Screen Flow Velocity Through A Cased Hole Gravel Pack Completion

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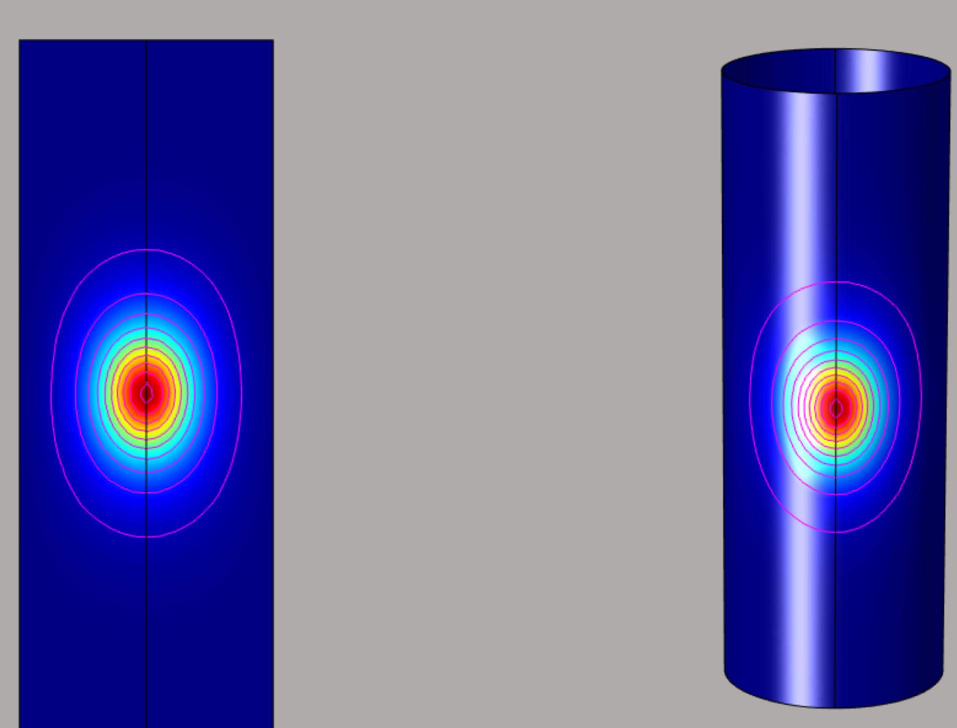
Background

- When drilling an oil well, we always want to have certain completions in place to protect the well and keep it stable throughout the its lifetime.
- A well completion consists of several different parts such as the casing, the production tubing, cementing, packings and perforations.
- Well completions can vary drastically depending on what the well is going to be used for such as productions wells, injectors and especially if they are in unconventional reservoirs.
- We are trying to find the relationship between fluid entering the gravel pack completion and the fluid impinging on the well screen.
- We want to understand what size of casings and screens would yield the least amount of damage on the screen while also providing maximum production.
- The experiments and research provided the proof of how effective a gravel pack completion can be.

Method

- We used COMSOL Multiphysics to display the simulations of a fluid entering a gravel pack completion in a cased hole and hitting the screen.
- COMSOL Multiphysics is an engineering software used to simulate and solve cross platform problems using multiphysics modeling and finite element analysis.
- We were able to get velocity readings upon impact as well as distributions of that velocity on the screen.
- In cases like this, it is very common for fluid flowing through a gravel pack and hitting the screen (a cylinder) for the velocity distribution to be sorted into ellipses.

