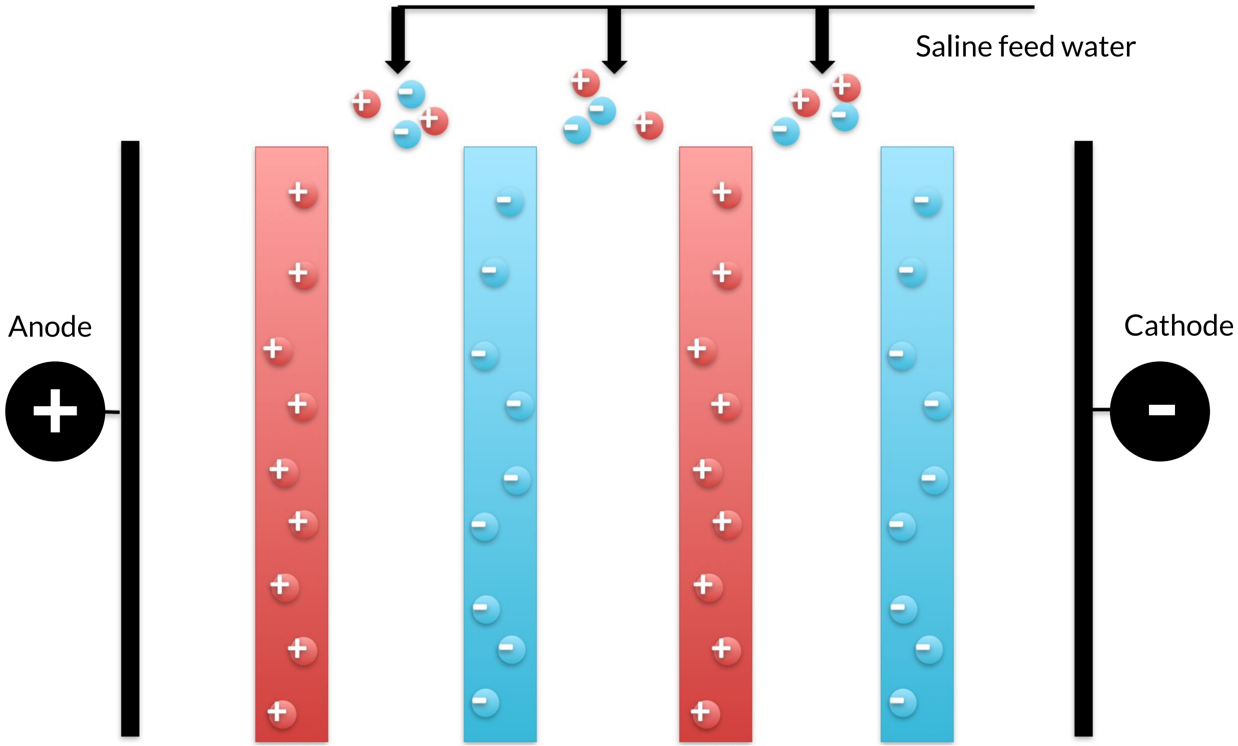
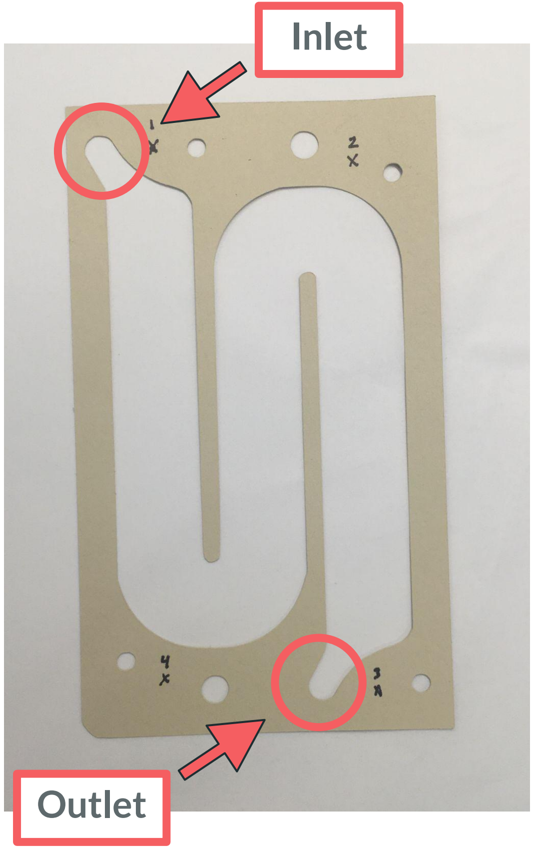
2.29: Analysis of alternative spacer designs in ED desal systems

