

## ABSTRACT

### Zero Liquid Discharge for Produced Water- Proven Technology Delivers Solids to Landfills

The paper reviews the development of a unique wastewater concentrator design based on the premise that evaporative technology *would* surpass the efficacy of all other available options for managing difficult and highly variable aqueous wastewaters *if five shortcomings of conventional evaporators could be eliminated*. Thus, the designers set out to devise a most “forgiving technology” that would not lead to extensive bench scale studies or full blown R&D projects for each particular wastewater stream to be treated. The commercial success of LM-HT<sup>®</sup> Produced Water and Landfill Leachate Concentrator’s<sup>1</sup> clearly demonstrates that all of these broad stroke goals have been met.

Five critical shortcomings of conventional evaporative processes that have been eliminated are: 1) fouling of heat exchangers and other wetted process surfaces; 2) process downtime required for periodic and often difficult cleaning cycles related to fouling; 3) limits on the degree of concentration that can be attained by inability to perform beyond the point of saturation where precipitates become suspended solids; 4) high capital costs due to substantial quantities of high alloys required to resist corrosion, especially on heat exchanger surfaces; and 5) relatively high costs for thermal energy to affect evaporation of water compared to other treatment technologies. Considered in total, these shortcomings essentially *eliminate* sound reasoning for choosing an evaporative process.

Key features of the concentrators are embedded in the design philosophy of applying simple, reliable and effective elements for which form follows function. Key technical aspects for the concentrators are: elimination of all heat exchangers as used in conventional evaporators including MVR, forced circulation and thin-membrane heat exchange systems; incorporating provisions for the units to operate on waste heat from conventional combustion devices such as IC engines, turbines and flares; and maintaining highly turbulent conditions throughout the process system in order to manage suspended solids, especially precipitated solids that develop when operating well beyond the point of saturation.

Having allayed all critical concerns, the proprietary wastewater concentrators operate continuously to safely and reliably reduce produced water and other aqueous waste streams to very minimum volumes at levels up to and including zero liquid discharge (ZLD). Direct results of the unique design include the ability to manage broad ranges and changes in feed characteristics while employing simple and reliable conventional techniques to convert precipitated particles produced within the process to solids that meet Paint Filter, TCLP and radiological criteria for disposal in permitted landfills. Supernatant liquid and filtrate produced in the conventional liquid-solid separation processes, both being at the point of saturation with dissolved salts, are continuously returned to the evaporative zone to “wring out” additional

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<sup>1</sup> LM-HT Wastewater Concentrators are manufactured under one or more patents and/or pending patents that are owned by Heartland Technology Partners, LLC

precipitate, a feature unattainable in conventional evaporation systems that cannot manage suspended solids, and a key element in attaining ZLD.

Commercial success reviewed within the presentation includes details of a continuing joint research project instituted in early 2011 between Seneca Resources, Division of National Fuel Gas, Waste Management, Inc., RNI Industries and Heartland Technology Partners, LLC to further streamline operations and reduce costs for treating high TDS produced water from the Marcellus Gas Play to meet landfill disposal criteria. This commercial scale project, which was initially operated at Seneca Resources' Detweiler Pad F in Covington, PA, demonstrated that produced water with high scaling tendencies (8,000 to 12,000 ppm barium, 18,000+ ppm calcium and 230,000 to 270,000 ppm TDS in feed) generated extremely important knowledge through hands-on experience. As a result, Seneca Resources has purchased two concentrator systems as part of their corporate commitment at the board level to zero surface discharge (ZSD) for gas wells in PA. One of these systems is now in operation at Seneca's Owls' Nest well field in northwest PA where well-head gas is the sole energy source for the concentrator. A second unit, which is being fabricated, will be installed at Seneca Resource's Cherry Flats Compressor Station where waste heat from the compressor engines will be the principal source of thermal energy.