$$Area\ of\ an\ ellipse = \pi ab$$



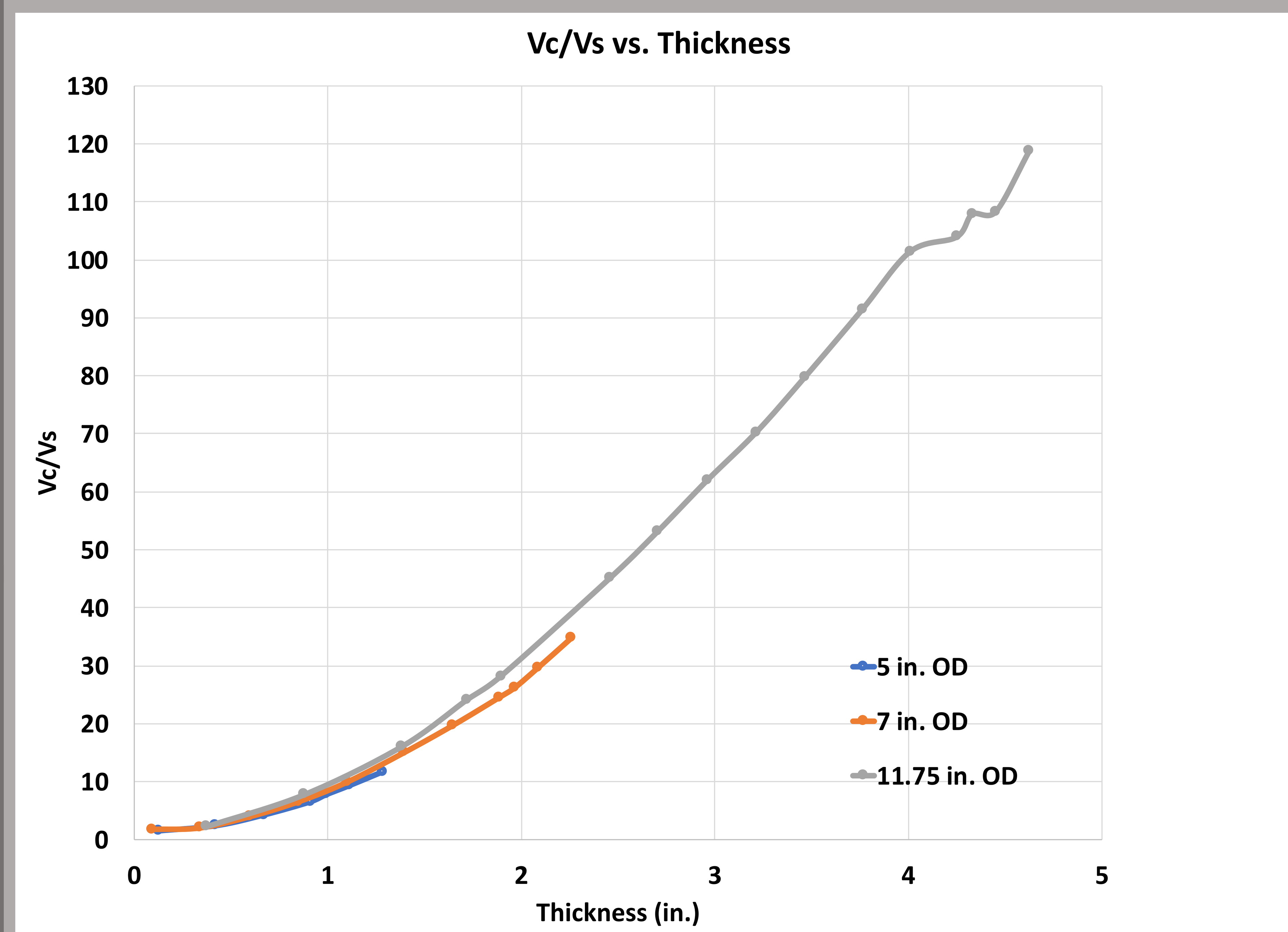
- We used the following equation to find the weighted average screen velocity of each case where A_i was the selected ellipse, V_{si} is the average velocity for that selected ellipse and $\bar{V}_s$ was the weighted average screen velocity for that case.

$$\bar{V}_s = \frac{\sum_{i=1}^{n} V_{si} \times A_i}{A}$$

- We tried to model our experiments over the most common casing and screen sizes in the industry with 5, 7 and 11.75 inch casings.

