Figure 2: Linear equations for kinetic calculations (K'' and A).

Steel magnetic residue used as substrate to treat and adsorb amoxicillin- kinetic studies

G.F. da Silva, L.C. Freitas , N. Ortiz

Institute for Nuclear and Energy Research -IPEN, São Paulo - Brazil
http://www.ipen.br
nortiz@ipen.br

INTRODUCTION

The development of the antibiotics is probably one of the most important improvement for medicine and public health. Recently, monitoring results indicate those compounds and derivatives have been also widely discharged in water resources (Figure 1). Their presence in surface water can cause significant interference with the physiology, metabolism and behaviour of the species and alter some immune defences of affected organisms. The low cost adsorption processes can promote sewage and wastewater treatment before those compounds reaches the water reservoir. The use of steel industry solid residue- the magnetite as a magnetic substrate with surface deposition of an abundant bentonite clay have been promoting the amoxicillin and derivatives removal from sewage and wastewater. Published works indicate the magnetite and bentonite clay adsorption process shows correspondence with Langmuir, Freundlich and Temkin isotherm (Maichin et al, 2013)(Ortiz, et al, 2001) .

Figure 1: Pharmaceutics incorrect discharge

METHODS

The magnetite was collected as small particles in air filters, periodically washed and the resultant sludge was pumped to a press filter series. The cake (17 ton / day) with 26 % moisture was collected and characterized. The results confirmed the main composition of small particles of magnetite 98% as the following steps:

- The sludge was dried, crushed and separated in different particle size those fractions were stabilized by the addition of acid suspension of bentonite clay.
- The surface treatment with organophilic clay was chosen accordingly with its purpose of organic compound adsorption, the clay is traditionally used to clarify some comestible oil.
- The solutions of amoxicillin were prepared as recommended by the United States Pharmacopeia 3, 2005 (USP 31).
- The identification and quantification was performed using Cary-UV-Vis spectrophotometer at 273nm.
- The adsorption process was studied using a reactor with a capacity of 500 mL, with heating system, mechanical stirrer, thermometer, an electrode to monitor the pH values and the collection of aliquots on different time intervals.
- The parameters optimization was obtained using design experiments project.

• Figure 2: The magnetite material

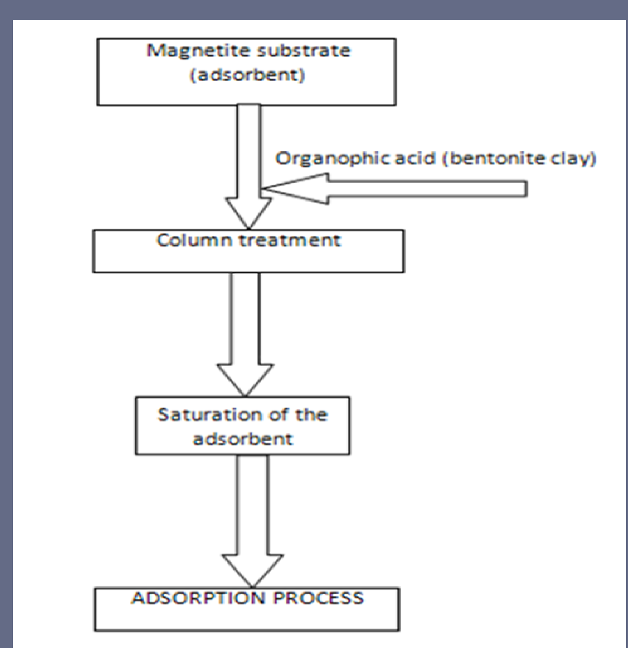

Figure 3: Magnetite surface treatment

RESULTS AND DISCUSSION

The Figure 3 was prepared using the experimental results and the equations I and II for the determination of K_{ab}, K'' and A, Table 1.

