



# COMPARISON OF REMOVAL OF COPPER (II) IONS FROM AQUEOUS SOLUTIONS BY BIOSORPTION ONTO OLIVE STONE AND PINE BARK

M.A. Martín-Lara; G. Blázquez; G. Tenorio, M. Calero

Chemical Engineering Department. University of Granada. Avda. Fuentenueva s/n 18071 – Granada (Spain).

Olive stone (OS) and pine bark (PB), two agricultural solid waste by-products have been used as effective and efficient biosorbents for the removal of Cu(II) from aqueous solutions. Batch adsorption experiments were carried out as a function of initial metal ion concentration. Equilibrium data agreed well with Langmuir isotherm model. The biosorption capacities of pine bark and olive stone for Cu(II) were determined at 25°C with the Langmuir model as 11.94 mg/g and 1.97 mg/g, respectively. Specially, pine bark was shown to be a promising biosorbent for Cu(II) removal from aqueous solutions.

## EXPERIMENTAL

### Biosorbent preparation:

**Olive stone (OS):** was provided by an oil extraction plant "Cooperativa Nuestra Señora del Castillo" located in Vilches, province of Jaen (Spain).

**Pine bark (PB):** was provided by the company Carsan Biocombustibles, S.L. located in Padúl, province of Granada (Spain).

The two solids were milled with an analytical mill (IKA MF-10) and <1.000 mm fraction was chosen for the biosorption tests without any pre-treatment.

### Batch biosorption experiments:

Equilibrium isotherm studies were conducted at 25°C with a constant amount of biosorbent (10 g/L), at a constant pH 5 for over 100 minutes, and for an initial metal concentration between 10 and 300 mg/L (prepared using CuSO<sub>4</sub>·5H<sub>2</sub>O in distilled water) to evaluate the copper biosorption capacity of PB and OS. Experimental setup is shown in Figure 1. Then, the mixture was centrifuged and filtrated and finally, the Cu<sup>2+</sup> in the remaining solution was then analyzed in an Atomic Absorption Spectrometer.

The amount of metal uptake was obtained by the following equation:

$$q_e = \frac{(C_0 - C_e) \cdot V}{m}$$

where  $q_e$  (mg/g) is the amount biosorbed,  $C_0$  (mg/L) and  $C_e$  (mg/L) are the initial and the equilibrium concentration, respectively while  $m$  (g) is the mass of biosorbent and  $V$  (L) is the volume of solution.

## RESULTS AND DISCUSSION

The biosorption isotherm indicates how the sorbate molecules distribute between the liquid phase and the solid phase at equilibrium. The analysis of the isotherm data by fitting them to different isotherm models is an important step to find the suitable model that can be used for design purpose. In this research, biosorption isotherm study was carried out on one well-known two-parameter isotherm: Langmuir isotherm.

The Langmuir isotherm represents the equilibrium distribution of metal ions between the aqueous and solid phases following the equation:

$$q_e = \frac{b q_m C_e}{1 + b C_e}$$

where  $C_e$  is the equilibrium copper solution concentration (mg/L),  $q_e$  is the amount of copper biosorbed onto the solid at equilibrium (mg/g),  $q_m$  is a Langmuir constant of the maximum copper uptake (mg/g) and  $b$  is also a Langmuir constant of the ratio of the biosorption rate constant to the desorption rate constant, which is related to the energy of sorption through the Arrhenius equation.

As seen from Figure 2, both sorbents fit quite well into the Langmuir model. The correlation coefficients were extremely high as shown in Table 1. The maximum biosorption capacity of the OS and PB biomass regarding copper ions are found to be 1.97 and 11.94 mg/g, respectively. The value of  $b$  for OS and PB are 0.0208 and 0.0247 L/mg, respectively.

