Sewage and Wastewater Sludge-to-Power

by Applied Plasma Technologies, Corp. USA
29th September 2024

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Introduction

Applied Plasma Technologies (APT) is a leader in developing advanced gasification technologies aimed at sustainable waste management and energy production.

Under the visionary leadership of Dr. Igor Matveev, our team, including experts like Professors Serhiy Serbin, Nikolay Washchilenko and Tamara Shevchenko, is dedicated to pioneering innovative solutions.

Objectives of the project

Waste into renewable energy

Shift from power-consuming to power-generating, we convert sewage into valuable resources like fuel, hydrogen, electricity, heat, and distilled water

Our aim

Produce a safe, disposable effluent that causes no harm to the environment, while effectively preventing pollution and protecting ecosystems

The goal

Create an innovative, scalable platform that transforms slow biological wastewater treatment into a fast, efficient, eco-friendly plasma process

Resources (US sample)

234M tones*

of sewage treated daily in US
60% of all produced sewage

2.3M tones

of biosolids with calorific value 12 MJ/kg

5,000 GWxh

daily if converted into electricity

1.5 million people

could be powered by the electricity generated

*ASCE's Infrastructure Report Card

Mission to Innovate

Innovation

Introduce a groundbreaking plasma gasification approach to sewage sludge treatment for the global market

Transition

Shift sewage treatment from being an energy consumer to an energy producer

Sustainability

Promote sustainable and eco-friendly energy production, reducing the carbon footprint and reliance on traditional fossil fuels

Renewables

Utilize high-moisture sewage sludge as a renewable feedstock for plasma gasification, leading to high-yield hydrogen syngas production

Efficiency

Harness syngas for the efficient production of electricity, hydrogen (H_2) heat, and distilled water, transforming waste into valuable resources

Safety

Elevate environmental safety standards with cutting-edge technology

Conventional Sewage Treatment

Anaerobic digestion of sludge (methanation tanks) → **Sludge conditioning** (introduction of flocculants/coagulants, application of oxidizers) → **Sludge dewatering** (centrifuges, dehydrators, filter presses) → **Thermal treatment** of sludge (thermal drying, incineration) → **Sludge utilization** (fertilizer, land reclamation, as an additive in construction materials)

Anaerobic digestion:

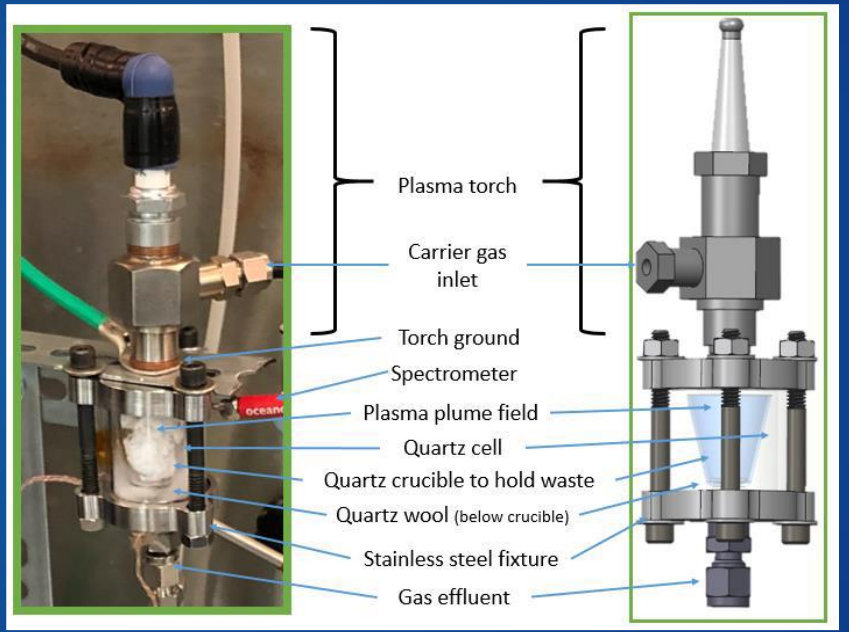
- digestion process takes 24-28 days
- Bulk structures: both the methanation tanks themselves and gas holders (structures for accumulating the produced biogas)
- Methanation tanks have a high level of explosiveness
- The obtained digestate (digested sludge) is NOT SAFE in terms of microbiology.
- The volume of sludge does not decrease

