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.

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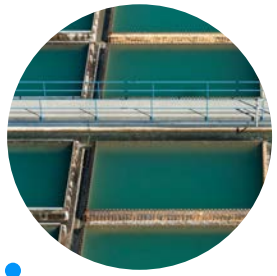
The Encore Flow Process

Our proprietary process is customized based on the amount of sludge that must be destroyed. We work with each plant to solve their unique needs, with the ultimate goal of remediating PFAS compounds in a carbon neutral way.

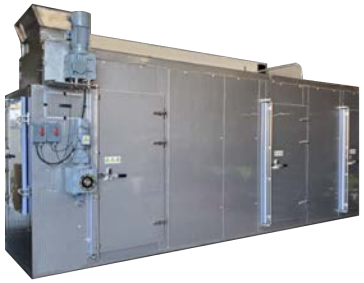


Mineral Nanoparticles

We use our customized all-natural nanoparticle filtration to attack the PFAS compounds from the water into the sludge for removal.

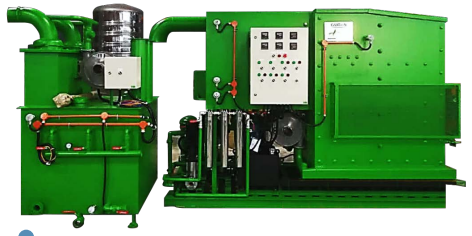
Dewater Sludge/Biosolids

Remaining wastewater sludge that holds the PFAS compounds are dewatered with our system or the current WWTP's system.



Dry Sludge/Biosolids

Encore Flow's unique closed-loop drying system dries the dewatered sludge down to 90% solids. The captured water from the drying process is used in the plasma generator.



Heated & Eliminated

Our EPA approved plasma generator system heats over 1000° C to eliminate PFAS compounds while remaining energy efficient and carbon negative.

Energy Converter

We add an optional energy converter that uses ORC Technology to generate electricity from waste heat to create a completely closed-loop system.

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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.

