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FACULTY OF BIOSCIENCE ENGINEERING

Nutrient and energy recuperation from digestate

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WHY RECOVER NUTRIENTS AND ENERGY?

Europe is facing with various environmental problems, among which increased dependency on fossil fuels and disturbing unbalance of nutrient redistribution, are focus points of Europe 2020 energy objectives. Therefore, solution is needed, and possible solution will be provided by two European proojects, ARBOR (INTERREG IVB) and INEMAD (FP7). Both of this projects, are focused on the foster and accelerate use of biomass (e.g. energy crops, manure/digestate, VFG, …).

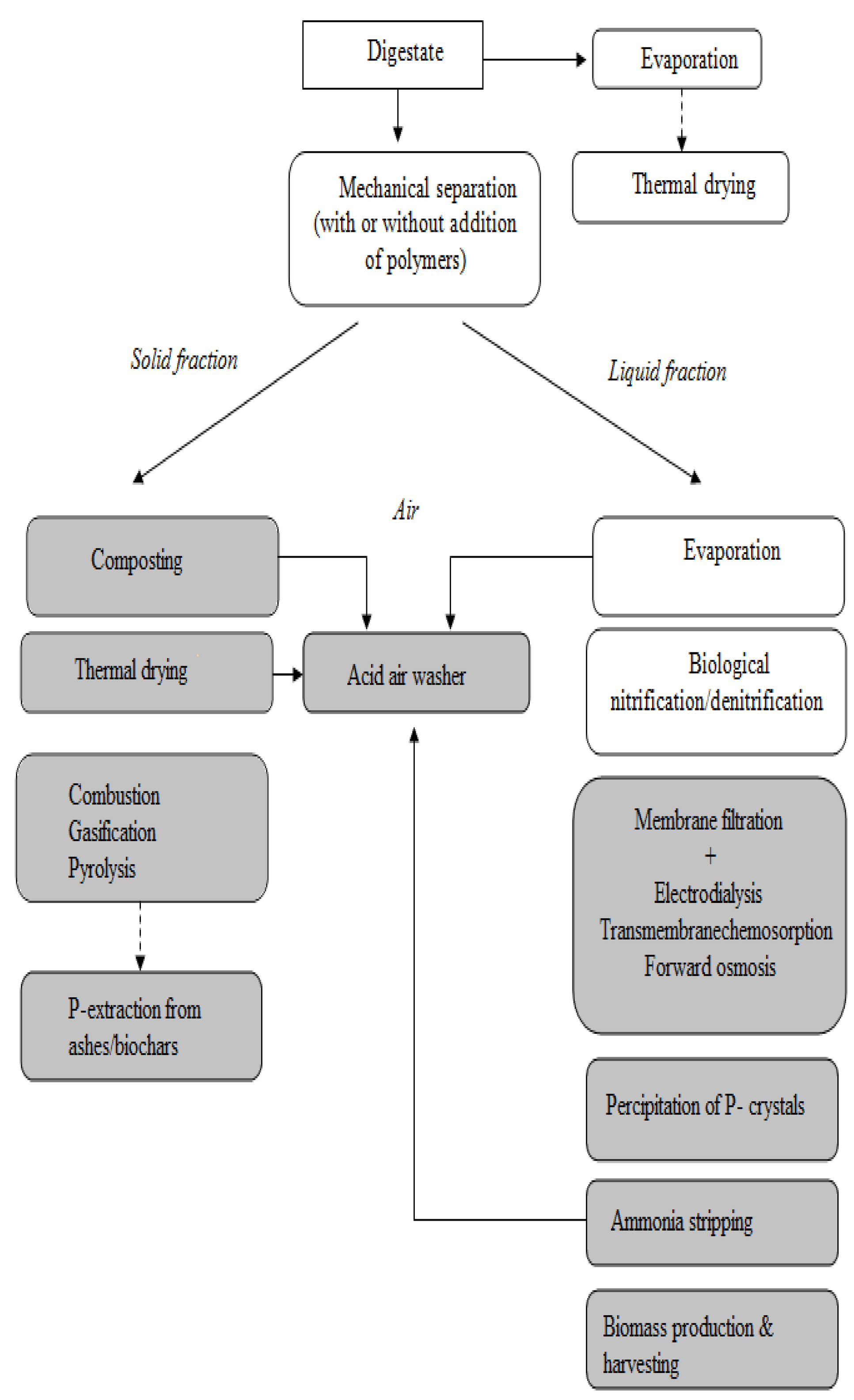
While ARBOR is aiming on improving the sourcing of biomass materials and efficiency of biomass conversion in North West Europe, INEMAD is trying to reconnect livestock and plant production on the European level, through improved nutrient and energy management. Special focus is on nutrient and energy recuperation from digestate. Efficient use of, biomass (i.e. manure/digestate) could lead to higher production of alternative fuels (i.e. biofuels) which would decrease the current increasing dependency on fossil fuels. At the same time effficient use of digestate could offer a solution to phosphorus depletion and help nutrient- rich areas to manage their nutrient surplus through applying different nutrient recovery techniques.

