



Encore Earth™

Encore Flow

An Encore Earth Company

Patent-Pending Process for the Total Remediation of PFAS Chemicals

October 2021

REMOVAL OF PFAS

There are 5 steps that must be performed to remove PFAS out of wastewater treatment plants.

1

STEP 1: PRECIPITATE

Precipitate or Drop PFAS out of the wastewater stream and into the sludge.

2

STEP 2: DEWATER

Dewater the sludge so it can be dried

3

STEP 3: DRY

Dry the sludge so it can be baked.

4

STEP 4: BAKE

Bake the sludge at high temperature to break the chemical bond.

5

STEP 5: ELECTRICAL GENERATION

ORC waste heat electrical generator.



GROUNDBREAKING PFAS REMOVAL

Patent-Pending PFAS Remediation Solution

The only turn-key solution that captures and destroys PFAS compounds out of water and sludge in an environmentally friendly process without adding additional filters to the water or wastewater treatment plant.

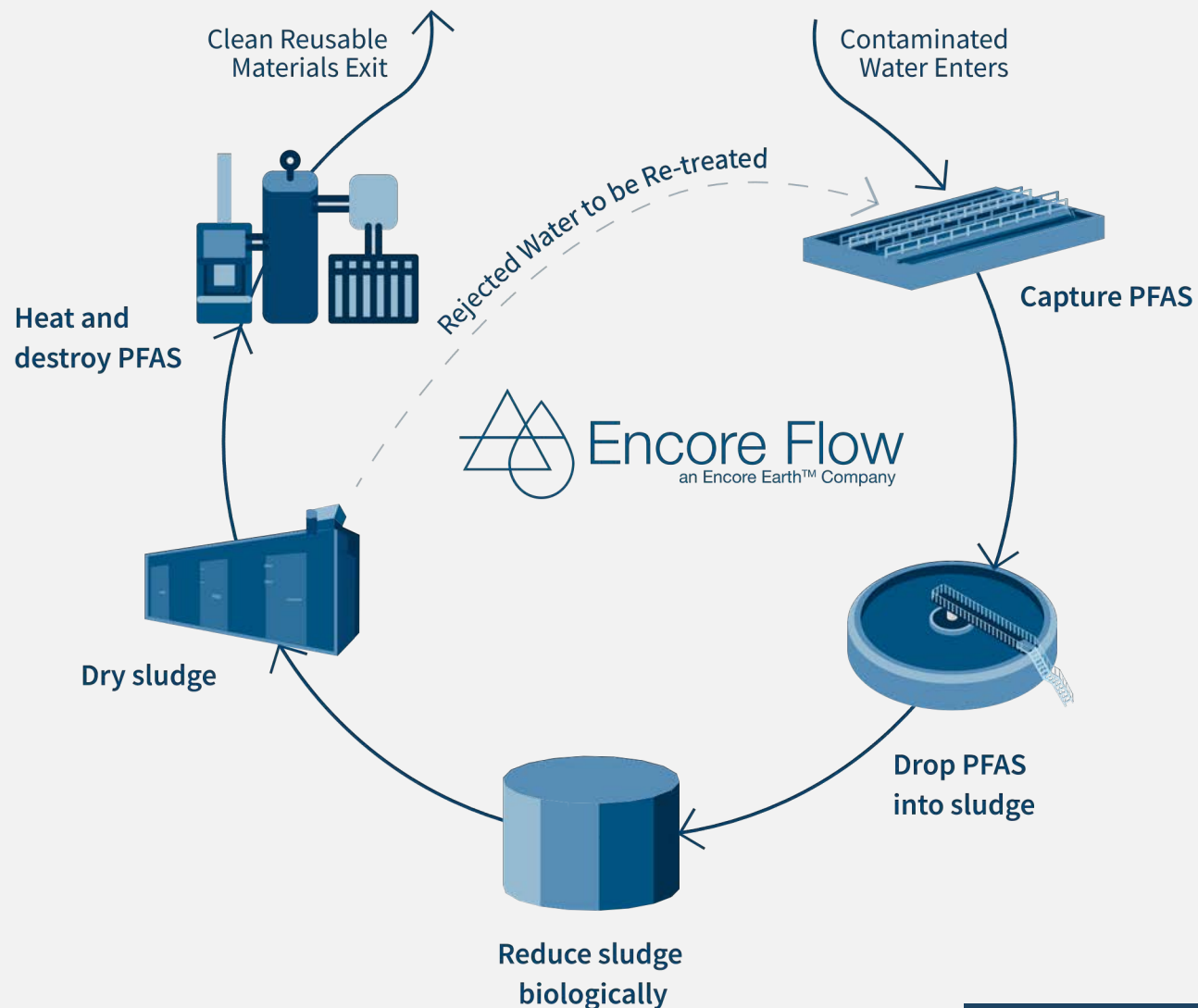
4/16/2021 - Patent Filing

PFAS in situ Remediation in Water

A waste treatment method that includes the steps of: adding mineral compounds to water to separate solid material from the water through settling or filtration, adding biological compositions to digest organic matter, dewatering the sludge with a Press or Centrifuge or include screw, then dried to at least 75% solids, and gasified incinerated or plasma charged burning at a minimum of 1,750 degrees Fahrenheit. The remediation method may be used in any water.

