Comparison of Nozzle vs. Impeller Agitation in Quench Systems

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Outline Of Presentation

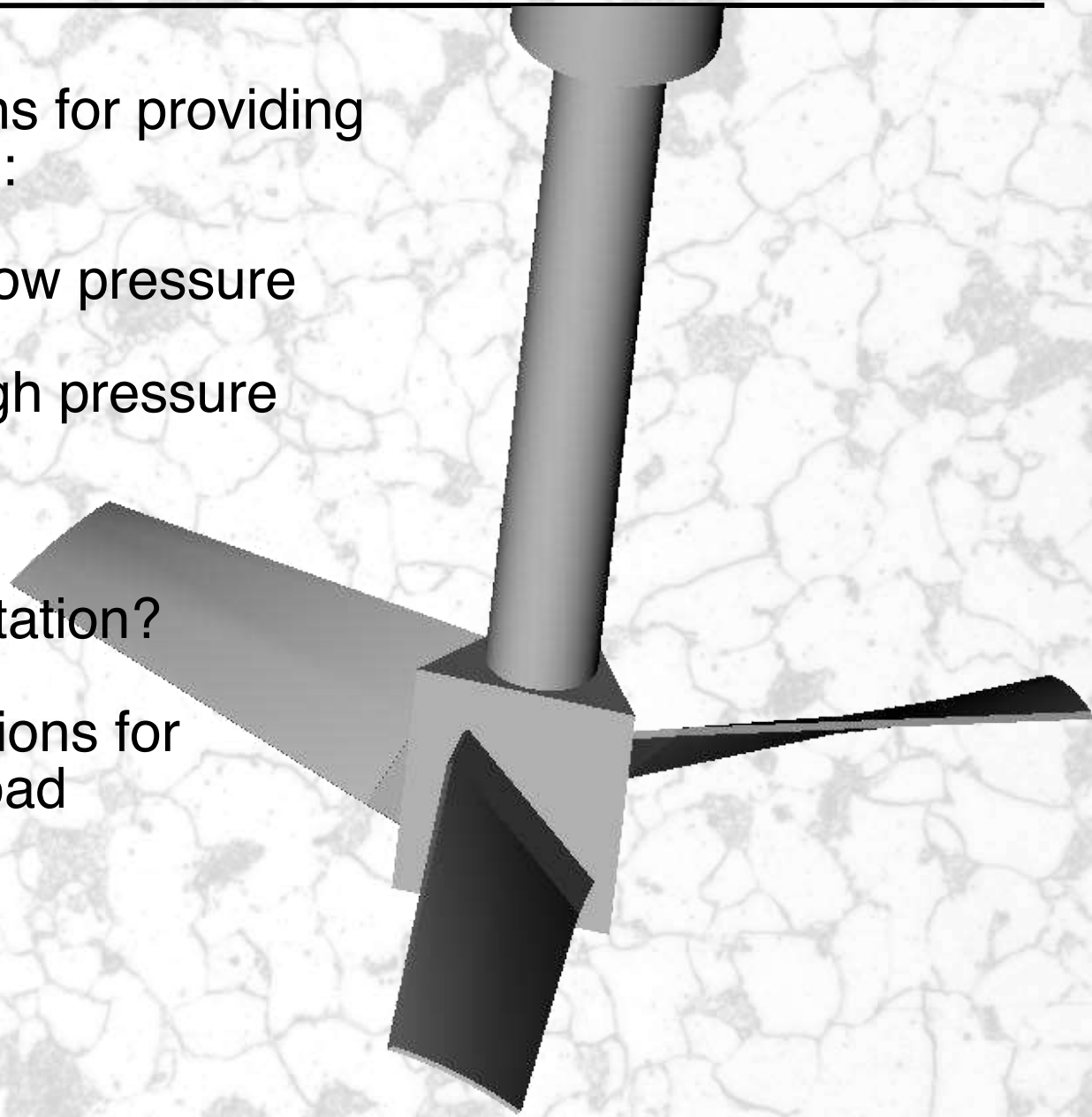
- Motivation
- Goals
- Approach
- Data Analysis
- Results
- Conclusions

Motivation

There are two main options for providing agitation for quench tanks:

Impellers – High volume low pressure devices
Nozzles – Low volume high pressure devices

Questions:
Which provides better agitation?
Which is more efficient?
Which provides better options for delivering flow to the load



Approach

CFD models used to address two considerations:

