Recovering Ammonia from Wastewater

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Stream

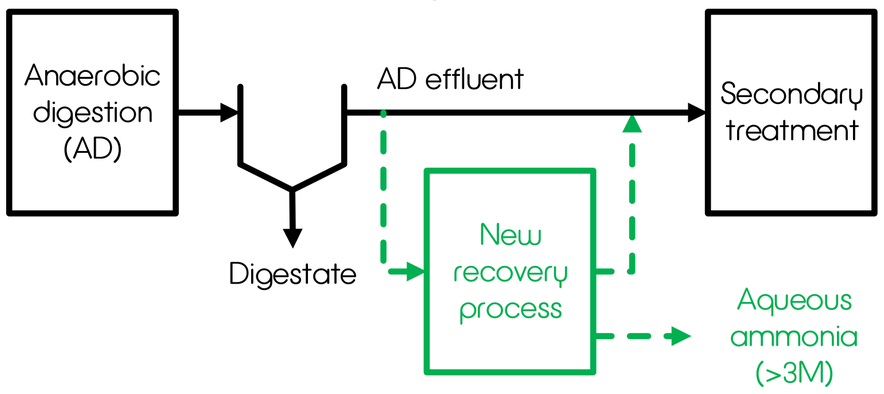
The Industrial Doctorate Centre for the Water Sector

Opportunity

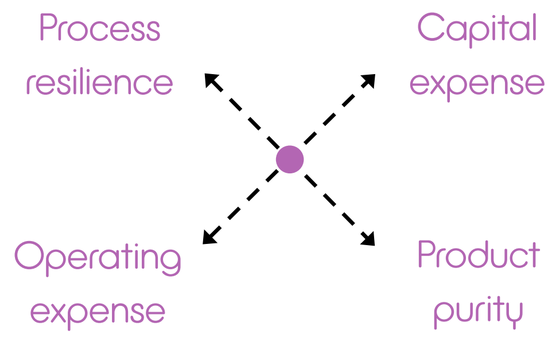
In conventional sludge treatment, excess ammonia is eliminated through nitrification which is energy intensive and expensive.

Alternatively, this project aims to recover ammonia as a valuable by-product.

Sludge treatment



Challenge: Technology selection



What is the value of ammonia?

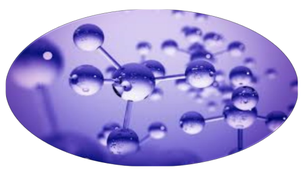
Alternative income

The market price for pure ammonia is approximately £210/tonne in 2019.

Feeding the world

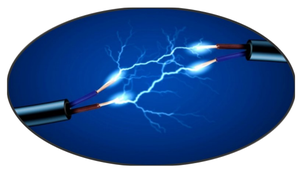
30-50% of global food is grown using ammonia based fertilisers.

Green chemistry



Recycling reduces our reliance on energy intensive ammonia synthesis.

Powering our future?



Ammonia has enormous potential as a carbon-free fuel.

