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(54) **Title**: A COMPOSITION CONTAINING HEAVY ASHES AND ITS USE AS A CHARGE FOR PLASTIC MATERIAL

(57) **Abstract**: The present invention relates, in general terms, to a solid granular composition having a particle size comprised from 10 \Xm to 30 μπι, comprising bottom ash produced from the incineration of waste, in admixture with an alkaline or an alkaline earth silicate, and at least an alkaline or an alkaline earth sulphide and/or phosphate, and to the use thereof as a filler for plastic material.

A COMPOSITION CONTAINING HEAVY ASHES AND ITS USE AS A CHARGE FOR PLASTIC MATERIAL

The present invention relates in general terms to a composition having a particle size comprised from 10 μm to 30 μm, comprising bottom ash produced from the incineration of waste, in a mixture with an alkaline or an alkaline earth silicate, and at least an alkaline or an alkaline earth sulphide and/or phosphate, and the use thereof as a filler for plastic material.

Background art

Waste treatment is a complex process that includes a number of stages and procedures aimed at assuring that the waste has a minimal impact on the environment. In particular, waste management involves the collection, transport, treatment and also reuse of the waste materials in an attempt to reduce the effect thereof on human health and the environment. Among thermal waste treatment processes, incineration undoubtedly represents the most widely used technique, which can be carried out, for example, in incinerators and waste-to-energy plants. However, incinerators used to reduce the volume of waste and recover part of the thermal energy thereof produce residual material of combustion (generally called bottom slag) in an amount that may vary between 20% and 30% relative to the weight of the incinerated material. Said slag can generally be classified into “bottom slag” and “fly slag”. The former represents the most substantial fraction of waste produced by the incineration process, whereas the so-called fly slag represents the smaller fraction, and typically derives from purification treatments of the gaseous effluents and ash from boilers.

Bottom slag appears as a solid residual mass which mainly comprises: silicon, calcium, sodium, aluminium and iron oxides, as well as magnesium and potassium oxides. There can also be present traces of heavy metals and organic compounds such as lignin, amino acids, carbohydrates and/or compounds deriving from the thermal decomposition of organic materials, such as aliphatic and aromatic acids, styrene, polycyclic aromatic hydrocarbons, chloroorganics and the like.

By way of example, the residual material of combustion obtained at the end of a solid waste incineration process (bottom slag) can contain approximately the following components:

components	% by weight
SiO_2	40.0
CaO	20.0
Al_2O_3	12.0
Fe_2O_3	11.0
MgO	5
Na_2O	5
K_2O	2
Organic compounds	3

Generally speaking, the above-described residual material is collected at the bottom of the combustion chamber of an incinerator and cooled, for example using tanks, and then transported by means of chain conveyors. The material obtained is subsequently picked up and since it is classified as special waste its disposal must take place in specific landfills for special waste.

Alternatively, the residual material of combustion can be further treated by means of processing which can comprise: sieving steps, for an initial selection of the materials based on their particle size; steps of extracting metals such as: iron (for example with electromagnets), aluminium and steel; and also steps of extracting other materials that may still be present, such as, for example, glass, ceramics, silicates and the like. At the end of this process one obtains a so-called "bottom ash", which appears as a solid material with a morphology similar to that of a common ash or powder having a particle size that can vary from one micron to as much as one centimetre.

Notwithstanding the above-described processing steps, however, the bottom ash can still contain traces of metals or compounds of another nature (such as chlorides, for example), which make the reuse of the ash problematic without further inertization treatments. In this regard, in fact, when evaluating the potential recovery of bottom ash, particular attention must be paid to the possible release from the ash of heavy metals and other substances that may be present in it.

Therefore, upstream of the process of recovery and reuse of bottom ash, deriving, that is, from the treatment of residual material of combustion (bottom slag), from waste incineration processes, further stabilization and/or inertization treatments are necessary in order to render the bottom ash a material with physicochemical characteristics such as to permit its reuse. In this regard, there are treatments known in the art which comprise, for example, aging, stabilization, and vitrification processes, all aimed at obtaining a material that does not release any toxic or harmful compounds over time and which can be used as a recycled material.

