POLYMER EXTRUSION DIES MODELLING AND DESIGN USING GID AND MCAD SYSTEMS

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SUMMARY: The advances obtained until the moment with the computer aided tool development for the three-dimensional modelling and design of polymer extrusion flat dies are in this work. Using a commercial Mechanical Computer Aided Design MCAD system (Solidworks) was developed a module based in models in the literature published and SolidDies 1.0 called. The import and mesh within GID software was explored, with the purpose of solving the equations of energy and momentum coupled in a second phase using meshless numerical methods and radial functional basis or conventional numerical methods. The interchange of data between Solidworks® and GID®, the traditional mesh obtained and the exploration of the GID as pre and postprocessor to reach the final objective is presented here.

KEYWORDS: Polymer Extrusion Dies, Applications of GID, Data Interchange, Solidworks, GID, IGES, Parasolid.

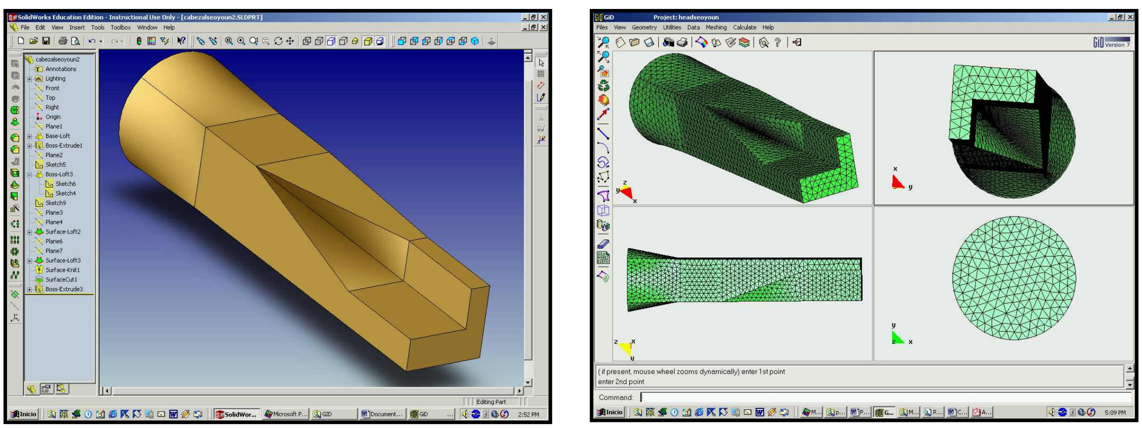
INTRODUCTION

The design of polymer extrusion dies involves a great quantity of conditions that should be fulfilled with the objective of obtaining optimal operation conditions. The flow of the polymer inside of the die, the velocity, pressure and temperature distribution and the stresses and deformations that are generated due to the high pressures losses should be known to reach an appropriate design of the tooling and to begin their production in machines of Computer Numerical Control CNC usually. The complex equations that govern the phenomenon are affected by the high nonlinearity that imposes the Non-Newtonian behaviour of the melt polymer, as well as the viscoelastic component, the heating due to viscous dissipation, the variation of the properties with the temperature and the couple existent between the energy equations, momentum and viscoelasticity [1]. Due to this much of the well-known simulation programs has been developed in 2D or 3D with many simplifications in the equations with the purpose of making the problem numerically possible and to obtain solutions approached in reasonable times. The use of numerical methods as finite differences DFM, finite elements FEM and boundary elements BEM have been traditional in the simulation of the flow of polymers[2]. However and given the complexity of the equations, the meshless numerical method are shown like a promissory alternative for their use in the numerical solution of conservation equations with smaller simplifications, in a coupled way and applied in the three-dimensional models (3D simulation) at an appropriate computational time.