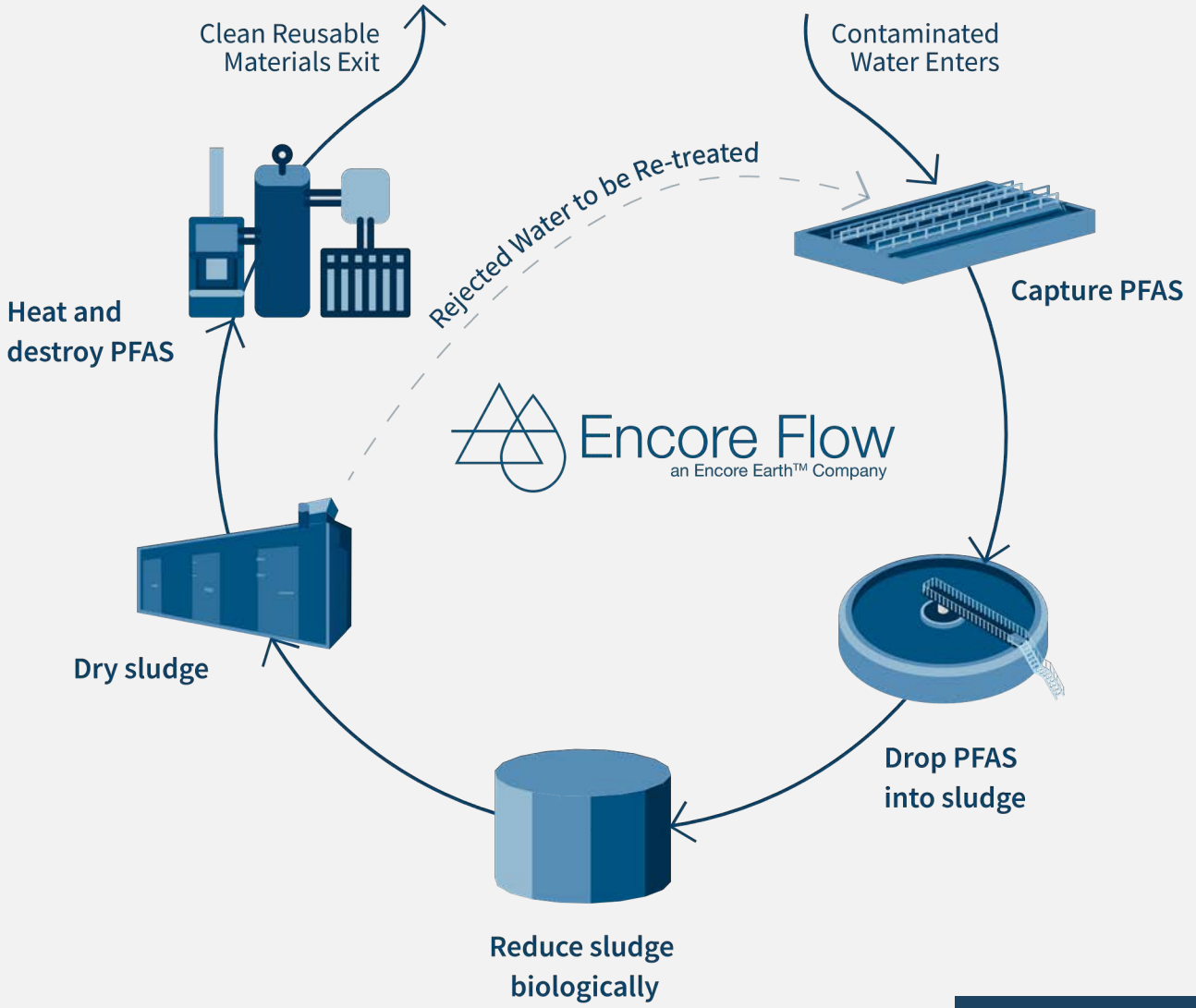
4/16/2021 - Patent Filing

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

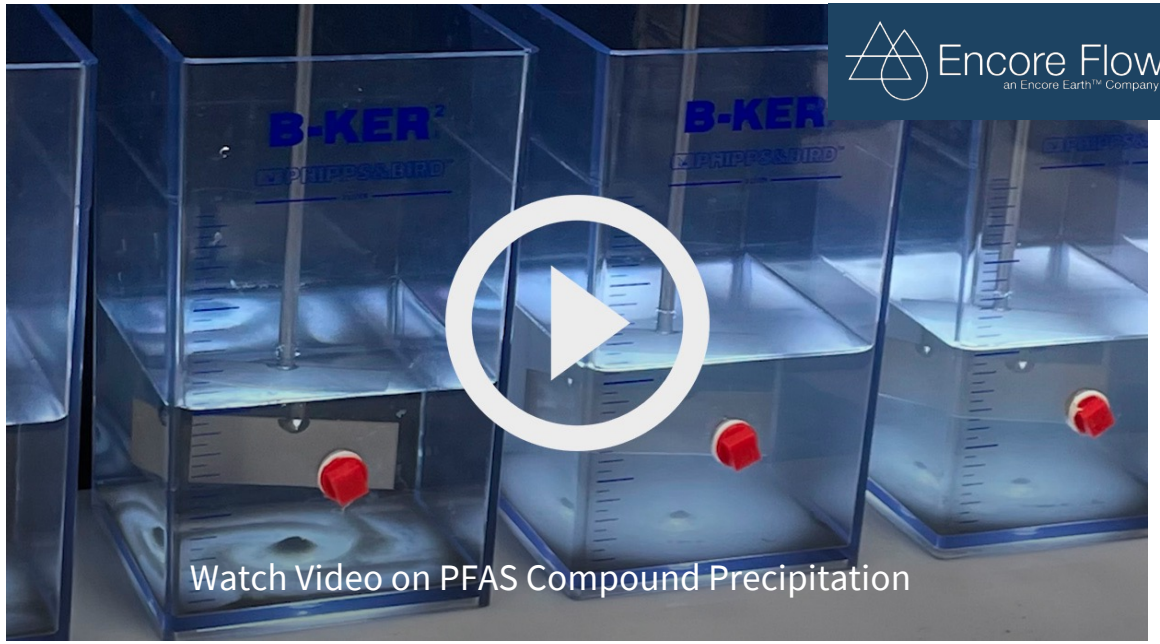


STEP 1: PRECIPITATE

Precipitate or Drop PFAS out of the water or wastewater stream

Our PFAS compound 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



STEP 1: PRECIPITATE

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+.

STEP 1: PRECIPITATE

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.

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RECENT PROPRIETARY REMEDIATION RESULTS

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%

Reference will be provided upon request.

90%

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

