FLY ASH DISPOSAL
Life+ Project
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Some 250 million tonnes/yr of municipal solid waste is produced in Europe and about 20% of this waste is burned in incinerator, creating large volumes of slag and fly ash. Indeed, the incineration process has two main kind of by-product: the slag represents about 20% or more by weight and 10% by volume of the solid waste input; fly ash is the lightest, finest and thermo-labile part collected by a filtration system and it represents more than 1% by weight of the total waste.

Some recycling options exist for slag, but satisfactory technologies are not available to reuse fly ash yet. Fly ash is classified as hazardous waste, the most used treatment method for this typologies of waste is landfilling, normally after a neutralization treatment.

The characteristics of fly ash are very variable, because they depend on the burnt material, the combustion type and the temperature. Generally, fly ash is a highly soluble and reactive material that contains significant quantities of heavy metals (Zn, Pb, Cd, Cr, etc.). Often the heavy metals are present as anionic salts (chlorides and sulphates), and alkaline anionic salts represent one of the main components of this waste (up to 25% of Cl in some samples). In this inorganic fraction, which is very variable in composition, we find an organic fraction relatively rich in unburnt elements, aromatic compounds and often also rich in dioxins and furans.

This waste is difficult to stabilize and its disposal costs vary in Europe from 150 to 500 €/ton, hence it’s important to find a new solution to avoid environmental pollution and reduce costs too.

LIFE programme, and LIFE+ after it, finances several researches concerned in finding an alternative solution to fly ash disposal or in developing current method.
The following project, financed by LIFE program, are the ones that studied the environmental problem of fly ash disposal, in chronological order.

<table>
<thead>
<tr>
<th>Duration</th>
<th>Project Name</th>
<th>LIFE code</th>
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<tr>
<td>01/05/1998 to 01/06/2001</td>
<td>Treatment and valorisation of municipal waste fly ash using a thermo-chemical conversion</td>
<td>LIFE98 ENV/F/000326</td>
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<td>01/10/1998 to 31/12/2001</td>
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<td>RECUPYL S.A.</td>
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<td>Total Budget</td>
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<td>EU contribution</td>
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| Project Location| Rhône-Alpes, Provence-Alpes-Côte d’Azur, France  
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| Publication     | No publication found |

**LIFE98 ENV/F/000326**  
01/05/1998 to 01/06/2001

**Treatment and valorisation of municipal waste fly ash using a thermo-chemical conversion**
About RECUPYL S.A.
RECUPYL was established in 1993 as a subsidiary of INPG Entreprise SA, the business development arm of the Institut Polytechnique de Grenoble (INPG). Its aim was to find ways of industrialising and exploiting the scientific results obtained at the INPG-CNRS solid-state electrochemistry and physical chemistry laboratory concerning the processing of used batteries. RECUPYL benefited from a LIFE grant in 1994 for another project dealing with the recycling of batteries.

Objectives
The ashes washed from the fumes are a very active by-product that need recycling, the project aimed to develop an innovative treatment process for fly ash and to refuse what result from the incineration of municipal wastes. This was aimed at making it possible to end the disposal of such toxic waste in special landfill and to recover a large quantity of products, which are currently lost.

Starting with its initial experience in the treatment of used batteries and industrial waste via hydrometallurgical treatment, RECUPYL aimed to develop a new treatment process for fly ashes.

Actions and Tests
The project main stages involve a scientific study of the problem in hand, then a feasibility study of the new process.

Eventually the project target is the industrialisation and distribution of the process, either via a licensing agreement and assistance with installation, or by developing a partnership with an industrial concern.
Results
From a scientific and technological perspective, it has become clear that hydrometallurgical treatment is essential in eliminating and recovering heavy metals, provided that this form of treatment is combined with other techniques, in particular thermal and mechanical treatment. Hydrometallurgy covers all metal extraction processes involving the creation of a solution (with an acidic or basic solvent), leaching and electrolysis. A hydrometallurgical process includes the following individual operations:

- dissolution of the fraction of ore containing the necessary chemical element,

- purification and concentration of the solutions,

- transformation to metal state.

In addition to all of its technical advantages, this process is environmentally friendly, because the hydrometallurgical processes causes practically no atmospheric pollution by the emission of gas, dust or steam. The technology developed by RECUPYL allows a complete treatment of the fly ashes and the enhancement of several by-products.

One ton of fly ashes will produce the following recycled elements:

- 670 kg of mineral granulate that can be utilised for building roads
- 180 kg of salts that can be utilised on roads when these are frozen
- 120 kg of gypsum, that can be utilised in the construction industry
- 20 kg of zinc and 10 kg of other metals that can be utilised as standard raw material.

The environment advantages of the process are many, first of all the landfills are not invaded by toxic refuse coming from incinerators and natural resources are preserved by the utilisation of the recycled material.

Furthermore treating the fly ash on the incineration site will decrease the dangerous waste that is carried around on long distance. Eventually the public image of incineration is improved.

The demonstration phase was successful and the commercial success also seems guaranteed. A treatment line build on the premises of an incinerator, with a treatment capacity of 4000 tons/year will result in a treatment cost of EUR 260 per tonne, very similar to the cost of dumping. The cost per unit will decrease rapidly for a larger capacity and fall well below the cost of dumping. Furthermore, the sale of the recycled material will also help to ensure economical viability.
Beneficiaries
- Contento Trade S.r.l.
- Stazione Sperimentale per il Vetro di Murano (SSV) - IT
  Murano(VE) CTG S.p.A.
- Italcementi Group IT-Bergamo (BG)
- IFTH – Institut Francais du Textile et de l’Habillement
  France KEMA - NL- Arnhem

Total Budget 1,248,808.39 €
EU contribution 374,642.52 €

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Project Location
Friuli-Venezia Giulia, Italy

Publication
“Waste Based Reinforcing Materials”, Contento Trade, 2002, 8 pages

LIFE98 ENV/IT/000132
01/10/1998 to 31/12/2001

WBRM - Waste Based Reinforcing Materials
About Contento Trade s.r.l

Contento Trade was founded in 1987 thanks to a group of researchers coordinated by Mrs Maria Pia Contento. Presently the company activities are subdivided in the following sectors: Research, Technological innovation development, Industrial services, Analysis & testing.

In the industrial services sector, the company is specialized in three connected fields: Life Cycle Analysis (LCA) of products and processes; Company strategies for the innovation and the environment; Promoting and intermediating activities on innovative processes and technologies.

For the analysis and testing sector, the company owns specially-equipped laboratories for the execution of tests by third parties concerning the following materials: Aggregates; Mortars and plaster; wastes.

Objectives

The WBRM process produces a glassy material, at commercial specifications, using fly ashes from municipal solid waste incinerator and other special wastes. This process uses alkaline metals and heavy metals existing in the ashes, to speed up the melting process of the glass mass and to reduce the silicate softening point that are the main constituents. In this way, starting from 1 kg of fly ashes it’s possible to obtain up to 2.5 kg of glass, depending on the chemical characteristics of the used ashes.

The project aims to prove the viability of the production of high quality, high added value vitreous fibres from wastes by means of a new clean technology and the possibility of an alternative route for ash recycling at a much lower environmental cost.