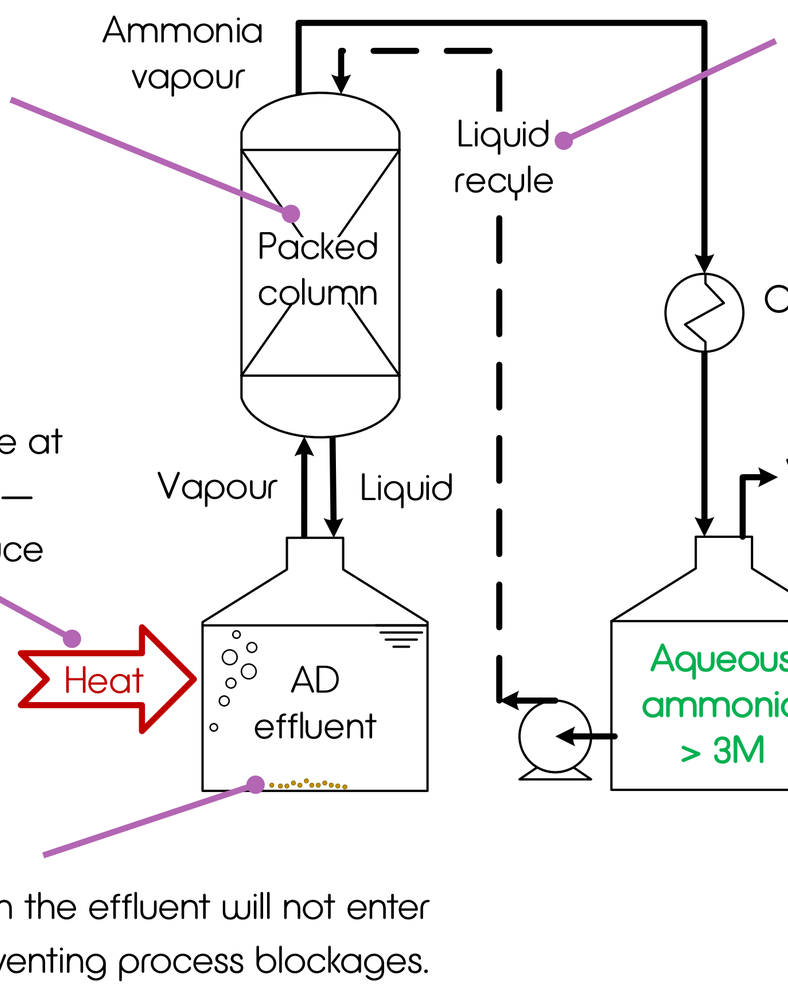
Selected technology: Vacuum distillation

Capital expense

Packing material will increase the surface area for mass & heat transfer —reducing the size & capital cost of the column.

Operating expense

Waste heat—available at most treatment plants—can be utilised to reduce heating costs.



Process resilience

Particulates within the effluent will not enter the column—preventing process blockages.

Product purity

Recycling a proportion of the liquid product back into the column will enable a high degree of concentration control.

Operating expense

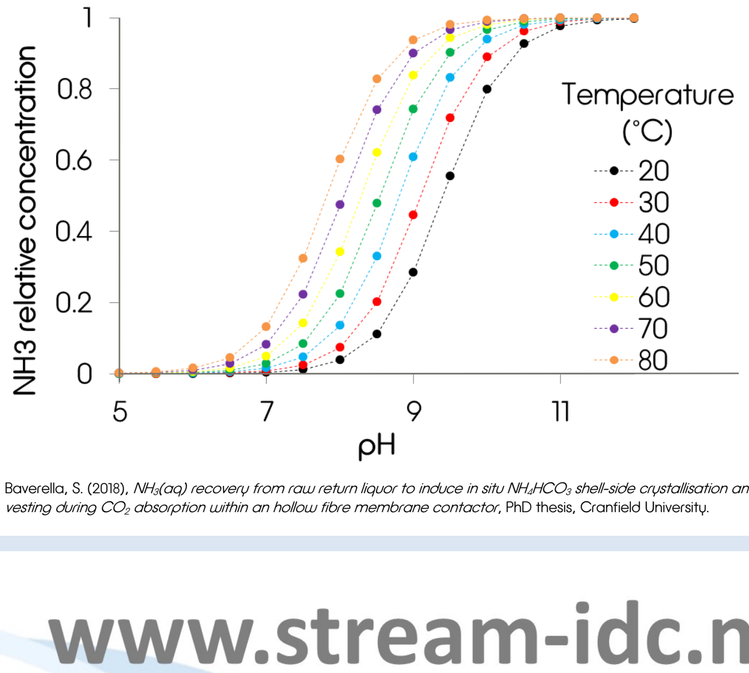
Operating the system under a vacuum will lower the effluent boiling point – further reducing heating costs.

Progress so far

- ✓ Vacuum distillation selected for the recovery ammonia from wastewater.
- ✓ Lab-scale vacuum distillation process designed & built at Cranfield University.