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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

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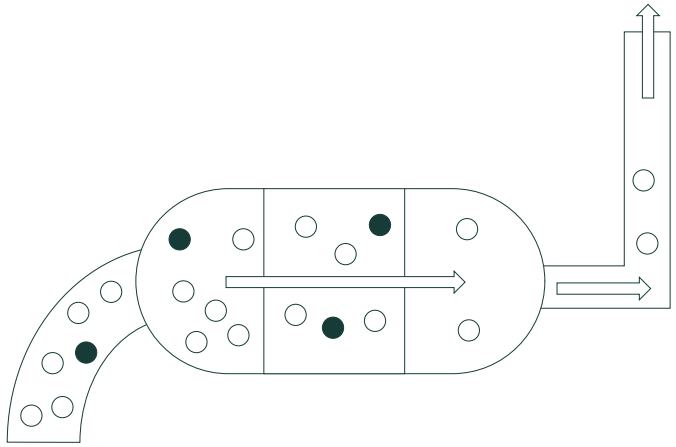
SWEENEY WATER TREATMENT PROCESS

Current Filtration Choices

Like all other treatment plants who are setting up filtration systems for PFAS, Sweeney had three choices: Granular Activated Carbon (GAC) contractors, 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

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

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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.

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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	Up to 40 Tons of dried solids per 24-hour day.
Project Designer	Encore Sludge

