

Heartland Water Technology

Company Introduction
2019

Overview

Founded in 2008, Heartland Water Technology (“Heartland”) has patented and commercialized novel technology for treating difficult-to-treat industrial waste waters

The Heartland Concentrator™ is a direct contact evaporator that sets new benchmarks for reliability, ease of use and cost to treat

Proven technology with Tier 1 customers in key applications



Proven Applications

- Landfill Leachate
- Flu Gas Desulfurization
- Produced Water
- Enhanced Pond Evaporation

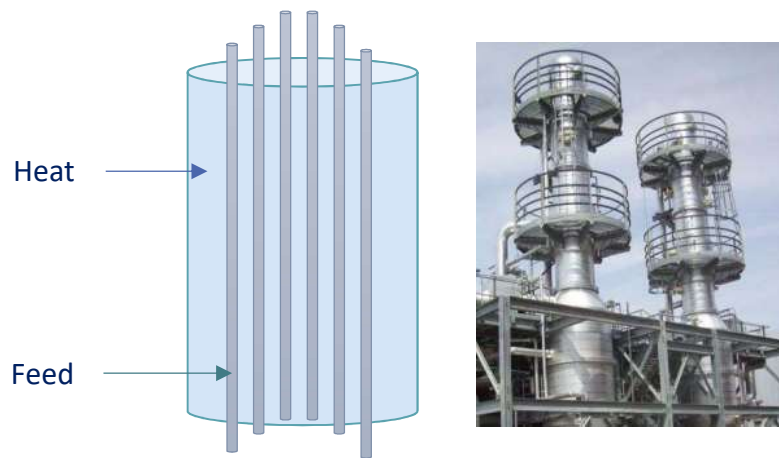




Solution

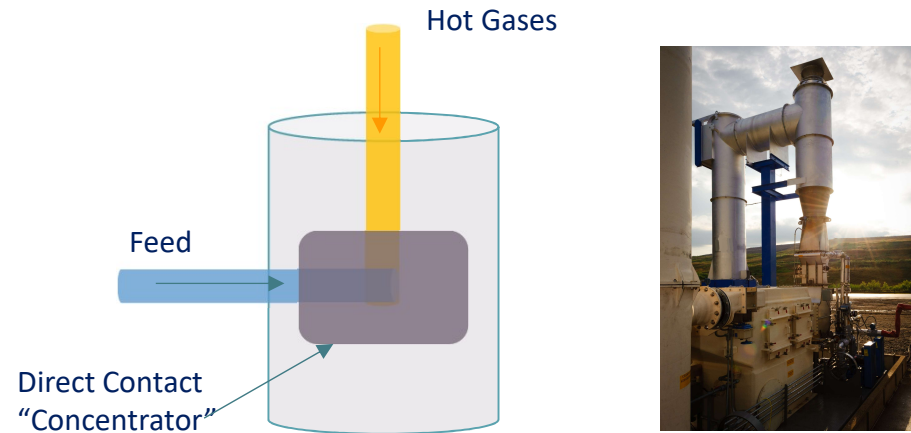
Concept of Operation: Brine Concentration Methods

Thermal Brine Concentrators



- Feed water interior to tube bundles.
- Heat transfers across tube bundles.
- Tube bundles prone to fouling, rapid corrosion.
- Requires considerable high-alloy metals.
- Requires considerable pre-treatment and highly experienced water operators
- Requires a crystallizer to achieve ZLD

Heartland Concentrator™



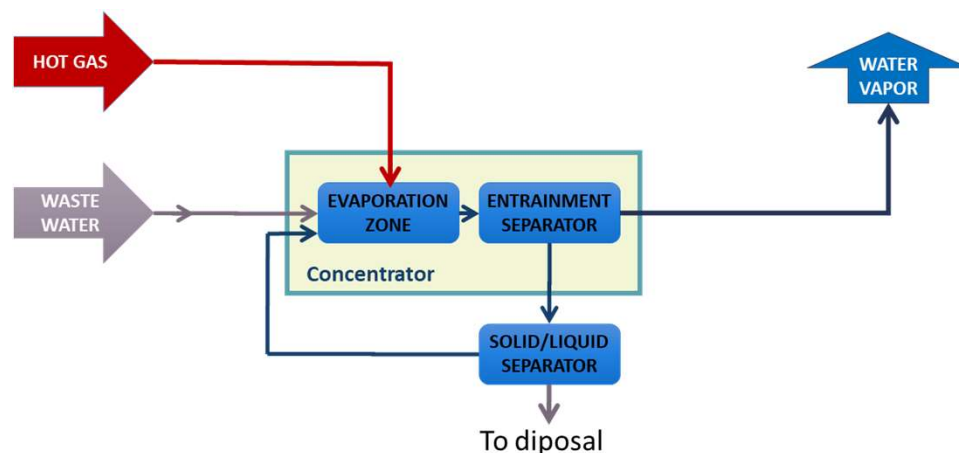
- **No heat exchange surfaces** or membranes to foul; low-cost materials.
- **Direct use of waste heat** (exhaust gases).
- Patented Gas-Liquid Section creates acres of surface area for rapid evaporation.
- **Require little-to-no pre-treatment** and anyone can be trained to operate
- **Can deliver ZLD in a single unit operation ... no crystallizer required**