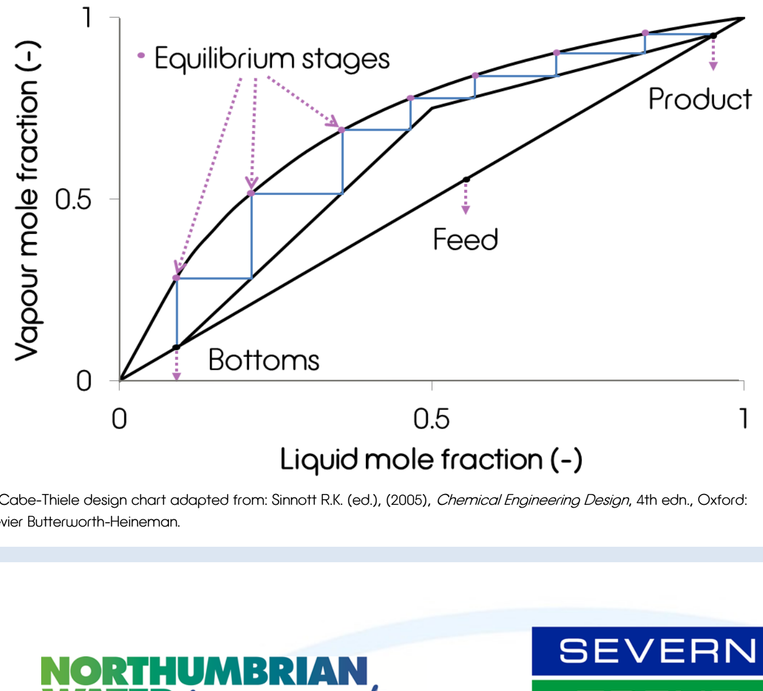
Next steps: Determine 5 key design parameters through experimentation & evaluation

1 & 2) The temperature and pH will determine the availability of free ammonia in the feed solution — directly influencing the mass transfer kinetics.



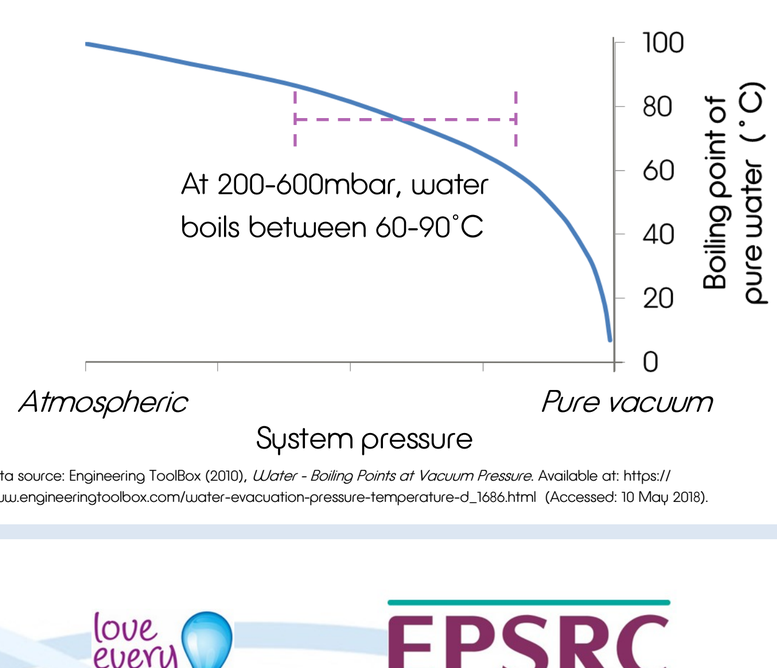
Baverella, S. (2018), *NH_3(aq) recovery from raw return liquor to induce in situ NH_4HCO_3 shell-side crystallisation and harvesting during CO_2 absorption within an hollow fibre membrane contactor*, PhD thesis, Cranfield University.

3 & 4) The column height (number of equilibrium stages) and recycle ratio will determine the purity of the final product.



McCabe-Thiele design chart adapted from: Sinnott R.K. (ed.), (2005), *Chemical Engineering Design*, 4th edn., Oxford: Elsevier Butterworth-Heineman.

5) The vacuum point will determine the economic balance between the electrical and heat energy requirements.



Data source: Engineering ToolBox (2010), *Water - Boiling Points at Vacuum Pressure*. Available at: https://www.engineeringtoolbox.com/water-evacuation-pressure-temperature-d_1686.html (Accessed: 10 May 2018).

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