It is likewise known that the stabilization and inertization of bottom ash can also be achieved by using organic agents selected, for example, from among: thermoplastic substances, organic polymers and macro-encapsulating compounds in general. However, such stabilization processes have limited application on an industrial scale, due above all to the high costs of implementing them.

The applicants have now found that when the bottom ash originating from residual material of combustion (bottom slag) obtained from the incineration of waste, preferably urban solid waste (USW), is admixed with a specific inorganic stabilizing additive and subjected to grinding, a granular composition is obtained which has a particle size comprised from 10μm to 30μm (microns), is inert and stable over time and can be conveniently reused as a filler for plastic materials. It is well known, in fact, that the plastic material commonly used is a material comprising at least one polymeric component in a mixture with auxiliary substances (called fillers or additives) typically chosen according to the application for which the material is intended. Such auxiliary substances have the purpose of stabilizing, preserving, protecting against oxidation, and in general of modifying the workability of the resulting plastic material.

Advantageously, when the present composition is used as a filler for plastic material, the resulting material exhibits excellent physic-mechanical characteristics, which render the present composition a valid alternative to the fillers commonly used in the production of plastic material, e.g. calcium carbonate or talc.

Summary of the invention

In a first aspect, the invention relates to a composition having a particle size comprised from 10μm to 30μm (microns) and comprising:

- bottom ash, and
- a stabilizing additive comprising: an alkaline or an alkaline earth silicate, and at least an alkaline or an alkaline earth sulphide and/or phosphate,

wherein said stabilizing additive is present in an amount of at least 2% by weight.

In another aspect, the present invention relates to a process for preparing the above-described composition, said process comprising:

- mixing the bottom ash with at least 2% of a stabilizing additive comprising: an alkaline or an alkaline earth silicate, and at least an alkaline or an alkaline earth sulphide and/or phosphate; and
- subsequent grinding, preferably dry grinding.

Preferably, said process relates to the preparation of a composition comprising at least an alkaline or an alkaline earth silicate, an alkaline or an alkaline earth sulphide and phosphate.

A further aspect of the invention consists in the use of the present composition, preferably comprising at least an alkaline or an alkaline earth silicate, an alkaline or an alkaline earth sulphide and phosphate, as a filler for polymeric plastic material.

Finally, in a final aspect, the invention relates to a plastic material comprising at least one polymeric

component in a mixture with the present composition, the latter preferably comprising at least an alkaline or an alkaline earth silicate, an alkaline or an alkaline earth sulphide and an alkaline or an alkaline earth phosphate.

Detailed description

Unless otherwise specified, the term "percentage by weight" of a component means the amount of the single component relative to the total weight of the composition.

The terms "alkaline or alkaline earth" silicate, sulphide and phosphate mean a salt formed from the silicate anion (i.e. SiO_3^{--}), or sulphide anion (S^{--}) or phosphate anion (PO_4^{---}), or acid phosphate (HPO_4^{--}), or also dihydrogen phosphate ($H_2PO_4^{-}$), with a metal of the group I or II of the periodic table, such as, for example: sodium, lithium, potassium, calcium, magnesium, barium and strontium.

"Bottom ash" means the solid residual, typically having a morphology similar to a powder or ash, obtained by treating the residual material of combustion (bottom slag), deriving from the incineration of solid waste. Typically, said treatment comprises steps of sieving, removing metals such as iron, aluminium and steel and removing other materials such as ceramics and glass. At the end of such treatment a granular material is obtained, with particles of variable size, comprised from 0.1 mm to 10 mm, known to the person skilled in the art as bottom ash.

The applicants have now found that when the above-described bottom ash is mixed with at least 2% of a stabilizing additive comprising an alkaline or an alkaline earth silicate, and at least an alkaline or an alkaline earth sulphide and/or phosphate, let to stand, and then ground to a particle size comprised from 10μm to 30μm, a

composition is obtained which is stable, easy to handle and reusable as a filler for plastic material.

