

DROSS DUST PROCESSING

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Abstract

The paper deals with the processing of dross dust fractions from flux less rotary furnace to the mentioned products by dry process. It means that the procedure of leaching of the soluble components is not used as the law salt content from melting process with a salt factor below 0,2 is acceptably low. The undersize non-smeltable parts are a source of raw materials for the pellets production. Strength and drying of the pellets are provided by exothermic reaction, suitable binders, and combinations of the mixture granulometry. This paper describes the history of the research and development of the processing of dross dust fractions in the Confal Inc., which is currently still developing. Confal, Inc. operates on research and development program along with Developmental and realization shop of Faculty BERG Kosice. The purpose of the research and development program is the continual production of dry pellets.

Keywords: Confal, conditioners, flux less, dust, pellets

Introduction

Company Confal, Inc. is the largest aluminum waste recycler in Slovak Republic. The company has been operating in the market of aluminum scrap processors since 1998. Until 2006, the company operated under the KOVOD Trade name. Part of the company producing foundry aluminum alloys has become independent since 1.1.2006 and operates under the CONFAL Inc. name. Currently it produces about 10 to 11000 tons of aluminum alloys a year.

The business activities have gradually been extended to the dross processing from smelting processes to smeltable parts – granulated material that are returned back into the melting process for recovery. Dross dust fractions are processed into products for the steel industry like slag and desulphurization conditioners.

1. The industry environmental transformation:

The company has about 100 employees, deployed in two operations - the first operation is the purchase and pretreatment of scrap, the second operation is the production of alloys and processing of the waste from the smelting - aluminum dross. Annual production is currently about 11000 tons of alloys and about 5000 tons of slag conditioner for steel plants based on waste from melting.



Fig. 1 10 ton – low salt rotary furnace



Fig. 2 The view to the smelters



Fig. 3 Heat exchanger air - exhaust gas

1.1 Cost model of the control for decision-making level

Final products of the main production - the melting of scrap and production foundry alloys are alloys in the form of ingots according EN and customer requirements.

Other metal products characters are disoxidated pyramid-shaped alloys with a 7 x 7 cm base and a height of about 7 cm. In the future we are planning production of disoxidated granules with a particle size 5-15 mm.



Fig. 4 Ingots and pyramids

The products of secondary production are the slag conditioners, desulfurization additives and means for deoxidation including cleaning neck buckles of converters in the steel industry.

We purchase commercially available aluminum scrap and melt - processable waste - dross from aluminum foundries, which is if necessary pretreated by crushing and sieving, metal part is processed by recasting to full value alloys. Undersized parts unsuitable for melting are one of the sources for products such as slag conditioners.

The waste produced by casting, consists of two types of waste. From low salt consumption rotary furnace is a waste, category “non-hazardous” of chamber furnaces waste category “hazardous”, that is due to about 50 % - metal content after mechanical treatment by crushing and sieving, returned to the melting process in the rotary furnace. Ultimately, all wastes that leave the melting shop are after reprocessing in the category 'non-hazardous' not “hazardous”.

The waste of the category “non-hazardous” from the rotary furnace is the type of waste which further use and placement to products initiated the cooperation with the VRP to FBERG Kosice.

Except the production waste about 3 % of dust is formed, which is according to the character and composition the waste of the category 'hazardous' unworkable in the conditions of Confal Inc. And it is placed on controlled landfills for hazardous waste.

2. Disposal and recovery of production waste:

Smelting technology in low salt consumption rotary kiln provides the formation of waste, which is categorized as waste "non-hazardous". This fact led our company to the idea to review its properties and to consider a possible recovery in products for the steel industry in a modified form. Annually, about 2500 tons of waste is created from smelting in the form off dross, placing this waste to the landfill would significantly damage the environment, and it would also be very expensive.

Recycling waste is now widely recognized concept not only in relation to the environment, but also to the reduction of world reserves of metal resources and their obtaining from natural resources. Use of natural resources brings other negative effects in the form often insensitive interventions in ecosystems and finally it causes twice as much harm on the environment.

The company therefore decided to enter the path to the future environmental friendly production and the final objective is to achieve a closed production cycle, which means the location of all production waste into other products that can be placed on market while minimizing energy consumption of processes.

