnes were delivered abroad directly from plants in Germany, ten years later this had grown to more than 92,000 tonnes, an increase of more than 80%.

The design of the dies is a very important part in the production chain. With the help of the finite element method the designer is able to consider all the required conditions for a good design e.g.

- better support against flexion of the mandrels, which is divided over various positions,
- less movement and more stability of the mandrels,
- less impact pressure with the billet,
- less friction with reduction of the working pressure and temperature from start to finish of one extrusion,
- increasing of the extrusion speed.

Altair HyperXtrude is a finite element based simulation tool for analysis and design of aluminum extrusion dies and process. This tool accurately simulates the material flow and heat transfer during extrusion processes thereby allowing the user to significantly reduce die design time and costly die tryouts. It is developed to meet the needs of extrusion process/product design engineers.

HyperXtrude improves the productivity of design engineers by

- minimizing die design time and cost through robust, reliable and fast analysis,
- helping troubleshoot existing dies,
- validating new die designs,
- helping calculate optimal bearing/land lengths.

This software is a finite-element method-based numerical simulation tool that uses arbitrary Lagrangian Eulerian Codes. This means that the mesh is adjusted in preselected areas such as die exit, billet tool, etc. (Lagrange), in other regions a fixed mesh (Euler) is used. The program solves the time-dependant nonlinear partial differential equations (Navier-Stokes-, Fourier Field-, Euler-Lagrange equations) with respect to the second law of thermodynamics. Results are velocity, temperature, pressure and strain distribution inside the extrusion and in the die. A complete understanding of the flow and temperature field, of the load distribution and the nonlinear material behavior under all operating conditions is necessary to select and optimize process variables. The presentation demonstrates the powerful help of the method by a new die design for the automotive industry and attempts to explain the theoretical basis of the method.