In this regard, the term "plastic material" is meant to indicate artificial materials with a macromolecular structure which under given temperature and pressure conditions undergo permanent changes in form. They may be divided into thermoplastics, thermosetting plastics and elastomers, and are generally obtained by polymerization of a quantity of base molecules (monomers). Examples of plastic materials are: polyethylene (PE), polypropylene (PP), polyvinylchloride (PVC), nylon, teflon, plexiglas and the like.

In a preferred embodiment, the stabilizing additive of the present composition comprises an alkaline or an alkaline earth silicate selected from: sodium silicate, potassium silicate, calcium silicate and magnesium silicate, sodium silicate (Na_2SiO_3, CAS No. 6834-92-0) being particularly preferred. In addition to said alkaline or alkaline earth silicate, the stabilizing additive comprises at least an alkaline or an alkaline earth sulphide and/or phosphate. Preferably, the composition comprises at least a sulphide in a mixture with an alkaline or an alkaline earth phosphate. In this regard, examples of preferred sulphides and phosphates are salts of: calcium, sodium, potassium, magnesium and, even more preferably, sodium or calcium. Sodium or calcium acid phosphates (HPO_4^{--} or $H_2PO_4^-$) are equally preferred. In a particularly advantageous embodiment, the stabilizing additive of the invention comprises: an alkaline or an alkaline earth silicate, preferably of sodium (Na_2SiO_3), and at least one calcium or sodium sulphide and phosphate, possibly in a mixture with an acid phosphate, preferably of sodium or calcium.

The alkaline or alkaline earth sulphide and/or phosphate

can be present in an amount comprised from 1% to 10% relative to the amount of alkaline or alkaline earth silicate used.

In any case, the percentage of stabilizing additive present in a mixture with the bottom ash of the composition of the invention is equal to at least 2% of the total weight of the composition, preferably in a percentage amount by weight of up to 20%, preferably comprised from 5% to 10%, even more preferably comprised from 2% to 5%. It has been noted, in fact, that amounts exceeding 20% can result in an undesirable increase in the costs of preparing the composition, whereas percentages below 2% could lead to a stabilizing effect on the ash that is too low for it to be used for example, in the preparation of a plastic material for common use, such as for bottles or containers in general. The stabilizing additive comprising silicate and at least one sulphide and/or phosphate as described above can be previously prepared and added to the bottom ash, or else it can be prepared in situ, i.e. by mixing all of the components of the present composition together in a single step. The bottom ash of the present invention can derive from the combustion residue obtained from the incineration of urban solid waste (USW), or from the non-degradable fraction of separately collected waste (SCW) or also from the incineration of industrial waste, such as sludge, or it can also derive from the residue originating from the combustion of waste in waste-to-energy plants in general or the combustion residue from thermoelectric plants.

Preferably, the bottom ash of the present composition is obtained from the combustion residue (bottom slag) obtained from the incineration of urban solid waste (USW).

In one embodiment, the composition of the invention can

optionally also comprise further components, such as, for example: surfactants, dyes and fluidifying agents, typically according to the use for which the composition is intended. When present, said further components are preferably used in a percentage comprised from 5 to 20% by weight, preferably comprised from 10 to 15% by weight.

In an additional aspect, the invention relates to a process for preparing the composition of the invention, said process comprising mixing and grinding, preferably dry grinding, the bottom ash, having a particle size comprised from 0.1 mm to 10 mm, preferably comprised from 0.1 mm to 6 mm, with at least 2% of a stabilizing additive comprising an alkaline or an alkaline earth silicate, and at least an alkaline or an alkaline earth sulphide and/or phosphate, possibly in the presence of further components as indicated above.

In a preferred embodiment, the mixing takes place between a stabilizing additive comprising an alkaline or an alkaline earth silicate, and at least a sulphide in a mixture with an alkaline or an alkaline earth phosphate, as described above in detail.

Preferably, the bottom ash is mixed with at least 2% of the stabilizing additive, let to stand, and then ground so as to obtain the composition of the invention with a defined particle size comprised from 10 μm to 30μm. Mixing can take place using a low-cost dynamic mixer of the paddle or ploughshare type, easily applicable on an industrial scale.

