Proceedings World Geothermal Congress 2026, Calgary, Canada, June 8—11, 2026

Numerical Model Analysis of Supersonic Ejector for Geothermal Wells at Theistareykir Geothermal Power Plant

Christine J.Groves[1], Ximena G. Muguruza[1], Yonatan A.Tesfahunegn[1], Maria S. Gudjonsdottir[1]
Reykjavik University, Iceland[1]

INTRODUCTION

Geothermal well productivity often declines over time, and some new wells exhibit low pressure from the start. This can render wells inoperable, necessitating expensive drilling [1]. The Geoejector Research Group at Reykjavik University is attempting to restore wells with ejectors by connecting the low pressure and high pressure wells to create a usable well with a higher flow rate, measured by entrainment ratio (ER) [2]. ER is defined as ratio between the secondary (5) and primary (1) inlet flows. Higher ER indicates more flow, which leads to more power production [3]. Numerical models of an industrial-scale ejector, using data from Theistareykir Geothermal Power Plant were created to test different geometries without manufacturing [3].

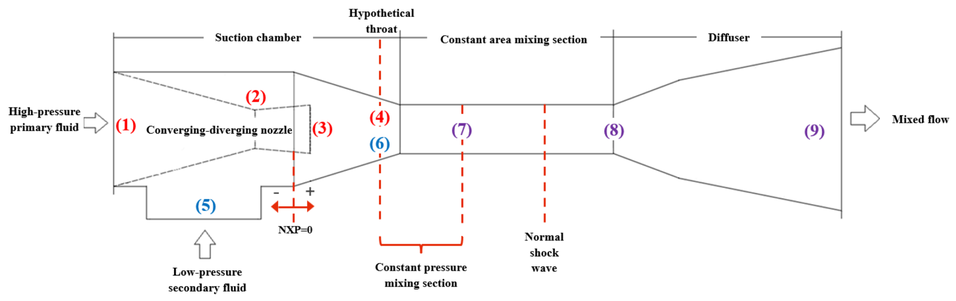


Figure 1. Labeled ejector diagram, showing the key components used for analysis.

METHODS

The internal dimensions of the industrial-scale ejector prototype, modified from previous tests [3], were used to create a 3D model of the ejector in ANSYS Fluent. Coarse, medium and fine meshes were used to determine mesh convergence. Pressure and temperature boundary conditions were specified at the primary and secondary inlets and outlet of the ejector. The standard k-e turbulence (SKE) model, pressure-based solver, and wet-steam model were used for all simulations. Once a model was validated, different nozzle positions were simulated to optimize the ER.

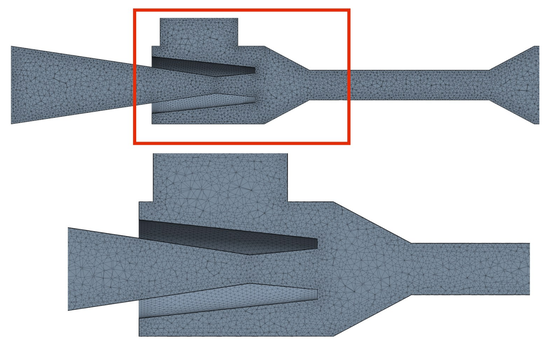


Figure 2. Fine Mesh Structure and Inflation Layers. The dark lines at the edges indicate the inflation layers used for boundary layer resolution.

RESULTS

The numerical model of the industrial-scale ejector was validated against field test data from Theistarykir Power Plant. Validation was conducted at the point of maximum ER (ER = 0.38), recorded at 13:35 hours when both inlet wells were at full pressure capacity (P1 = 28.5 Bar, P2 = 6.6 Bar) . The tested ejector had a nozzle exit position (NXP) of –17 mm, indicating the nozzle was located upstream of the converging mixing chamber. Using this validated model, a parametric study was performed to analyze the effect of varying NXP on the ER. Figure 3 presents the resulting Mach number profiles for different NXPs, while Figure 4 shows the corresponding ER curve.

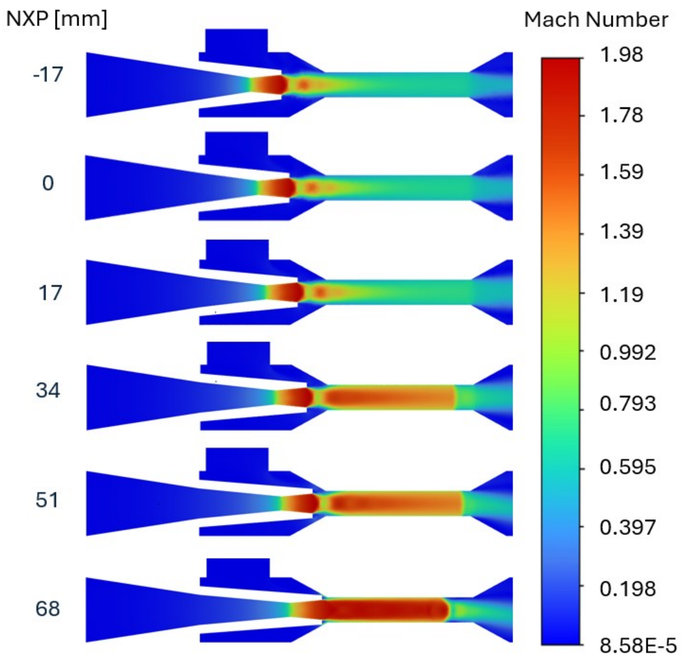


Figure 3. Mach number profiles at different simulated nozzle exit positions (NXPs).