Efficiency of delivering flow –

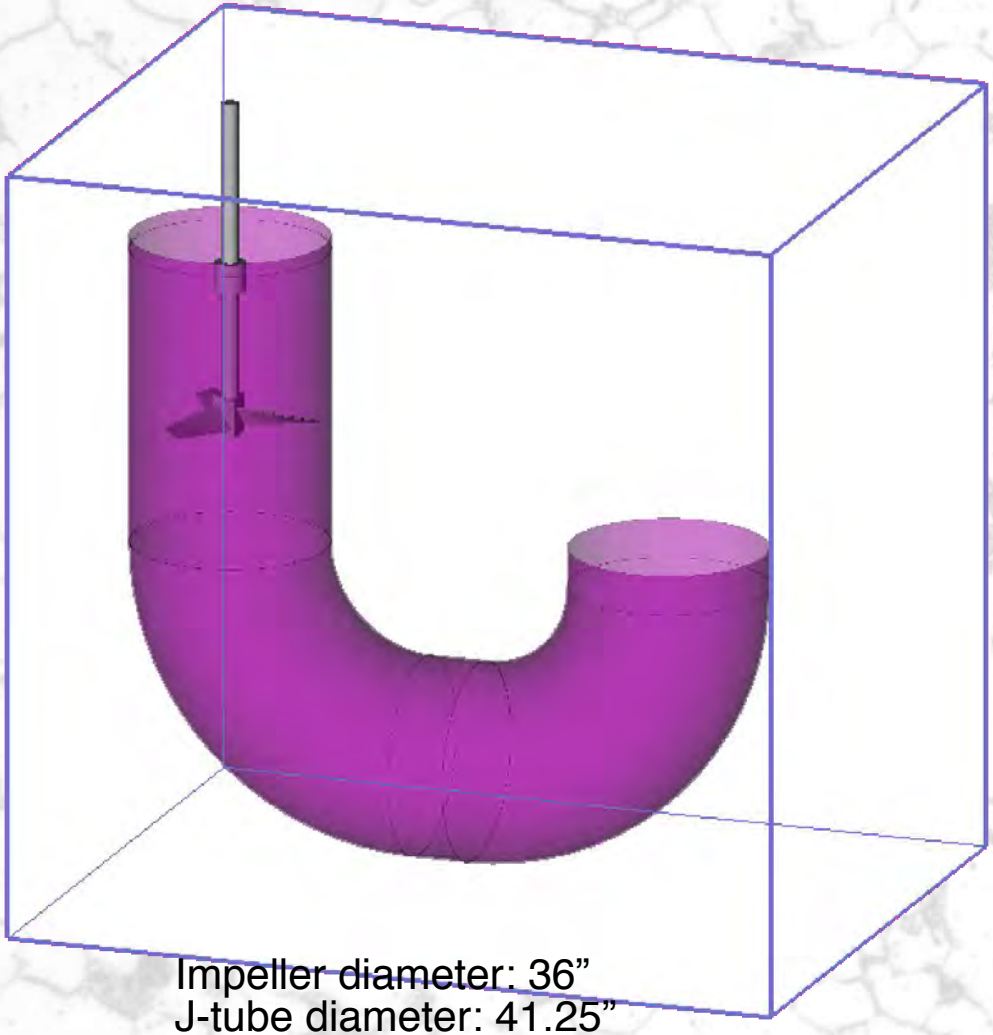
- Single impeller in J-tube
- Single nozzle

Ability to provide heat transfer to load –

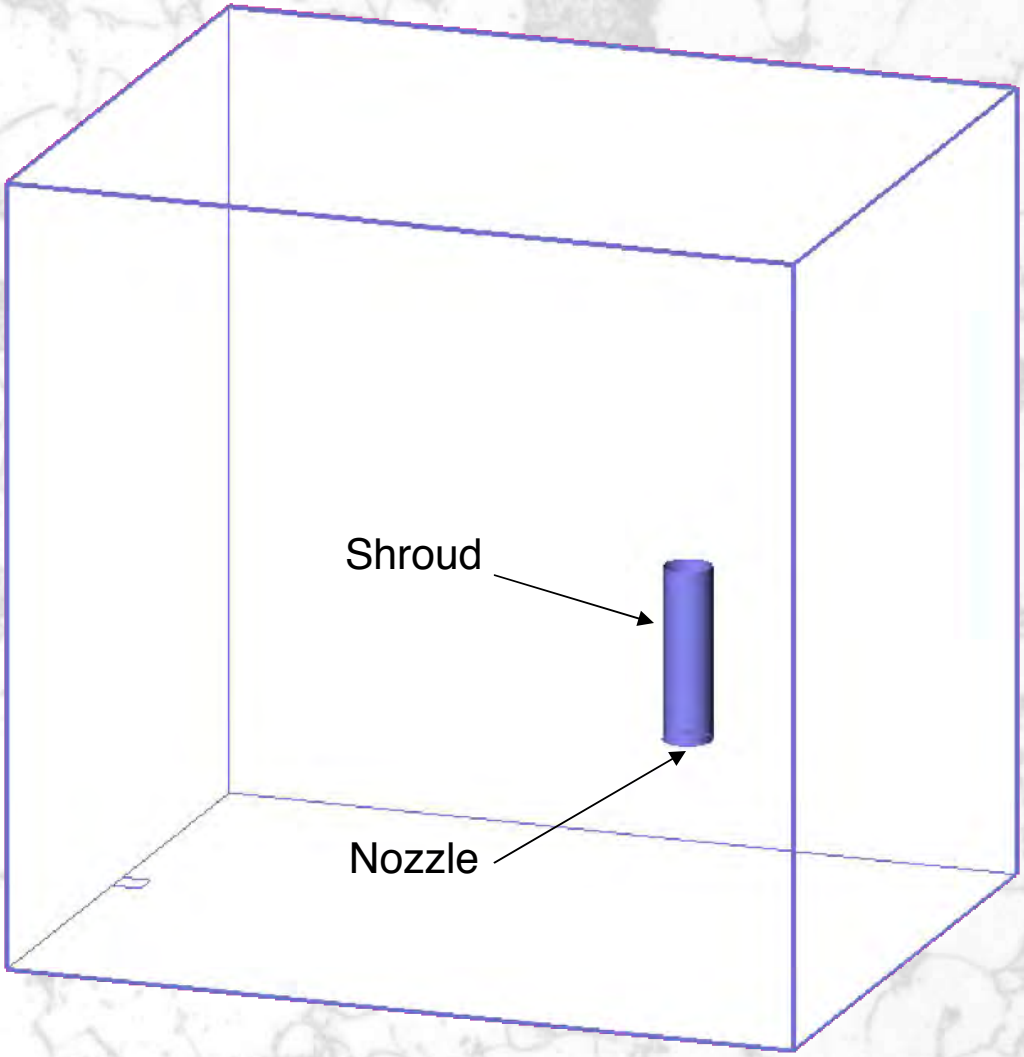
- Same single impeller w/J-tube
- Array of nozzles

