



Workshop

Assolombarda - Sala Bracco, ore 14.30 – 7 ottobre 2014



 POLITECNICO DI MILANO

Prospettive e opportunità di sviluppo nelle tecnologie di depurazione delle acque civili e industriali e trattamento fanghi



I fanghi di depurazione - spunti per la discussione

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Problema fanghi

Trattamento dei fanghi: tecnologie disponibili

Alcuni esempi



Direttiva europea sulle discariche 99/31:

norme per i rifiuti biodegradabili

- Smaltimento in discarica solo dopo pretrattamento
- progressiva riduzione delle quantità smaltite in discarica rispetto al 1995 (... salvo deroghe...)
 - ✓ al 75% a partire dal 2006
 - ✓ al 50% a partire dal 2009
 - ✓ al 35% a partire dal 2016

Proposte di aggiornamento prevedono:

- limiti più restrittivi per metalli e composti organici
- stabilizzazione e disinfezione per i fanghi da destinare ad uso agricolo
- prescrizioni restrittive sui suoli agricoli destinati a ricevere i fanghi

Nuova normativa Regione Lombardia (DGR X/2031 del 1/7/2014)



Alcuni dati in aree urbane

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(data refer to years 2008 – 2009)

Plant	PE	COD			Sludge disposed of				Yobs	Disposal routes
		in (t/y)	removed (t/y)	removal efficiency %	t/year (total)	average % dry matter	t/y (dry matter)	gSS/PE/d	kgSS/kgCOD removed	
Como (7 plants)	665,442	27,301	23,839	87.3%	26,405	23.4%	6,180	25.4	0.26	6 AS, 1 AD; A 100%
Florence (17 plants)	478,000	22,681	20,413	90.0%	20,888	24.1%	5,034	28.9	0.25	AD in all plants; average 2008-2009: A 46.3%; C 34.3%; L 19.4%
Milan province (33 plants)	2,000,000	80,300	72,270	90.0%	67,855	23.0%	15,607	21.4	0.22	Most plants AS; 2008: A 75%; L 25%; 2009: A 76%, ER 1%, L 23%; 2010: A 71%; ER 10%; ER 11% (cement kiln); L 8%.
Milan city WWTP1 (Nosedo)	1,250,000	50,188	47,377	94.4%	53,969	30.9%	16,663	36.5	0.35	AS; ER 5% (cement kiln after drying at 95%DS); A 95%. 2010: ER 50%
Milan city WWTP2 (Milano San Rocco)	1,000,000	40,150	36,100	89.9%	7,000	90.0%	6,300	17.3	0.17	AS; ER 100% (cement kiln)
Rome city + surroundings (112 plants)	3,422,780	149,918	134,926	90.0%	125,174	23.0%	28,790	23.0	0.21	AD in the main 6 plants; L 100%
Turin - city + province (12 plants)	2,734,000	109,789	101,083	92.1%	203,807	22.0%	44,838	44.9	0.44	AD in the two largest plants; A 54%; L 46%.
Venice (4 plants)	545,000	21,874	19,475	89.0%	25,529	29.1%	7,439	37.4	0.38	AD in the largest plant; 2008: L 100%; 2009: C 32.3%; ER 67.7%
Total (or average)	12,095,222	502,200	455,482	90.7%	530,626	24.7%	130,849	29.6±30%	0.29	

(AD = anaerobic digestion; AS = aerobic stabilisation; L = landfill; A = agriculture; C = composting; DS = dry solids ER = energy recovery; MR = material recovery, Yobs = observed sludge yield).



ISTAT 2009

AE totali in Italia: 168 milioni

60% residenti

14% presenze turistiche

14% attività commerciali e servizi

12% attività industriali

Produzione specifica stimata: ca. $30 \text{ gSS/AE/d} = 11 \text{ kgSS/anno/AE} = 1.9 \text{ Mt SS/anno}$

Assumendo un valore medio di secco del 25%, la stima di fango umido da smaltire si colloca a circa

7,80 Mt/anno ($\pm 30\%$)

Si può stimare una produzione ODIERNA in Italia di circa

6,00 Mt/anno ($\pm 30\%$)

(perchè 15% della popolazione non è ancora servita da popolazione e molti impianti si devono ancora dotare di trattamenti terziari e di filtrazione)



2001

- Discarica: 46%
- Utilizzo agricolo + compostaggio: 51%
- Incenerimento: 3%

2009

- Discarica: 24%
- Utilizzo agricolo + compostaggio: 69%
- Incenerimento: 2%
- Stoccaggio temporaneo: 5%

