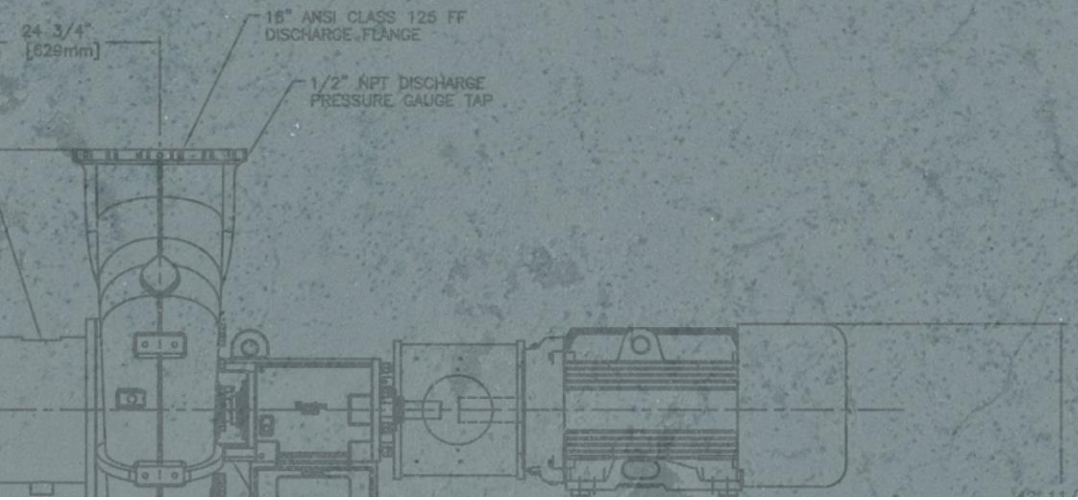
Vaughan
Unmatched Reliability

Doing More with the Same? Effect of THP on Digester Mixing

Erik Larson, PE



MADE IN AMERICA

Why Consider THP?

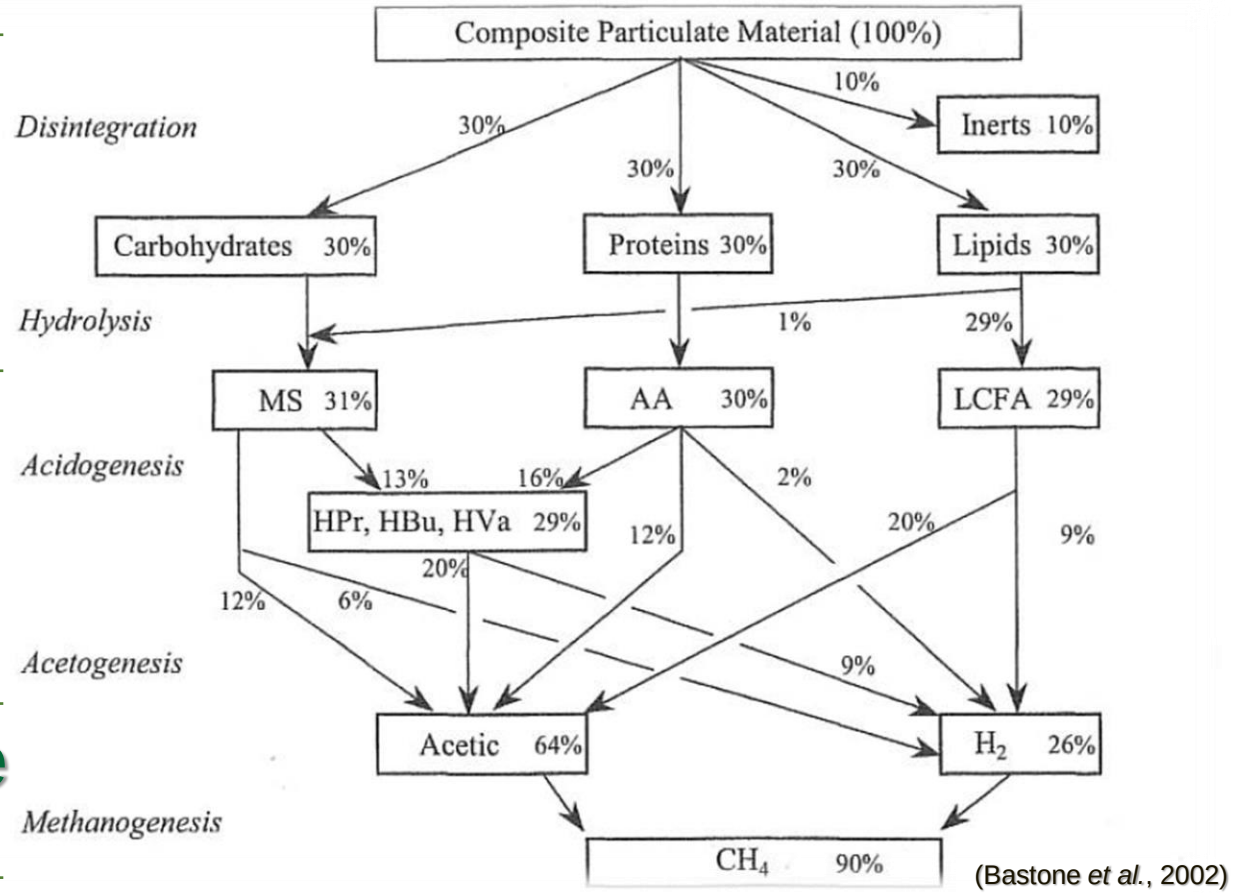
- Achieve Class A biosolids
- Increase digester capacity
- Improve gas production
- Improve dewatering

Anaerobic Digestion

Hydrolysis
Slow

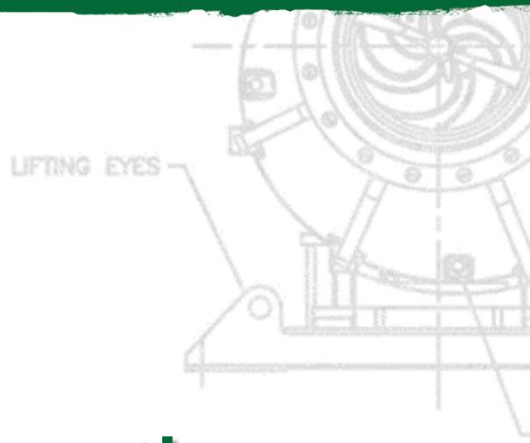
Acid Phase
Fast

Methane Phase
Fast



(Bastone *et al.*, 2002)

What is Rheology?