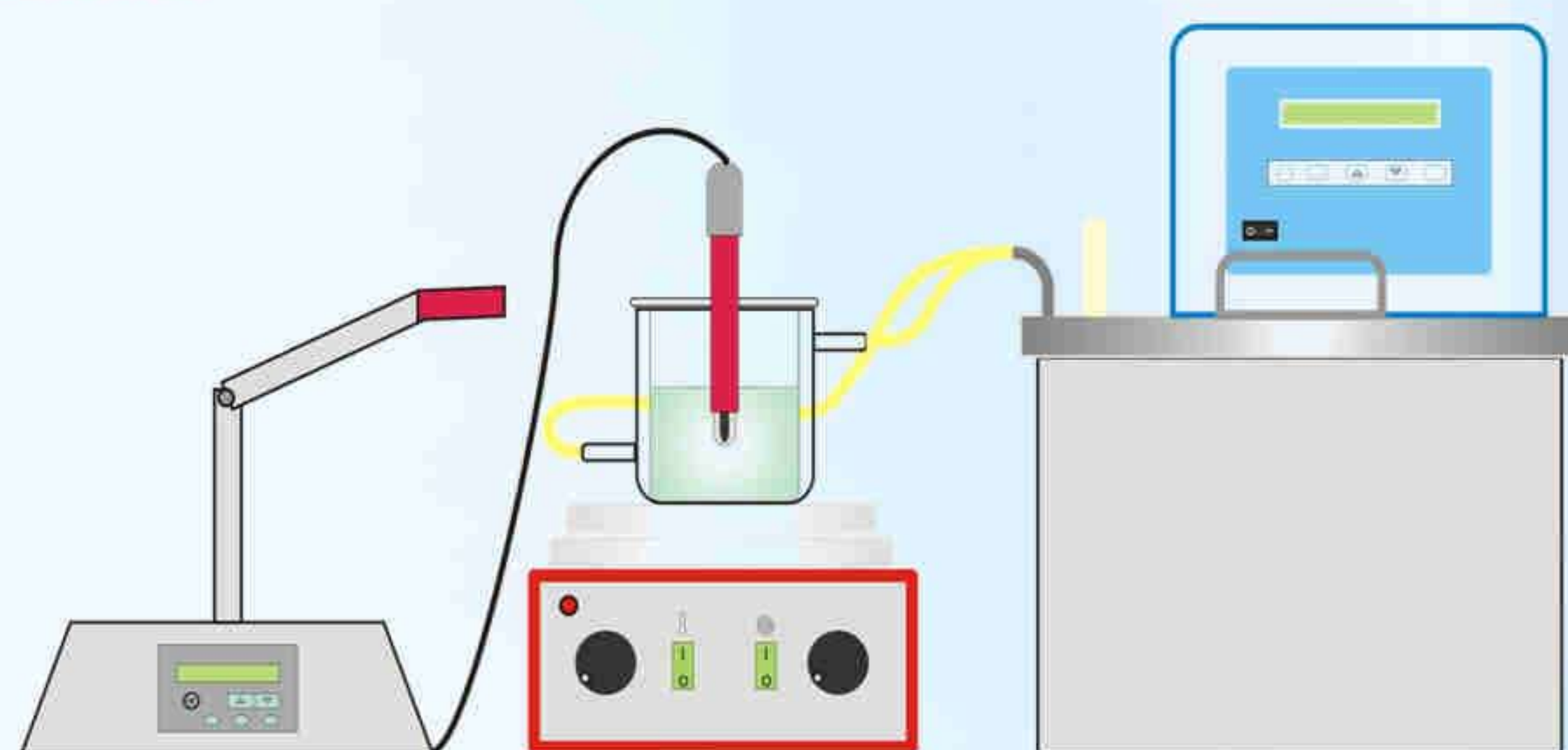
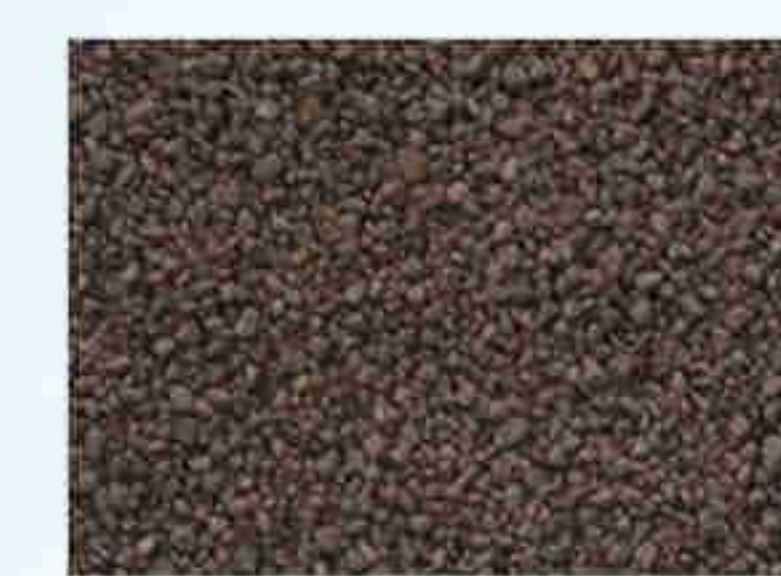