Plasma gasification

Space Technologies on Earth

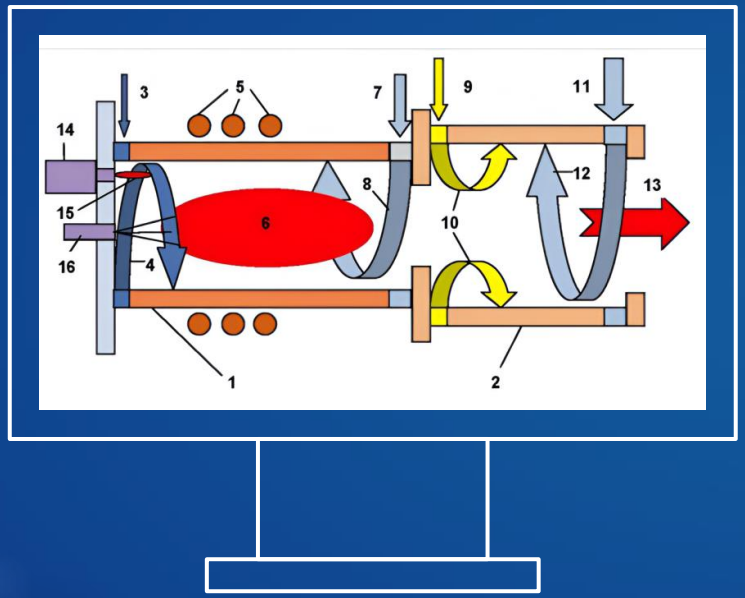
In 2019 Applied Plasma Technologies, Corp. (APT) developed a DC plasma torch system for NASA's Science Technology Mission Directorate at Kennedy Space Center. This system was designed to convert solid and liquid mission waste into gas, helping reduce waste volume on long-duration space missions.

The torch operates with 120 VAC input voltage, generating a 400 W plasma pilot arc with air as the carrier gas. APT demonstrated its effectiveness in processing various materials, including hygiene products, astronaut clothing, plastics, food packaging, paper, fecal waste simulants, and plant matter. This technology is key for waste management on space vehicles and habitats



https://techport.nasa.gov/view/94177

New Technology Overview



1. **Input:** Primary sludge with high moisture content + any liquid industrial waste with high organic content (e.g. food waste, farm waste)
2. **Plasma Gasification:** Conversion of sludge into high calorific value syngas, water steam and hydrogen (H_2)
3. CO_2 sequestration by using it as plasma gas
4. **Electricity Generation:** a syngas burning gas turbine drives electrical generator
5. **Steam Production:** Residual heat produces steam for additional power
6. **Distilled water production**
7. **Ash:** heat treated solids


You don’t
need this!

Plasma-powered treatment process

~~**Anaerobic digestion** of sludge (methanation tanks)~~

Sludge conditioning (introduction of flocculants/coagulants, application of oxidizers)

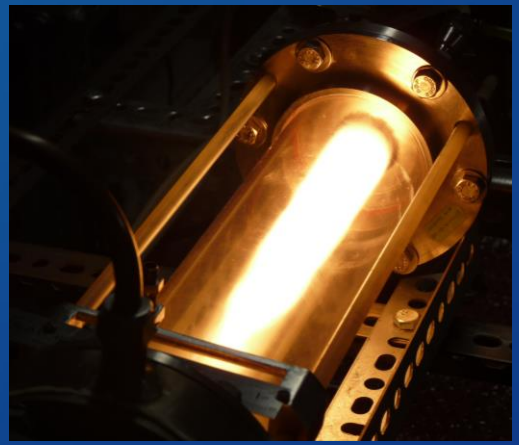
Sludge dewatering (centrifuges, dehydrators, filter presses)

