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Non-dispersive solvent extraction of *p*-toluic acid from purified terephthalic acid plant wastewater with *p*-xylene as extractant

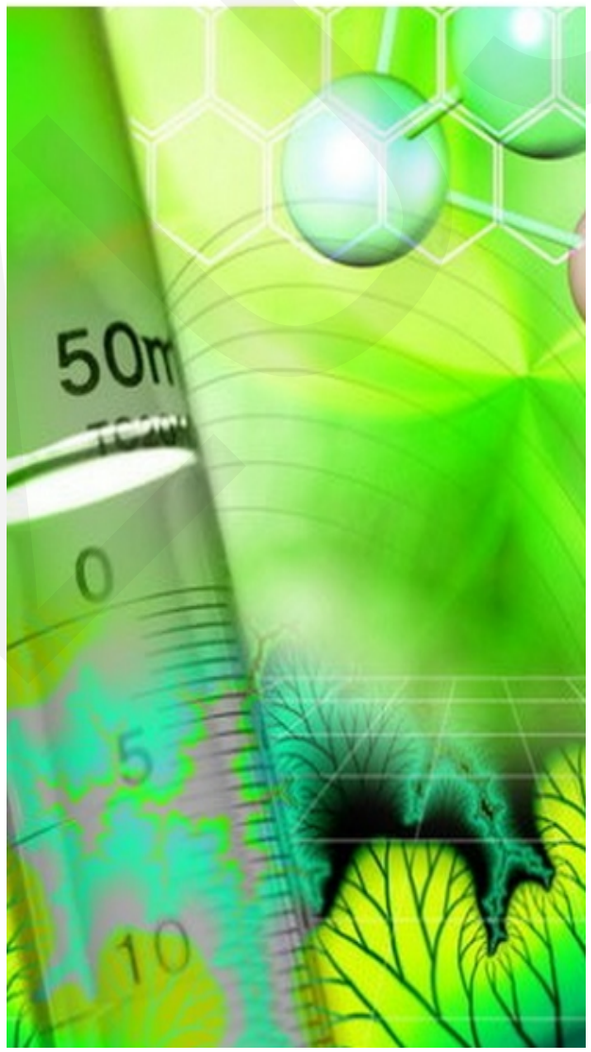
Key words:

NDSE, PTA wastewater, *p*-toluic acid, *p*-xylene, Mass transfer

Background

Side effects of PTA wastewater

- Large discharge, more than 100 million tons per year worldwide.
- Serious pollution of natural waterways.



Shortage of current wastewater treatment

- Bio-degradation, low efficiency, costly and unavailable of water re-use.
- Traditional extraction, emulsification and secondary pollution.

Non-dispersive solvent extraction

- The best choice for the extraction of PTA wastewater with following advantages.

- ➢ Wastewater re-use
- ➢ No emulsification
- ➢ Extractant re-use without purification
- ➢ Enhancement of PTA yield
- ➢ Fresh water saving
- ➢ High efficiency

Experimental demonstration

- Experiments indicate that PTA could be purified to the re-use standard under industrial operating conditions.

