



A short report on the

4th European Slag Conference

held in Oulu, Finland, 20th – 21st June 2005

Oulu, Finland

Under the patronage of EUROSLAG, the 4th European Slag Conference has been held and 140 experts from 20 different countries met to discuss and exchange knowledge on the latest developments in technology for the production and use of blast furnace and steel slag. The Finnish steel group Rautaruukki Oyj and its subsidiary, Ruukki Production, Co-Products, which is responsible for the processing and marketing of slag, hosted the event from 20th to 21st June 2005 in Oulu, Finland. Twenty-two experts presented 25 different lectures reporting on the latest developments in three different topic areas

- Utilization of slags in general
- Applications
- Slags and Environment.

In his welcoming speech, H. Sandvik (Rautaruukki Oyj) pointed to the historical importance of slag production in the Oulu region. Ruukki (which is the new name for Rautaruukki) was founded in the 1960s to meet the demands for steel of the Finnish metal industry. The decision was taken to locate it in Oulu, one of the reasons being its proximity to excellent Swedish ore (Luleå is only six hours away by ship) and another its central location for manufacturers using steel. Today Ruukki is one of the most modern steelworks in Europe. The production of iron and steel is directly connected to the production of slag. This is why Ruukki decided early on to explore ways of exploiting slag. With the help of Ruukki Production, Co-Products, a form of slag management could be developed that nowadays allows the slag that is produced to be utilised completely.

The chairman of EUROSLAG, H. Motz welcomed the participants and in his welcoming speech first commented on the statistics produced on the European production and utilisation of slag. These demonstrate that nowadays a large amount of slag is utilised in very many different fields. Nevertheless, some amounts of slag still have to be disposed of although the properties and fields of application of slag are well-known and have been intensively researched. When it was founded in 2000, EUROSLAG set up four working groups "Hydraulic binding agents", "Road construction material", "Fertiliser" and "Public relations", which since then have been intensely involved in the research and development of slag and its use, as well as representing the interests of the

association. Today members of EUROSLAG can be found representing its members' interests on all European committees for standardisation that are concerned with slag.

Utilization of slags in general

Led by S. Haimi (Ruukki, FIN) the first topic on the general status of slag production and utilisation was opened.

M. Dean (Civil & Marine (Holdings) Ltd., UK) illustrated this using the situation in Great Britain as an example, where out of what was previously deposited of, a slag product has been developed with a very high potential demand, and which nowadays can in many cases no longer be supplied in sufficient amounts due to the limited amounts that are produced. Reference was also made to the unsatisfactory situation with regard to European law, which is increasingly being used by administrative authorities as a means of declaring slag as waste.

The situation regarding slag in Brazil was reported on by N.O. da Silveira (CST, BR). Since the privatisation of the steel industry in Brazil in the 1990s, the highest priority has been given to the utilisation of slag. Following extensive research, for example into the volume stability of steel slag, today most of the slag produced can be put to use.

A speciality is provided through the production of ferrochromium in Finland. The slag that is produced is used in its entirety in road construction. As M. Kauppi (Outokumpu Oy, FIN) explained, the chromium parts of the slag are tightly integrated in spinels, thus suppressing the leaching of chromium. He considers the manufacture of these slag products to be the "best available technique – BAT" and an essential contribution to environmental protection.

A further important application for blast furnace slag and steel slag is their use as fertiliser. M. Rex (Thomasdünger GmbH, D) stressed the importance of fertiliser from iron and steel slag on the yields from agricultural products. Long-term experiments in the laboratory and in the field have demonstrated the sustainability of fertilisers from iron and steel slag.

K. Kujala (University of Oulu, FIN) described the necessity of requirements on road construction materials as a result of the weather conditions in Finland. More attention must be paid because of the long period of frost when considering the thermal conductivity of the products used. In this regard, more and more products from iron and steel slag have proven to be very advantageous. He explained that through the use of iron and steel slag in road construction, the entire construction sector has benefited from the advantages.

In his lecture P. Tanskanen (University of Oulu, FIN) covered the mineral composition of iron and steel slags and its effect on the properties of usage.

Applications

Although nowadays slag arising out of the manufacture of iron and steel can be put to use in many different ways, the search continues for the possibility of using it for a qualitatively high-value use.

In this regard, A. Tikkakoski (Finnish Road Enterprise, FIN) reported on the use of mixtures of blast furnace and steel slag. He came to the conclusion that mineral mixtures with up to 70% LD slag do not surpass the critical volume expansion of 5% in laboratory tests. Thus the volume stability of steel slag can be improved effectively by mixing it with air cooled or granulated blast furnace slag.

An increase in the load capacity of soils through its mixing with cement was the subject of two other papers presented. M. Mäkikyrö (Ruukki, FIN) reported on a method of stabilisation of low load bearing sub-bases through mixing in binding agents composed of cement, slag and lime. The binding agents that have been developed are pumped through compacting columns to the load-bearing sub-base or are directly used as load-bearing substrata. In his lecture M. Mäkikyrö spoke in particular about the possibilities of the use of ground granulated blast furnace slag, which was activated with cement for the purpose described above.

A method for column stabilisation for non-load bearing substrates through the use of electric arc furnace slag was presented by N. Jones (Multiserv, UK). By this method electric arc furnace slag is inserted into drilling holes with the help of vibration flushing. The choice of electric arc furnace slag was for its excellent stability and very good environmental properties. The excellent workability of electric arc furnace slag was made visible in a short film detailing the installation.

