COMPARISON OF SLUDGE TREATMENT METHODS

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Comparison of Sludge Treatment Methods

Wastewater treatment facilities main purpose:

Treating wastewater generated from households, businesses and other sources.

What Federal Regulation controls the standards for wastewater treatment?

National Pollution Discharge Elimination System (NPDES).

The purpose is to treat the wastewater to reduce pollutants to certain levels when discharged to streams.

What is the most common byproduct of wastewater treatment?

Comparison of Sludge Treatment Methods

Comparison of Sludge Treatment Methods

Biosolids or Sludge

For the most part it can be used interactively.

“Biosolids” is considered sludge that is generated at a sewage treatment plant.

Other types of sludges can be industrial was sludge from manufacturing and coal processing. which can be high in toxic metals. They are not biosolids.

For all intensive purposes “sludge” will mean sludge generated at a sewage treatment facility.

Comparison of Sludge Treatment Methods

Sludge is generated in clarifiers (settling tanks) to rid of solids in wastewater.

Primary Sludge – Raw sewage

Secondary Sludge – After some wastewater treatment.

- Activated Sludge (aerobic process)
- Trickling Filters/RBC (aerobic process)

Comparison of Sludge Treatment Methods

What to do with sludge?

- Send to off site (another facility, landfill). Note that there are costs for transport/tipping fees as well as testing for acceptance by the receiving facility.
- Treat sludge onsite!

Comparison of Sludge Treatment Methods

Common processes at all facilities include sludge thickening and dewatering.

Sludge consists of 2 – 4 percent solids so thickening and watering will be needed for some processes which may vary.

Water removed will return to the head of the facility.

Comparison of Sludge Treatment Methods

Three main types of Sludge Treatment

- Aerobic Digestion (Composting)

  Composting needs a large area and will need odor control.