Approach

Model geometry and details



Impeller diameter: 36”
J-tube diameter: 41.25”
Blades on impeller: 3
Impeller speed: 280 RPM

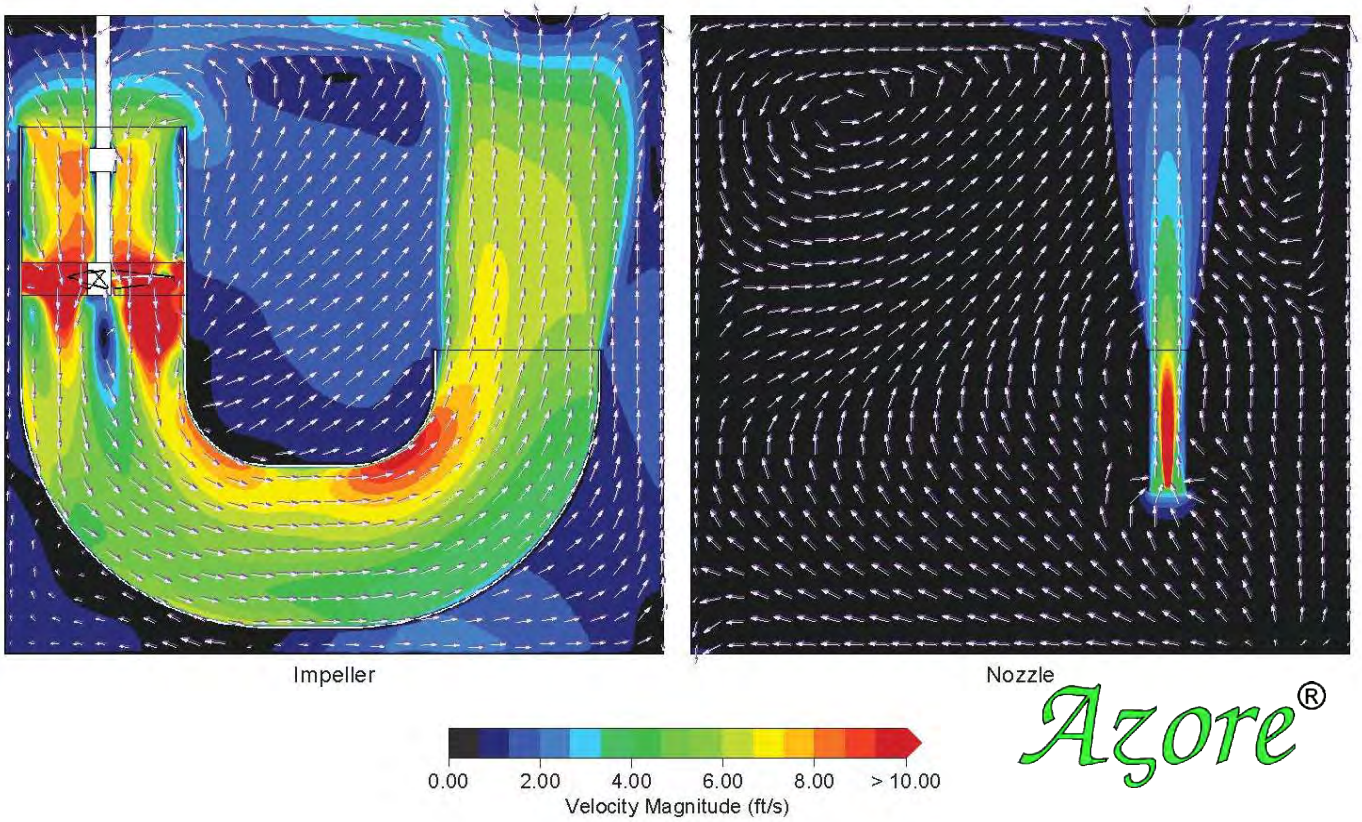


Nozzle diameter: 1”
Flow rate: 100 GPM
Shroud: 10” diameter

Shroud used to assess amount of entrained flow

Results – Flow Generated

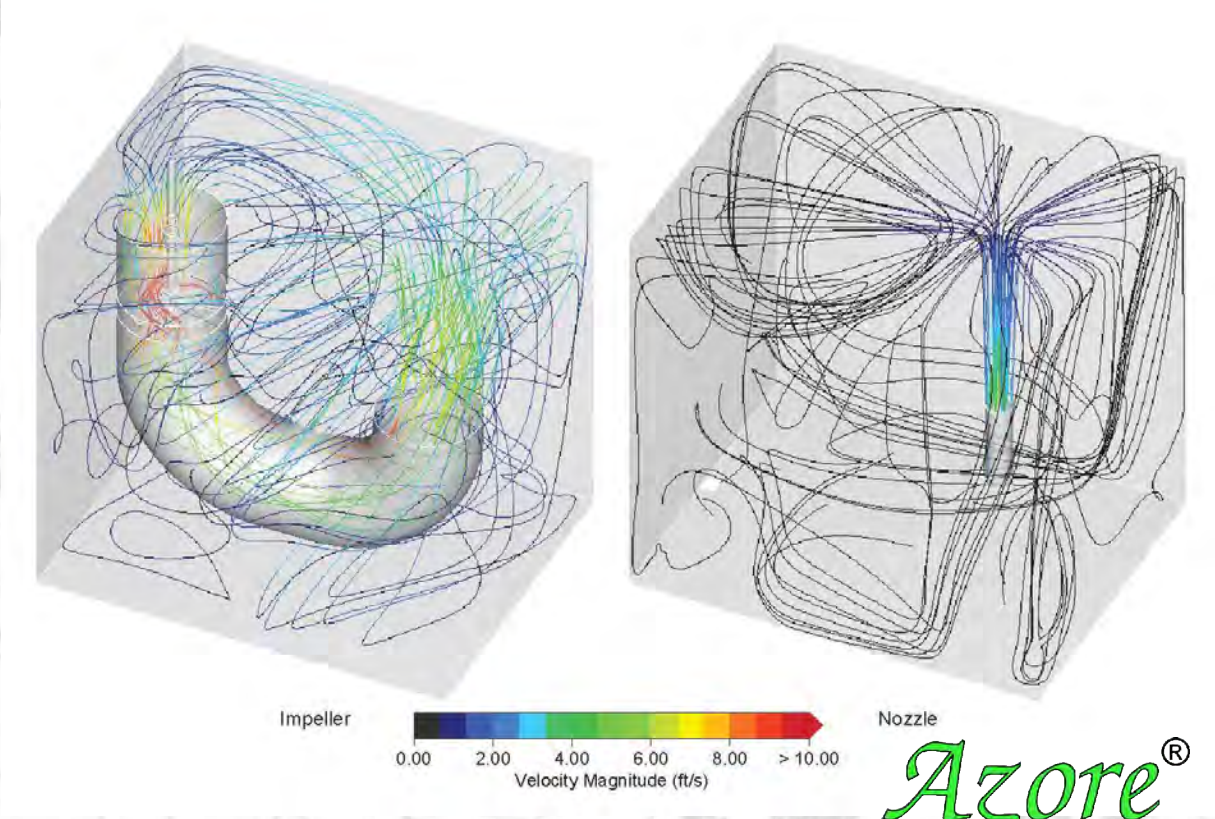
System	Impeller	Nozzle
Area of tube exit	0.89 m^2	0.05 m^2
Average velocity	1.63 m/s	1.15 m/s
Flow rate	1.45 m^3/s	0.06 m^3/s



Flow from nozzle is 0.0063 m3/s. Reported value of 0.06 m3/s includes entrained flow.

Results - Efficiency

System	Impeller	Nozzle
Flow rate (GPM)	22,900	921
Shaft Power (HP)	25.7	0.93
GPM/HP	893	993



Impeller power based on shaft torque from CFD model and impeller speed.

Nozzle power based on flow rate and pressure losses (nozzle, piping, elbows) and 75% pump efficiency.