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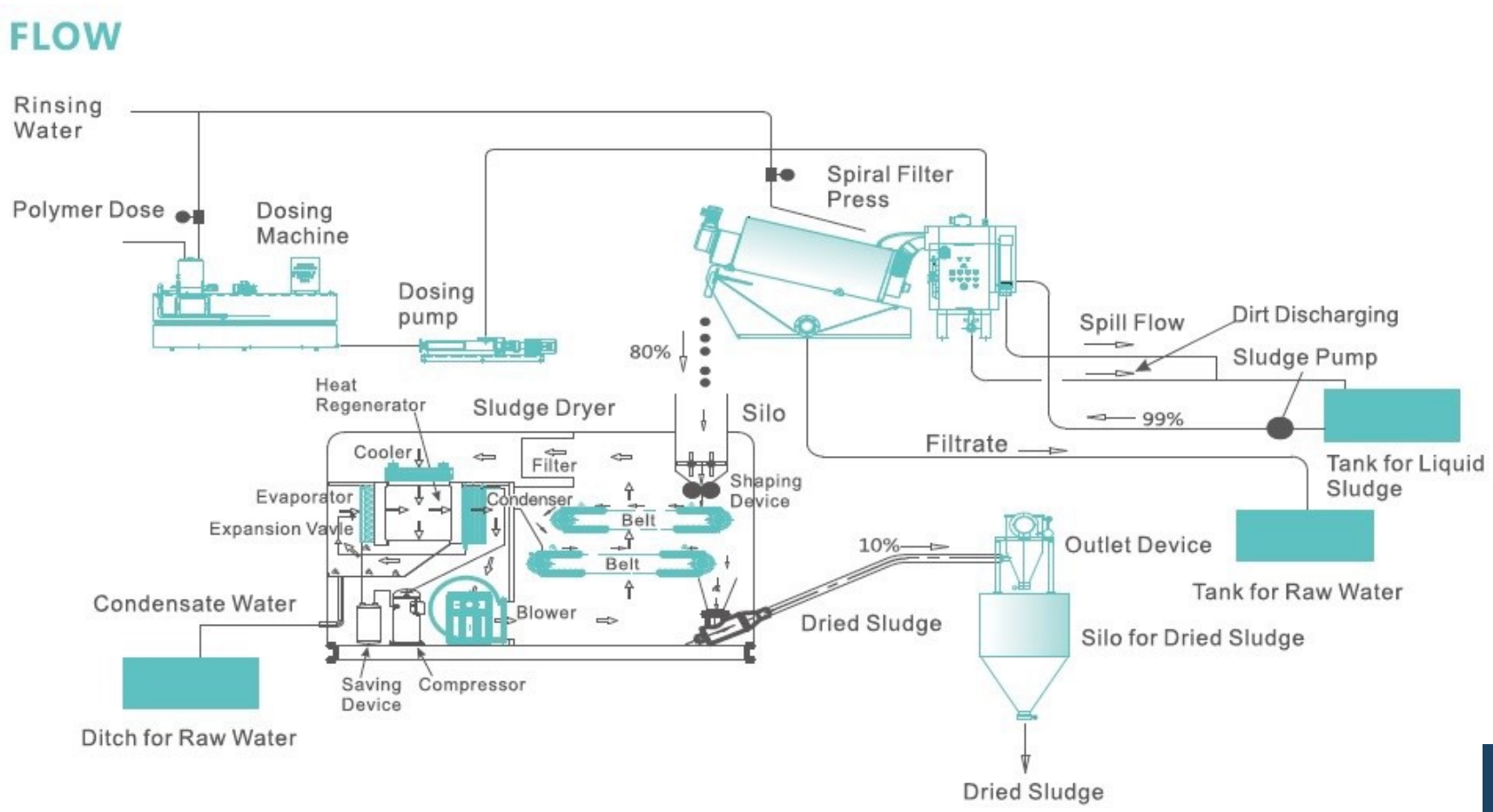
HOW IT WORKS

Total Sludge Drying System Overview

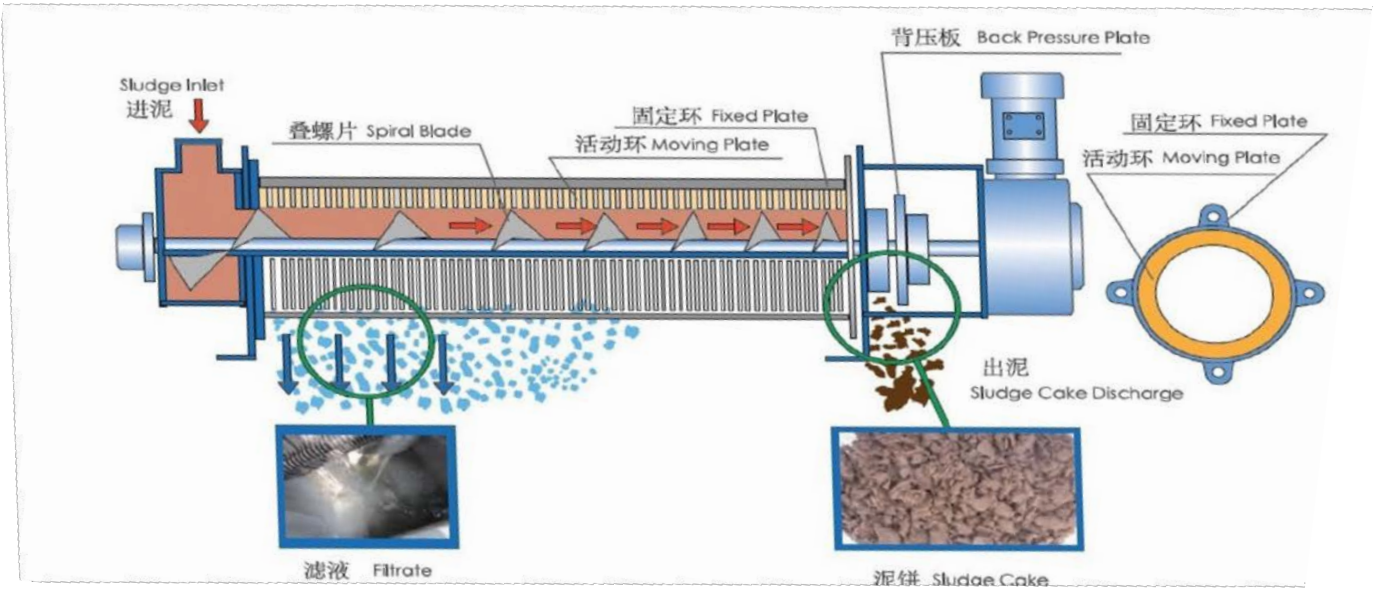
The total sludge treatment system consists of two integrated modules that receive inlet sludge from the current sludge processing stream at 1.0 – 5.0 % solids. The treatment system then dewaters and dries the sludge up to 90% solids in a slow moving all-in-one process creating a burnable solid. The system 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.