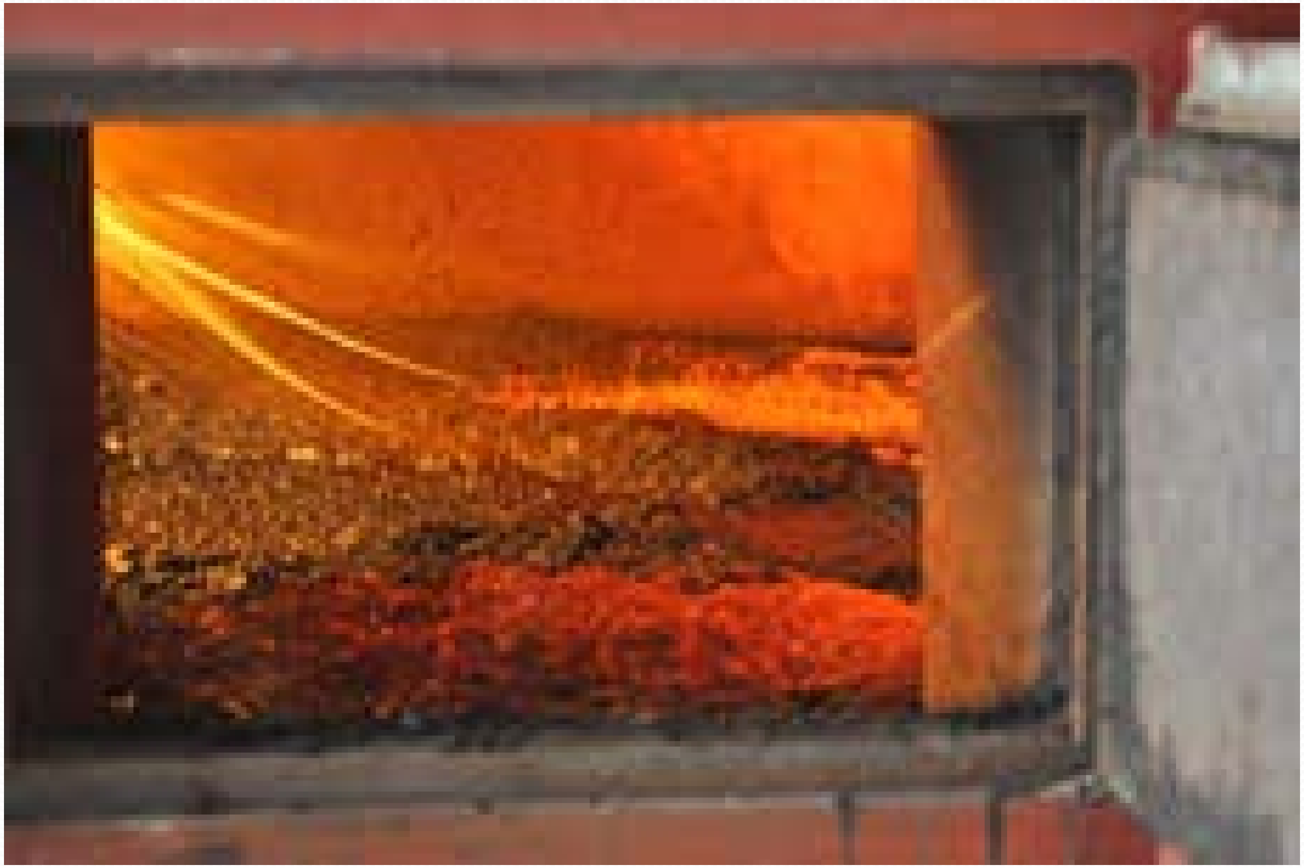
- Anaerobic Digestion

  Main byproduct is biogas (60 percent methane/40 percent carbon dioxide)

- Incineration – Combustion of Sludge

All three methods will greatly reduce sludge which will need to be removed from site. Which one of these methods will reduce sludge the most?

Sewage Sludge Incineration



Sewage Sludge Incineration

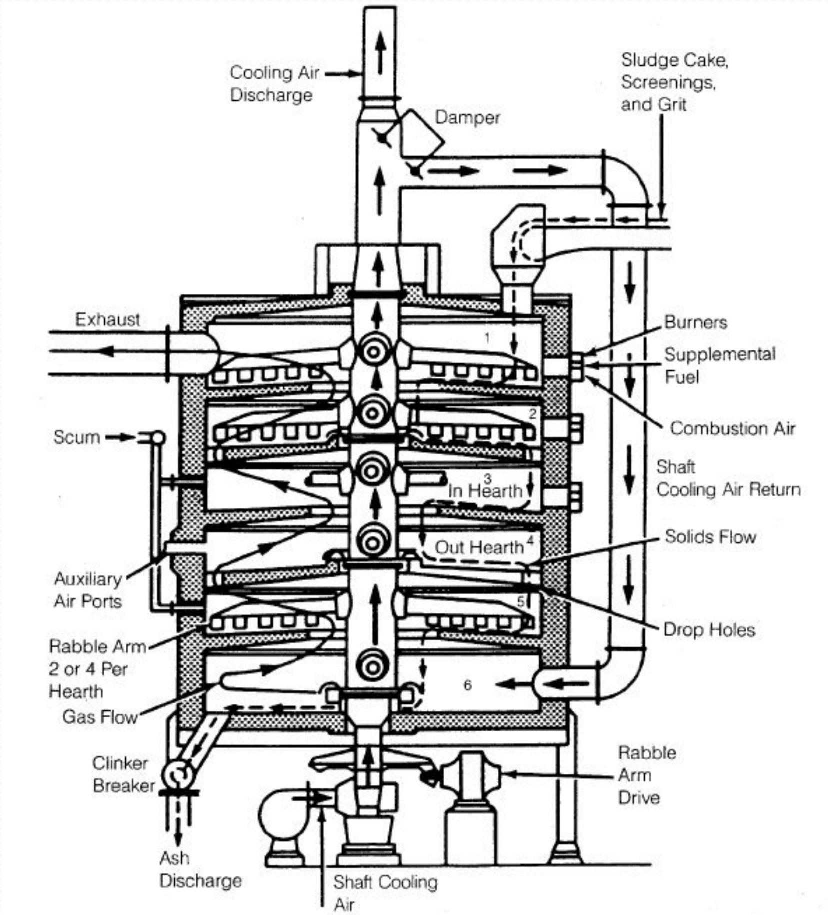
On average sewage sludge incineration reduces dry sludge by 85 percent.