As mentioned above, in a preferred embodiment, the mixing of the bottom ash and stabilizing additive is followed by a step in which the composition thus obtained is let to stand. Said step, which preferably takes place after mixing and before grinding, can be carried out by leaving

the composition at a temperature comprised from about 15 to about 40° C, typically for a period of several days, preferably comprised from 5 to 10 days, in order to enable a complete interaction between the stabilizing additive and the bottom ash, intimately mixed with each other. In this manner it is possible to ensure a practically complete stabilization and inertization of the bottom ash. After the step in which it is let to stand, the composition of the invention undergoes grinding in order to obtain a product with a defined particle size, particularly useful, for example, as a filler for plastic material. In particular, the bottom ash can be mixed together with at least 2% of the stabilizing additive, and ground to obtain the composition of the invention with a particle size (understood as the average diameter of the particles making up the solid composition of the invention) comprised from 10μm to 30μm.

In a preferred embodiment, the present composition is obtained by mixing with the selected stabilizing additive, the latter being added in the form of an aqueous solution. In this regard, in fact, the stabilizing additive can be conveniently obtained by preparing an aqueous solution of an alkaline or an alkaline earth silicate and adding to it the selected sulphide and/or phosphate, preferably a mixture of alkaline or alkaline earth sulphide and phosphate. In a further embodiment, the aqueous solution of silicate, preferably sodium silicate, has a concentration from 15 to 35%, preferably comprised from 28 to 32%, whereas the sulphide and the phosphate, both preferably of sodium or calcium, are added to said aqueous solution in an amount comprised from 1 to 10%, preferably comprised from 1 to 4%. The aqueous solution comprising the above-described additive is then mixed with the bottom

ash, preferably using a dynamic mixer of the paddle or ploughshare type, and then ground so as to obtain the present composition having a defined particle size. Grinding can take place using machinery known in the art, such as, for example, presses, mills or the like, preferably using a horizontal axis tubular mill.

After grinding one obtains the composition of the invention with the desired particle size comprised from 10μm to 30μm, stabilized by the additive, which is practically incorporated and absorbed by the initial bottom ash. The ground composition is thus ready for use as a filler for plastic material, or also to be stored if necessary. In this regard, in fact, thanks to its high stability and inert character, the present composition can be conveniently stored or conveyed without any particular precautions or environmental risks.

Based on the data indicated in the experimental part herein enclosed, it is evident that a plastic material comprising the composition of the invention is characterized by high mechanical strength, excellent elongation at break and notch toughness, comparable and in some cases even superior to those of a corresponding plastic material (e.g. polypropylene PP) containing calcium carbonate as a filler.

Therefore, in a further aspect, the present invention relates to the use of the present composition for the preparation of a plastic material, and to a plastic material comprising at least one polymeric component in a mixture with the present composition. Preferably, the invention relates to the use and to a plastic material obtained using the composition of the invention comprising silicate and at least a sulphide in a mixture with an

alkaline or an alkaline earth phosphate, according to each of the embodiments defined above.

The applicants have noted that particle sizes of the present composition exceeding 30 μm result in final plastic materials that are poorly reproducible on an industrial scale and have physic-mechanical characteristics that are of little value or convenience, compared to plastic materials to which traditional fillers have been added.

Said mixture preferably contains at least 30% by weight of the present composition, preferably at least 50%, even more preferably at least 65%. The plastic material of the present invention, preferably for industrial use, is obtained by polymerization of a suitable monomer, using known techniques such as extrusion, casting, blowing, calendering and the like, and can be formed into various shapes and objects such as, for example: sheets, tubes, profiles, packaging, supports and containers in general.

Preferably, said plastic material comprises at least one polymeric component selected from among: polypropylene (PP), polyvinylchloride (PVC), polyethylene (PE), polyethylene terephthalate (PET), polyamide (PA), polyester (PS), nylon and teflon. Advantageously, and as illustrated in the experimental part herein enclosed, the plastic material that is obtained using the present composition as a filler exhibits optimal physic-mechanical characteristics in line with the quality standards demanded for a commonly used plastic material, while maintaining the process for the preparation thereof substantially unchanged.