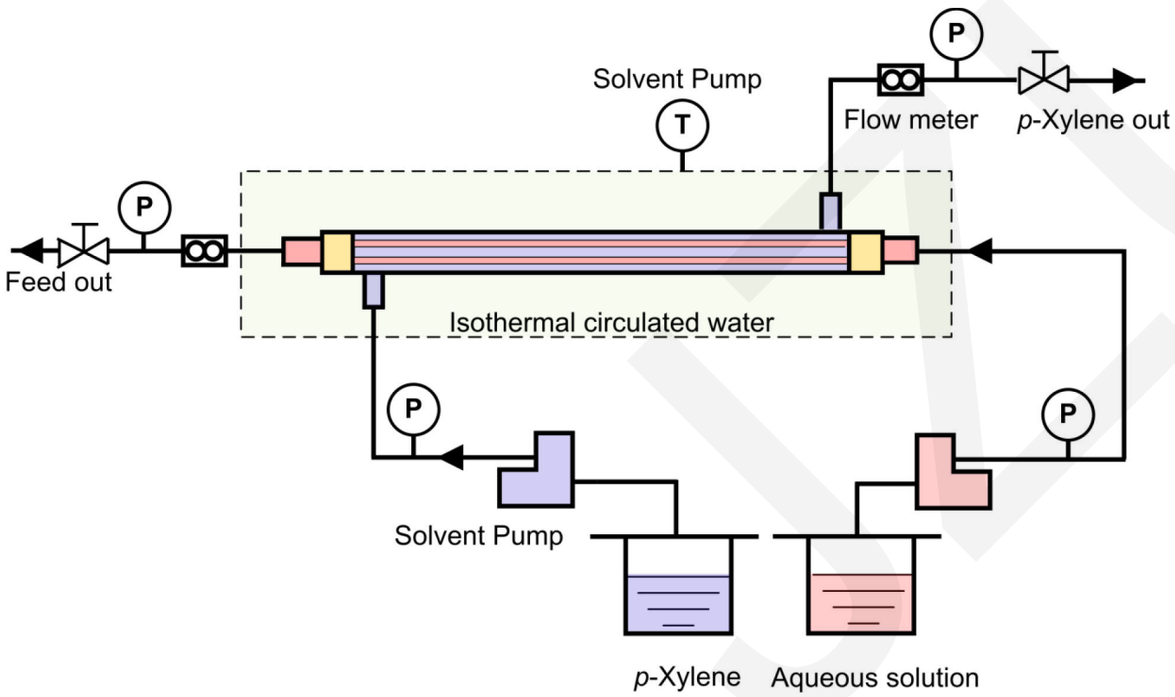


Figure 1. Schematic diagram of the NDSE experimental setup.