The main objective was to test, at pilot scale, the productive process of new typologies of glassy fibres useful for production of textiles and non woven fabrics and for the reinforcement of cement, plastic and bitumen based products. The project intended to transform mixtures of municipal waste incineration ashes (MWI), coal combustion ashes and steel making dusts (SM) in long vitreous fibres, with good mechanical characteristics and high chemical resistance.
**Actions and Tests**

The main stages of the project are:

- The demonstration of industrial validity of the fibre production process, thanks to the non-stop production at pilot scale strictly monitored;

- The punctual determination of the chemical, physical and mechanical characteristics of the new fibres and of their production cost;

- The control of the process adaptability to the different MWI ashes (from municipal wastes) existing in Europe;

- The execution of an environmental evaluation (LCA) of the new fibres to underline the advantages linked to their use;

- The production and the characterization of the finished products made with the new fibres, underlining the potentialities of the proposed technology and its versatility also as finished product.

**Results**

The technical innovation presented for the treatment and the recycling of the WBRM (mainly ashes) appears to have both economical and environmental advantages. The technology developed seems to be adequate for implementing a better life cycle of raw materials and wastes, because it seems to be environmental friendly and less expensive than traditional processes. The innovative aspect consisted principally in developing a process to re-use the municipal waste incineration (MWI) ashes, coal combustion ashes and steel making (SM)dusts.

The objective of the project was well reached and the process should be reproduced, particularly considering the importance of the environmental problem regarding the re-use of wastes.

The fibres obtained from wastes with this new technology have very good characteristics. For instance the presence of heavy metals as zinc and iron in the glassy structure improve the chemical stability of the obtained fibers, creating a real protective coat that reduce the velocity of the alkali silicate reaction, increasing the durability of the obtainable fiber reinforced cement. At the same time the presence of heavy metal oxides may lead to an improvement of adhesion of the fibers with the polymeric matrix used in the composite industry (thermoset resin like polyester or thermoplastic resin like polypropylene or polyamide). Furthermore the presence of metal compounds may also affect the electrical properties (low resistively) and lead to higher thermal conductivity of the fibers.
The main technical proprieties of the fibres result from the tests are the following:

The WBRM fibers have an alkali resistance of medium value between the E glass and the AR glass added with zirconium oxide;

The WBRM fibre length is included between 3 mm and 60 mm;

The costs ratio production/performances is surely inferior to the one of E glass fibres;

Even if the planned resistance to tensile stress of 1.700 MPa has not been obtained, some fiber samples showed a resistance to tensile stress inferior of less than 10% compared to E glass fibers (maximum value 1.432 MPa against the 1.576 MPa of E glass). It should be noted that neither of the commercial samples tested showed the limit value 1.700MPa.

Even the technical results obtained with the environmental tests on the glass are completely satisfactory because this product turned out to be completely stable and reliable for any environmental application, exactly like the glasses used at industrial level.

In any case the most interesting technical results came from the tests on the possible final applications of the WBRM glass fibers.

The non woven fabrics produced showed excellent thermal properties and a surprising adaptability to the typical processing phases of the industry of the sector. In short, the WBRM fibers turns out to have characteristics completely similar to the E glass fibers largely used at industrial level.

Figure: WBRM fibres and glass
The plastic materials produced in the project belong to the most demanded type by the market, to be used in varied applications: from the car industry to the building industry sector. Even in this case, the obtained results demonstrated that the WBRM fibers can substitute completely the conventional E glass fibers without altering the fibroreinforced material characteristics. This result is very important because the fibroreinforced plastic materials represent the main market outlet for the commercial E glass fibers.

The bituminous materials produced and subjected to tests in this project showed the excellent perspectives of the WBRM fibers in this sector for special application as bituminous sheath and for innovative applications as bituminous conglomerates.
Even in the sector of cement products, where the CEM FIL fibers (specifically studied for this application) resulted superior, the WBRM gave performances in any case better than the E commercial glass fibers, representing a good application opportunity that could be later on improved (if necessary) adding zirconium oxide in the basic mixture. Obviously the use of this raw material could influence the production cost of the WBRM fibers, but we must notice that currently, the CEMFIL cost from 10 to 5 times more than E glass fibers. The process is highly transferable, particularly considering the importance of the environmental problem regarding the recycling and re-use of waste in the light of EU environmental policy. The project has a great potential for the scope of LIFE Environment Programme, environmental policy and legislation (Incinerator Directive) and therefore to the creation of long-term environmental benefits. According to an ex-post follow-up questionnaire completed by the beneficiary in 2004, the technology has been patented. The intention is to prepare a new consortium for the WBRM valorisation involving some of the initial partners, as well as other new industrial partners.
Beneficiaries
- Institut Scientifique de Service Public (ISSeP)
- Vlaamse Instelling voor Technologisch Onderzoek (VITO) - BE
- Laboratoire Environnement Minéralurgie (LEM) – FR

Total Budget 674,421.70 €
EU contribution 333,492.45 €

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Project Location Vlaams Gewest and Région Wallonne, Belgium;
Lorraine, France

Publication Layman Report, January 2003

LIFE99 ENV/B/000638
01/10/1999 to 01/10/2002

REFIOM 1/10/2002 - Assessment of the long term behaviour of the fine residues of municipal waste incineration processes treated with hydraulic binders.
About ISSeP
Institut Scientifique de Service Public (ISSeP) is a public institute depending on the Walloon government, it’s a research and development centre working inter alia for industry. The fields of activities concern natural resources, environment and de-pollution and technical and industrial security. The institute is also a laboratory of reference for the wastes characterization.

In this project, the ISSeP coordinates the other research centres, Vlaamse Instelling voor Technologisch Onderzoek (VITO) and Laboratoire Environnement Minéralurgie (LEM). It’s notable that researchers from VITO are agents of Belgium at European level in standardization comities, and they develop leaching tests (CEN/TC292 WG2-6).

Objectives
The solidification/stabilization of fly ash has been used for many years, however the long term durability of these solidified waste still remains a subject requiring further research. At present, what is known about their evolution over time depends on models validated only on the short term, at laboratory scale, by mean of test-bars of rather small dimensions; these models are limited to explain and understand the processes that affect stabilised fly ash over time. Indeed the evolution of stabilised fly ash over time is a function of complex thermo-chemical reactions and transfer laws.

The project pursues three objectives:

- Study the evolution of the MWSI stabilized/solidified in hydraulic binders and naturally aged, by use of classical methods of analytical chemistry and leaching tests, and contribute to the validation of the stabilization/solidification processes or define corrective measures;

- Propose a methodology for the characterization of these materials, allowing to foresee or to model the long term evolution of the solidified wastes;

- Propose a validation programme of the methodology and supply a basis for reflection as to the valorization of the inerted wastes.

The project focussed on the inorganic properties of fly ash, mainly heavy metals and salts; it did not deal with organic compounds like dioxins and furans.
Actions and Tests

The samples of material, in addition to the raw MSWI, were blocs of MSWI stabilized in cement and naturally aged in their stocking sites and samples of fresh solidified MSWI. Analysis have been also carried out on small test-bars realized with mixture of water+cement+raw MSWI.

The analysis method is based on a multi-disciplinary approach in order to investigate how to understand and possibly predict the long-term behaviour of stabilised fly ash. This methodology includes leaching test, physical tests and the chemical, petrographical and mineralogical analysis.