The present invention will now be described in the following experimental part, without limiting its scope in any way.

Experimental part.

Example 1:

Leach tests

Leach experiments were conducted on the present composition and the non-stabilized bottom ash through contact with water, as reported for the following experiments 2a and 2b, carried out in line with European standard UNI ENV 12920.

Leaching (or solid-liquid extraction) refers to a process consisting in the separation of one or more soluble components from a solid mass by water.

Example 1a: leach test on non-stabilized bottom ash.

A sample of 100g of bottom ash obtained after treatment of the residual material of the combustion of USW was subjected to a leach test with water in accordance with European standard UNIENV12920, with an analysis of the amount of substances released by the ash and present in the eluate. The results are summed up in Table 1a, in relation to the required limits set by laws and regulations for the use of ash as a secondary raw material (SRM).

Table 1a: water leach tests of non-stabilized bottom ash.

	Bottom ash		**Required limits**
	mg/l		mg/l
COD(*)	161		30
Chlorides	453		100
pH	12.2		12
Barium	1.6		1
Chromium	0.1		0.05
Lead	0.8		0.05
Mercury	0.075		0.001

Copper	1.7		0.5
Zinc	5		3
Fluorides	0.8		1.5

(*)COD: chemical oxygen demand

As may be seen from the data in Table 1a, the non-stabilized bottom ash shows values of components in the eluate which do not comply with the limits imposed by current laws and regulations.

Example 1b: water leach test of the bottom ash stabilized according to the present invention

A sample of 100 g of bottom ash was mixed in a dynamic paddle mixer with an aqueous solution containing 30% of sodium silicate, to which sodium sulphide and sodium acid phosphate were added (2% by weight).

After mixing, the composition was let to stand at room temperature for 8 days. After that period had elapsed, the composition underwent dry grinding in a horizontal axis tubular mill so as to obtain the composition of the invention with a particle size of 10 μm. The results are shown in Table 1b.

Table 1b: water leach test of a sample of ash stabilized according to the present invention

	Stabilized ash (present composition)		**Limits**
	mg/l		mg/l
COD(*)	< 30		30
Chlorides	90		100
pH	11.2		12
Barium	0.2		1
Chromium	<0.001		0.05
Lead	<0.1		0.05
Mercury	<0.001		0.001

Copper	0.1		0.5
Zinc	0.25		3
Fluorides	0.3		1.5

(*)COD: chemical oxygen demand

As can be seen, the results obtained demonstrate that the composition of the invention complies with the required limits set by laws and regulations and can thus be considered inert and reusable in the production cycle, for example as a filler for plastic material.

Example 2: physic-mechanical tests on a plastic material (PP) to which calcium carbonate (30%) has been added, compared to the plastic material to which the composition of the invention (30%) has been added.

An assessment was made of several physic-mechanical characteristics of a polypropylene (PP) based plastic material to which calcium carbonate and the composition of the invention (30% by weight) as per example 1b (particle size of around 10μm and containing sodium silicate in a mixture with sodium sulphide and sodium acid phosphate (2%)) were added.

The results are summed up in the following tables, in which:

"MFI": indicates the Melt Flow Index, which is known in the art as the basic quality control tool and indicates the weight of a melted polymer flowing through a standard nozzle (2.095 x 8mm) at a given temperature and with a standard weight applied to the piston which pushes the sample.

"Elongation at break": is a measure of the ductility of a material obtained in a tensile test. The greater the elongation, the greater the ductility.

"Modulus of elasticity in bending": it is the ratio of

maximum fibre stress to maximum strain, within the elastic limit of the stress-strain curve obtained in the bending test.

"Notched Izod impact strength": it is a standard method for determining the notch toughness of a material.

Table 2a: plastic material (polypropylene) containing calcium carbonate.