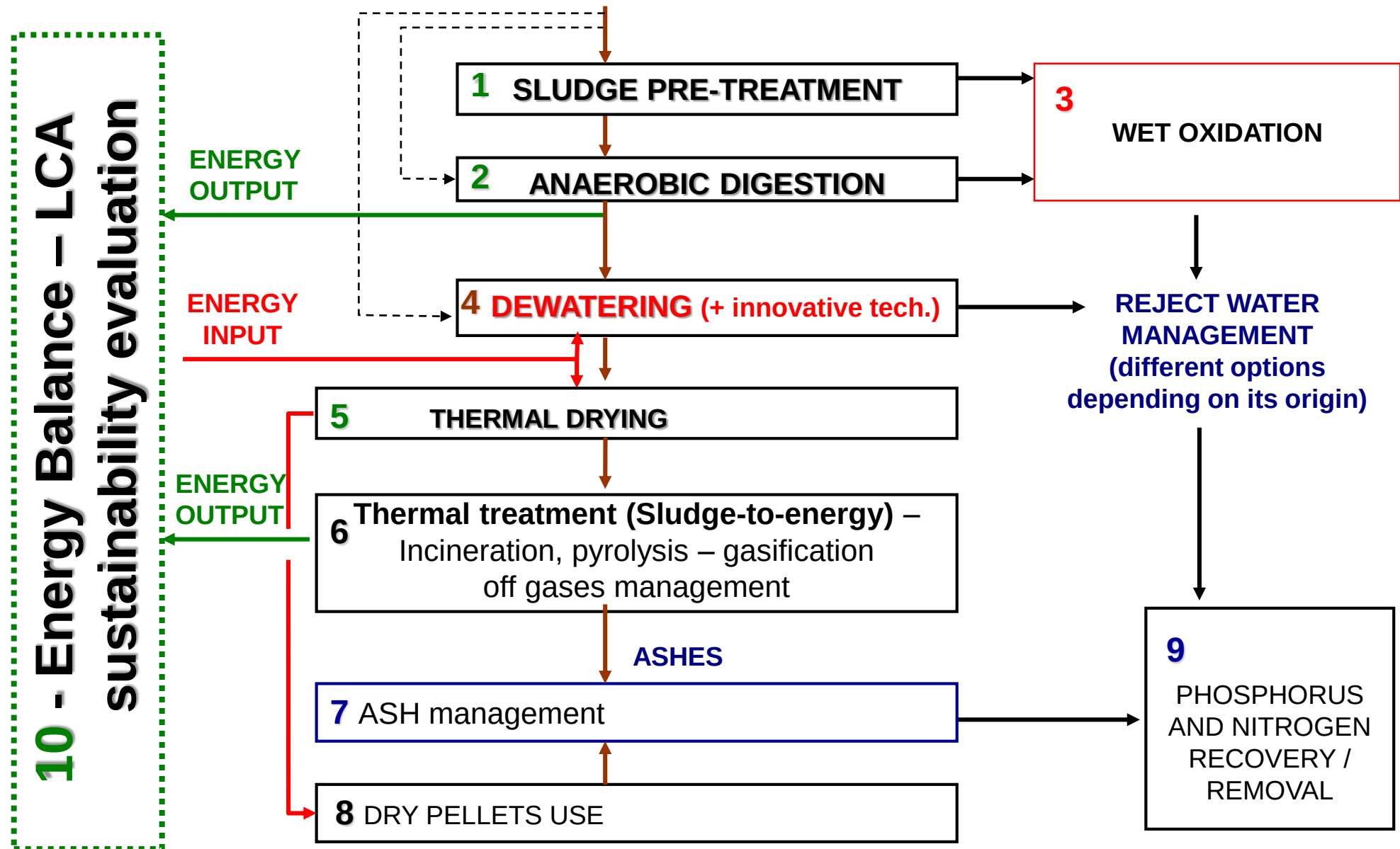


Area	Pianificazione smaltimento futuro
Province di Como e Milano	Recupero energetico in forni o cementerie (70-80%). Riuso agricolo dopo compostaggio con altre matrici organiche (20-30%)
Firenze	Riuso agricolo, con limiti più restrittivi su composti organici e metalli
Torino e provincia	Abbandono della discarica; incremento del riuso agricolo diretto e dopo compostaggio e del recupero energetico
Venezia	Piano per recupero energetico (100%)
Roma e provincia	Abbandono della discarica; riuso agricolo diretto o dopo compostaggio e recupero energetico
Zurigo (CH)	In atto: 100% recupero energetico mediante incenerimento in forno dedicato; divieto di riuso agricolo



Trattamento e gestione dei fanghi - schema concettuale

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Inter-departmental cooperation

DEIB (ICT), DICA (Environmental technology and Hydrology),
Physics (nanosensors), Chemistry (materials and electrochemistry)



SIST&MS	Management of sewage sludge at district level
N-FREE PRINTING	Reduction of nitrogen loads discharged from digital textile printing processes
SCOPE	Quantification of micropollutants in wastewater by means of simulation models
NSC	Development of an innovative electrochemical sensor for measuring nonylphenol in water
WINTES	Water innovation: new technologies, environment and society
SWARM-NET OR3	Monitoring of discharges into the sewer system to optimize wastewater biological treatment units and agricultural reuse of effluent and sludge
SLUDGEtreat	Electro-osmotic dewatering to prolong the life cycle of sewage sludge, by i) improving sludge quality and ii) increasing the percentage of sludge dry matter up to 50% of solid content for high added-value re-uses (i.e. as energy, biomass), other than fertilizers.



