18 - 20 July 2018

4th International Congress

# water, waste and energy management

Madrid, Spain

# Scientific Program

# Welcoming Message

Dear Colleagues,

**The 4th International Congress on Water, Waste and Energy Management (WWEM-18)** is organized by academics and researchers belonging to different scientific areas of the University Complutense of Madrid, University Carlos III of Madrid, University of Extremadura and University of las Palmas de Gran Canaria with the technical support of Sciknowledge European Conferences.

This event has the objective of creating an international forum for academics, researchers and scientists from worldwide to discuss worldwide results and proposals regarding to the soundest issues related to Water, Waste and Energy Management.

This event will include the participation of renowned keynote speakers, oral presentations, posters sessions and technical conferences related to the topics dealt with in the Scientific Program as well as an attractive social and cultural program.

The papers will be published in the Abstracts E-book of the Conference. Those communications considered of having enough quality can be further considered for publication in International Conference Journals. At the authors' choice, those works not suitable for publication in any of the congress journals will be published in the Extended Abstracts E-book.

To finish, I hope that all of you will enjoy the Conference, and I wish our visitors from abroad will have a very pleasant stay in Madrid.

Thank you

Prof. Joaquín R. Domínguez Ph.D.
Chemical Engineering Department
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Spain, UE

## Poster Session

Topic 1 WASTE
Topic 2 WATER
Topic 3 ENERGY

### POSTER SESSION 1
### Wednesday, 18th July 2018

| Title | Author | ID | Topic |
|---|---|---|---|
| Industrial catalytic applications of valorized zinc oxide from non-ferrous metal waste | Enrique Añó | 414 | 1 |
| Thermal valorization of sludge wastes from Paper industry in a conical spouted bed combustor | Maria J San Jose | 476 | 1 |
| Characterization of Carbonized Porous Media manufactured by Sewage Sludge in Pyrolysis conditions | Younghan Yoon | 521 | 1 |
| Aerobic and anaerobic decomposition of wood sludge from pulp production with enzyme additions | Jiri Rusin | 549 | 1 |
| Analysis of the feasibility of the use as fertilizers, of leachates from a mechanical biological treatment plant for municipal solid waste | Jonathan Cardoso | 387 | 1 |
| Anaerobic digestion of selected waste biomass from the pharmaceutical industry | Katerina Chamradova | 551 | 1 |
| Dehydrated biomass recovered from processing of "biju" maize flour and its potential as new ingredient | Manoel Soares Júnior | 392 | 1 |
| Physicochemical quality and sensory acceptance of biscuits with partial replacement of wheat flour by dehydrated biomass recovered from processing of "biju" maize flour | Manoel Soares Júnior | 393 | 1 |
| Dehydrated biomass recovered from processing of "biju" maize flour in cereal bar | Márcio Caliari | 394 | 1 |
| Shelf life of cereal bar formulated with dehydrated biomass recovered from processing of "biju" maize flour, rice flakes and oat flakes | Márcio Caliari | 395 | 1 |
| Desorption of lead from a heavy metal-polluted calcareous soil | Antoine Karam | 399 | 1 |
| Nitrification process in treatment of leached sludge by a sequential batch biological reactor SBBR | Álvaro Chávez Porras | 610 | 1 |
| Vermicomposting in processes of decontamination of recalcitrant sludge | Álvaro Chávez Porras | 611 | 1 |
| Evaluation of solid residues from waste incineration | Veronika Blahuskova | 620 | 1 |
| Activated carbons prepared from a compost obtained in mechanical biological treatment plants for municipal solid waste processing | Helder Gomes | 624 | 1 |
| New concept of bioconversion of tanned leather fibres with applications in the construction industry | Gabriel Zainescu | 712 | 1 |
| High yield hydrogel systems obtained from leather wastes | Gabriel Zainescu | 713 | 1 |
| Exchangeable acidity in a residual peat soil amended with calcitic limestone | Antoine Karam | 766 | 1 |
| Biological degradation of the textile dye Remazol Blue using the pedicels of dates as a support and organic substrate for microbial consortia | Rezzaz-Yazid Hynda | 249 | 1 |

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and energy management

# Index

# Analysis of the feasibility of the use as fertilizers, of leachates from a mechanical biological treatment plant for municipal solid waste

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**1. Introduction –** The main environmental issue associated with the compost production is the production of a liquid leachate. Therewith, compost leachate may also be considered as a source of nutrients and used as fertilizer. The main pollution issue associated with this compost treatment is the production of a liquid leachate that is characterized by high organic load [1].