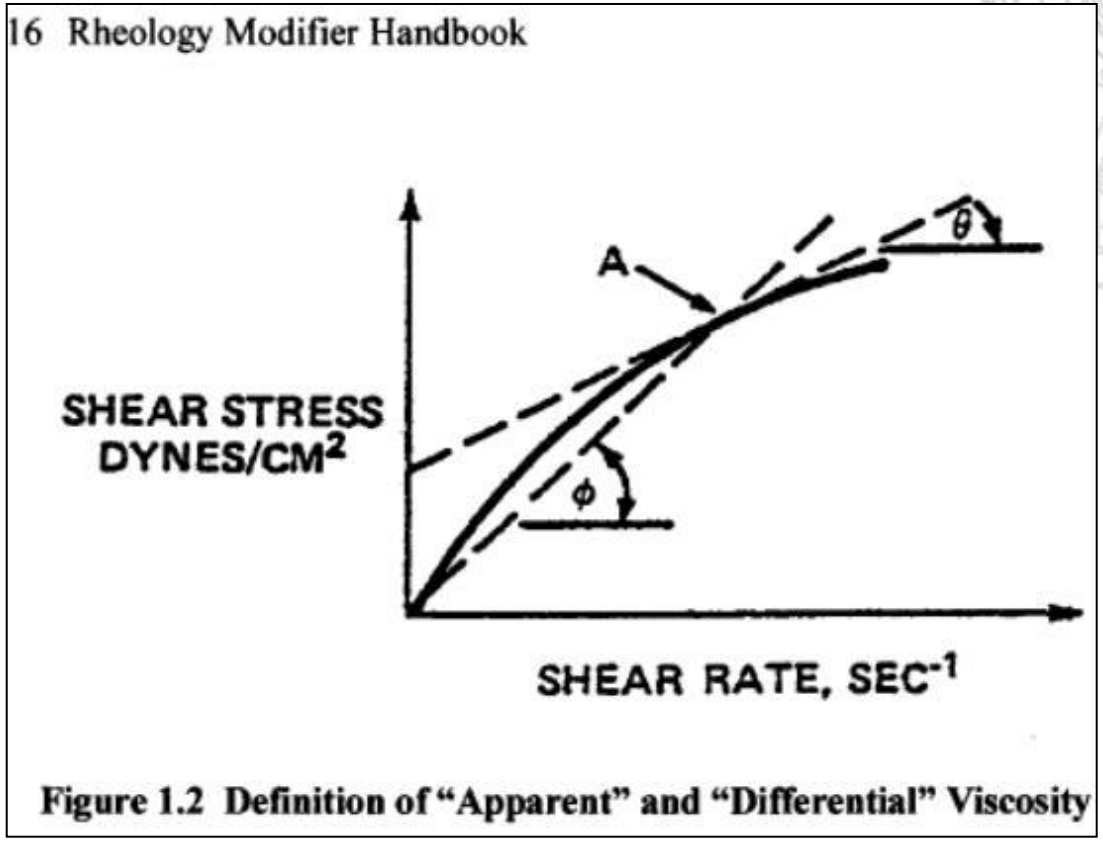
A Science Dealing With The Deformation And Flow Of Matter.

Merriam-Webster

Apparent vs Differential Viscosity

The ‘apparent’ viscosity is equal to the slope of a line that connects the origin with a given point on the shear stress versus shear rate curve (or the tangeant of the angle ϕ).

The ‘differential’ viscosity is equal to the slope of the shear stress versus shear rate curve at some point A (or the tangent of the angle θ).

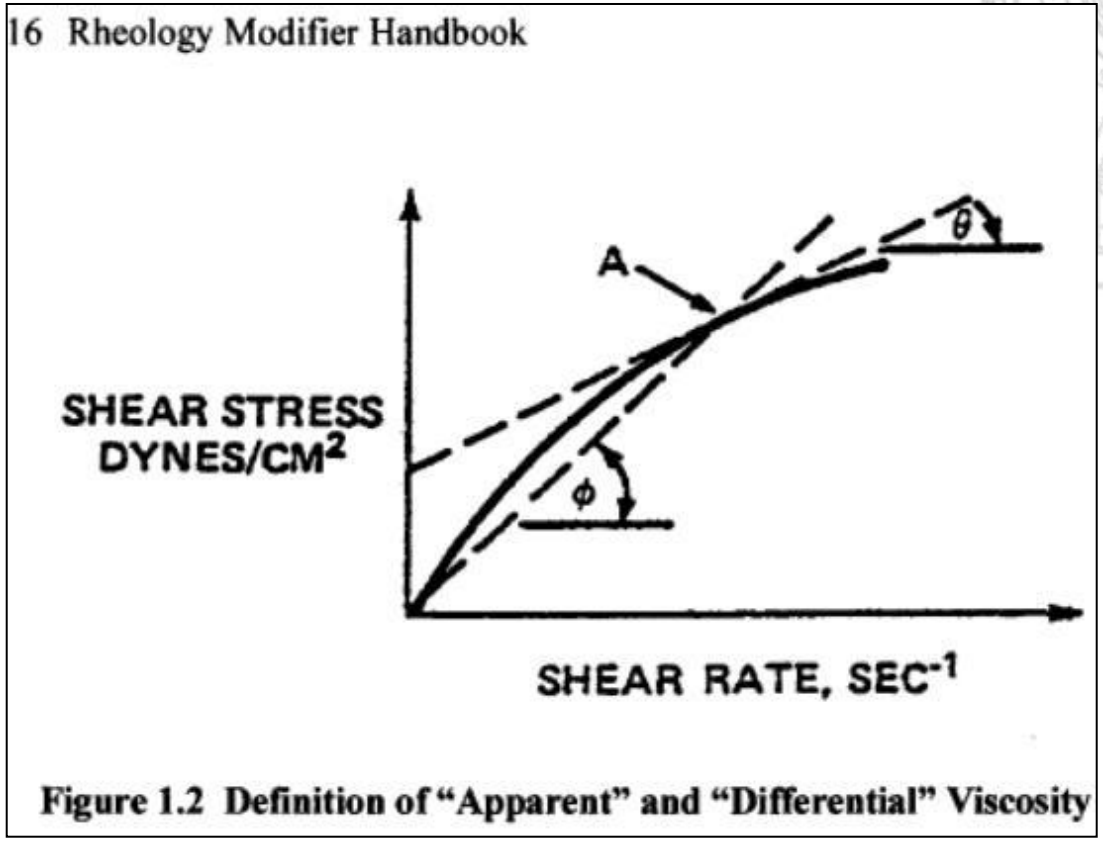


Braun, D.; Rosen, M. (1999) *“Rheology Modifiers Handbook: Practical Use and Applications”, William Andrew Publishing, 1st edition, Figure 1.2.*

Apparent vs Differential Viscosity

The ‘apparent viscosity’ is usually what is being referred to when you see viscosity data because it is simple to measure.