2.1 The future of recycling technologies

On the basis of generally known facts it can be stated that recycling is the issue of the future in all directions. The table below shows the percentage of energy savings in recycling metals. The aluminum is a metal in the form of alloys.

Tab. 1 Summary of energy saving

Material	Energy saving
Steel	74 %
Aluminium	95 %
Copper	85 %
Lead	65 %
Paper	64 %
Plastic	80 %

Any kind of recycling is more complicated manufacturing process than direct production from pretreated materials, as secondary raw materials are always contaminated by other materials. These are necessary to be removed by complicated working procedures and then to proceed to reprocessing of the raw material itself. In most cases, it is the production of the same material in different qualities, depending on the purity of the recycled material.

Since the scope of business in Confal Inc. is aluminum waste recycling to the full value aluminum foundry alloys and subsequent processing of waste to form other products, I want to remark the way recycling technologies affected this field.

A few decades ago, almost all castings were produced from so-called primary aluminum alloys (Silumin). The source of aluminum was in electrolytic aluminum and it was alloyed by silicon and other alloying additions (Fe, Mn, Mg, Ti, ...). By the development of recycling it has been found that naturally existing aluminum scrap in Europe, produces after melting a chemical composition which corresponds to today's most commonly used alloy EN 46 000 and its modifications (DIN 226). The chemical composition of these alloys is adjusted to its present form based on metallurgical and mechanical properties. The development of simulation and optimization of the casting process had significant influence on the gradual evolution of the chemical composition of secondary aluminum alloys production.

Dust fractions of waste from smelting (dross) of aluminum scrap were unloaded at landfills for hazardous waste, aluminum scrap was reprocessed only by salt melting (adding salt of the salt factor to 1,0) also in static chamber furnaces.

Research has shown the possibility of using dust components of dross in a completely different field of metallurgy - steel industry - but also in the production of cement and other special areas.

The leaders in this area are companies from Germany. Especially ALSA Hannover, with 3 operations in Germany and fourth in Canada, because of their volumes processed salt dross and especially Serox portfolio of products of different qualities it is a leading company, and also AluScholz Stockach.

The Company Confal Inc in comparison with the German producers of secondary aluminum alloys is a small company and transport of dross for further processing over long distances would mean big losses. Therefore, the company is trying to develop their own procedures without the need for costly hydrometallurgy.

Our goal is to perform sophisticated environmental criteria.

3. The beginning of the research

The first attempts to the research of the aluminum dross properties date back to 2006, when low salt 10 ton capacity rotary furnace had been used for a year in the company Confal Inc. We contacted the former researchers from the research center in Bridlicna and Dobris where they did the research work on the properties of aluminum dross taken from the salt rotary furnaces and on aluminum dross in general. Existing research work in collaboration with the University in Katowice, were describing a big amount of energy in dross, they were describing their chemical composition, reactivity, the gases that were able to be released in the process of decomposition, but none of this work had solved the problem how to deal with this energy, especially how to obtain and develop the energy in sophisticated way. Dross dust fractions during the processing behave spontaneously, chemical reactions go on dross composition and their intensity depends on the track skimming, their metal content, the content of residual salt from melting and method of cooling after their removal from the smelter. We have gained a lot of information concerning the dross taken from the salt rotary furnaces, but these could not be fully generalized in the conditions of Confal Inc.

For about 2 years we had been trying to work towards some sort of methodology to actually proceed to the processing of dross dust fractions without leaching technology.

At that time (in summer 2008), we met doc. Ing. Spisak at a conference in High Tatras mountains and created the foundations for future cooperation.

First of our common attempt was directed to rapid cooling of the dross from the rotary furnace, the way it was operated in Velvary. Devices

for rapid dross cooling are not new. In the company Bridlicna cooling device AROS was in operation, in Velvary (CR) the cooling device for dross by water cooling was used at the time of former Czechoslovakia. It was a product of the previous research. Feeding rate of dross was limited due to the amount of energy that was necessary to be taken from dross to decrease the temperature of about 1000° C to 100° C.