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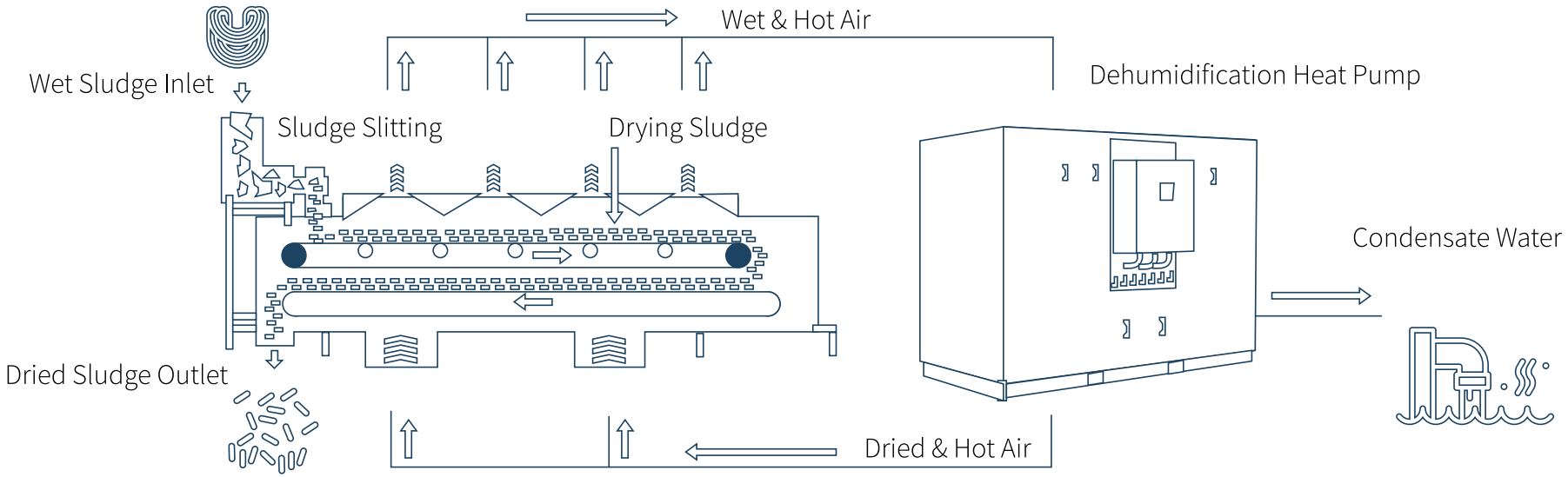
Drying System Overview

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.