- The **leaching tests** give information on the behaviour of toxic elements present in a solid material submitted to the action of an aqueous solvent. The leached concentrations (mg/Kg) of the pollutants, depending on leaching time, water pH, etc., must allow the classification of the pollutants bearing material as dangerous, no dangerous or inerted waste.

- The **physical tests** give information on the mechanical cohesion of a solid material. In this case, the permeability tests have been carried out only. Practically, a water flow through a cylindrical test-bar, managed in the studied material, is measured, thus the cohesion of this latter deduced.

- The **chemical analysis**, which in this case have been carried out after dissolution of samples, give the total concentrations of the various chemical elements.

- The **petrographical analysis**, a method used for a long time, allows the identification of the components of a solid material and the description of the aspect of this material at the scale of the microscope. Since this microscopic exam is realized by transparency, thin section of 30 micron sick are traditionally cut from the solid material to be analysed. Briefly, the parameters to be considered are a low cohesion of materials, the potential toxicity of their sawn products, the very high solubility or the limited thermic stability of some components.
The *mineralogical analysis* deal with the study of mineral phases, namely solid compounds with defined composition and atomic structure. The mineralogy leads not only to the identification of crystallized mineral phases but also to the knowledge of their properties and their origin. In this case, the analysis has allowed the characterization of major minerals, namely phases which are present in high quantities and identified on the global rock, as well as the characterization of minor minerals, namely important phases but present in very low quantities and identified on isolated grains and/or thin sections.

**Results**

Here there are the results from the analysis performed on the samples.

The leaching test results, in compare with the values accepted by the European directive for inerted wastes, indicate a problem with chloride and lead, and show that sulphates are not ideally immobilized.

The permeability tests clearly show that, when compared with classical concretes, the solidified MSWI are characterized by a mediocre behaviour with a water drain-off through the cylinder test-bar of 4000 to 6500 cm$^3$ instead of 11 cm$^3$ in case of a good concrete.

At the scale of the polarizing microscope, the various samples exhibit common texture and composition which can be summarized as follow:

- net of micro-cracks, related to freeze-taw cycles and/or shrinkage cracks;

- chemical reactions, for instance dissolution (very high pH), affecting fly ashes.

The major mineralogical phases formed during and/or after the solidification/stabilization of MSWI give very interesting information. The presence of calcium bearing complex salts explains the high quantity leached of some toxic constituents such like chlorides and sulphates. The hydrated silicates inform on the temperatures reached in huge stocking sites, namely 80 to 100°C. Such temperatures, kept during a long period, can induce complex reaction series.
The fine analysis of solidified MSWI and aged in their stocking sites leads to a very complex mineralogy. Practically, this means that a given toxic chemical element is incorporated in different mineral phases. In particular, this is the case for zinc, lead and chromium.

At the contrary, the small tests-bars realized at the laboratory with cement and MSWI show a more simple mineralogy. Such a result is indicative of the limit of reliability of models established from small tests-bars which cannot take into account the complex reality of the huge stocks of solidified MSWI.

The combined fine study of raw MSWI and solidified MSWI inform about the mineralogical story of heavy metals. Some toxic elements are present in phases contained in raw MSWI and in solidified MSWI (inherited phases), whereas some others are located in minerals identified only in solidified MSWI, thus crystallized during or after the solidification process (neoformed phases).

Crucially, the project has demonstrated that, due to the chemical compounds they release, the stabilized fly ash must be considered as dangerous waste and cannot be considered for further use. The multidisciplinary study which has been carried out leads to a better understanding of the long term behaviour of the MSWI stabilized with hydraulic binders and, beyond the statement and prevision, the analysis of results gives relevant indications about potential treatments to be envisaged in order to improve the process.

The following scheme, published in the Layman Report, illustrates clearly the usefulness of each step of the multidisciplinary approach:

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<th>I</th>
<th>LEACHING TEST</th>
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<td>Behaviour of toxic elements in terms of time, pH and temperature</td>
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<th>II</th>
<th>PETROGRAPHY AT THE SCALE OF MICROSCOPE</th>
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<td>prediction of physical properties of solidified MSWI; identification of some major minerals and story of some reactions</td>
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<th>III</th>
<th>a) MINERALOGY ON GLOBAL ROCK</th>
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<td>identification of major minerals which could contain dangerous elements</td>
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<th></th>
<th>b) MINERALOGY ON GRAINS AND THIN SECTIONS</th>
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<tr>
<td></td>
<td>amorphous phases; important minerals present at very low quantities; mineral associations and reactions; identification of micro-phases</td>
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<tr>
<th></th>
<th>a ) + b )</th>
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<tbody>
<tr>
<td></td>
<td>understanding of the behaviour of toxic elements</td>
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“Beyond the prediction of the behaviour at long term, the scheme I, II and III could be useful for producers of solidified MSWI in order to control, for instance each year, the evolution of their products. By analogy, the scheme III could be helpful for a regularly control of raw MSWI”.

In conclusion, the MWSI stabilized with hydraulic binders must be considered as dangerous wastes and, at present state of things, cannot be envisaged for utilization. Because of the dangerous character of these materials, their disposal in landfills for hazardous waste should be envisaged. In order to improve the process of solidification/stabilization of MSWI in cements, the project suggest economically viable treatment which are based on the “geo-mimesis” principle: those pollutants which cannot be immobilized using cement only, are helped to evolve towards mineralogical compositions which are known to be stable at the geological time scale. Applied to the raw MSWI before their incorporation in cements, these treatments should enhance the immobilization of toxic elements such like lead, chlorides and sulphates.”
| Beneficiaries | SMEDAR - Syndicat Mixte d’Élimination des Déchets de l’Arrondissement de Rouen
Gaz de France, France |
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Website: www.smedar.fr |
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| Publication   | No publication found                                      |
About SMEDAR
SMEDAR is a public organisation that sorts and treats 600 000 tons of waste each year from a number of French cities, it manage the waste for 164 municipalities dealing with recycling, composting and energy production.

SMÉDAR aims to ensure the operations involved in the treatment and recovery of waste, as well as its transportation, sorting or storage. The company objectives are to ensure energy recovery, material recovery, or recycling, and agricultural recovery according with environmental matters, these aims are reached building, maintaining and operating the equipment and studying on the subject.

Objectives
In France, such residues from domestic waste incineration smoke and industrial waste (REFIOM2 and REFIDI3) represent 3% of incinerated material. The 420 000 tons of smoke purification residues produced in 2002 was made up of 390 000 tons REFIOM and between 25 000 to 30 000 tons REFIDI. Once stabilised, the REFIOM are very water soluble but the transport of REFIOM is expensive and stabilized waste is not inert.

The vitrification process Vitriflash offers an alternative. It is a means for transforming hazardous substances in usable materials. The objectives of the project were to optimise an innovative pilot process of REFIOM vitrification and to demonstrate how vitrified products can be profitably used.

Initial tests lasting 6 000 functioning hours were proposed during which time 1 200 tons of REFIOM were planned to be treated. This expected to produce 112kg of vitrified product and 10kg of metallic residues each hour. Recycling of by-products was forecast to limit negatives impacts associated with the extraction of raw materials, such as noise, dust and air pollution.

Results
Due to difficulties encountered during the project’s preliminary stages, this project was terminated ahead of schedule and therefore did not reach its objectives. The beneficiary faced complications with having the conception studies for the pilot plant completed. The initial conception studies did not deliver the required standards and this quality gap was considered a too high risk.