The Heartland Concentrator™ is a rugged and cost-effective solution that can concentrate the widest range of challenging wastewaters all the way to zero liquid discharge (ZLD) in one-unit operation.

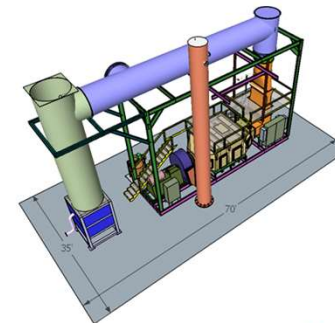
The Heartland Concentrator is a 'direct-contact evaporator' – where hot gases are mixed directly with feedwaters in Heartland's proprietary Low-Momentum, High-Turbulence (LM-HT) process.

With only 2 moving parts, no heat exchangers or membranes to foul, low-cost materials of construction, little-to-no pre-treatment required, and ease of operation, Heartland can deliver zero liquid discharge (ZLD) in a single unit operation – with no crystallizer required.

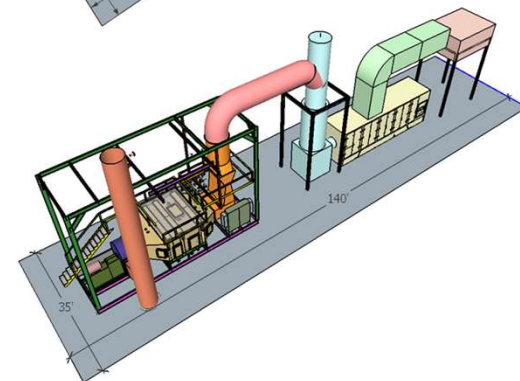
Heartland Concentrator™ Process Flow



Flare Configuration



Cogeneration Configuration



LM-HT[®] Heartland Concentrator[™]

LM-HT: Low Momentum – High Turbulence



- ① Heat Source
- ② Evaporation Zone
- ③ Feed and Recirculation
- ④ Droplet Separator
- ⑤ Sump
- ⑥ Exhaust

Sizes	12K to 144K gpd per unit 35 – 550 m3/d per unit
Applications	MSW, Brine Ponds, O&G, FGD Purge Water, Other
Delivery	6-9 months; Fully skidded, Modular and re-deployable
Flex-Heat	Flare, Recip Engine Exhaust, Recip Engine Jacket, GT, Hybrid
Value Added Solutions	Plume Suppression; Ammonia Management
Lifespan	20+ years



Left: Process fluids as they exit the concentrator.

Right: Solids accumulating in a settling tank. Liquid recycled back to the concentrator.

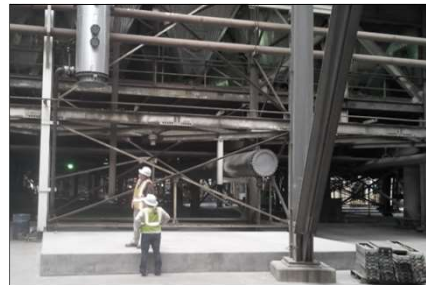
Thermal Heat Source Flexibility

While economical running on natural gas, Heartland's Concentrator delivers the industry's lowest cost to treat when utilizing unconventional waste heat.

