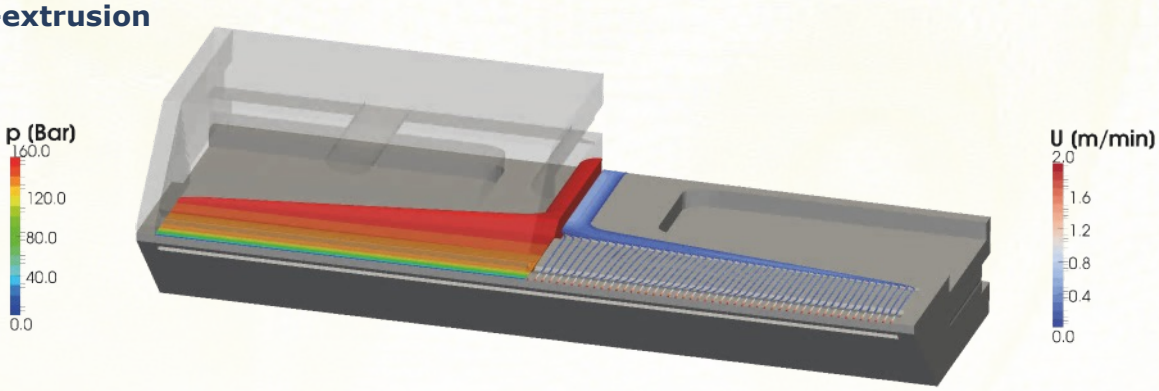
CastNet for plastics processing applications

CastNet is DHCAE Tools' pre-processing and simulation control system for the open source CFD library OpenFOAM® and the FEA solver CalculiX. With a comprehensive extension and customization of the OpenFOAM® solvers to fit the needs of plastics processing applications, a cost efficient, user friendly and reliable design tool for the plastics industry was created by DHCAE Tools.

Typical areas of application in the plastics processing industries

The combination of the GUI based pre-processing capabilities of CastNet with the excellent CFD toolbox OpenFOAM® results in an efficient software tool for many applications in polymer processing. Typical application examples are:

- **Profile extrusion**, e.g. PVC-window profiles
- **Flat slit dies**, e.g. sheet extrusion
- **Tube extrusion**, e.g. for medical products
- **Wire coating**
- **Co-extrusion**



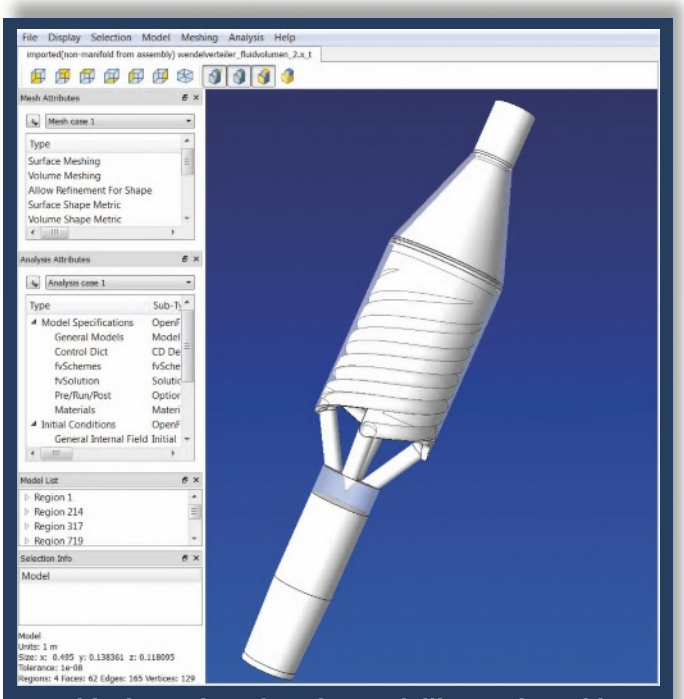
Case setup and mesh generation for plastics processing applications

CastNet imports CAD geometry models from your CAD system in high quality CAD kernel formats like ACIS or Parasolid. Mesh generation attributes or boundary conditions are directly applied to your CAD model.

With the help of predefined templates the user can prepare the simulation case for his specific calculation task quickly.

CastNet provides different mesh generation approaches to cover a wide range of application areas:

- With tetrahedral elements even small regions in the flow channel can be resolved perfectly. High quality prismatic boundary layers provide reliable results of wall shear rates, wall shear stresses or residence times in wall proximity.
- Hex-dominant grids for complex geometries can be defined with little manual effort.



