ANSYS Fluent Meshing Watertight Geometry Workflow

Workshop 6: Finned-tube Heat Exchanger

The aim is to generate a CFD-ready mesh for cross-flow heat exchanger for the conjugate heat transfer analysis. The aim is to use translational periodic boundaries and learn to use transform volume mesh commands.

Finned-tube heat exchangers are tubes with closely spaced fins, with heat transfer flowing perpendicular to each other. For this geometry, only one repeating section is modeled. Periodic boundary condition was assigned perpendicular to the y-axis sides and symmetry boundary condition was assigned to surfaces on both the sides of the geometry perpendicular to the z-axis. Fig. 1 shows the repeating section of the heat exchanger.

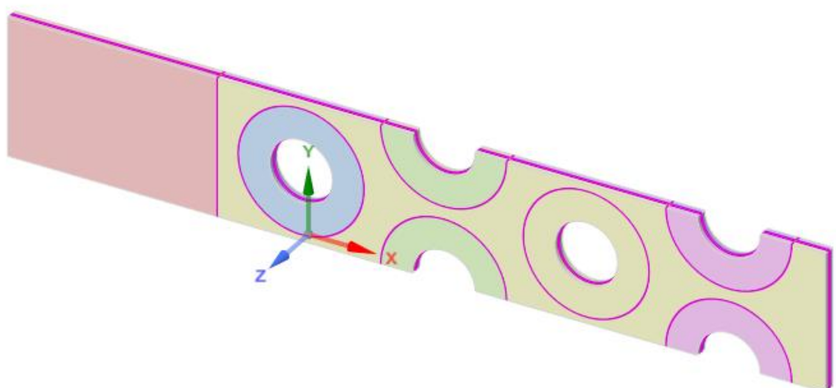

Fig 1: CAD geometry of the repeating section

In Fig. 1 hole is left for the tube spaces as flow in the tube was not modeled, instead a constant temperature was assigned to the tube surface. Fig. 2 shows the imported geometry in ANSYS Watertight meshing workflow.

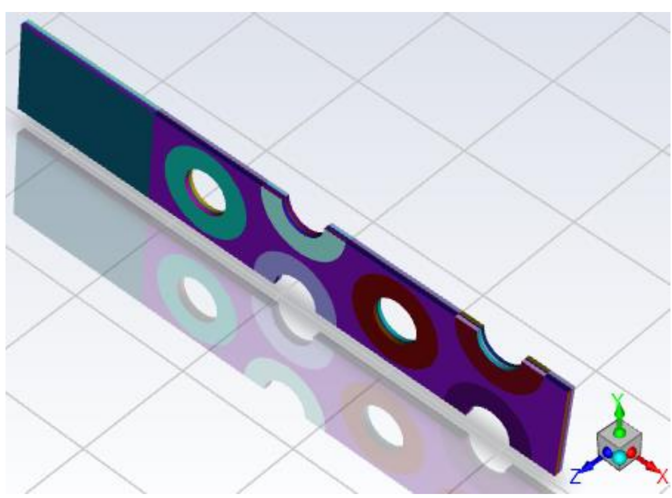

Fig 2: Imported geometry in ANSYS meshing

For the surface mesh following parameters were used:

- Minimum size – 0.3 mm
- Maximum size – 3 mm
- Cells per gap – 2
- Scope proximity for – faces

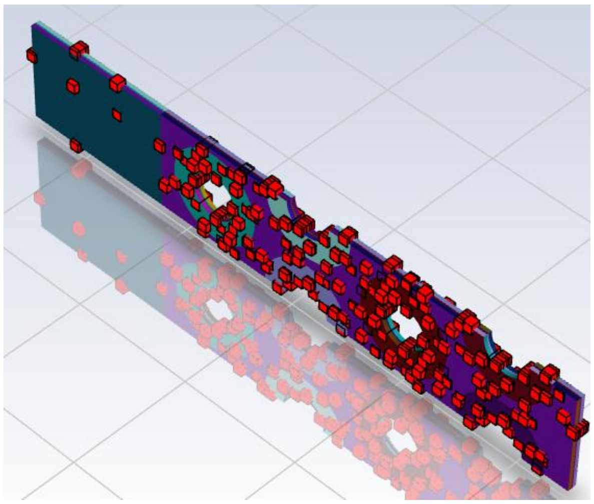

Fig 3: Preview of cells before surface meshing

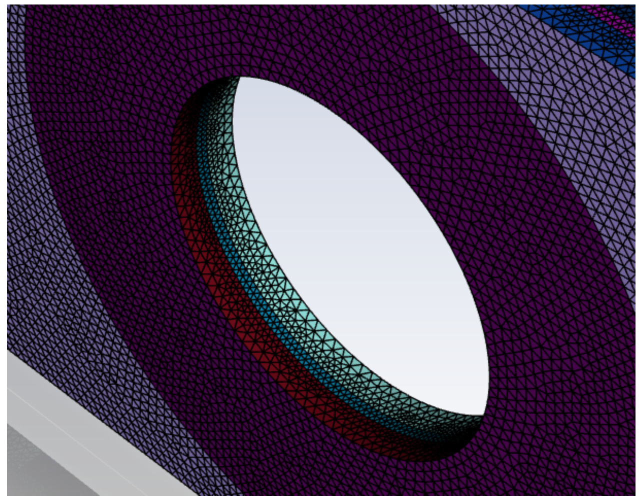

Fig 4: Curvature capture in surface meshing

Fig. 3 and 4 shows the preview of meshing cells before the surface meshing and the curvature capture during the surface meshing, respectively. For the curvature capturing, 10 deg. was used as input.

