SORPTION PROPERTIES OF PLANT-DERIVED SILICA IN RELATION TO Pb(II) IONS AND METHYLENE BLUE

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Silica (SiO_2) is a material of significance, exhibiting a variety of forms and properties that are contingent on its provenance and the methodologies employed in its production. Depending on its properties, silica can be used in different areas: as a filler for tires and rubber products, as a hygienic filler, for the production of cosmetics and toothpaste, for beer filtration, for construction, for paint and varnish materials, etc.

Depending on the field of application of silica, different requirements are imposed on its different types regarding composition, purity, morphology, sorption and surface properties, in order to ensure its effective and safe use.

In this study, four types of silica obtained by different methods are considered: a reference sample obtained by hydrolysis of tetraethoxysilane by the modified Stöber method (sample ST); silica obtained by calcination of rice husk (sample SC); silica gel obtained from liquid glass synthesized from rice husk (sample SG); and silica precipitated in an alkaline medium from liquid glass synthesized from rice husk (sample SP). The objective of this study is to analyse the sorption properties of silica and to establish their dependence on the method of preparation.

Table – Characteristics of the obtained samples

Sample	**ST**	**SC**	**SG**	**SP**
Purity SiO_2, %	99,56	99,20	97,83	98,52
PZC	5,41	6,77	6,16	6,48
A_∞ (Pb), mmol/g	0,079	0,064	0,655	0,012
A_∞ (MB), mmol/g	0,274	0,026	0,124	0,043
SSA, m^2/g	309,7	29,5	139,6	48,6

A wide maximum is observed in the X-ray diffractograms, the position of which varies from 19° to 24° for different samples, all samples are X-ray amorphous. In the IR spectra of all samples, with the exception of SC obtained by calcination, there is an absorption band in the region of 945–966 cm^{-1} corresponding to the bonds in the silanol groups of Si–OH, which are sorption centres. This is confirmed by the minimum sorption capacity of the SC sample with respect to methylene blue (MB).

The samples of silica deposited from liquid glass in different ways (SG and SP) have almost identical infrared spectra. However, silica deposited in the form of silica gel has been shown to possess a significantly higher sorption capacity (see Table). This capacity in relation to methylene blue is 2.9 times higher than that of precipitated silica (sample SP) and 53 times higher in relation to lead. Silica obtained by TEOS hydrolysis has the maximum capacity with respect to MS, but a low capacity with respect to lead.

In order to characterise the surface of the obtained materials, the point of zero charge was determined. The value of the point of zero charge in silica samples ranges from 5.41 to 6.77, indicating that the surface of the material is negatively charged in a neutral medium. This is attributable to the presence of silanol groups. Methylene blue is a cationic dye and is positively charged, exhibiting significant electrostatic attraction to the negatively charged silica surface. This explains why the material exhibiting the lowest point of zero charge (sample ST) demonstrated the maximum sorption capacity towards MS. This phenomenon can be attributed to the lower value of surface charge, which favours interaction with cationic dyes.

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