SIST&MS

<http://131.175.143.146/dbdepuratori/>

Product	Company	Research Institution
Coordination models for “SII” and research of innovative technologies for sludge disposal	---	Politecnico di Milano - DICA + Hydroinformatics Lab

«SII» of Como District in collaboration with leading service operators of WWT of the area



- *Update information flow managers - public bodies*
- *Streamline planning decisions and investment*
- *Innovation in managing WWTP and choose sustainable technologies for the disposal of sludge*

Activity POLIMI (HIL)

Creation of an open, interactive DB	Model calibration and validation
Implementing services for data sharing between operators and authorities	Scenario Analysis
Offer information and participation to citizens	Evaluation of environmental and energy indicators
Optimize management decisions using updated data	Definition of viable and sustainable alternatives for sludge disposal at district level

Targets

Self financed by Polo di Como

Start: May 2013

End: April 2015

Development of a coordination model between Water Service Companies aimed at optimizing wastewater treatment at district level. The involvement of local Water Service Managers on an open access platform will allow an easy flux of updated information to improve the overall knowledge of the district cluster and to propose innovative solutions through the analysis of experiences and best practices at national and international level to reduce waste sludge production and optimize energy and material recovery.



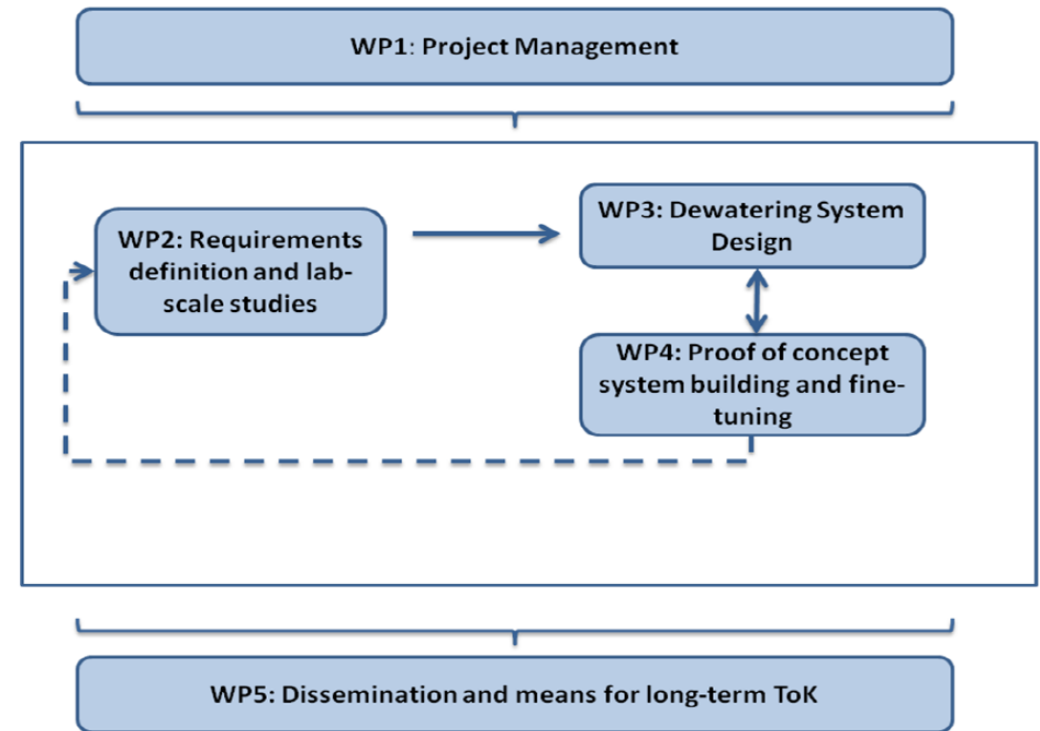


Product	Company		Research Institutions
Electro-osmotic dewatering prototype	AST (ES)	Flubetech	Politecnico di Milano (I) AIN (ES)

European research project – Marie Curie Actions FP7 – Industry Academy Partnership

Proposers intend to move away from sewage sludge disposal as landfilling, as this gradually has to be phased out by EU (Waste Framework Directive 2008/98/EC on waste), and agricultural use as fertilizers, as the latter presents strong limitations coming from organic and inorganic pollutants that sewage sludge may contain. On the other hand, sludge thermal drying for further re-use instead disposal, still needs considerable amounts of fossil fuel to provide the heat necessary to the process and thus remain an unexplored (but added-value potential) research and market area.

Enhanced dewatering can be a step towards more modern sludge management



Innovazioni mature:

- Riduzione fanghi (ozonolisi, metabolic uncoupling)
- Pretrattamenti per potenziare la digestione anaerobica (es.: disintegrazione meccanica, termolisi)
- Digestione a più stadi (acido + metanigeno; termofilo + mesofilo)
- Condizionamento elettro-assistito (es.: biocracking)
- Disidratazione elettro-assistita (es.: elettrosmosi)
- Rimozione autotrofa dell'azoto ammoniacale dai surnatanti (es.: processo Anammox)