Several authors have developed a series of traditional equations for the modelling flat slit dies for the extrusion of sheets [1], [3]. In other recent publications simulations have been reported in 3D using the method of finite elements FEM and verified experimentally with extrusion dies for profiles [4], which will be used later on as comparison with the obtained results using meshless methods. This work shows three-dimensional modelling of the extrusion dies in the MCAD system Solidworks® of Solidworks Corporation which is easy to use , have a short learning curve and is very easy for the programming from VisualBasic or C language and the exchange of data is evaluated in standard formats (Parasolid, ACIS, IGES, VDA) with the GID program for the pre and post-processing [5] with the purpose of evaluating the generation of different meshes for its use in FEM, BEM and especially as generator of points for meshless methods. Finally the pre and post-processing possibilities of GID are evaluated with the imported three-dimensional models.

MODELLING

For the modelling of the extrusion die for profiles verified experimentally in [3] (call from now Reference Profile Die RPD), the reported dimensions are used to 3D solid modelling in Solidworks and it was imported to GID for their evaluation with simple geometric forms with excellent results. In the Fig.1 are illustrated the initial results:

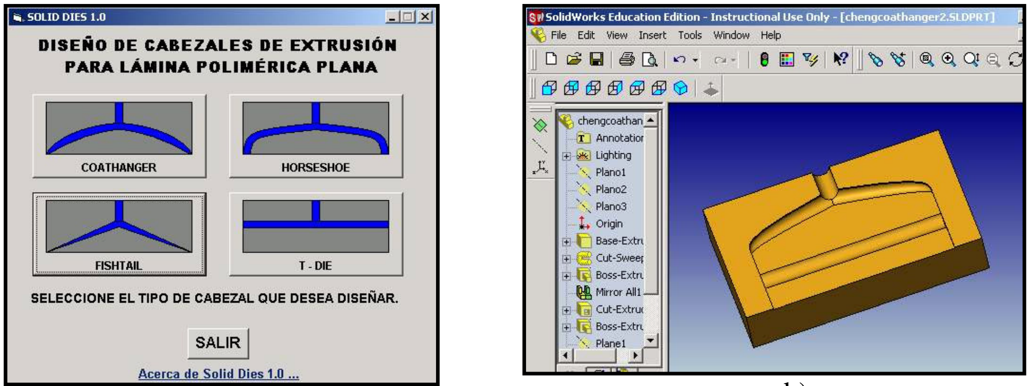


(a) b)

Fig. 1: Solid modelling and mesh to Reference Profile Die; (a - Solidworks modelling; b- Imported solid model and mesh in GID.)

For the modelling of the flat slit die for the extrusion of sheets an application was programmed in VisualBasic so that through the API (Automatic Programming Interface) of Solidworks it models a 3D parametric solid in an automatic way based on the equations published in [1, 3] and SOLIDdies called [6]. In the fig. 2 are observed the developed interface for SolidDies and the automatic modeling of a flat slit die. Several basic forms were programmed known as coathanger, horseshoe, fishtail an T-dies published by these authors. Other commercial forms and mathematical methods for the modelling will be programmed to future.

For both cases (RPD and flat slit die) files of exchange of data were generated in the formats Parasolid (Solid model), ACIS (surfaces model), IGES (surfaces model) and VDA (surfaces model), which are available in GID like formats to import 3D models from CAD systems.



a) b)

Fig. 2: Flat slit die modeling; a- Solid Dies Interface ; b- Solidworks Modeling.

IMPORTING AND MESHING

Using the command *Files-Import* (*IGES, ACIS, Parasolid* or *VDA*) the models exported from Solidworks were imported in GID. To verify the quality of the import in GID they were applied on the imported models the following operations: 1) Import, 2) Render, 3) Creation of Volume (Solid Model) for the case of imported surfaces. To verify the capacity of meshing of GID on the imported models they were carried out the following operations: 4) Generation of mesh on the surface (BEM applications), 5) Generation of the Mesh in the volume (FEM applications), 6) Generation of clouds of points in the surfaces and in the volume (Meshless applications). The obtained results are shown in the Table 1 for the RPD [3] (NP= not possible; FAILED= systems crash or error generated; OK= successful operation); in the fig. 3 some of the results are illustrated.