In addition, the original cost estimates for the pilot plant were revised significantly upwards. The beneficiary therefore decided to stop the project, approximately half way through the proposed 41 month period.

The project’s main useful outputs refer to the tests conducted to choose between different technical options and validate the feasibility of proposed processes and technical solutions. These tests were carried out during work on the preliminary studies. The pilot was not constructed during the project but the LIFE project concept was presented at a number of conferences.

Despite the project’s contractual difficulties, the beneficiary remains convinced of the potential environmental, economic and social benefits that Vitriflash technology has to offer and is still keen to pursue the project concept in the future. Findings from the LIFE project remain relevant.
Beneficiaries

Sasil SpA
Stazione Sperimentale per il Vetro di Murano (SSV) - IT-30141 Murano (VE) CTG S.p.A.

Total Budget 3,508,580.00 €
EU contribution 1,738,239.00 €

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Project Location
Piemonte, Italy

Publication
No official publication available yet;
Newsletters published on Sasil’s website and on the magazine of “Stazione sperimentale del vetro”

LIFE08 ENV/IT/000421
01/01/2010 to 31/12/2012

VALIRE - Valorisation of incineration residues
About Sasil SpA
The beneficiary, Sasil SpA, is a private sector company specialising in mining services and minerals used for glass, ceramics and other bathroom materials.

SASIL S.p.A. operates in Biella Area since 1975 in mining, with mines in Curino and Masserano and plant in Brusnengo. SASIL produces feldspathic and silica sands, washed glassy sands and feldspar for glass and ceramic industry and sanitary ware.

Objectives
VALIRE project aims to realise two principle objectives.

The first one is to demonstrate the feasibility of two technologies by which the glassy combustion residues (slag, classified as special waste) and fly ashes (classified as hazardous waste) of incinerators can be recycled, reducing the environmental impact of the newest generation incinerators – still considered often as pollutive - to approximately zero.

The second objective is to provide new secondary raw materials which can substitute the use of primary raw materials in the production of high value building materials, in particular glass wool and glass foams, leading to significant reductions in energy consumption of the production processes and in the employment of natural resources, while making more affordable those products with high isolation properties as to increase their market penetration.

Secondary, objective, concerns the demonstration of a new way to recycle car batteries and residues of the natural minerals leaching process: their diluted sulphuric acid will be recovered and used to neutralize the high presence of CaO, (produced in the incinerator following the thermal degradation of carbonates present in the original waste) in slag.

Another objective is to raise awareness and knowledge amongst municipal solid waste managers, public authorities and environmental protection groups on the possibilities, shown in the project, of rendering incinerators an environmentally friendly and economically profitable way of dealing with unrecyclable waste. This may lead to reduction of social protest against incinerators, which are the main alternative to landfill, and to promote the introduction of – until now – expensive and complicated recycling methods for slag and fly ash.

Lastly the project aims to raise awareness and knowledge amongst producers of construction materials, especially insulators, of the existence of cheaper and more ecological ways to produce their product, enlarging in this way the market penetration of their products.
**Actions and Tests**

The main steps of the project consist in:

1. Characterization of the slag;
2. Design, construction and testing of a pilot plan for the treatment of slag;
3. Design of an industrial plant for the treatment of the slag;
4. Characterization of the fly ash;
5. Design, construction and testing of a pilot plan for the treatment of fly ash;
6. Awareness campaign and diffusion of the results for the construction sector, the citizen, the authority and managers of the municipal waste incineration plants.

**Results**

The VALIRE project is still working, indeed final results are not available yet. However there are several publications on preliminary results, these are published on the SASIL's newsletter available on the company's website, in Italian and sometimes in English, or, every semester, on the Stazione Sperimentale del Vetro's magazine (last publication on march-april 2012, n°2, vol 42).

The following information is taken from mid-terms publications, it doesn’t represent the final results of the project.

The chemical and physical properties of several tens of samples of slag and fly ash, collected from five different Italian incineration plants, have been detected by XRF, XRD, DTA, and wet chemistry. Based on the analytical results, the most suitable waste materials were selected.

Chemical and physical analysis showed that the composition of fly ash is very different in the different plants. The variations of concentration in calcium oxides (35-55% in weight) and chlorine (6-16% in weight) are remarkable. Furthermore heavy metal (lead, antimony, zinc) oxides have been found in all the samples, though in concentration lower than 1%. Traces of dangerous organic compound were found in fly ash, like dioxins.

Slag samples have been processed for the elimination of metallic impurities, and grinded to grain size of 63 micron. The processed samples were used as: neutralization agents of acid solutions from industrial mineral processes; fluxes in the porcelain stoneware production; sintered glass-ceramics.

Furthermore slag and fly ashes were used as secondary raw materials together with other waste materials in batches for the production of rock wool both on the laboratory and industrial scale. In the melting processes the gas and particulate emissions have also been detected in order to evaluate the environmental impact of the processes. The results of the tests are good, even if not all the problems are of immediate resolution, in particular it's necessary to take care of the emissions, trying to burn the toxic substances to convert them all into the normal combustion products CO2 and H2O.

Anyway the results of these tests leads the project to go on in the subject.
Beneficiaries
CSMT – Centro Servizi Multisettoriale e Tecnologico
University of Brescia, IT – Brescia (BS)
Contento Trade s.r.l., IT – Terenzano (UD)
Tekniker (TEK), ES - Eibar

Total Budget 2,007,907.00 €
EU contribution 995,354.00 €

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Project Location Lombardia, Friuli-Venezia Giulia, Italy

Publication
LIFE08 ENV/IT/000434
01/01/2010 to 01/01/2013

COSMOS - COlloidal Silica Mediu to Obtain
Safe inert: the case of incinerator fly ash
About CSMT
C.S.M.T. is a public-private consortium based at the University of Brescia, Italy, which promotes collaboration between the academic world and companies on training, applied research, technical services and technological transfer on a non-profit basis.

The mission of CSMT is to put the innovation into action, using qualified international knowledge from the University of Brescia and the traditional concreteness of Brescia’s industry. The CSMT aims to transform the innovation in results that are measurable, applicative, operative and gainful.

Objectives
At the University of Brescia a new low temperature process, based on colloidal silica medium, has been developed for treatment and refuse of fly ash from municipal waste incinerators, creating a new product called COSMOS. This approach appears to be quite promising for industrial application in view of the easiness that can be foreseen in applying it to existing plants treating industrial fly ash. In addition, the obtained inert product show good mechanical properties when employed as a filler. This fact hints that COSMOS can significantly help the target of the reduction of fly ash disposal. Indeed, the characteristics of COSMOS, already tested at the laboratory level, seems promising for pushing the reuse of inert fly ash, as filler in matrices such as cement, plastics, rubber.

The aim of the project is the technological transfer of the laboratory know-how, developed at the University on the inertization of the fly ash by using silica colloidal medium, to practical application on an industrial scale.

The industrial partners are be in charge of the prototype system construction to produce suitable amounts of the COSMOS filler. COSMOS will is used for evaluating its feasibility and the technological and economical advantages on different matrices. Three demonstrative products and the economical plane for their commercialisation have been delivered.

