**CHEMICAL ENGINEERING TRANSACTIONS** Volume 20, 2010
Editors Enrico Bardone, Aurelio Viglia
 ISBN 978-88-95608-12-9 ISSN 1974-9791
DOI: 10.3303/CET1020035

# Sintered Sewage Sludge As Support Material Used In Drinking Water Filtration

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The processing of industry and domestic effluents in wastewater treatment plants reduces the amount of polluted material and forms reusable water and dehydrated sludge. The generation of hazardous municipal sludge can be decreased, as well as the impact on surface and underground water and the risk to human health. The aim this study is to verify the possibility to use sintered sewage sludge as support material after thermal treatment in the production of a filtering material to water supply systems. After thermal treatment the sewage sludge ash was characterized by X-ray fluorescence (XRF), leaching test and water solubilization. Dehydration of sludge was performed by controlled heating at temperatures of 180°C, 350°C, 600°C, 850°C and 1000°C for 3 hours.

**Keywords**: support material, water filtration, water soluble, leaching.

## 1. Introduction

The ashes after fired are contaminated with metals in various concentrations. The inorganic particulate can be formed during the incineration of sludge. Usually, the sewage sludge ash content, in the dried sludge, a large quantity of toxic metals and halides derived from wastewater treatment (Petterson et al., 2008).
Solidification and stabilization are an alternative solution for disposal of sewage sludge containing heavy metals (Obrador et al., 2001; Andrés et al., 1998). Solidification/stabilization technologies are the processes used to treat inorganic and

Please cite this article as: Morais L., Dweck J., Campos V., Rosa A.H, Fraceto L.F. and Buchler P., (2010), Sintered sewage sludge as support material used in drinking water filtration, Chemical Engineering Transactions, 20, 205-210; DOI: 10.3303/CET1020035

organic waste materials, in which waste materials are mixed with various binding media to obtain a new product with improved physical properties.
Sintering stabilization is one of the methods to reduce the leachability of heavy metals in waste materials without increasing the volume of stabilized products (Viguri et al., 2000). This process can be used to produce ceramsite with sewage sludge as additive which has the potential to reduce the cost of sludge treatment (Xu, et al., 2006). The main concern is whether it is safe to use ceramsite made with sludge containing heavy metals.
The aim of the present work is to obtain a ceramic material to use in drinking water filtration.

## Material and methods

### XRF

The sludge sample fired at 1000°C for three hours and dried at 105°C were analyzed by X-ray fluorescence spectrometry using a Philips-PW2510 spectrometer with type tube PW2592/ 15 Rh and molten pastilles with Lithium Metaborate and Lithium Tetraborate, to determine oxides and trace elements as heavy metals.

### Leaching test

A liquid-to-solid ratio of 50:1 was used to determine 0.1M $HNO_3$ extractable and distilled water extractable metals. The 0.1M $HNO_3$ sludge solution was shaken for one hour. Al, Ba, Cr, Cu, Fe, Mn, Na and Zn leached were analyzed by inductively coupled plasma optical emission spectrometer (ICP-OES, an ARL-3410, sequential spectrometer, UK).

## Results and Discussion

### XRF

Tables 1 e 2 show XRF results of the sludge dried at 105°C and after sintering at 1000°C for 3 hours, expressed in oxide contents of major elements and in elemental composition of minor components. At 1000°C, the main oxides refer to those formed mainly due to the present clays dehydroxilation during simultaneous combustion of the organic components. Within the trace elements, it can be seen that after sintering, chlore presence is not significant due to the previuos volatilization in the form of chlorides. Fluor and sulphur contents also decreased significantly. When dried and sintered sludge analyses are compared, an increase of other trace elements content is noted, due to a natural concentration process in the mineral phases present in the original sludge solids.