Submitted by Kenneth Ray Brummett

USPTO Customer # 97BClim@52&N



STEP 1: PRECIPITATE

Precipitate or Drop PFAS out of the water or wastewater stream

Our PFAS or (Forever Chemicals) remediation process is a simple, continuous, addition of mineral compounds (Bio-Clean and a Rare Earth Lanthanide Solution) to the aeration basin or mixing chamber of any water and wastewater treatment plant. Combining these two solutions together in an aeration basin or mixing tank will precipitate PFAS/PFOS out of the water or wastewater and into the sludge. Lanthanides are so far down on the periodic element chart that their inherent qualities are more powerful than any other "safe" elements found in nature.

- ✓ Improves settling
- ✓ Settles scum, filamentous bacteria, algae, grease, and foam
- ✓ Reduces BOD, TSS and SVI
- ✓ Improves DO
- ✓ Reduces Dewatering costs
- ✓ Stabilizes sludge blankets
- ✓ Reduces washouts
- ✓ Increases sludge density without packing
- ✓ Natural, safe, and efficient



[Watch Video on PFAS Compound Precipitation](#)



The hydrocarbons (oil, street run off, etc) that enter the Canal are broken down by our Mineral Treatment.

HOW IT WORKS

Bio-Clean Technical Composition

H

Hydrogen is the lightest element. It is by far the most abundant element in the universe and makes up about 90% of the universe by weight. Hydrogen as water (H₂O) is absolutely essential to life and it is present in all organic compounds.

C

Carbon is a Group 14 element. Carbon is distributed very widely in nature. It is found in abundance in the sun, stars, comets, and atmospheres of most planets. The atmosphere of Mars contains 96 % CO₂.

N

Nitrogen is a Group 15 element. Nitrogen makes up about 78% of the atmosphere by volume but the atmosphere of Mars contains less than 3% nitrogen. The element seemed so inert that Lavoisier named it azote, meaning "without life". However, its compounds are vital components of foods, fertilizers, and explosives. Nitrogen gas is colorless, odorless, and generally inert. As a liquid it is also colorless and odorless.

O

Oxygen is a Group 16 element. While about one fifth of the atmosphere is oxygen gas, the atmosphere of Mars contains only about 0.15% oxygen. Oxygen is the third most abundant element found in the sun, and it plays a part in the carbon-nitrogen cycle, one process responsible for stellar energy production.

Na

Sodium is a Group 1 element (or IA in older labeling styles). Group 1 elements are often referred to as the "alkali metals". The chemistry of sodium is dominated by the +1 ion Na⁺.

THE NEW SOLUTION

PFAS will forever change the way biosolids and sludge is handled.

DIGESTING

Once PFAS is attached to the sludge we can then go ahead and dewater and dry the solids. We can treat digested or undigested sludge but we believe digested sludge or biosolids with PFAS may cause problems downstream in the gas line if the digester gas is not burned on site at a suitable temperature to destroy the PFAS compounds in the moisture stream of the digester gas. Digesting sludge is necessary to stabilize biosolids for land application per the EPA 503 rules but if we are “baking” dried biosolids then digesting only serves the purpose of reducing the volume of solids to be baked.

DEWATERING

Dewatering sludge or biosolids with PFAS can be done the same way as treatment plants do now. Centrifuges and belt presses can be used to remove 40% of the water from the sludge without harm to operators because the sludge is not being thermally treated. Almost all sludge or biosolids are land applied or sent to the landfill but that will soon change. The days of taking sludge to a landfill or land application are numbered because it will be assumed that the sludge or biosolids has dangerous PFAS Chemicals...which most treatment plants already have.

Since the (Wet) or dewatered biosolids can not be disposed of via a landfill or land application then the solids will need to be dried. EPA 503 regs specify certain drying criteria for Class A and Class A EQ land application but those criteria will be a thing of the past because of PFAS legislation. Composting, Open Air Drying, and Forced Air Drying using oil or natural gas will not be permitted because of the moisture content of the air leaving the dryer. The only safe way of drying sludge or biosolids will be by dehumidifying a Hot Box full of sludge where no air can escape. This leaves 95% of the dryers on the market unusable.