Property	**Method**	**Unit of measurement**	**Value**
MFI (230°C/2.16)	ISO1133	g/10'	11
Elongation at break (speed 50 mm/min)	ISO527	%	15
Modulus of elasticity in bending (speed 2 mm/min)	ISO178	MPa	1878
Notched Izod impact strength	ISO180	Kj/m^2	3.0
residual % (650° C for 1 hour)	Internal method	%	16

Table 2b: plastic material (PP) containing the composition of the invention (30%), which comprises an additive containing sodium silicate in a mixture with sodium sulphide and phosphate (2%).

Property	Method	Unit of measurement	Value
MFI (230°C/2.16)	ISO1133	g/10'	11
Elongation at break (speed 50 mm/min	ISO527	%	21
Modulus of elasticity in bending (speed 2 mm/min)	ISO178	MPa	1441
Notched Izod impact strength	ISO180	Kj/m^2	4.0
residual % (650° C for 1 hour)	Internal method	%	17

As may be noted from the above tables, given an equal weight of the MFI, the polypropylene material containing the present composition (30%) exhibits higher elongation at break, greater robustness (corresponding to a lower modulus of elasticity in bending) and higher notch toughness (indicated by Izod impact strength) than the same plastic material containing the same amount of calcium carbonate.

Similar results can also be obtained using the present composition with a particle size of around 30 μm.

Example 3: comparative tests on PE, PP and PVC based

plastic material containing talc, $CaCO_3$ and the composition of the invention (Cinderlite) as fillers.

For the comparative tests of example 3 use was made of a composition of the invention (indicated as "Cinderlite"), comprising 2% of an additive containing sodium silicate in a mixture with sodium sulphide and phosphate and having a particle size of around 11 microns.

The plastic material was stabilized with 20% by weight of stabilizer (talc, calcium carbonate and the present composition).

Plastic materials used:

the following polymers were used to prepare the samples of stabilized plastic material:

- PE-HDPE Eltex® B42020N1343 (high-density polyethylene)
- PP-Moplen HP500N (polypropylene)
- PVC-TPV AM 22 (polyvinylchloride)

Fillers used

- $CaCO_3$ - calcitec V/40
- Talco - Talc CM3
- Cinderlite (composition of the invention in example 3)

Operating procedure

- Dry blending of the individual polymers with the fillers in a percentage of 20% by weight;
- Extrusion of the dry blend by means of a twin screw extruder and subsequent pelletization using a mechanical granulator;
- Injection moulding of samples for physic-mechanical characterization;

- Characterization of test specimens by:
  - i) mechanical tensile tests
  - ii) mechanical bending tests
  - iii) Notched Izod impact tests.

Example 3(i): mechanical tensile testing with dynamometer (UNI EN ISO 527).

The test specimens for carrying out the tensile test have the typical "dog bone" shape. They have geometrical and dimensional characteristics as required by the standard and shown in Table 3 and were produced by injection moulding.

Table 3: geometrical characteristics of tensile test specimens as required by the standard

Geometric characteristic	Dimensions (mm)
Total length	150
Length of usable part	50
Width of ends	20.00
Width of usable part	10.00
Thickness	4.00

For the purpose of determining the tensile modulus, the test was carried out with a traction speed of 1mm/min and with an initial stress (pre-loading) of 0.20MPa. The test specimen was subjected to stress until reaching deformation values of 1.5%. For the purpose of determining the deformation at break, the test was carried out with a traction speed of 50mm/min and with an initial stress of 0.50MPa. The tests were all conducted under the same conditions of temperature, around 23° C, and under the

same conditions of relative humidity, i.e. 50%.

The results are shown in Tables below: Table 4 (PE), Table 5 (PP) and Table 6 (PVC).

Table 4: tensile modulus – PE-based specimen.

	PE without filler	**PE + 20% $CaCO_3$**	**PE + 20% TALC**	**PE + 20% Cinderlite**
Elastic modulus [MPa]	590.8	756	1089.3	833.8
Breaking stress [MPa]	14.8	13.4	14.2	13.6
Elongation at break [%]	270.5	73.3	70.8	65.5

Table 5: tensile modulus – PP-based specimen.