Acceptable cooled amounts were incomparably smaller than in our case. From our rotary furnace we had in one go 2500 kg of dross. If cooling is not completed within 15 minutes, the effect is missed as the contact with atmospheric oxygen leads to spontaneous combustion of residual aluminum and temperature increase in the volume of dross up to 1500 - 2000° C.

Attempt in the cooling cylinder seemed successful, but a lot of questions that would need the long research arised. As a side product it was produced a granulate, with the remaining metal part of about 20 % metallic aluminum, but the granules were oxides of aluminum contaminated by oxides of other accompanying elements and in particular by the big amount of the reactive materials, which could be initiated at any time in a suitable environment and could lead to the slow decomposition.

The experiments were stopped for two years as it had been shown that this is not the right way because the dross contained about 10% mechanical iron from scrap of different shapes and sizes. It could cause passage blocking in an enclosed space.

The research project of granulation of dross dust fractions, their physical and chemical properties was elaborated. The main objective of the project is currently development of the device for the production of pellets from dust fractions and their chemical stabilization in the production process so to avoid subsequent disintegrating reactions of the containing substances.

The work does not deal with hydrometallurgical processing method for removing melting salts and other soluble components.

Another important objective of the project is to use energy that is contained in dross for technological purposes - bring it back into the recycling process, and not to produce waste of any form, that would cause the harm of environment.

In the meantime, while the limits of the project were being developed, we tried to solve the compaction of dross dust fractions using liquid binders in partnership with VU CHT Bratislava. They designed the binders and in their laboratories they produced a series of experiments. The results of the experiments were pellets of high hardness, which did not have the essential requirements of potential customers. By reducing the amount of binder, the pellets kept spontaneously falling apart. These binders had a relatively low degradation temperature, about 140° C.



Fig. 5 First experiments with liquid binders, partially disintegrated pellets

4. Cooperation with VRP FBERG Kosice

This joint project set many objectives, which should result in creating useful products from waste that would otherwise end up in a landfill. To meet this objective we aim to develop, construct and operate technological line, in which the process of production would be possible to control and check at any point.

In general it can be stated that the way of making usable products from the waste - recycling is the way to protect the earth's resources and not to cause harm to the environment in search of raw materials.

After the experience from the first experiments we have chosen as a partner, VRP FBERG because common grounds on the field of the research were found. Company Confal Inc does not dispose of the conditions for development in the way VRP does. VRP has considerable potential, which is directed to the industrial application of the result. Experience of dealing and application of the products in practice is exactly the direction that the company Confal Inc needs within this research - implementation project.

The important part in the project is the company Spiscol Ltd. It deals mainly with the particular treatment technologies in the project.

Together, we have gradually become members of the Centre for excellent research and as we can see from the results of our cooperation, that we have chosen the right partners.

4.1 The results our cooperation so far

Research activity was initiated by compaction experiments both in the laboratory of VRP FBERG and partial results were tested in the company Confal Inc. On that basis, on the approved requirements of potential customers we have defined the product.



Fig. 6 Part of the compactor. As you can see, it is an experimental device



Fig. 7 Dusted final drying box and a buffer store

On the next figures there are the sieved products of the compacting of different grain size.



Fig. 8 Product 15-20 mm



Fig. 9 Product 10-15 mm



Fig. 10 Product 3-10 mm

Quality requirements of the product

In the case of products such as slag conditioner and desulfurization additive, quality can be defined as the sum of the properties that are able to meet internal and external requirements of the product.

Internal product requirements mean a set of mechanical, physical, chemical, technological and environmental characteristics of the product. These characteristics will ensure that product will not change its properties during handling, storage and logistics to customers.

External requirements are the sum of logistic, usability and environmental characteristics of the product.

In other words, compacted products after production shall withstand without any changes the handling, mixing into the final mixed product on the mixing line, internal technological logistics, transport to the client, the client technological logistics. After dosing into the steel, the particles must disintegrate and fulfill their chemical and technological roles within the time limit specified by the client. The time limit is important from the point of view of technological subsequent of the production. In the set of these requirements several contradictory performance requirements can be found (hardness and strength vs. consistency, reactivity vs. low emissions). In such cases it is necessary to ensure compromise between features, which are one of the key tasks of the project.

