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System for Sludge Advanced Fuel and Energy (SAFE) *Technology Fact Sheet for EnbioCons Co. Ltd.*

Performance Claim

1. At a 95% confidence level, the EnbioCons Co. Ltd. System for Sludge Advanced Fuel and Energy produces dried sludge with a moisture content of less than or equal to 7.6 % under the specified operating conditions; with the moisture content of the incoming sludge ranging from 80 to 84%.
2. At a 95% confidence level, the calorific value of the dried sludge obtained from the EnbioCons Co. Ltd. System for Sludge Advanced Fuel and Energy is at least 3130 kcal/kg under the specified operating conditions, i.e. the lower calorific values of the incoming sludge ranges from 49 to 212 kcal/kg, the moisture content of incoming sludge ranges from 80 to 84%, and the temperature of the dryer inlet and outlet ranges from 600 to 800°C and from 130 to 160°C respectively.
3. At a 95% confidence level, with the assumption that all dryer units will behave the same, the energy required to remove 1 kg of water from the incoming sludge from one unit dryer within the EnbioCons Co. Ltd. System for Sludge Advanced Fuel and Energy is less than or equal to 3.5 MJ/kg under the specified operating conditions; assuming that the moisture content of the incoming sludge is from 80 to 84% and the moisture content of the final product is less than or equal to 7.6%.

Performance Conditions

The key operating conditions of this test unit are as outlined in the Table below. The energy required for dryer operation is determined through control of the temperature of gas discharged from dryer. Important factors are the moisture content and amount of sewage sludge fed into dryer, as well as the temperature of gas fed into the drier and that discharged from the back of dryer.

After determining the requirements for dryer operation, an operational log was prepared and continuous, stable operating conditions were established. The ranges of temperatures at the dryer inlet and outlet were 600 - 800°C and 130 - 160°C respectively.

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Performance Conditions (cont'd)

Key Operational Factors and Operating Conditions

Test Parameters		Unit	Operating Conditions
Test Process	Operational Factors		
Air Heating	Outlet temp.	°C	600~800
Dryer	Moisture content of Input sludge	Wt%	80 or more
	Sludge treatment volume	Tons/day, unit	100
	Inlet/ outlet temperature	°C	600~800 /130~160
	Drum rotation speed	rpm	1~3
	Disintegrator rotation speed	rpm	340~360
Dried Sludge	Moisture content	wt%	10 or less
	Particle size	mm	20 or less

Technology Application

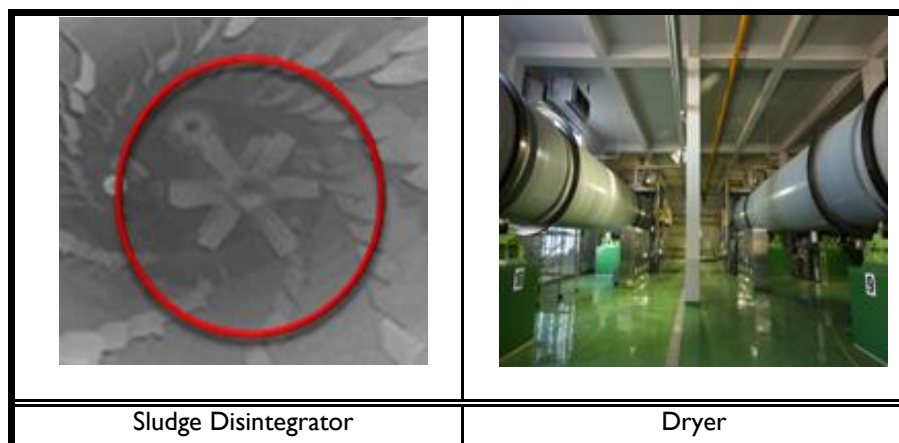
The SAFE technology at the SUDOKWON Landfill Site is located in a fully automatic sewage sludge drying facility, which is electronically controlled and monitored by a control center. The facility is operated by EnbioCons Co. Ltd.