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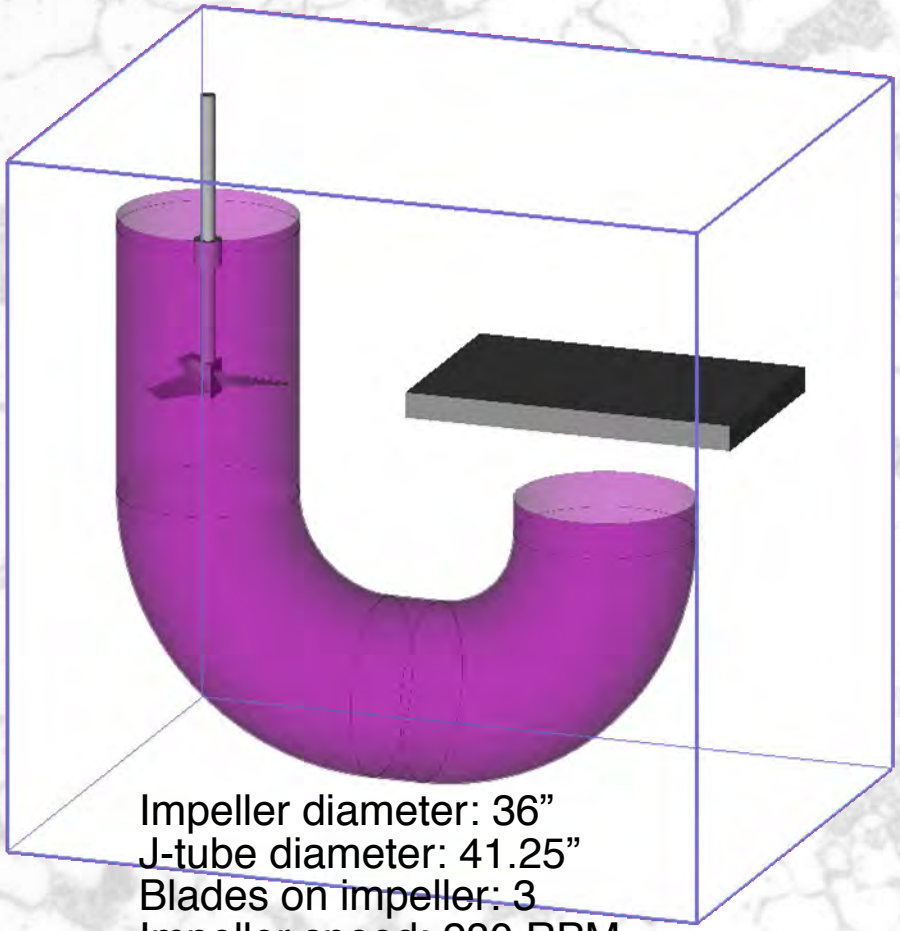
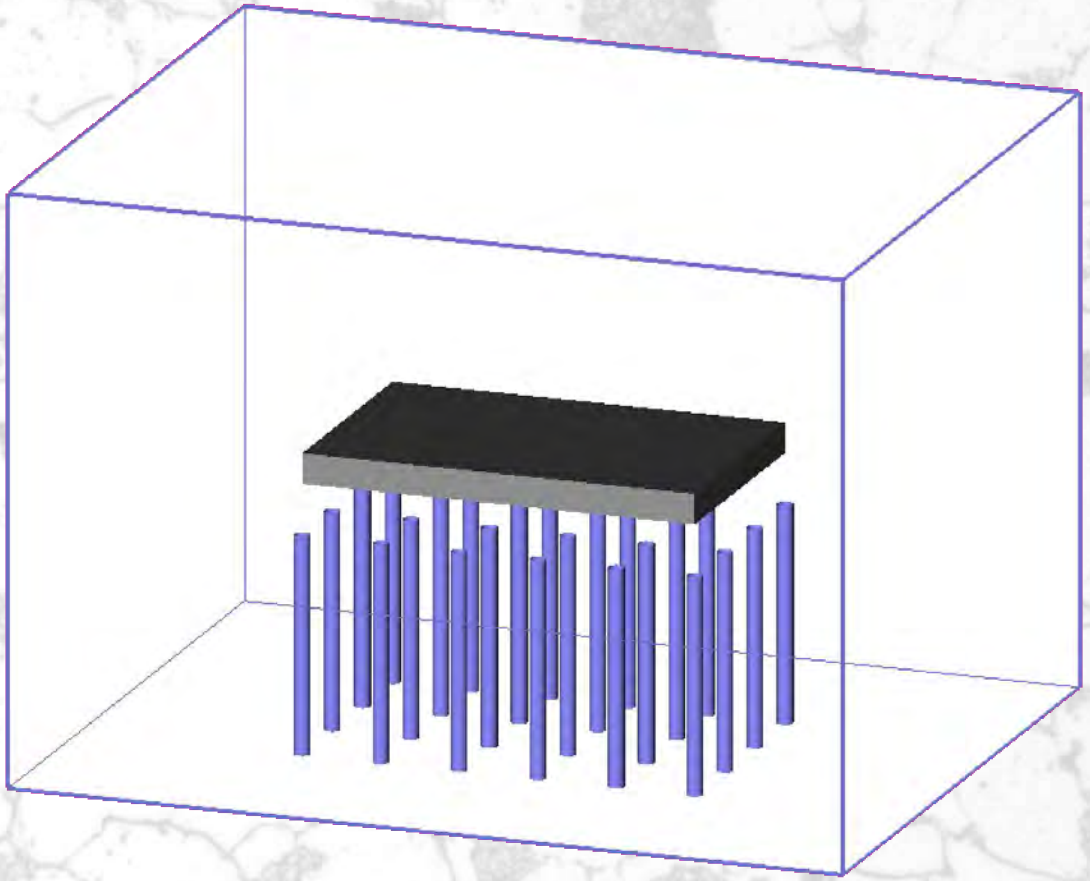
Approach

