

RUBBER INJECTION MOULDING PROCESS SIMULATION

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ABSTRACT

Simulation analyses of injecting plastics are a tool for increasing the quality of plastic products and plastic tools, equipment used for shortening the time necessary for preparation of new products for the market and hence leading to lowering production costs. The simulation analyses are nowadays commonly used for production of thermoplastic parts. This article stresses on the fact that injecting rubber mixtures could be from the calculation purposes analysed already in the constructive phase during the preparation of the production to achieve positive assets, till now related only to the thermoplastic parts.

Keywords: rubber, injection molding, simulation

1. GENERAL DESCRIPTION OF CADMOULD RUBBER

Cadmould Rubber is software generally called Computer Aided Engineering (CAE). It calculates the filling time, speed and vulcanisation time in the mould and consequent after-curing depending on the material used and technological parameters. One of the most important outputs is, besides the representation of filling progress (cold joints, places where air bubbles may be held), the representation of pressure and voltage ratios in the component and determination of optimum technology. The technological parameters during rubber processing have crucial impact on the final quality of the product; simultaneously it is possible to project adequate period of the production cycle which may lead to significant savings. Original and patented calculative FE net is worth mentioning, automatically prepared by Cadmould Rubber software, its features likened to complex 3D FE nets, however enabling markedly faster calculations even though the thinnest walls are in their thickness divided into 25 calculation knots. This feature allows a very precise analysis having the possibility to carry out range of control calculations. Cadmould Rubber enables constructing different profiles of the jet system including the possibility of cold jets. It is possible to calculate multiple and compound moulds, eventually apply the function of entering symmetrical cavities shortening the time needed for simulation calculations.

2. DOCUMENTS FOR CADMOULD RUBBER ANALYSIS

2.1. Component construction

The basic format used by the Cadmould Rubber analysis is the STL. The component construction to be simulated is converted into this format. STL is the default document for automatic net formation of the final elements. Even though the simulation software uses very good correction features, it is beneficial – also, besides other, due to the calculating times – to use STL file without crucial mistakes for the analysis, especially without gaps and without immersed false constructions. In most of the CAD programmes, the features used for creation of good transfer are of STL format. Nevertheless, not only the Cadmould software users, who do not have any CAD programme, benefit from the software for creations and correction of STL format, for instance 3Data Expert for STL, produced by DeskArtes. Fig. 1 shows an example of STL construction of a rubber component – Insulator – and automatically processed calculating net. A denser calculating net is created on the places of wall connection on the corresponding surfaces for more effective evaluation of potential sink marks.

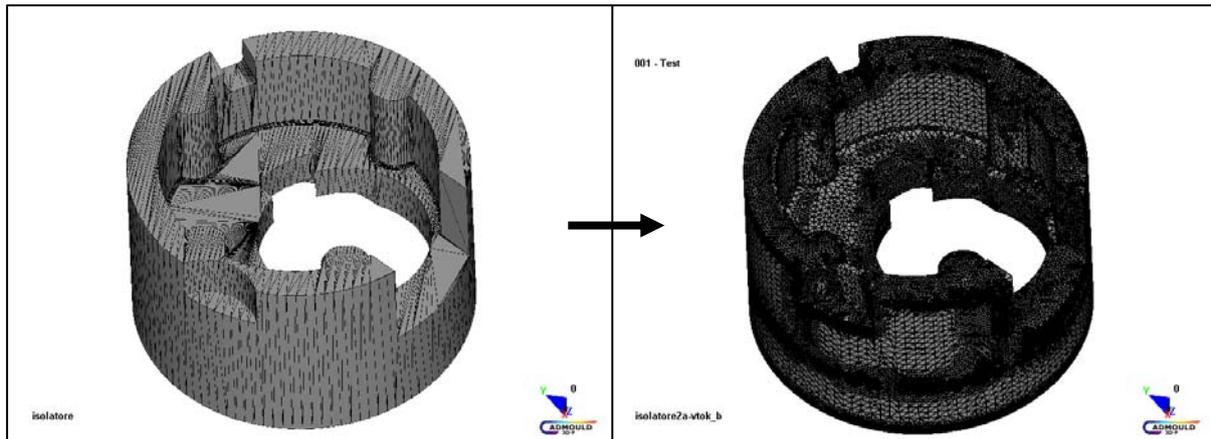


Figure 1. STL model and calculating net Cadmould 3D-F of the insulator component

2.2. Jet construction

With respect to the requirements of the customer, the user may create (according to his experience or template) jet system directly in Cadmould Rubber system. It has got prepared smart constructive tools for this purpose. In case the jets are already designed in CAD, they may be saved as axis in IGES format and transferred to calculating software. The program user easily “wraps” the axis by canals of required diameter. An example of jet system for 4 shaping cavities is seen in Fig. 2.