Ancora in fase di ricerca industriale e sviluppo

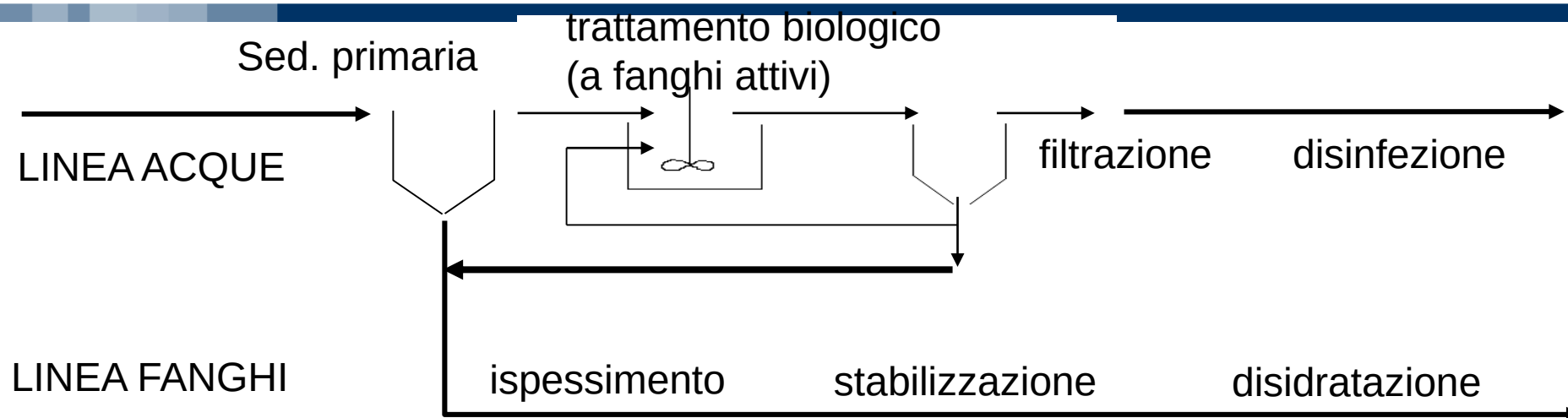
- Gassificazione / Pirolisi
- Ossidazione a umido



1) Riduzione dei fanghi

- **termolisi** (su fanghi da avviare a digestione anaerobica)
- **ozonolisi** (su parte del ricircolo dei fanghi)

2) Disidratazione elettrosmotica



1. linea acque

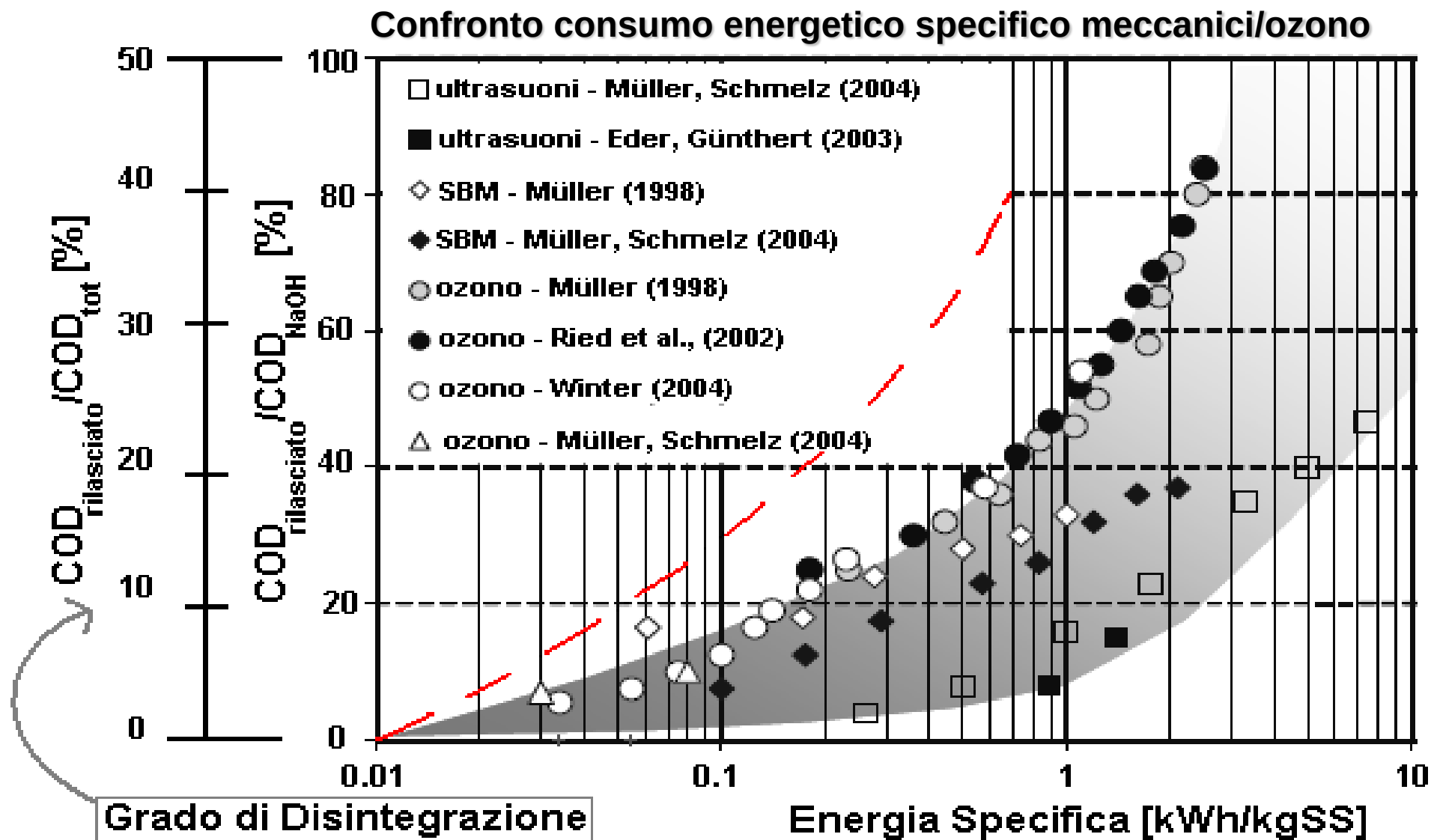
riduzione della **massa secca prodotta**
dal processo biologico

