AJChE 2007, Vol. 7, No. 2, 137-140

Study of the Peptizability of Boehmite and Its Application for the Formation of γ-Al_2O_3 in Spherical Shape

Tran Vinh Hoang
Tran Dai Lam
Pham Thanh Huyen
Nguyen Han Long
Faculty of Chemical Technology, Hanoi University of Technology
Dai Co Viet Street, Hanoi, Vietnam

This paper shows the results of the peptizability of boehmite and its application for the formation of γ-Al_2O_3 in spherical shape. The obtained γ-Al_2O_3 in spherical shape have high mechanical strength and high surface area. The water vapor adsorption ability of sphere of γ-Al_2O_3 has also been determined. The γ-Al_2O_3 in spherical shape can adsorb moisture up to 65% of their weight.

Keywords: Adsorption, boehmite, peptizability, *and* γ-Al_2O_3.

INTRODUCTION

γ-Al_2O_3 is a mesoporous material which has high acidity, activity, and good mechanical and thermal strength. Hence, γ-Al_2O_3 is widely used as adsorbent and catalyst in the refinery and in petrochemical technology, in particular; and, in the chemical industry in general (Leach 1984, Farrauto and Barholomew 1999). However, in order to use it in chemical processes, besides the study to increase its surface area (Huyen, Long, and Hoang 2005), the formation of γ-Al_2O_3 in spherical shape is very important.

One of the most important properties of boehmite is its peptizability to be the binder for other materials that do not have this ability. So the application of boehmite as the binder has greatly increased the value and the application range of γ-Al_2O_3 and other materials.

The refinery and petrochemical industry is being developed in Vietnam. Each year, a large amount of γ-Al_2O_3 in spherical shape is imported to be used as the adsorbent in the drying of natural gas. So finding a procedure to synthesize γ-Al_2O_3 in spherical shape from cheap and available domestic raw material is very necessary.

EXPERIMENTAL

γ-Al_2O_3 has been synthesized from available domestic raw materials, such as waste aluminum, Tan Binh aluminum hydroxide, and industrial aluminous material.

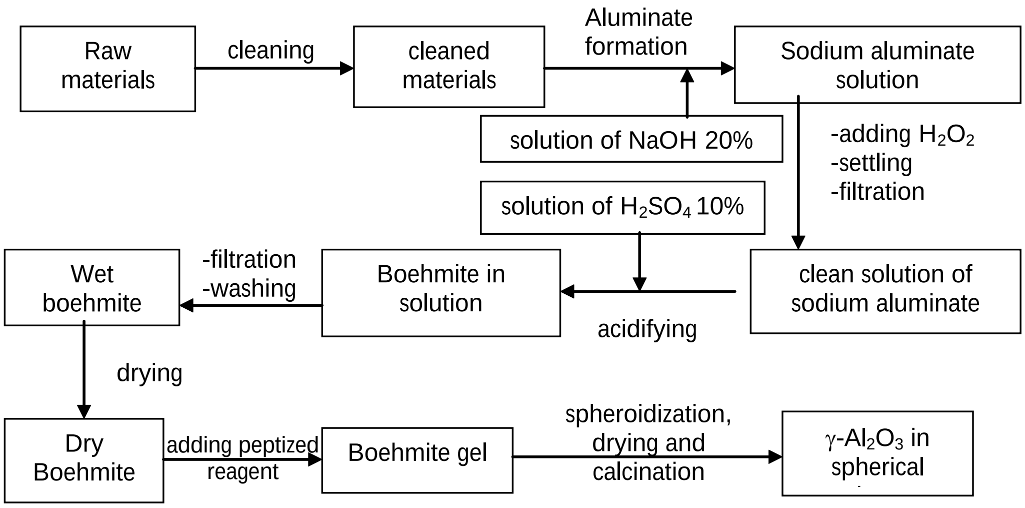

Figure 1. Procedure for the Synthesis and Spheroidization of γ-Al2O3

Other chemicals include: NaOH, H_2SO_4, H_2O_2, organic additives, and peptized reagents. These chemicals are first used in pure form and then in industrial form to determine the reiteration and prepare them for large-scale manufacturing.

The procedure to synthesize γ-Al_2O_3 and to form the finished product is shown in Figure 1.