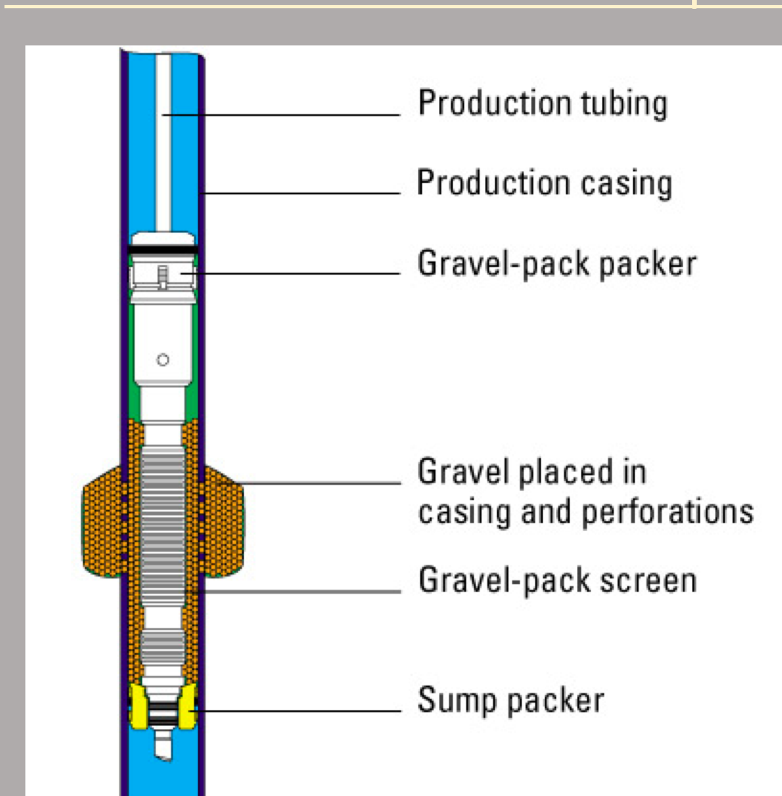
Results

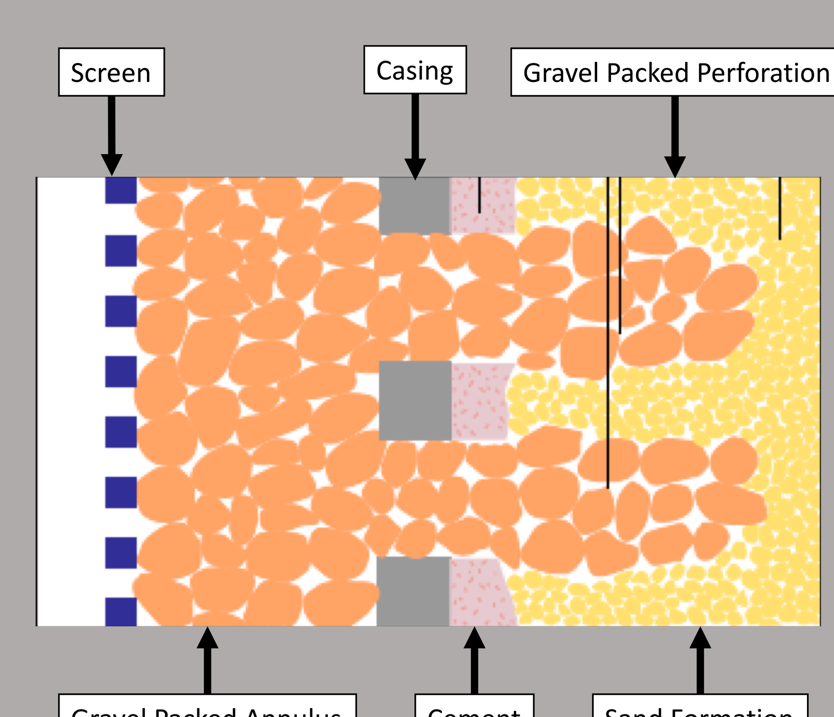
- We used a normalized value, the ratio of the velocity entering the casing to the velocity impinging on the screen (V_c/V_s), to help us be consistent with our information. It allowed us to compare data sets with different models because it took into account the same velocity that was entering the gravel pack and varied as it impacted the screen.