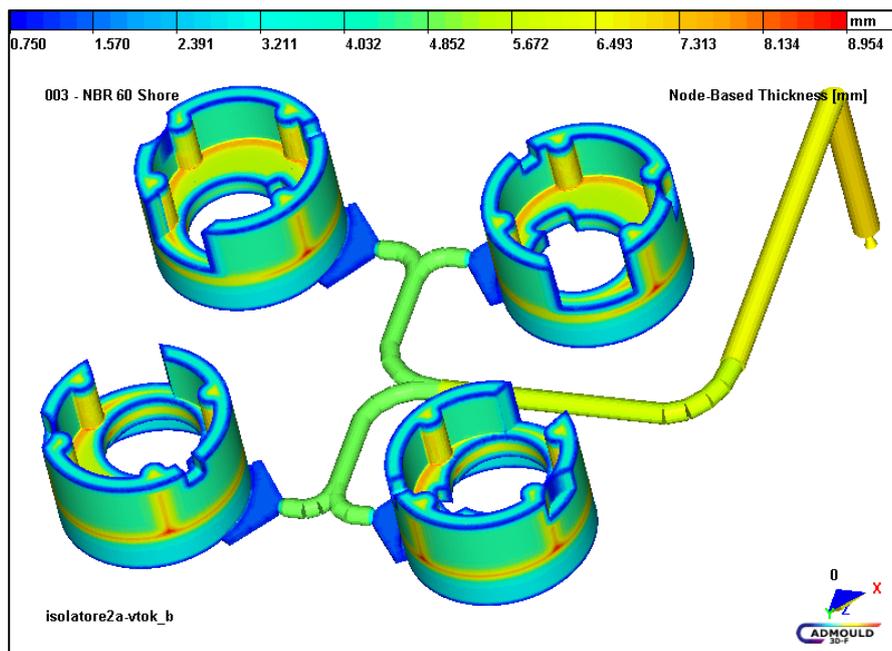


Figure. 2 Runner system for 4 shaping cavities designed in Cadmould Rubber software

2.3 component material

It is necessary to enter the exact rubber type from the material database Cadmould Rubber into the simulation calculations, which is editable by the user. However, it is beneficial to know approximate material data essential for the calculations.

2.4. Technological parameters

The determination of technological parameters is one of the outputs of the Cadmould Rubber simulation analyses. It is necessary to enter the estimated data for the first calculation to take place. These data are specified in the following calculations. It is however possible to input variations of chosen technological data and carry out automatic optimization of the technology.

Overview of technological data:

- filling time,
- temperature of the injected material (preset value),
- mould temperature (preset value) – temperature spread on the shaping cavities surface area may be calculated using the Cadmould Cool software,
- cure time, eventually min. and max. percentage of vulcanized bonds,
- surrounding temperature (preset value),
- temperature transfer coefficient (preset value),
- after-curing time outside the mould, eventually min. and max. percentage of vulcanized bonds.

3. SOME RESULTS OF CADMOULD RUBBER CALCULATIONS

Cadmould Rubber software offers many figures and graphical and table results, which may help the user analyse entered task. Some of them are stated below:

a) Filling Progress, Filling Pressure and Material Temperature

Fig. 4 shows the filling progress. Filling progress analysis can determine the position of cold joints, places liable to trapped air, places filled last, places with incorrect filling progress etc. The average temperature of the material in wall thickness at 208 s of the vulcanizing time is shown at Fig. 6.

b) Scorch

The scorch expresses above all time period during which the rubber mixture may be injected into the shaping cavities. Max. scorch = max. drop of filling safety: values related to the end of the filling time – Fig. 5. Scorch time progress in the most crucial places of the shaping cavity (here the min. scorch = min. safety drop time progress). Middle value of scorch time progress at the chosen point in the shape – Fig. 7.

c) Cure rate

The percentage of vulcanized bonds may be displayed at any instant of the production cycle. Similarly as with scorch, we can also show the percentage of vulcanized bonds at the selected instant or the overall vulcanization time progress. The trend of the wall thickness at a selected spot and time can also be shown for all calculated parameters. The graph of vulcanization progress can be seen on Fig. 8.

