PHYSICAL CHEMISTRY 2004

Proceedings

of the 7th International Conference on Fundamental and Applied Aspects of Physical Chemistry

Volume I and II

September 21-23, 2004
Belgrade, Serbia and Montenegro

PHYSICAL CHEMISTRY 2004

Proceedings

of the 7th International Conference on Fundamental and Applied Aspects of Physical Chemistry

Volume I and II

Editors
A. Antić-Jovanović and S. Anić

ISBN	86-82457-12-x
Title:	Physical Chemistry 2004. (Proceedings)
Editors	A. Antić-Jovanović and S. Anić
Published by:	The Society of Physical Chemists of Serbia, Studentski trg 12-16, P.O.Box 137, 11001 Belgrade, Serbia and Montenegro
Publisher:	Society of Physical Chemists of Serbia
Printed by:	"Jovan" Printing and Published Comp; 300 Copies; Number of Pages: x + 906; Format B5; Printing finished in September 2004.
Text and Layout:	Aleksandar Nikolić

300 – copy printing

DETERMINATION OF THE POINT OF ZERO CHARGE OF ALUMINA BY BATCH EQUILIBRATION METHOD

Ž. N. Todorović and S. K. Milonjić

Vinča Institute of Nuclear Sciences, P.O.Box 522, Belgrade, Serbia&Montenegro

Abstract

In this work we present the points of zero charge, pH_{pzc}, of five commercial alumina samples, of an alumina/solution ratio of 0.100g/25 ml, obtained by batch equilibration method. As an inert electrolyte, KNO_3 of 0.001 - 0.1 moldm^{-3} concentration was used. The obtained points of zero charge values are about 7 and they are independent of KNO_3 concentration, except the sample labeled as ICN (Alumina B). In this case, the increase in electrolyte concentration (from 0.001 to 0.1 moldm^{-3}) leads to a decrease in pH_{pzc} (from 7.5 to 6.7) indicating specific sorption of K^+ ions on the sample.

Introduction

The point of zero charge of a solid, pH_{pzc}, represents the suspension pH value at which an immersed solid surface has zero net charge or the amounts of positive and negative charges are equal. The isoelectric point, pH_{iep}, is defined as the pH at which the ζ-potential = 0. If there is no specific adsorption of ions on the oxide surface, these two points will be equal. Specific adsorption of cations shifts pH_{pzc} and pH_{iep} towards lower and higher pH values and the specific adsorption of anions shifts these two points to the opposite directions [1,2].

The point of zero charge can be determined by several methods. The most widely used are the batch equilibration method described by one of the authors [3], acid-base potentiometric titration [4], mass titration [5], electrophoresis, and electroosmosis method [6].

In this work, we present the results of the point of zero charge, pH_{pzc}, of alumina obtained by batch equilibration method, for five commercial alumina samples.

Table 1. The point of zero charge of studied alumina samples

No	Al_2O_3 samples different producers	pH_{pzc}
1	Merck	7.0
2	Kemika	6.6
3	ICN(Alumina B)	6.7-7.5
4	ICN (Adsorbentien)	6.8
5	Alcoa A16	6.9

Experimental

Five commercial alumina samples were investigated and the results are given in Table 1. All alumina samples were used as received, purity more than 99.5%. All other chemicals were of analytical reagent grade.

The pH_{pzc} were investigated in aqueous KNO_3 (as an indifferent electrolyte) solutions, concentrations 0.1-0.001 mol dm^{-3}. Samples of alumina

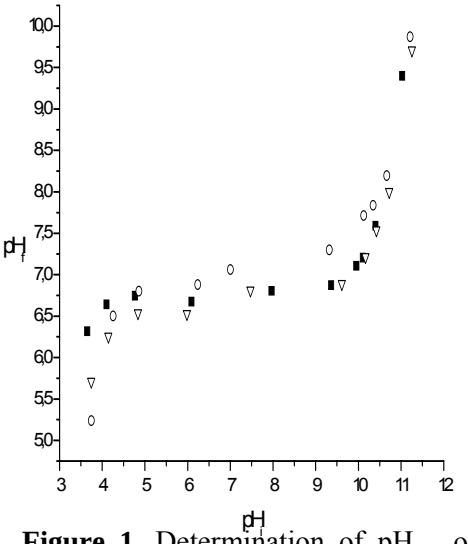

Figure 1. Determination of pH_{pzc} of ICN (Adsorbentien) alumina sample in KNO_3 solutions of ○-0.001, Δ-0.01 and ■-0.1 mol dm^{-3} concentrations (pH_i-initial value, pH_f- final value)