	PP without filler	**PP + 20% $CaCO_3$**	**PP + 20% TALC**	**PP + 20% Cinderlite**
Elastic modulus [MPa]	1047	1412.58	1725.46	1425.46
Breaking stress [MPa]	18.4	24.8	29.1	23
Elongation at break [%]	137.9	15.6	13.4	21.6

Table 6: tensile modulus – PVC-based specimen.

	PVC without filler	**PVC + 20% $CaCO_3$**	**PVC + 20% TALC**	**PVC + 20% Cinderlite**

Elastic modulus [MPa]	2196.4	2858	2969.2	2559.9
Breaking stress [MPa]	30.7	27.6	38.1	30.3
Elongation at break [%]	10.8	16.9	8.8	14.4

Example 3(ii): mechanical bending test.

Bending tests were performed on 5 test specimens per sample. The test was conducted applying a beam lowering speed of 2mm/min and a distance between supports of 51.2 mm. The result (bending modulus) is the average of 5 tests and is shown in tables 7, 8 and 9 below.

Table 7: bending modulus of PE.

	PE without filler	**PE + 20% $CaCO_3$**	**PE + 20% TALC**	**PE + 20% BOTTOM ASH**
Elastic modulus [MPa]	819	944	1314.5	989.2

Table 8: bending modulus of PP.

	PP without filler	**PP + 20% $CaCO_3$**	**PP + 20% TALC**	**PP + 20% Cinderlite**
Elastic modulus [MPa]	973.1	1251	1724	1351

Table 9: bending modulus of PVC.

	PVC without filler	**PVC + 20% $CaCO_3$**	**PVC + 20% TALC**	**PVC + 20% Cinderlite**
Elastic modulus [MPa]	2621.2	3124.1	4372.6	3366.8

Example 3(iii): impact test.

The Izod impact test was performed by releasing a pendulum from a given height and making it strike the test specimen of the material so as to break it. The test specimen, a vertical cantilevered beam, is broken by a single strike of the pendulum with the line of impact at a preset distance from the point where the test specimen is fixed and - in the case of notched test specimens - from the central notch line.

The test specimens used have a width of 10mm, thickness of 4 mm and length of 80 mm.

The tests were performed with a CEAST 9010 pendulum.

In practical terms, the Izod impact tests were conducted according to standard ASTMD256 at 23° C, with a pendulum energy of 2.75J for PE and 1J for PP and PVC. The test was conducted on 6-7 test specimens per mixture and the total impact energy values are shown in tables 10-12 below.

Table 10: absorbed energy for PE samples, using the pendulum of 2.75J.

Absorbed Energy (J)				
	PE without filler	**PE + 20% $CaCO_3$**	**PE + 20% TALC**	**PE + 20% Cinderlite**
	0.328	0.198	0.189	0.163

	0.331	0.194	0.191	0.184
	0.322	0.199	0.194	0.159
	0.330	0.205	0.180	0.171
	0.345	0.192	0.192	0.166
	0.339	0.208	0.185	0.166
	0.336	0.205	0.189	0.171
average	**0.333**	**0.200**	**0.189**	**0.169**

Table 11: absorbed energy for PVC samples, using the pendulum of 1J.

Absorbed Energy (J)				
	PVC without filler	**PVC + 20% $CaCO_3$**	**PVC + 20% TALC**	**PVC + 20% Cinderlite**
	0.156	0.072	0.074	0.083
	0.138	0.093	0.083	0.090
	0.155	0.091	0.084	0.083
	0.150	0.082	0.086	0.084
	0.153	0.097	0.079	0.083
	0.169	0.094	0.090	0.088
average	**0.154**	**0.088**	**0.083**	**0.085**

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Table 12: absorbed energy for PP samples, using the pendulum of 1J.

Absorbed Energy (J)				
	PP without filler	**PP + 20% $CaCO_3$**	**PP + 20% TALC**	**PP + 20% BOTTOM ASH**
	0.066	0.080	0.072	0.059
	0.065	0.078	0.072	0.060
	0.055	0.065	0.069	0.079
	0.058	0.073	0.060	0.058
	0.090	0.072	0.063	0.068

	0.072	0.081	0.070	0.064
		0.076		0.062
average	**0.068**	**0.075**	**0.068**	**0.064**

Example 4: determination of test specimen density.

