John N Hryn

John N. Hryn works as a investigator in the **Argonne National Laboratory**, in the Energy Systems Division. Is one of the five most important laboratories in United States. **Its mission consists of causing to advance the energy and economic national security of the United States and to promote the technological and scientific innovation.**

I know the installations of IDALSA. The changes and the technological improvements that IDALSA has applied in recent years have been based on our investigations. The last time that was in Zaragoza they impressed myself a lot the technological adaptation of the refinery to the recommendations that we did after our investigations.

IDALSA is one of the few businesses that have taken our investigation, they have followed it and they have established many of the recommendations that we did as a result of to have been investigating for many years. Therefore we are quite satisfied when we find a business, above all a business that is so far from us, that has established our work and has done it in the way that has done it IDALSA.

Since we visit them for the first time we have remained very impressed with the improvements that have carried out in the process and also we are impressed by how do they carry the plant.

I will do a synthesis of the investigation that have carried out in our laboratory with respect to **the recycling of the salt cake**.

Argonne was founded in 1946. It is a complex of the American Government negotiated by the University of Chicago. We have some 4,000 employees, in a complex of 10 Km^2., with a budget of 500 million dollars. We carry out investigation in sectors that go since the chemistry, to the science of materials, to the physics and to the industrial technology and we work with other federal laboratories, universities and with the private sector.

Our group in Argonne form splits of the Energy Systems Division. Is an interdisciplinary division that itself center in the investigation applied. Our group has three main areas of investigation and development:

Recycling processes development. This includes the aluminum and the magnesium and includes the investigation on salt cake that will analyze superficially subsequently.

Processes to recover materials of the scrapyards of the sector of the car and of the electrical appliances and of the recycling of the glass.

Also we have a group that carries out the **modeling and simulation of different ovens of fusion**.

The project that wanted to comment is the project on the one that carry working more than ten years: the recycling of the salt cake of aluminum. **The recycling of aluminum generates a by product that is called salt cake or excoriates saline and contains metal of aluminum, sodium and potassium in the shape of chlorides, of you leave that they are utilized like flux and a not metallic product that is evident chiefly of oxide but that has also other components**.

Traditionally the salt cake has been carried to dumps and only there is very few businesses that utilize a method responsible for management of salt cake as does it IDALSA.

Also an environmental worry in United States exists. And by this reason we begin to undertake this problem. **Our objective consisted of developing an effective technology in prices for the recycling of salt cake**. We wanted to recover the aluminum, you leave them and the not metallic product and to convert this NMP, this not metallic product, in products with value added to justify the recovery of the components of the salt cake.

Schematically seems very simple. We have the salt cake with three components: recovers the aluminum of the salt cake and is returned the smelters; recovers the salt and is reused; and, the remainder becomes materials valuable that are utilized for the production iron and steel works, like commodity for the production of cast iron and also for the production of fireproof. Therefore the procedure in itself seems quite simple **but in reality the results were not viable**.

We begin to work in 1990 when we begin to receive funds to study the problem. We initiate the experiments in 1994 and in the 96 we begin to collaborate with an aluminum recycling installation in Cleaveland in United States. We did an evaluation of different technologies and we identify those that we think they could be commercially viable and we initiate the trials to pilot scale in 1998. In the 2001 we begin ourselves to realize that we were not going to be successful short-term in the identification of a technology and our program of experimentation was suspended.

The preliminary conclusions of our work was that, of course, technically the salt cake in its different components can be separated and, in fact, any material of another material with unlimited resources can be separated practically but to do it, economically, is not possible for the salt cake and, therefore, for the time being, **the best option for the salt cake is to maximize the recovery of the aluminum in the salt cake and then Having the remaining material, you leave them and the NMP in a dump controlled.**

Exactly just as it does it currently IDALSA.

The stimulus of our investación is the fact that they are generated 1 million Tons of salt cake in United States every year, slightly more than the 10% of the production of aluminum, this is, an important quantity of residues in the sector of the aluminum is generated. On the average, there is approximately a 6% of aluminum in the salt cake and this represents an important source of energy in this salt cake and this is the material that wanted to recover and to reuse.

Upon recovering the aluminum also we would be able to undertake the portions of you leave and not metallic products and to try to justify

its recovery in base to the value added that would be able to recover in the process.

The approach that has been utilized to recycle the aluminum or for recycle the saline dross consists of grind the salt cake, to become a dust quite fine and to recover the part more gross of aluminum, then to dissolve the salt and the remaining oxides, to sift them for recover more aluminum and for be able to send this aluminum to the smelters. The remainder of the saline solution contains oxides disueltos, the NMP is filtered, is filtered and is sent to the possible market while the saline solution is heated and all the is eliminated water to recover the salt.