During all these activities the environmental characteristics of products (limited content of undersized part, without pungent odor, without hygroscopic properties, low emissions during application) must be fully manifested.

Based on the partial results, in cooperation with VRP FBERG TU Kosice we have gradually built an experimental pilot production line for further research. The production of slag conditioners, desulfurization additives and additives for removing neck buckles of convertors has started in Confal Inc company.

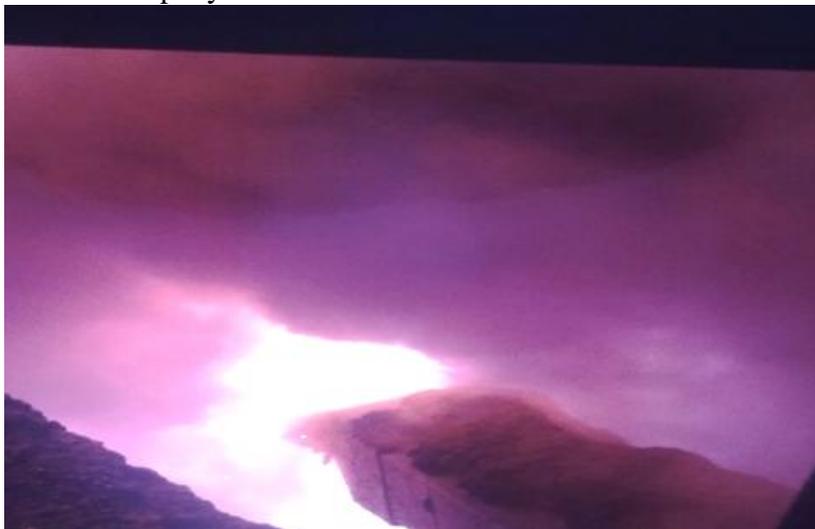


Fig. 11 Addition of slag conditioner at bar gauge, its disintegration is causing fumigation at the moment when it begins to blow through the bottom of the pan

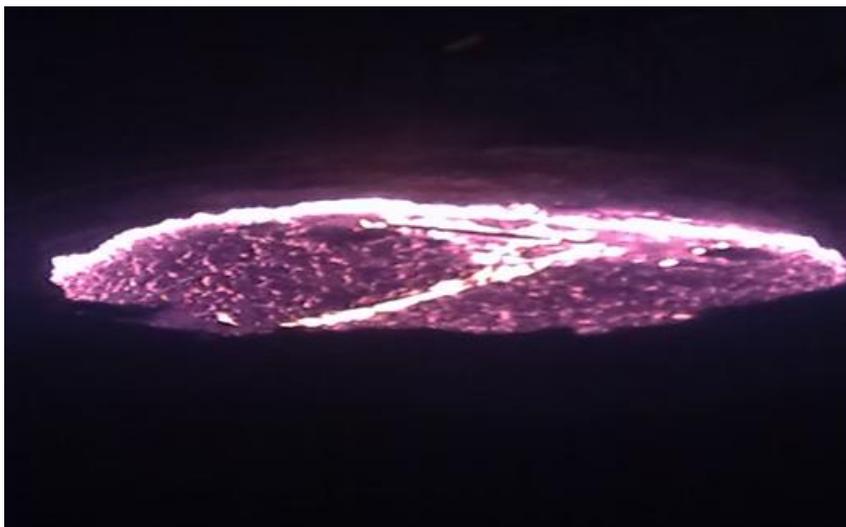


Fig. 12 Finished lower blow, slag has the appearance of a typical synthetic slag



Fig. 13 Active lower blow after transport to the vacuuming station, again fumigation



Fig. 14 End of fumigation at the vacuuming station, the reactivity of slag conditioner closed

Conclusion

We currently continue our collaboration in designing and constructing variable line based on the acquired knowledge and experience. The line is being built in the new production hall and it will be the part of the processing system of dross in Confal Inc. Products delivered to the U.S. Steel Kosice as slag conditioners, desulfurization additives, emulsions for removing neck buckles of convertors function well, yet we are constantly working on improving them, and of we are as well extending the portfolio of these products.

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