PILOT SYSTEM

Our pilot system is designed to treat up to 13 wet tons a day of sludge or biosolids. We have a multi drying system that can treat 75 wet tons a day at 20% solids per machine and be coupled in groups of 8 to dry 600 wet tons a day to 80% solids.

These heat pump dryers are self-contained, insulated, closed loop systems where the air in the dryer is not released out of the drying cabinet making them the most energy efficient dryers in the world. These units dry the sludge using the heat pump cycle instead of burning fuel oil, or natural gas. Solar PV Panels can be installed, and grid tied to generate the electricity needed to operate the heat pump cycle and the moisture released from the organic cell is condensed and sent back to the headworks.

Encore Flow PFAS Removal Results

This is a remediation of PFAS chemicals from a [wastewater treatment facility](#) in 2021 using our patent-pending process.

Current federal testing levels of PFAS in potable water allow for only 70 PPT

	Before Treatment	After Treatment (PPT)	Percentage Removed
PFPeA	126.70	53.80	58%
PFHxA	2,568.06	60.6	98%
PFHpA	793.95	16.60	98%
PFOA	2,478.90	49.80	98%
PFNA	142.08	1.50	99%
PFDA	107.37	2.06	98%
PFBS	4,016.62	42.30	99%
PFPeS	122.93	1.72	99%
PFHxS	264.96	12.40	95%
PFOS	240.79	14.70	94%
4:2 FTS	125.54	1.11	99%
8:2 FTS	28.11	ND	100%
PFOSA	104.05	ND	100%
N-MeFOSAA	109.93	6.78	58%
N-EtFosaa	123.68	3.49	58%

90%

The average removal of PFAS chemicals after treatment was 90%.

Reference will be provided upon request.

EXAMPLE OF THE CURRENT TREATMENT PROCESS

Sweeney Water Treatment Plant Finds PFAS

The Cape Fear Public Utility Authority (CFPUA) operates one surface water treatment plant, the Sweeney Water Treatment Plant (WTP), which treats surface water from the Cape Fear River. In 2016, the plant was tested for novel PFAS, including GenX, and found them to be at about 631 ng/L, which is well above the non-enforceable health goal of 140 ng/L currently set for GenX in drinking water in North Carolina.

Other PFAS compounds have been found in the water at Cape Fear, the nearby river, because of the Chemours plant, which was discharging PFAS chemicals into the river, before they found their way into the water treatment plant. A lawsuit is in progress to force Chemours to help pay for the costs, but several years later, it is still not resolved. The city went ahead and developed a plan for getting rid of PFAS chemicals from their water.



Sweeney Water Treatment Plant

Capacity: 35MGD (infrastructure for 44MGD)

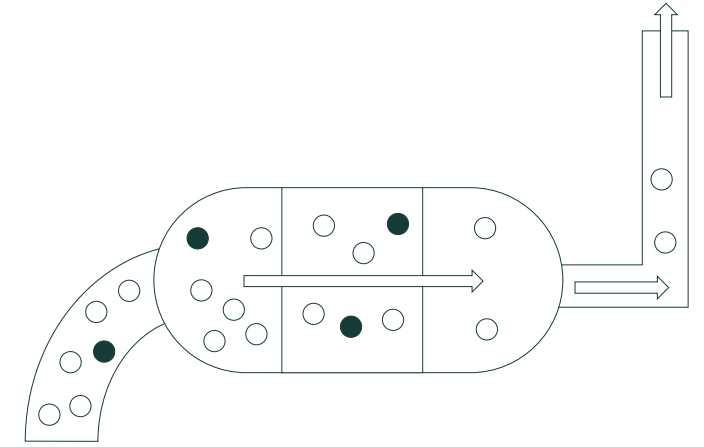
Currently Treating: 14MGD

https://www.awwa.org/Portals/0/AWWA/ETS/Resources/Technical%20Reports/CFPUA%20Case%20Study%20Report_FINAL.pdf?ver=2021-01-19-095055-317

Current Filtration Choices

Like all other treatment plants who are setting up filtration systems for PFAS, Sweeney had three choices: Granular Activated Carbon (GAC) contactors, Ion Exchange Vessels, and Reverse Osmosis. Their selection was driven by cost, how the technology complements the previous investments made into the existing treatment plant, and environmental and flexibility benefits.