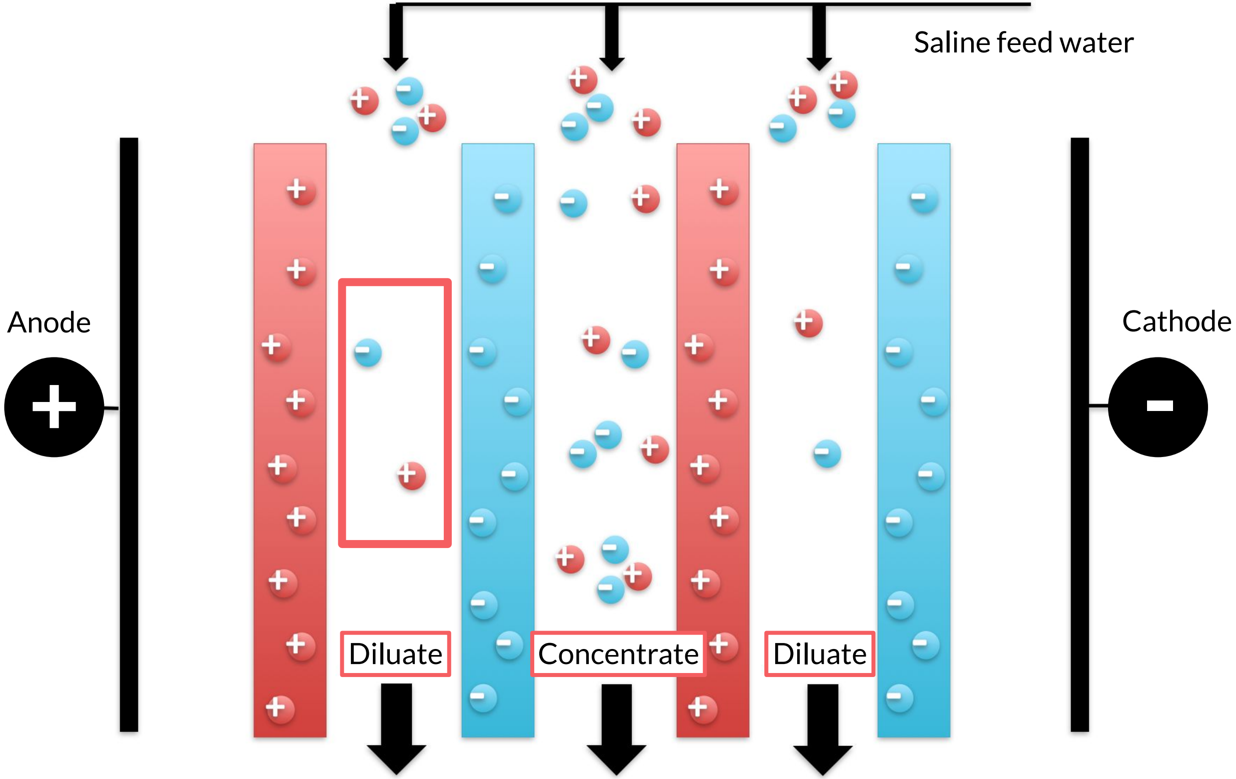
Rashed Al-Rashed

Electrodialysis (ED) applies voltage to extract salt



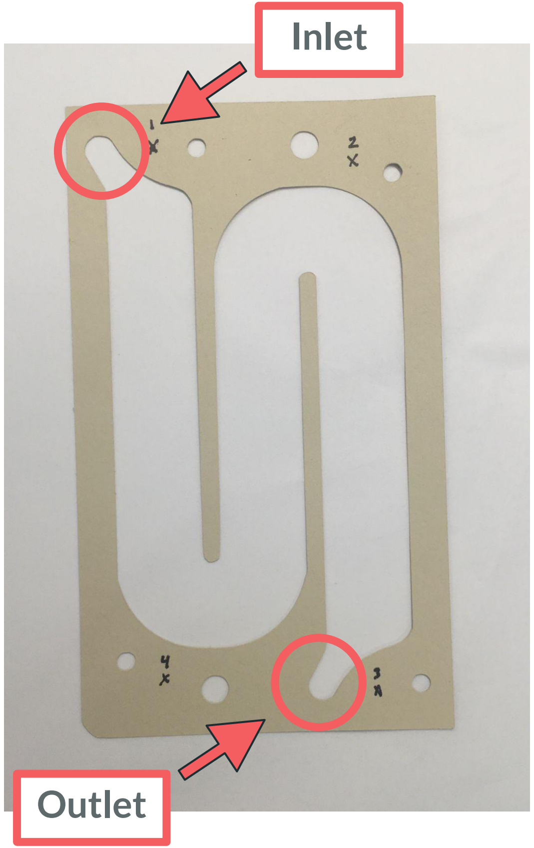
Flow spacers guide flow between ED membranes





Flow path length-width-height: 450 x 20 x 0.3 mm

Novel spacer design could be the source of issues



