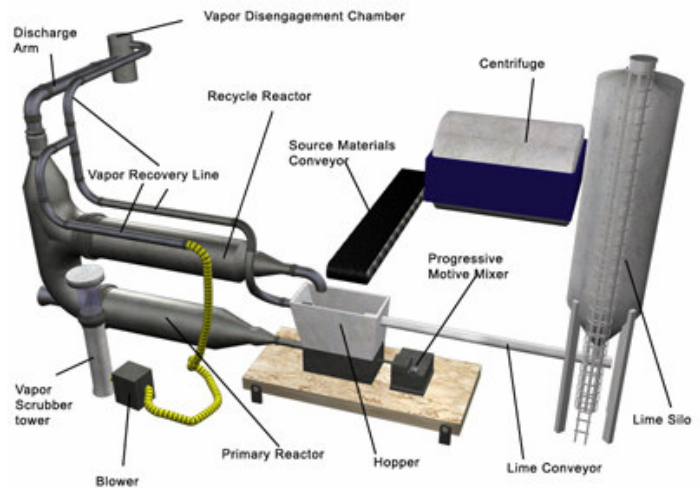


## USES FOR TREATED ECO-SOLID PRODUCT

The Eco-Solids Process is a continuous lime stabilisation process suitable for treating all types of sewage sludge. The process produces an enhanced treated biosolid product, or Class A/EQ product, called *Eco-Solid*, which exceeds European and US regulatory requirements.

The process has several key effects on the on the sludge:

- A reduction in sludge volume
- Improved percentage of solids of the product
- Complete inactivation of microbiological activity
- A reduction in volatile solids (VS)
- A reduction in water extractable phosphates
- A reduction in nitrates



Several uses for the *Eco-Solid* have been identified:

- As an agricultural field dressing;
- Mixed with coal finings to produce coal briquettes;
- As a constituent in cement;
- As a fuel and sulphur scrubbing agent in coal fired power stations; and
- As a constituent material in building materials

This report provides details of these possible uses for *Eco-Solid*, the treated biosolid material from the Eco-Solids Process.

Full technical details about the Eco-Solids Process and its benefits can be found in a separate report entitled 'Eco-Solids Process Technical Description', which is available for download from our website ([www.ecosolids.com](http://www.ecosolids.com)).

### Protecting People and the Environment from Disease, Chemicals and Smells

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## 1 Use for Treated Eco-Solid Product as an Agricultural Field Dressing

*Eco-Solid* is an enhanced treated (Class A/EQ) soil amendment material, having a pH of between 11 and 12.5. The source of this pH is quicklime, or calcium hydroxide (Ca(OH)<sub>2</sub>). The quicklime content is approximately 40% of the total dry solids and the remaining 60% is organic humus. Compared to untreated or Class B sludge, the material has several advantages when it is applied to land:

- This product has the major advantages of providing lime and humus to low pH soils, reducing high sodium (natric) soils and micronutrient-deficient soils. Increasing the lime content increases the cationic exchange capacity (CEC), potassium (K) losses are retarded from surface soils, thereby increasing its availability to the crop.
- Soil pH affects nitrification in soils, i.e. the conversion of ammonia (NH<sub>4</sub>) to nitrate (NO<sub>3</sub>). At pH levels below 5.4, the rate of nitrification is less than that at 7.0. Since NH<sub>4</sub> is attracted to the negative charges of the soil particles, the NH<sub>4</sub> will not leach to any great extent. NO<sub>3</sub>, on the other hand, leaches from the soil more readily than NH<sub>4</sub>. Therefore, nitrogen (N) will be lost as the ratio of NH<sub>4</sub> to NO<sub>3</sub> decreases. It is generally accepted that the uptake of NO<sub>3</sub> is decreased and the uptake of NH<sub>4</sub> is increased as the soil pH is increased. The relative amounts of NH<sub>4</sub> and NO<sub>3</sub> taken up by the plant also affect the pH of soil immediately adjacent to the root. The decrease in rhizosphere pH may be as great as 2.4 pH units in plants supplied with NH<sub>4</sub> which can result in toxicity and plant death.
- *Eco-Solid* addition increases phosphorus (P) availability for plants by neutralizing exchangeable alumina ions (Al<sub>3</sub><sup>+</sup>) and solubilising unavailable aluminium-phosphate (Al-P) compounds, as well as promoting vigorous root exploration in a larger volume of soil. Considerably more P is needed when the pH is low than when a soil is limed to an acceptable pH range.
- Phosphate runoff from the sludge is dramatically reduced as most of the phosphate is transformed from sodium phosphate to calcium phosphate, which is significantly less soluble\* (there is a log 3 reduction in water extractable phosphates). The conversion equation utilised by the Eco-Solid Process is:



Tests carried out on sludge samples show that phosphate concentrations are typically 4,000 to 10,000mg/kg. In the treated material the water extractable phosphate is less than 50mg/kg, and typically less than 20mg/kg.