2. linea fanghi

riduzione dei **fanghi da smaltire** –
aumento della produzione di biogas

3. smaltimento finale

riduzione dei **residui finali** –
recupero energetico



La linea tratteggiata indica il livello raggiunto oggi nell'ozonolisi



Trattamento e minimizzazione dei fanghi



Lab-scale ozonator

Full-scale ozonator



**Reduction of 17% of
the observed cell yield**

Y_{obs}
due to:

Longer SRT ~ 14.8%

Higher decay rate b_H ~ 26.5%

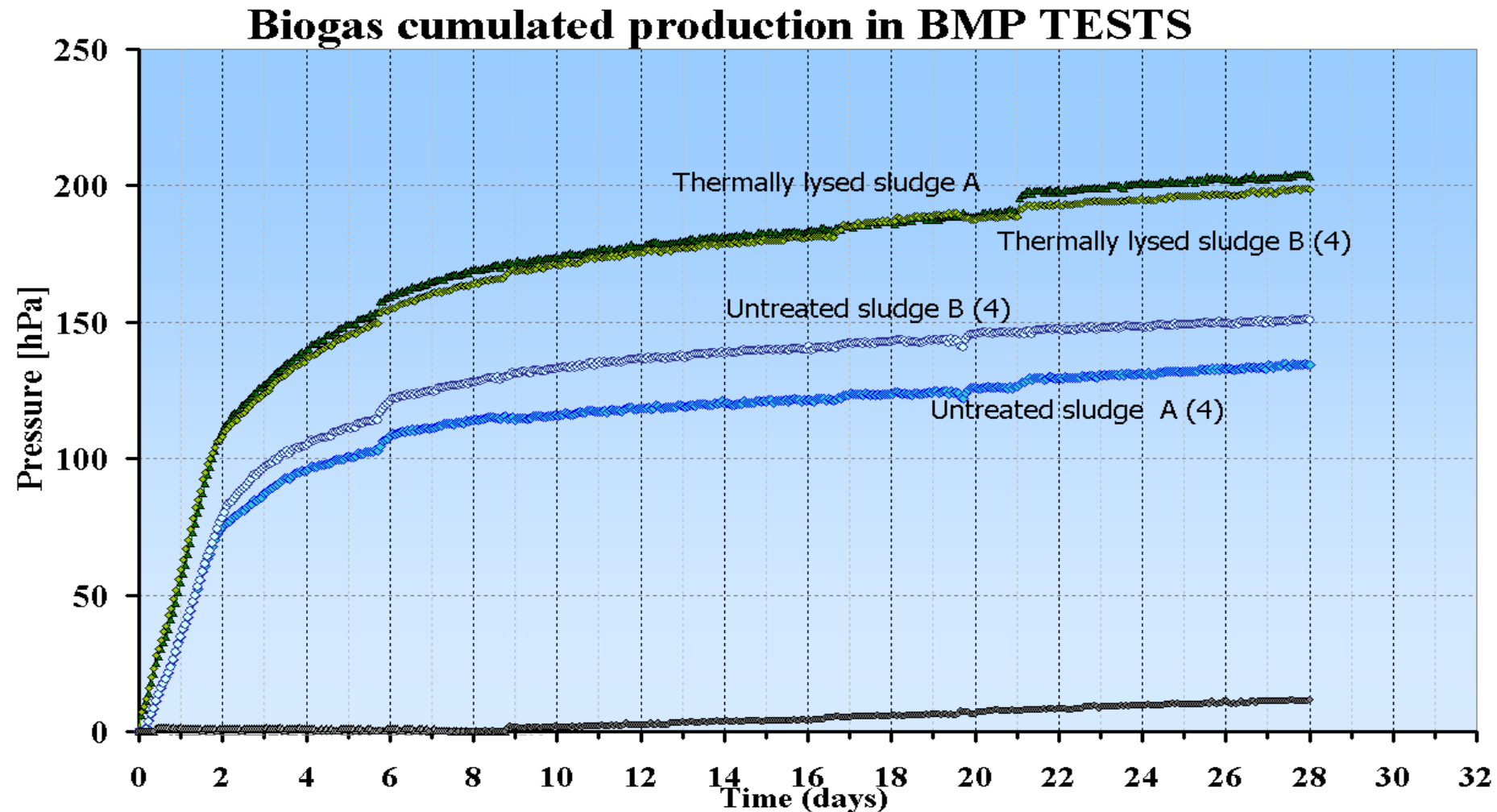
Lower biological cell Yield Y_H ~ 11.7%

Suspended solids solubilization ~ 47%



Applicazione di test BMP - Effetto delle lisi termica

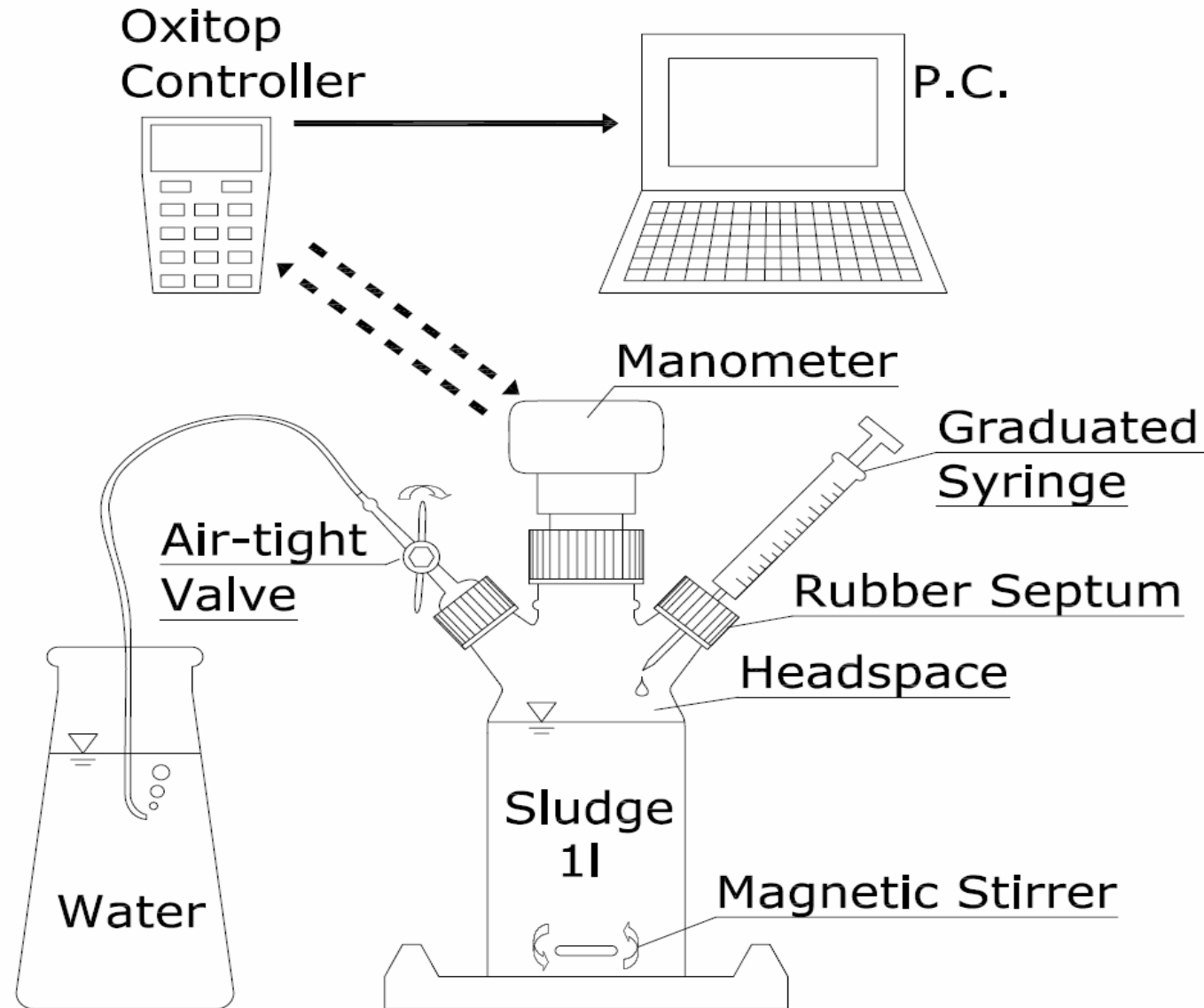
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Che cos'è un test BMP?