Although municipal waste compost leachate is one of the problems of compost production, it may be considered as a source of nutrients. Compost leachate from municipal wastes contains carbon, nitrogen, phosphorus, potassium and trace elements that can be used as nutrients by plants. The advantages of the use of organic wastes such as compost leachate as fertilizers are evident. Their use would reduce the consumption of commercial fertilizers which need in their production high cost and energy [2]. Leachate is a waste product, which means that no direct production costs are associated. The use of leachate in agriculture also means that the costs at waste treatment plants can be reduced, since processes for nitrogen and phosphorus removal would not be necessary [3].

In that point of view, this work aims to determine the chemical properties for a raw leachate from a mechanical biological treatment plant for municipal solid waste, to check if it meets the adequate requirements for using as commercial fertilizer according to the proposal of regulation of the European Parliament of 2016, for fertilizers [4]. This study intends to assess if the leachate can be used as potential source for fertilizers. It qualitatively meets the requirements established for the composition of commercial fertilizers and the production cost of leachate as raw material is low. Preliminary results showed low concentrations of heavy metals and suitable amounts of nutrients after the concentration of the leachate by simple batch distillation [5].

**2. Experimental –** TOC analysis was performed with 1:1000 dilution, in a Shimadzu TOC-L 5000A equipment while density assessment was done using 5 and 10 mL pycnometers dried for 24 hours.

Heavy metals quantification was performed by digesting the samples with $HNO_3$/HCl, filtration using a 0,2 µm syringe filter in a 50 mL volumetric flask, completed with a 5% $HNO_3$ solution, with subsequent analysis by atomic absorption spectroscopy.

Total Kjeldhal Nitrogen (TKN) analysis was performed by digesting the sample with $H_2SO_4$ and Kjeldhal catalyst for 30 minutes after a colorless solution forms, which is subsequently distillated. The distillate was collected using boric acid solution at 4% and then titrated using hydrochloric acid 0,0978M previously standardized. Ammoniacal Nitrogen was characterized through the distillation of the initial sample. The distillate was collected using boric acid solution at 4% and then titrated using hydrochloric acid 0,0978M previously standardized. Organic Nitrogen was calculated through the difference between Total and Ammoniacal Nitrogen.

Phosphorous analysis was performed by digesting the sample with $HNO_3$ for 45 minutes and then with $HClO_4$ for 1 hour until a colorless solution is formed. This solution is transferred to a 250 mL volumetric flask, which is filled. Afterwards it is filtered and 85 mL of the filtered solution is mixed with 15 mL of vanadate molybdate solution. The solution is left to rest for 10 minutes. The 500 ppm standard solution were prepared using 0,9640g of 40% purity $KH_2PO_4$, dried for 2h at 105°C, in 1000 mL volumetric flask. The standards solutions used for calibration are produced from the 500 ppm solution by adding aliquots containing 2,0 - 2,5 - 3,0 - 4,0 and 5,0 mL of the previously prepared $KH_2PO_4$ solution, 20mL of distilled water and 15mL of vanadate molybdate solution in 50 ml volumetric flasks, where the volume was completed. These solutions contain 20, 25, 30, 40 and 50 ppm of $P_2O_5$, respectively. The standards must stand for 10 minutes to complete color development and determination of the absorbance of the solutions is carried out at 400 nm using as a blank the solution containing 20 ppm of $P_2O_5$. From the obtained data, the regression equation is calculated, and the samples concentrations are obtained. The percentage of $P_2O_5$ is calculated using equation I where C is concentration in ppm of $P_2O_5$ in the sample, A is volume of the aliquot taken from the extract, in mL, for this analysis, 85 mL, and G is initial mass of the sample, in grams.

$$\%P_2O_5 = \frac{1,25C}{AG} \qquad \text{(I)}$$

**3. Results and Discussion** – Chemical properties of the original leachate and the concentrated leachate are summarized in Table I. The original raw leachate used as initial sample must be concentrated to fulfill the requirements of the EU fertilizers legislation. Some samples are processed to reach 3% of TOC and the density and heavy metals concentration was determined in the concentrated samples. As shown in Table I, Cd and Cr must be removed to achieve the fertilizer requirements. However, the concentrate leachate still show potential to produce a viable commercial fertilizer.