Graphical user interface for modelling and meshing

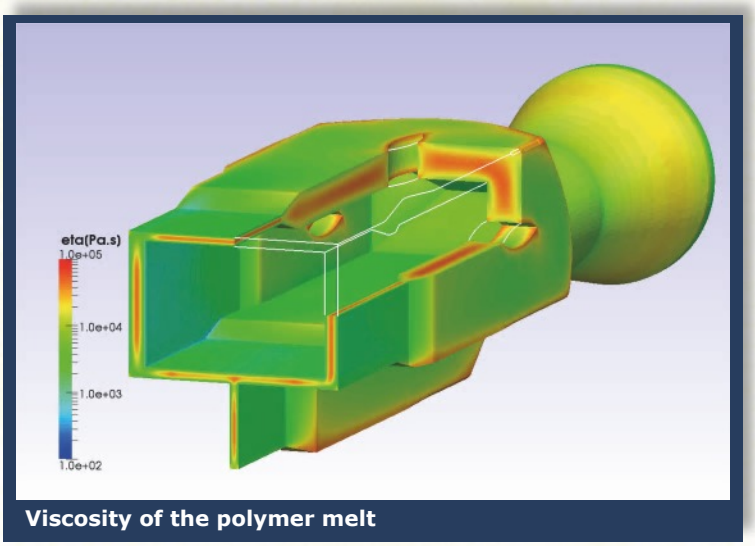
DHCAE Tools' extensions for plastics processing applications based on OpenFOAM® technology

The OpenFOAM® basis system was extended by DHCAE Tools to fit the specific modelling requirements of polymer processing simulations. These extensions are included in DHCAE Tools' customized polymer solvers and utilities which are placed at your disposal completely. All in all these models for Non-Newtonian fluids are available:

Non-Newtonian fluid models

For the simulation of Non-Newtonian fluid behavior of polymers all common viscosity models are supported, for example:

- Carreau, Carreau-Bird, Carreau-Yasuda and variants
- PowerLaw, CrossPowerLaw and other
- Bingham, Herschel-Bulkley, Yield-Carreau and more viscosity models with yield point



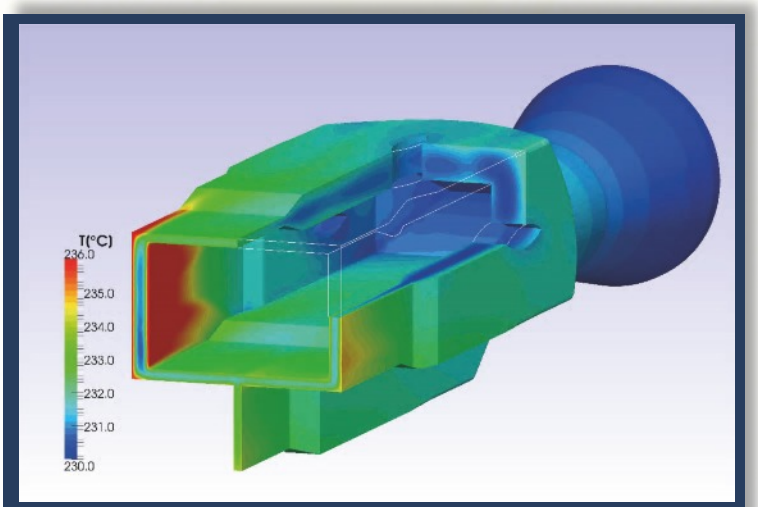
Viscosity of the polymer melt

If you have additional requirements regarding the simulation of your materials in use, DHCAE Tools can integrate your rheological models into your customized solvers and utilities.

Temperature dependent rheological behavior of polymer melts

Many steps of plastics processing operations must consider the working temperature of the polymer melt.

- **Temperature dependent viscosity models**: The material properties and especially the shear thinning behavior is strongly influenced by temperature. For the correct modelling of the Non-Newtonian flow behavior, different temperature shift models based on Arrhenius- or WLF (Williams-Landel-Ferry) equation are available.