Their final choice was GAC Filters. The GAC facility includes eight, single-cell, concrete contactors, each nominally rated for 5.5 MGD treatment capacity, for a total treatment capacity of 44 MGD. The facility was designed for a 20-minute EBCT at the maximum 44-mgd treatment capacity, requiring about 3,000,000 pounds of GAC.



	GRANULAR ACTIVATED CARBON CONTACTORS	ION EXCHANGE VESSELS	REVERSE OSMOSIS
Capital Cost	\$46 M	\$46 M	\$150 M
Annual Operating Cost	\$2.9 M	\$2.1M	\$4.7 M
Present Value	\$215 M	\$176 M	\$504 M

Pricing Comparison

Below is a pricing breakdown based on the actual costs from the Sweeney Water Treatment Case Study.

Assumed Growth (Plant Size)		15.00	18.75	23.44	29.30	36.62	
Filtration Options	Capital Cost	2022	2023	2024	2025	2026	Total Cost in 5 Yrs.
GAC	\$46,000,000	\$2,900,000	\$2,900,000	\$2,900,000	\$2,900,000	\$2,900,000	\$60,500,000
Reverse Osmosis	\$150,000,000	\$4,700,000	\$4,700,000	\$4,700,000	\$4,700,000	\$4,700,000	\$173,500,000
Ion Exchange	\$46,000,000	\$2,100,000	\$2,100,000	\$2,100,000	\$2,100,000	\$2,100,000	\$56,500,000
Encore Flow Solution	\$2,000,000	\$1,129,896	\$1,412,370	\$1,765,463	\$2,206,828	\$2,758,535	\$9,273,092

Rough estimate based on public and private numbers and assumptions.



STEP 2 + 3: INNOVATIVE SLUDGE DRYING

About Encore Sludge

Encore Sludge is a High-Tech Enterprise devoted to dehumidification heat pump sludge drying.

This new line of dehumidification heat pump sludge dryers are the most advance sludge drying machines in the world.

Encore Sludge has broken through the difficulties and the high costs associated with traditional gas drying equipment by implementation of a fin-type regenerative cycle with advance slitting, combined with double and triple effect heat pump cycling which dramatically lowers the cost of sludge drying by reusing the heat that would normally be discarded in a traditional sludge drying system.

This high-tech drying system has a small footprint, effectively treats many different kinds of sludge, requires no odor control equipment and doesn't require an fossil fuel emissions permit.



STEP 2 + 3: INNOVATIVE SLUDGE DRYING

Encore Sludge PFAS Treatment System

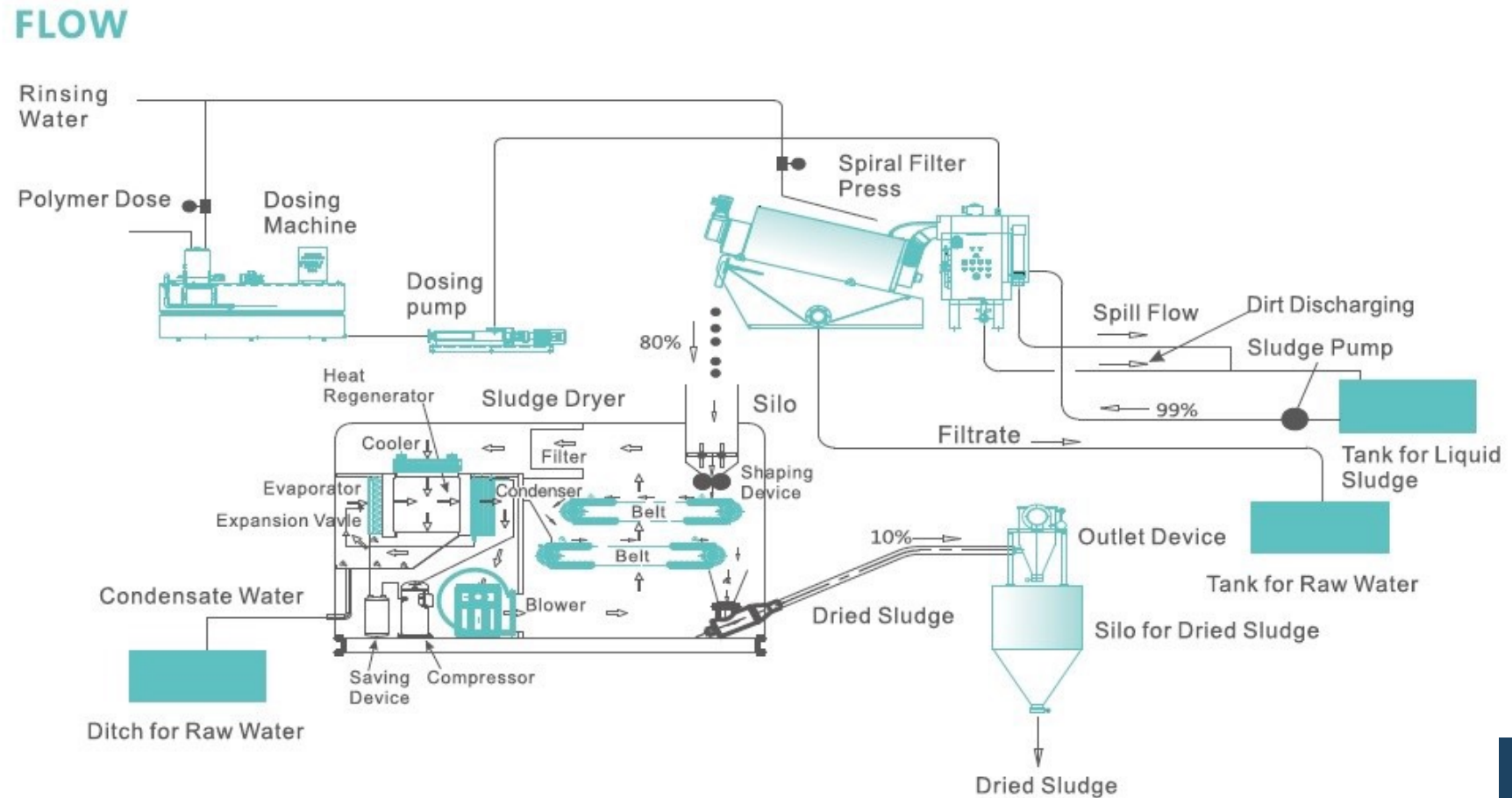
Project Entity	Anyone
Project Description	PFAS Drying Plant
Project System	PFAS In-situ treatment/sludge dewater/drying.
System Sludge Inlet	500,000 Gallons a day at 2% solids (40 Dried Tons)
System Outlet Sludge	Approximately 40 Tons of dried solids per 24-hour day.
Project Designer	Encore Sludge



