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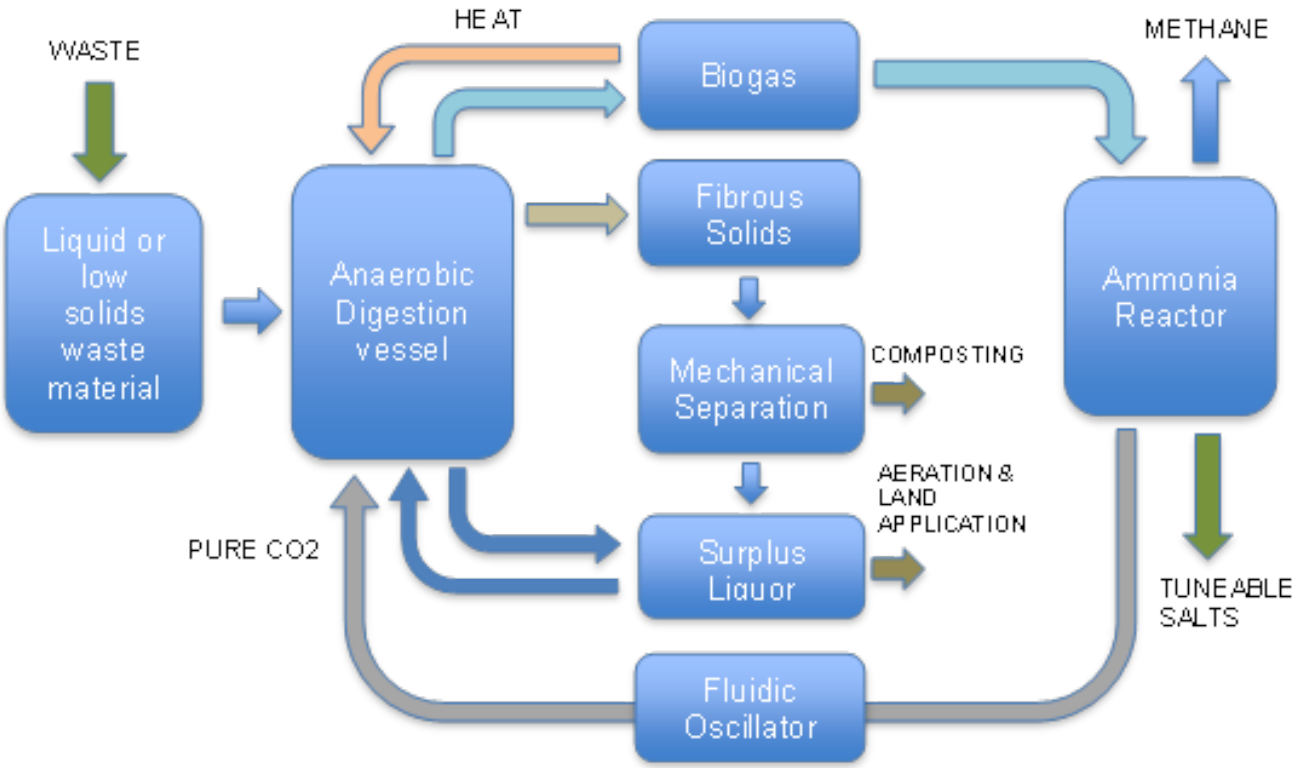
Desai-Zimmerman Anaerobic Digestion (DZAD) Cycle – Sustainably Intensified Anaerobic Digestion with Novel Biogas Sweetening

The DZAD is a process based on two major innovations:

1. Process Intensification by periodic CO_2 microbubble injection (preliminary underpinning academic study found here) developed by Zimmerman *et al.* – results in approximately 110% improvement in rate of biogas yield
2. Novel Microbubble mediated Biogas Sweetening developed by Desai and Zimmerman that results in a room temperature, atmospheric pressure, sans catalyst, and exothermic conversion into tuneable ratio of precipitated salts of ammonium carbonate/carbamate (can be stopped prior to precipitation).

The cycle is illustrated below



The entire cycle results in a reduction of the process return on investment by reduction in capital expenditure and operational expenditure. The process enhancement increases the rate of biogas production resulting in a reduction in capital expenditure by reducing the plant size required for the same throughput. However, this is not responsible for the majority of the reduction in the payback period.

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The major advantage is due to the combined cycle and the use of biogas sweetening which results in the following products:

a. Heat – exothermic process which can be used for maintaining the temperature for the AD
b. Precipitated tuneable ratio of salts of ammonium carbonate and carbamate with 70% conversion per pass (up to 95% conversion per pass and up to 9:1 tuneability ratio) –which is an excellent and portable fertiliser or compost additive – a valorised product.
c. Methane – the biogas has now been sweetened to form enriched methane which has a much higher calorific value than biogas and additionally have increased value and potential upgrading to other compounds.
d. Slurry – can also be used as a fertiliser and mixed with compost for additional nutritive value.

Ammonium carbonate and Ammonium carbamate are excellent fertilisers in their own right. Carbamate salt can be converted to urea which is the most important nitrogen based fertiliser used globally. Generating the carbamate at room temperature and pressure as well as without catalyst is a major advantage as it is a covalent bond and results in the possibility for organic chemistry with CO_2.
If carbonate salts are preferred, high ratios of carbonate salts can be tuned specifically.

The team of Desai (Perlemax), Zimmerman (University of Sheffield) , and Thomas (Viridor) were highly commended in the ADBA global awards for best Research Project category for their Energy Catalyst Round 5 Project.

Desai is now leading a £1.5 Mn grant for the Energy Catalyst Round 6 Award as Perlemax with Zimmerman as PI from the University of Sheffield. This project will involve a larger scale ($50m^3/day$) system and involves partners from India and the UK.
This process has a few other important innovations –
The ammonia is to be sustainably sourced from landfill leachate or digester centrate. These waters contain between 300ppm- 10,000 ppm of ammonia. Remediating this ammonia to bring it down to consent limits is an expensive process and destroys the ammonia. Sourcing the ammonia from these systems can be possible via microbubble stripping pioneered by Desai and Zimmerman. This is performed in a cost effective manner and converts the process by reducing the liability by £8-£16 per m^3 treated liquor.
The ammonia off gasses are to be converted into higher value chemicals including heterocycles (examples seen here in work with Prof. Harrity and TUoS).
The DZAD reduced the payback period from 8 years to approximately 3.5 years. The higher value heterocycles will likely decreases the payback period to 1.8 years.
The reduction in the ammonia liability increases revenue due to savings and therefore results in revenue based operation of this cycle (based on the site and savings with the methods).
This modified DZAD cycle is a form of 'Waste Factory' or Desai-Zimmerman Microbubble Mediated Ammonia Recovery Processes - DZ MMARP as seen here.

For more information, please contact info@perlemax.com