Feeding sludge into a plasma gasifier and producing syngas

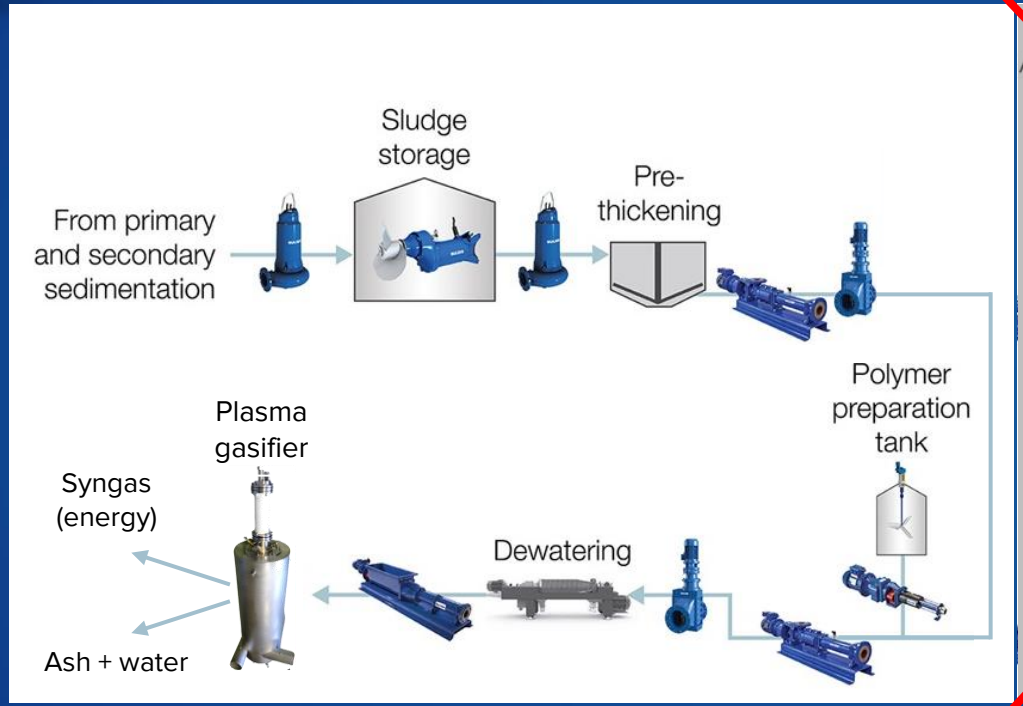
Sludge utilization (fertilizer, land reclamation, as an additive in construction materials)

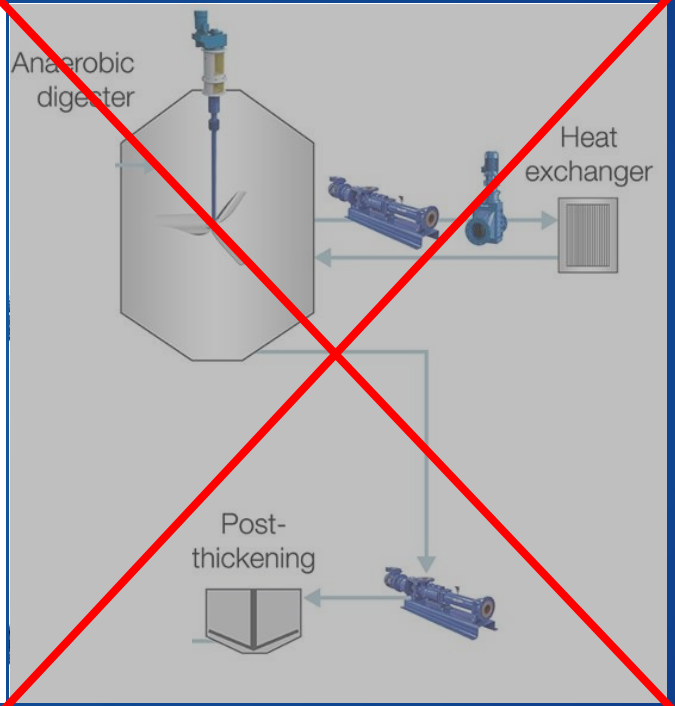
Plasma gasifier:

- The process of syngas production takes less than 1 second
- Compact gasification unit
- Electricity generation based on the produced syngas
- The obtained ash is **MICROBIOLOGICALLY SAFE**
- Reduction of ash volume by 95-100 times



Much easier and shorter cycle





Advantages

Innovation

Plasma gasification replaces biological methods – a new physical principle for sludge treatment

Speed

Ultra-fast processing – over 10,000,000 times faster than traditional methods

Efficiency

Elimination of anaerobic digestors and methane tanks replaces biological digestion with plasma-based treatment

Simplification

Final product volume reduction by ≥ 100 times and plant footprint reduction by 25-30%

Inertness

Chemically inert output no extra thermal treatment needed - delivering sludge safe for people and environmentally friendly

Safety

All heavy metals, medications, antibiotics, and other contaminants are chemically neutralized in the plasma process, making them inert and safe for repurposing, including use as fertilizers

Comparison with Traditional Waste Management Methods

Criteria	Plasma-Assisted	Landfilling	Incineration	Anaerobic Digestion
Efficiency	High	Low	Moderate	Moderate
Environmental Impact	Low (reduced emissions)	High (methane, etc.)	Moderate to High	Low to Moderate
Flexibility	High	Limited	Limited	Limited
Energy Production	High	None	Moderate	Moderate
Footprint	Compact	Large	Large	Moderate

Savings on Digesters

Size	Smaller plants	Medium-sized plants	Large plants
Capacity	serving <100,000 people	100,000 to 500,000 people	serving >500,000 people
Flow	15,000 m^3/day	75,000 m^3/day	150,000 m^3/day
CAPEX*	$10-20M	$50-80M	$100-200M
OPEX**	$300,000 - $1M annually	$1.5-3M annually	$5-10M annually

* generally covers the complete anaerobic digestion system, including the methane/biogas tanks and other necessary infrastructure
** rough estimate of the OPEX, including labor, energy, maintenance, chemical inputs, sludge handling and disposal

Scalability and Key Stages

Stage 1: Pre-feasibility study

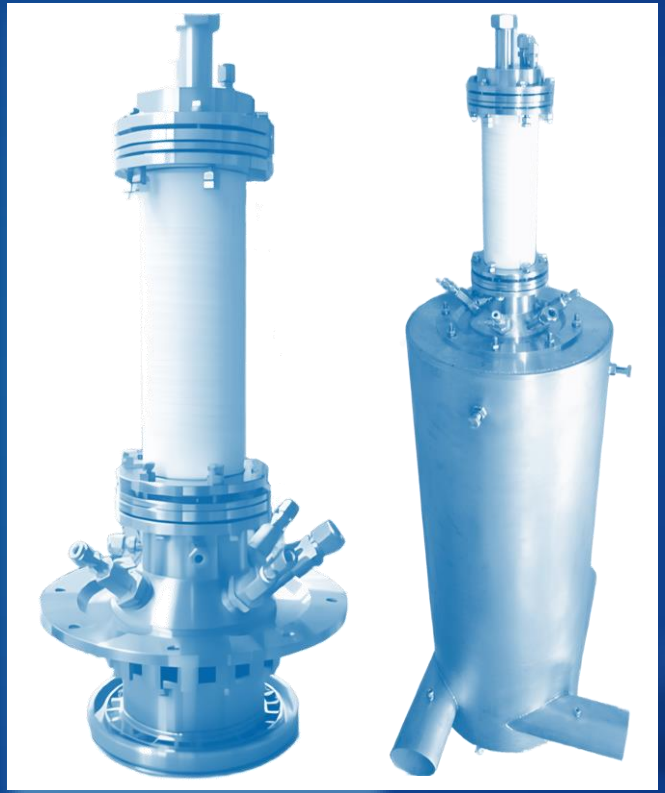
- timing 8-9 month

Stage 2: Pilot project

- timing 2-3 years
- space 100-150m2
- capacity - TBD

Stage 3: Scaling-up

- construction and engineering - TBD



Conclusions

Innovation

Conversion of potentially any liquid bio- and industrial waste into valuable products as syngas, hydrogen (H_2), electricity and clean water

Revolution

A new paradigm in transforming waste into valuable resources. 10,000,000 times faster and more efficient than conventional technologies

Efficiency

Delivering superior performance with optimized energy and operational efficiency

Environment

Dramatic reductions in waste and emissions, contributing to a greener future

Opportunity

Integrate new types of waste into the power generation process. Unlocking new opportunities across diverse industries with massive market potential

Versatility

Capable of processing a wide range of liquids – from animal waste to used motor oils and hazardous hydrocarbons

Thank you!