The procedure to form the sphere of γ-Al_2O_3 is as follows: first, the viscosity of peptized solution is adjusted to a suitable value by adding distilled water; and, then it is forced through holes with different sizes to form spheres of different diameters. These drops fall slowly through a column containing different layers of oil and ammonia. At the bottom, the spheres are separated, dried, and calcined.

The obtained boehmite and γ-Al_2O_3 are characterized by X-Ray Diffraction (XRD) on a D8 Advance (Bruker) at Petrochemical and Catalysis Material Laboratory, Hanoi University of Technology (PCM–HUT). The analysis regime is as follows: Cu Kγ radiation (γ=1.5406Å), voltage of 40kV, electric current of 40mA, temperature of 25^{o}C, 2γ =10 - 70^o , step 0,1^o and son on.

RESULTS AND DISCUSSION

Characterization of Obtained Boehmite and γ-Al_2O_3 by XRD

XRD patterns of boehmite and γ-Al_2O_3 are shown in Figure 2.

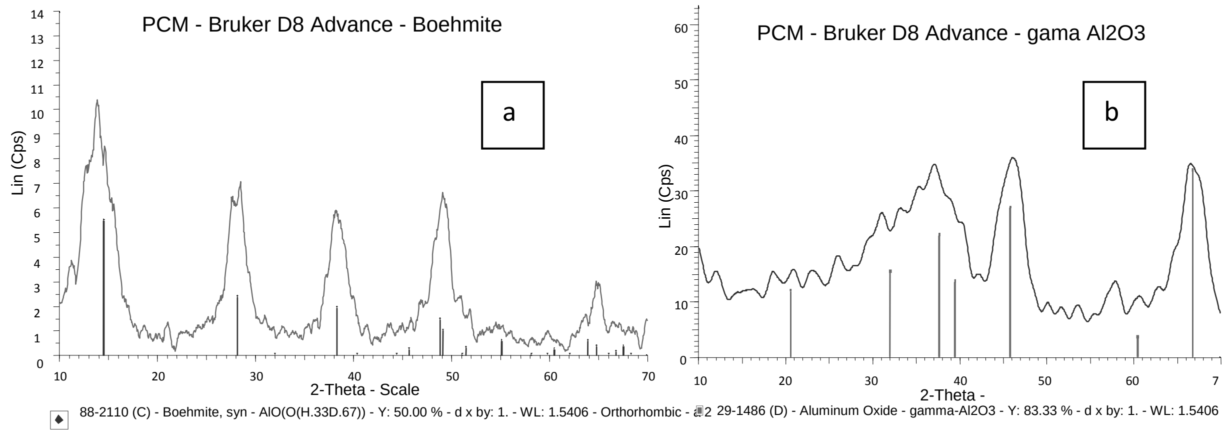

Figure 2. XRD Patterns of (a) Boehmite and (b) γ-Al_2O_3

Figure 2 shows that obtained boehmite and γ-Al_2O_3 contain only single phase characterized for boehmite and γ-Al_2O_3. This confirms that the obtained products are very pure. The XRD pattern of peptized boehmite gel after drying at 120^{o}C is exactly the same as that of boehmite. This means that the peptized reagent has completely been decomposed at 120^{o}C.

Influence of Technological Parameters on the Spheroidization of γ-Al_2O_3

Through preliminary studies, it was found out that when the content of peptized reagent was greater than 10%, the obtained gel after calcination was very hard and brittle and the adsorption ability of the product was very low, so it is not suitable to be used as a binder. Moreover, according to Leach (1984) and Khahn (1976), the greater the peptized content, the lower the surface area of γ-Al_2O_3. With the data obtained from the studies on the influence of peptized regent content on the mechanical strength and adsorption ability of spheres of γ-Al_2O_3, it has been realized that the content of peptized reagent is optimal between 6% and 7%.

The results obtained in the spheroidization of γ-Al_2O_3 with different kinds of oil and at different heights of oil and ammonia column are presented in Table 1.

Table 1. Influence of Some Technological Parameters on the Spheroidization of γ-Al_2O_3

Column	Height (mm)	Result
Peanut oil	-	No spheres formed
Bean oil	-	
Kerosene	10	flattish shape
	20	flattish shape
	30	spherical shape
	40	spherical shape
	50	flattish shape
Ammonia 10%	50	spheres are stuck together
	70	spheres are stuck together
	100	spheres are separated
	150	spheres are separated

When the drops of peptized boehmite fall through the oil column, under the surface tension force, these drops tended to form a spherical shape. When they fall through the ammonia column at a height of greater than 100mm, the outside layer will be neutralized and hardened. These hardened drops fall to the bottom of the column and are neither distorted nor stuck together (Richardson 1992). If the height of the ammonia column is less than 100mm, the peptized boehmite drops cannot be neutralized completely, so they are stuck together.

