Over-expanded Nozzle - Mesh

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Mesh

It is preferred to have predominant quadrilateral elements, rather than triangles, since it will provide lower skewness on the mesh, improving the convergence. You also have more control on the mesh.

Generating the mesh in 2D problem usually isn't complicated. However, in this problem we want a very fine mesh in certain regions, but not in others. For that, we have to virtually split the geometry (using Virtual Topology) into seven sub-regions, and apply different mesh controls on each one. This is tedious and require a lot of trail and error, so the mesh file will be provided.

But in summary, you mesh should:

1) Be **very** fine in the converging diverging part

2) Be **very** fine at the exit of the nozzle and progressively become more coarse

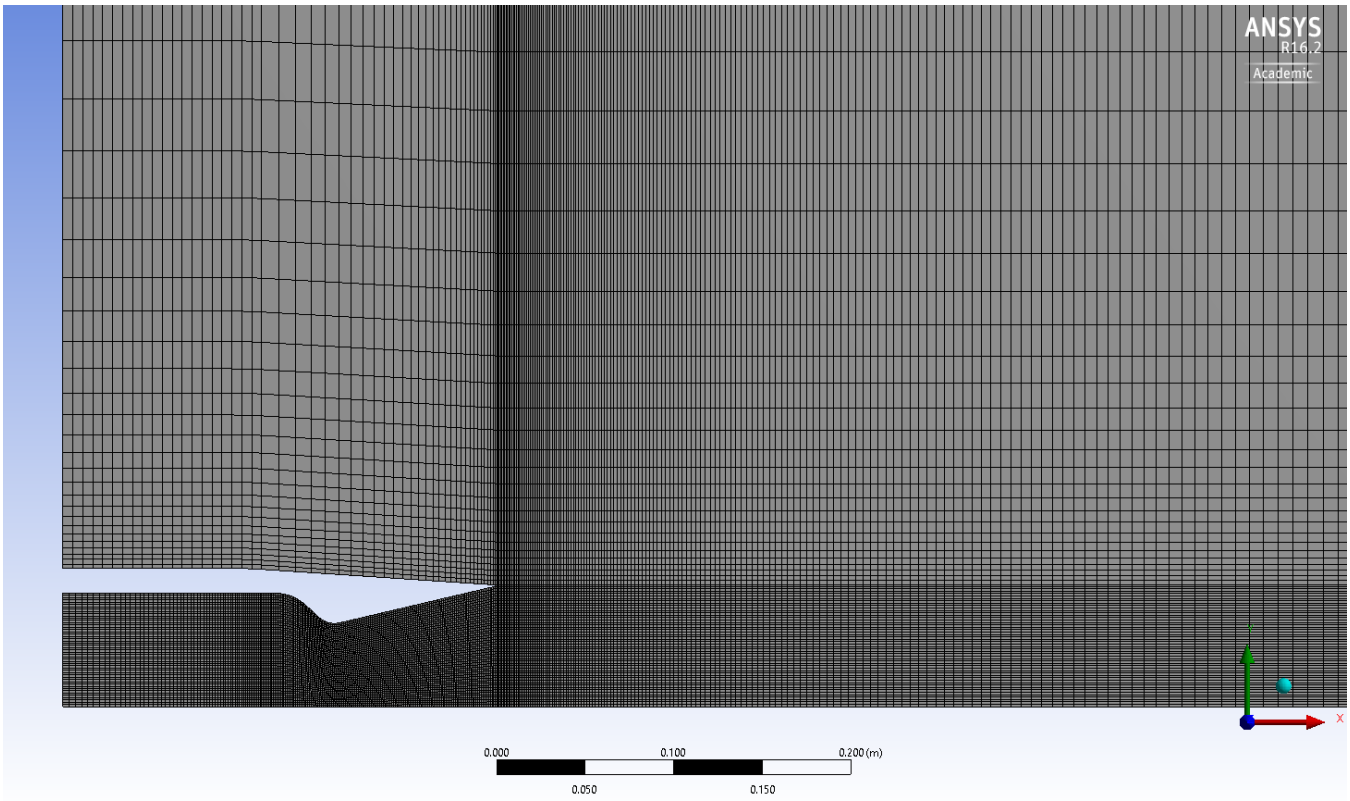
3) Be relatively fine inside the nozzle

4) Be considerably fine closer to the jet region, and progressive become coarse far from it, until the coarser mesh in the upper right corner of the domain

5) Ideally should be fine right above the nozzle, to account for the farfield effects (no done here, beyond the scope of this tutorial)

6) Ideally inflated around the nozzle to account for drag and to possibly estimate the thrust (not done here, beyond the scope of this tutorial)

The mesh close to the nozzle looks like this:



Far from the nozzle, the elements get poor quality, particularly a very high aspect ratio. This isn't relevant for the purpose of this tutorial, but is something that should be taken care of in the case of a more precise simulation.

You can download the workbench file here. (LINK)

For curiosity, a mesh with 200k elements (finer version of the one provided here) had severe convergence problems. A lot of tweaks in the relaxation factors had to be done, and several steps of simulations were done, each with around 100,000 iterations. After almost 4 days running, with way more than half a million iterations, an OK results was obtain, yet with considerable mass imbalance. This will be discussed in the Verification and Validation Section.

⚠ Under Construction

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