The ‘differential’ viscosity requires measurements at several shear rates to determine the slope at the shear rate of interest and it more complex to define.



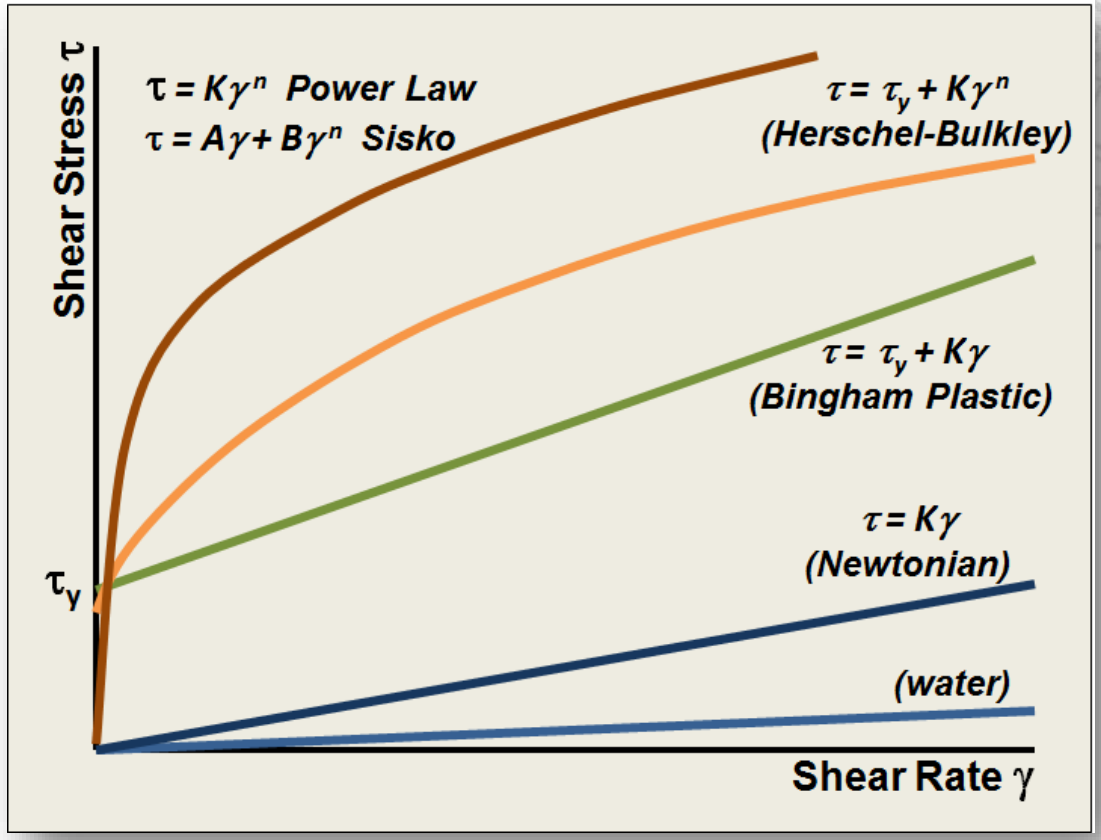
Braun, D.; Rosen, M. (1999) *“Rheology Modifiers Handbook: Practical Use and Applications”, William Andrew Publishing, 1st edition, Figure 1.2.*

Equations for modeling Viscosity

The equation used should be chosen based on the shear rates being modeled and the level of accuracy required.

For digester mixing, the Power Law equations provide the most accuracy at low shear rates.

Remember, the viscosity is the slope of the curve at a given shear rate.

