Master of Environmental Industrial Sciences

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Approach of the problem of mineral oil in compost

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Abstract

1 Introduction

IVVO (Intercommunale voor de vuilverwijdering en -verwerking voor de sector Veurne en Ommeland) is an intermunicipal company that accepts domestic waste. The company also accepts organic biologic industrial waste. This waste is processed at the digestion plant in Ieper (Belgium). The first step is to separate the waste from the pollutants, such as plastic packings and others impurities. Next, the waste is mixed to release the degradable components and to increase the wet fraction above 90 %. This step also removes light (plastics, leaf veins, …) and heavy (stone, metal, glass, …) pollutants. This mass is now turned into biogas (65 % CH_4 and 35 % CO_2) through a wet (dry fraction maximum 15-20 %) and mesophilic (35 °C) digestion process. The biogas is burnt in four gas-engines each connected to a generator to produce electricity.

After a retention time of two weeks in the digesters, the digest is dewatered by six slow turning screw-presses. The dry fraction increases from 5 % to 30 %. Finally, the pressed material is mixed with structural material and is led to the composting section of the factory. The first step in the composting process is an intensive aeration in closed boxes. The

temperature raises during five days above 55 °C. At this temperature pathogens, seeds and moulds are destroyed. Next, the compost is aerated in an open space for a few weeks. Finally, the compost is sieved and ready to be sold.
Analysis of the compost shows that higher values of mineral oil are in the compost than the Belgian Vlarea-legislation allows (560 mg/kg DS). This could mean that IVVO does no longer gets the needed certificates to sell the compost. This thesis intends to find a solution for this problem.

2 Content

2.1 Identification of the pollution

Research has shown that the mineral oil enters the process at the dewatering step of the digest. During this step, there is a poly-electrolyte (Praestol K 110 L) added to the digest. This product causes flocculation of the digested matter, and so the mass can be easily dewatered. This poly-electrolyte is composed of a long chain of the monomers acrylic amide and a positively charged acrylic acid derivate. This flocculant is delivered as an emulsion in isoparaffin hydrocarbons, which is the source of the mineral oil pollution. The use of a poly-electrolyte in the form of a powder could mean a solution for this problem.

2.2 Determination of the most suitable poly-electrolyte

To be able to use these types of flocculants, IVVO has to place a new unit where the flocculant can be dissolved for two hours. This dissolution process is the stretching of the long chains that are in the particles of the powder. The starting of this unit is the first task during the internship.
A second task is to test flocculants of different suppliers and to look at the possible good results of the different flocculants. Results are good if the flock structure is good and if the dry fraction is about 30 %. Six different flocculants are tested and the dosage needed for good results is noted down. After the different tests, the operating costs are calculated. This will determine which one will be chosen. These tests showed that the flocculant Praestol 851 BC, supplied by Brenntag, is the best alternative poly-electrolyte.

2.3 Optimization of the process with the powder poly-electrolyte

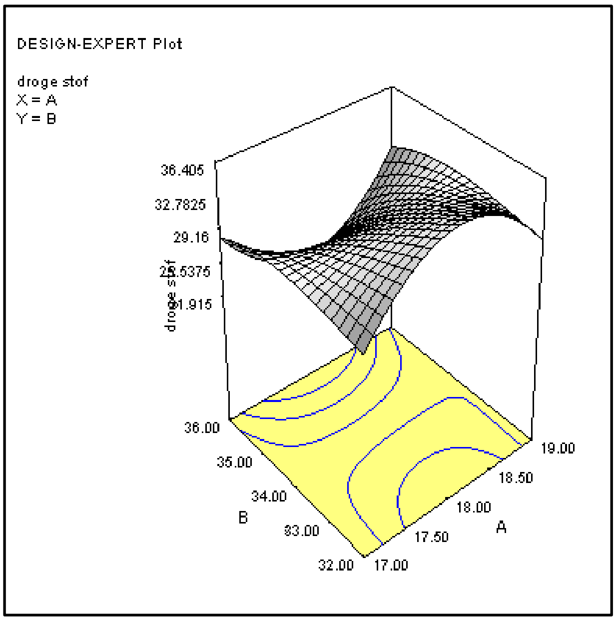
Once the flocculant selection is known, an optimization of the dewatering process follows. This is done by modeling the process in the computer program Design-Expert.
The response of a process is determined by controllable and non-controllable (temperature, humidity, …) variables. This response is represented by a second- or third degree

polynomial. The program suggests an experimental design with a limited number of experiments and a number of central points are determined to neutralize the influence of the non-controllable variables. If the experiments are done, the program will try to fit the response to a model by an analysis of variance. This model can be optimized by setting up some criteria (demands). The controllable variables are the dosage of the poly-electrolyte and the turning speed of the screw-presses. The response is the dry fraction (*droge stof* in the picture). The polynomial that represents the process is the following:

$$DF = 30{,}8 + 0{,}563A - 6{,}652B + 0{,}112A^2 - 1{,}64B^2 + 0{,}013AB - 0{,}593B^3 + 6{,}977A^2B$$

In this polynomial, A is the normalized variable poly-electrolyte dosage and B is the normalized variable turning speed of the screw. De normalization is needed, because the values vary over a different range and the units can't be compared.

This polynomial is now presented graphically and immediately it shows a maximum for the dry fraction can be reached by specific settings of the variables.



The response is optimized by a minimum dry fraction of 30 % as the criterion. This are the solutions the program suggests:

Solutions				
Number	**poly-electrolyte**	**turning speed**	**dry fraction**	**Desirability**
1	18.41	32.55	34.3834	1
2	17.95	32.77	34.3644	1
3	18.16	32.97	33.87	1
4	18.05	32.42	35.3369	1
5	17.51	32.30	33.9483	1
6	18.12	32.35	35.4947	1
7	17.81	32.63	34.5054	1
8	18.64	32.02	33.9433	1
9	18.40	32.12	35.2846	1
10	17.97	32.66	34.6904	1

3 Conclusion

- The model isn't very good, it contains an error of 11 %, and this is higher than the presupposed 5 %.
- The best powder poly-electrolyte is Praestol 851 BC. This has a low operating cost (10614 euro) in resemblance to the other poly-electrolytes and it gives results of 31 % dry fraction.
- The model gives the following ideal setting: an average dosage of the poly-electrolyte of 18,1 % and an average turning speed of 32,5 %.