Table 1: Import Results to RFD die.

FORMAT	IMPORT	RENDER	CREATE VOLUME	MESH SURFACES	MESH VOLUME	MESH ONLY POINTS
PARASOLID	OK	OK	OK	OK	OK	OK
ACIS	FAILED	NP	NP	NP	NP	NP
IGES	OK	OK	OK	OK	OK	OK
VDA	OK	OK	FAILED	OK	NP	OK

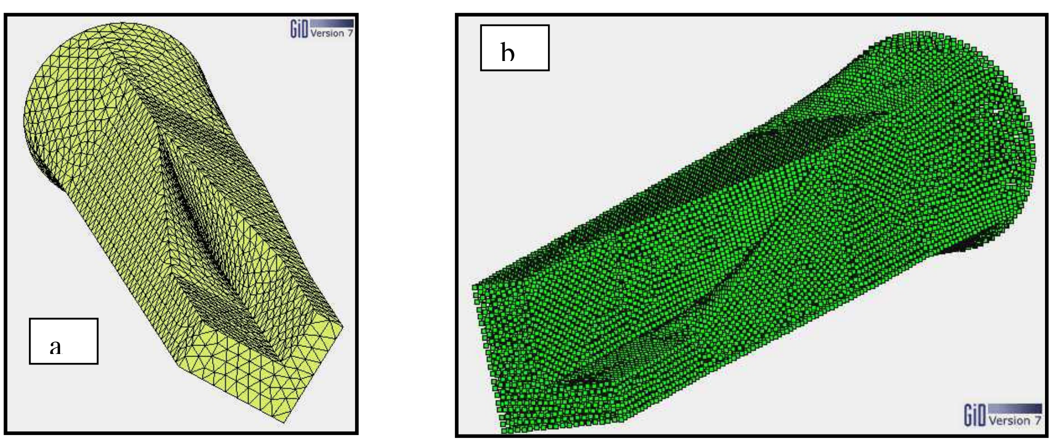
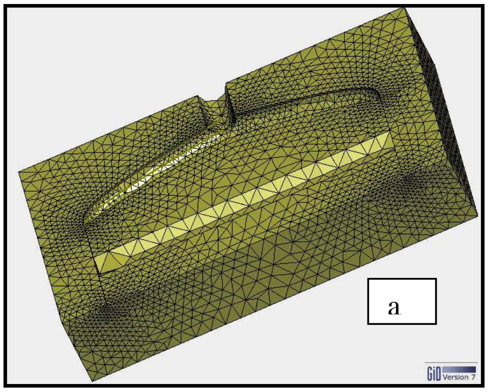


Fig. 3: Import Results: a- Gid volume mesh with Parasolid Format; b- Cloud points with IGES Format and volume creation.

In the table 2 are shown the results to a coathanger flat slit extrusion die [3]; in the fig. 4 some of the results are illustrated.



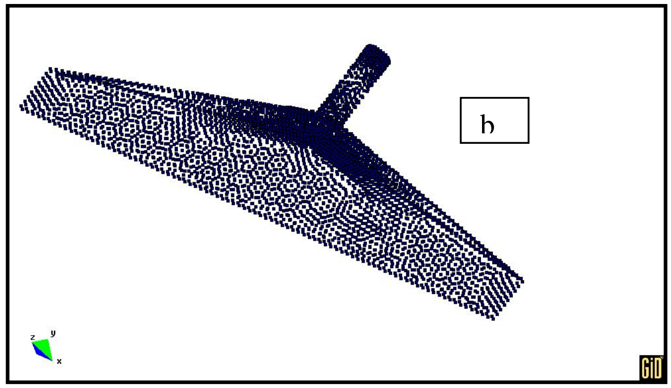


Fig. 4: Flat slit extrusion die ; a- coathanger die Volume Meshing; b- Fishtail manifold and land cloud of points.

