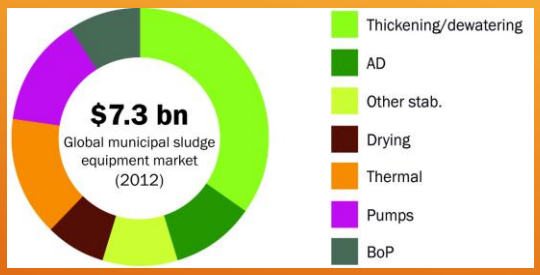
Activated sludge: 100 *plus* 1 years - New trends and perspectives

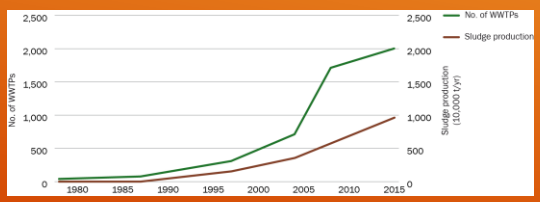
OPTIMIZATION OF SLUDGE TREATMENT IN WWTPS TO REDUCE ENERGY CONSUMPTION AND GHG PRODUCTION

ludovico.pontoni@unina.it

Università degli Studi di CASSINO e del LAZIO MERIDIONALE

Sludge Management – a global issue



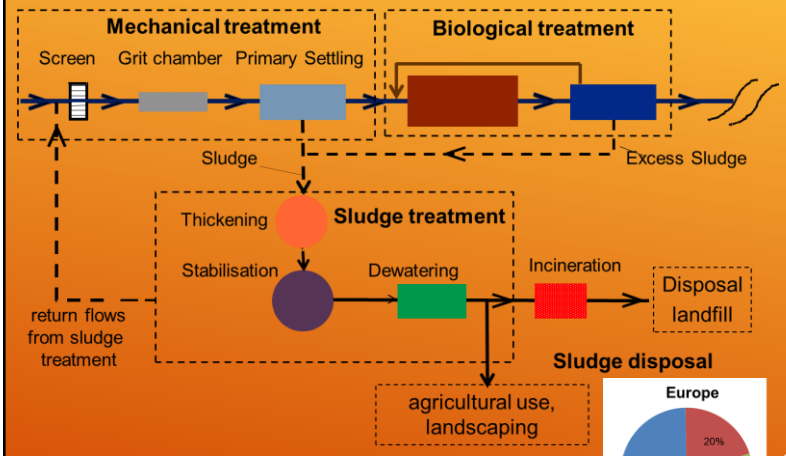


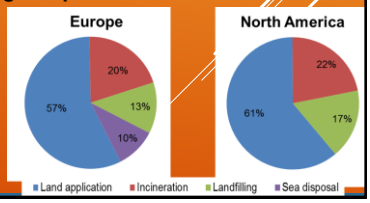
Sludge management contributes up to 50% of the total costs of WWTPs
Spinosa e Vesilind, 2001

> "Sludge is the final frontier of water and wastewater treatment. Every other area of the water sector is essentially a mature market addressed by mature technology."

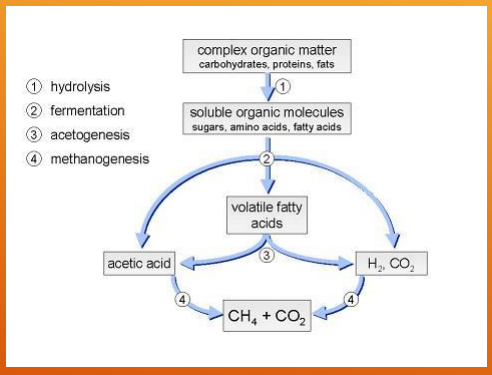
Global Water Intelligence (2012)
Sludge Management: Opportunities in growing volumes, disposal restrictions and energy recovery

Sludge treatment and disposal





Sludge treatment through anaerobic digestion (AD)



GHGs balance from anaerobic stabilization

Direct GHG Emissions from

- Exhaust gas from Biogas valorization
- Accidental biogas release from safety valves of the digester due overpressures (rare)
- Biogas loss from sludge and digestate storage

Indirect GHG Emissions from

- Use of chemicals for sludge conditioning prior to dewaternig
- Energy required for digested sludge dewatering
- Energy required for eventual advanced sludge treatment
- Digestate transportation and disposal (landfilling, incineration, soil spreading, etc…)

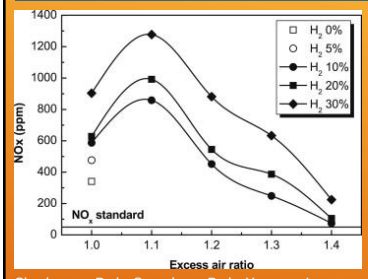
Overall GHGs emission are reduced
Optimizing

- Energy recovery by biogas valorization – Sludge BMP
- Dewatering properties of the sludge
- Quality of digested sludge
- Recovery of nutrients (N,P)