Model geometry and details

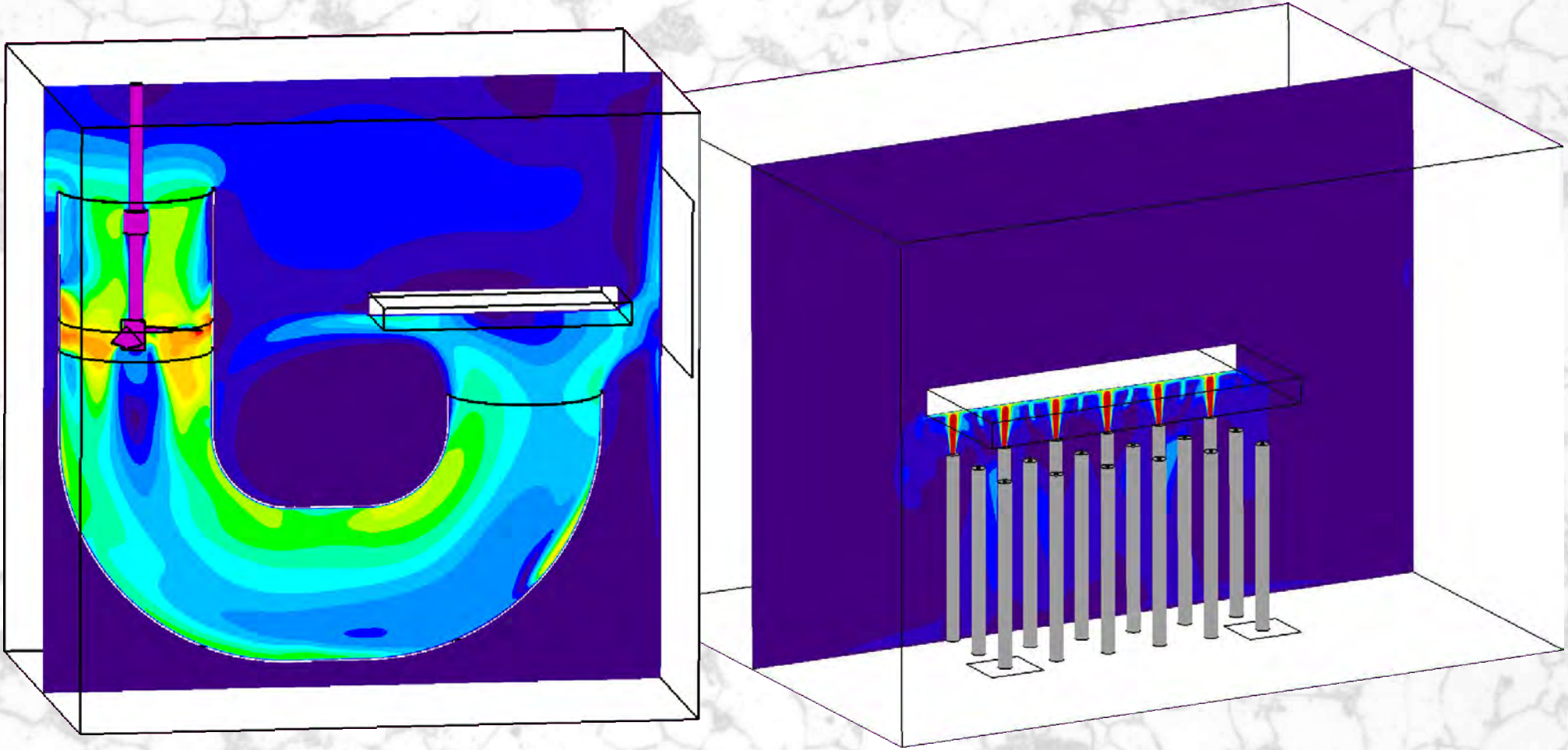


Impeller diameter: 36”
J-tube diameter: 41.25”
Blades on impeller: 3
Impeller speed: 280 RPM
50” x 78” plate as load