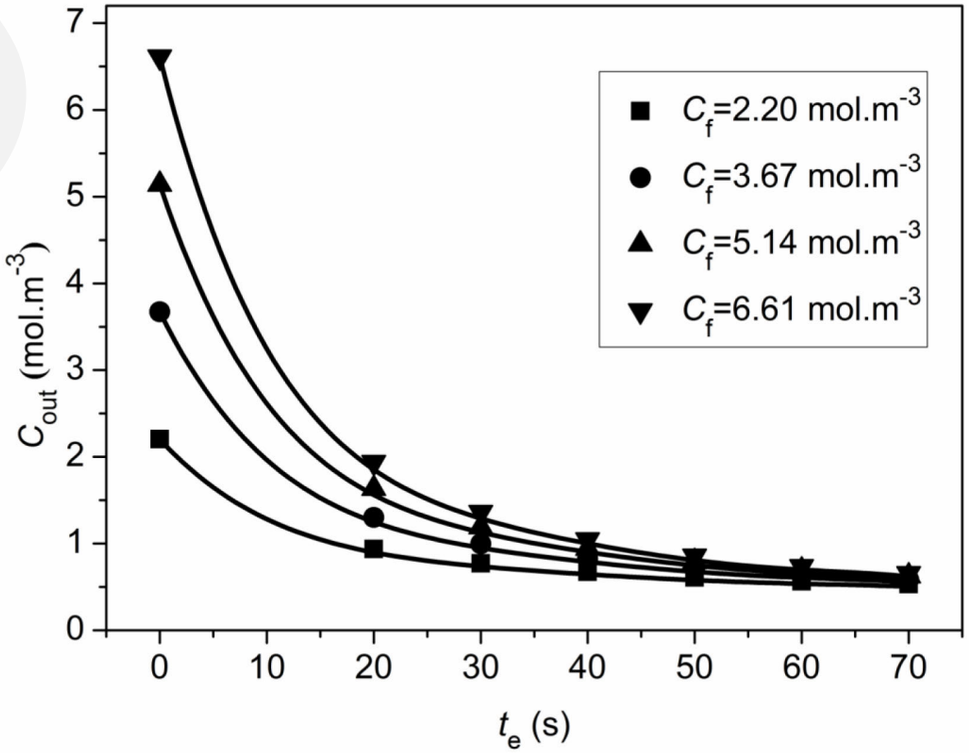
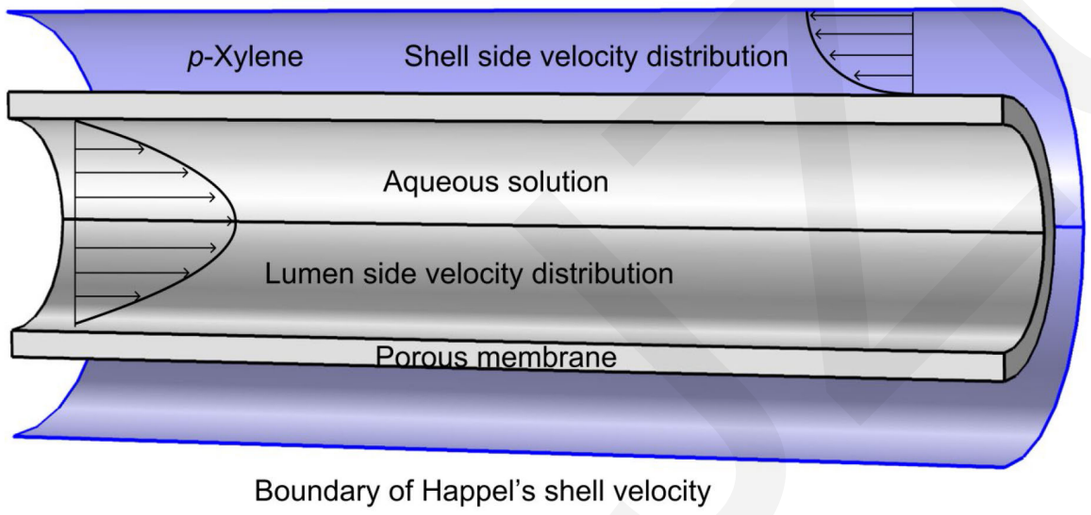