The environmental friendly character of the proposed technology aims at reaching specific targets, with positive impact on the environmental protection. For these reasons the project aims to demonstrate nearly complete reuse of all stabilised material in a way that achieves all the functional and economic objectives.
Actions and Tests
The project consists in eight main task:

1. Analysis of legal constrains for the commercialisation of products containing inerted fly ash, it involves survey for the social acceptance of stakeholders regarding materials obtained by inertization process.

2. Development of the necessary technique for the technological transfer of COSMOS process. The COSMOS protocol is transferred to industrial partners who will then construct a prototype system capable of generating 100 kg/day of the COSMOS filler from fly ash.

3. The project carries out a Life Cycle Assessment (LCA) of COSMOS process and of the processes commonly used in incinerator fly ash management. The comparison between the processes informed on the best applications of the COSMOS filler from financial and environmental points of view.

4. The prototype process provided enough material to test its application in at least five matrices. The functional and mechanical performance of the new materials have been compared with the commercial ones to inform the choice of three products to be delivered for demonstration and dissemination purposes.

5. Monitoring activities

6. Dissemination

7. Project management and coordination

8. After-LIFE communication plan

Results
The inertization of MSWI fly ash, using colloidal silica, gives birth to COSMOS, an inert material. The process occurs at low temperature by adding a mixture of the three powders (MSWI fly ash, flue gas desulfurization residues, and coal fly ash in the relative weight percent: 65, 20, and 15%, respectively) to about 25 wt% of colloidal silica solution. The obtained inertized material is washed to recover salts.
The process seems to be effective in the stabilization of fly ash, even from different incinerator, the leaching quantities of heavy metals are much more inferior than the beginning. In some cases law limits aren’t reached but the problem can be solved.

Finally the patented inertization procedure blocks heavy metals in the matrix and allows the recovery of the soluble salts simply by washing. The final chlorine-free material COSMOS can be obtained as a solid and a friable brick which is easily transformed into a fine powder.

COSMOS characteristics (i.e., its composition, the absence of soluble chloride and the stabilization of heavy metals) makes it suitable for use as a second-hand raw inert material.

Moreover, despite that final reuse of COSMOS is mainly addressed to construction materials, other application fields were investigated.

Polymer composites materials are being increasingly used in several applications, including construction, transportation and sports equipment industries, because of their advantages over traditional materials. Such advantages include lightness, high mechanical performance, and possibility of production in any shape. Polymer composites market share is continuously growing. Composites are made of a polymer and one (or more) solid fillers, that are employed because the final properties are a combination of the main properties of the two (or more) solid phases.

For polymers, a lot of filler materials have been developed in the past.

COSMOS powder was added to different polymers obtaining very good results also in terms of workability of the composites.

Results about the possibility to employ COSMOS as a filler of polymers are very promising. The inert inserted into polymer matrices results very well integrated and homogeneous dispersed in the polymer.
Beneficiaries
CSMT – Centro Servizi Multisettoriale e Tecnologico
University of Brescia, IT – Brescia (BS)
Contento Trade s.r.l., IT – Terenzano (UD)
Regione Lombardia, Italy

Total Budget
1,337,504.00 €
EU contribution
659,224.00 €

Contacts
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Project Location
Lombardia, Friuli-Venezia Giulia, Italy

Publication
No publication available yet

LIFE11 ENV/IT/000256
01/06/2012 to 31/05/2015

COSMOS-RICE - COLloidal Silica Medium
to Obtain Safe inert from RICE
About CSMT

C.S.M.T. is a public-private consortium based at the University of Brescia, Italy, which promotes collaboration between the academic world and companies on training, applied research, technical services and technological transfer on a non-profit basis.

The mission of CSMT is to put the innovation into action, using qualified international knowledge from the University of Brescia and the traditional concreteness of Brescia’s industry. The CSMT aims to transform the innovation in results that are measurable, applicative, operative and gainful.

Objectives

The project will develop the University of Brescia’s method for treating fly ash, that will be an evolution of COSMOS project. It will derive silica gel from rice husk ash, and will use the gel to make fly ash from municipal solid waste inert, via a chemical process.

The project will:

- Demonstrate that using rice husk ash as a precursor for silica leads to lower environmental impacts and economic costs, and that the silica gel can be used to treat fly ash;

- Evaluate the performance of the new materials obtained by the treatment, and the markets for the end products;

- Reduce the consumption of natural resources, in favour of recycled material; and

- Generate new knowledge, by combining the know-how and competence of different researchers and staff from industry.

Expected results

The project’s main results will be:

Eventually, using rice husk ash as a source of silica gel, and using the silica gel to treat fly ash, all rice husk ash in Europe could be reused, with a significant reduction in waste destined for landfill. At the same time, there will be a possibility of fly ash recycling, producing a new, environmentally-friendly product, with properties similar to or better than some commercial fillers, which are made from natural resources.
The following projects are related with fly ash disposal from different typologies of combustion plant, for instance power plant, paper industry, waste sludge incinerator. Every plant that works with combustion process need a flue gas depuration system, hence with production of fly ash.

Depending on the burned material and the combustion temperature, different kinds of fly ash is obtained, usually MSWI fly ash is much more polluting than the others, however it’s interesting to see how different fly ash can be reused.

### The projects: fly ash from different sources

<table>
<thead>
<tr>
<th>Duration</th>
<th>Project Name</th>
<th>LIFE code</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/07/1998 to 30/06/2002</td>
<td>Kemira - Disposal management system for utilization of industrial phosphogypsum and fly ash</td>
<td>LIFE98 ENV/FIN/000566</td>
</tr>
<tr>
<td>01/12/2001 to 31/12/2004</td>
<td>Environmentally friendly systems to renovate secondary roads. A demonstration project in Luopioinen, Finland</td>
<td>LIFE02 ENV/FIN/000329</td>
</tr>
<tr>
<td>01/06/2005 to 01/12/2007</td>
<td>BioCrete - Utilization of ash from incineration of waste sludge (bio ash) in concrete production</td>
<td>LIFE05 ENV/DK/000153</td>
</tr>
<tr>
<td>01/09/2011 to 30/04/2014</td>
<td>EcoWASTES - New building materials by ecosustainable recycling of industrial wastes</td>
<td>LIFE10 ENV/RO/000729</td>
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</table>
Beneficiaries: Kemira Chemicals Oy
The Finnish Road Administration, FI

Total Budget: 926,615.40 €
EU contribution: 412,051.68 €

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Project Location: Siilinjärvi, Finland

Publication: LIFE - Environment in action - 56 new success stories, P.98-99; Author: European Commission, Environment DG, LIFE; Unit Year: 2001 Editor: Office for Official Publications of the EU No of pages: 2

LIFE98 ENV/FIN/000566
01/07/1998 to 30/06/2002

Kemira - Disposal management system for utilization of industrial phosphogypsum and fly ash
About Kemira Chemicals Oy
Kemira is a global, over two billion euro water chemistry company serving customers in water-intensive industries. The company started as The State Sulphuric Acid and Superphosphate Plants of Finland in 1920 and grew during the last century.

Headquartered in Helsinki, Finland, Kemira offers water quality and quantity management improving customers’ energy, water, and raw material efficiency.

The services are organized in three main segments: the Paper segment serves customers in the pulp and paper industry, the Municipal & Industrial segment serves customers in municipal and industrial water treatment, and the Oil & Mining segment serves customers in the oil, gas and mining industries.

