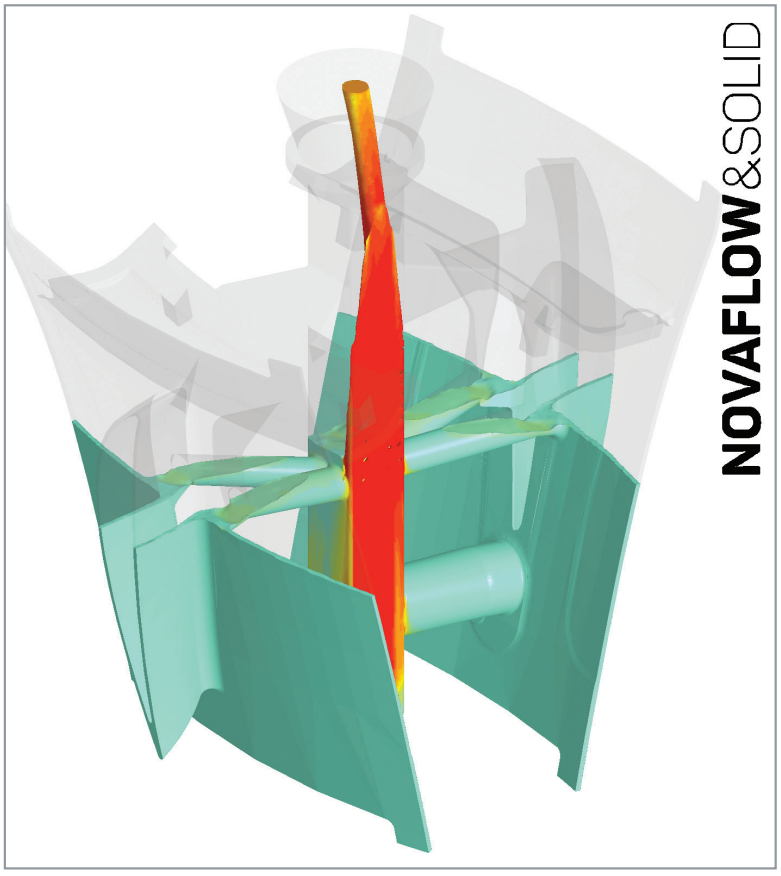
Higher calculation speed using irregular mesh technology in mould

Calculation time for casting process simulation is always a very interesting development point, says Håkan Fransson, technical manager simulation, NovaCast Systems AB. With higher calculation speed comes the possibility of running more accurate simulations with finer elements or with more criteria selected. More simulations can also be run per day giving an improved chance to truly optimise castings, ingates and feeding systems. It also facilitates larger castings which normally demand huge processing power to be calculated. Here we consider a new development called irregular mesh in mould which is added in the new version of NovaFlow&Solid 6.5.

NovaFlow&Solid uses a finite volume mesh method and until now the program has used the same mesh size in casting as in the mould, cores etc. This is called regular mesh and means that you set a structured grid with equal size of mesh over the whole calculation domain. The mesh elements are cubic but in the boundary between materials, the cube can be shared by different materials describing the casting part and boundary in between parts perfectly in shape. This is a very robust and accurate method, but it means that there are a lot of mould elements that are not necessary if compared to the mould material thickness or the rate of changed temperatures in the mould materials. Because of that, NovaCast Systems has developed a new variant of the meshing which means that in solids that are not casting material, an irregular mesh can be used. This irregular mesh is automatically generated by the system. A fine mesh (equal to casting mesh size) nearest to the casting boundary is created. Then step-wise, it is increasing the elements' size by doubling the size after a specific equation the further away from the casting surface it gets.



Simulation detail

Advantages using irregular mesh in mould:

- Mesh amount in mould is reduced by up to 90 per cent.
- Calculation times reduced by 50 per cent for solidification.
- More complex tasks with more mesh in casting can be performed.
- Automatic mesh generation – no manual work to optimise mesh is needed.
- In the future (upcoming versions) the file sizes will also be smaller, thus resulting in memory saving.

How much faster is the solidification simulation using irregular mesh in mould? Here is an example showing the potential.