For verification purposes, the intended application of technology can be defined in terms of the matrix, the target and the effect of the product. The matrix is sewage sludge generated in a municipal wastewater plant. The main targeted application is the removal of moisture from sewage sludge. The main effect of the application evaluated is improved energy efficiency.

Technology Description

EnbioCons Co. "System for Sludge Advanced Fuel and Energy" (SAFE) is a technology for sewage sludge drying that uses a two-axis rotary type disintegrator in a hot air kiln dryer to increase the heat transfer area of sewage sludge fed into the inside of a rotary kiln, and thus drying the sewage sludge with moisture content of 10% or less.

The innovative parts of the SAFE technology, the sludge axis disintegrator and dryer, are illustrated below.



Sewage sludge consists of organic substances with high viscosity and high moisture content. Therefore, unless the particles are atomized in the initial phase of drying, a sticky zone with moisture content of 40 - 50% is formed as drying progresses, resulting in the formation of sewage sludge mass. Consequently, even if thermal energy is continuously supplied, only the surface of the sludge mass is dried leaving moisture inside. As a result, drying efficiency is lowered rapidly.

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Technology Description (cont'd)

When direct high-temperature air (600 - 800°C) and high viscosity sewage sludge with moisture content of 80±5% are put into the EnbioCons SAFE sloping rotary type dryer mounted with two axis disintegration system with the rotating speed of 340~360rpm, the surface of sewage sludge dries rapidly and the sewage sludge is turned into particles by the disintegrator. Drying and disintegration as such are carried out more effectively according to the shapes and arrangements of lifts that continuously drop sludge into the disintegrator. Through the process of disintegration inside the dryer, sewage sludge is turned into particles. The sewage sludge particles have a greater surface for heat exposure, and thus the drying efficiency is maximized. Accordingly, dried sludge with moisture content of 10% or less and particle size of 20mm or less can be produced.

The shapes of the lifts inside the EnbioCons SAFE sewage sludge dryer are designed so that the sludge falling points can be adjusted through rotation of the outer shell of dryer. For the front part of the dryer, the lift is short so that sludge can be dropped extensively to the center of a fast-rotating disintegrator in order to turn the sewage sludge mass into particles. After the disintegration zone, the lift is designed to permit a consistent amount of sludge to be evenly deposited over a wide area inside the dryer in order to maximize the surface in contact with hot air, and thus to maximize drying efficiency.

Odorous gases produced during the drying process are used internally within the unit for combustion, thus preventing odorous discharges.

Co-Verification

The performance claims of EnbioCons Co.'s *System for Sludge Advanced Fuel and Energy (SAFE)* technology were verified by the Korea Environmental Industry & Technology Institute (KEITI) and GLOBE Performance Solutions (GPS) within the framework of a co-verification initiative between Korea and Canada. The Korea Environmental Industry & Technology Institute (KEITI) operates a Korea verification scheme, supported by the Korea Ministry of Environment, while GLOBE Performance Solutions (GPS) operates the Canadian ETV Program on behalf of Environment Canada. The Canadian co-verification component was completed by the GPS Technical Expert, Edmonton Waste Management Centre of Excellence located in Edmonton, Alberta, Canada, using the Canadian ETV Program's General Verification Protocol (June 2012). Testing and preparation of the test report were performed by an independent testing organization in Korea, the Korea Testing Laboratory (KTL). KEITI supervised the testing and preparation of the test report by the independent testing organization.

The Korean ETV Program and Canadian ETV Program

The Korean Environmental Technology Verification (ETV) Program is operated by the Korea Environmental Industry & Technology Institute (KEITI) and is supported by the Korea Ministry of Environment

The Canadian Environmental Technology Verification (ETV) Program is delivered by GLOBE Performance Solutions under a licence agreement from Environment Canada. The Canadian ETV Program is designed to support the environment industry by providing credible and independent verification of technology performance claims.

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