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WATCH OUR VIDEO

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

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STEP 4: DESTRUCTION

Bake & Destroy PFAS

Our plasma generated utilizes a plasma magnetic field that decomposes and bakes waste at up to 1000 degree Celsius under a pyrolysis process that meets compliance standards, eliminates smoke and harmful gasses from being discharged.

Self-Sustainable

Our unit requires no external energy, electricity, diesel or gas, even for 24/7 operations. Our machine uses integrated solar panels to operate even under low sunlight.

Eco-Friendly/EPA Accepted

Our unit passes all tests and standards required by the EPA. It has been tested for the suppression of dioxin and furan and has passed.

Cost-Efficient

The CAPEX for our unit is roughly 20% of a conventional incinerator, with a similar capacity. The long lifespan of the unit results in a high ROI.

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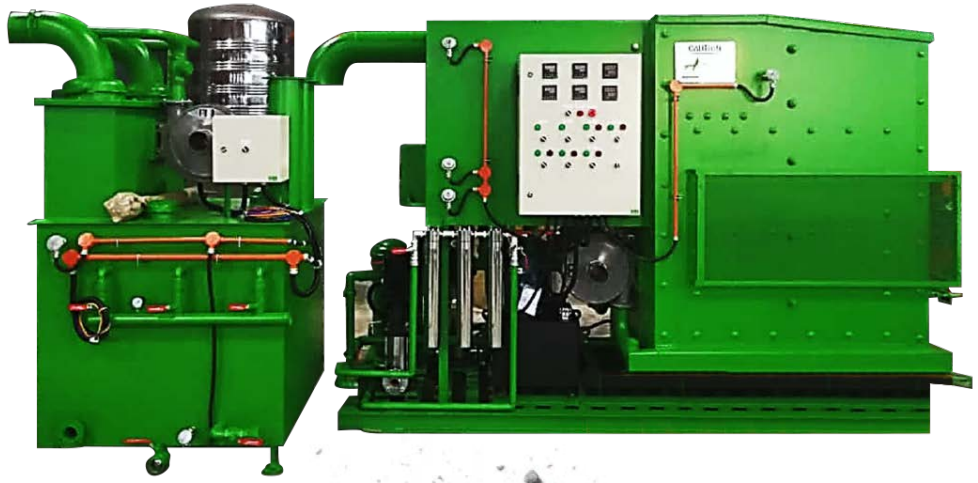
STEP 4: DESTRUCTION

High temperature plasma gas destruction system

- ✓ Our Gasification system is simply the most cost-effective way of destroying the PFAS/PFOS compounds in bio-solids.
- ✓ Utilization of *plasma magnetic field to create activated negative-ion that leads to decomposition of inorganic and organic materials through the process of **pyrolysis.
- ✓ *Plasma: Hot ionized gas consisting approximately equal numbers of positive ions and negative electrons.
- ✓ **Pyrolysis: A thermal degradation of substance in the absence of oxygen at high temperature up to 1600 degree Celsius. This breakthrough innovation has enabled continuous self-combustion process without the need of external energy sources (diesel, fuel, electricity).



5 wet tons or 1 ton of dried solids converts to 80 lbs. of ash that can be safely used as fertilizer when mixed with dried green waste or sawdust.