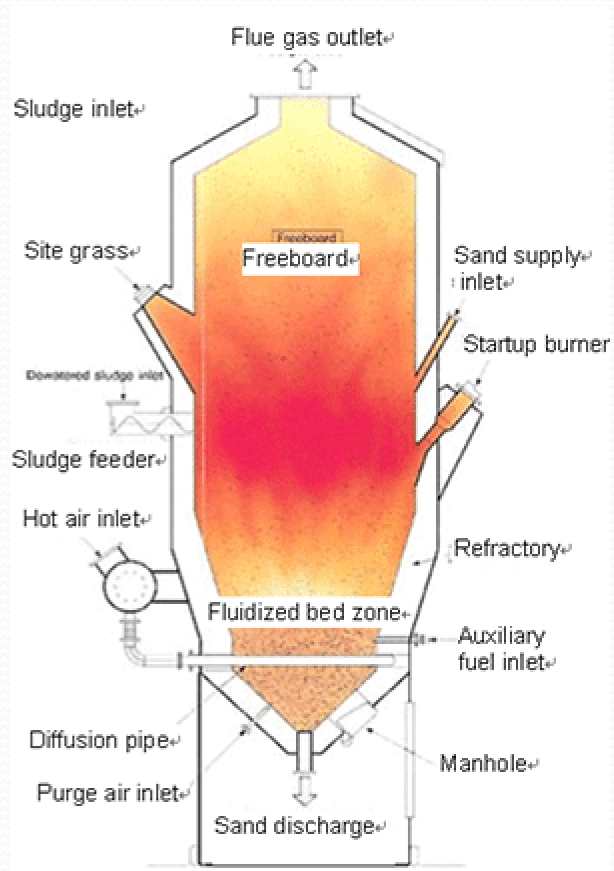
Sewage Sludge Incinerators reduce sludge to ash which and can be less costly to landfills. However, ash may need to be tested for Toxic Characteristic Leaching Procedure (TCLP) for metals and other toxic compounds.

Prior to combustion sludge also needs to be dewatered by thickening and a belt filter press to remove most of the water.

There are two main types of sludge incinerators.

Sewage Sludge Incineration



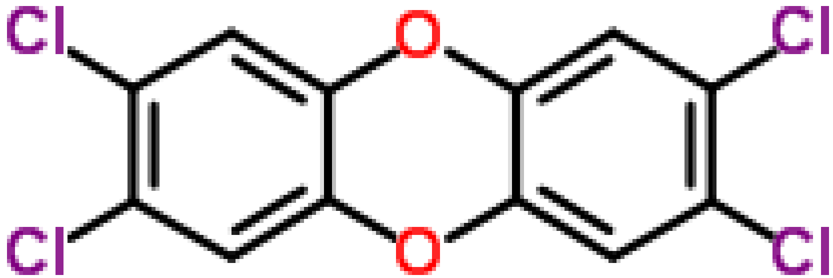


Sewage Sludge Incineration

Problems with Sludge Incineration

- Air Emissions
- High NOx content (with VOC Ozone Generation)
- High SO_2 Generation (dependent on sulfur content)
- Hydrogen Chloride Generation (dependent on chlorinated compounds content)
- High Particulates
- Greenhouse Gases (CO_2, N_2O)
- Toxic Metals (Cadmium, Chromium, Beryllium, Lead, Arsenic, and Mercury)

Sewage Sludge Incineration



Sewage Sludge Incineration

2,3,7,8 – Tetrachlorodibenzodioxin *(2,3,7,8 –TCDD)

Extremely toxic substance where this and similar compounds like dibenzofurans generate as products of incomplete combustion from chlorinated carbon compounds.