Preventing

- Accidental emissions
- Anaerobic digestion unbalances

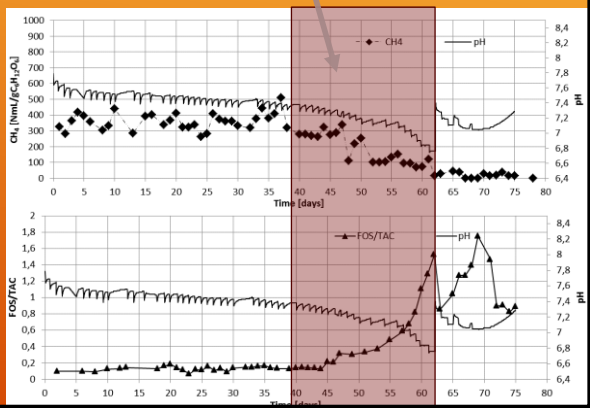
Effect of AD unbalances on GHG emissions



Cheolwoong Park , Seunghyun Park , Yonggyu Lee , Changgi Kim , Sunyoup Lee , Yasuo Moriyoshi
Performance and emission characteristics of a SI engine fueled by low calorific biogas blended with hydrogen
International Journal of Hydrogen Energy, Volume 36, Issue 16, 2011, 10080 - 10088

Ludovico Pontoni, Antonio Panico, Ernesto Salzano, Luigi Frunzo, Paola Iodice, Francesco Pirozzi
Innovative Parameters to Control the Efficiency of Anaerobic Digestion Process
Chemical Engineering Transactions, Volume 43, 2015 – In Press

Potential Hydrogen production Interval



Materials

Massa Lubrense – Marina del Cantone **(MBR1)**

Capri – Occhio Marino **(MBR2)**

Nola **(CAS1)**

Massa Centro **(CAS2)**

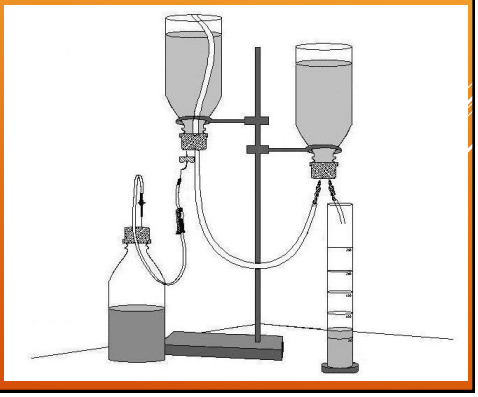
	HRT [h]	Flow rate [m^3/h]	SRT [d]	COD [mg/L]	N-NH_4^+ [mg/L]	Membrane
MBR1	20	12	30	450	40	Hollow
MBR2	24	65	35	350	35	Plain
CAS1	7	3300	40	310	22	-
CAS2	18	100	15	350	35	-

Methods (I) BMP – batch tests

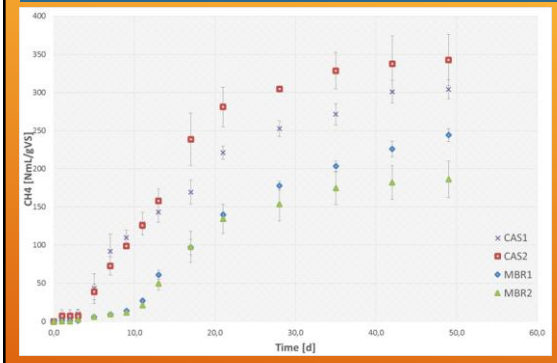
Sludge preparation and characterization

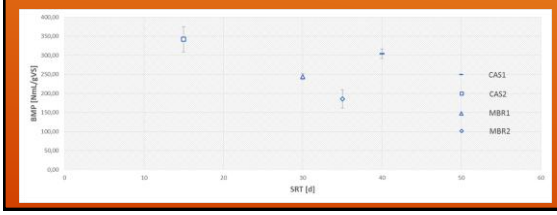
- **Thickening 2h**
- **TS-VS (**EPA method 1684**)**
- **EPS extraction**
- **BMP test**

Water displacement measuring system (eudiometer)



Results - Stability of sludge vs SRT





- The BMP potential is affected by the treatment technology
- CAS sludges show generally a higher BMP than MBR
- The BMP trend is decreasing at increasing SRT , ONLY at parity of biomass selection

Sludge Dewatering

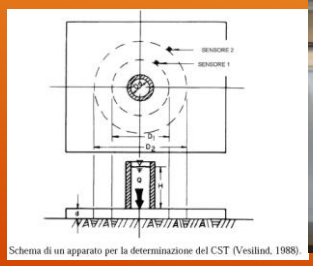
Is generally affected by

- **Properties of the influent WW**
- **Sludge's partcle size distribution**
- **Suspended Solids concentration**
- **Dissolved oxygen concentration**
- **T and pH**
- **Presence and concentration of colloidal particles and dispersal microorganisms**
- **Viscosity**
- **Concentration and properties of Extracellular Polymeric Substances (EPS)**
- **AD?**

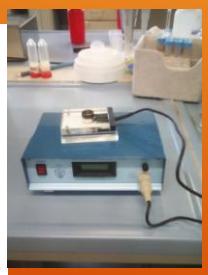
Methods (II) Dewatering

➢*SRF (Specific Resistence to Filtration)*
(Buchner funnel vacuum filtration)