Objectives
The aim of the project was to develop a management system for increasing the utilisation of industrial PG and FA as soil construction materials in an environmentally safe way. Phosphogypsum (PG) is a by-product produced by over 30 phosphoric acid plants in Europe (including Russia) and the total annual production is more than 21 million tonnes, for fly ash (FA), produced by power plants in the EU (42 tonnes per year), they are constantly searching for new ways of recycling and re-using. The increased utilisation of these byproducts contributes to sustainable development by saving significant quantities of natural soil material, by protecting ground waters and natural landscape, and by reducing the amount of industrial wastes.

Actions and Tests
The demonstrative project for the utilisation of industrial PG and FA was carried out on a pilot plant scale using three management tasks.

The first task consisted of laboratory tests on the mixtures of PG, FA and divergent binders. Water permeability, compression strength, frost stability and leaching of mineral elements from the mixtures were tested. In addition, the task included estimations of the factors affecting material quality, and the quality assurance system and improvements needed in the processes in order to control and eliminate factors of uncertainty in manufacturing the material.

The second task was about the construction of the two demonstration pilot sites: landfill and road construction. In these pilot constructions, different mixing, compression and insulation technologies were tested.

The third task concerned the technical and environmental impact assessment and included the monitoring of technical index characteristics, hydrology and mineral element diffusion in the soil. The monitoring data was used for the dynamic model creation in order to calculate the environmental impacts on the specific landfill and road construction projects.

Finally a design guide was compiled for the future utilisation of PG and FA in soil construction in a technically and environmentally safe way.
Results

The technical aspects of the project are now finished. The project has provided a means of investigating the applicability of phosphogypsum as a road construction material and as a sealing material (mainly to protect ground water). The construction and renovation of two pilot roads was completed.

The first pilot road used phosphogypsum and gravel as structural materials, without compromising technical properties.

The second pilot road concentrated on sealing the road (or rather the leaks, liquid emissions) from the groundwater.

Both pilot projects were monitored and the results were encouraging: i.e. the phosphogypsum material can be used with conventional road construction materials. The leaching properties still need improvement.

The large-scale use of phosphogypsum in road construction, as a replacement for virgin materials, is still a long way off however. The main obstacles are economic ones. Phosphogypsum is available in only a few places, which makes transportation expensive in comparison to traditional materials, which are more widely available. The overall assessment is that the original objectives were achieved and that the tasks indicated in the application were fulfilled. The management system was developed and tested and the results were very positive. The stabilisation of the old road was very successful for both sites, and strength development and the bearing capacity are clearly better than in the reference sections, or even the laboratory tests in the first task. The structural course sections did not meet the expectations concerning strength development and the bearing capacity and showed no difference to the reference group. The condition of the section has remained excellent however, which indicates that the mix is very resistant to frost damages. The results from the groundwater protection section did not show adequate impermeability with respect to the hydraulic barriers.
Environmental friendly systems to renovate secondary roads. A demonstration project in Luopioinen, Finland
About the Finnish Road Enterprise

The beneficiary is a government owned company specialised in the construction and maintenance of roads and other heavy infrastructure.

Objectives

The objective of the “KUKKIA-CIRCLET” project was to demonstrate the sustainable, environmental and competitive benefits of road construction methods that reuse old road material and recycle high-volume waste from the paper (fibre sludge and fly ash) and chemical industry (process gypsum and filter-cake) in the construction and maintenance of the secondary road network. It was intended that a wide exploitation of the project results was to protect non-renewable natural resources and reduce the quantity of waste and the need for landfills in Europe. Industrial waste will never compensate for all natural stone materials, but it is estimated that it could potentially cover 20-25 % of the current consumption level.

Actions and Tests

The project tests the new, innovative methods to the full scale, assesses the performance of the new processes and shows the favourable long-term environmental, technical, social and economic benefits of the new methods to various interest groups in Europe.

The project planned and implemented four different types of road improvement interventions, each of them presenting different technical characteristics and problems.

1) A section of unpaved rural road of some 7 kilometres, suffering from deformations during frost-melting periods, was renovated by applying a thick surface layer, consisting of a mixture of gravel, paper sludge and fly ash.

2) Another, short unpaved rural road section of some 0.5 km suffering from structural weaknesses was renovated by adding a very thick surface layer also with a mixture of gravel, sludge and fly ash.

3) Approximately one kilometre of a paved regional road was widened to include light-traffic lanes (pedestrian and biking) in a road section with steep gradient again using a mix of gravel, fly ash and sludge material.

4) The last intervention was the construction of two sections of light-traffic lanes, one in a sensitive groundwater area and another which was to demonstrate the use of waste material mix in the surface layer instead of asphalt.

The project surveyed the stability and technical characteristics of the constructions and also monitored the possible environmental impacts such as the leaching of harmful or hazardous substances from the waste material mix.
Results

The surveys and monitoring of the structural stability resulted in the conclusion that the waste containing material can easily replace the virgin gravel as a load bearing, structural element and that the material as surface element is as tough as the more commonly used fine gravel. In the light traffic lanes the waste mix gave a paved/asphalt like touch to the surface. No specific leaching was detected from the renovated structures. The waste containing material allowed steeper structural gradients, which obviously made certain renovation works easier.

However, the practical working methods will need some fine-tuning and the commonly used road construction equipment some light modifications to be suitable for handling the material, which has slightly different physical characteristics compared to the traditional gravel mixes. For the time being, the waste-containing construction materials have no standards or classification. Each separate intervention is usually assessed, from the environmental point of view, as an individual exercise, which increases the costs. This project has contributed to the harmonisation of the practices and supports the case for standardization of the materials, which then could be applied in a more routine way in the design phase. The financial cost of the large volume waste is usually very low, which makes it an attractive substitute for virgin materials. However, long transport distances counterbalances the low cost of the waste material.
<table>
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<tr>
<th>Beneficiaries</th>
<th>Avedoere Wastewater Services</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Lynettefællesskabet I/S,</td>
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<td></td>
<td>Denmark UNICON A/S,</td>
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<td>Total Budget</td>
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<td>EU contribution</td>
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<tr>
<td>Contacts</td>
<td>Project Manager : Bo Neergaard Jacobsen</td>
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<td>Tel: +45 3634 3850</td>
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<td>Fax: +45 3634 3801</td>
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<tr>
<td></td>
<td>Email: <a href="mailto:bnj@spvand.dk">bnj@spvand.dk</a></td>
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<tr>
<td></td>
<td>Website: <a href="http://www.biocrete.dk">www.biocrete.dk</a></td>
</tr>
<tr>
<td>Project Location</td>
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<tr>
<td>Publication</td>
<td>Bio Ash in concrete-a guideline. Layman Report (EN)</td>
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**LIFE05 ENV/DK/000153**
01/06/2005 to 01/12/2007

**BioCrete - Utilization of ash from incineration of waste sludge (bio ash) in concrete production**
About Avedoere Wastewater Services
Avedoere Wastewater Services (AWS), a public body located in Copenhagen, own and operate one of the largest sludge incinerators in Denmark. AWS participates in the European Water Association and International Water Association.

Objectives
The concrete industry uses large amounts of fly ash from coal-fired power plants as a partial substitute for cement. Using ash reduces the need for its disposal in landfills. Furthermore, it reduces the consumption of fossil fuels due to partial substitution of cement in concrete production. This saves natural resources and reduces CO2 emissions, in line with the EU’s Sixth Environmental Action Programme and the Environmental Technologies Action Plan.