Figure 2. Experimental results of lumen side outlet PT acid concentration with various extraction time and initial PT acid concentration.

Mass transfer modeling

- The mass transfer of PT acid was modeled with relative error less than 6% of experiments.



Boundary of Happel's shell velocity

Figure 3. Transport scheme of PT acid in a counter-current flow pattern with Happel's free surface model.

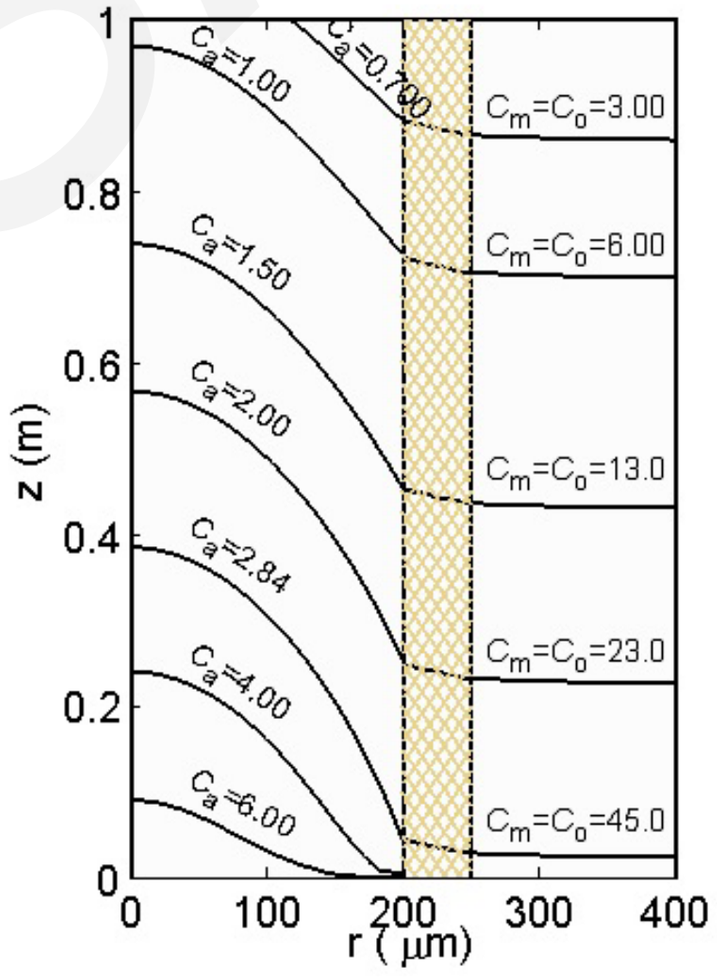


Figure 4. PT acid concentration profiles in all the sub-region. The three parts, from left to right, represent the lumen side, the membrane and the shell side.

Operating condition optimization

- Key operating parameters were optimally designed as t_e=50-60 s, *a/o*=9.0, T=318 K, r_1=200-250 μm and ε/τ=0.20-0.45.

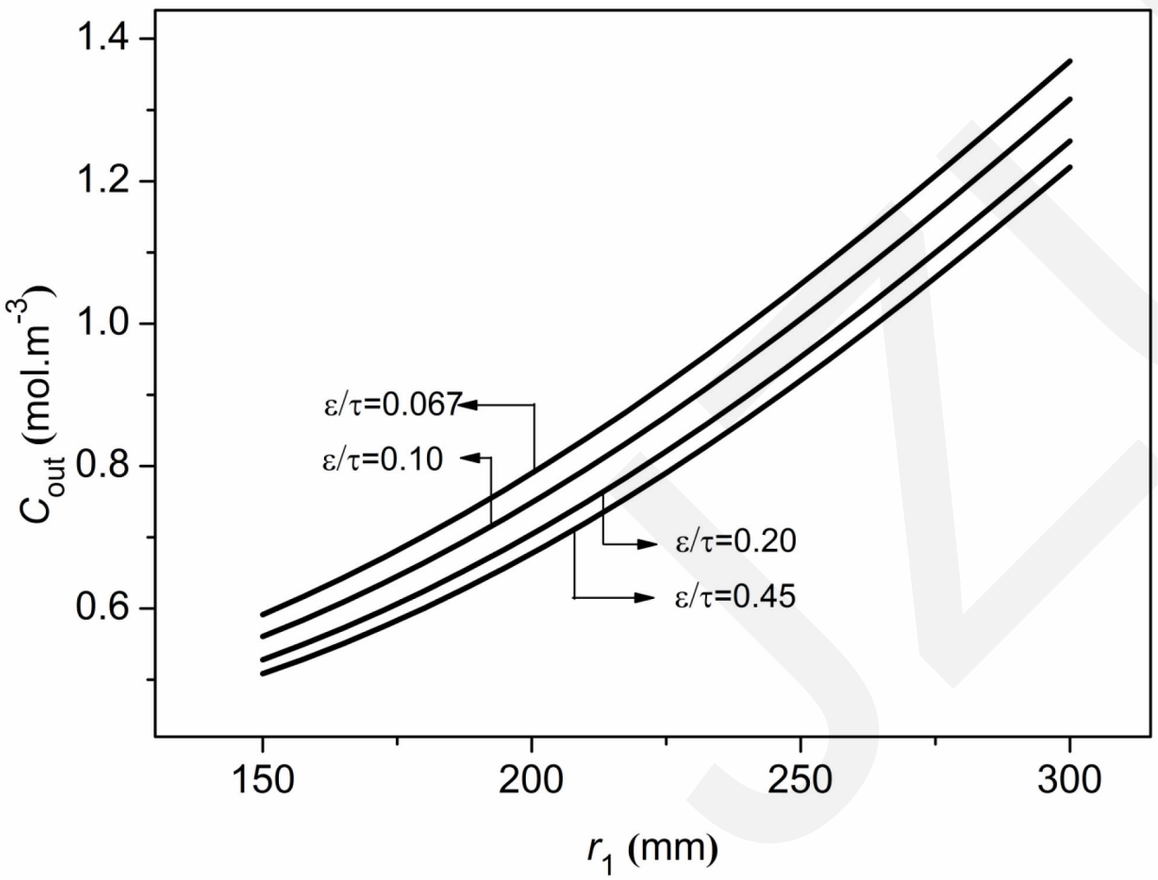


Figure 5. Effects of the fiber inner radius and porosity-to-tortuosity ratio on the aqueous outlet PT acid concentration.