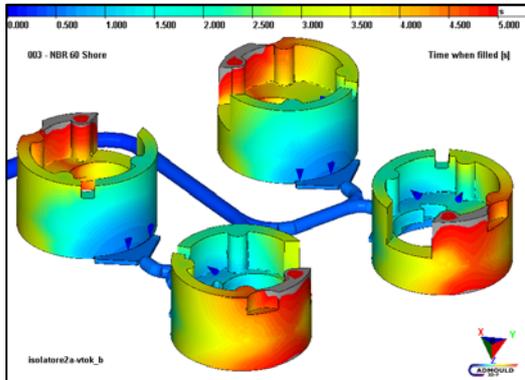


Figure 4. Time progress of filling, state at 99.1% shaping cavity filling

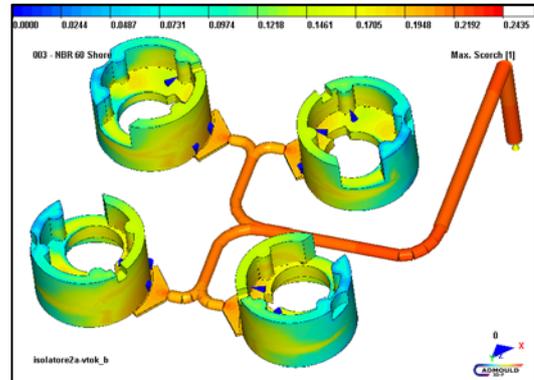


Figure 5. Max. scorch at the end of filling time

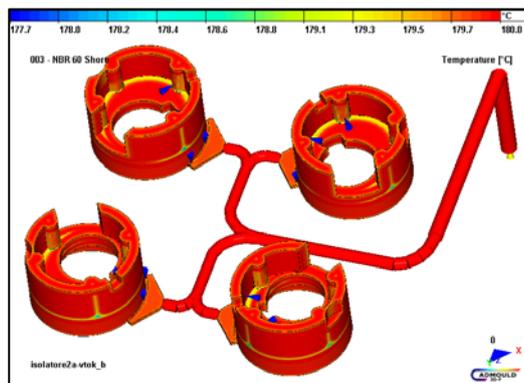


Figure 6. Temperature of the material in 208 s with cure time

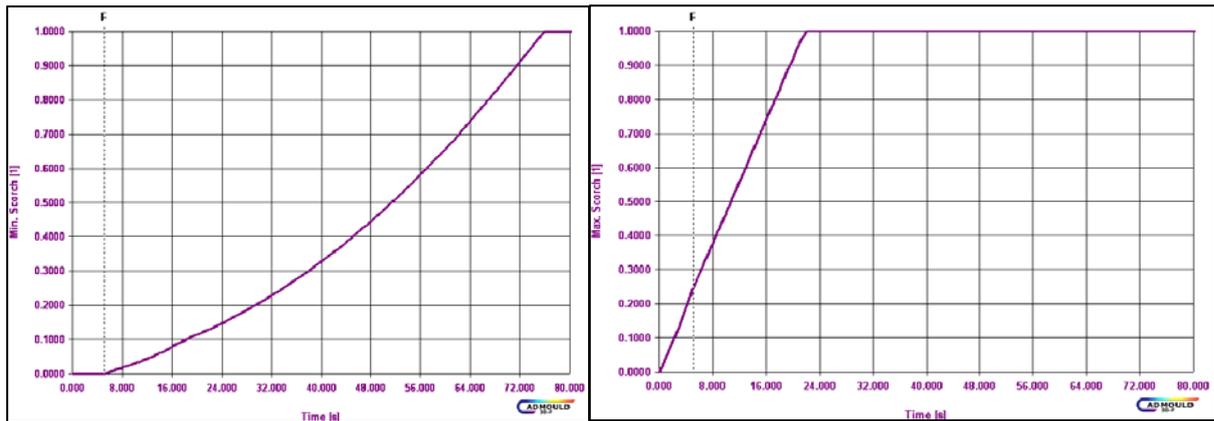


Figure 7. Time progress of scorch of rubber mixture – min. and max. scorch

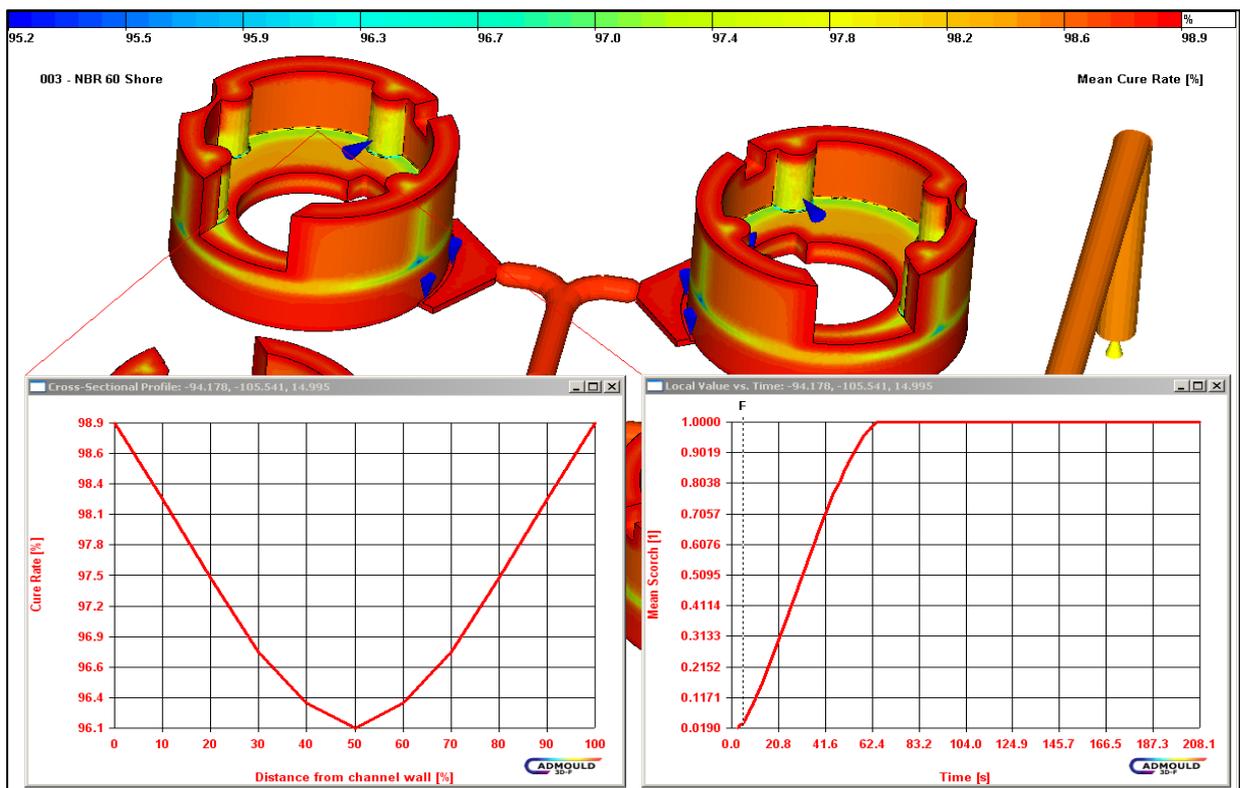


Figure 8. Cure rate expressed by middle % of vulcanized bonds in 208 s, % vulcanized bonds in the wall thickness and time progress in the middle safety value at the selected spot

4. CONCLUSION

The simulation analysis Cadmould Rubber represents quality and interesting calculation tool which may increase the quality of injected rubber parts, cut the costs connected to the mould repair and accelerate the preparations of new productions. It is evident from the experience with the situation analyses that it is better to analyse than try and repair.

5. ACKNOWLEDGEMENT

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6. REFERENCES

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