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Contents

- Project aim.........................3
- Steel cycle.........................4
- Slag-Rec system means...6
- Sand, gravel and slag......8
- Slag like lava.....................8
- The EAF loading.................9
- Development and
  opportunities....................10
- Reached results...............11
- Contacts.........................12
Project aim

The aim of the SLAG-REC project was the creation of an innovative system for the treatment of the slag which come from the electric arc furnace to make it totally recyclable in various fields of application and conduct a series of marketing activities designed to present this innovation system and its performance to potentially interested operators, represented by the European electrical steel plants.

Project activities have been carried out in the way and in the times figure out by the strategic cooperation between the three partners: a dynamics steel mill, particularly attentive to innovation and environmental aspects, creator and first user of the new system; a well-established engineering company who oversaw the design, and a company leader in the machine construction, which has already built the first machine to treat slag by the Slag-Rec system.

An innovative system turns slag of the electric arc furnace in a reusable product for road construction and other applications, helping to preserve natural resources.

Eco-innovation in steelmaking: a new system for 100% recycling of electric-arc furnace slag (SLAG-REC)

The arrival of the Slag-Rec system to ASO Steel Works from MFL
The electric cycle of the Steel starts with the melting of scrap in the EAF (Electric Arc Furnace). The slag deriving from steel melting has always been dumped in landfills as waste after undergoing crushing and iron removal processes. Slag produced during a normal melting process corresponds roughly to 10% of steel production, so we can easily have an idea of the volumes involved.
The SLAG REC system rapidly cools down and disaggregates the slag either directly received from the slag door of the furnace, or poured from a slag pit. The new system is a complete solution for dry granulation to solve slag handling and treatment in EAFs. The machine can granulate the slag by two contra rotating cylinders which make the slag granulate and vitrify because of the rapid cooling. This slag can be reused as a by-product.
A reduction of the use of non-renewable natural resources and their replacement with slag from electric arc furnace granulated dry by the SLAG-REC system in the construction of roadways or in various other applications.

A reduction of the amount of slag in the landfill, the reduction of the costs to process the slag and the saving of some areas designed to stock slag.

A global system for making steel from scrap more eco-friendly, an increase in the steel mill's reputation as environmentally friendly system.

An improvement in working conditions in the steel plant due to the reduction of dust emissions, water consumption, and reduction of noise associated with the slag handling operations, crushing and grinding, and making in the park.
The hot and cold slag under the Slag-Rec machine at the end of one of the first trial 

A picture from the thermo-camera recording of the starting of a trial test
Sand, gravel and slag

Sand, gravel and crushed stone are natural resources that mankind has always exploited and still exploits in a large quantity to use it in various fields of application: for filling works, as background during roads construction, for the construction of permanent way or embankment or for the preparation of concrete or asphalt. These natural materials come from crushing compact rocks and from the slow workings of the waters of rivers and seas, which have beveled edges and polished surfaces; so the natural formation processes occur in geologic times. Their widespread use should also be related to their characteristics: in fact these materials are compact, friable, non-water soluble, non-powdery, with good frost and compressive strength resistance. For some of their characteristics they are often indicated as inert materials. More than 80% of the oxides that made slags of the Electric Arc Furnace are.

Slag like lava

When the slag formed inside the EAF during the scrap melting, it is forced out from the slag door of the furnace, looks like the lava during volcanic eruptions. When its temperature is high, the color is yellow, very light, blinding, and runs fast, smooth, when the temperature decrease the color become red, gradually darker, the consistency is more viscous and the front of the casting progresses more slowly. The similarities between slag and lava does not end here, even the chemical composition is very similar, and this means that the slags can be assimilated to certain types of igneous rocks of volcanic origin.
the same constituents of rocks found in nature, which combined together in different ratios, form most of the types of the rocks of the Earth's crust. From this realization came out the idea of considering also the slag as aggregates and consequently to replace natural materials with them. In addition to the iron oxide (FeOx), the main constituents of the electric furnace slag are calcium oxide (CaO), silicon oxide (SiO2), aluminum oxide (Al2O3) and magnesium oxide (MgO).

Slag formation in the Electric Arc Furnace depends on the elements that are introduced for the manufacture of steel, consisting of:

- **scrap**, which is not only to recycled iron, but it's iron containing alloying elements of steel scrap, accompanied, according to their degree of "cleanliness", also from other non-ferrous metals (copper or aluminum based), plastic materials, paints, rubbers, oils, and soil;

- **coal**, added as an additional source of energy, whose contribution to the formation of slag is given by ash residue of its combustion.

- **additions of lime and magnesium lime**, which are used to adjust the chemical composition of the slag, making it suitable for metallurgical operations that you want to take on the bath of liquid steel;

From the earliest data acquired during the first dry granulation test by a thermocamera the slag temperature at the outlet from the drums was nearly 900 -1000 °C.
Development and opportunities

Up to now the issues treated in the slag formation were limited to the metallurgical needs and did not pay attention to minor components and to the type of constituents which were forming inside the solid slag as a function of chemical composition, solidification’s way and subsequent cooling. The future way of thinking must pays equal attention in operating practices for the steel production, also in various stages of the production cycle of the slag in order to give them the quality characteristics required to a real product, such as a specific chemical composition, mineralogical constitution, morphology and mechanical inertia in front of the environment and safety for human health. For this reason it becomes important to be able to govern and control not only the preparation phase of the slag in the furnace, but also the next stages of solidification and cooling. The simple reversal of the slag on the soil under the furnace or inside a ladle, as it is now a common practice, do not produce it in a controlled and repeatable conditions and create uncertain conditions on the mineralogy constitution of the slag, which can give the possibility to some elements to release heavy harmful metals into the environment. The SLAG REC system not only controls the slag solidification and its cooling to low temperature, but also generates a much smaller size of grain compare to the one obtained with conventional systems, resulting also in a lower power consumption and a lower costs to grind the slag in final commercial sizes.
Expected results of the project and the results reached before the end of the project are:

- The first SLAG-REC system constructed, installed and tested at the steel mill of the ASO Ospitaletto (Bs);
- A model that will enable operators of electrical steel to make an analysis of costs and benefits in the case of the introduction of this new system into their production system (the model is available on the website at: www.slagrec.eu).

The SLAG-REC slag after the grinding and screening in three different commercial size.
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