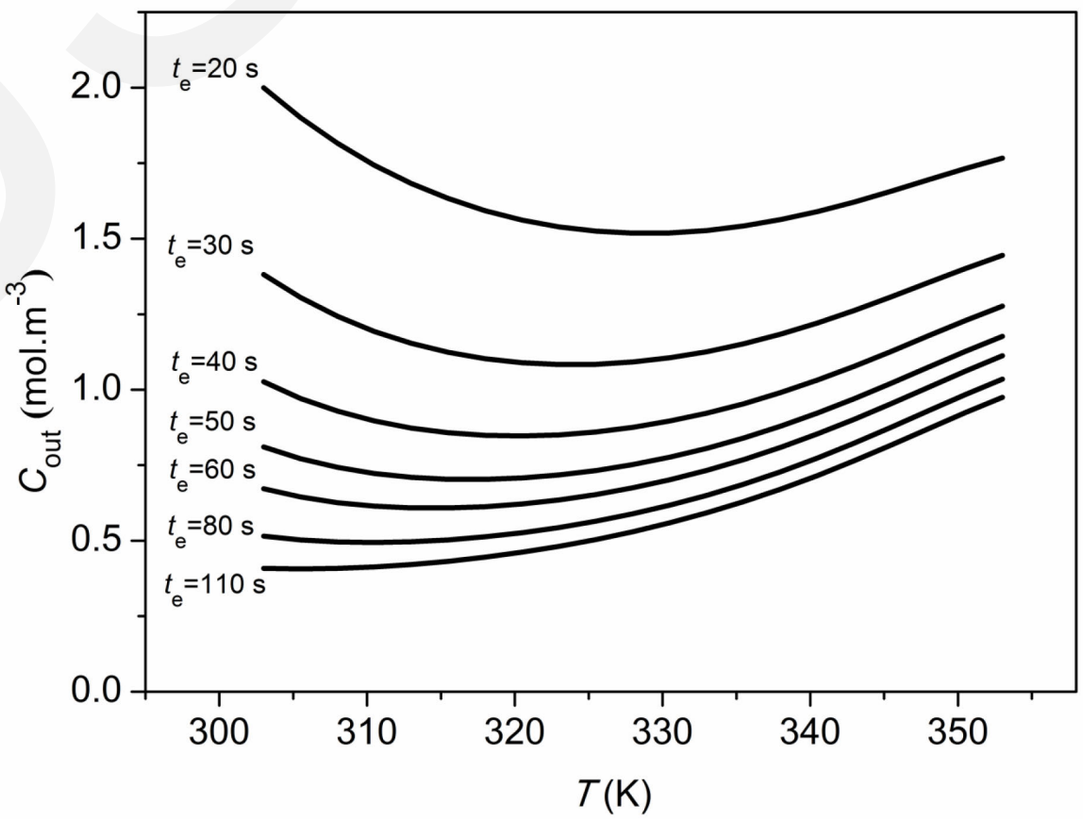


Figure 6. The effects of the operating temperature and the extraction time on the aqueous outlet PT acid concentration.

Conclusions

- NDSE to recover both PT acid and water from PTA wastewater was shown to be feasible and effective.
- The rate determining step of mass transport was found to be within the aqueous solution.
- The extraction time and fiber radius are the two parameters to PT outlet concentration is most sensitive.
- Under the optimized conditions, PTA wastewater can be purified and reused, together with PT acid recovery, with acceptable efficiencies of the membrane module and solvent.