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SLUDGEtreat³



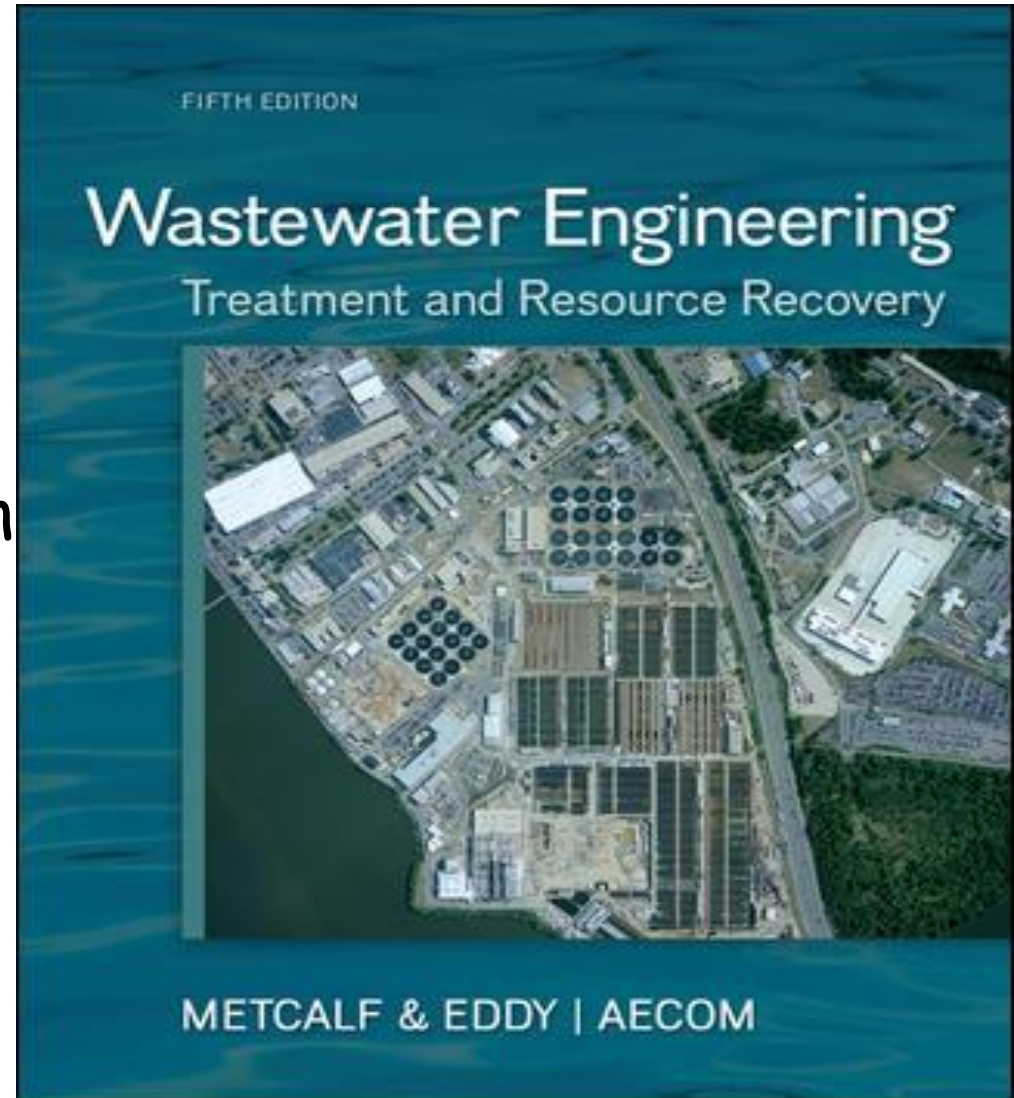
Disidratazione elettrosmotica dei fanghi