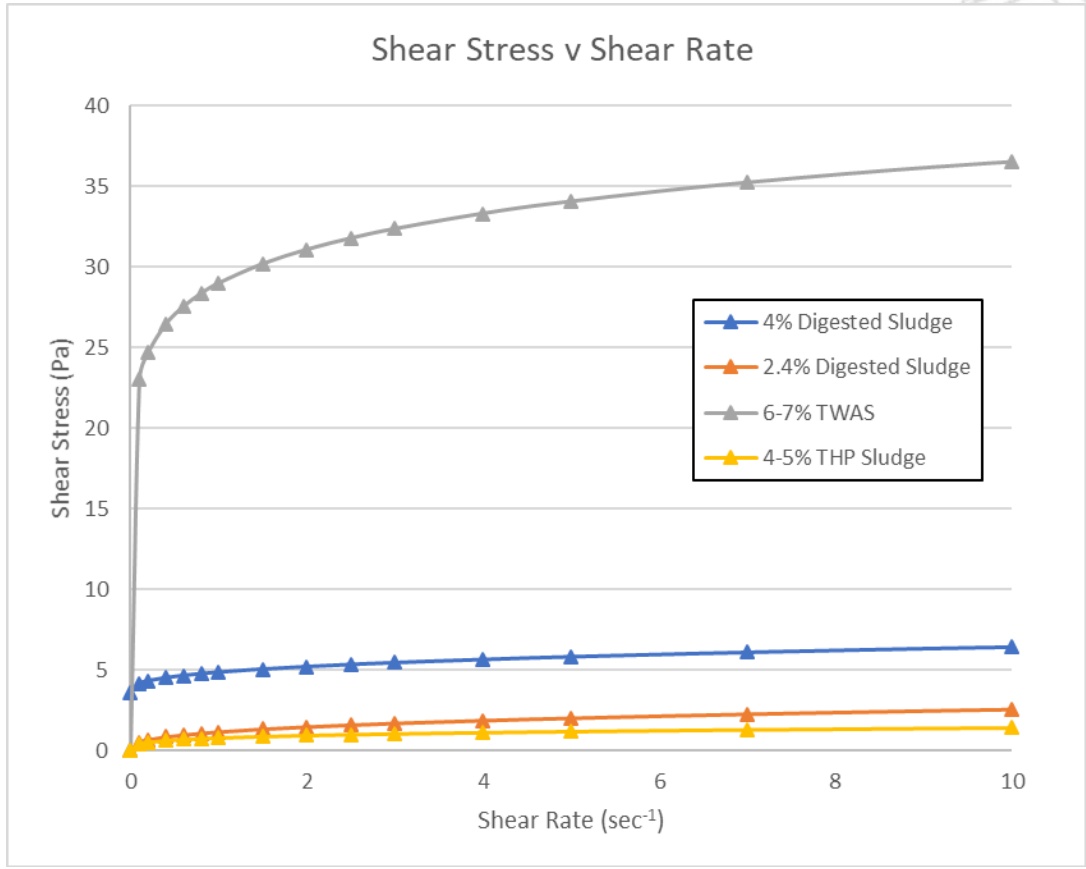


Conventional Sludges vs THP Sludges

Sludge viscosities vary depending on many factors and each sludge will be different, the values shown are representative.

THP sludges will generally have significantly lower viscosities than conventional sludges.

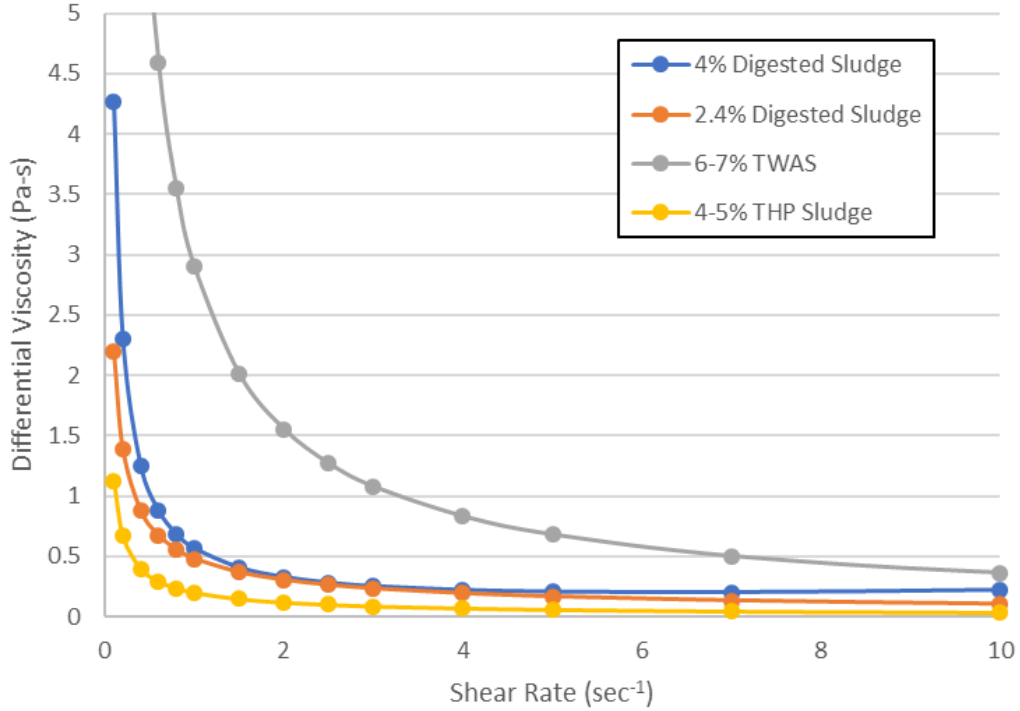
Polymer thickened TWAS will generally have the largest viscosities.



Conventional Sludges vs THP Sludges

For context, piping flows will generally have shear rates of 80-100 s^{-1}

The mixing flows in a digester will generally create shear rates of less than 1 s^{-1}