IC Engine Exhaust



Flue Gas



Flare Gas



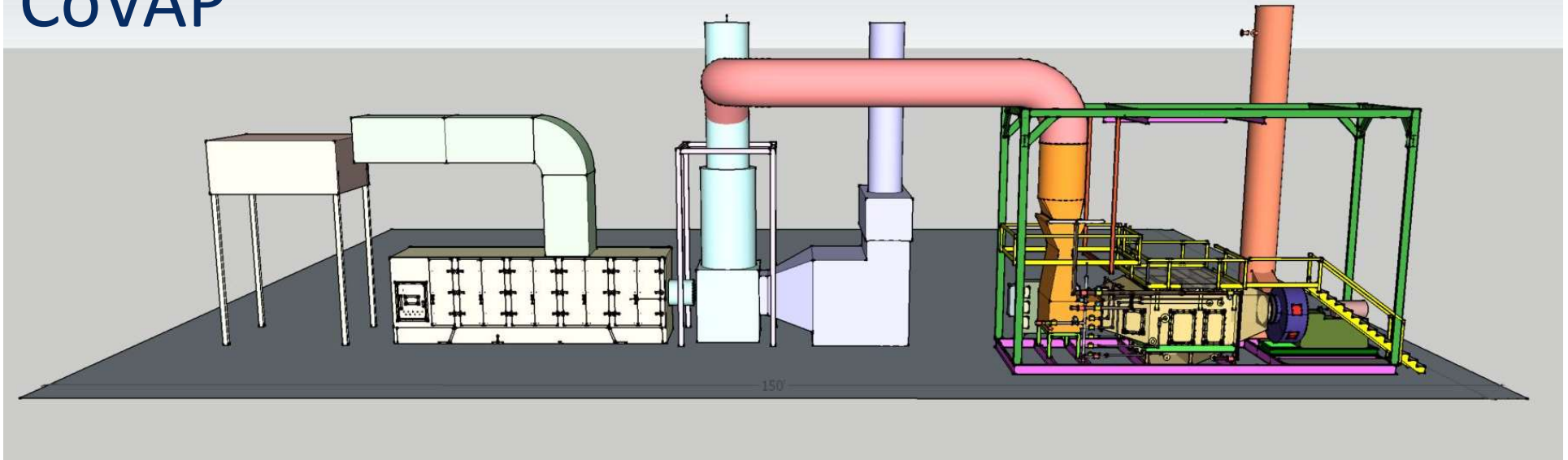
GT Exhaust



Electric Heater (pilot)



Biogas



Cogeneration for Industrial Wastewater Evaporation (CoVAP™)

A New Category of Cogeneration Application

- Traditional
- 1. Additional Power Generations
 - 2. Industrial Steam
 - 3. Hot Water
 - 4. Refrigeration

and now...

New

5. CoVAP

Benefits of CoVAP™:

- 1. Distributed, reliable renewable power
- 2. Energy efficient use of waste heat
- 3. Reliable and cost-effective wastewater treatment
- 4. Easy and reliable integration
- 5. Simple to retrofit into simple cycle
- 6. Rapid deployment



All Heartland Concentrators are full Skidded and Ready for Rapid Deployment

1. Minimize field installation complexity – often in remote areas
2. Factory-tested to ensure seamless start-up and commissioning
3. Lower total cost-of-delivery

Other Technologies

Thermal
Evaporators



Reverse
Osmosis (RO)



Evaporation
Ponds



Deep Well
Injection



Spray Dryers
(Power Industry Only)



Forward
Osmosis (FO)



Enhanced
Evaporation



	Evaporators	Dryers	RO	FO	Ponds	Deep Well	Heartland
CAPEX							
OPEX							
ZLD							
Ease of Use							
Fouling Potential							
Maintainability							
Uptime							
Environmental Challenges							

Worst
 Best

Intellectual Property

- Heartland maintains a comprehensive IP management program.
- Heartland currently owns 47 active US and foreign patents and patent applications, including:
 - 34 issued US patents, and
 - 13 issued foreign patents
- Heartland's IP is generally directed to and covers various aspects of Heartland's technology, which includes
 - Low momentum, high temperature (LM-HT®) evaporative technology, and
 - The basic configuration and construction of the the LM-HT® Concentrator system, and
 - The use of the LM-HT® Concentrator with different types of fuel sources and at different temperatures, including low temperatures.
 - The result: unmatched, proprietary ability to assist clients in solving their wastewater treatment needs using a broad range of previously 'wasted' thermal energy sources.



Heartland Concentrator™

Zero Liquid Discharge	<ul style="list-style-type: none">- Single unit operation- Future proof (POTW, Regulations)
Flex-Heat Solution	<ul style="list-style-type: none">- Enable/Leverage LFG-to-Energy- Access CHP Incentives- Hybrid Configuration maximizes electricity sales; gas utilization
LM-HT® Process	<ul style="list-style-type: none">- No Heat Exchangers or Membrane- Low risk of corrosion or fouling- Ability to handle widest range of waste streams, including chlorides, suspended solids
Highly reliable	<ul style="list-style-type: none">- Only two moving parts- No water chemistry experience req'd
Low Cost Materials of Construction	<ul style="list-style-type: none">- Low cost- Highly corrosion resistant- Long-lived (20+ years)