Potential issues with new design:

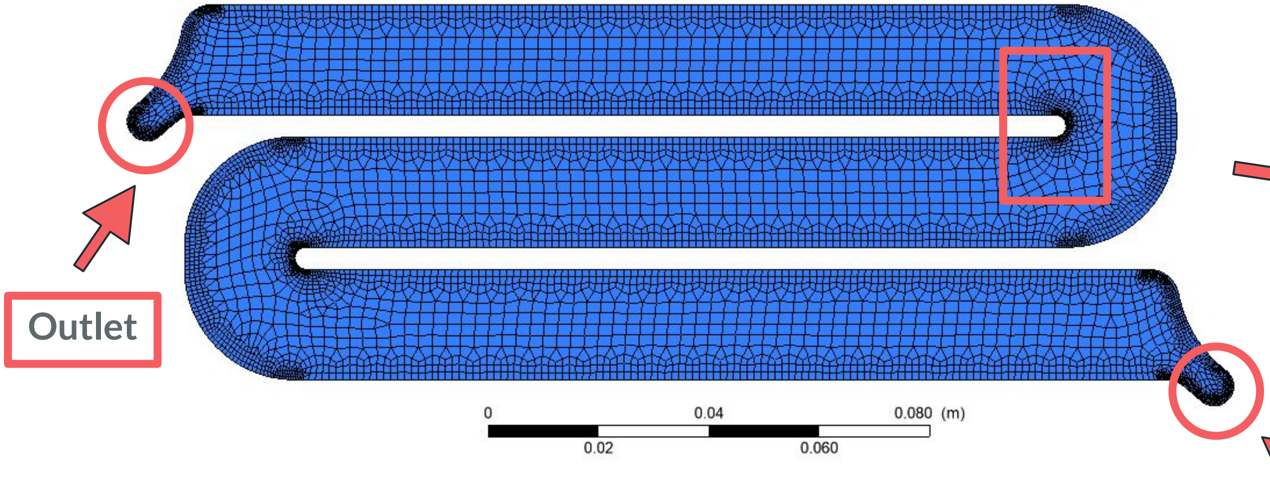
- Desal performance suggests potential stagnant/dead zones along flow path
- Measured pressure drop is higher than desired

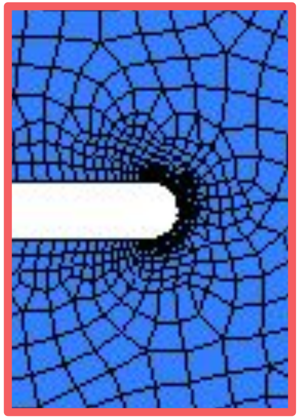
Project objectives using CFD:

- Investigate dead zones along flow path at different flowrates (2-5mL/s)
- Compare pressure drop to equiv. straight path

Flow path length-width-height: 450 x 20 x 0.3 mm

CFD analysis was set up and verified across various meshes/modelling conditions

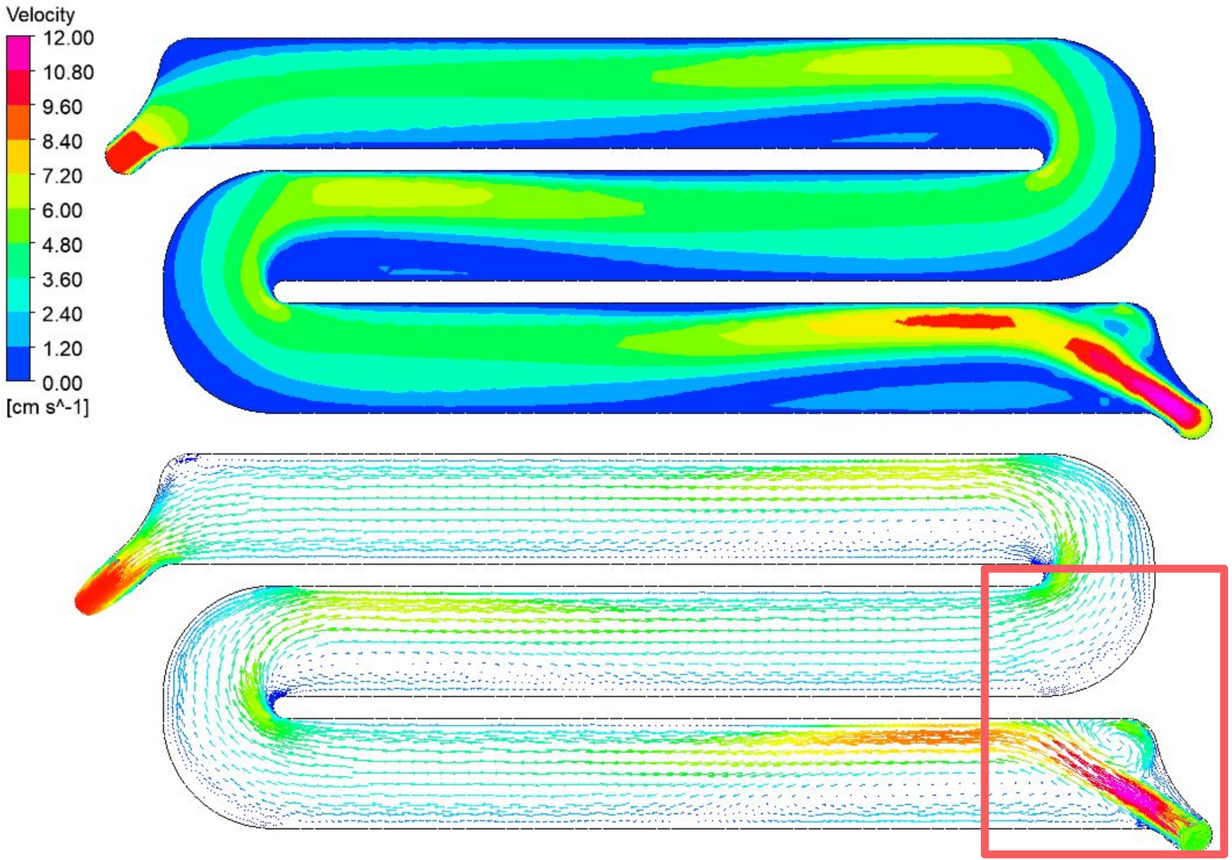


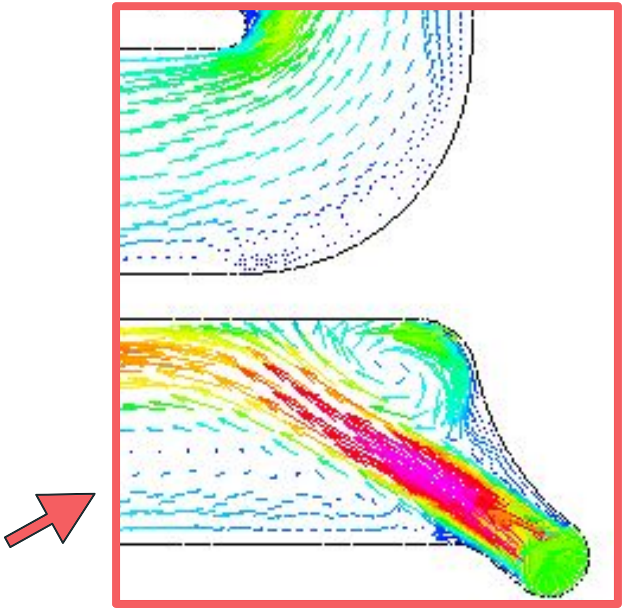


2D, steady, laminar, incompressible flow

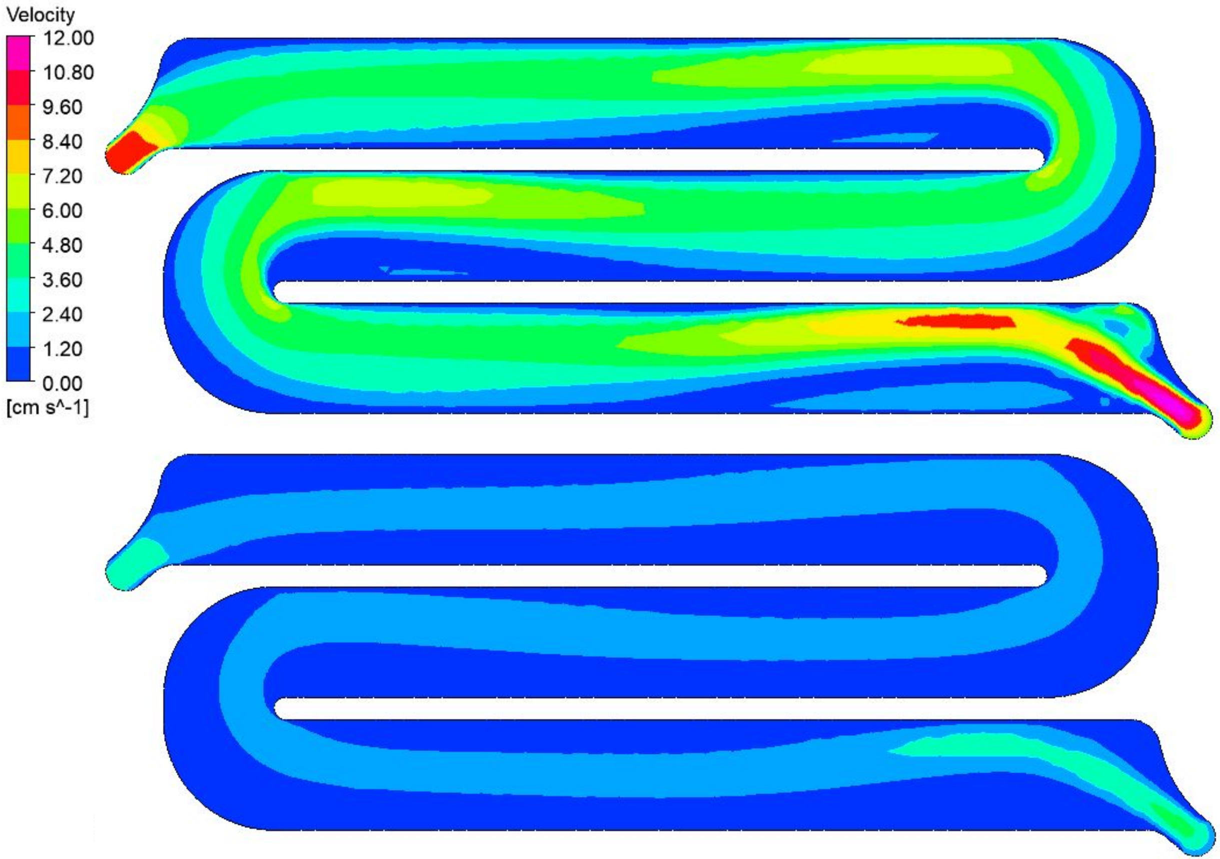
Flow path length-width-height: 450 x 20 x 0.3 mm