HOW IT WORKS

Total Sludge Drying System Overview

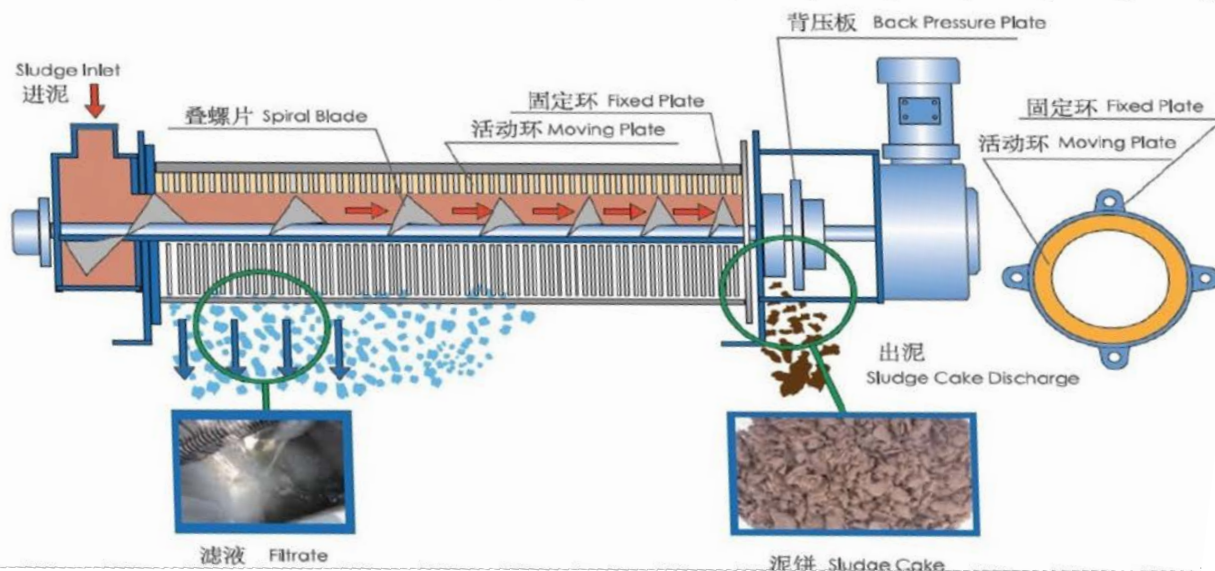
The total sludge treatment system consists of two integrated modules that receive inlet sludge from the current sludge processing stream at 1.0 – 5.0 % solids. The treatment system then dewateres and dries the sludge up to 90% solids in a slow moving all-in-one process creating a burnable solid. The system uses a heat pump, powered by electricity, to dry the sludge from 20% solids up to 90% solids.



