

ALUMINA FOR THE ALUMINIUM INDUSTRY

L.A. ISAYEVA
/ Ph.D. in
Economic
Science,
Associate
Professor of Light
Metals and
Alumina
Production Chair,
ILM&G, Siberian Federal University



This woman devoted about 40 years of her life to science. She defended her Ph.D. thesis, went as a trainee to the Norwegian University for Science and Technology, and published over a hundred research papers.



Lyubov Isayeva graduated from Krasnoyarsk Institute for Non-Ferrous Metals and Gold in 1971 with a degree in non-ferrous metals. After obtaining her diploma, she did not want to leave the institute, as she decided to devote her life to science. She entered the post-graduate course where she studied diffusion kinetics under the supervision of Pyotr Vasilyevich Polyakov. In five years, Lyubov Alexeevna successfully defended her Ph.D. thesis in Electrochemistry. After that, she continued working for the institute which became home to her then, and started teaching, at the same time continuing research at the chair of non-ferrous metals and alumina production in the position of Associate Professor and Senior Research Officer. The major aspects of her scientific studies are heat and mass transfer during reduction of melted salts; alumina properties and melting in cryolite melts. In the early 1990's Lyubov was sent for training to Norway, to the Electrochemistry Institute of the Norwegian University for Science and Technology located in Trondheim City. For the period of her work at the Institute for Non-Ferrous Metals and Gold, Lyubov prepared over 100 research articles which were published in Russian and foreign periodicals.

We have nothing left but to guess what effort and time are needed for the work similar to what Isayeva has been doing up till now, but obviously it takes a lot. However, this woman manages everything: She is a happy mother of three children, a caring grandmother, a sportswoman and a sports fan. She likes books – she reads a lot; she prefers going to the countryside to relax, skies in winter and walks about the Stolby natural reserve on summer weekends.

- Lyubov, could you tell us about the studies you are conducting and the techniques used for them?

- We have been conducting alumina studies at the chair of non-ferrous metals and alumina production together with the 'Light Metals' Scientific & Technical Centre since 1995. We have developed and created devices and laboratory units where various alumina properties are metered and studied, such as fluidity, dusting index, adsorption and desorption of fluoride compounds by alumina, hygroscopicity, dissolution rate and solubility; we also consider the structure of alumina particles, generation, dissolution, and properties of cryolite-alumina crust. The major research techniques that we use for studying the properties are thermogravimetric, differential-thermal analysis, electronic scanning microscopy, and chemical analysis. The dusting index is measured by means of a konimeter, fluidity – by means of special funnels with tips of various diameters. The alumina dissolution rate is studied by the visual method with sampling and further analysis of bath samples, and electrochemical methods which include



voltammetry and potentiometry*.

- Does alumina produced by Achinsk and Nikolaev alumina refineries, Kazakhstan Alumina and the Guinean refinery dissolve in the same way?

- All these types of alumina, when loaded into bath, generate agglomerates in the form of specific cryolite-alumina crust which is dissolved in bath. The dissolution rate of alumina from different suppliers depends to a large degree on the structure of the agglomerates formed, which in turn is determined by the physicochemical properties of the loaded alumina. The lowest dissolution rate is demonstrated by AGK's alumina which is chiefly related to the heterogeneous particle size distribution and the highest content of α -phase among all suppliers. Agglomerates very quickly break down into small fragments which make up a pile on the bottom of the reservoir. AK's alumina dissolves slightly better; it is distinguished by high content of fines. NGZ's and Guinean alumina dissolve best of all, though the presence of a large amount of -45 μm grade in NGZ's alumina makes it problematic to use it in pots with point-feeding.

- Is the structure of alumina particles from different producers the same? If not, how does it impact the properties of Al_2O_3 ?

- Alumina from different producers has different structures. For example, NGZ's alumina grains are of a rounded form with well-developed fissured surface. By their appearance, these particles differ little from that of sandy alumina. The difference consists in a considerably larger amount of fines in NGZ's alumina. The surface of Achinsk alumina particles is very well developed. At the same time, their surface structure and particle form differ radically from those for NGZ's alumina and all other types of alumina. An AGK particle represents an agglomerate of fine particles, a few microns in size, stuck to each other. The agglomerate surface is seen as extremely rough compared to the relatively smooth surface of grains of other alumina types. Fine particles detach easily from the main agglomerate and generate a dust-like grade of alumina. Such performance of agglomerates is confirmed by the data of particle size distribution studies. AK's alumina by the grain form and structure takes an intermediate position between alumina from NGZ and AGK, since it has quite a loose structure and contains a large amount of fines.

- What can you recommend to process engineers if the quality of alumina changes?

- I believe process engineers know this a lot better than me. This is improvement of automated point-feeding control algorithms, varying alumina feeding modes and certain process parameters, such as anode-

- Let's consider AGK's alumina in detail. Which of its properties, in your opinion, should be improved in order to use it in automatic point-feeding systems?

- First of all, it is necessary to achieve the homogeneity of the alumina particle size distribution. Also, to reduce the content of α -phase, without reducing the loss on calcination of 0.8-0.9% at the same time; to reduce the value of the specific area of alumina surface (BET surface) to 80 m^2/g .

- What alumina is preferable to use in 'dry' scrubbers?

- The most significant parameter for dry scrubbers is a BET surface. The optimal value is 60-80 m^2/g . NGZ and Guinean alumina meets these requirements. AGK's and AK's often exceed the value of BET surface of 100 m^2/g , which leads to increased alumina hygroscopicity, and during loading to the bath – to increase dusting and higher fluoride loss. A high content of fines in NGZ's and AK's alumina, as well as ultrafines (less than 20 μm) in AGK's alumina is not advisable for dry scrubbers. The most suitable type for dry scrubbing from the above-mentioned alumina is Guinean alumina.

- Could you tell us about your plans, in conclusion?

- I have quite a few. I will continue to carry out scientific research by orders from plants, including those on alumina. We are planning to expand our laboratory base. In the nearest future, we are planning to create a plant and test the rotating disk technique for studying the solubility and dissolution rate of alumina in low-melting bath and obtaining data of mass transfer and diffusion rates. We are going to detect gibbsite in alumina from different suppliers, as well as its influence on the reduction technology; we will conduct studies of alumina performance in promising types of bath for pots with inert electrodes; studies of conditions for formation and properties of cryolite-alumina crust and pot mixture hoods. And of course, I will continue to study, will upgrade my professional skills, and I'm going to participate in training programmes for improving the qualifications of engineers.

* Young employees Alexey Braslavsky, Natalya Vasyutina, and Oleg Sluchenkov successfully develop and implement different





to-cathode distance, cryolite ratio, and bath temperature.

research techniques for alumina and cryolite-alumina crust. Besides laboratory testing, they carry out measurements and testing in production pots. Their work is distinguished by creative initiative and reliable results.



