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## ENVIRONMENTAL TECHNOLOGY VERIFICATION (ETV)

### VERIFICATION STATEMENT

TECHNOLOGY TYPE : **CARBONIZATION FURNACE**

APPLICATION : **Waste-to-Energy**

TECHNOLOGY NAME : **SK-05 Carbonization Furnace**

COMPANY : **Biodiesel and Energy Resources Corporation**

#### Disclaimer

*This report is the result of an impartial, consensus-based approach to evaluating innovative environmental technology in accordance with the ETV Technical Protocol. The data presented are believed accurate and the analyses credible. The statements made and conclusions drawn regarding the product evaluated do not, however, amount to an endorsement or approval of the product in general or for any particular application.*

*This report is based from a survey activity supported by the Biodiesel and Energy Resources Corporation, IPCT ETV Group, and the Technology Expert Panel.*

*Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the Authors and do not necessarily reflect the view of the Department of Science and Technology.*

A handwritten signature in blue ink is located in the bottom right corner of the page, overlapping the bottom edge of the main text box. The signature appears to be 'A. Magno'.

This ETV Statement is a summary of the ETV Report of the *SK-05 Carbonization Furnace* (ETV-06-014).

### ETV TEST DESCRIPTION

During the initial Technical Panel meeting discussions, the panelists agreed that a desktop evaluation of the technology is sufficient since the waste-to-energy facility is located in Germany. The evaluation and verification coverage for the *SK-05 Carbonization Furnace* technology encompassed the following:

- Visual presentation of the operation of the technology and inquiries on the performance of the equipment
- Authenticated results of tests and analyses
- Permitting documents from Germany
- Authenticated review of technology by the officially appointed and certified expert for waste disposal and waste management (Dr. Rudiger Schmidt)

### VERIFIED TECHNOLOGY DESCRIPTION

The carbonization plant consists of two-line carbonizer assembly with waste heat boiler and electricity generation set up. The following components are integral part of the carbonization furnace – two-line waste feed bunker with feed conveyor and bunker discharge conveyor, two 3-zone carbonizers, two thermal afterburner as eddy current combustion, one waste heat boiler for steam generation and one turbo generator with steam extraction turbine (with approximate terminal power of 2.5 MW). The plant is being designed to accept a total input of approximately 25,000 tons of garbage annually.

### VERIFICATION OF PERFORMANCE

This section presents the evaluation and discussion of the results of the verification procedures.

- The *SK-05 Carbonization Furnace* is a non-burn technology as per Rule XXVIII of the Phil Clean Air Act as it fulfills conditions that fire is not used within the construction chamber and that no additional oxygen is added within the destruction chamber
- The **BERC** through the **inora AG** submitted an authenticated test of the carbonized after the thermal afterburner (TAB). Table 1 shows the partial result of the analysis as compared with the Phil. Clean Air Act. The feed material used in the sample was of industrial waste.

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Table 1. Results of the Analysis of the Carbonized Gas at the TAB

Parameters	Unit	Ave. Value	Max. Value	Threshold Value (German Federal Pollutant Control Ordinance)	Threshold Value (Phil Clean Air Act)
Dust	mg/m <sup>3</sup>	17	24	30	150
CO	mg/m <sup>3</sup>	52	65	100	500
NO <sub>2</sub>	mg/m <sup>3</sup>	102	190	400	500
SO <sub>2</sub>	mg/m <sup>3</sup>	87	91	200	700
HCl	mg/m <sup>3</sup>	10	18	60	
HF	mg/m <sup>3</sup>	<0.3	<0.3	4	50
TOC	mg/ m <sup>3</sup>	12	20	20	
PCDD/PCDF	ng/ m <sup>3</sup>	-	0.067	0.1	
Mercury	mg/m <sup>3</sup>	<0.005	<0.005	0.05	5
Cadmium	mg/m <sup>3</sup>	<0.005	<0.005	0.05	10
Thallium	mg/m <sup>3</sup>	<0.005	<0.005	0.05	10
Co	mg/m <sup>3</sup>	<0.005	<0.005		10
Cu	mg/m <sup>3</sup>	0.030	0.040		10
Antimony	mg/m <sup>3</sup>	0.006	0.006	-	10
Vanadium	mg/m <sup>3</sup>	0.006	0.007	-	

- The technology proponent also submitted an analysis of the ash from the carbonization. The testing result was done on May 5, 2007 and conducted by SAFE Analytik in Germany. This test result (shown in Table 2) was sent through an e mail to the IPCT ETV Group.

Table 2. Analysis of Ash from Carbonization Furnace

Parameter	Unit	Method	Value
Dry material	% wt	DIN 38414-S2	98.7
Ash content	% wt (d.b.)	DIN 38414-S3	95.9
Total Cl	% wt (d.b.)	DIN 51727	6.64
Total Flourine	% wt (d.b.)	DIN 51723	0.02
Total Sulfur	% wt (d.b.)	DIN 51724	1.31
Total Nitrogen	% wt (d.b.)	E DIN 51732	0.61
SiO <sub>2</sub>	% wt (d.b.)	DIN 51729	10.1
Al <sub>2</sub> O <sub>3</sub>	% wt (d.b.)	DIN 51729	13.7
As	mg/kg (dry matter)	DIN EN ISO 11969D18	3.2
Pb	mg/kg (dry matter)	DIN EN ISO 11885-E22	538
Cd	mg/kg (dry matter)	DIN EN ISO 11885-E22	14.4
Co	mg/kg (dry matter)	DIN EN ISO 11885-E22	85.2
Cr	mg/kg (dry matter)	DIN EN ISO 11885-E22	3,588
Cu	mg/kg (dry matter)	DIN EN ISO 11885-E22	2,976
Fe	mg/kg (dry matter)	DIN EN ISO 11885-E22	39,840
Mn	mg/kg (dry matter)	DIN EN ISO 11885-E22	762
Ni	mg/kg (dry matter)	DIN EN ISO 11885-E22	1,836
Hg	mg/kg (dry matter)	DIN EN 1483-E12	<0.07
Vanadium	mg/kg (dry matter)	DIN EN ISO 11885-E22	272
Zn	mg/kg (dry matter)	DIN EN ISO 11885-E22	2,088
<b>PCDD/F</b>			
2378-tetraCDF	ng/kg (dry matter)	QMA504-173	2,460
12378-pentaCDF	ng/kg (dry matter)	QMA504-173	1,700

