Heartland Water Technology

A proven solution for beneficial use of flare gas for evaporation

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Key Takeaways

Heartland’s LM-HT Concentrator:

1. A proven solution for treating produced water and frack water to zero liquid discharge with starting solids concentrations up to 300,000 mg/l
2. A proven solution for using flare gas or engine/turbine exhaust as thermal energy for evaporation
3. Has materials of construction that can stand up to the harsh, corrosive nature of produced water brine
4. A proven ability to easily recover water vapor for reuse
5. A rugged, simple, easily re-deployable solution
Produced Water and Flare Gas

30B bbl of Excess Produced Water in the Next Decade

Disposal Well Pressures are Rising and can not Support this Volume

Water Disposal Causing an Increase in Seismic Activity

104B mcf Flared in 2018, enough to Evaporate 600,000 bbl/day

15% More than Florida’s Lake Okeechobee

Prior to 2013: n=8

Water is Not Longer "Just a Cost" to be Managed
**A Work Horse:**
Heartland’s LM-HT® Concentrator™

LM-HT: Low Momentum – High Turbulence

<table>
<thead>
<tr>
<th>Features</th>
<th>Specifications</th>
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<tbody>
<tr>
<td><strong>Sizes</strong></td>
<td>300 to 4000 bbl/day</td>
</tr>
<tr>
<td><strong>Delivery</strong></td>
<td>6-9 months; modular and re-deployable</td>
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<tr>
<td><strong>Flex-Heat</strong></td>
<td>Flare, CoVAP, Hybrid</td>
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<tr>
<td><strong>Lifespan</strong></td>
<td>20+ yrs</td>
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Feed, Brine Concentration, Zero Liquid Discharge
Cogeneration for Industrial Wastewater Evaporation (CoVAP™)

A New Category of Cogeneration Application

<table>
<thead>
<tr>
<th>Traditional</th>
<th>New</th>
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</thead>
<tbody>
<tr>
<td>1. Additional Power Generations</td>
<td>5. CoVAP</td>
</tr>
<tr>
<td>2. Industrial Steam</td>
<td></td>
</tr>
<tr>
<td>3. Hot Water</td>
<td></td>
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<tr>
<td>4. Refrigeration</td>
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</table>

and now...

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
Flare Configuration

Proven solution for using waste gases for thermal energy for evaporation, such as O&G Flare Gas, Biogas, Flue Gas

Cogeneration (CoVAP) Configuration

Using the exhaust from turbines for the thermal energy for evaporation
Proven Solution for Frack Water
CoVAP for Produced Water
US Produced Water Using Compressor Station Waste Heat

Waste Heat from Compressor Engines

Waste Heat Collected into a Common Header

ID Fan Draws Heat into the Heartland Concentrator

Water Collected and Re-used with Simple Condensing

Salts Solidified and Stabilized for Disposal
### Ability to ‘Dial-in’ Residual Concentration

<table>
<thead>
<tr>
<th></th>
<th>TS (mg/L)</th>
<th>TDS (mg/L)</th>
<th>TSS (mg/L)</th>
<th>Specific Gravity</th>
<th>Chlorides</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14,000</td>
<td>14,000</td>
<td>~0</td>
<td>1.0</td>
<td>4,000</td>
<td>5-6</td>
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<tr>
<td></td>
<td>385,000</td>
<td>291,000</td>
<td>84,000</td>
<td>1.21</td>
<td>125,000</td>
<td>4-5</td>
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<tr>
<td></td>
<td>471,000</td>
<td>383,000</td>
<td>88,000</td>
<td>1.26</td>
<td>165,000</td>
<td>2-3</td>
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<tr>
<td></td>
<td>565,000</td>
<td>460,000</td>
<td>105,000</td>
<td>1.36</td>
<td>192,000</td>
<td>3-4</td>
</tr>
<tr>
<td></td>
<td>1,030,000</td>
<td>~475,000</td>
<td>~555,000</td>
<td>1.67</td>
<td>~200,000</td>
<td>~3</td>
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</tbody>
</table>

Chlorides: 4,000 - 200,000 mg/L
Specific Gravity: 1.0 - 1.67
Chlorides: 4,000 - 200,000 mg/L
pH: 5-6 - ~3
Proven Integrations
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
Remote Operation & Unattended Campaigns

- Heartland has extensive experience in the O&G industry, and understands the need for reliable and rugged operation with a minimal and rotating staff.

- Heartland has included the following features geared toward serviceability and maximizing remote and unattended operation potential:
  
  - An automated CIP sequence system that periodically flushes the Concentrator system with water and/or a cleaning agent to reduce frequencies of required servicing and cleaning
  
  - Remote control and operation via an integrated 4G LTE data package coupled with VPN service, that can be securely accessed remotely via laptops, Android devices, or iOS devices
  
  - Data logging and trending of key process parameters with automatically generated and emailed daily reports
  
  - Operator user access and security levels, including logging of critical process changes by location, personnel, and time
  
  - Remote alarm call-out and/or email notification for system warnings, notifications, and alarmed shutdowns.
Heartland’s 25 BPD Pilot Unit
300 BPD
Demonstration Unit

- Capacity: 300 BPD
- Heat Source: NG / Propane Burner
- Electrical / Burner Approved for use Canada (CSA Group, Enefen)
- 2-3 day set-up time
- Remote monitoring
## Heartland Concentrator™

### Zero Liquid Discharge
- Single unit operation
- Future proof (POTW, Regulations)

### Flex-Heat Solution
- Enable/Leverage LFG-to-Energy
- Access CHP Incentives
- Hybrid Configuration maximizes electricity sales; gas utilization

### LM-HT™ Process
- 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
- Only two moving parts
- No water chemistry experience req’d

### Low Cost Materials of Construction
- Low cost
- Highly corrosion resistant
- Long-lived (20+ years)

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