BRITE SILEX PROJECT

CONTENTO TRADE SRL

Technological innovation for the environment

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Recovery of major elements from coal fly ashes

BRIEF DESCRIPTION:

Partners:

KEMA Nederland, Arnhem, The Netherlands
Technische Universiteit Delft, Delft, The Netherlands
Contento Trade, Campoformido, Italy
University of Limerick, Limerick, Ireland
Consejo superior de investigaciones cientificas, Madrid, Spain

Objectives:

SILEX project aims to realize the scientific and technical foundations which are necessary for the reutilization of the main constituents, Si Al, from the coal cinders, through extraction or conversion, so that they could be used for manufacture of high quality products.

The project aims to develop of a productive process from a technical and economic point of view; through this process, the combustion residues could be transformed into pure zeolites, produced according to the requests, or other high quality products.

It includes:

The transformation of the main constituents of the flying cinders into useful and high quality products, as the pure zeolites; it could be considered as a big innovation for the flying cinders recycling. The pure zeolites show advantages compared to those including a cinders residue (for example, the purity).

If the pure zeolites of SILEX were produced using industrial residues as source of Si and Al, their production should be less expensive. The producers of combustion waste could have a new profits, the environment could have protected and the natural resources will be preserved.

OBJECTIVES:

The production of energy in the coal fired power stations results in the generation of a considerable amount of residues, mainly in the form of ashes. About 25% of the energy demand in the EU is produced from coal and lignite fuel and this accumulates to over 60Mt/y of fly ashes. It is expected that world coal reserves will last much longer than oil and gas reserves, so that in the long run the

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dependence on coal fired electricity plants for energy production is likely to increase. This will consequently lead to the generation of fly ash in the future.

Leaching of potential hazardous elements and the changing quality of fly ash, as a consequence of changing combustion technology and co-combustion of waste materials with high energy content, will possibly restrict the utilization of fly ash in the future. Disposal of these residues is becoming more and more expensive.

More than 90% of fly ashes consist of valuable resources such a glass (about 70-80%), mullite (10-20%) and magnetite (5-10%). With the correct technologies applied, there exist the potential to recycle all of these resources. The heavy metals , responsible or the environmental (leaching) problem, at the contrary, form only trace amounts of the fly ash.

The objective of SILEX project is to build up the scientific and technical basis for the complete recovery of the major elements Si and Al, from coal fly ash, either by extraction or conversion, so that they may be used for the manufacturing of high quality products.

In the long term this will lead to the development of a technical and economically efficient process by which combustion residues can be converted into different types of pure tailor-made zeolites or other quality products such as functional fillers.

A market study carried on by one of the SILEX partners showed that the potential market for fly ash derived products is equivalent to the utilization of more than 20% of the residues in the countries concerned. The expected benefits for those products were estimated between 20 and 40 Euro per ton. Strategic decision analysis of fly ash conversion project showed return on investment ratios between 100 and 200. Extrapolating these figures to an European level with a conservative conversion of 10-15% this may result in a profit of 200-300Meuro/year.

The SILEX project is planned for three years; assuming technical success of SILEX, a follow up project is envisaged to optimize the relevant process parameters, to examine in closer detail the economical viability and test possible applications for the products. Hereafter the following logical step would be the realization of a pilot plant project.

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STATE OF THE ART

The conversion of fly ash into zeolitic material has been reported for more than 20 years; this is usually carried out though a hydrothermal treatment of the fly ash with an alkaline solution. The type and amount of zeolite obtained depend on the chemical composition of fly ash, the composition of the reaction solution, the liquid/solid ratio, the temperature, the reaction time and the intensity of mixing.

The existing patents protect preliminary results obtained on laboratory scale only: in all reported cases the conversion process results in a mixture of zeolites and residual fly ash. Direct conversion of fly ash results in a product with about 50% zeolite, the reminder consisting of residual phases, mainly mulite and glass. Since these residual phases still contain Si and Al, this indicates incomplete conversion.

The incomplete availability of Si and Al is caused by:

- ✓ the microstructure of the fly ashes themselves
- ✓ the presence of aluminosilicates such as mullite and other phases, which are not reactive under the applied conditions

the specific nucleation and crystallization behaviour of zeolites synthesized from fly ash, including an important induction period during which glass dissolves and zeolite nuclei are formed in an amorphous crust enveloping the fly ash particles. Only at the end of this induction period the crystallization of zeolite can proceed fair rapidly and finishes with an equilibrium condition between the zeolite crystallized, the remaining glass and the concentration of hydroxide, aluminium and silica in solution.

MAIN INNOVATIONS

The complete conversion of the major components of coal fly ash into useful high-quality/high-value products such as pure zeolites, is a major innovation in the field of utilization of fly ash. No research in this field has been recorded so far.

The pure zeolites synthesized from fly ash have a number of advantages in comparison with those containing residual fly ash. Most important of these are:

- ✓ purity: the pure zeolite product can be used for both catalytic and absorption purposes while the zeolite containing residual fly ash can only be used for absorption purposes.

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- ✓ variety: a wide range of pure tailor-made zeolites can be synthesized. Because each type of zeolite has individual characteristics, this opens up a broad field of applications.

- ✓ physical properties : pure fly ash derived zeolites can be produced with a narrow particle size distribution, which together with the white color, increases the number of possible applications further (es. as functional filler).

Pure zeolites synthesized from fly ash are expected to complete with zeolites of catalytic quality which are produced from pure chemical reagents. Since SILEX pure zeolites will be produced by using industrial residues as a source for Si and Al, it is expected that production will be inexpensive compared to the production from pure chemicals. It also means that:

- ✓ a new source of income will be generated for the producers of combustion residues
- ✓ the residues will be re-utilized (environmental benefit)
- ✓ primary natural resources (zeolites, raw materials for bulk chemicals) can be saved.

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