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23478-pentaCDF	ng/kg (dry matter)	QMA504-173	2,950
123478-hexaCDF	ng/kg (dry matter)	QMA504-173	2,010
123678-hexaCDF	ng/kg (dry matter)	QMA504-173	1,620
123789-hexaCDF	ng/kg (dry matter)	QMA504-173	<639
234678-hexaCDF	ng/kg (dry matter)	QMA504-173	3,050
1234678-heptaCDF	ng/kg (dry matter)	QMA504-173	5,550
1234789-heptaCDF	ng/kg (dry matter)	QMA504-173	438
OctaCDF	ng/kg (dry matter)	QMA504-173	1,930
2378-tetraCDF	ng/kg (dry matter)	QMA504-173	68.9
12378-pentaCDD	ng/kg (dry matter)	QMA504-173	268
123478-hexaCDF	ng/kg (dry matter)	QMA504-173	202
123678-hexaCDD	ng/kg (dry matter)	QMA504-173	414
123789-hexaCDF	ng/kg (dry matter)	QMA504-173	415
1234678-heptaCDD	ng/kg (dry matter)	QMA504-173	2,540
OctaCDD	ng/kg (dry matter)	QMA504-173	2,530
WHO-PCDD/F-TEQ (a)	ng/kg (dry matter)		3,000
WHO-PCDD/F-TEQ (c)	ng/kg (dry matter)		3,060
WHO (2005)-PCDD/F-TEQ excl. LOQ (a)	ng/kg (dry matter)		2,380
WHO (2005)-PCDD/F-TEQ excl. LOQ (c)	ng/kg (dry matter)		2,440
ITE-(NATO/CCMS)excl. LOQ (a)	ng/kg (dry matter)		2,870
ITE-(NATO/CCMS)excl. LOQ (a)	ng/kg (dry matter)		2,930

TEQ- toxic equivalent – weighs the toxicity of the less toxic compounds as fractions of the toxicity of the most toxic TCDD

(a) – the concept of “lowerbound” requires using zero for the contribution of each non-quantified congener to the toxic equivalent (TEQ)

(b) – the concept of upper bound requires using the limit of quantification (LOQ) for the contribution of each non-quantified congener to the TEQ

There is no existing local regulation on the TEQ of dioxin in bottom ash. Moreover, there is no guidance on acceptable levels of dioxins, should be bottom ash be used as construction materials.

Typical measurements of dioxins in soil, taken from a German study, are 10 ng TEQ/kg in rural areas, 10-30 ng TEQ/kg in urban areas and 100-8,000 ng TEQ/kg near municipal waste incinerators.

- The *SK05 Carbonization Furnace* has been granted the European CE Marking certifying that all relevant safety procedures are meeting European standards. These European directives are issued by MIOBA for the following: 98/37/EC – approximation of the laws of the Member States relating to machinery; 90/396/EEC- approximation of the laws of the member states relating to appliances burning gaseous fuels; etc. In addition, (also Annex D) the following standards of the Deutsches Institut für Normung (German Institute for Standardisation) were also conformed; DIN EN ISO 12100-1 safety of machinery; DIN EN 294 safety distances to prevent danger zones from being reached by the upper limbs; DIN EN 746-1 Common safety requirements for industrial thermo processing equipment; DIN EN 746-2 safety requirements for combustion and fuel handling systems and DIN EN ISO 13849-1 safety –related parts of control systems and DIN EN 60204-1 safety of machinery – electrical equipment of machine.

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- The authenticated review of Dr. Rudiger Schmidt, officially appointed and certified expert for waste-disposal technology of the Chamber of Commerce and Industry for Munich and Upper Bavaria, states the following;
- If possible, small-scale plants, such as SK05 procedure should be designed for one specific type of waste in order to keep the treatment effort down to minimum. Moreover, small-scale plants react much faster and more strongly to changes in the composition of the waste
  - The planned tunnel furnace should be seen as a unit that enables control over the complex processes involved in a combustion where the individual part processes overlap in a sequence of processes with drying, carbonization and oxidation.
  - The chamber needs to be carefully insulated in order to keep the heat loss low, and when installing the thermal expansion compensators, highest standards will have to be applied. Compensators are very susceptible to wear and tear and need to be replaced quite frequently
  - An emergency cooling system should be installed for safety, possibly a water quench actuated via the temperature measurement
  - The treatment technology as well as the processing of the flue gas with boiler and flue gas purification have been tried and tested in the most varied waste treatment plants for years and can be seen as state of the art. A procedural risk involved in the construction and operation of these parts of the plant cannot be spotted.
  - The tunnel furnace means unknown technological ground- however, no insurmountable problems are to be expected for the construction and operation of this technology. After the test and optimization period has been completed and the normal operation of the plant has started, one can expect the plant to function without problems

**Based on the above verification procedures, the claim of Biodiesel and Energy Resources Corporation on the merits of the *SK-05 Carbonization Furnace* as environmentally friendly waste-to-energy system has been verified.**

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