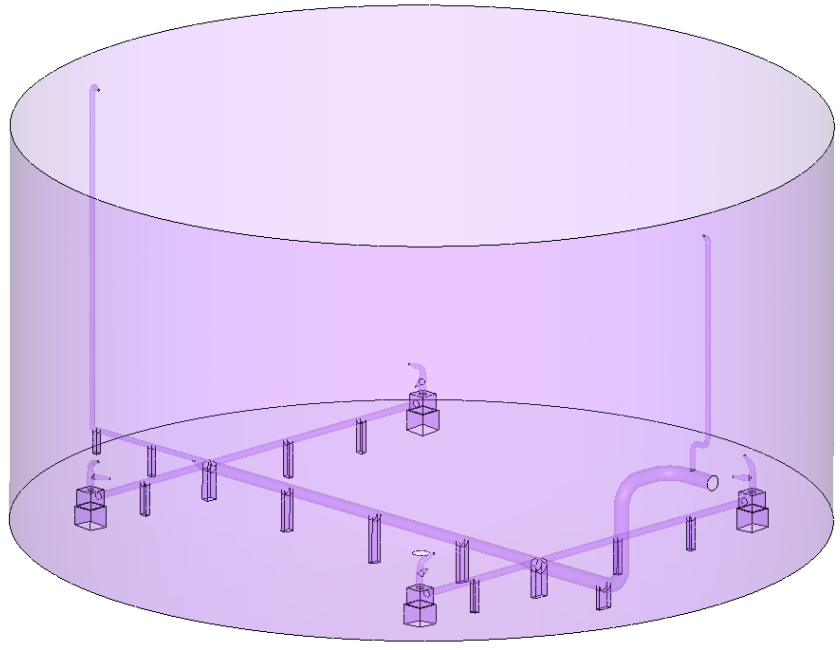
Digester Model

Geometry

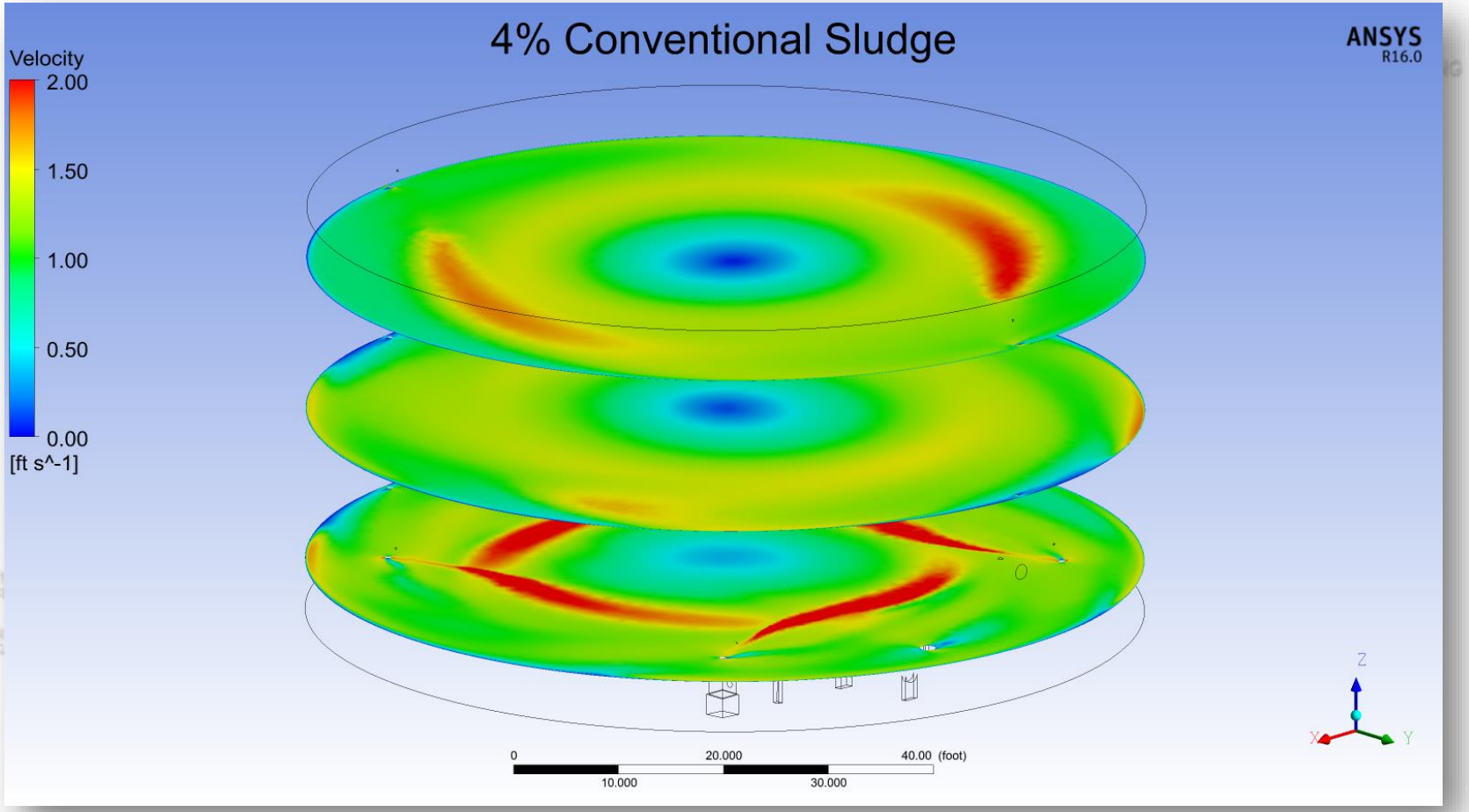
- 80’ Dia x 40’ HWL, 1.6 MG
- Total of 10 nozzles (8 lower, 2 upper) providing 6200GPM of mixing flow

Analysis

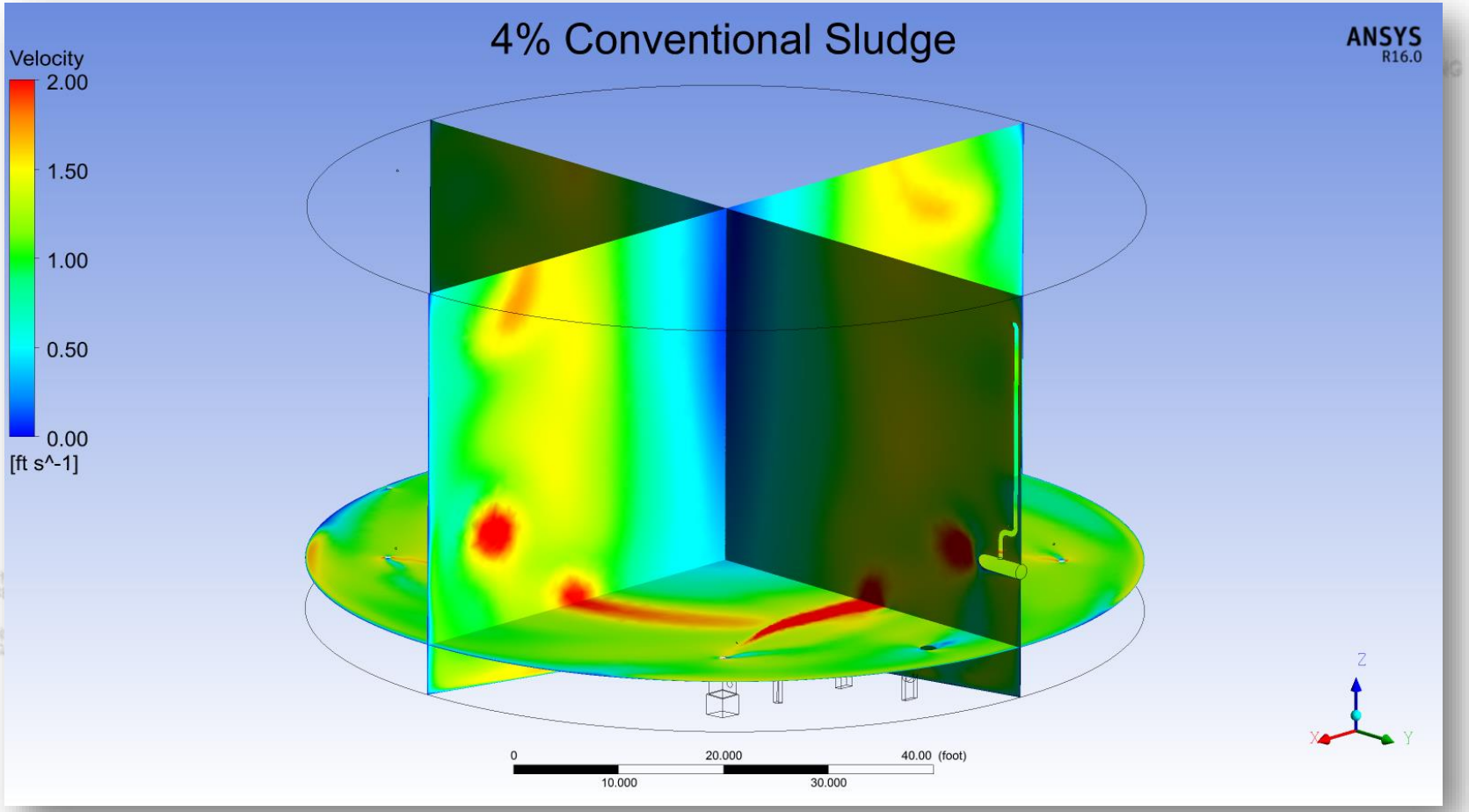
- Steady State
- Non-Newtonian fluid model
- User defined viscosity model (modified power-law)



