

Comparative techno-economical evaluation of mechanical dewatering of sludges in the dairy industry

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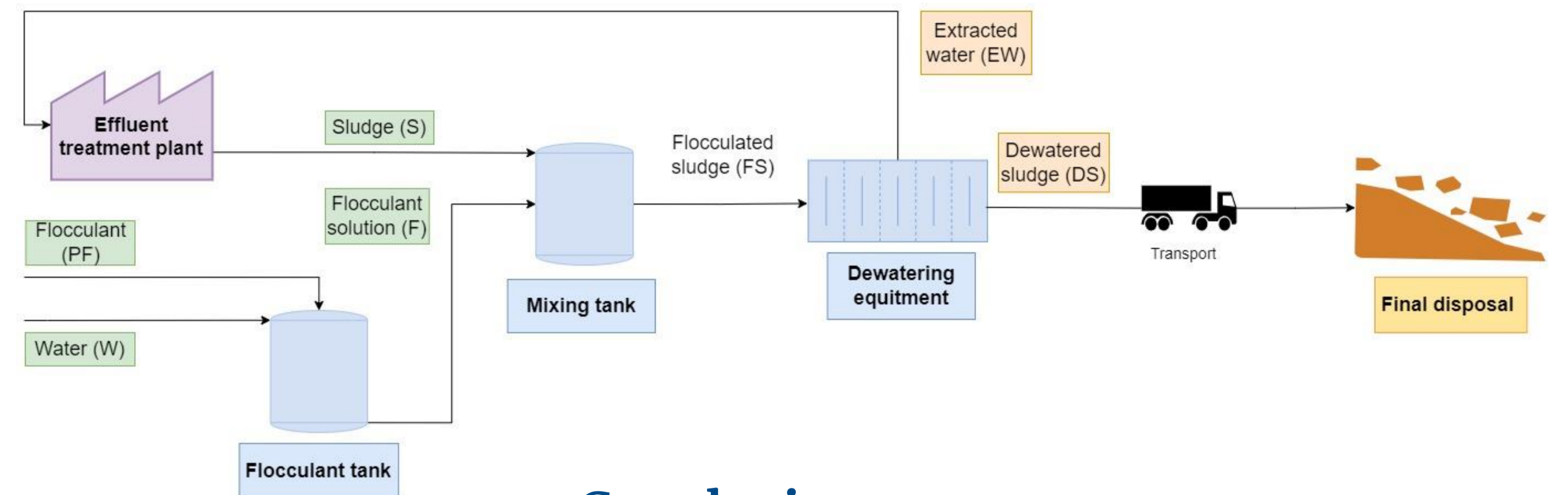
Introduction

In general, the dairy industry produces a huge amount of dairy processing wastewater treated sludge (DPWTS). In Uruguay, the disposal pathways include land spreading as a soil improver, composting, landfill and valorization as a combustible. The different final means of transport as a requirement which cost is directly proportional to the volume of the material. In order to reduce the transport cost there are a variety of processes that decrease the volume of sludge by eliminating water, including mechanical dewatering and drying.

Materials and methods

Based on information provided by “Cooperativa Nacional de productores de leche (Conaprole)”, the most important Uruguayan dairy company, bibliographic data and experimental results obtained by the group (moisture, characterization), we modeled the dehydration process so we can predict the mass balance of each type of equipment. To achieve easy access and a better understanding we used Microsoft® Excel to develop the model.

This simulator allows the user to compare between three different equipment options by using the inputs variables. The technology studied in this research were geotextile dewatering tubes, screw press and belt filter press.



Conclusion

In conclusion, we present an interactive tool developed in Microsoft® Excel. The interface guides the user and provides a list of questions to be asked to the machinery supplier, in order to compare different types of equipment and the cost associated with each one. Producing information about the costs involved using graphics and indicators relevant to the company interest. This simulator is the first step toward a more general informatic tool of process synthesis for the wastewater sludge management.

INPUTS

SLUDGE DATA	FLOCCULANT DATA	DEWATERING EQUIPMENT DATA
<ul style="list-style-type: none"> Solid concentration Sludge volumetric Flow Bulk solid density 	<ul style="list-style-type: none"> Flocculant cost Concentration of flocculant Required flocculant concentration on the sludge 	<ul style="list-style-type: none"> Equipment type Capacity Design solid concentration Bulk solid density Power consumption Retention time of mixing tank Required operator hours Required supervisor hours Maintenance hours per days
SERVICE DATA	PLANT OPERATION DATA	
<ul style="list-style-type: none"> Water cost Electricity cost Transport cost Distance to final disposal 	<ul style="list-style-type: none"> Working hours Working days per hours Operator salary Supervisor salary 	

Results

OUTPUTS

SIMULATOR

COST PER REMOVED WATER	ANNUAL OPERATION
COST PER SOLID OBTAINED	COST DISTRIBUTION
COST PER INTEL SOLID MASS	INVESTMENT
TOTAL SOLID RELATION OUTLET-INTEL	

Solid mass balance in the Dewatering Equipment

$$\rho_{FS} * FS * \%_{TS_{FS}} * \epsilon_i = \rho_{DS_i} * DS_i * \%_{TS_{DS_i}}$$