*Table 1: XRF data of ash showing oxides.*

| Oxides(%) | 105°C | 1000°C - 3h |
|---|---|---|
| $SiO_2$ | 13,74 | 34,33 |
| $Al_2O_3$ | 7,63 | 20,14 |
| MnO | 0,040 | 0,075 |
| MgO | 0,64 | 1,8 |
| CaO | 2,45 | 6,57 |
| $Na_2O$ | 0,02 | 0,52 |
| $K_2O$ | 0,5 | 1,36 |
| $TiO_2$ | 0,694 | 1,75 |
| $P_2O_5$ | 3,537 | 9,774 |
| $Fe_2O_3$ | 5,71 | 14,43 |

*Table 2: Results of XRF data of ash for heavy metals and trace elements.*

| Elements (mg.kg$^{-1}$) | 105°C | 1000°C-3h |
|---|---|---|
| Ba | 735 | 1472 |
| Ce | 122 | 213 |
| Cl | 2552 | 15 |
| Co | 17 | 25 |
| Cr | 927 | 1078 |
| Cu | 842 | 1044 |
| F | 650 | 327 |
| Ga | 9 | 9 |
| La | 46 | 103 |
| Nb | 13 | 40 |
| Nd | 27 | 47 |
| Ni | 284 | 684 |
| Pb | 109 | 176 |
| Rb | 21 | 64 |
| S | 2914 | 157 |
| Sc | 8 | 19 |
| Sr | 111 | 322 |
| Th | 25 | 43 |
| V | 60 | 122 |
| Y | 10 | 39 |
| Zn | 2847 | 4123 |
| Zr | 172 | 554 |

**Leaching tests**

Tables 3 and 4 presents the results obtained in leaching test of the sintered sludge, with respect to solubility in distilled water and to acid extraction with HNO3 0,1M in pH = 1.01. This essays show that practically there is no solubilization of the heavy metals present in the original sludge, due to their stabilization in the ceramic matrix during the sintering process (Morais et al., 2006). This result also indicates that the sludge ashes can be used as raw materials in ceramic compositions with no environmental problems.

*Table 3: Water soluble elements concentrations.*

| Elemento | 180°C | 350°C | 600°C | 850°C | 1000°C |
|---|---|---|---|---|---|
| Cu | 0.072 | 0.06 | 0.001 | 0.001 | 0.001 |
| Fe | 0.036 | 0.331 | 0.03 | 0.026 | 0.231 |
| Mn | 0.028 | 2.666 | 0.164 | 0.061 | 0.001 |
| Zn | 0.423 | 14.22 | 0.227 | 0.047 | 0.001 |
| Ba | 0.001 | 0.107 | 0.073 | 0.014 | 0.001 |
| Na | 0.572 | 9.939 | 1.525 | 1.899 | 1.699 |
| Cr | 0.003 | 0.003 | 0.003 | 0.018 | 0.016 |
| Al | 0.002 | 0.002 | 0.002 | 0.002 | 0.075 |

*Table 4: Acid extractable concentrations.*

| Elemento | 180°C | 350°C | 600°C | 850°C | 1000°C |
|---|---|---|---|---|---|
| Cu | 0.201 | 1.559 | 0.97 | 2.242 | 1.735 |
| Fe | 0.468 | 9.441 | 1.722 | 1.994 | 0.677 |
| Mn | 0.129 | 2.165 | 0.689 | 3.565 | 2.65 |
| Zn | 1.589 | 29.45 | 2.843 | 5.171 | 2.792 |
| Ba | 0.018 | 0.475 | 0.298 | 0.299 | 0.922 |
| Cr | 0.003 | 0.076 | 0.003 | 0.147 | 0.016 |
| Al | 0.171 | 7.495 | 7.85 | 10.344 | 5.279 |

## Conclusions

The stabilization of the metals present in the sludge is very effective during the sintering process, which promotes their chemical insertion in the ceramic matrix formed during the thermochemical transformations of the mineral components of the sludge.
The lixiviation tests of the sludge ashes sintered at 1000ºC, indicate that the concentration of potentially toxic elements in the lixiviate is under the environmentally allowed limits for these elements, indicating their use as support material in drinking water filtration.

## Acknowledgments

The authors want to acknowledge São Paulo Research Foundation (FAPESP), CNPq e Fundunesp.

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