So, by using a kerosene column with a height of 30–40mm and an ammonia column greater than 100mm, γ-Al_2O_3 in spherical shape with various diameters were obtained.

With the peptized boehmite gel, an extrudates container could also be formed by extrudation. The obtained extrudates were then dried and calcined to get the finished products.

Figure 3 shows the photo of spheres and extrudates of γ-Al_2O_3 with a diameter of 3mm.

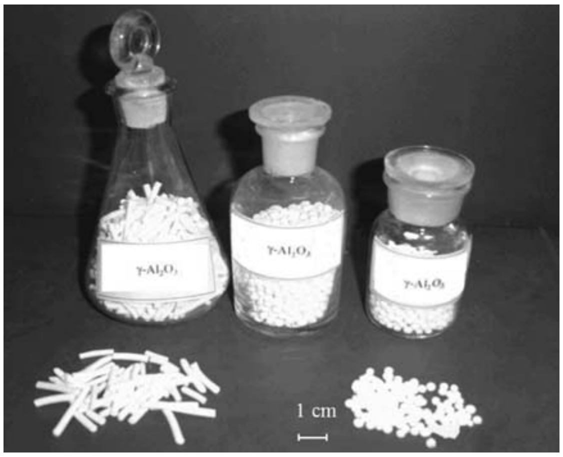

Figure 3. Spheres and Extrudates of γ-Al2O3

From the above results, this procedure can be applied to form the spheres and extrudates of other materials, such as zeolites, for use as catalysts or adsorbents to increase the value and the application range of these materials.

Study on the Adsorption Ability of Product

The results that present the relationship between adsorbed moisture content/γ-Al_2O_3 weight (A%) and time on stream are shown in Figure 4.

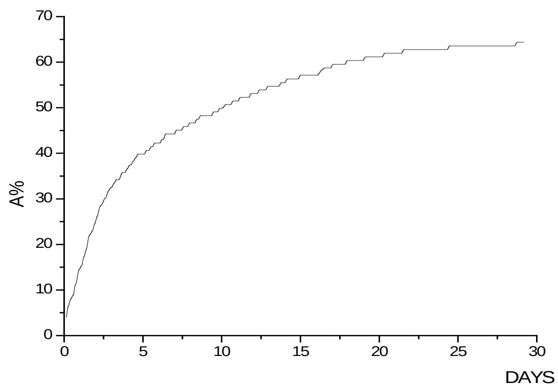

Figure 4. Moisture Adsorption Ability of γ-Al2O3 in Spherical Shape

Figure 4 shows that spheres of γ-Al_2O_3 adsorb moisture quickly at the beginning (<3 days), then the adsorption slows down and reach the saturated level after 30 days with the adsorbed moisture content taking up to 65% of the γ-Al_2O_3 weight.

These initial results prove that spheres of γ-Al_2O_3 meet the necessary requirements to be applied as the appropriate adsorbent in the drying of natural gas.

CONCLUSIONS

The results showed that γ-Al_2O_3 could be synthesized from cheap and available domestic raw materials.

The optimal technological parameters for the spheroidization of γ-Al_2O_3 have been found. The obtained spheres of γ-Al_2O_3 have various desired diameters, high mechanical strength, and high surface area. It has increased the application value of γ-Al_2O_3.

Spheres of γ-Al_2O_3 have good adsorption ability, so they can be used in the drying of natural gas.

REFERENCES

Farrauto, R.J., and Bartholomew, C.H. (1999). *Fundamentals of Industrial Catalytic Processes*. Blackie Academic & Professional.

Huyen, Pham Thanh, Long, Nguyen Han, and Hoang, Tran Vinh. (2005). *Proceedings of the 4th Asia-Pacific Chemical Reaction Engineering Symposium.* 12-15 June. Gyeongju, Korea.

Khanh, Tran Cong. (1976). *Experiments of Organic Synthesis.* Hanoi University of Technology.

Leach, Bruce E. (1984). *Applied Industrial Catalysis.* Vol. 3. Academic Press.

Richardson, James T. (1992). *Principles of Catalyst Development*. Plenum Press, New York and London.