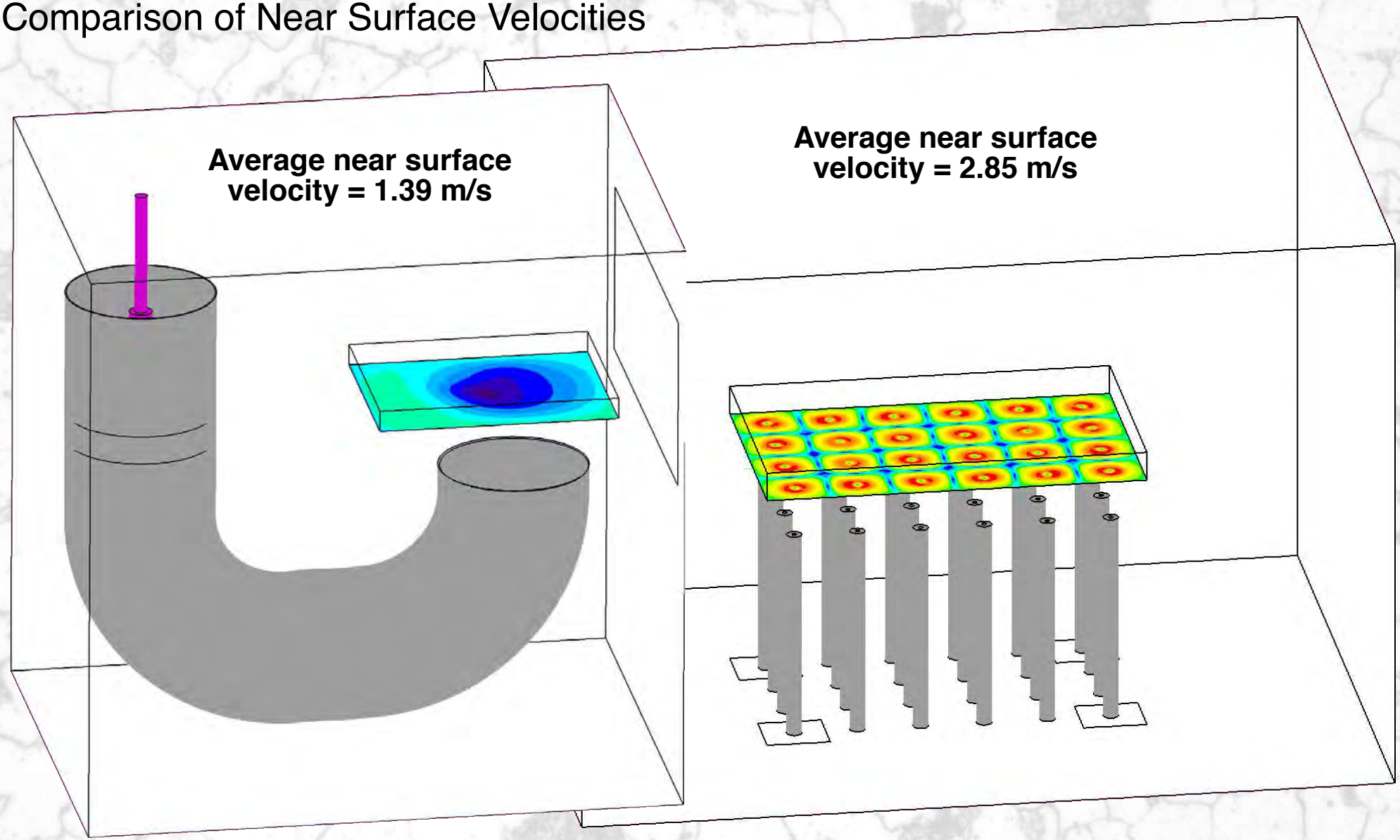
Array of nozzles
Nozzle diameter: 1”
Supply tube: 3”
Flow rate: 100 GPM/nozzle
Spacing: 12.5” x 13”
50” x 78” plate as load

Comparison of Flow Patterns



Results

Comparison of Near Surface Velocities



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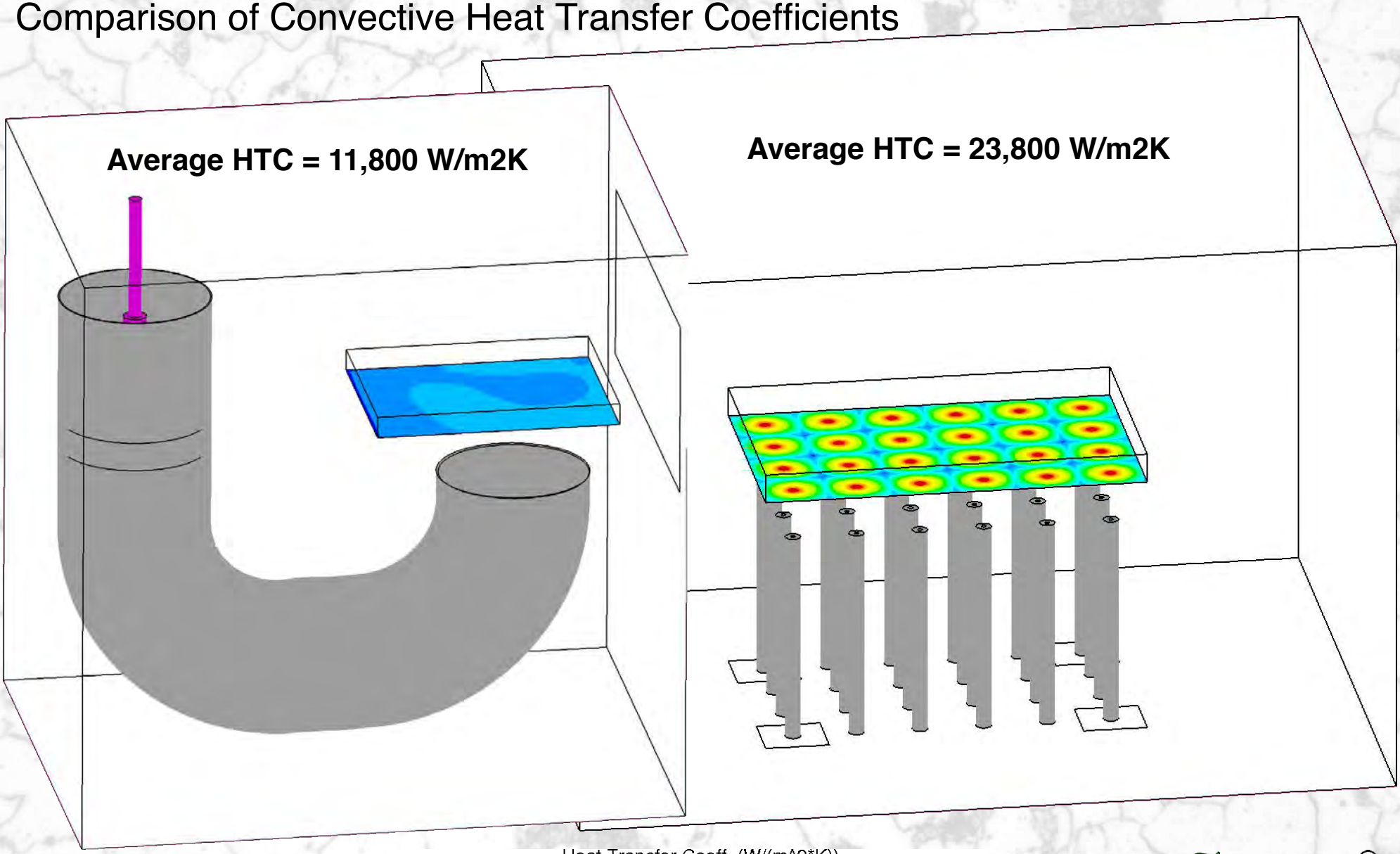
Comparison of Convective Heat Transfer Coefficients