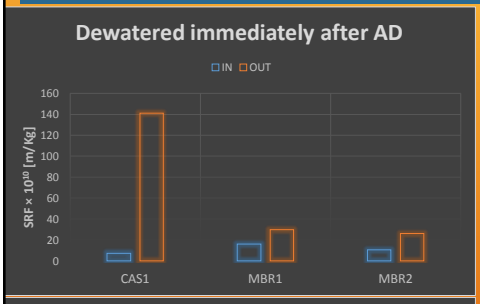
➢*CST (Capillary Suction Time)*
(Standard CST apparatus - Triton, UK)

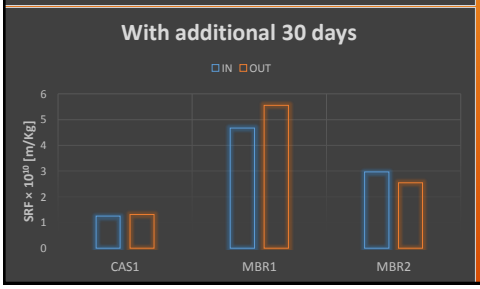


Schema di un apparato per la determinazione del CST (Vesilind, 1988).



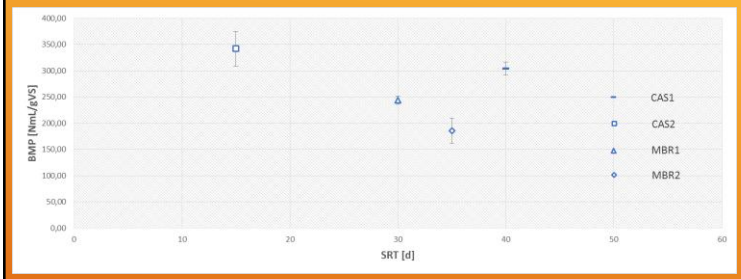
Adjustment extra-time



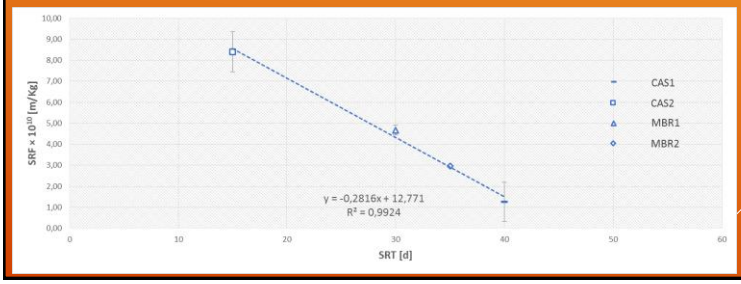


Anaerobic digestion followed by a 30 days adjustment time did not cause worse dewatering properties of the tested sludges. Such worsening, is not present if an adjustment time is waited before sludge dewatering

SRT vs stability and dewaterability

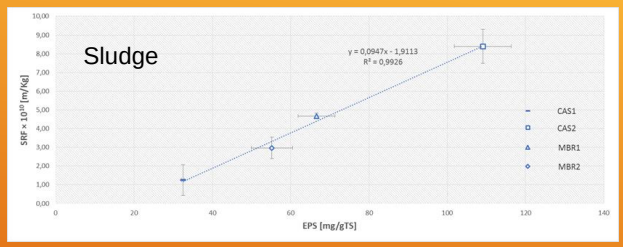


BMP

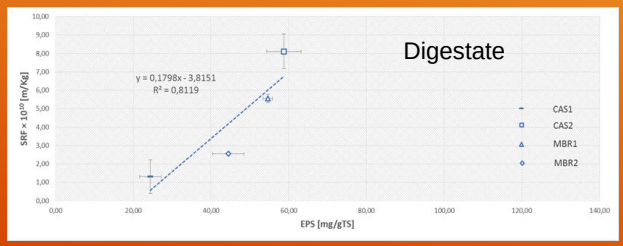


SRF

EPS vs resistence to filtration



EPS amount in the sludge affects its dewatering properties.



Conclusions

- Sludge treatment has noticeable impact on the overall energy consumption and GHGs emissions of WWTPs
- The anaerobic treatment of sludge could be sustained by its relatively high BMP also in the case of MBR reactors.
- Process unbalances of the AD may lead to higher NO_x emissions due the immission of hydrogen in the cogeneration engine.
- SRT shortening maximizes methane production while it decreases sludge dewaterability. Hence the optimization of the sludge production of the plant has important consequences on energy and emissions balances
- Anaerobic digestion followed by a 30 days adjustment time did not cause worse dewatering properties of the tested sludges. Such worsening, is not present if an adjustment time is waited before sludge dewatering.
- Further studies are needed taking into consideration a higher number of sludges from different WWTPs operated in different conditions to assess the correlation between the sludge SRT, BMP, EPS concentration and the effect of anaerobic digestion on the dewatering properties of digested sludge. In this way it could be possible to optimize WWTPs sludge properties in order to reduce energy consumption and GHGs emissions

Thank you for your kind attention

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