Dewatering Overview

The Spiral Filter Press mounts on top of the Dehumidification unit and accepts sludge with solids as low as 1% and as high as 5%. This slow moving system delivers cake at a consistent 20% solids to the dehumidification unit without the need for adjustment with the filtrate water being sent back to the plant for treatment.

This unit can operate 24 hours a day.



Dewatering Overview

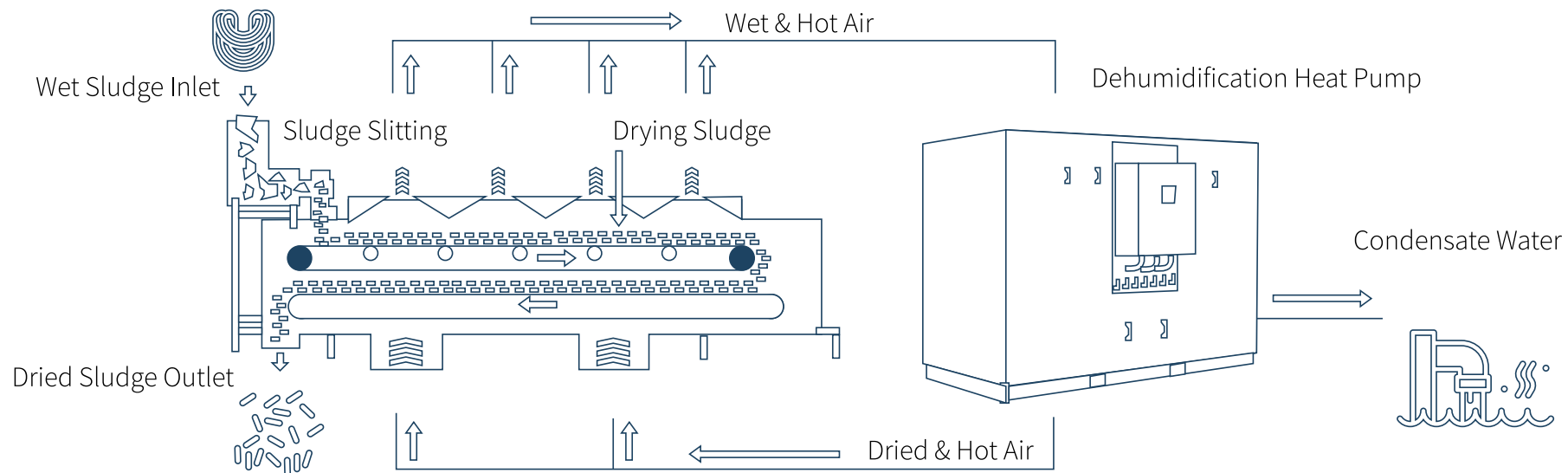
Below is a schematic of the Encore Sludge Dryer. The dehumidification heat pump dries the wet sludge to dried Class A Fertilizer. The hot air and the condensate water are captured within the system.

There are no odor issues when using this closed cabinet drying system. The heat transferred from the compressor and fan motor is dissipated using a fan coil unit. The condensate water is captured and can be reused or recycled to the headworks of the treatment facility.

The dehumidification heat pump used in the proposed Encore Sludge dryer utilizes the refrigeration principal to cool and dehumidify hot wet air. Through the heat pump principal, the heat pump recycles the latent heat released from steam congealing to water

liquid. A dehumidification heat pump is equal to the dehumidification process (moisture removal or moisture dehumidifying) plus a heat pump process (energy recycling). A dehumidification heat pump can internally collect all the latent heat and sensible heat during air exhaust, bringing no waste heat to the outside.

The evaporation of sludge moisture absorbs latent heat; and the condensation of the generated vapor on the heat pump cycle releases latent heat. The evaporation process absorbs the same quantity of latent heat that the condensation process produces, according to the laws of thermodynamics and the law of conservation of energy. As a result, the drying process does not require additional heat capacity, resulting in the reduction of energy costs. The energy consumed during the process is only the electricity needed to operate the compressors and the air handlers.





[WATCH OUR VIDEO](#)

<https://encoreearth.com/sludge-drying/>

STEP 4: DESTRUCTION

Plasma Destruction

Our Partner, Integrated Energy provides its expertise in developing projects utilizing Waste Conversion Technologies with a primary focus on Pyrolytic Conversion systems. The company provides services in every aspect of project development and operations of “Waste Conversion” technologies, to include, but not limited to, Feasibility and Technology Evaluation, Commercial System Design Engineering, Project Engineering, Project Pre-Development, Project Management, Procurement and Operations.