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HOW IT WORKS

Plasma Gas Design

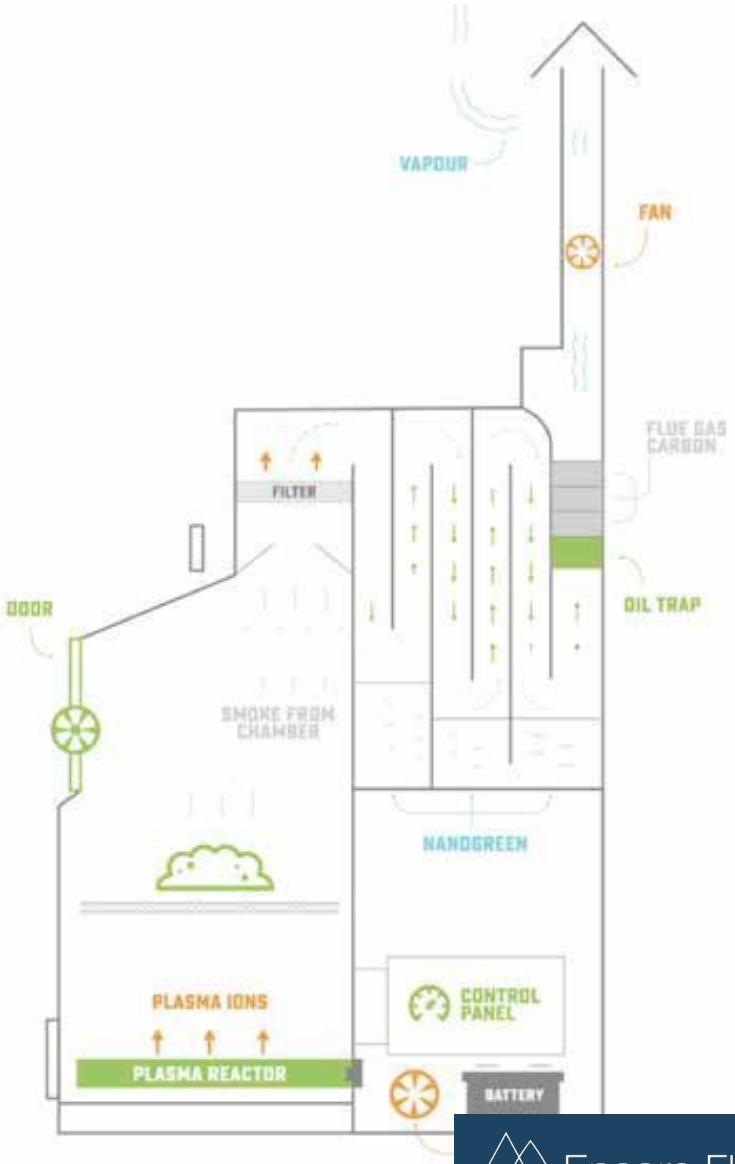
The sludger can handle all types of wastes including Municipal Solid Waste, biosolids, tires, plastics, carboard and green waste. (We cannot treat, glass, metal and concrete.)

The build structure of the Sludger is guaranteed to last not less than 10 years when it is operated, managed and maintained in accordance to the manufacturer's established protocol.

The outer structure is made of 6mm mild steel with a 100mm refractory of concrete which is designed to withstand temperature up to 1650 °Celsius. There are 4 pieces of 10mm 310L stainless steel after the installation of the refractory in the thermal degradation chamber which is designed typically high and elevated temperature operation to as high as 1200 °Celsius.

The Sludger can function and operate normally even under heavy rain, strong wind, high altitude or cold weather. The sludger can easily be operated with one person per shift and requires very simple training supervisions for operations and maintenance.

Maintenance and operation protocols are documented and can be easily mastered. Installation and commissioning at sites will take only 4-6 hours per unit. Maintenance cycles are weekly and quarterly.



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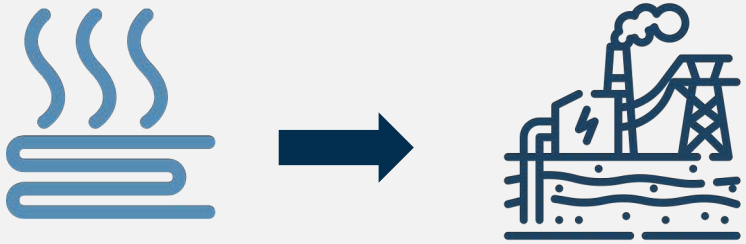
STEP 5: REUSABLE WASTE HEAT

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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