Bio ash, which is currently disposed of in landfills, can also be used for concrete production, with the same environmental benefits as fly ash. However, full-scale bio-ash concrete production remains a very small segment of the industry. A lack of documentation of environmental impacts and the technical properties of resulting concrete products, and the need for structured dissemination of existing know-how, are some of the factors impeding its more widespread use.

The project aimed to prove the technological, economic and environmental viability of the use of ash from wastewater sludge incineration for the production of concrete. A number of demonstration projects were planned, and results and expertise were planned be collected in a handbook with guidelines for the use and quality control of bio ash in concrete. It was expected that by the end of the project at least 50% (5 000 tonnes) of the Copenhagen area’s total annual generation of bio ash would be used for concrete production.

Actions and Tests
In order to provide the necessary documentation to overcome the barriers for extensive use of bio ash concrete, the project has been executed in two major phases:

1. Design, construction, implementation and use of systems required for full scale production of bio ashes concrete – as these systems did not exist at the start of the project.

2. Tests in the laboratory and in the field of the properties of the bio ash and bio ash concrete in order to document that full scale production of bio ash concrete can take place without adverse effects on the final structures.

The full scale production test consisted of activities relating to the design and installation of outlets for dry bio ash at the incineration plants, the design and installation of bio ash handling facilities at the concrete plant, the delivery of bio ashes concrete to various construction sites in the Copenhagen area including extended testing and follow up on the execution experiences during casting of the concrete.

The laboratory tests of the bio ash and concrete included documentation of the chemical and physical properties of bio ash over a full production year, the leaching of heavy metals from bio ash concrete, the development of strength of bio ash concrete (including the consequences of the content of phosphate in the ashes), and the long-term durability of the bio ash concrete. Existing bio ash concrete structures was investigated to establish the field performance of bio ash concrete.
Results

The project has reached its objectives and found an innovative, contemporary solution to a large and increasing trans-European waste problem. The solution involved an upgrading of the bio ash from a waste material that is currently landfill deposited to a raw material for concrete production. The use of bio ash for concrete production follows the successful use of fly ash from coal-fired power plants. As a result, the project focused on the technical characterization of bio ash compared with the fly ash.

During the LIFE project period 1 900 t of bio ash was reused in concrete. This was less than expected due to the finding that ash from fluidised bed furnace was directly applicable whereas ash from multiple hearth furnace needed milling prior to the use in concrete. Indeed it was necessary to install a bow sieve with 10mm holes diameter.

The type of incinerator results to be really important to the properties of the ash: bio ash from a multiple hearth oven is without pre-treatment less suitable for concrete production than bio ash from a fluidised bed oven.

The facilities for handling of ashes at the concrete production plant have been installed without problem and they are in full operation. The bio ash can be handled in normal powder handling systems at the concrete plants, the use of bio ash in concrete production, as well as any other change or any new material, will demand investments to secure that the process are still in control and recorded by a computer system.

At the same time, it was concluded that for visible structures the maximum use of bio ash would need to be limited due to its reddish colour, which could be problematic if concrete without bio ash was used in the same part. Studies showed that the maximum amount of bio ash, which can be used in order to avoid the reddish colour of the concrete, is estimated to be 5-10 kg per m³ of concrete when using iron precipitated bio ash and approximately 20-40 kg/m³ when using aluminium precipitated bio ash, as the colour is significantly lighter, when using the light aluminium bio ash instead of the red (iron precipitated) bio ash. Technically the light bio ash is at least just as good as the red bio ash. However the use of aluminium precipitated bio ash is not always economically feasible as the aluminium is normally more expensive than iron.

The project results re-confirmed that a maximum 50% of the fly ash can be replaced by bio ash, without a reduction in the workability and strength of concrete.

Concrete with bio ash does not deviate from concrete without bio ash as concerns the mixing properties (i.e. dosage and ability of the air entraining agent to form air in the concrete); although concrete with bio ash demands more water than concrete without bio ash to achieve the same consistency. To maintain the strength level, there has to be added more cement (to retain the w/c ratio).
When the reference concrete and the concrete with bio ash are compared, there is no significant difference in the strength at 28 days for either 8 MPa or 12 MPa, when the fluctuation of the water/cement ratio is taken into account. Due to the reddish bieffect bio ash could not be used in higher strength classes which are used in “visible” constructions.

The project has proved that bio ash quality fulfils the European standard for coal fly ash (EN-450-1) and can be used as a partial substitute of fly ash in concrete mix designs. Bio ash could, however, not reduce the amount of cement. An example of a “Product Standard” is integrated into the guideline for use of bio ash concrete.

The heavy metals leaching tests showed that the use of bio ash for concrete production has very limited environmental impact and there is not significant difference in this respect between concrete with or without bio ash.

The guideline for use of bio ash concrete suggests limits for chemical composition and content of heavy metals in bio ashes. If the chemical composition differs from the “normal level” the ash should not be used in concrete without further testing, as the effect of concrete durability is uncertain.

The limits suggested for parameters of chemical composition are:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Method</th>
<th>Normal-Level</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>WDXRF</td>
<td>20 - 21%</td>
<td>≥ 18%</td>
</tr>
<tr>
<td>CaO</td>
<td>WDXRF</td>
<td>20 - 23%</td>
<td>&gt;18%</td>
</tr>
<tr>
<td>P₂O₅</td>
<td>WDXRF</td>
<td>25 - 27%</td>
<td>&lt;30%</td>
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<tr>
<td>Fe₂O₃</td>
<td>WDXRF</td>
<td>15 -17%</td>
<td>13-20%</td>
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<tr>
<td>Al₂O₃</td>
<td>WDXRF</td>
<td>6 - 7%</td>
<td>4-8%</td>
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<tr>
<td>MgO</td>
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<td>2.8 - 3.4%</td>
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<tr>
<td>K₂O</td>
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</table>
The limits for content of heavy metals are:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Normal-Level</th>
<th>Results from leaching test&lt;sup&gt;1)&lt;/sup&gt;</th>
<th>Limit&lt;sup&gt;1)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>As</td>
<td>15 - 17</td>
<td>12.5</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Ba</td>
<td></td>
<td>960</td>
<td>&lt;1200</td>
</tr>
<tr>
<td>Cd</td>
<td>4 - 7</td>
<td>5.4</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Cr</td>
<td>40 - 190</td>
<td>64</td>
<td>&lt;200</td>
</tr>
<tr>
<td>Cu</td>
<td>520 - 860</td>
<td>790</td>
<td>&lt;1000</td>
</tr>
<tr>
<td>Hg</td>
<td>1 - 19</td>
<td>11</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Mn</td>
<td>600 - 900</td>
<td>680</td>
<td>&lt;1500</td>
</tr>
<tr>
<td>Ni</td>
<td>50 - 100</td>
<td>62</td>
<td>&lt;150</td>
</tr>
<tr>
<td>Pb</td>
<td>100 - 150</td>
<td>170</td>
<td>&lt;200</td>
</tr>
<tr>
<td>Zn</td>
<td>1400 - 2100</td>
<td>1800</td>
<td>&lt;2500</td>
</tr>
</tbody>
</table>

The unit is mg/kg ash, corresponding mg/Kg dry matter. 1) Test method UT012, wich is equivalent to Danish Standard method DS 259. The samples are dissolved in semi-concentrated nitric acid at 120°C in 30 minutes followed by analysis on ICP-AES.