Figure 1. Experimental setup for batch biosorption experiments

Table 1. The comparison of the Langmuir constants obtained from biosorption isotherms of Cu(II) ions by OS and PB

Biosorbent	$q_m$ , mg/g	$b$ , L/mg	$R^2$
OS	1.97	0.0208	0.961
PB	11.94	0.0247	0.983

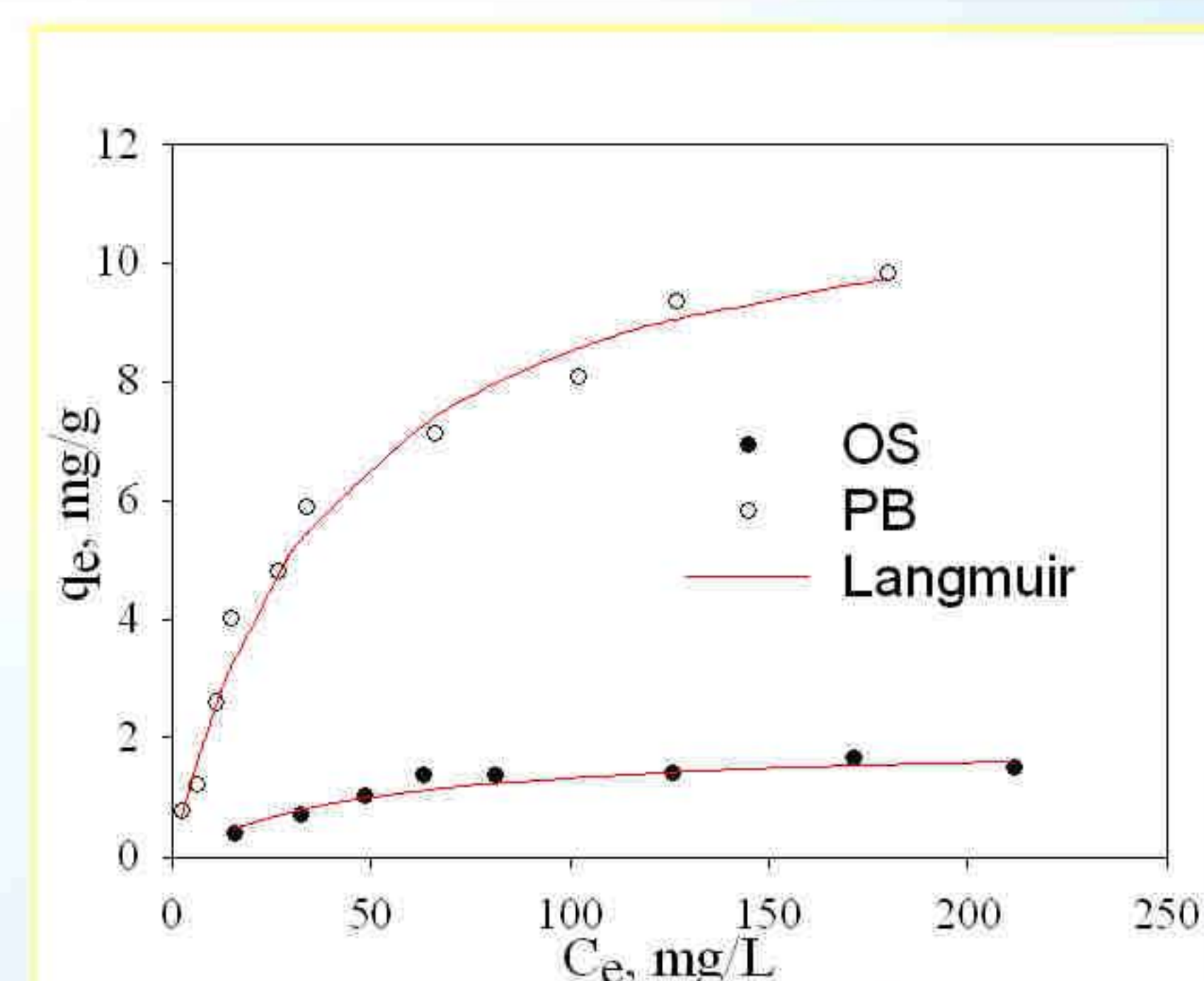


Figure 2. Langmuir plots for copper(II) ion sorption by OS and PB ([biosorbent] 10 g/L; temperature 25°C; pH 5)

### ACKNOWLEDGEMENTS

The authors thank the Ministry of Science and Innovation (Spain) for financial support of the Project CTM2009-10294.