Example of solidification simulation with irregular mesh:

- Regular mesh calculation time: 27 min 51 seconds.
  Casting elements - 285661; Regular mould elements – 6214656.
- Irregular mesh calculation time: 13 min 28 seconds.
  Casting elements - 285661; Irregular mould elements – 523673.

In this case, which is only solidification calculation, the calculation time is reduced by 51.6 per cent.

Irregular mesh combined with multi mesh

NovaFlow&Solid uses something called multi mesh technology. Multi mesh technology switches the whole mesh grid during filling simulation or in between filling and solidification. It can also be used during a cycling simulation where for example 4mm mesh size can be used for the first seven cycles and then in the last cycle there could be for example 2mm mesh size.
When using multi mesh, all the results are transferred to another mesh grid resolution. Several steps can be set during either mould filling and/or solidification with either smaller or bigger mesh size. Multi mesh is superb to use to reduce calculation time which means that there could be, for example, a 4mm mesh for the filling simulation and then a finer mesh equal to 2mm for the solidification. This enables the right accuracy at optimised speed.

With the new irregular mesh technology, there is a possibility to use it in combination with multi mesh technology. Here, mesh generation and recalculation of mesh grid

during simulation is completely automatic. The interesting thing is that there seems to be an even higher effect on the calculation time when using a combination of multi mesh and irregular mesh.

(1) Regular mesh with regular multi mesh

Mesh filling: 6mm elements (total elements 765,408; casting elements 40,119).
Mesh solidification: 3mm elements (total elements 6,168,960; casting elements 285,068).
Calculation time for mould filling: 8 min 26 sec.
Calculation time for solidification: 27 min 50 sec.

(2) Multi mesh with irregular mesh

Mesh filling: 6mm elements (total elements 104,492; casting elements 40,119).
Mesh solidification: 3mm elements (total elements 521,479; casting elements 285,068).
Calculation time for mould filling: 8 min 49 sec.
Calculation time for solidification: 10 min 44 sec.

A slight increase in the calculation time of mould filling for irregular mesh can be seen, but a really big reduction of the calculation time for the solidification. Calculation time for solidification is reduced by 62 per cent.

The irregular mesh technology is more effective for simulations that have a bad casting mould ratio meaning that there are many mould elements to begin with. With many mould elements, there is also high potential for reduction and they strongly influence the calculation time.

Since the irregular mesh is based on the casting element size, the irregular mesh will also be remade for each multi mesh step. All the results are then transferred from the old mesh to the new mesh. The whole process is undertaken by a scheme that is set up in the pre-processor. It is fully automatic.

As a summary, it can be said that an already fast program has become even faster!

THE PROGRAM – BASICS

NovaFlow&Solid is a Windows-based casting process simulation system that can simulate most commercial casting methods, such as gravity sand casting, low pressure diecasting, high pressure diecasting, lost wax method and centrifugal casting. When it comes to possible materials to simulate, it is just a matter of material data, but the standard material database is coming with the most common materials on the market. The system can use all types of mould and core materials and exothermic materials, chills and both foam and extruded filters. The meshing method also enables the simulation of real extruded filters with for example 3D scanned foam filters. It can also simulate re-meltable materials (chills or inserts) as well as pouring of two different materials (like steel and cast iron) in the same mould enabling several possibilities.