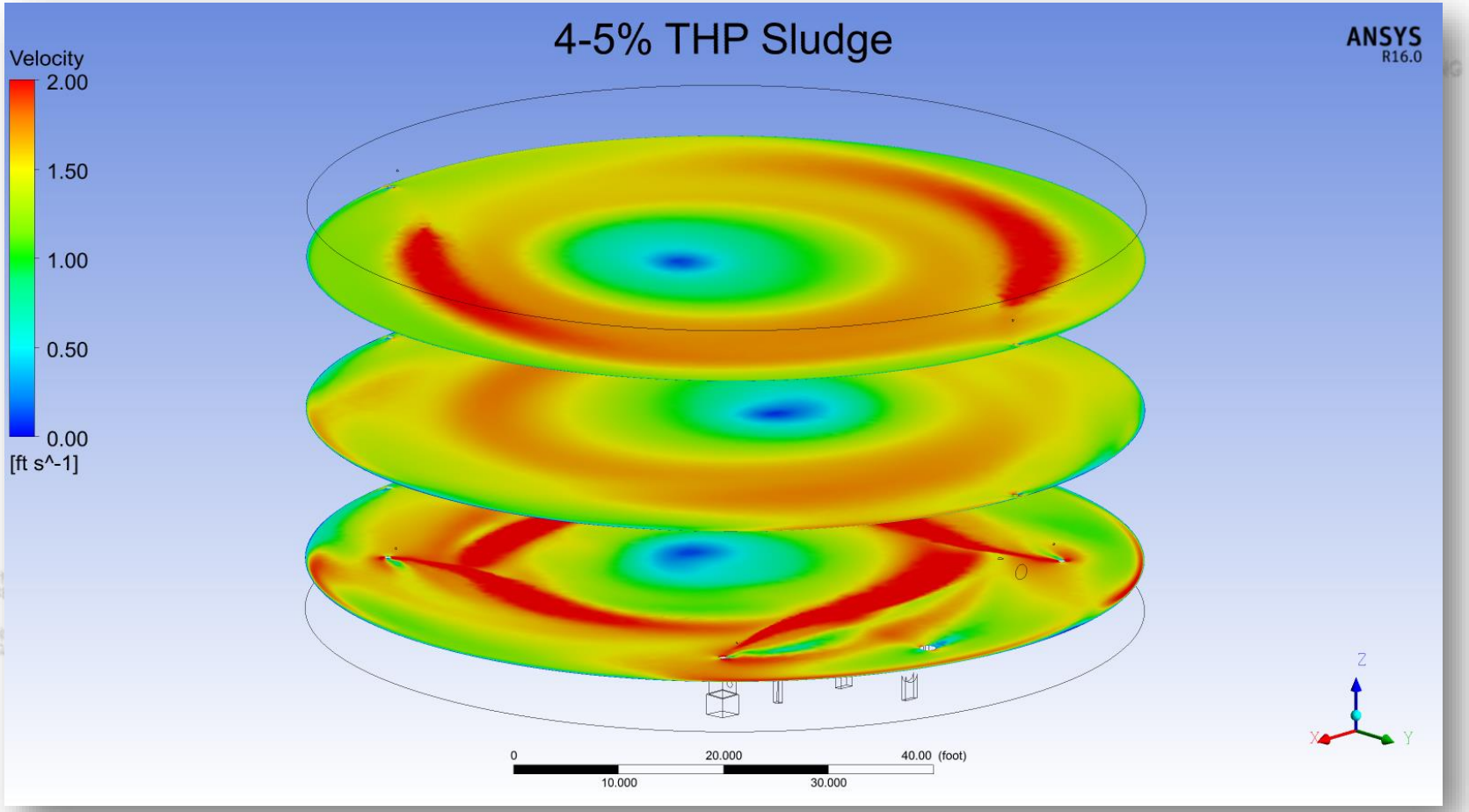
Effects on Digester Mixing Design



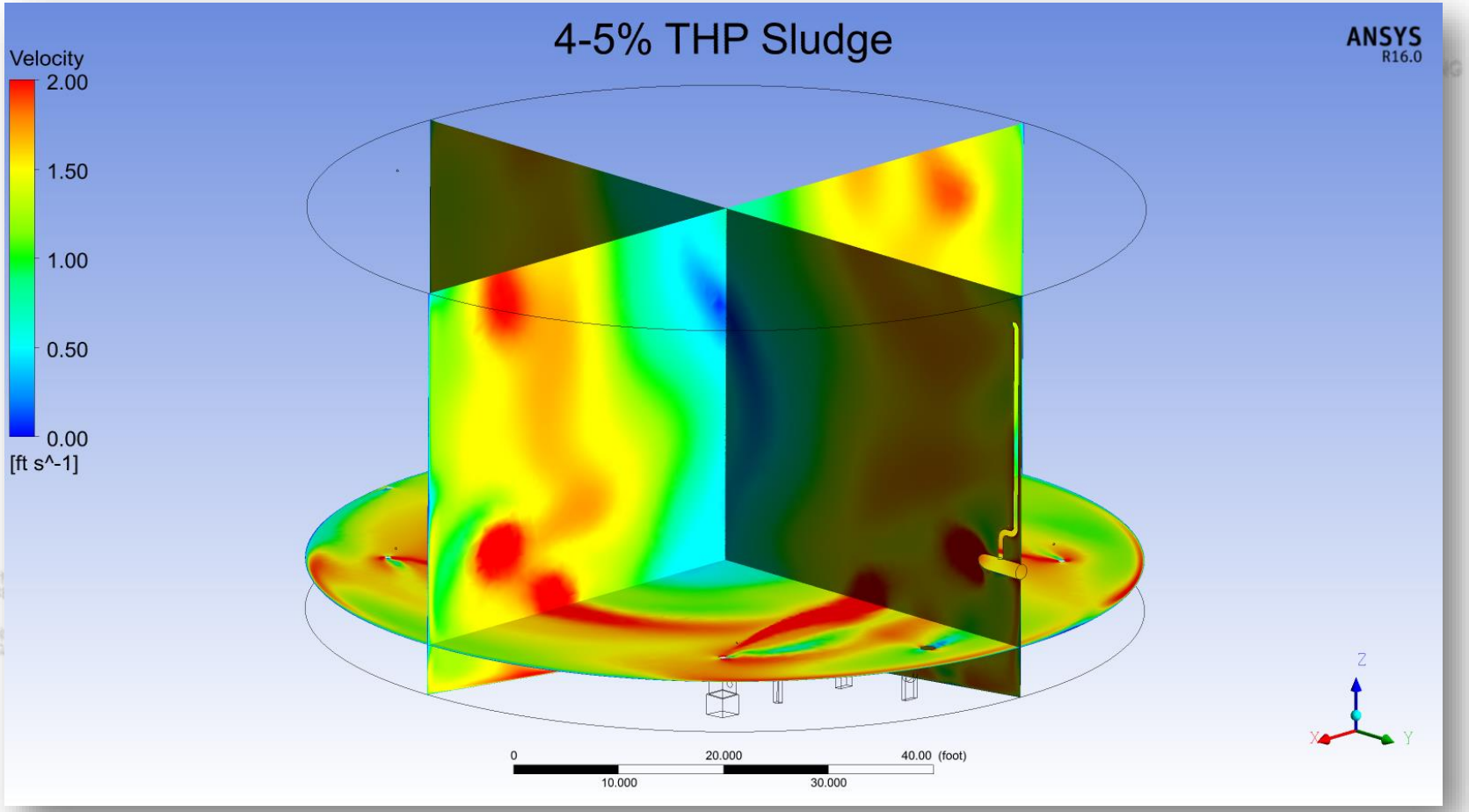
Effects on Digester Mixing Design



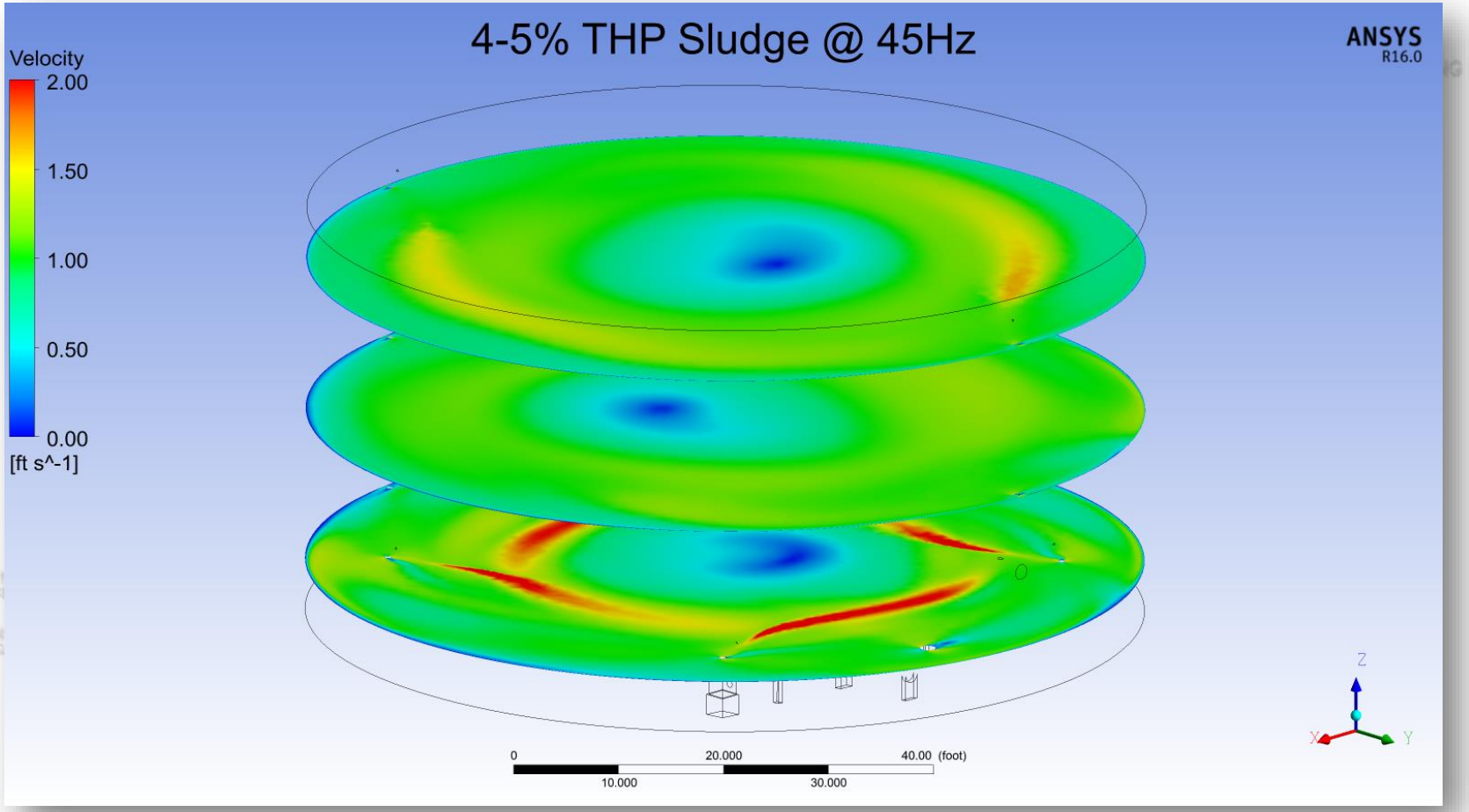
Effects on Digester Mixing Design



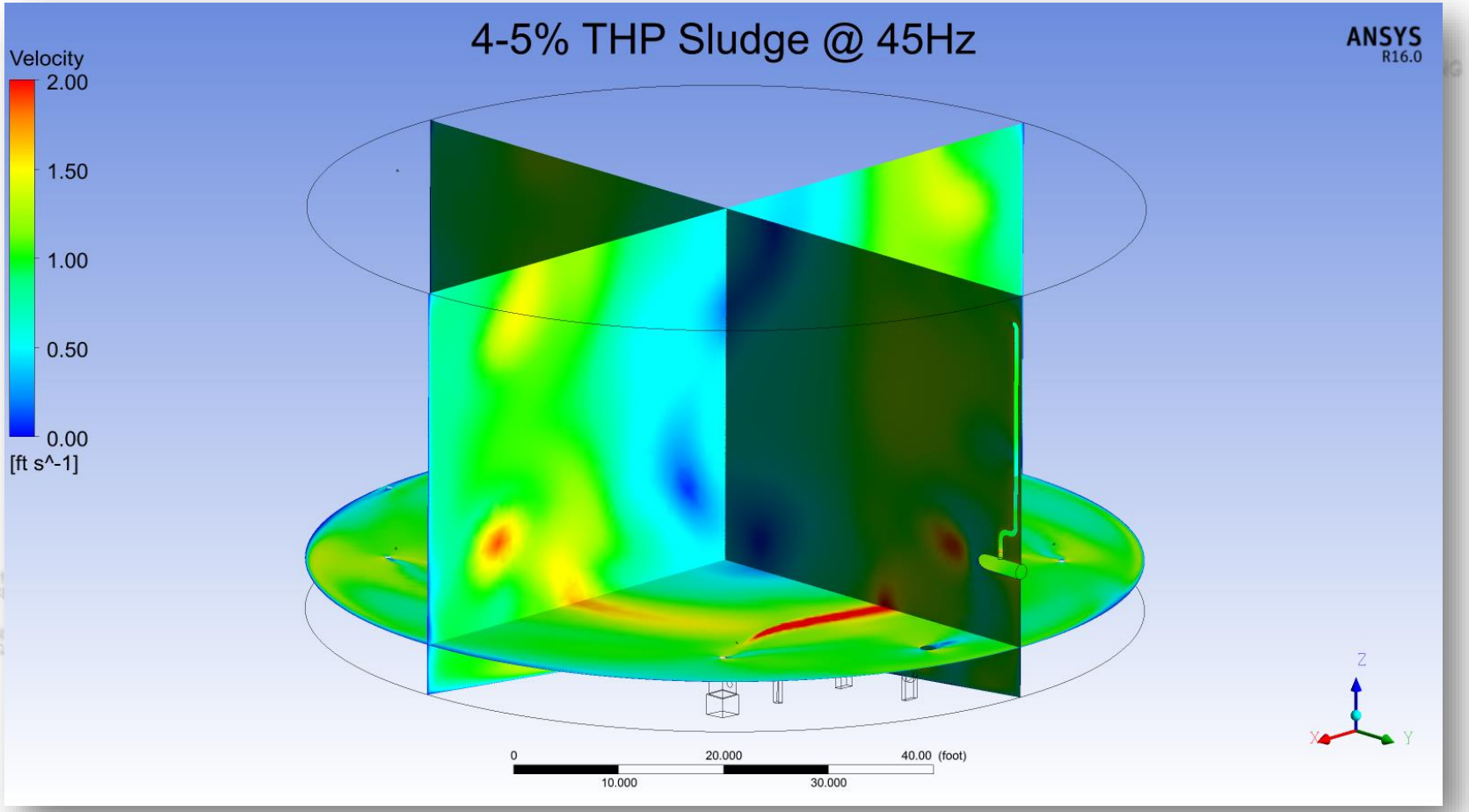
Effects on Digester Mixing Design



Effects on Digester Mixing Design