**Safe, Simple, Rugged, Reliable and Cost Effective
Built by Operators for Operators**



Customers

Core Focus with Proven Success



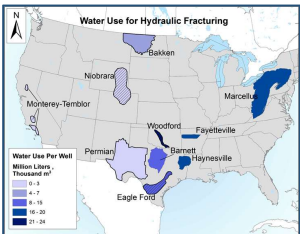
Power

- FGD blowdown to Crystallization
- FGD Pond Evaporation
- Landfill Leachate treatment



Solid Waste Management

- Up to 97% of leachate evaporated as water vapor using landfill gas and turbine and engine exhaust



Oil & Gas

- Evaporate low and high TDS produced water to a brine and to ZLD, disposing in municipal solid waste landfill (meeting TCLP, Paint Filter and RAD requirements)
- Produce custom tailored heavy brine for fracing

The environmental challenges of treating industrial waste waters and the related costs are increasing rapidly.





CoVAP™ for Landfill Leachate

Virginia Landfill

8,000 tons per
day of solid
waste

100K gpd of
leachate

Turbine Plant

- 4 Solar Centaur 40 Turbines

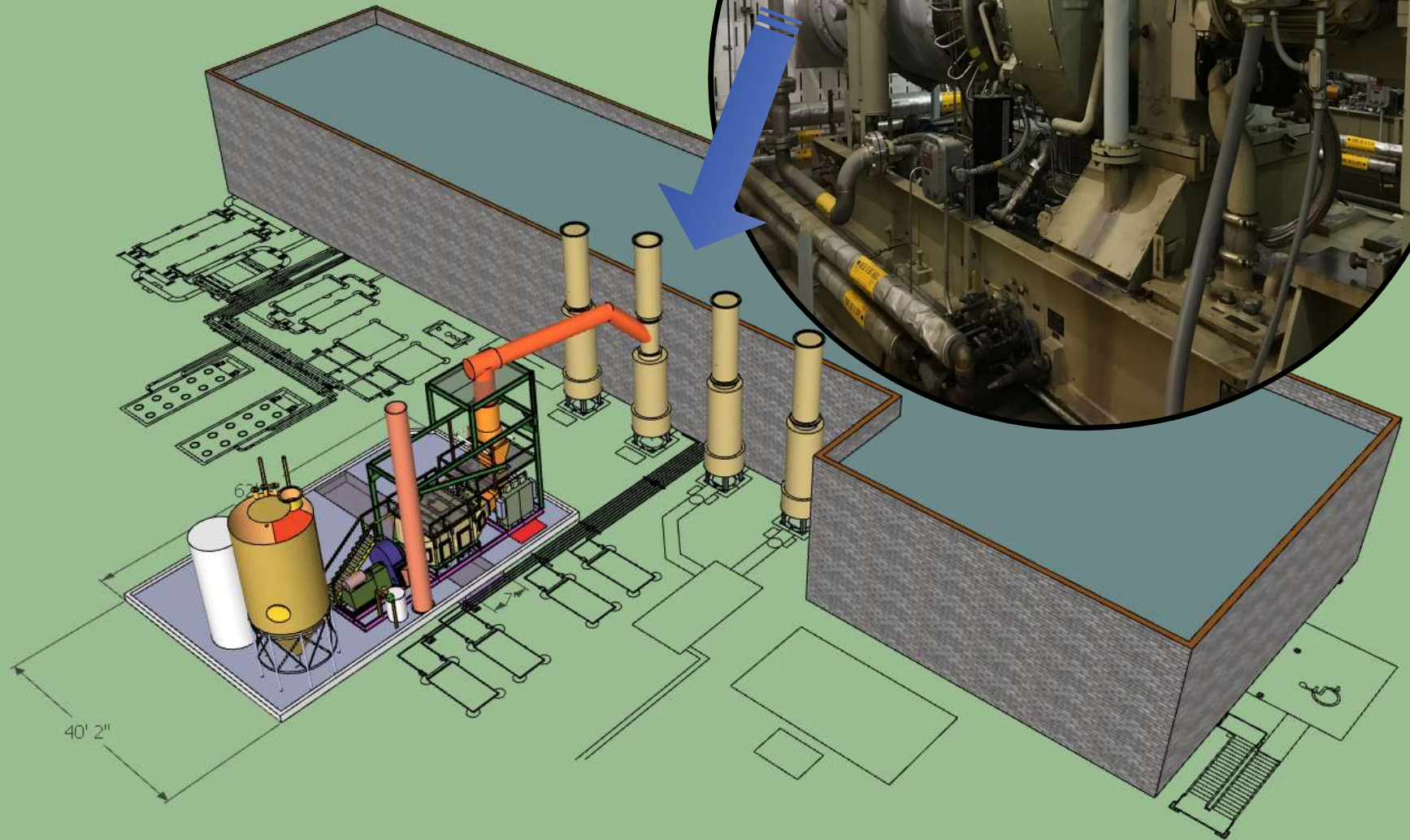
Heartland Plant

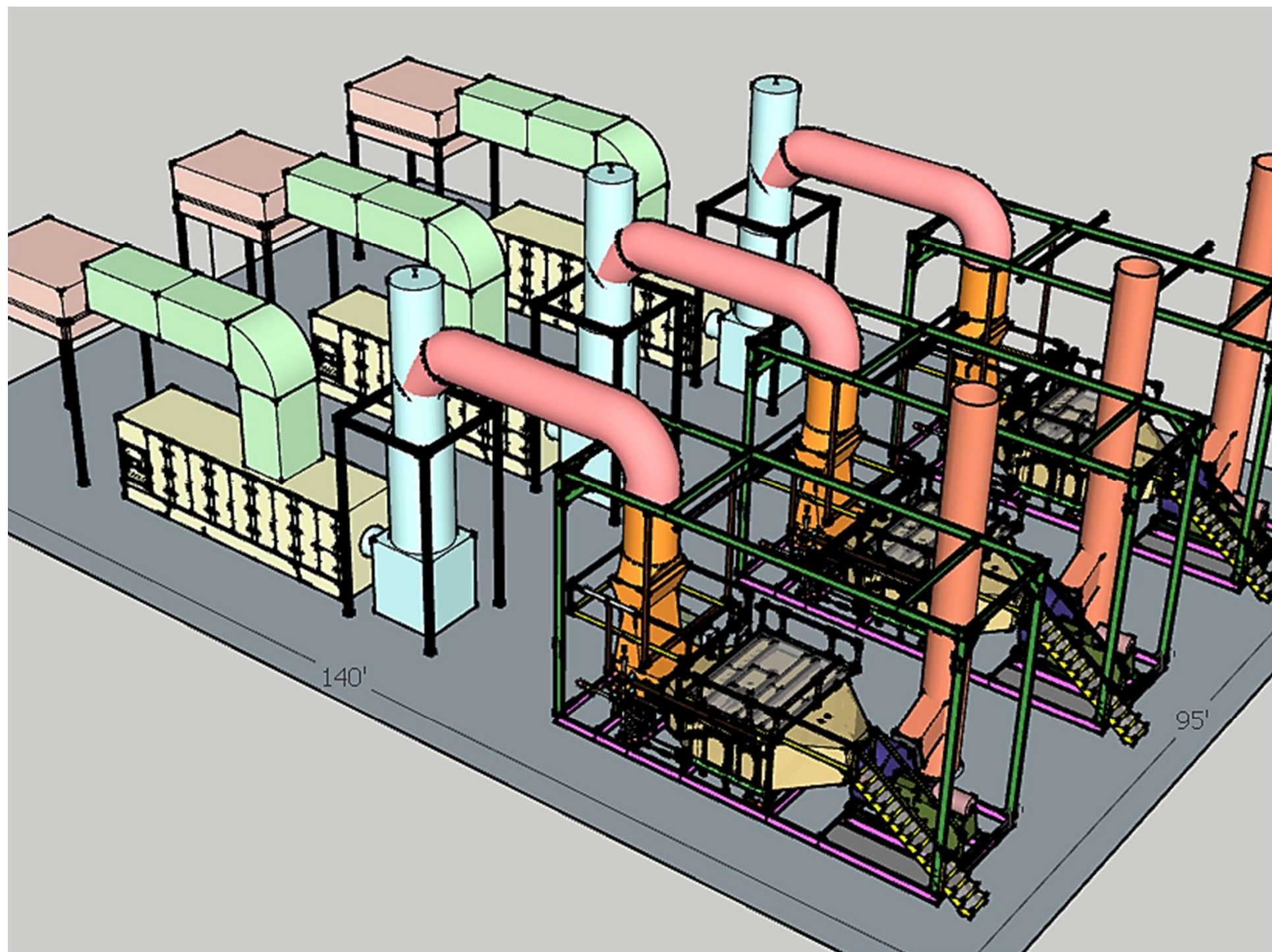
- 3 40,000 gpd concentrators



Solar Turbines

A Caterpillar Company



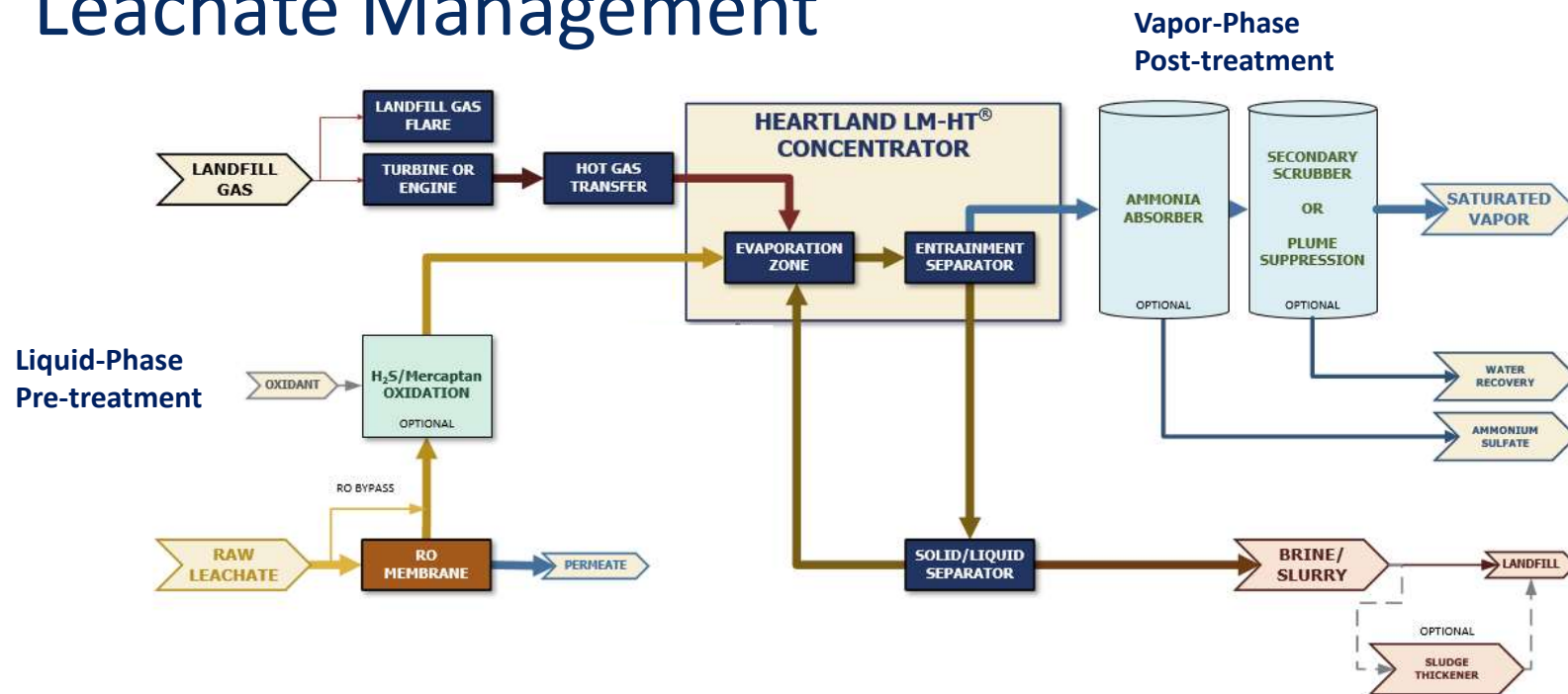




Simple and Safe Integration



Integrated Solution for Onsite Landfill Leachate Management



Reverse Osmosis

- Used if large leachate volumes or thermal limitations (heat capacity or cost)
- Use raw leachate or employ limited pre-treatment
 - Easy to 'chase' higher recovery w/ pre-treatment. Adds cost/complexity
- Need to manage permeate

Liquids Pre-treatment

- Oxidation used on raw leachate or RO concentrate
- Primary targets are H₂S and Mercaptans, and others
 - Can be treated to low concentrations or to non-detect
- Oxidant recipe is modified if other odor causing compounds are prevalent

