LIFE LAW PROJECT

CONTENTO TRADE SRL

Technological innovation for the environment

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Lightweight Aggregates from Wastes

BRIEF DESCRIPTION:

Partners:

Contento Trade srl, Campoformido (UD), Italy
Vomm srl, Rozzano (MI), Italy
Teksid, Italy
Amici della Terra, Rome, Italy
CTG - Italcementi, Italy

OBJECTIVES:

Aim of this project is the development of a new type of rotating oven specially designed for the production of innovative lightweight ceramic aggregates obtained from industrial waste of the metallurgical, tanning, and other sectors.

This oven can work both with oxidizing and reducing atmosphere, and go up to 1350°C.

The oven has been designed to be built in different ways, to suit particular needs of the treated waste; the following configurations are possible:

- ✓ in-flow oven: the material to be treated and the combustion fumes flow in the same direction
- ✓ opposite flow oven: in this configuration the material and the combustion fumes flow in opposite directions.

The production of innovative light weight aggregates is based upon use of a new expanding agent, obtainable from several kinds of industrial wastes, for example coal combustion ash, urban waste incinerator ash, foundry emissions treatment waste, steel making dusts and sand, water purification mud.

Its main properties are: low water absorption , high mechanical resistance/density ration, very good freeze/thaw and chemical stability.

Using these aggregates it's possible to produce concrete with extraordinary mechanical resistance/density ratio and high durability.

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The complete production process is divided into the following operating steps:

- ✓ raw materials preparation, i.e milling and refining of not muddy components, eventual pretreatment of too liquid material, ecc.;
- ✓ homogenization of raw materials in suitable equipment;
- ✓ granulation of the mixtures with pelletisation or fast granulation plants specifically optimized;
- ✓ superficial protection of the granules with refractory material, to avoid adherence problems with the walls of the oven;
- ✓ granules desiccation and cooking in a specific two-phases oven, to be realized on pilot scale within this project;
- ✓ filtration and reduction of the gaseous emissions produced during the cooking phase.

After the cooking phase, all the granules must be tested as inert, i.e. the limits of their leaching tests shall be lower than the limits fixed by law for the leaching test.

Using three kind of lightweight aggregates that gave the best results, some kinds of concrete will be produced and a campaign for the realization of concrete will be set up to identify the best mix for building elements production.

On the basis of the obtained results, it will be possible to plan a final industrial installation.

STATE OF THE ART

The following waste materials will be tested within the project:

a) Steel making dusts

In Italy every year more than 226.000 tons of dusts are produced only in electric arc furnaces and roughly 64% of them are sent to zinc recovery process, while the 36% are sent to toxic waste dumping (about 82.000 ton/year); the production of these residues reach 3.430.000 ton/year all over the world. Zinc recovery systems from steel making dusts used at present give good results if starting from dusts containing at least 15% of zinc.

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Regarding the dusts with a low Zinc content (< 15%) actually there isn't any convenient method, and in Italy these materials are dumped, with costs varying from 0.077 and 0.18 euro/kg .

b) Tannery mud

In Italy roughly 277.000 ton/y of tannery mud are produced and directly landfilled in dumps for toxic elements; the production of these residues reaches the 500.000 ton/year at European level.

Several technologies have been tested to exploit the organic fraction of this mud; the main problem is linked on the production of ash with high Chromium VI (toxic waste) and on production of emissions containing aromatic hydrocarbons, dioxins and furans.

In spite of the large research carried on, most part of these residues are landfilled, both in Europe and all over the world with cost of about 0.04-0.1 euro/kg.

c) Sand and mud from steel casting moulds

In Italy roughly 300.000 tons per year deriving from steel casting moulds are produced, these materials are sent to dumps for special wastes. The worldwide production for these wastes is about 25.000.000 ton/year.

These residues are not highly polluting, but the material is anyway difficult to recycle, in fact all the Italian production is actually landfilled.

Sand as it is cannot be recycled because of its ferrous components which prevent it from being used both in the glass industry and in the ceramic industry. Actually despite several techniques have been studied to recycle this sands, the Italian ones are landfilled with costs between 0.01 and 0.025 euro/kg.

d) Mud from granite processing

In Italy roughly 400.000 ton/year of mud from granite processing are produced, and are totally sent to special waste dumps. The production at European level for these residues is about 450.000 ton/year.

Mud from granite workings cannot actually be recycled: some tests for their reuse have been performed in the concrete filed, but the grain size is not suitable for this application, and their reuse in the ceramic sector is inadequate because of

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their ferrous fraction. So actually also this kind of waste is landfilled and it costs between 0.005 and 0.015 euro/kg.

e) Coal combustion ashes

In Europe nowadays about 20.000.000 tons/year of coal combustion ashes are produced in thermal power stations.

The thin material can be easily recycled in cement; some power stations however use water (or seawater) to cool ash after the pulling down, and in the case of seawater the such obtained material cannot be recycled in cement nor concrete.

Besides, the current regulations penalize unburned presence in ash; moreover the low efficiency of some milling systems used in Italy produces ashes with high unburned C contents.

For these reasons great part of the produced ashes is at the moment landfilled (about 8.000.000 ton/years in Europe).

A process able to treat the industrial residues destined to dump and to recycle them in the production of innovative lightweight aggregates would allow a saving of energetic resources and of raw materials used to produce traditional lightweight aggregates.

MAIN INNOVATIONS

The pilot plant that will be realized is completely different from traditional one-stage rotating furnaces, normally used for the calcination of chemical substances (i.e. Titanium dioxide), or two stage ones, used i.e. to produce expanded clay.

In the traditional furnaces the material to be cooked feeds in the opposite direction compared to the combustion fumes coming from the burner (against the tide); this solution imply a good energetic saving, since allows to warm up the material with the exhausted fumes while advancing but, for our specific application, it doesn't fit because:

- ✓ it prevented a complete combustion of the organic fraction existing in the material to be treated with short cooking cycles;
- ✓ produced an incomplete combustion of the organic fraction present in the material to be treated, causing leaching of complex unburned organic pollutants (i.e. aromatic hydrocarbons) in the fumes.

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The chosen innovative solution consists on a two stage structure, fed by two burners, one placed on the head and the other on the median line of the furnace; inside this structure the material goes on in the same direction of the fumes.

The material put inside the furnace reaches immediately a very high temperature, variable in function off the thermal requirements of the material itself. So the combustion of the organic parts starts immediately and, due to the high temperature with which it's carried out, it produces only very low quantity of complex organic pollutants.

Changing the rotation speed and inclination of the first section of the furnace, the material can be kept in this area until complete combustion of the organic part contained in the material happens.

In the second part of the furnace the temperature rises further; the rising happens in oxidizing conditions and triggers the expanding agent that performs its swelling action.

This section of the furnace has a second rotating system, which allows to set precisely the time during which the granules remain in the hottest point of the oven, where the expansion occurs; shortening the stop time the thermal efficiency of the process is improved, adherence among granules is reduced and light-weight and strong aggregates with thinner bubbles and more diffused are produced.

The use of this innovative typology of furnace seems to be able to optimize the production of aggregates, minimizing the risks and greatly reducing the presence of organic pollutants in the fumes, allowing remarkable simplifications in the treatment systems of gaseous emissions.

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