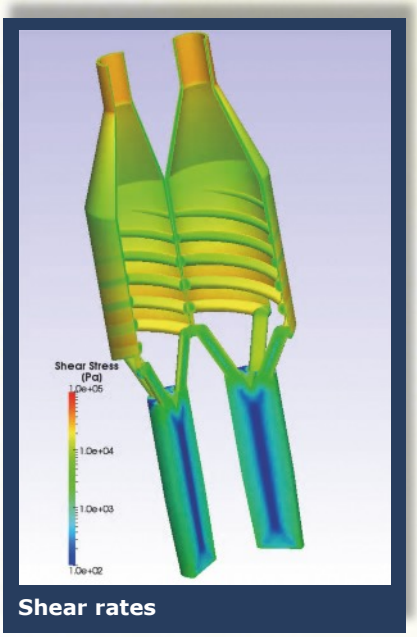
Temperature distribution and viscous heating

- **Thermal load:** The processing temperatures of polymer melts are often located within a critical range, within which the product quality can suffer if residence time is high and local temperature peaks occur. The temperature peaks and residence times are calculated by the solver and critical regions can be identified.
- **Viscous heating:** The internal friction of high viscous polymer melts increases the temperature during processing. The viscous heating is calculated by the solver together with the temperature transport.
- **Heat convection and conduction:** The heat convection by the flowing melt in combination with the very low thermal conductivity of plastics result in complex temperature distributions throughout the fluid and the mold or die. A wide range of boundary conditions is available for proper simulation. Conjugate heat transfer with solid and fluid regions can be considered as well.

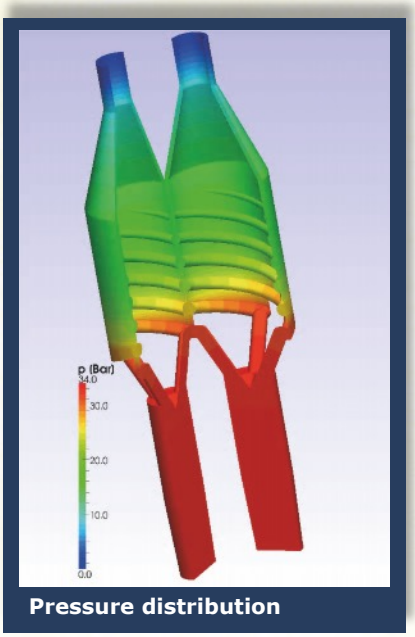
Gaining results rapidly with stable and accurate numerical methods

DHCAE Tools' polymer solver provides additional user friendly features for stable and reliable simulation runs:

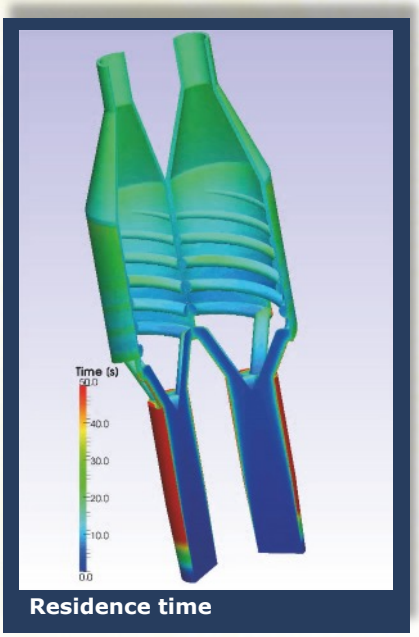
- **Automatic initializations**: The fields and initial conditions are automatically predefined with stable settings resulting in fast convergence of non-Newtonian fluid simulations.
- **Stabilizer module**: An additional Stabilizer module manages the settings for numerical solvers and numerical schemes in such a way that the CFD solver switches from a stable initial setup to an accurate final setup on the fly as soon as convergence rate is stable.



Shear rates



Pressure distribution



Residence time

Post-processing for the specific requirements of plastics processing

For the design plastics processing tools, a couple of post-processing results and characteristic quantities are of particular interest. DHCAE Tools' polymer solver provides (amongst others):