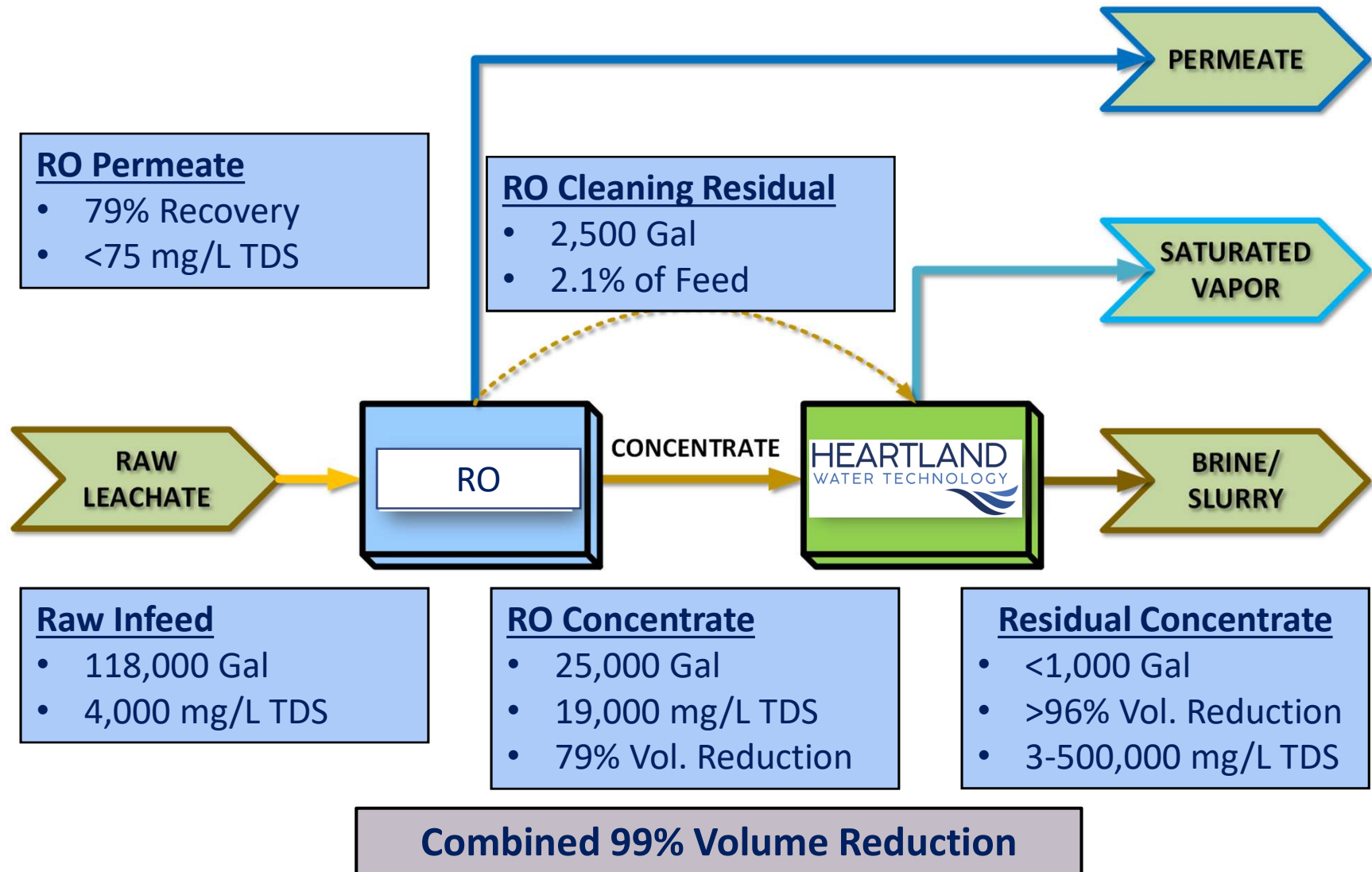
Vapor Post-treatment

- Most commonly, no vapor-phase post-treatment required
- Ammonia absorbed in Concentrator exhaust, and produces a marketable 30% liquid ammonium sulfate (LAS), or dilute form for sewer disposal
- Secondary treatment, such as caustic scrubbers or condensers, can attack other odor causing compounds and/or mitigate the visible plume

Residual Management

- Residual safely return to the landfill
 - 95%+ volume reduction
 - Thermal process kills biologics
- Optional sludge thickening provided if no liquid residual to the landfill is allowed

RO Followed by Heartland Concentrator™



Chemistry Summary

	Raw Infeed	Phase I*	Phase II*	Phase III- Avg*	Phase III- Max*
TS (mg/L)	14,000	385,000	471,000	565,000	1,030,000
TDS (mg/L)	14,000	291,000	383,000	460,000	~475,000
TSS (mg/L)	~0	84,000	88,000	105,000	~555,000
Specific Gravity	1.0	1.21	1.26	1.36	1.67
Chlorides	4,000	125,000	165,000	192,000	~200,000
pH	5-6	4-5	2-3	3-4	~3
					



Heartland Values

Heartland Values

Values are the enduring beliefs that form the basis of our culture. Our values guide us in making those daily decisions, both large and small, that over time determine our achievement.

