



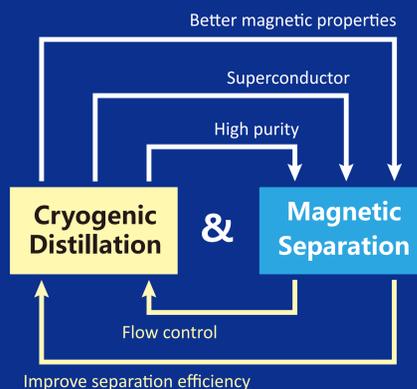
Enhancement of cryogenic distillation by the presence of gradient magnetic field

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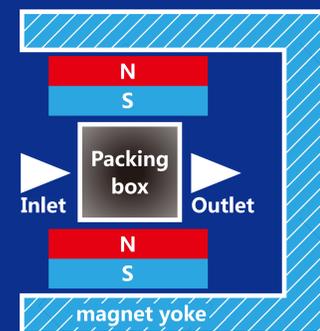
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- ◆ Cryogenic distillation mainly employs the different boiling point of species to realize separation. It's a difficult task to greatly improve the separation efficiency of such a well developed technology.
- ◆ Fortunately, oxygen is a paramagnetic substance. This unique property has been employed to measure the concentration of oxygen, promote combustion, and control convective heat transfer.
- ◆ To further improve the separation efficiency, we come to an idea of enhance cryogenic distillation by the presence of gradient magnetic field.

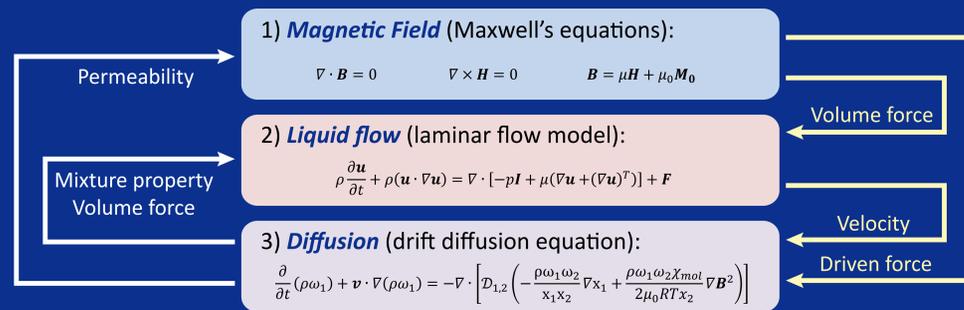
Motivation 1



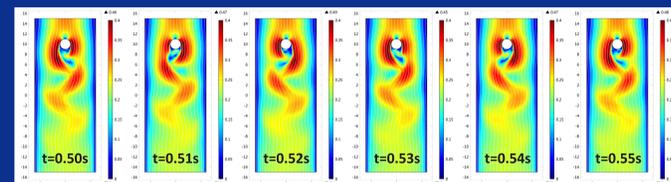
Numerical model 2



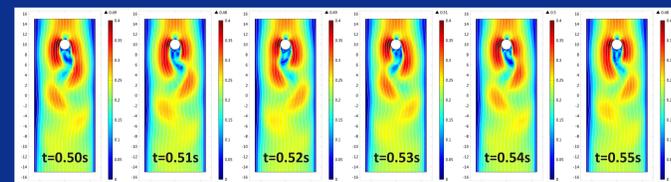
- ◆ This physical model was based on industrial magnetic separator. The fillings in the packing box struggle the magnetic induction line inside and produce a high magnetic gradient around the surface.
- ◆ In consideration of the limited concentration variation and in order to reduce the computing time, the backward coupling relations were ignored in this study.



Theoretical framework



Velocity field without magnetic force

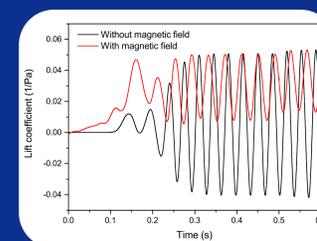
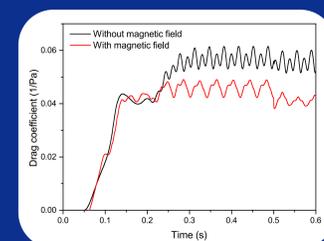


Velocity field with magnetic force

- ◆ Vortex shedding was found in both conditions.
- ◆ Non uniform magnetic force reduced the stability of flow.
- ◆ The unsteady flow may result in additional mixing in the surrounding fluid, and enhancement of mass and heat transfer on the other hand.

Result and discussion 3

- ◆ Cylindrical wire and flow channel constitute the classic problem of flow around a cylinder.



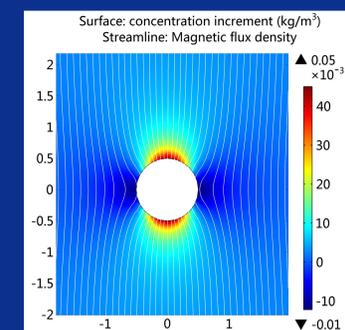
Variation of drag coefficient and lift coefficient with time

(2) Affect flow stability

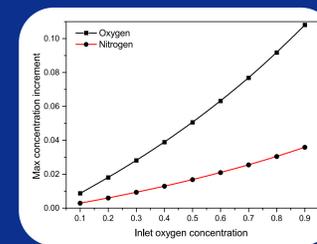
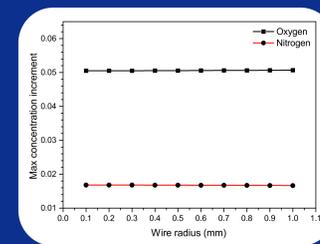
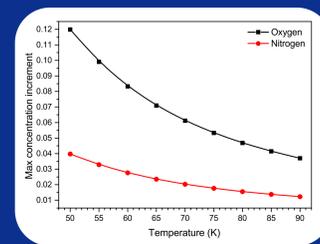
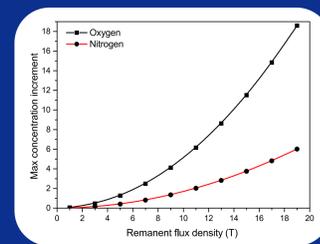
Magnet & Distillation

(1) Extra oxygen enrichment

- ◆ A higher oxygen concentration was found above and below the wire, where the magnetic field intensity was relatively high.
- ◆ The maximum concentration increased at lower temperature, larger magnetic flux density, and higher inlet concentration. Wire radius had little influence on concentration.



Oxygen enrichment around the wire

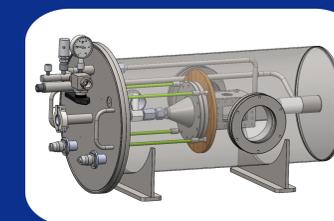


Effect of important parameters on the maximum concentration increment of oxygen and nitrogen

Conclusion 4

- ◆ A multi-physics model was developed to demonstrate the possibility of magnetically actuated enhancement of cryogenic distillation.
- ◆ The numerical simulation results reported here indicate that magnetic induced enrichment and flow can be a useful technique for controlling flow and speeding up separation during distillation.

Future work



Verification experimental setup is under construction

Reference

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