- The graph helped show how the term V_c/V_s was changing as the thickness between the casing and the screen changed.
- The graphs never reach 0 inch thickness because then there would be no gravel pack.
- The noise at the end of the 11.75 inch casing plot is due to rounding errors performed by the computer. When the thickness gets too large, there is minimal change in velocity values that start to become insignificant the further you move away from the center.

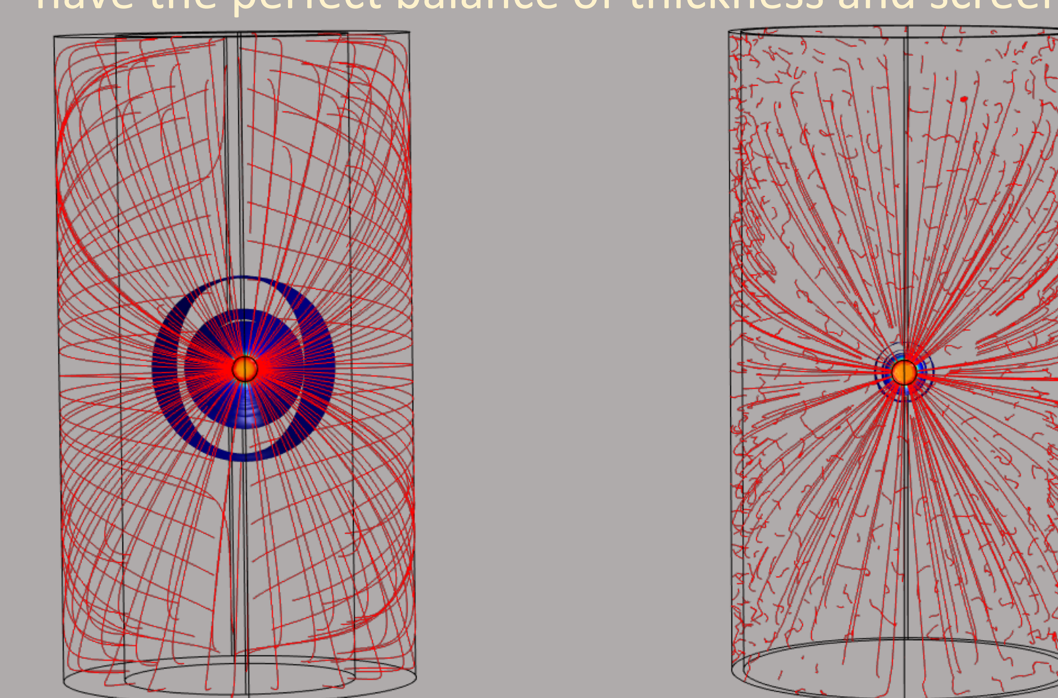
Cased-Hole Gravel Pack Completions





Discussion

- After finding the relationship between the casing velocity and the screen velocity, we were able to see how velocity decreases as the gravel pack thickness increases.
- We want to have a large thickness to decrease the velocity of the fluid and further prevent damage to the screen.
- We also want a large screen diameter so that all the fluid is hitting the screen and not going around it.
- However, large screen diameters can cause a stuck pipe. It also does not leave much room for a suitable gravel pack.
- It is a decision the team of engineers will have to decide to have the perfect balance of thickness and screen size.



Conclusions and Future Work

Conclusions

- We looked at how changing the thickness of a gravel pack can aid significantly in reducing the entering velocity into the wellbore.
- The data we gathered and the plots we produced show accurate information as our values of V_c/V_s converged to 1 as the thickness approached 0.

Future Work

- More improvements to the design of the model can further validate our sizes and simulation results.
- Additional improvements may result from using different size perforations or adding perforations.
- We could design large scale experimental tests to be done in lab settings for more realistic results.

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References

[1] Wong, G. K., Fair, P. S., Bland, K. F., & Sherwood, R. S. (2003, January 1). Balancing Act: Gulf of Mexico Sand Control Completions, Peak Rate Versus Risk of Sand Control Failure. Society of Petroleum Engineers.
[2] Gravel Pack: Schlumberger: glossary.oilfield.slb.com/Terms/g/gravelpack.aspx
[3] Gravel Pack: petroblogweb.wordpress.com/2016/09/08/gravel-pack-design/