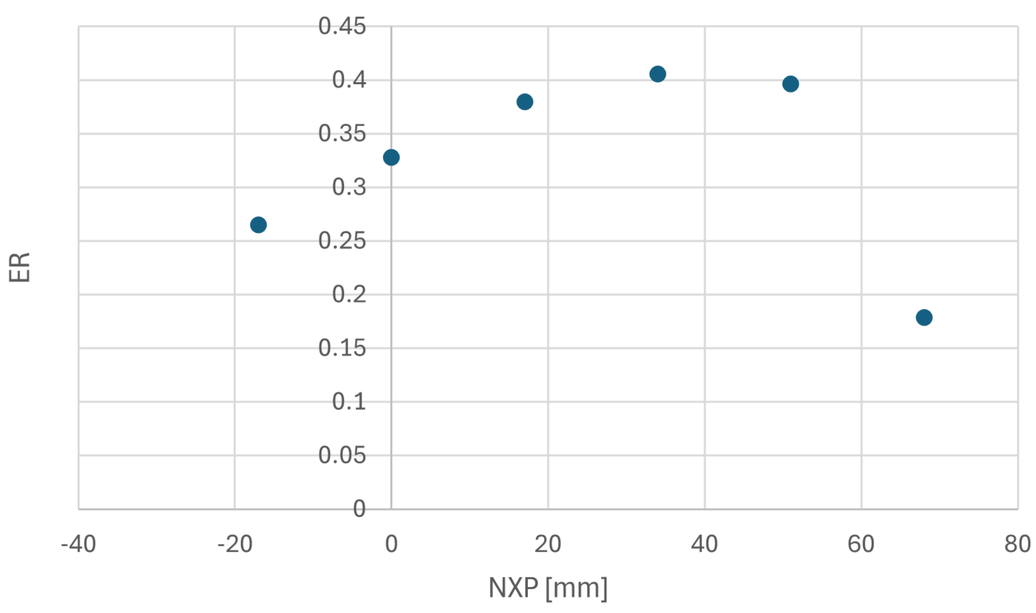


Figure 4. The entrainment ratio (ER) versus the nozzle exit position (NXP) for the Thestareykir ejector from CFD simulations (Ansys Fluent).

DISCUSSION

The Mach number profiles in Figure 3 reveal how the internal flow evolve with the nozzle exit position (NXP). At negative NXP values (Figure 5), the primary flow impinges on the walls of the converging section of the mixing chamber, increasing local pressure and hindering the entrainment of the secondary fluid. The ER reaches a maximum at an NXP of 34 mm (Figure 4), representing the ejector's optimal design condition. Beyond this optimum, further increases in NXP cause the supersonic primary flow to expand excessively within the constant-area mixing section (CAMS), leading to a blockage of the secondary fluid entrainment.

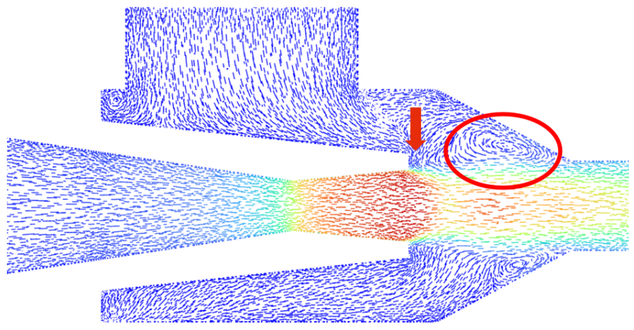


Figure 5. Velocity path lines for –17NXP, showing minimal entrainment (arrow) due to a vortex (circle) from the shock wave.

CONCLUSION

- The NXP of an ejector has a significant impact on the ER.
  - NXP < optimal value → the supersonic shock will occur too early, preventing entrainment.
  - NXP > optimal value → the mixing chamber will be blocked and the secondary flow will be unable to mix with the primary, preventing entrainment.
  - NXP = optimal value → increase entrainment, directly increasing the amount of power available from the previously unusable well.
- Numerical model improvements:
  - Turbulence model analyses
  - Examine optimized ejector and nozzle geometry and ideal operating conditions
  - Explore CFD models to allow for the simulation of more water in the flow
  - Unsteady simulations
- Additional field tests, with additional NXPs should be tested to validate results and provide additional data points for future numerical models.

Acknowledgements

I would like to thank my supervisors and the Geoejector team for all of their support and mentorship throughout this project: Maria Sigridur Gudjonsdottir, Gudrun Arnbjorg Saevarsdottir, Yonatan Afework Tesfahunegn, Ximena Guardia Muguruza, Nursanty Elizabeth Banjarnahor, Agata Rostran Largaespada, and Hugo Ernesto Quinteros Segovia. Thank you to the VOR Reykjavik Energy's Research and Innovation Fund, Reykjavik University Innovation Fund, and the Technology Development Fund from Rannis for providing funding for this project.

REFERENCES

[1] Purwaningsih F.O., Husnie R., Afuar W., and Abdurrahman G. : "Make-up wells drilling cost in financial model for a geothermal project," IOP Conference Series: Earth and Environmental Science, vol. 103, p. 012 010, Dec. 2017
[2} Gudjonsdottir M., Andal J., Guardia Muguruza X., et al., "Geoejector: Extracting geothermal fluid from a low-pressure geothermal well," in Proceedings 45th New Zeland geothermal Workshop, 2023.
[3] Muguruza X., Andal J., Larusson R., et al.: "Connecting high- and low-pressure geothermal wells using an ejector: Analysis of first field tests at the Theistareykir Geothermal Power Plant," ProceedingsWorld Geothermal Congress 2023, Apr. 2023