Table 2: Import Results to a coathanger flat slit extrusion die.

FORMAT	IMPORT	RENDER	CREATE VOLUME	MESH SURFACES	MESH VOLUME	MESH ONLY POINTS
PARASOLID	OK	Failed	OK	Failed	Failed	Failed
ACIS	FAILED	NP	NP	NP	NP	NP
IGES	OK	OK	OK	OK	OK	OK
VDA	OK	OK	OK	OK	Failed	OK

In the table 3 are shown the results to a Fishtail flat slit extrusion dies [1]:

Table3: Import Results to a Fishtail flat slit extrusion die.

FORMAT	IMPORT	RENDER	CREATE VOLUME	MESH SURFACES	MESH VOLUME	MESH ONLY POINTS
PARASOLID	OK	Failed	OK	Failed	Failed	Failed
ACIS	FAILED	NP	NP	NP	NP	NP
IGES	OK	OK	OK	OK	Failed	OK
VDA	OK	OK	OK	OK	Failed	OK

For this case in the volume mesh creation was possible repair the geometry easily using the appropriate commands in GID.

PROCESSING AND POST-PROCESSING

In the order of verifying the validity of the obtained models were carried out validations on the meshing obtained and on the possibilities of customisation of GID like pre and post-processing program, by means of the use of academic versions of the programs CALTEP and RamSeries[7] with the purpose of executing calculations and post-processing on the imported and meshing models with excellent results. The examples of post-processing are presented at the fig. 5.
The results show that the import and the meshing obtained in GID are reliable, as well as the use of the graphic interface of GID. The cloud of points obtained in complex 3D models are satisfactory.

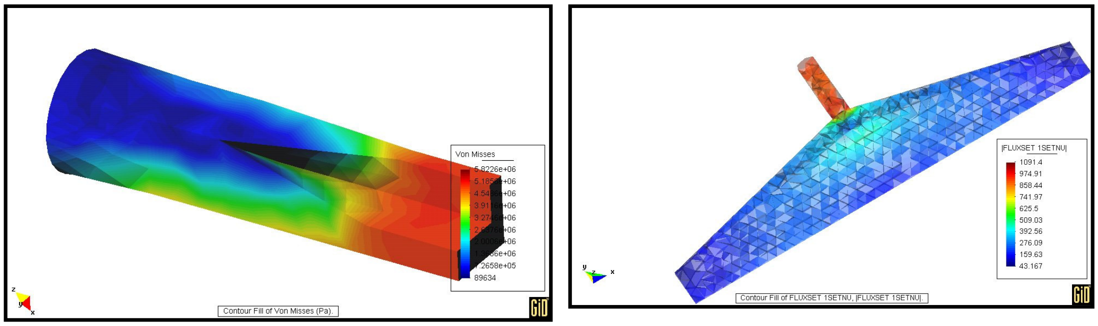


Fig 5. Post-processing using RamSeries and CALTEP in GID.

CONCLUSIONS

GID is a very easy to use, quick and friendly program. Your capacity to import models from Solidworks and your possibilities of generation of meshes for different numerical methods places it like a tool for the development of high level applications in polymers flow. For the case of design of extrusion dies using new numerical methods, it was evaluated as an appropriate program for the generation of the required clouds of points for the selected method. The wide capacities of post-processing allows a quick and reliable evaluation of the obtained results. The tool is shown very compatible with the three-dimensional solid models generated in Solidworks. The use of the format PARASOLID is recommended in simple geometries (profile dies) and the use of the format IGES for complex geometries (coathanger, horseshoe and fishtail dies). The format ACIS generated finally by Solidworks is not recommended for your use with GID. The format VDA in some cases works well but depends thoroughly on the geometry. In formats where import problems are presented, GID offers a series of commands that allows the repair easily of the imported model. Although later on difficulties can be presented with the meshing process.

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