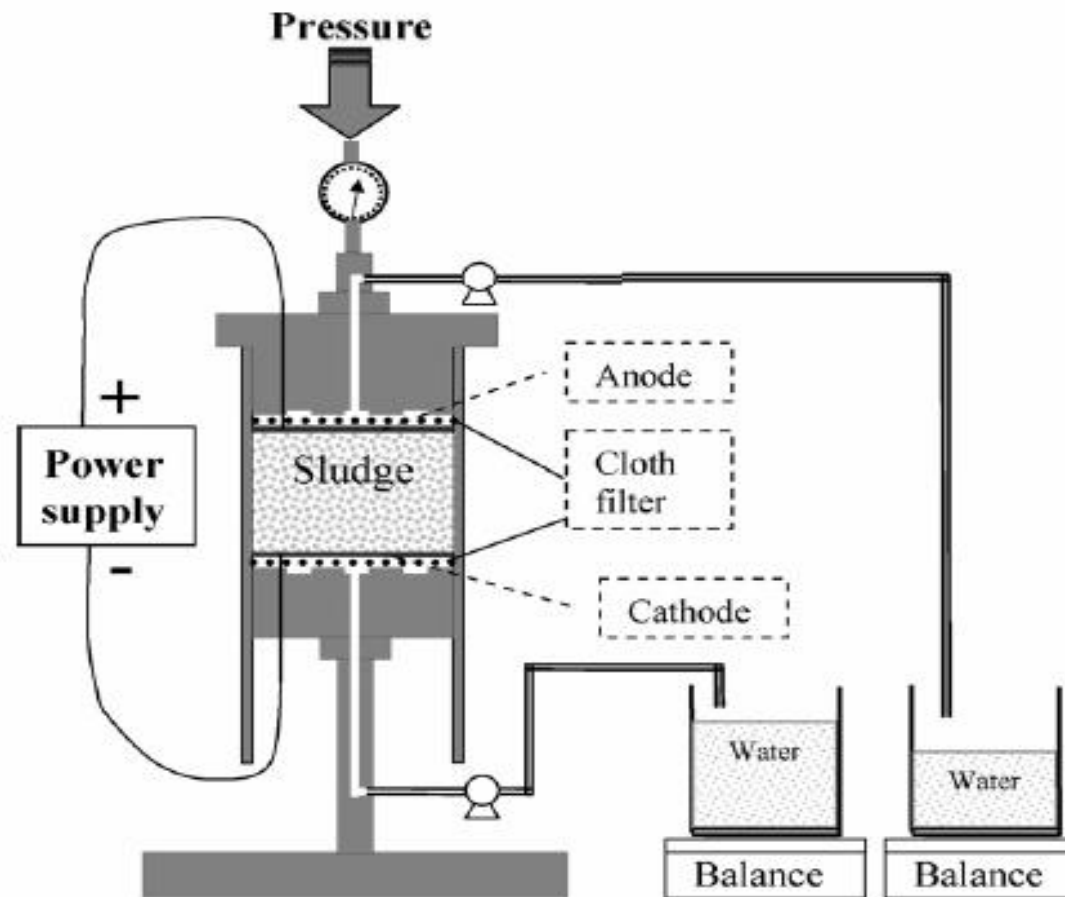
For the first time

**electrically-assisted
dewatering**

appeared in the 2014 edition
of the
world-renowned
Wastewater Engineering
Manual



traditional pressure-driven electro-dewatering reactor (A)



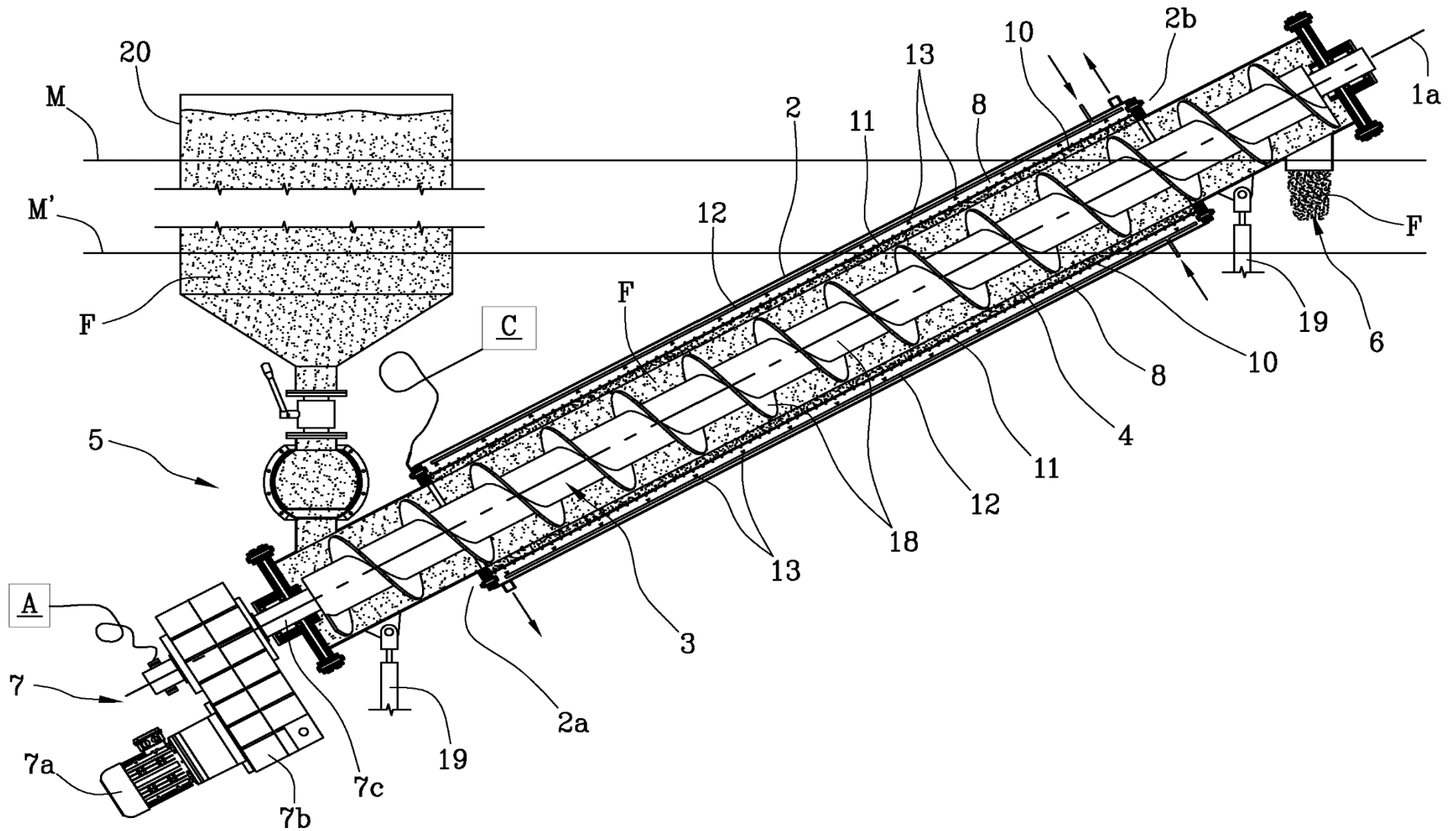


- At present, ED machines (ELODE, ACE group, KR; Ovivo's CINETIK®, GLV group, CN)
apply **static electrodes**: dry sludge cake develops at the anode and act as an insulator
- Consequences
 - Higher electric energy consumption
 - Lower dry content in the dewatered sludge



Rotating electrodes can optimize the process by:

- mixing the sludge during the dewatering process (avoiding stratification) and maintaining it in a «sol» state (instead of developing drier «gel»-like layers)
- better drainage of the excess water







DOMANDE?

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