Response to Prof. Dr. habil. Endre Kiss

Questions:

Q1. According to some preliminary experiments, when the RM is treated by arc furnace technology, the Scandium is moving to the sludge, and the initial concentration is doubled. What is the method tried by you is the best to treat those samples (in the sludge containing even metallic iron)? It can be worthwhile or not?

A1. I didn't try out any arc furnace technology samples or comparable furnaces have 1500 - 1600 °C, it is not available at University of Pannonia. As it's known, the red mud contains the iron mostly in hematite form, Fe_2O_3. My experiments were carbothermal reduction, in which used the magnetic separation to separate the reduced iron (Fe_3O_4) from treated red mud and coal powder as a reducing agent. The reduction of hematite with coal powder was carried out in a muffle furnace at 1000 and 1200 °C, followed by crushing and magnetic separation with different magnetic strengths (data are not presented in the dissertation). As a result, the composition of iron-rich and iron-poor fractions after magnetic separation were studied. In both fractions, in addition to iron, scandium was found in the same amount, as well as other components (Na, Mg, Al, Si, Ti).

For arc furnace samples, I suggest the following steps:

1. Carry out ultrafine grinding of collected samples <0.45 micro.
2. Leaching by 2M of HCl solution for 1h time to avoid iron dissolution.
3. Magnetic separation by low magnetic field (iron is by-product).
4. To avoid any possible loss of Sc, it’s better to apply second leaching step.
5. Separation and purification procedures (LLE or SLE).

Q2. As the title of the dissertation is containing the word bauxite, the question arises that if the goal is to get scandium, is not sensible to try to get that metal directly from bauxite. What is your opinion about that? Is that more difficult, or easy?

A2. The main objective of this work was recovery of scandium from the red mud which is presently considered as a waste material. The red mud is a residue of the bauxite processing industry obtained during the alkaline extraction of alumina from bauxite ore. Mainly Bayer process for producing alumina is used all over the world and includes leaching of bauxite ores with a solution of sodium hydroxide (NaOH) to extract alumina minerals contained therein as a solution of sodium aluminate ($NaAl(OH)_4$). The dissolution of Sc either from ore or from red mud can be achieved by using different method, namely acid dissolution. The Sc content of bauxites used for production of aluminium oxide in Hungary was ~ 30 ppm. Usually, after bauxite processing the Sc concentration increases in 3-4 times (90-120 ppm). Therefore, from an economic point

of view, it is better to deal with secondary raw material (red mud) containing a higher concentration of the target element.

Q3. In the majority of the scandium ore mines the normal scandium concentration is lower that can be measured in red mud. What was the highest initial scandium concentration you ever tried?

A3. The highest initial scandium concentration was in Hungarian red mud leachate produced from Sulfation–Roasting–Leaching process. The concentration of Sc was high~ 95 mg/L, but the disadvantage of this method it consumes energy 700°C,3h during the roasting step and time ~24h.

Q4. How many thesis points are supposed 3, or 6? All are based properly with experimental and modelling results and by publication and stand individually, too. For the reviewer both number is acceptable.

A4. Thank you for your comments and questions**.** The major thesis points are three (5.1., 5.2., and 5.3) based on thesis parts, each point includes 3 subpoints.

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17.05.2023