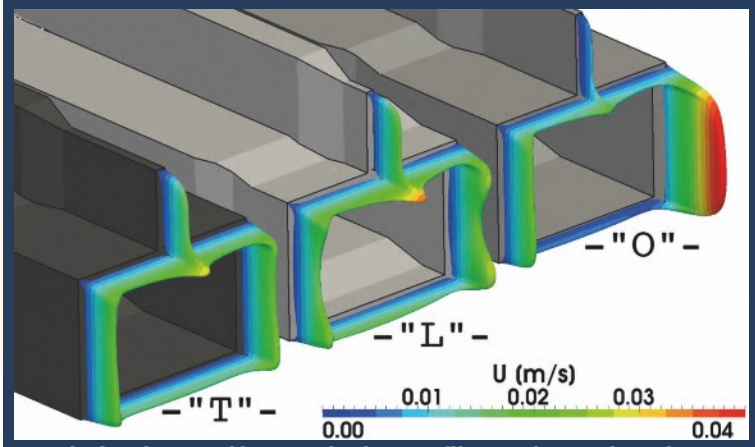
- **Velocity distribution**: A primary goal of extrusion die optimization is a balanced velocity profile at the dies outlet.
- **Wall shear rates**: These are important to estimate self-cleaning capacities of the die and for the calculation of other derived results.
- **Wall shear stresses:** With the knowledge of critical wall shear stresses, shark-skin or melt fracture effects can be prevented.
- **Residence times:** High residence times in combination with high thermal loads can reduce the final products quality for temperature sensitive polymers.
- **Viscosity:** The local viscosities of the shear thinning polymers indicates opportunities for flow channel design improvements.
- **Pressure loss:** The pressure loss of the extrusion die essentially determines the energy consumption and the maximum operational speed of the production line.
- **Temperature distribution:** Local temperature peaks have influence on the local polymer viscosity and may lead to quality problems in the final product.
- **Forces:** The forces acting on potential weak points like mandrel holders in an profile extrusion die are calculated.
- **Local dimensionless numbers:** Local residuals are useful to rate the quality of numerical results.

DHCAE Tools provides extended services for the plastics processing industry

In addition to the provided software for in-house simulations, DHCAE Tools provides extended and specialized services for the integration of CastNet and OpenFOAM® into the customers' established workflows.

- **Consulting**: We will be pleased to give you advice and support in all aspects of OpenFOAM® integration and migration, simulation options for plastics processing applications or software and hardware selection for mesh generation, simulation and post-processing.

- **CFD services**: We provide the complete CFD simulation service for your extrusion dies (mesh generation, simulation, post-processing) and give advice for the optimization of flow channel design. Of course you can use these services complementary to the simultaneous integration of CastNet and OpenFOAM® into your company workflows to ensure a maximum efficiency, too.

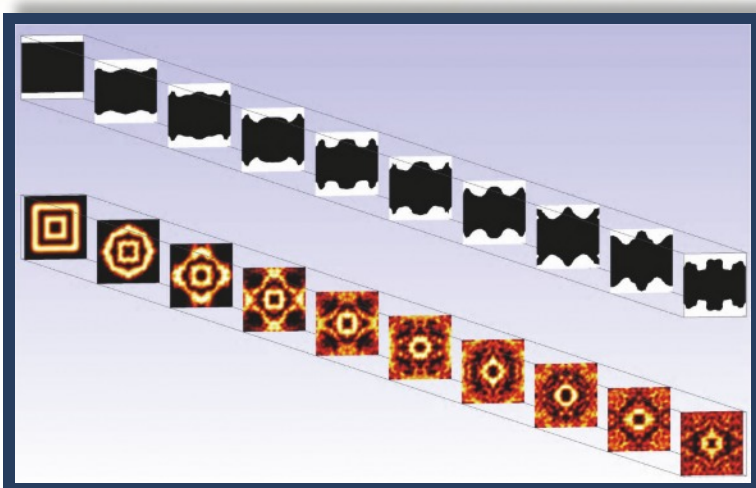


Optimization: Uniform velocity profile on the outlet of an extrusion die

- **Software development**: We develop software for the integration of CastNet and OpenFOAM® into your established workflows. Besides the implementation of new models or customization of solvers and libraries, we provide software development for automatic CAD construction and mesh generation of standard die designs. The graphical user interface can be customized to fit your specific needs, post-processing tasks can be automated for simulation series etc.

- **Training**: We offer regular training courses for CastNet and OpenFOAM®. In addition, we also offer special training courses on-site with a focus on your specific needs, for example mesh generation strategies for extrusion dies, simulation of polymers, or post-processing and analysis of molten plastics applications.

- **R & D projects**: We provide assistance for research and development projects. We support industry-oriented, scientific research projects, for example in the form of Bachelor or Master Thesis being conducted in your company, where we assist with know-how or implementation support for numerical models.


R & D: viscoelastic effects, visualization of secondary flow effects

DHCAE Tools GmbH

Address: Friedrich-Eberst. 368 47800 Krefeld, Germany
Phone: +49 2151 9490-200 Fax: +49 2151 9490-209
Website: www.dhcae-tools.com E-mail: info@dhcae-tools.de