Velocity profile shows significant stagnation around flow path bends





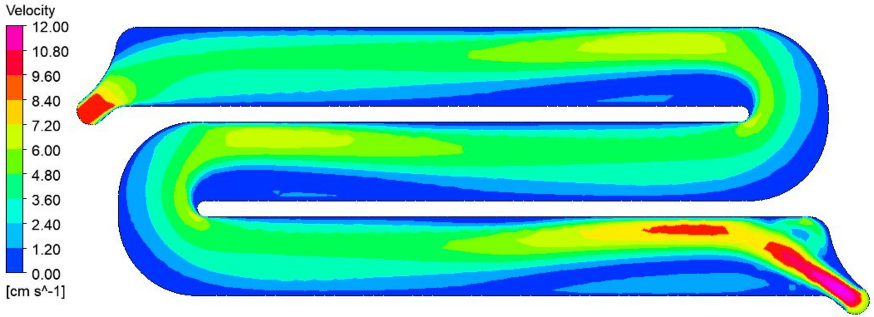
Similar behavior is observed at lower flowrates



High flowrate (5 mL/s)

Low flowrate (~2 mL/s)

Flow through "unwrapped" channel was modelled to build confidence in simulation and compare ΔP



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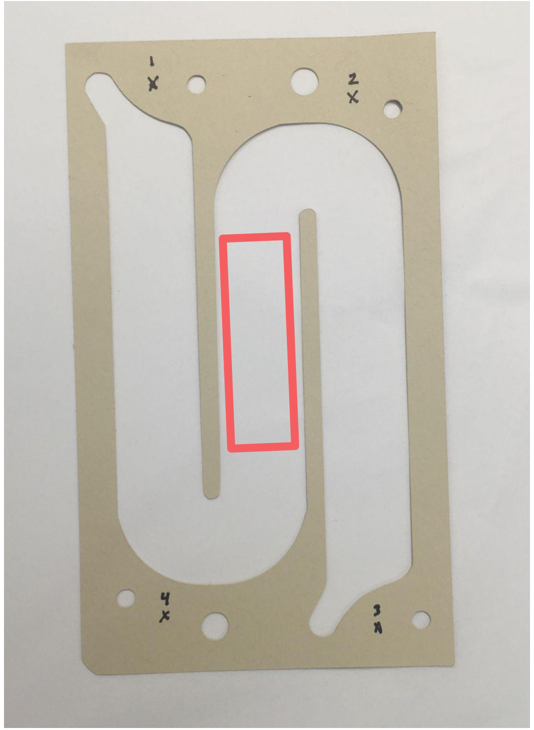
Summarized findings:
-Curved path increases ΔP by ~10x (0.2 to 2 Pa)
-unwrapped channel agrees w/ analytical sol'n

Important caveat:
2D flow neglects the the main source of ΔP (2 Pa vs ~2 KPa)

Flow path length-width-height: 450 x 20 x 0.3 mm

Adding a turbulence promoter ("mesh") along path improves desal performance, with some caveats



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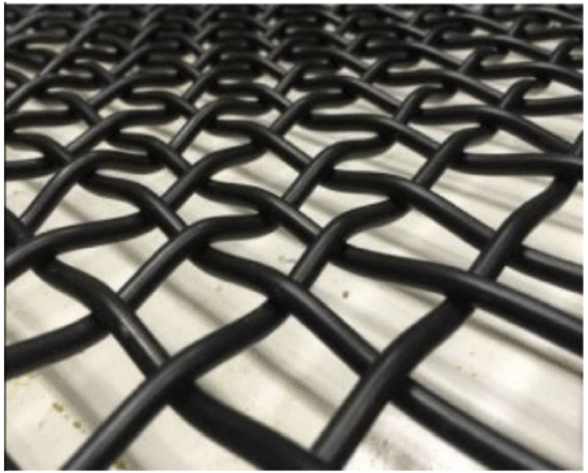