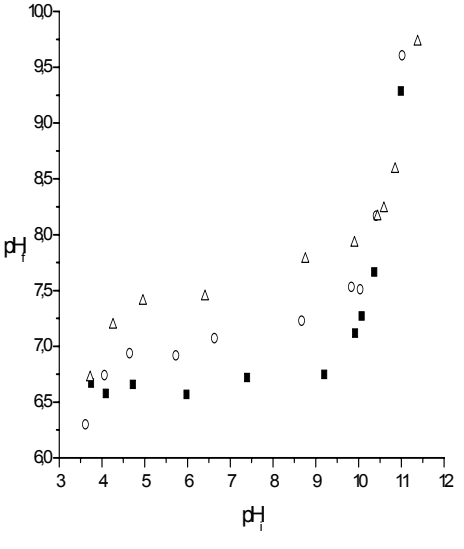

Figure 2. Determination of pH_{pzc} of ICN (Alumina B) alumina sample in KNO_3 solutions of Δ-0.001, ○-0.01, and ■-0.1 mol dm^{-3} concentrations.

(0.100 g) with 25 ml of 0.1, 0.01 or 0.001 mol dm^{-3} KNO_3 solution of different pH values were shaken in PVC vials for 24 h. Initial pH values were obtained by adding a small amount of HNO_3 or KOH solution (0.1 mol dm^{-3}), keeping the ionic strength constant. The amount of H^+ or OH^- ions adsorbed by alumina was calculated from the difference between the initial and the final concentration of H^+ or OH^- ions. A Beckman pH-meter was used to determine the concentration of H^+ or OH^-.

Results and Discussion

Experimental results obtained for pH_{pzc} of ICN (Adsorbentien) alumina sample are illustrated in Figure 1. As can be seen, the final pH (pH_f) is presented as a function of initial pH values (pH_i) of the solution, for three different KNO_3 concentrations. pH_f are pH values of filtered solutions after equilibration. The point of zero charge, pH_{pzc}, represents the pH_f level where a common plateau is obtained. The pH_{pzc} value for this alumina sample is 6.8.

Table 1 presents the pH_{pzc} values obtained for all investigated alumina samples. They are all close to 7.

pH_{pzc} of alumina is very sensitive to surface treatment, synthesis process, presence of impurities, etc. A literature review showed that the measured pH_{pzc} vary significantly from 5 to 9.4 [7]. As found in our previous study [8], the point of zero charge of alumina depends on the solid/liquid ratio. Increase in alumina/solution ratio (up to 2.00g/25ml) leads to an increase in pH_{pzc} value. All results presented in this work were obtained for the solid/liquid ratio 0.100g alumina/25 ml KNO_3.

Also, determination of pH_{pzc} in KNO_3 solutions of different concentrations gave the same results. It means that pH_{pzc} is independent of the ionic strength of KNO_3 solutions. The same results were obtained for other investigated samples, except ICN

(Alumina B). The pH_{pzc} of this sample is dependent on KNO_3 concentration (KNO_3 is not an indifferent electrolyte). An increase in electrolyte concentration decreases the pH_{pzc}, and leads to the specific sorption of K^+ -ions on the sample (Figure 2). pH_{pzc} is 7.5, 7.0 and 6.7 for KNO_3 concentration of 0.001, 0.01 and 0.1mol dm^{-3} , respectively.

Conclusion

The points of zero charge of five commercial aluminas are determined by the batch equilibration method in KNO_3 solutions. For solid/liquid ratio of 0.100g/25ml, the obtained pH_{pzc} values are around 7. KNO_3 is an indifferent electrolyte for all used commercial samples except ICN (Alumina B). In this sample, K^+-ions are specifically sorbed on the alumina surface.

Acknowledgements

The research reported in this paper was supported by the Ministry of Science and Environment Protection of the Republic of Serbia (Project 1978).

Reference

[1] N. Kallay, V. Hlady, J. Jednaček-Bišćan, S. Milonjić, Investigation of Surfaces and Interfaces-Part A. Physical Methods of Chemistry Series, B.W. Rosites, R.C. Beatzold, editors, 2nd ed., Vol.IXA, A. Wiley-Interscience, New York, 1993.
[2] S.K. Milonjić, Ph. D. Thesis, University of Belgrade, Belgrade, Serbia&Montenegro, 1981.
[3] S. K.Milonjić, A.Lj. Ruvarac M.V. Šušić, Thermochimica Acta, 1975, 11, 261.
[4] G. A. Parks, P.L. de Bruyn, J. Phys. Chem., 1962, 66, 967.
[5] J. S. Noh, J. A Schwarz, J. Colloid Interface Sci., 1989, 130, 157.
[6] H. Sadek, A.K. Helmy, V.M. Sabet, Th.F. Tadros, J. Electroanal. Chem. 1970, 27, 257.
[7] M. Kosmulski, J.of Coll.Interf. Sci. 2002,253,77-87.
[8] Ž.N. Todorović,S.K. Milonjić, S.P. Zec, V.T. Dondur,Mat. Sci.Forum, 2004, 453/454, 361.