Also, the disassociation rate of calcium phosphate is generally less than the take-up rate at which crops can absorb it, which provides a slow release of phosphorous and helps to prevent the long-term build of phosphorous in the soils.

- Liming alone generally decreases the availability of sulphate (SO<sub>4</sub>), since sulphate adsorption is decreased as soil pH is increased. When SO<sub>4</sub> is not absorbed, it is readily leached with water and will be removed from the root zone. *Eco-Solid*, on the other hand, contains sulphates, thereby, replenishing the sulphate levels in the soil.
- The plant availability of molybdenum (Mo) is largely governed by soil pH. The solubility of Mo is greatly enhanced by raising the soil pH, thus increasing its availability to plants. Increasing the soil pH can completely eliminate the need to supply fertilizer Mo.

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\* Langes Handbook of Chemistry; eleventh edition; 1973; pages 4-33 and 4-123.

- Increasing soil pH detoxifies heavy metals in soils. This occurs in agricultural situations where municipal wastes are applied. For example, when peach (*Prunus persica*) orchards were returned to row crop production, cotton and soybeans often showed zinc (Zn) toxicity symptoms and reduced yields. Peanuts (*Arachis hypogaea*) grown on these same soils also exhibited distinct Zn toxicity symptoms. The orchards had received substantial amounts of Zn oxysulphate and elemental sulphur (S) as fungicides; thus, the soils had large accumulations of Zn and had a low pH. When the soil pH was increased with lime to pH>5.5 to 6, these effects were completely eliminated.
- Since the optimum soil pH needed to grow a given plant decreases as the organic matter content of the soil increases, and since *Eco-Solid* contains over 40% organic matter, *Eco-Solid* is the perfect additive for eliminating phytotoxicity. The reason for the reduction in phytotoxicity is that the organic matter in *Eco-Solid* complexes polycationic Al ions that are in most instances the phytotoxic agent in acid soils.

Additional papers on this subject are available for separate distribution:

*Benefits of Eco-Solid*, Samuel L. Shepherd, A.A. Chemistry; B.S. Chemical Engineering; M.S. Engineering Technology, Diplomat American Board of Forensic Engineering.

*Beneficial Aspects of Land Utilization of "Bioset" Processed Biosolid Products*, Rosa M. Muchovej, Ph.D, University of Florida, Soils, Crops and Environment Specialist.

(Note: Eco-Solids International Ltd hold the international rights to the Bioset process. The Eco-Solids Process is an improved version of the Bioset process, to which this paper refers, and so the issues discussed in this paper relating to "Bioset" processed biosolid also apply to the *Eco-Solid*.)

## **2 Use of Treated Eco-Solid Product when mixed with Coal Finings to produce Coal Briquettes**

The treated product can be mixed with coal finings to create coal briquettes. The benefit of using the treated material in this way is that a form of coal is created that behaves like lignite coal. The aluminium oxide and silica contained in the finings react with the lime contained in the Eco-Solid Product to form a high tensile strength product. The sulphur in the finings reacts with the calcium hydroxide to form calcium sulphates which accumulate in the ash on combustion. It is therefore a stable product having a high calorific value, is pathogen free, and has low sulphur air-emissions.

## **3 Use of Treated Eco-Solid Product as a constituent in Cement**

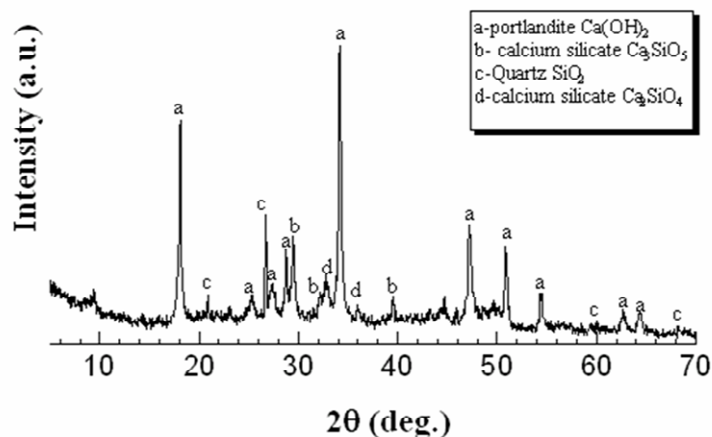
Holcim, one of the world's leading suppliers of cement and aggregates (crushed stone, sand and gravel) as well as further activities such as ready-mix concrete and asphalt including services, has been undertaking research in the use of treated sewage sludge in the manufacture of cement. They have concluded that the use of renewable treated sludge in cement manufacture will provide a significant environmental benefit.

Eco-Solids International is liaising with Holcim about advancing the use of the treated Eco-Solids product in cement manufacture. The characteristics of the treated Eco-Solids product, having high lime content, make it an ideal cement constituent.