**Table I.** Chemical properties of the leachates samples.

| Samples | % TOC | Density (mg/L) | Cd (mg/kg) | Pb (mg/kg) | Ni (mg/kg) | Cr (mg/kg) |
|---|---|---|---|---|---|---|
| EU Legislation, 2016 | 3,00 | - | 1,50 | 120,00 | 50,00 | 2,00 |
| Original leachate | 0,14 | 1,01 | - | - | - | - |
| 24x | 3,48 | 1,15 | 1,64 | 4,42 | 13,74 | 3,28 |
| 36x | 3,53 | 1,13 | 1,74 | 4,85 | 13,65 | 4,73 |
| 45x | 4,69 | 1,22 | 2,34 | 6,99 | 18,29 | 4,64 |
| 45x | 4,30 | 1,20 | 2,37 | 5,99 | 18,47 | 6,37 |
| 50x | 3,54 | 1,02 | 2,48 | 6,99 | 20,98 | 4,82 |
| 90x | 7,01 | 1,34 | 3,75 | 8,99 | 36,02 | 7,46 |

It's observed that the organic carbon content has a strong influence on the final density of the concentrate obtained. Hence some statistical resources can now be used to verify the correlation between bulk density and TOC. Using the test of significance for Spearman's correlation coefficient, it is concluded that there is a significant correlation for significance tests with α = 0.05 and α = 0.01. Therefore, it can be stated with 99% certainty that there is a significant correlation between density and TOC.

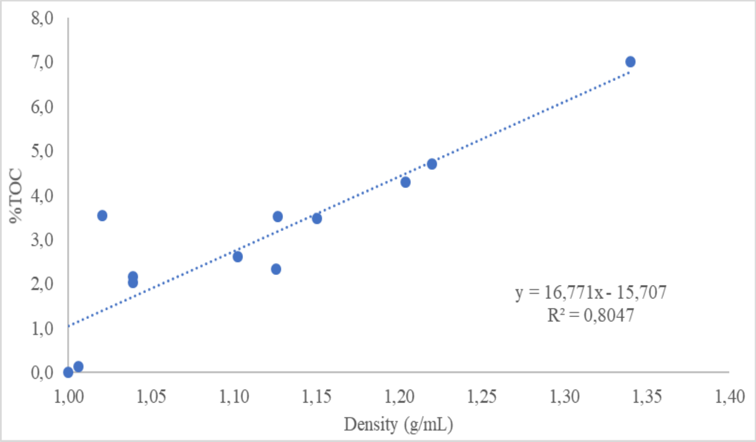

**Image I.** Correlation between density and TOC.

The procedure for the characterization of organic nitrogen was carried out to obtain parameters for the leachate in the legislation. The results obtained through the difference of values between the total and ammoniacal nitrogen are shown in table II, the analysis was proceeded only using the original leachate, that's because with the distillation process amount of nitrogen is lost due the heating used.

**Table II.** Concentration of total, ammoniacal and organic nitrogen.

| Sample | TKN | Ammoniacal | Organic |
|---|---|---|---|
| | N (%w/w) | N (%w/w) | N (%w/w) |
| 1 | 0,0286 | 0,0227 | 0,0059 |
| 2 | 0,0245 | 0,0231 | 0,0014 |
| 3 | 0,0272 | 0,0227 | 0,0045 |
| 4 | 0,0259 | 0,0222 | 0,0036 |
| 5 | 0,0218 | 0,0215 | 0,0002 |
| 6 | 0,0231 | 0,0218 | 0,0014 |
| 7 | 0,0211 | 0,0209 | 0,0002 |
| 8 | 0,0218 | 0,0209 | 0,0009 |
| 9 | 0,0218 | 0,0211 | 0,0007 |