Periodic boundaries were set up by inserting another task in "Set-up periodic boundaries". In Fluent meshing, translational periodicity can be added in only one direction while maintaining the conformal nature of the mesh. For cases with multiple translational periodicities, meshes in other directions will be non-conformal.

Boundary layers were added in both fluid and solid regions. A smooth transition mesh were used for growing boundary layers. This method allows us to control the transition ratio and growth rate of the inflation layer. The transition ratio is the ratio between the cell area of the last layer of inflation and the first cell area out of the inflation, whereas the growth rate represents the increase in element edge length with each succeeding layer of elements.

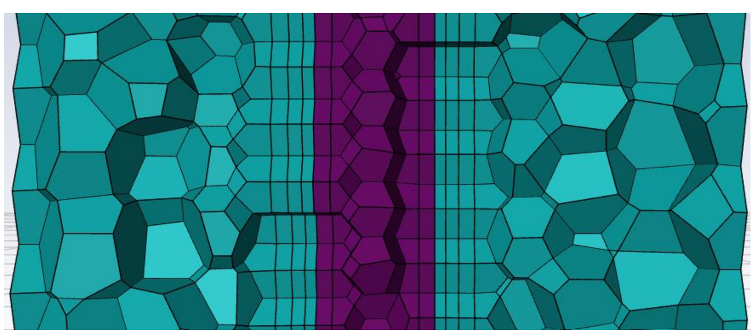

Fig 5: Boundary layers in the volume mesh

In fluid regions, 3 boundary layers were used, and in solid 1 boundary layer was developed on the solid-fluid interfaces to avoid sharp jumps in the temperature values during conjugate heat transfer analysis. Fig. 5 shows the boundary layers present in the polyhedra volume mesh.

For choosing the best volume fill-with method, the selection is made on the basis of minimum orthogonal mesh quality and the total number of mesh cells. Table 1 below shows the mesh characteristics of three types of mesh.

Type of mesh	Minimum orthogonal quality	Total mesh count
Hexcore	0.03	6386111
Polyhedra	0.19	1367969
Poly-hexcore	0.19	1713818

Based on the meshing characteristics presented above in Table 1, **Polyhedra is selected for this geometry**. During the volume meshing, both the fluid and solid regions are meshed. Fig 6. shows the polyhedra mesh present in both the solid and fluid regions of the computational domain.

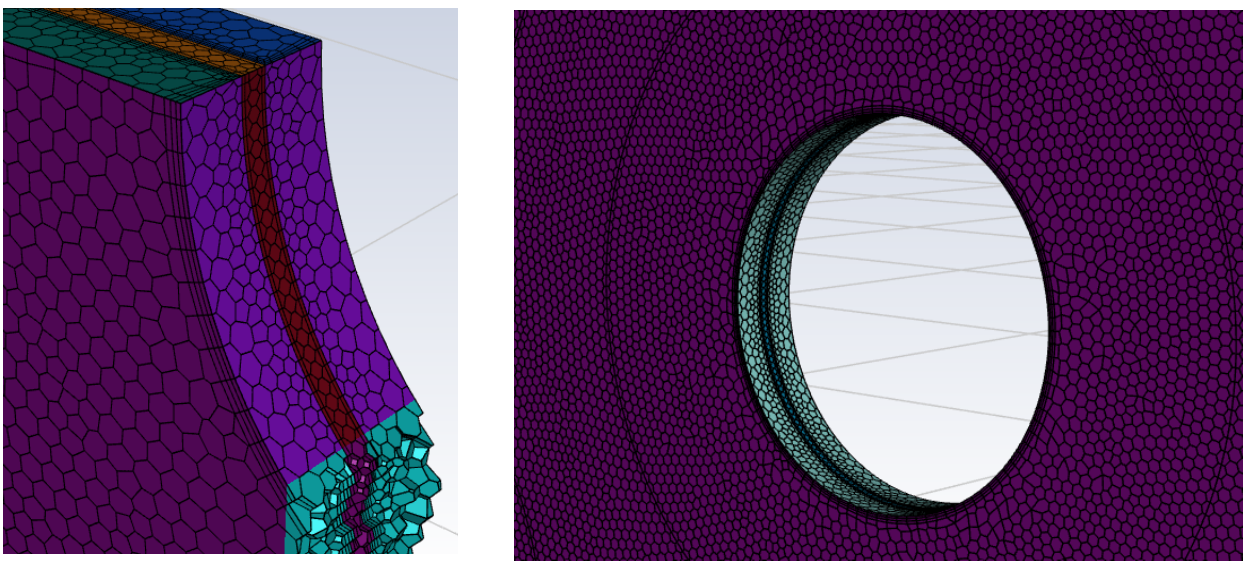

Fig 6: Polyhedra volume mesh

The above-generated mesh can be translated to different locations using the "Transform Volume Mesh" task. In this case, since the mesh corner was not present at the origin, the mesh was translated to keep one corner of the mesh at the origin. This task becomes crucial at later post-processing stages.