INFLUENCE OF SLUDGE CHARACTERISTICS ON PRESSURE-DRIVEN ELECTRO-DEWATERING OF STABILIZED SEWAGE SLUDGE

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BACKGROUND AND GOALS

Nowadays, to reduce sewage sludge water content filter presses, centrifuges and belt presses are the most widespread technologies in WWTPs and can produce wet sludge with 20-30% dry solid (DS) content.

Recently, pressure-driven electro-dewatering (EDW) was shown to be an efficient technique to increase the DS content up to 40-45% [1,2,3]. However, so far the high variability of sludge samples produced by different WWTPs prevented from predicting EDW efficiency for all the sludge types [4].

In the present work, the feasibility of the pressure-driven EDW tests on different stabilised sludge samples was assessed. The influence of initial DS content (DS_I), volatile to total solids ratio (VS/DS), conductivity, zeta potential, capillary suction time (CST) and conditioning, by addition of polyelectrolyte at different dosages, on EDW performance was studied.

MATERIALS AND METHODS

Aerobically and anaerobically stabilised sewage sludge samples were taken from four different WWTPs around the metropolitan area of Milan (Italy). Conditioning of sludge samples was performed by jar test with three dosages (0, 4 and 8 g/kg_{DS}) of polyamidic and high cationic polyelectrolyte (Tillflock CL-1480). Sludge characteristics are shown in **Table 1.**

Pressure-driven EDW tests, performed by a lab-scale device (**Figure 1**), consisted of two successive stages:

- Filtration/compression by applying pressure (P=300 kPa) for 10 min;
- Application of a potential (V=15 V) for 25 min.

Table 1. Characteristics of sludge samples taken from the four WWTPs.

Sample	Stabilisation	Polymer dosage	DS_I	VS/DS	pH	Conductivity	CST	Zeta potential	DS_{CFG}
		g/kg_{DS}	%	%	-	mS/cm	s	mV	%
1-A		0	2.0	68.3	7.5	1.34	32.0	-11.9	8.8
1-B	Aerobic	4	2.4	68.3	7.4	1.33	22.5	-11.5	7.7
1-C		8	2.2	68.3	7.4	1.29	19.8	-11.5	8.6
2-A		0	3.3	78.4	6.9	1.84	103.3	-13.1	7.5
2-B	Aerobic	4	3.2	78.4	6.5	1.79	92.7	-12.6	7.8
2-C		8	3.2	78.4	6.6	1.68	68.8	-11.9	8.0
3-A		0	3.2	72.7	6.9	1.28	35.7	-13.4	8.4
3-B	Aerobic	4	3.0	72.7	6.9	1.26	28.3	-12.9	8.2
3-C		8	2.8	72.7	7.0	1.26	17.8	-12.1	8.1
4-A		0	4.3	64.8	6.7	4.00	155.6	-11.3	9.8
4-B	Anaerobic	4	4.3	64.8	6.7	4.00	81.6	-11.5	9.7
4-C		8	4.3	64.8	6.7	4.00	102.3	-11.0	13.9

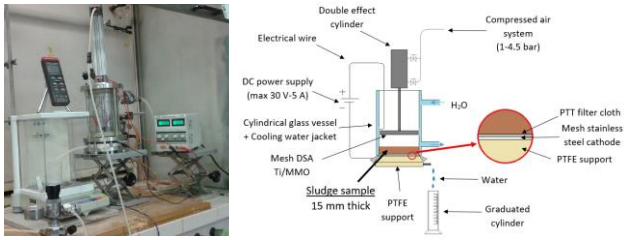

Figure 1. Lab-scale device for pressure-driven EDW tests.

ACKNOWLEDGEMENTS

Authors wish to thank Cap Holding Group for supplying sludge samples and Industrie De Nora Spa for providing DSA electrode. This work has received funding from the Project SLUDGEtreat, co-funded by the European Commission within the FP7 (2007–2013) Marie Curie Actions-Industry-Academia Partnerships and Pathways - IAPP, GA n. 611593, and from the LIFE14 project no. ENV/IT/000039 "ELECTRO-SLUDGE", with the contribution of the LIFE Programme of the European Union.

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RESULTS AND DISCUSSION

The results of pressure-driven EDW are shown in **Figure 2**:

- For sludge 1 and sludge 4 the highest dosage of polyelectrolyte is needed to reach the highest value of DS_V (24.6-26.1%, respectively);
- For sludge 2 a dosage equal to 8 g/kg_{DS} is not motivated by an increase in the DS content with respect to the lower dosage;
- For sludge 3 a DS content of 30.9% is reached without conditioning;
- For aerobically stabilised sludges, the DS content of conditioned samples was higher than those reached by conventional mechanical dewatering in the WWTPs.

The characteristics of aerobically stabilised sludges, such as VS/DS ratio [5] and the measure of CST, can be considered as an indicator for the mechanical pressure-driven stage. On the other hand, zeta potential is an indicator of the EDW process efficiency (**Figure 3**).

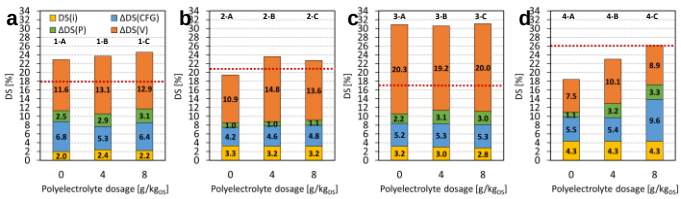

Figure 2. Pressure-driven EDW results of (a) sludge 1, (b) sludge 2, (c) sludge 3 and (d) sludge 4. The red lines show the average DS content reached after mechanical dewatering in the WWTPs (sludge 1, 2, 4: centrifuge; sludge 3: belt press).

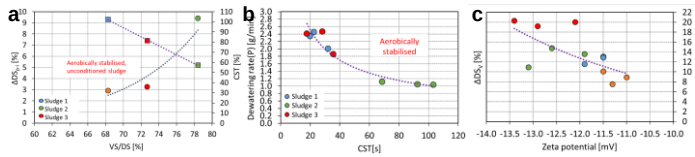

Figure 3. Relationships between sludge characteristics and pressure-driven EDW results: (a) VS/DS ratio vs. ΔDS_{p-i} / CST values, (b) CST vs. dewatering rate of the mechanical pressure stage and (c) zeta potential vs. ΔDS_V.

CONCLUSIONS

- Each sludge has a different behavior for pressure-driven and EDW stages. Aerobic digestion promotes EDW with respect to anaerobic one.
- Pressure-driven stage is affected by VS/DS ratio for aerobically stabilized samples, while CST values are reliable predictors of efficiency.
- A more negative zeta potential leads to an increase of DS during EDW stage. An increase in zeta potential due to polyelectrolyte addiction hinders the DS increase with electric potential application.

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