

ECO-COAL – FUEL OF THE FUTURE

by
Samuel Shepherd
Innovations Director, Eco-Solids International Limited

Diplomat American Board of Forensic Engineering and Technology
B.Sc. Chemical Engineering
M.Sc. Engineering and Technology

1 INTRODUCTION

This study was conducted on behalf of HAZMACO, a U.S. company specializing in the development of technologies for the Petrochemical and Environmental Industries. The purpose of the study was to evaluate and examine the feasibility of combining Class A sterile biosolids with coal finings to produce an alternative fuel, called *Eco-Coal*. The following issues were examined:

- Health and safety of personnel handling biosolids.
- Methods of handling and processing biosolids to mitigate population exposure to pathogens.
- Data generation and performance characteristics of *Eco-Coal*.

The desire of the current global regulatory environment is such that the hazards of biosolids containing pathogens and odourants must be minimized. The recent study by the Centre of Disease Control, at Lesourdesville, Ohio, confirmed that the potential for exposure to pathogens in Class B biosolid aerosols is an issue. Congressional hearings are being held, and the National Academy of Sciences is evaluating the science behind the current land application rules with regard to Class B biosolids. Two lawsuits involving the death of Shane Connors and Tony Behune are alleging that both deaths were a direct result of exposure to Class B biosolids.

Currently, about 8 million tons/yr of human biosolids and 350 million tons/yr of animal waste are generated in the U.S. per annum.

Protecting People and the Environment from Disease, Chemicals and Smells

Head Office:
Eco-Solids International Limited
Cheshire House, 16 Old Milton Road
New Milton, Hampshire
BH25 6DX, Great Britain
Tel: +44 (0) 1425 627136
Fax: +44 (0) 1425 627137
Email: info@ecosolids.com

Registered Office:
Eco-Solids International Limited
Coneygar Farm, Shutes Lane
Buckhorn Western, Dorset
SP8 5HZ, Great Britain
Tel: +44 (0) 1425 835035
Fax: +44 (0) 1747821411
Mbl: +44 (0) 7767760290

2 ECO-COAL PROCESS DESCRIPTION

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.

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).

HAZMACO developed *Eco-Coal* as an outlet using the lime-containing end product (*Eco-Solid*) and coal finings as a feedstock. *Eco-Solid*, contains approximately 40% hydrated lime and 60% organic humus, which is combined with coal finings using a mixer to create *Eco-Coal*. The mixture proportion is shown below:

Table 1 *Eco-Coal* mixture

	%	BTU value/lb
<i>Eco-Solid</i>	12	1,400
Coal finings	87.5	9,000
Others	0.5	18,000

After mixing the components for 10-15 minutes, the finished product is poured into a mould and cured for 12 hours. After the cure time, the material retains a tensile strength in excess of 200psi. An analysis of *Eco-Coal* prior to combustion is shown below:

Table 2 Analysis of *Eco-Coal* prior to combustion

Analysis	As received	Dry basis
% Moisture	5.7%	N/A
% Ash	36.8%	39.02%
% Volatile	29.28%	31.05%
% Fixed Carbon	28.22%	29.93%
BTU/lb	7723	8237
% Sulphur	2.01%	2.13%

Eco-Coal is a stable material, having a pH greater than 8.5. The benefits of this material are a direct result of the following characteristics:

- The aluminium oxide and silica contained in the coal finings react with the lime contained in the *Eco-Solid* to form the calcium-aluminium oxide-silicate pozzolanic material. This gives the material a cement characteristic, having a tensile strength in excess of 200 psi.
- The other major advantage is that the sulphur reacts with the calcium hydroxide 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 from burning the coal.

The *Eco-Coal* is pathogen free and hence poses no pathogenic problems to workers or the public. The *Eco-Coal* is black in appearance and behaves like lignite coal.

Combustion Analysis

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

Table 3 Eco-Solids Process Coal – Combustion Analysis

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

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.

3 MARKET INFORMATION

In this section we provide an outline of the market requirements for *Eco-Coal*. The volumes required to manufacture are indicated below:

Table 4 Material volumes

Component	Millions of dry tons/year
Biosolids from humans	8
Biosolids from animals	320
Biosolids needed to produce 1 million tons of <i>Eco-Coal</i> /year	0.1
Tons of coal finings required to convert 8 million tons of biosolids/year	80
Tons of coal finings required to convert 320 million tons of animal waste	3200

Indicative unit costs to manufacture *Eco-Coal* are shown below:

Table 5 Costs to produce 1 ton of *Eco-Coal*

Units	% weight	unit cost (\$/unit)	cost contribution
<i>Eco-Solids</i> tons	12	\$5.00	\$0.60
Coal finings tons	87.5	\$4.00	\$3.50
Other tons	0.5	\$200.00	\$1.00
Freight tons	-	\$6.00	\$6.00
Labour	-	0.04 man hrs/ton @\$30.00/man hr	\$1.20
Total	-	-	\$12.30/ton <i>Eco-Coal</i>

It costs approximately \$12.30 to manufacture each ton of *Eco-Coal*. *Eco-Coal* has a minimum BTU content of approximately 8000btu/lb, which is equivalent to 16,000,000btu/ton.

Coal pricing is approximately \$1.25/1,000,000btu. Therefore, *Eco-Coal* potentially has a maximum Markey value of \$20.00/ton (not including alternative fuel tax credits!!)

N.B. The equivalent sterling maximum selling price would be £11.00/metric tonne.