The density of the solids was determined using a hydrostatic balance.

The results are shown in the density table below:

	Density ($g/cm^{3)}$
PE	0.952
PE + 20% $CaCO_3$	1.073
PE + 20% TALC	1.087
PE + 20% CINDERLITE	1.077
PP	0.90
PP + 20% $CaCO_3$	1.033
PP + 20% TALC	1.049
PP + 20% CINDERLITE	1.037
PVC	1.310
PVC + 20% $CaCO_3$	1.458
PVC + 20% TALC	1.483
PVC + 20% CINDERLITE	1.467

In conclusion, based on the results shown in this experimental part, it may be deduced that:

- the plastic material stabilized with the composition of the invention (Cinderlite) was obtained in a manner that is substantially analogous to what takes place in the industrial preparation of a polymeric material stabilized with talc or calcium carbonate,
- the tensile mechanical properties of the polymeric material containing the present composition are comparable to or even better than those of the

material containing the other fillers. In particular, the composition of the invention stands between the materials stabilized with talc and those stabilized with carbonate,

- the bending modulus of the mixtures containing the present composition is comparable to or better than the bending modulus of the mixtures containing calcium carbonate,
- as regards the impact strength tests, the polymeric material comprising the composition of the invention is comparable to or better than the materials stabilized with talc,
- the densities are very similar to those obtained with calcium carbonate.

- **CLAIMS**

1. A composition having a particle size comprised from 10µm to 30µm, comprising:

- bottom ash, and
- a stabilizing additive comprising: an alkaline or an alkaline earth silicate, and at least an alkaline or an alkaline earth sulphide and an alkaline or an alkaline earth phosphate,

wherein said stabilizing additive is present in an amount of at least 2% by weight.

2. The composition according to claim 1, wherein said bottom ash is obtained by the treatment of the material obtained from the incineration of solid urban waste.

3. The composition according to any one of the preceding claims, wherein said stabilizing additive comprises sodium silicate.

4. The composition according to any one of the preceding claims, wherein said stabilizing additive comprises sodium silicate, a calcium sulphide and a calcium phosphate.

5. The composition according to any one of the preceding claims, wherein said at least a stabilizing additive is present in an amount comprised from 2 to 30%.

6. The composition according to claim 5, wherein said at least a stabilizing additive is present in an amount comprised from 2% to 5%.

7. The composition according to any one of the preceding claims, further comprising: surfactants, dyes or fluidifying agents.

8. A process for the preparation of the composition according to any one of the preceding claims, said process comprising:

the mixing of the bottom ash, with at least 2% of a

stabilizing additive comprising: an alkaline or an alkaline earth silicate, and at least an alkaline or an alkaline earth sulphide and an alkaline or an alkaline earth phosphate, and

the subsequent grinding, preferably dry grinding.

9. The process according to claim 8, wherein after the mixing and before the grinding, the composition is let to stand, preferably for a period of time comprised from 5 to 10 days.

10. The process according to claims 8 or 9, wherein said mixing is carried out by dynamic mixer with paddle or ploughshare and said grinding occurs by means of a horizontal axis tubular mill.

11. Use of a composition having a particle size comprised from 10μm to 30μm, comprising:

- bottom ash, and
- a stabilizing additive comprising: an alkaline or an alkaline earth silicate, and at least an alkaline or an alkaline earth sulphide and/or phosphate,

wherein said stabilizing additive is present in an amount of at least 2% by weight,

as a filler for plastic material.

12. Use according to claim 11, wherein said composition is defined according to claims 1-7.

13. Plastic material comprising the composition as defined in any one of the claims from 1 to 7, or 11, in admixture with at least a polymeric component selected from the group consisting of: polypropylene (PP), polyvinylchloride (PVC), polyethylene (PE), polyethylene terephthalate (PET), polyamide (PA), polyester (PS), nylon and teflon, being polypropylene preferred.