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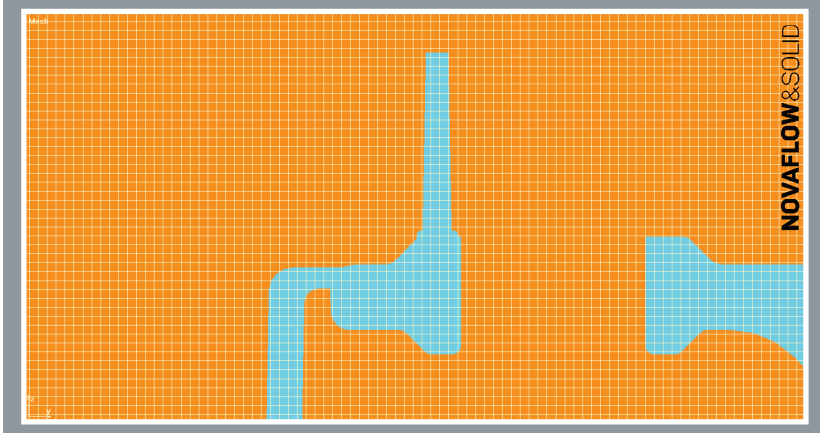
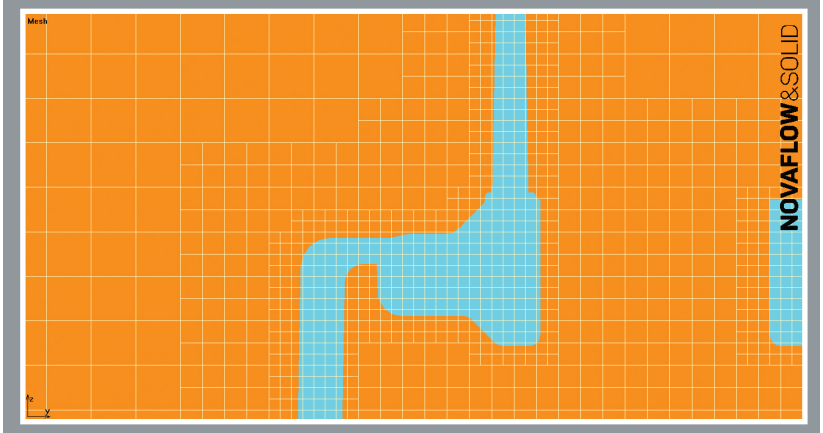
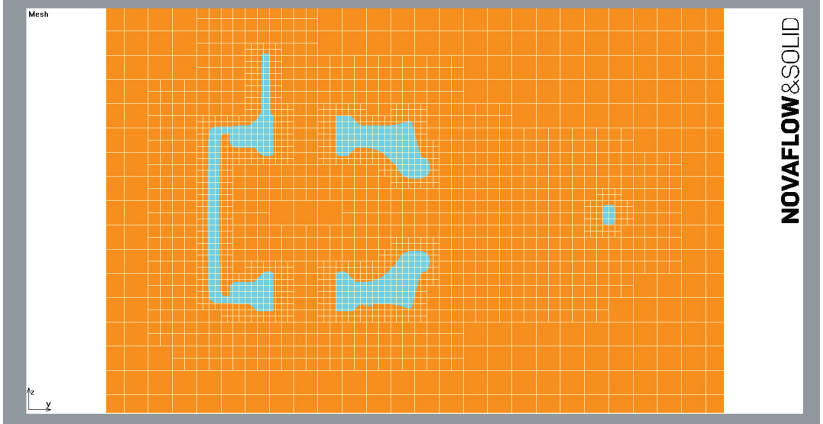


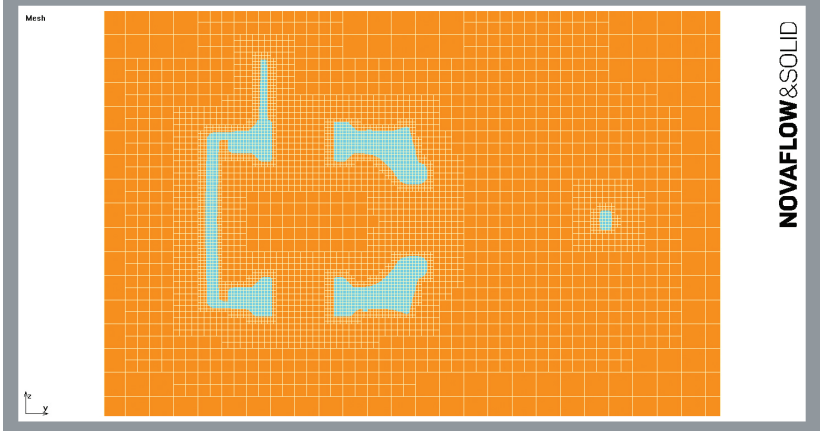
Regular mesh (Finite Volume Method)



Irregular mesh in mould



6mm mesh



3mm mesh