Breathable toxicity levels in nanograms per cubic meters

To reduce products of incomplete combustion like 2,3,7,8 – TCDD combustion temperature should be at minimum 1,500 degrees Fahrenheit which increases NOx generation.

Combustion temperature does not change metals and particulate emissions.

Sewage Sludge Incineration

Pollution Control Equipment needed for Sludge Incineration

- Afterburners to reduce products of incomplete combustion.
- Venturi Scrubber to remove particulates and some metals
- Tray Scrubber to remove acid gases (SO_2 and HCl) as well as particulates
- Wet Electrostatic Precipitator (WESP) to remove fine particulates and metals
- Carbon absorption to remove mercury and VOCs.

Sewage Sludge Incineration

Air permits may require monitoring of metals and chlorides in sludge continuous monitoring of CO and NOx and maintaining incinerator temperature and operating parameters of pollution control devices.

Energy and operational costs are higher than that of other types of sludge treatment with little or no renewable value.

Sewage Sludge Incineration

Federal New Source Performance Standards (NSPS) were issued specifically for Sewage Sludge Incineration.

40 CFR 60 Subpart LLLL – New incinerators and all incinerators commencing construction after October 14, 2010 and modification (to increase emissions) after September 21, 2011.

Sewage Sludge Incineration

40 CFR 60 Subpart MMMM – NSPS for Sludge Incinerators built prior to and including October 14, 2010 and have not been modified after September 21, 2011.

All sewage sludge incinerators in New Jersey are subject to it.

Sets increased pollution control standards for several pollutants.

Sewage Sludge Incineration

Subpart MMMM Emission Standards for Fluidized Beds

NO_x – 150 dry parts per million volumetric

CO – 60 dry parts per million volumetric

SO_2 – 15 dry parts per million volumetric

HCl – 0.51 dry parts per million volumetric

Particulates – 18 milligrams per dry standard cubic meter

Mercury – 0.037 milligrams per dry standard cubic meter

Lead – 0.0074 milligrams per dry standard cubic meter

Cadmium – 0.0016 milligrams per dry standard cubic meter

Dioxins/Furans 1.2 nanograms per dry standard cubic meter (total mass basis) or 0.1 nanograms per dry standard cubic meter (toxicity basis).

Sewage Sludge Incineration

Subpart MMMM Emission Standards for Multiple Hearth Incinerators

NO_x – 220 dry parts per million volumetric

CO – 3800 dry parts per million volumetric

SO_2 – 26 dry parts per million volumetric

HCl – 1.2 dry parts per million volumetric

Particulates – 80 milligrams per dry standard cubic meter

Mercury – 0.28 milligrams per dry standard cubic meter

Lead – 0.30 milligrams per dry standard cubic meter

Cadmium – 0.095 milligrams per dry standard cubic meter

Dioxins/Furans 5.0 nanograms per dry standard cubic meter (total mass basis) or 0.32 nanograms per dry standard cubic meter (toxicity basis).

Sewage Sludge Incineration

All incinerators must meet these emission limits by March 21, 2016.

A Title V Operating Permit application was to be submitted by March 21, 2014 regardless of Title V emission thresholds

Subpart LLL of 40 CFR 62 provides operating requirements for Incinerators including annual emissions testing for all parameters listed in Subpart MMMM.

Title V Comparisons

A Title V permit would require additional compliance measures including.

- Semi-annual compliance reports to DEP and EPA.
- Completion of Annual Emission Statements.
- Annual fee costs due based on annual emissions ($117.23 per ton).
- 30 day public comment period and 45 day EPA review for permit modifications.
- Permit renewal application every 5 years.
- Minor source compliance measures.

Sludge Composting

Sludge Composting

The most common form of Aerobic Digestion of sludge is composting.