NUTRIENT AND ENERGY RECUPERATION FROM DIGESTATE

- Digestate = valuable by-product (together with biogas) of anaerobic digestion that contains the non-digested resilient organic fraction, water, micro- and macro- nutrients.
- Composition depends strongly on ingoing streams (digestate contains 80% less organic matter than the ingoing streams)
- Organically bound N is released as NH_4^+ → directly available for crop uptake

DIGESTATE CHARACTERISTICS

PARAMETER		*AVERAGE VALUE*
Dry matter	Decreases due to organic matter decrease. More cattle/pig slurry → lower DM-content	9%
Total N	Constant during digestion. More pig slurry → more N	5 kgN/ton (+m)3 kg N/ton (-m)
Mineral N	Increase due to organic N → NH_4+ More organic waste → lower share of NH_4+	44 –47% up to 82% (100% pig slurry)
pH	Increase due to decomposition volatile fatty acids. Less dependency on input streams.	8.3
Phosphate content	Constant during digestion. More pig slurry → more P	4 kg P_2O_5/ton (+m)3 kg P_2O_5/ton (-m)
Heavy metals & impurities	Constant. Can be problematic for Zn and Cu in pig slurry. Inactivation of weed seeds & pathogens depends on T & residence time	-



- Nutrient recovery techniques separate NPK from OM
- Result of mechanical separation → P nutrient-rich solid fraction and NK nutrient-rich liquid fraction
- Depending on the wanted end- product, different nutrient techniques are applied → result: end-product with a higher concentration of NPK than raw digestate

END-PRODUCTS

TECHNIQUE	STARTING FROM	END-PRODUCT
Composting	SF digestate	P- fertilizer (compost), CO_2, H_2O + possible NH_3 and GHG emissionss
Thermal drying	SF digestate or digestate	P- fertilizer (solid fraction) or NPK-fertilizer (digestate), NH_3 and condensate
Pyrolysis	Dried SF of digestate	Biochar, biocrude oil and syngas (mixture of CO_2, CO, CH_4, H_2 and N_2, as well as S-containing gases) + possible emissions of GHG
Gasification	Dried SF of digestate	Biochar (P-fertiliser) and syngas (CO_2, CO, CH_4, H_2 and N_2) + possible emissions of GHG
Combustion	Dried SF of digestate	P nutrient - rich ash, heat & power + possible emissions of GHG
P-extraction	Ashes/biochar/SF digestate	Acid P-extract/$CaHPO_4$
Acidair washer	Air charged with NH_3	$(NH_4)_2SO_4$solution
Reversed osmosis	UF/MF/DAF-permeate	RO-concentrate (NK-fertiliser)
Forward osmosis	UF/MF/DAF-permeate	FO-concentrate (NK-fertiliser)
Electrodialysis	LFdigestate	NK-fertiliser
TMCS	LF filtered on 10 μm	NK-fertiliser
P-precipitation	(LF)digestate	$MgNH_4PO_4/MgKPO_4/CaNH_4PO_4$
NH_3-stripping& acid air washer	LFdigestate	$(NH_4)_2SO_4$ solution
Biomass production	Diluted LF digestate	Biomass

FUTURE PERSPECTIVES : REPLACEMENT OF MINERAL FERTILIZERS WITHIN GREENHOUSE CROPS

Awareness of increasing artificial fertilizer use :
- Energy consuming
- Economical burden for farmer

- Field experiment (greenhouses 2x 400 m^2)

Replacement will be done by 4 type of products:
(1) Struvite (P)
(2) Liquid fraction of digestate (NK- fertilizer)
(3) Ammonium sulfate (air scrubbing or stripper)
(4) Urea (derived from pig urin)

- Experiment will start mid of May 2013, and last for 7 weeks
- Test plant (lettuce (*Lactuca sativa*) / bean (*Phaseolus vulgaris*)

END-PRODUCT THAT CAN SUBSTITUTE ARTIFICIAL FERTILIZER **OR** AS A FEEDSTOCK IN INDUSTRIAL PROCESSES

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