- ✓ Reduces Greenhouse Gas Emissions
- ✓ Reduces Dependence on Fossil Fuels
- ✓ Provides Clean, Renewable Energy
- ✓ Provides Reliable Power (24/7 Operations)
- ✓ Compliments Recycling Ops and Reduces Landfilling
- ✓ Pyrolytic Converter Handles Multiple Types of Waste
- ✓ Permitted in Southern California



STEP 4: DESTRUCTION

Benefits



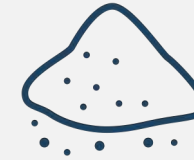
EASY TO INCORPORATE

The technology can easily be incorporated into an integrated municipal solid waste management program or wastewater treatment plant that is focused on a “zero waste” initiatives, and promotes programs that include aggressive recycling and material recovery.



REDUCE WASTE BY 90%

The Waste Conversion technology can reduce the volume of waste and can divert up to 90% of the waste that enters the facility, and potentially utilizing the carbon char residue as a By-Product allowing it to be diverted from a landfill. The Carbon Char can safely be disposed in a landfill or be mixed into building materials, road base.



NON-TOXIC CHAR

The Carbon Char residue has been tested on multiple waste streams and was found to be non-hazardous. Not only does this allow for the Carbon Char to be used in materials, it can be used as a fuel in cement kilns and also be classified as Alternate Daily Cover (ADC) for landfills where it can capture odors and additional GHG emissions

OUR CAPABILITIES

Many Kinds of Waste

Our integrated system works with all different kinds of waste.

- ✓ Municipal Solid Waste Municipal Solid Waste (MSW)
- ✓ Medical Waste
- ✓ Industrial and Commercial Waste
- ✓ Hazardous Waste
- ✓ Agricultural Waste/Animal Waste
- ✓ Electronic Waste
- ✓ Tires
- ✓ Sewage Sludge/Biosolids
- ✓ Biomass
- ✓ Construction and Demolition Waste





[WATCH INTEGRATED ENERGY VIDEO](#)

https://youtu.be/yPoE_LSu0zg

Facts

In Feed Conveying System

The in-feed conveying system will be designed specifically to handle the solid wastes that will be processed at the proposed facility.

Electricity and Biochar

Our system produces electricity and Waste Heat as well as carbon char residue, which has the potential as a product that can improve water quality, increase soil fertility, raise agricultural productivity and reduce pressure on old-growth forests with some additional additives.

No Toxic Gases Emitted

The typical Pyrolytic process will operate under negative pressure to ensure no egress of noxious gases. The air locks prevent excess air from entering the system to prevent combustion of the waste which prevents Dioxins and Furans from forming as well as reducing Greenhouse Gas Emissions.



THE PROCESS

How It Works

The process can be designed to produce energy through a steam turbine generator or gas turbine depending on the waste stream and project requirements



1 The waste is delivered by a conveyor for processing in the Thermal Converter to be processed into syngas.



2 Thermal Oxidizer (TO) will combust the syngas which will reduce VOCs by 99.9% and produce waste heat.



3 The Waste Heat Boiler will convert the Waste Heat exhausted from the TO creating Steam for power.



4 The Steam will be used to generate renewable energy from the steam from the boiler.



5 BACT Pollution Control is an important part of the process mitigating GHG emissions and ensuring that the system meets all EPA / AQMD regulations.



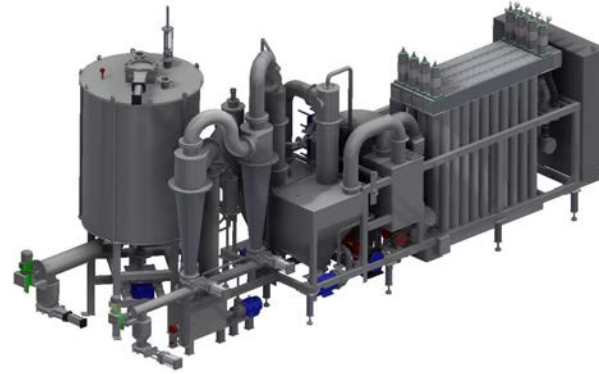
Integrated Energy Pyrolytic Waste Conversion Plant