Do you have any questions?

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Marshall, VA 20115, United States

Back-up slides

Resources

1. NASA TechPort - Project Data
2. Sewage Sludge-to-Power
3. Plasma-Assisted Treatment of Sewage Sludge
4. New Combined-Cycle Gas Turbine System for Plasma-Assisted Disposal of Sewage Sludge
5. Demonstration of Plasma Assisted Waste Conversion to Gas
6. Plasma Assisted Trash Conversion with CO2 Carrier Gas - NASA Technical Reports Server (NTRS)
7. Utilizing a CO 2 Carrier Gas in a Plasma Assisted Waste Conversion Test Cell for Space Applications
8. Plasma Combustion, Gasification and Pollution Control. Volume 1. Methods of Plasma Generation for PAC
9. Plasma Assisted Combustion, Gasification and Pollution Control. Volume 2. Combustion and Gasification

Our Company

Applied Plasma Technologies (APT) is an American R&D corporate located in Washington, D.C. area, operating own lab and testing facilities of over 10,000 sq ft.

was founded in 2003 based on the intellectual property of Dr. Igor Matveev, a world-renowned specialist with over 40 years of experience in plasma-assisted technologies R&D, and innovative product manufacturing.

Our experts in plasma sewage treatment

Dr. I. Matveev

42+ years of R&D
+ practical
experience

Prof. N. Washchilenko

50+ years in
sewage treatment
R&D, modelling

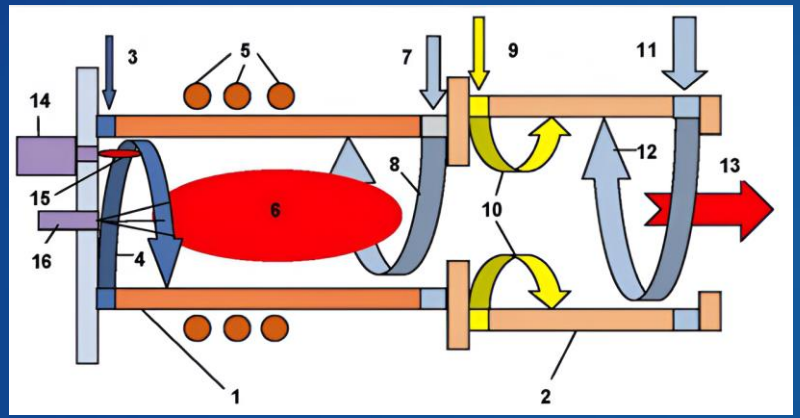
Prof. T. Shevchenko

20+ years in
sewage treatment
R&D, modelling

Prof. S. Serbin

40+ years in
R&D, modelling
and lecturing

Inside the Technology



Plasma-based gasifier for liquid and solid feedstock.
US Patents 7,452,513 B2, 8,252,243 B2

1 – plasma generation module
2, 3, 4 – stages of the combustion/ partial gasification module
5 – starting torch
6 – starting torch plume
7 – starting gas
8 – starting gas vortex
9 – inductor
10 – plasmoid
11 – main plasma gas (air, oxygen, blends)
12 – main gas reverse vortex
13 – feedstock 1 fraction 1
14 – feedstock 1 flow
15 – feedstock 2 (optionally water steam)
16 – feedstock 2 vortex

1,500+

Plasma products in operation worldwide

10W - 200kW

High-power ICP/RF plasma torch systems

+20,000 hrs

Maintenance free operation of critical parts

Some of our key customers

Certified by DARPA

Find more information about the company clients and portfolio here

Our Global Coverage

5 continents

13 countries

Universities	Corporations	Space agencies	National Labs
30	18+	7	5

Thank you!

Do you have any questions?

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