According to European Union legislation, in order to be considered as a liquid organ mineral fertilizer, the fertilizer product must contain at least one of the following declared nutrients in the minimum quantities: 2% by weight of total nitrogen (N), of which 0,5% by mass of the fertilizer product must be organic nitrogen (N) or 2% by weight of total phosphorus pentoxide ($P_2O_5$) or 2% by mass of total potassium oxide ($K_2O$). Therefore, as the nitrogen values do not fit the values described in the legislation, it is necessary to carry out the Phosphorus and Potassium analyzes, using the concentrated leachates, to verify the possible setting in one of the required nutrients.

For the characterization of total phosphorus, the standard solutions were produced with concentrations of 20, 25, 30, 40 and 50 mL, respectively, to obtain the regression curve for the calculation of the phosphorus concentration in the samples. The image II shows the regression curve obtained for all standard solutions at 400 nm.

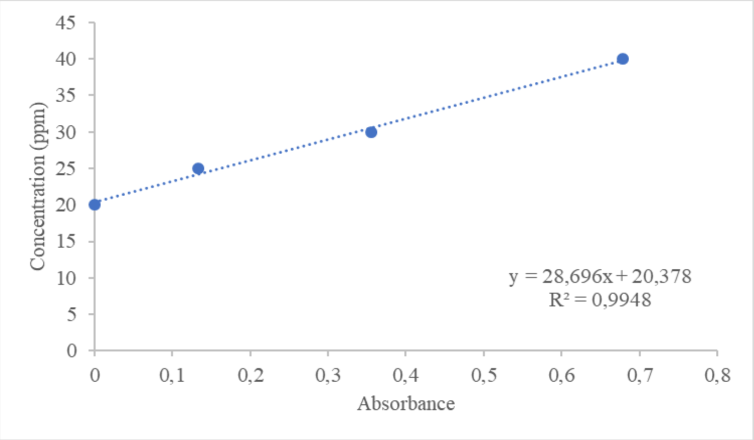

**Image II.** Regression curve of standards solutions.

The samples were characterized in sequence, following the same conditions applied to the standards. In Table III data referring to absorbances, concentration in ppm and %w/w of each sample is presented, in addition to the minimum concentrations required by the legislation.

**Table III.** Concentration %w/w of $P_2O_5$

| Sample | Absorbance | Concentration (ppm) | Concentration (% m/m) |
|---|---|---|---|
| EU Legislation, 2016 | - | - | 2 |
| 24x | 0,144 | 25,521 | 0,036 |
| 50x | 0,345 | 30,278 | 0,039 |

The values obtained are below the minimum required by the legislation, even in more concentrated samples such as that was concentrated 50 times compared to the original residue. These values denote a low concentration of $P_2O_5$ in the sample collected from the supernatant residue in the storage tank. More concentrated samples, such as the solids decanted in this collection tank, may present higher phosphorus levels without the need for further concentration processes. Another alternative is the collection of samples readily at the exit of the anaerobic treatment process, since these materials should be more homogeneous.

**4. Conclusions –** The concentrated leachate has potential to be used as fertilizer after simple processing. It shows high concentration of total organic carbon (TOC) and low levels of heavy metals but some adjustments must be made to tune the concentration of these components.

Nitrogen and phosphorus presented low concentrations, mainly due to the composition of the sample used since more than 99% of the original sample was composed of water. Samples that are more concentrated in organic content should be analyzed, as well as the samples taken directly at the exit of the composting process, instead of the storage open tank where the effluent is collected, before it is sent to the treatment process. These samples may show higher levels of organic carbon and nutrients without requiring an initial concentration process. Seasonal factors also lead to difficulties in the characterization of the residues due to the variation of the composition of the material, which is exposed to weather conditions and external contaminants. This factor can be solved through the introduction of an agitated batch mixing previous step, minimizing the need for further composition tuning processes, in order to adapt the liquid waste to fertilizer legislation composition requirements.

However, the potential for the use of these wastes as fertilizers is still great as there is the production of a high value-added material and, in addition, the recycling of wastes that are currently treated only as polluters.

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