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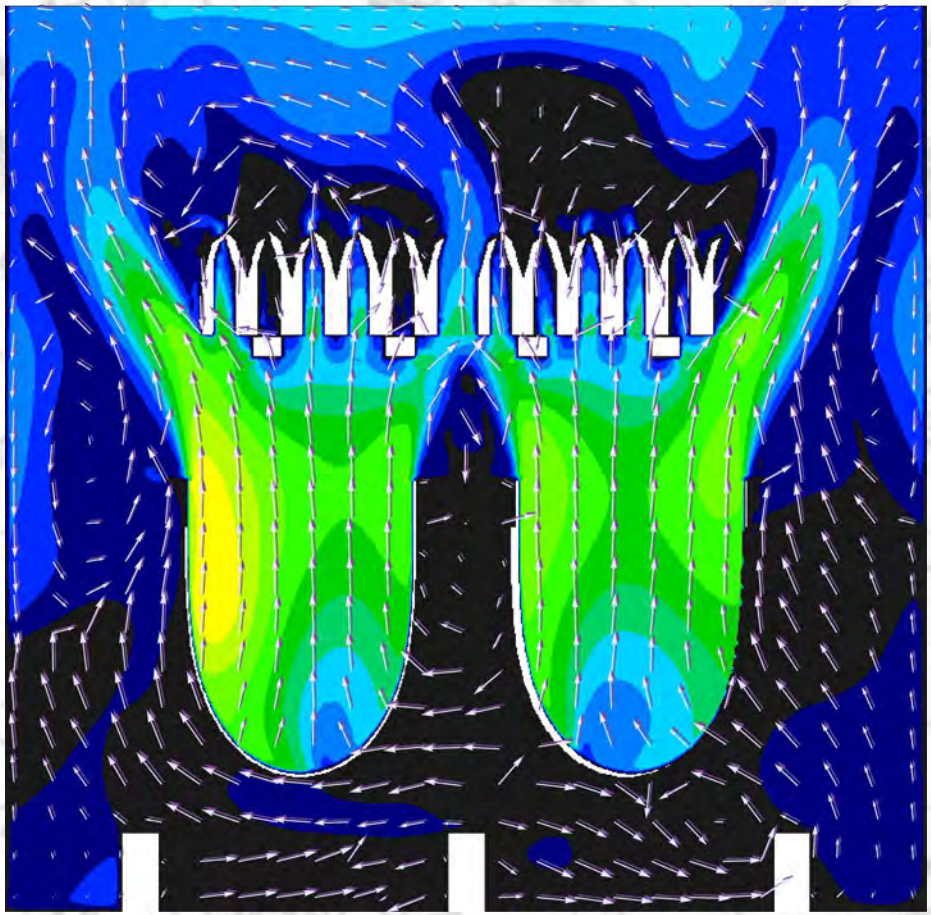
Conclusions

Ability to generate flow essentially equivalent.

Nozzles can potentially provide higher heat transfer coefficients.

Nozzles provide an option for directing flow to load and avoiding obstructions (piers, elevators).

Nozzle approach used widely in high pressure gas quenching, less so in liquid quenching.



Effect of load support fingers on flow patterns.