Comparison of bio ash concrete and reference concrete (with fly ash only) specimens has shown that different concrete mixes had overall similar properties regarding durability and strength development – the only major difference is bio ash concrete has a higher setting time.

Two structures have been inspected: The parts of the Green Bridge at Vejle in Jutland (constructed in 2002) made with bio ash and the “fill in” concrete in an underground sewage construction in connection with stormwater detention tanks constructed in 2004. It has not been possible to find older structures with bio ash concrete. These two structure are made with bio ash concrete, one is a high strength concrete and the other a low strength concrete. Currently, both concretes perform well and exhibit properties that do not deviate significantly from comparable conventional concrete without bio ash. As all Danish bio ash concrete, the investigated concretes are still young, and consequently it has not been possible to evaluate their long-term durability performance. However, there are no signs that the long-term durability will develop any different than expected for comparable conventional concrete.
**Beneficiaries**
Universitatea “Constantin Brâncuși” din Târgu-Jiu
Environmental Protection Agency Gorj, Romania
Metallurgical Research Institute, Romania
Energy Centre Turceni-ECT, Romania

**Total Budget**
1,043,725.00 €
**EU contribution**
475,462.00 €

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**Project Location**
Associated Romania (RO)

**Publication**
No publication available yet

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**LIFE10 ENV/RO/000729**
01/09/2011 to 30/04/2014

**EcoWASTES - New building materials by eco-sustainable recycling of industrial wastes**
About The University “Constantin Brâncuși” Targu Jiu
The University “Constantin Brâncuși” Targu Jiu (Romania), which was established in 1993, is specialised in the study of energy engineering and building materials. The university has implemented several applied research projects in partnership with industrial facilities seeking to develop building materials using waste ash from lignite combustion.

Objectives
The project aims to demonstrate the technically feasible alternative to recycle wastes from energy industry (coal ashes), petroleum extraction (drilled solid wastes) and metallurgy (steelmaking slag), since Romanian industry generates significant volumes of waste: the Turceni power station alone dumps some 700 000 tonnes/yr of fly ash; the Slobozia oil drilling company dumps some 100 000 tonnes/yr of drilling fluids; and the Bals City metallurgical facility dumps some 5 000 tonnes/yr of slag. In Gorj county, there are two large lignite-fired power stations. These generate significant quantities of ash and have a major impact on the environment as a result.

The project expects to achieve ceramic composites that will be used mainly in building materials industry, and also to find possibilities to perform impermeable layers within roads construction.

An existing pilot unit will be adapted at it’s expected to demonstrate the viability of recycling wastes into high added value products; this new innovation will be disseminated across the EU to encourage its widespread use. In addition, the project has the following

The expected results from the project will be to reduce the amount of waste going to landfill and save natural resources by recycling fly-ash, oil drilled wastes and metallurgical slag instead of using raw minerals. This will save energy with respect to traditional processes for producing building materials and reduce the carbon footprint associated with the production of building materials, and reduce the energy consumed in conventional raw materials recovery (clay, clay sand, feldspar, etc.).

A total of 50% of the target waste is expected to be recycled and 30-50% of the natural sand used in manufacturing ceramic products is expected to be replaced with fly ash.
**Actions and Tests**
The project main stages consist in:

- select and fully characterize the types of wastes (coal ashes, drilled solid wastes, metallurgical slag) identified as potential raw materials for the replacement of natural resources use;

- elaborate the most optimal methods and technologies for wastes processing;

- design, engineer and construct the improvements of the demonstration pilot equipments;

- apply and validate the process parameters of the innovative technologies on the experimental pilot for ceramic composites manufacturing, based on the new starting raw materials;

- prove significant natural resources and energy usage reduction based on the quantitative and qualitative potential of the targeted wastes, including their site location in order to establish a sustainable waste management;

- elaborate the documentation for the technological transfer;

- communicate the results to the outside world.

**Results**
Results are not available yet, however the website is constantly updated.
Fly ash disposal is a new problem, born with the diffusion of incineration treatment and the concern about air pollution, indeed the LIFE+ projects are spread over a period of time going from 1998 since now. Two projects have been developed in France, one in Belgium and four in Italy (three of them during the last two years).

Analysing data on numbers of incinerators in Europe and quantity of solid waste treated, there is a slight correspondence with the countries where the projects have been developed. That’s because the topics of LIFE+ project are strictly related with the environmental requirement of the country.

In MSWI fly ash treatments, the primary objective is the stabilization or the stripping of pollutants, in order to recover raw materials and to reuse fly ash in different application, like filler for construction material, avoiding landfilling.

One of the most common stabilization process has been the solidification of fly ash using an hydraulic binder, most of the times Portland cement, though this material can’t be used in construction sector and it needs to be disposed in landfill. The Belgian project “REFIOM – Assessment of the long term behaviour of the fine residues of municipal waste incineration process treated with hydraulic binders” (page 14) studied what happen to this material after a long period. The samples analysed are the raw fly ash from MSWI, blocs of stabilized fly ash in cement and naturally aged in their stocking sites and fresh solidified fly ash. The conclusions of this project are clear and important:

- The solidification process with hydraulic binder for fly ash from MSWI isn’t effective, on long term period not all the pollutants are immobilized.

- Analysis on test-bars don’t give always information on the behaviour of the material at long term, a multidisciplinary approach is necessary to understand the evolution of this material, including, for instance, mineralogy.

Three projects (WBRM, Vitriflash and VALIRE) have studied the application of vitrification processes, even if usually this treatment is expensive, it’s efficient from an environmental point of view. That’s why the objective of the projects was the production of high value glassy materials, such as glass fibres, glass wool, ecc.

The French project Vitriflash (page 20) started in 2005 and it didn’t reach its objectives due to economical issue in the preliminary stages. Better results were obtained by WBRM - Waste Based Reinforcing Materials (page 8): produced vitreous fibres were stable and reliable for any environmental application, like similar products that are available on the market. The WBRM glass fibres were used in several applications like reinforcing material: non woven fabrics, plastic and bituminous materials, cement producs.

The project COSMOS (page 27), developed at the University of Brescia, uses a inertization process based on an inorganic reagent (colloidal silica medium). The process occurs at low temperature, it’s efficient in the pollutants stabilization and it allows the recovery of the soluble salts simply by washing. COSMOS can be easily transformed into a fine powder and used as filler for construction materials, furthermore good results were obtained when the
powder was added to different polymer composite materials.

COSMOS-RICE is strictly connected to the previous project, silica gel, that is necessary to COSMOS process, will be derived from rice husk ash.

The project “Treatment and valorisation of municipal waste fly ash using a thermo-chemical conversion” (page 5) suggests to recover raw material from MSWI fly ash through hydrometallurgical process, the treatment line can be built on the premises of the incinerator.

The projects concerned the treatment of fly ash from different sources (power plant, paper industry, waste sludge incinerator) study the use of fly ash mainly in the construction materials. They don’t consider intermediate inertization processes, because this fly ash doesn’t contain dangerous pollutants like fly ash from municipal solid waste incinerators.

In conclusion, recover and reuse of fly ash is possible in different ways, however it’s necessary to support the research in this sector, in order to find a solution that guarantee at the same time economic viability and environmental safety.
Bibliography


WEBSITES