Separately Eco-Solids International is liaising with Professor Chris Cheeseman of Imperial College London about undertaking a research project to verify the ideal use of the treated



product in cement manufacture. Imperial College's initial product analysis confirms that the Eco-Solid Product's characteristics are ideal for cement manufacture.



Their XRD analysis of the Eco-Solid Product is set out above. The high intensity level of Portlandite and quartz are of key benefit.

#### 4 Use of Treated Eco-Solid Product as a fuel and as a sulphur scrubbing agent in coal fired power generation

##### (i) As a constituent fuel material in coal fired power generation

A study has been undertaken to show that the treated product can be used as a fuel in coal fired power generation. This study was undertaken to compare the use of The Eco-Solids treated product with dryer pellets.

This study was also conducted to evaluate and examine the valuation of producing an alternative sulphur/NO<sub>x</sub> absorbent material, namely Eco-Solids Process Coal. The following issues and assumptions were examined:

- Data generation and performance characteristics of Eco-Solids Process Coal.
- Calcium content (Measured as CCE)
- Elimination of onsite crushers
- Reduced metals content
- Low cost

The desire of the global energy community is such that alternative energy sources must be developed. Eco-Solids Process Coal is one such source that contributes to energy recovery and also dramatically reduces sulphur, CO<sub>2</sub>, and NO<sub>x</sub> emissions.

##### **Eco-Solids Process Coal Benefits**

Eco-Solids Process Coal is solid matter consisting of organic matter, and calcium hydroxide. It is uniformly mixed and can be provided in a wide range of particle sizes. The organic phase comprises 60-70% (14,000kJ/kg) and the remaining 30-40% is calcium hydroxide. The benefits of using this material are:

1. Calcium hydroxide is 35% more reactive than calcium carbonate.
2. The material contributes approximately 8,370kJ/kg of energy.
3. Eliminates the need for an onsite crusher.
4. Eliminates the carbon dioxide contribution caused by calcium carbonate use.
5. Very low metals content.
6. Ammonia content of Eco-Solids Process Coal greatly reduces NO<sub>x</sub> emissions (NH<sub>3</sub> + NO<sub>x</sub> → N<sub>2</sub> + H<sub>2</sub>O)

## Eco-Solids Process Coal Process Description

Eco-Solids Process Coal is a stable material, having a pH greater than 11.0. The sulphur in the coal reacts with the Eco-Solids Process Coal to form calcium sulphates. The calcium sulphate is a solid and accumulates in the ash. This process has a major impact on reducing sulphur air- emissions.

## Combustion Analysis

The analysis of the Eco-Solids Process Coal ash after combustion is as follows:

**Table 1 Eco-Solids Process Coal – Combustion Analysis**

Mineral Analysis	Ash, % Weight	Mineral Analysis	Value
Silica SiO <sub>2</sub>	46.2	Silica value	62.3
Alumina Al <sub>2</sub> O <sub>3</sub>	11.74	Fouling Index	1.16
Titanium TiO <sub>2</sub>	0.64	Ash Type	Lignitic
Iron oxide Fe <sub>2</sub> O <sub>3</sub>	7.26		
Calcium oxide CaO	19.3		
Magnesium oxide MgO	1.4		
Potassium oxide K <sub>2</sub> O	1.67		
Sodium oxide Na <sub>2</sub> O	1.16		
Sulphur trioxide SO <sub>3</sub>	9.02		
Others	1.61		
<b>Total</b>	<b>100%</b>		

The ash generated contains about 20% calcium oxide. This ash can be reused in the Eco-Solids Process, supplemented with calcium oxide, sold or given away to farmers or used as landfill cover.

### **(ii) As a sulphur scrubbing agent in coal fired power generation**

Research is currently being undertaken with a US Power Generating company regarding the potential use of the Eco-Solid Product in coal fired power stations using fluid bed combustion. These processes traditionally use lime to scrub the sulphur to reduce sulphur emissions. Initial indications suggest that using the Eco-Solid Product instead of lime would be 38% more effective and having a high BTU value would attract carbon credits. This research is being undertaken confidentially and a paper will be available on this subject in due course.

Aside of fluid bed combustion the treated Eco-solid Product could similarly be used in all coal burners as a scrubbing media replacing lime. The end product could then be used as a soil amendment, since the 12pH of the Eco-Solid Product is reduced to 7 after scrubbing.

## **5 Use of Treated Eco-Solid Product as a constituent in building materials**

The treated Eco-Solid Product could also be used in the manufacture of bricks and roofing tiles as well as other construction products. The benefit of the organic matter would be to create a lighter weight product that maintains a sufficiently high tensile strength. Further investigation is being undertaken on behalf of Eco-Solids International Limited in the USA.

To date the treated Eco-Solid Product has been used as a cladding material in a skyscraper in Shanghai.

**It should be clearly understood that some of these uses are in the development stage and are not yet in use commercially**