Calculation of the adsorption rate (K_{ab})

$$\log (C - C_e) = (- K_{ab} / 2{,}303)\, t + \log q_e \qquad \text{I}$$

Kinetic model of the variation of concentration by stirring time

$$\log(\log(t+1)) = \log K'' + A \log (C_o-C) \qquad \text{II}$$

Where: A- Empirical constant for the kinetic modeling, C_e=Amoxicillin concentration in equilibrium (mg L^{-1}), C_o – Initial amoxicillin concentration (mg L^{-1}), K'' – Empirical constant for kinetic modeling, K_{ad}- Adsorption rate (mg g^{-1} min^{-1}), q_e –amoxicillin adsorbed mass (mg g^{-1}), t_e - equilibrium time(min) and t- stirring time (min).The comparison between the adsorption rates on different temperatures indicates the better correspondence with endothermic process and the K_{ab} values had correspondence with those found in literature, in the range of 5.10^{-3} to 87 $.10^{-3}$ mg.g^{-1}.min^{-1} for Fe(III) and Cr(III) wastes, Ortiz(2001) and Namasivayam (1993).

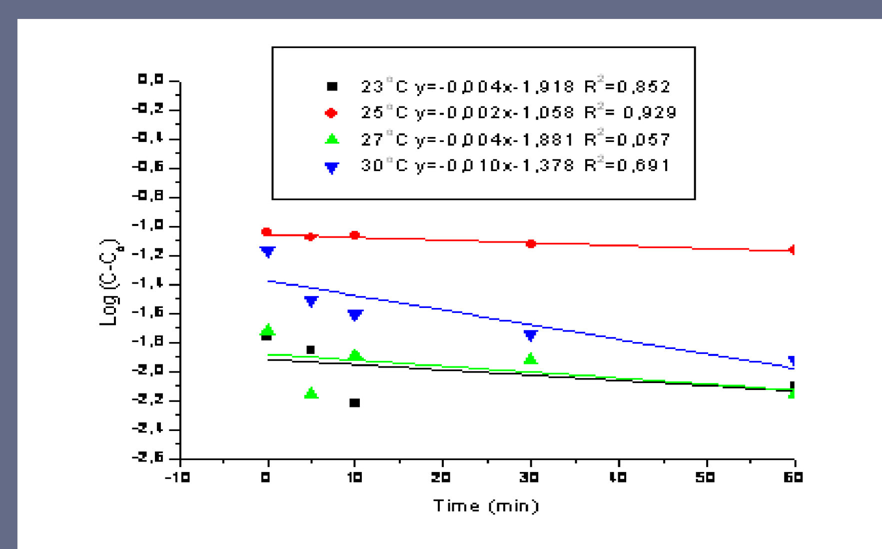

Figure 4: Linear equations for kinetic calculations (K'' and A).

Table 1: Kinetic Results

Adsorption Temperature (°C)	K_{ab} (mg.g^{-1}.min^{-1})	K'' (.10^{-3})	A
23	9,2	6,4	1,30
25	4,6	7,6	2,67
27	9,2	8,7	0,53
30	23,0	41,8	0,55

CONCLUSIONS

The conclusion was the use of the adsorbent substrate prepared with magnetite (the abundant and low cost converter slag) is promising, as magnetic material with surface deposition of organophilic bentonite clay showing 74% of amoxicillin removal percentage, in endothermic process with follows Langmuir, Freundlich and Tempkin isotherms. A novel low cost method to treat and remove pharmaceutical compounds from effluents and wastewater before discharge in surface water resources.

Maichin, F; Freitas, L.C.; Ortiz, N.(2012), The use of converter slag – magnetite to decompose amoxicillin by Fenton Oxidation Process-Proceedings of the 10th Leading Edge Technologies on Water and Wastewater –Bordeaux France, S-12-01740.

Namasivayam, C. Ranganathan, K. (1993), Waste Fe(III) /Cr(III) hydroxide as adsorbent for the removal of Cr VI from aqueous solutions and chromium plating industry wastewater . Environmental Pollution, 82, 255-261.

Ortiz,N.;Pires, M.A.F.; Bressiani, J.C. (2001), The use of converter slag as nickel absorber to wastewater treatment –Waste management Journal, 21, p. 631-635.

Acknowledgements: The authors acknowledge the Brazilian National Research Council