This is a batch process where dewatered sludge is set up on pile rolls and mixed in with wood chips.

The sludge is constantly turned and watered to prevent the piles from going anaerobic which cause odor problems.

Major emission from composting is carbon dioxide (CO_2).

Can reduce sludge up to 56 percent.

Sludge Composting

Large Ground Area is needed for composting.

Other possible emissions include SO_2 depends on sulfur content.

Particulates may be emitted from aggregate storage piles.

Biggest concern is odors if the compost piles are not treated properly.

No pollution control needed.

Anaerobic Digestion

Egg Shaped Digesters

Anaerobic Digestion

Anaerobic Digestion is a sludge treatment that reduces the amount of sludge in conditions without air. The anaerobic bacteria in sludge consumes the sludge and converts to carbon dioxide and methane. It is a similar process to fermentation.

The biogas which averages 60 percent methane and 40 percent carbon dioxide would need to be burned off using a flare. But it can also be used a fuel for other combustion sources.

Several facilities in New Jersey have installed Combined Heat and Power units to generate heat and electricity for use within the facilities.

Anaerobic Digestion

Anaerobic Digestion with the biogas burned in a flare or other combustion unit will have overall reduced pollutants including reduced NOx and CO and reduced greenhouse gas generation as compared with Incinerator combustion at the same process rate.

Also there are no metals and less sulfur, chloride, dioxins and furans emissions due to most of these substances remaining in the digested sludge and dioxin and furans will not generate.

Sulfur compounds and siloxanes (silicon compounds) are in the biogas and will need to be treated prior to combustion in engines.

Anaerobic Digestion

Anaerobic Digestion needs to operate at a specific temperature (around 80 degrees F) for optimal performance.

Flare is needed as a pressure relief valve due to biogas generation.

The biogas generated is a commodity that can be used in lieu of natural gas for combustion in boilers and engines (i.e. cogeneration units) and can save money from generated heat and electricity as opposed to purchasing them.

Comparisons of Sludge Treatment Processes – Per Ton of Dry Sludge

	Amount of Sludge Reduced to in Pounds	Biogas Generated (cubic feet)	Combustion Heat (MMBTU)
Incineration	300	0	10.7
Composting	800	0	0
Anaerobic Digestion	500	100	0.06

Comparisons of Sludge Treatment Processes – Per Ton of Dry Sludge

	Metals	Dioxins/Furans	Hydrogen Chloride
Incineration	Pb, Hg, Cd, etc.	Yes	Yes
Composting	None	No	No
Anaerobic Digestion	None	No	Deminimus

Comparisons of Sludge Treatment Processes – Per Ton of Dry Sludge

	NOx	CO	SO_2	Particulates	VOC
Incineration	1.7	2.1	0.3	460	3.2
Composting	0	0	0.0002	10	0.0001
Anaerobic Digestion	0.006	0.000504	1E-05	0.0000456	0.00003 3

All Emissions in Pounds

Comparisons of Sludge Treatment Processes – Per Ton of Dry Sludge

Greenhouse Gas Emissions CO_2 Equivalents

CO_2	1
Methane	25
N_2O	296

Comparisons of Sludge Treatment Processes – Per Ton of Dry Sludge

	CO_2	Methane	N_2O	CO_2 (Eq)
Incineration	7300	0.1	0.2	7361.7
Composting	880	8	0.6	1257.6
Anaerobic Digestion	12	0.00138	0.0001	12.073572

All Emissions in Pounds

Comparison of Sludge Treatment Methods

Conclusions

Sludge Incineration has greatest reduction of sludge but generates greatest amount of overall pollutants and greenhouse gases with little or no sustainability.

Aerobic Digestion (Composting) reduces sludge at a slower rate and will generate greenhouse gases but no significant amount of pollutants.

Anaerobic Digestion generates the least amount of greenhouse gases based on biogas combustion with no metal or dioxin/furan emissions and has greatest sustainability for cogeneration purposes.

There's Always Costs

Questions?

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