Safety

In valuing safety, we acknowledge that the well-being of our team members, partners and customers is always our first and foremost priority

Customer First

In order to help our customers, we must first understand at a deep level what they value, and how they succeed. Only then can we develop and deliver appropriate solutions for them.

Service

Service is a mind-set that says we care for those around us more than we do ourselves. The abundance we create for ourselves is a multiplier of how much we give of ourselves to others.

Solving Important Problems

We work hard. With the time we have available in our careers, we want to work on problems that will help sustain our planet and society for our next generations.

Winning as a Team

The best teams win, not the best collection of athletes. To be an effective team we must perform our jobs at the highest levels, trust in individuals around us, practice and train like professionals, and execute with a quiet confidence. Our ability to play as a team is the cornerstone of our success.



How we Behave

The foundation of all good teams is Trust. How we behave determines the level of trust we build collectively.

$$\text{Trust} = f(\text{Integrity, Respect, and Candor})$$

In addition to Trust, great teams have an intangible quality of always achieving more than management practice would deem possible.

$$\text{Impact Multipliers} = \text{Optimism} + \text{Initiative}$$

Integrity

Integrity means always doing what is right ... even when no one is watching.

Respect

It is through respect that we acknowledge the value and worth of those around us. We show respect for others in how we communicate, how we listen, how we deliver on commitments, and how we own up to our mistakes

Candor

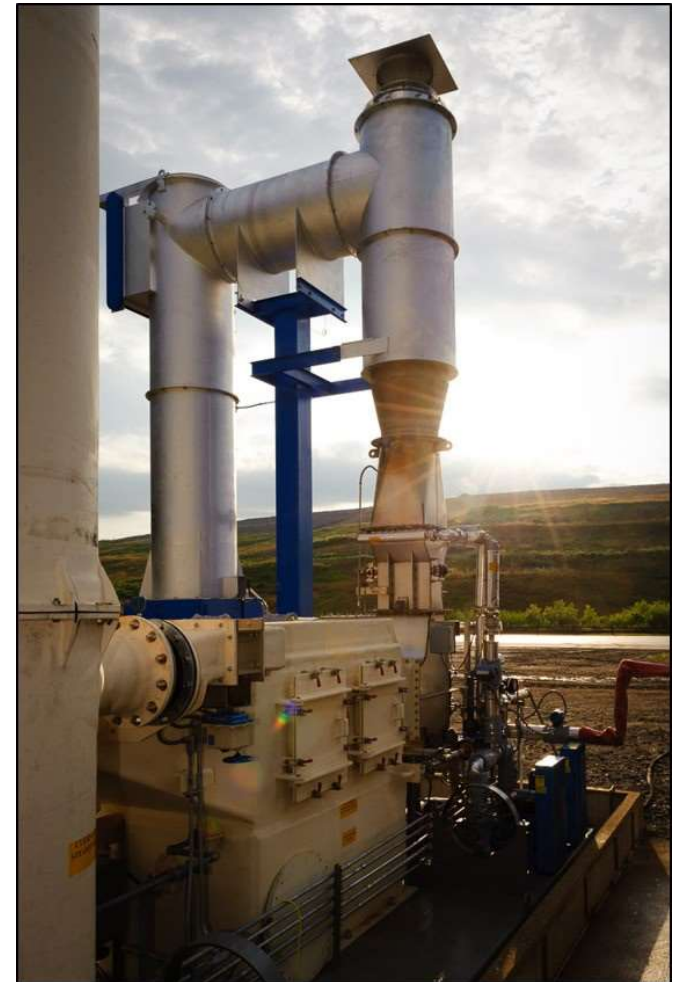
Candor is the quality of being open, honest, direct and sincere. Candor is bi-directional. Not only will 'I be candid with you' but I will have the confidence and defenselessness to allow 'you to be candid with me.'

Optimism

Optimism is a force multiplier. Optimistic teams are not bounded by the conventional wisdom of what is possible, and as a result, consistently achieve more... and have more fun along the way!

Initiative

Great teams and great team members do not wait around for direction. They seek to understand strategy and business intent, they "see around corners" to identify opportunities and threats, and move proactively to drive impact



What we do

Over and above our Values and Behaviors, our habits are the things we do each and every day irrespective of the goals and strategy of the company. Our habits, applied over time, are how we win.

We Win by:

Creating Value for our Customers

Having a Passion for Process Improvement

Simplifying the Complex

Being Insatiable Learners

Operationalizing Metrics and Scorecards

Embracing Problems and Challenges

Recognizing and Rewarding Impact



Thank You!

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