This is a very intense process in consumption of energy: to cause to boil all that water is unthrifty in energy terms. We try to recover part of the energy in an evaporator in order to having a loop closed of the water in the process. This it is the theory that has been proposed for the recycling of the salt cake but is not so simple. **It turns out to be very expensive to recover the fraction of you leave, to boil all that water supposes an enormous price of energy, an also important price of investment to create systems of evaporators and although this technology exists really itself is not utilized for a product of so low value**.

The recovery of this sodium chloride –that, basically, is table salt- has a value of only a few cents per kilogram.

The other problem in this strategy for the recycling of the salt cake is that himself did not have markets for the fraction of oxide and here we have almost a mountain of NMP in a recycling installation of United States.

They have tried to improve its quality and to find a market but the composition of the NMP variable, not only in itself but also depends on the material that is being processed. **The different alloys produce different types of NMP and the composition of oxides is not the adequate one for all the applications**.

The composition the NMP varies and although has as main constituent oxide of aluminum and oxide of magnesium, has also hydroxide of aluminum and an important quantity of impurities that affect to its characteristics.

The aluminum is that fraction that itself does not recover in the normal operations or in this process of digestion and is what forms part of this global process of recycling of the salt cake and this aluminum without reacting that can arrive to the 8% but typically is found inside a rank of the 1 - 2% and does that be a potentially damaging material.

We can wash the NMP, the “paval” that call in Spain, everything that we want but continues there being cracks to the ones that the water cannot arrive due to the superficial tension and therefore the NMP always contains a small quantity of salt can arrive at the 2%. The presence of salt and the changeability of the composition does that be an important disadvantage for many of the potential products that have been predicted for the NMP. Is not simply an aluminum oxide material that can replace other aluminum oxide materials in the market.

Our strategy of investigation with Alumitech, the smelter of aluminum with the one that were working in Cleaveland, began to be centered in methods to recover the salt in Argonne and we begin to explore the electrodialysis, a technology that would be able to enlarge the concentration of the saline solutions from the 8% to the 22% approximately, and this would permit to recover the salt by means of the crystallization.

On the other hand, Alumitech was centered in trying to produce a material one NMP that was free and was free of you leave and with this would try to manufacture products in base to this material one NMP and they were centered in the calcium aluminium chiefly for the steel industry. Nevertheless, to produce a NMP clean **Alumitech did not be able neither to approach this 8% of solution that needed we for produce a salt concentrated and as consequence we could not concentrate our solutions saline the sufficient thing for be able to recover the salt.**

The lesson that here is learned is that if you want to recycle the salt cake causes lacks a saline solution concentrated and a NMP clean and one must have the two things.

To obtain a saline solution concentrated is utilized a small quantity of water but then they remain residues of salt in the product NMP and for obtain a NMP very clean one must utilize a lot of water and to process it but by then no longer you would be able to recover the salt of a solution so diluted.

Therefore, if we try to utilize solutions diluted to recycle the salt cake we can produce a NMP clean and potentially has a value, if we can find a market for this type of material. But the salt in a solution diluted is recoverable by no process that we know and a brine so diluted he would have that to be eliminated.

If we pass to a process with a brine concentrated remains the salt in the NMP and therefore the NMP would not have value and there would be that to be eliminated preferably in dumps controlled but then we would be able to recover the salt that would have some value **but in any case, never we would be able to utilize the evaporation of multiple effect that is the proposed technology to recover the salt in any economically viable process.**

So views the perspectives of the legislation on the salt cake there has been a tendency to treat and to eliminate the quantity of processes that one must carry out to recover the material of aluminum, that is to say, we try to recover the material of aluminum as soon as possible, therefore we utilize drums of cooling off, coverings of inert gas, presses but then we have to utilize, **ovens newspapers for recover the remainder and this generates You excoriate saline and we can recover part by means of the grinding but again the residues of the grinding have to be sent to dumps.**

Therefore, like summary, we can say that there **is not an economically viable technology to recover all the components of the saline dross**. The salt to produce a NMP clean, a NMP can be produced clean or a high saline concentration but not the two things and this does not permit us to have an economically viable process. **The recovery of aluminum is viable, the markets of salt are limited and the recovery of salt is something really appointed for the reuso as flux in the sector of the aluminum but the process is very intense in consumption of energy and has some high prices of investment although the NMP has a potential value and is proposed to utilize them like commodity for the production of steel, cast iron, fireproof and other Material, themselves it has not been shown because the variable composition and still they remain you leave residuals that have not been eliminated.**

Therefore the best practice for the recycling of the salt cake, in our opinion, is what is being done in United States and this comes prompted by the business opportunities. **The best practice is to try to maximize the recovery of aluminum of the saline dross and to eliminate the so much residues of salt and not metallic products in scoops controlled** and several installations are doing it in United States. **In Europe, is causing it applying the best available technique, IDALSA.**

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