In addition, G. Ghataora (University of Birmingham, UK) reported on studies carried out to increase the pH-value of soil which had been used to cover an old heap of colliery spoil to neutral by mixing it with fine-grained LD slag and at the same time to stabilise the soil. The pH-value in the surface water at the beginning of the procedure had dropped to less than 2.7. Through the use of LD slag, the pH-value could be raised and thus the leaching of heavy metals could be reduced.

In his second lecture G. Ghataora described the stabilising of clay using LD slag and the resistance of the stabilised clay to sulphate. It was shown that through the use of ground LD slag and/or blast furnace slag, the sulphate attack could be reduced.

N.O. da Silveira (CST, BR) presented an LD slag product for road construction with good volume stability. The LD slag is laid out in thin layers of up to 20 cm and subject to heavy weathering for at least two to three months. During this time samples are regularly taken. If the test samples show a volume expansion of less than 5%, the slag is approved for use as aggregates for road construction.

This was followed by E. Lang (FEhS-Institute, D) who presented a paper on the freeze/thaw resistance of blast furnace cements. Through comparing laboratory results and results from years of field work, he could prove that the weathering effects determined in the CDF test for blast furnace cement do not reflect the actual behaviour of this cement in practice. This test is therefore not considered suitable for evaluating blast furnace cements.

In a further presentation, P. Bruncher (AFOCO, F) and D. Deneele (LPCP, F) reported on the use of slag in France. They showed very impressive how natural resources can be protected through the use of slag.

E. Lang (FEhS-Institute, D) presented a report on the test results on the grindability of granulated blast furnace slag depending on the conditions of manufacture which he had worked out together with A. Ehrenberg. Several influential factors were established. These are the microstructure, the chemical composition, the conditions of storage, the conditions of smelting and the granulation conditions.

The introduction of a quality management system for slag from the production of stainless steel in the Tornio works of the Outokumpu Stainless Oy was presented by J. Roininen (FIN). A determining factor in deciding whether slag can be used or not is the chemical composition. For this purpose, Outokumpu installed an automatic slag analysis system by which the slag composition can be analysed within a few minutes. Corresponding to the SP factor adopted by the FEhS-Institute, this allows decisions on the possibilities of use of the slag to be made at an early stage.

Slags and Environment

The third topic area was concerned with environmental aspects in the use of slag. S. Haimi (Ruukki, FIN) presented a paper on the current situation on the discussions about the status of slag as to whether it is a product or waste. He pointed out that over recent years the European Court of Justice has continuously broadened the scope of the expression "waste". This has resulted in problems in the use of slag in the construction industry. The European Commission has recognised the danger associated with the unclear definition of waste, which in general serves to hinder the recovery of materials and the re-use of recycled materials. The "waste framework directive" is therefore to be revised in the near future in order to provide new definitions for terms such as "waste", "by-products" and the "end of the waste property".

In connection therewith R. Bialucha (FEhS-Institute, D) presented a paper on the new regulations in the field of environmental aspects in the EU. She emphasised that strict distinctions must be made between the rules for waste and for construction products. The current European standards for construction products do not include any rules regarding environmental compatibility. These are to be drawn up by a new Technical Committee (TC) "Regulated Substances" of the CEN and incorporated into the European set of regulations. The corresponding mandate is currently being prepared.

For the most part, steel slag in Brazil is used in road construction projects. The manufacture of the aggregates and its marketing is usually carried out by small slag processing companies, who at the moment do not have sufficient experience with this type of construction material. M. Gomes da Silva (University Federal do Espírito Santo, BR) stated that with the help of the university a

scientific basis for the drawing up of guidelines with regard to the technical characteristics and possibilities of use is being created.

M. Tossavainen (University of Luleå, S), together with her research team, has studied the effects of the rate of cooling on the formation of the mineral structure of slag, in particular of steel slag. She comes to the conclusion that the rate of cooling has a distinct influence on the formation of the crystalline and vitreous phases, which in turn affects the leaching of chromium, molybdenum and vanadium.

L. Lind (SSAB MEROX AB, S) presented a paper on the adsorption of phosphates and heavy metals from industrial wastewater with ground granulated blast furnace slag. Sludge that is contaminated can be stabilised with ground granulated blast furnace slag so that no further leaching can take place and affect the environment.

L.I. Bowden (University of Newcastle, UK) extended the presentation from L. Lind and proposed the use of LD slag for the adsorption of phosphates and heavy metals. Through increasing the pH value, in many cases an environment can be created where re-growth can be cultivated.

In his capacity as chairman of EUROSLAG, at the end of the conference H. Motz (FEhS-Institute, D) could draw a very positive conclusion to the 4th European Slag Conference and for the current and future use of blast furnace and steel slag in Europe and other continents. The excellent response showed that manufacturers and users of slag throughout the world are very interested in blast furnace and steel slag as a construction material and as a fertiliser. Questions regarding the composition, the environmental compatibility and new possibilities of use are therefore at the fore.

The board of EUROSLAG has therefore decided to plan the **5th European Slag Conference for 2008**. Details of the conference will be published in due time on the EUROSLAG website.

EUROSLAG will publish all papers presented at the 4th European Slag Conference as "Proceedings – EUROSLAG Publication No. 3".