Biogas upgrading using ammonia from wastewater: An energy and resource recovery nexus

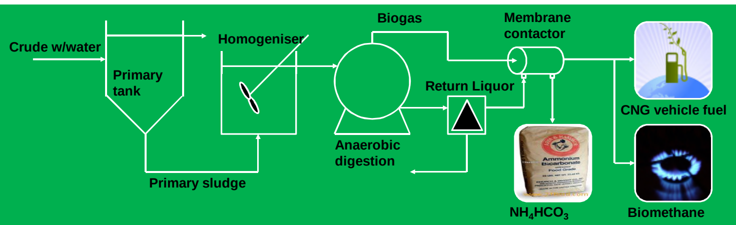
Salvatore Bavarella*, Marc Pidou*, Ewan McAdam*

*Cranfield University, UK

Stream

The Industrial Doctorate Centre for the Water Sector

Incentivisation provides a revenue of **€0.39 m^{-3}** for **biomethane** which compares to **€0.23 m^{-3}** for using biogas to produce electricity. Water utilities are now investing in biogas upgrading facilities for biomethane which must achieve methane quality **(>95%)**



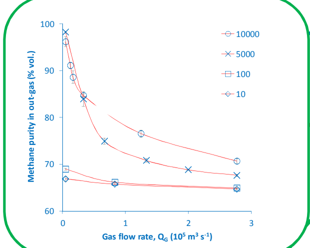
Hollow fibre membranes intensify processing, and allow contact between ammonia rich liquors and biogas. **Ammonia** and **CO_2 react**, increasing CO_2 flux. A **crystalline** reaction product, **ammonium bicarbonate**, is grown to recover ammonia as a **fertiliser**

Benefits

Mechanism

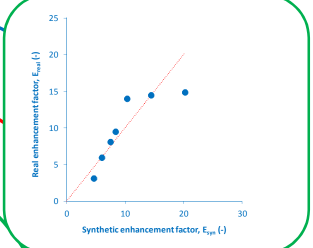
Process

Biogas quality

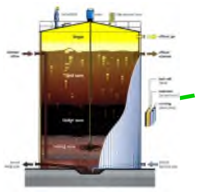


Methane in treated biogas exceeds 98% through facilitating enhanced CO_2 separation

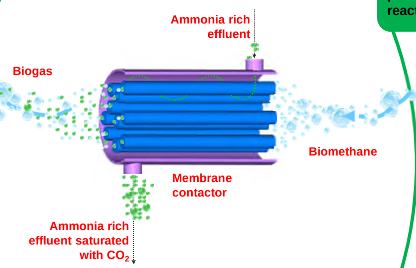
Sustainable chemistry



Real ammonia rich liquor provides same chemical reactivity as synthetic

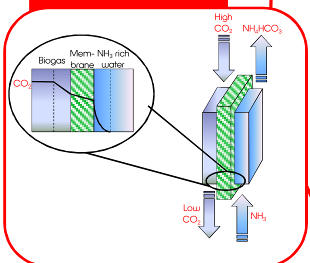


Biogas production from sewage sludge



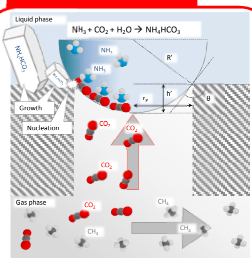
Biomethane replaces natural gas

Chemisorption



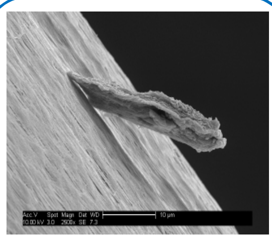
The micro-porous membrane enables non-dispersive chemical absorption, enhancing CO_2 flux

Crystal nucleation

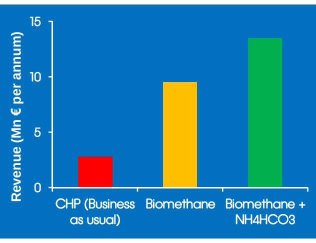


Supersaturation occurs at the gas-liquid interface nucleating crystal growth at membrane pores

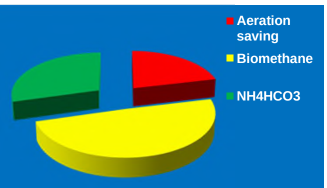
Fertiliser production



Crystalline product ammonium bicarbonate is formed – fertiliser with a resale of €150 tonne^{-1}



Gas/liquid hollow fibre membranes provide greater **process intensification** than existing biogas upgrading processes. Ammonia rich liquors provide a **sustainable chemical** source for chemisorption which further enhances intensification, whilst simultaneously producing a marketable **fertiliser** product and **treating return liquors** for ammonia. The net impact is around a **500%** increase in potential revenue



Contributions to revenue enhancement

Sponsored by: EPSRC, anglianwater, Northumbrian Water, Severn Trent Water

www.stream-idc.net

EPSRC Engineering and Physical Sciences Research Council

For further information: s.bavarella@cranfield.ac.uk
Postal Address: Cranfield Water Science Institute, Cranfield University, MK43 0AL, UK