THE PROCESS

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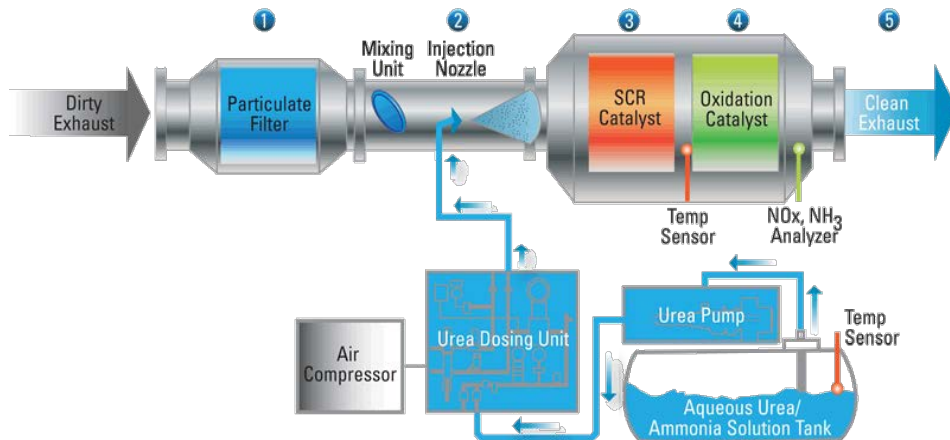


1 The waste is delivered by a conveyor for processing in the Thermal Converter to be processed into syngas and discharging a carbon char residue that is only a small percent of processed waste

2 The syngas moves through cyclones and gas cooling system that will remove particulate and reduce the temperature of the gas before it is compressed

3 The cooled syngas will enter the gas compressor and that include the blower will send the gas to the turbine.

4 After the gas has been compressed it proceeds to the Gas Turbine where it combusts the gas to generate power

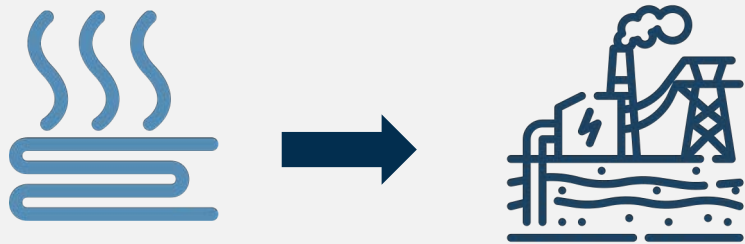


5 BACT Pollution Control is an important part of the process mitigating GHG emissions and ensuring that the system meets all EPA / AQMD regulations. A SCR will be used in conjunction with an Oxidation Catalyst to ensure environmental compliance.

STEP 5: REUSABLE WASTE HEAT

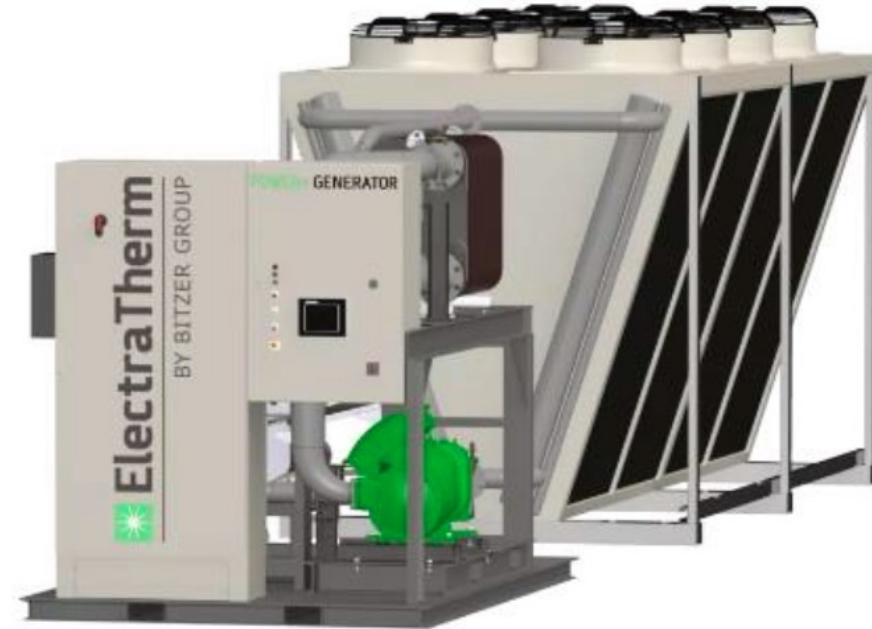
Heat Generated from Baking Process is Reusable

After baking the sludge in our system, the waste heat from the process is reusable. This energy converter uses ORC Technology to generate electricity from waste heat to create a completely closed-loop system.



Energy Returned to the Plant

The energy from our heating process can be returned to the plant.



SYSTEM PACKAGE

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