Total mass balance in the Dewatering Equipment

$$FS = DS_i + EW_i$$

Total mass balance in the Mixing tank

$$FS = S + F$$

Total mass balance in the Flocculant tank

$$F = PF + W$$

Required concentration in the sludge

$$FS * Conc_{req} * \gamma = Conc_{req} * F = PF$$

Investment

$$I = \left(\sum Cost_{Equit_i} + \sum Cost_{AUX_i} \right) * Factor$$

Total operation cost

$$TC_i = \sum c_j$$

Flocculant cost

$$C_{Fl} = \$_{Fl} * PF * WD$$

Water cost

$$C_W = \$_W * W * WD$$

Electricity cost

$$I = \$_E * \left(\sum P_j \right)_i * WH * WD$$

Supplies cost

$$If i = [Geotubes]$$

$$C_{Supplies} = \frac{DS_{Geo} * WD * \$_{Geo}}{Cap_{Geo}}$$

$$If i \neq [Geotubes]$$

$$C_{Supplies} = 0$$

Transport cost

$$C_{T-} = \frac{d_{FD} * \$_T * DS_i * WD}{Cap_T}$$

Supplies cost

$$If MH = []$$

$$If MH \neq []$$

$$C_M = F_{M_i} * I$$

$$C_M = MH * \$_{LR} * WD$$

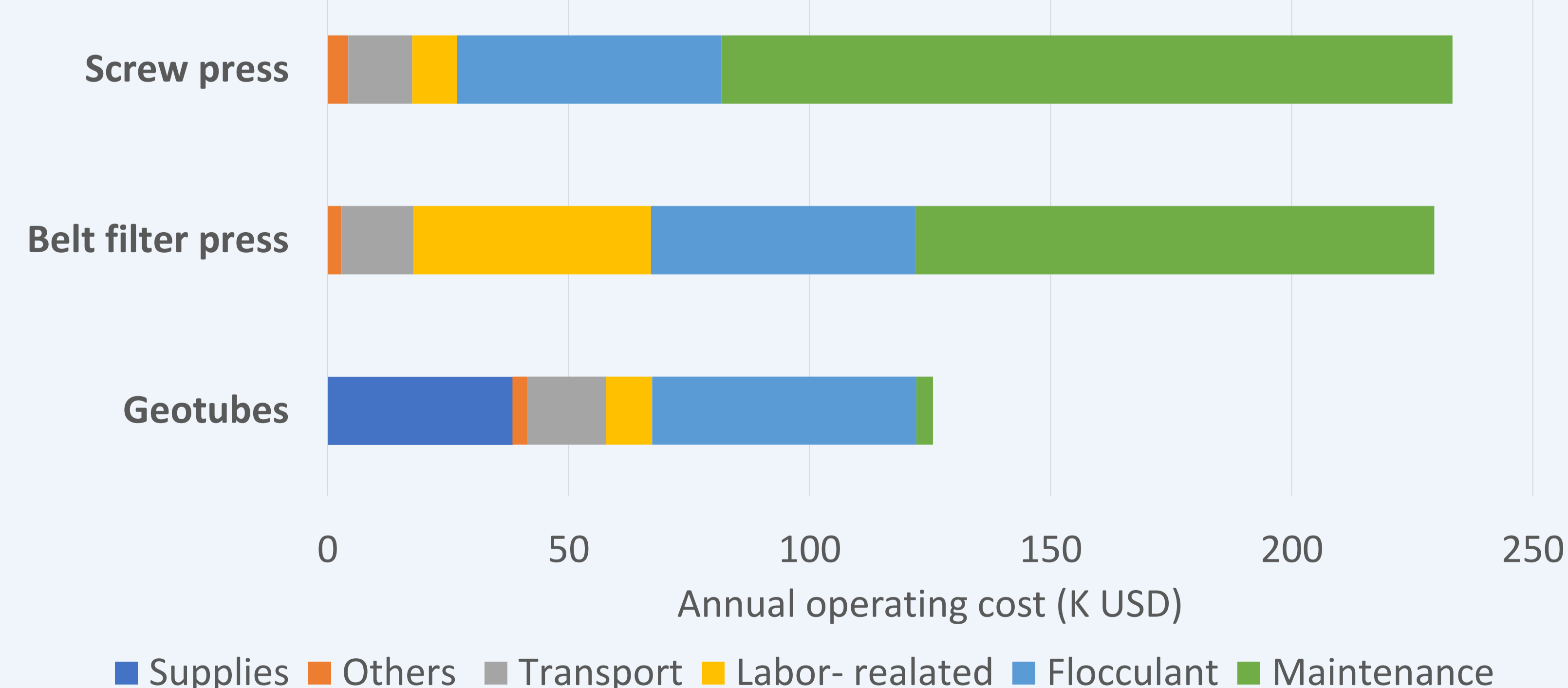
Total operation cost

$$C_{LR} = (\$_O * ROH * WD + \$_S * RSH * WD) * (1 + \%_b + \%_{extra})$$

Input Data	Unit	Value
Solid concentration	%	1,00
Sludge volumetric flow	m3/d	100
Sludge density	Kg/m3	1000
Flocculant data		
Cost	USD/Kg	5
Concentration in solution	%	0,5
Required concentration	ppm	300

Service data	Unit	Value
Water cost	USD/m3	0
Electricity cost	USD/KWh	0,083
Distance to disposal	Km	20

Equipment data	Unit	Geotube	Belt filter press	Screw press
Capacity		500	7	8
Design solid concentration	%	14	15	15
Bulk solid density	Kg/m ³	1000	1000	1000
Solid retention efficiency	%	92	90	80
Equipment cost	USD	6.300	262.000	530.000
Power consumption	KWh	0	2,7	5
Required operator hours	h/d	3	15	2



Acknowledgements

We express our sincere gratitude to the National Agency for Research and Innovation (ANII) for their financial support, which made this research possible. We are also grateful to Conaprole for providing us with valuable data and information, which contributed to the findings of this study. Their assistance and collaboration were instrumental in the successful completion of this project.