Effects on Digester Mixing Design



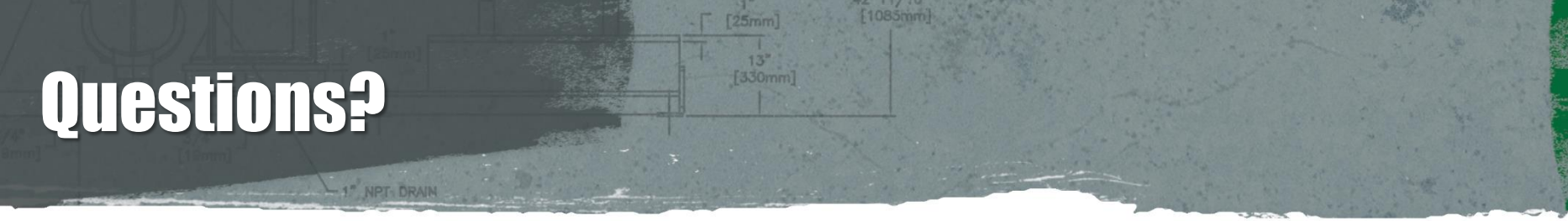
Conclusions

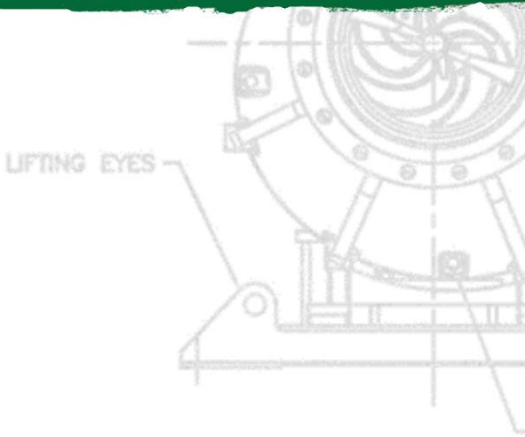
THP sludges will generally have significantly lower viscosities than conventional sludges.

This can reduce mixing energy requirements, but there are several other considerations:

- THP sludges produce biogas at an increased rate, and mixing must be adequate to enhance off-gassing and prevent rapid-rise expansion and bulking.
- THP sludges also have improved dewatering and increased settling velocities, and mixing must be adequate to prevent deposition.

Questions?





Contact Info:

Erik Larson, PE

Senior Process Engineer

erik.larson@chopperpumps.com