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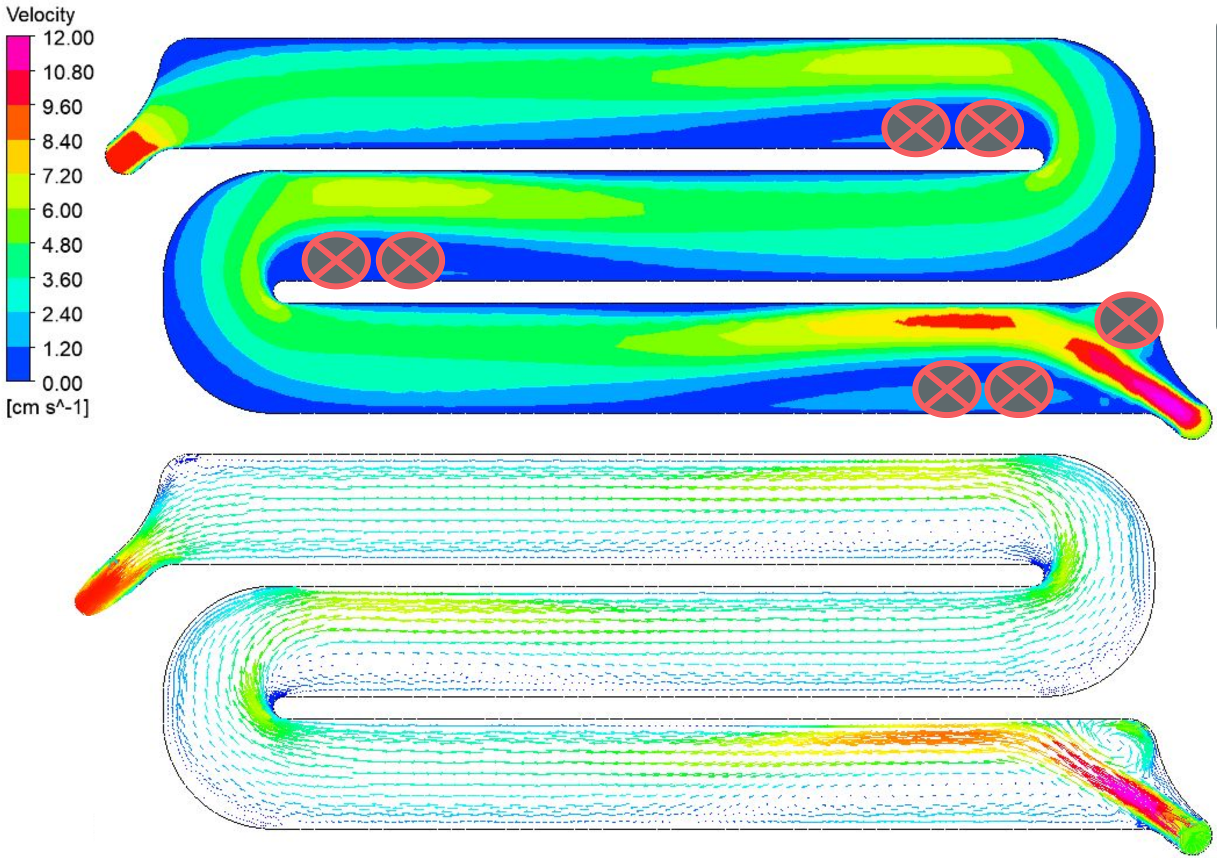
Mesh inclusion may help with dead zones but adds to modeling complexity

How can these findings influence future designs?



Potential alterations:

- Block/cut out areas of stagnant flow from path
- Adjust inlet angle/taper