Management and alkaline stabilisation of biosolids from food industries wastewater treatment plants: a case study

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IWA Specialist Conferences
International Water Association
WATER & INDUSTRY
1ST – 4TH MAY 2011
VALLADOLID - SPAIN

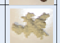
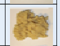
Introduction

The current regulation on recycling of sludge in agriculture requires that they have been treated (Directive 86/278/EC and Royal Decree 1310/1990 - Article 2), to reduce significantly its fermentability and the health risks of use. While the concentration of metals and their maximum application on the ground are well defined, the limits in terms of stabilization of organic matter and sanitation are very ambiguous. Now already has the third draft that would amend the 86/278 directive on recycling of sewage sludge in agriculture (Directive 99/31/EC). Its intention is clear and conclusive, enabling recovery in agriculture only those with very low sludge heavy metal, validated from the microbiological point of view (to completely eliminate *salmonella* and reduce the content of the bacteria *Escherichia coli* below 5 x 10^2 cfu / g will be required) and low content in organic pollutants

Alkaline stabilisation of sludge is an easy and a well know procedure to obtain stabilised biosolids and is regarded as an attractive alternative to aerobic or anaerobic digestion (Spinosa, 2004). The biosolids produced via the alkaline method can be applied in farming or improvement of the partially degraded soils (acidic soils) due to its high content of organic matter, macronutrients and micronutrients, useful for plant cultivation.

Wastes (detritus and physical-chemical sludge) were collected at different wastewater treatment plants from food industries sited in Burgos (Spain) and main characteristics are shown in Table 1. Individual wastes are assigned a six figure code that includes industry, materials and processes according European waste catalogue (i.e. 02 05 02 means: dairy wastes generated during "in situ" wastewater treatment processes). Analytical methods were performed according standard methods (APHA, 1989). Powder $Ca(OH)_2$ was used as alkaline reagent and mechanical mixer were employed to mix samples and alkaline reagent. Alkaline stabilisation protocol were performed according EPA Guidelines (WPCF, 1985; EPA, 2000)

Table 1: Main Characteristics of sludge and wastes employed in this work

Origin	EWC code[(a)]	pH	Dry matter (%)	Organic matter (%)	NKT (% N)	P (%P_2O_5)	% relative production	
Frozen fried potato and precooked products	02 03 05	4.3	19.7	90.8	6.04	1.86	7.3-6.5	
	02 03 99[(b)]	6.3	73.7	13.4	0.29	0.03	18.4-27.5	
Dairy products	02 05 02	4.5	19.9	88.1	6.42	1.98	7.3-6.5	
Fried potato and maize snacks	02 03 05	9	16.5	96.4	0.62	0.14	42.7-37.9	
	02 03 01	10.6	24.4	88.9	0.56	0.10	8.1-7.2	
Slaughterhouse	02 02 04	12.6	28.5	46.3	3.97	0.66	16.2-14.4	

(a) European Waste Catalogue Commission Decision 2000/532/EC (b) Earth and sand wastes

Results & Discussion

1. Calcification of non-stabilised sludge

In figure 1 optimization of $Ca(OH)_2$ doses for alkaline stabilisation of a mixture of sludge are shown. Optimization were made according EPA guidelines, in this sense alkaline stabilised biosolids type A were obtained at minimum doses higher than 6.2% of $Ca(OH)_2$. Nitrogen loses between 25 and 30% were obtained (volatilisation of ammonium), while available phosphorous decay around 25% due to insolubilization of present phosphates.

Characteristics of mixture of calcified sludge (MCS) is shown in table 2. The concentration of heavy metals of the biosolids obtained were much lower than actual legal restrictions, or even than those proposed in the 3rd draft (i.e. Cd concentration of 4.1 mg/kg was obtains and limits are 40 mg/kg (actual) or 10 mg/kg (future). *Salmonella*, *E-coli*, *faecal streptococcus* and *staphylococcus aureus* were not detected

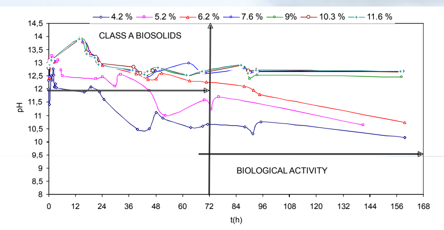


Figure 1. Time evolution of pH for mixtures of sludge at different powder $Ca(OH)_2$ doses (%).

2. Mixture of sludge and waste

Once optimized the process of calcification we proceeded to study the calcified sludge mixed with waste land (020 399) in different proportions according to production rate (FP in table 2). Initially the samples have high pH values that are reduced to values around neutrality (7.5-6.5) after 2 days. These pH values are appropriate of the intended application on agricultural soils slightly acidic (with pH values around 6). We studied the conditions of storage of finished product in aerobic and anaerobic conditions in order to establish the evolution of moisture, pH and possible biological degradation of organic matter. As shown in figure 2 for storage in aerobic conditions moisture is significantly reduced while the values of pH and organic matter content did not vary significantly. Under anaerobic conditions the pH decreases rapidly to values around 6, down slightly organic matter content and remaining constant moisture.

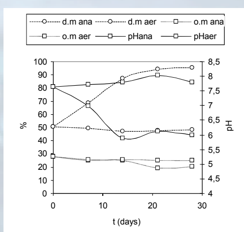


Figure.2. Time evolution of final product characteristics under aerobic (aer) and anaerobic (ana) storage conditions (d.m.: dry matter; om.: organic matter)

Table 2: Main Characteristics of mixed calcified sludge (MCS) and wastes (FP) employed in this work

Parameter	MCS	FP	Limit Soils pH<7	Limit Soils pH>7	Future EC limits (3th draft)
pH	12.3	8.6			
Dry matter (%)	24	47			
Organic matter (%)	15.5	13.63			
C/N	17	13			
NKT (%)	1.81	1.15			
NH_4^+ (%)	0.32	0.07			
K_2O (%)	0.24	0.32			
CaO (%)	17.89	1.81			
Mg (mg/kg)	0.16	0.23			
Fe (mg/kg)	0.08	0.69			
Cd (mg/kg)	4.1	<2	20	40	10
Cu (mg/kg)	15	7.7	1000	1750	1000
Ni (mg/kg)	24	14	300	400	300
Pb (mg/kg)	32	<30	750	1200	750
Zn (mg/kg)	48	26	2500	4000	2500
Hg (mg/kg)	<2	<2	16	25	10
Cr (mg/kg)	23	18	1000	1500	1000
Salmonella	Ausence	-			Ausence
E. Coli	Ausence	-			<$5x10^2$
Faecal streptococcus	Ausence	-			
Staphilococcus aureus	Ausence	-			

Conclusions

Alkaline stabilisation of sludge is an easy procedure to obtain stabilised biosolids from wastewater sludge and wastes from food industries. Final products are highly recommended as fertiliser to soil due to high organic content and very low metal concentration