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Halotechnics Intellectual Property Portfolio and Strategy

October 31, 2013

Halotechnics has eight patents pending that cover the composition of matter, system design, and use of our products. Our intellectual property falls in the following general categories:

* Composition of matter. These patent claims cover the proportion of each constituent in the preferred mixtures; the formula.
* Synthesis process. These patent claims specify the temperature, duration, and other steps and techniques for synthesizing our proprietary materials. We typically protect glass synthesis steps as trade secrets (glass manufacturing requires sophisticated process development and cannot be reverse-engineered).
* Novel use. We sometimes claim an existing material for a novel use, analogous to a pharmaceutical firm patenting a previously known chemical compound to treat a disease.
* Related equipment and system design. We have expanded our IP portfolio to include related technology for wetted components in the plant: anti-corrosion additives, coatings, pumps, tanks, system designs, and control algorithms.

We are working with the Silicon Valley IP law firm Kilpatrick Townsend & Stockton to draft and prosecute patents covering our technology. The attorneys at Kilpatrick have extensive experience in protecting compositions of matter, and in particular inorganic materials like molten salt and glass. We believe we will be able to defend our products in commercial applications by covering the broad application and composition as well as the specific mixture of the product. A recent patent granted to Sandia National Laboratories [[[1]](#footnote-1)] covering a novel molten salt mixture shows that there is precedent for issuing patents in this space. We believe we have freedom to operate and commercialize our novel designs and materials. We file both domestic patents as well as international patents in countries we expect our products to be used (for example, Germany, Spain, Australia, South Africa, and others). We protect the enabling details of our product development capabilities as trade secrets (high throughput chemistry techniques and software tools).

See the following list of active patent cases. We expect to file more patents in Q4 2013, in particular: (1) heat pump thermal storage system design, and (2) molten glass international applications.

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| 1. Saltstream 500 / Saltstream 300

*Title:* Inorganic Salt Heat Transfer Fluid*Patent:* US Patent Application No. 13/088605*Summary:* This invention exploits eutectic behavior with a novel composition of inorganic salts, resulting in a low melting point below 80 °C. This heat transfer fluid is thermally stable up to 500 °C.*Status:* US application filed April 2011 (priority date April 2010). |
| 1. Saltstream 565

*Title:* Molten Salt Material for Heat Transfer and Thermal Energy Storage*Patent:* US Patent Application No. 61/485,491*Summary:* This molten salt heat transfer fluid establishes an operating range of 250 – 565 °C. Such a range is comparable to conventional 60/40 Solar Salt, making Saltstream 565 suitable for drop-in replacement in molten salt energy storage systems, but with a reduction in cost. *Status:* US and PCT/GCC applications filed May 2012 (priority date May 2011). |
| 1. Eutectic Chloride Salt

*Title:* Thermal Energy Storage with Molten Salt*Patent:* US Patent Application No. 61/494,272*Summary:* The molten salt heat transfer fluid detailed herein has a melting point of 250 °C and is thermally stable up to 700 °C. Such an innovation in molten salt heat transfer and thermal energy storage allows steam turbines to operate in super-critical conditions, a more energy-efficient power cycle. Other applications include electrolyte in thermal batteries.*Status:* US application filed June 2012 (priority date June 2011). |
| 1. Saltstream 700, Advanced Heat Transfer Fluid

*Title:* Advanced Molten Salt for Solar Thermal Power Generation with Supercritical Steam Turbines*Patent:* US Patent Application No. 61/592,859*Summary:* This molten salt heat transfer fluid enables applications at extreme temperatures. This novel family of compositions allows the use of advanced technology in power generation (super-critical steam turbines and super-critical CO2). Other applications include in-situ oil shale conversion, chemical synthesis, and high temperature actuators.*Status:* US and PCT/GCC applications filed January 2013 (priority date January 2012). |
| 1. Haloglass CK

*Title:* Eutectic Glass Mixtures*Patent:* US Patent Application No. 61/891,562*Summary:* Haloglass CK has a melting point below 400 °C and is thermally stable up to 1200 °C. This fluid has extremely low viscosity over its entire operating range, making it suitable for high performance engineering applications.*Status:* Provisional US application filed October 2013. |
| 1. Thermal Electricity Storage System

*Title:* Reversible Heat Engine for Electricity Storage (RHEES)*Patent:* US Patent Application No. 61/895,606*Summary:* The RHEES system represents Halotechnics answer to grid scale electricity storage, where leveraging heat to store electricity enables sufficient scalability to stabilize intermittent renewable power generation. This system has clear advantages over existing battery technologies, where safety, lifetime durability, and cost are key performance metrics. The invention described herein utilizes a low-cost, reliable thermal storage system coupled to efficient turbomachinery for charging and discharging. This device can use proven turbomachinery technology to compress a gas to high temperature and then store that heat in a low-cost molten salt or molten glass.The RHEES system has already attracted attention from an energy industry strategic partner.*Status:* Provisional US application filed October 2013. |
| 1. High Temperature Molten Glass Pump

*Title:* Check Valve Pump for High-Temperature Molten Glass*Patent:* US Patent Application No. 61/727,271*Summary:* This patent describes a pump mechanism for efficiently moving molten glass. In the glass industry, no such innovation currently exists, where molten glass tanks currently rely upon gravity or manual bailing to facilitate glass movement. Halotechnics molten glass pump will be a key system component in our glass prototype thermal storage system, and would scale to larger industrial applications. *Status:* Provisional US application filed November 2012. |
| 1. Haloglass RX

*Title:* Very Low Cost, Low-Viscosity Liquid Glass for Heat Transfer and Thermal Energy Storage*Patent:* US Patent Applications No. 61/723,929 and 61/783,989 *Summary:* Haloglass RX enables applications at unprecedented temperatures, exhibiting a liquid operating range of 450 – 1200 °C. The composition covered in the patent is based upon non-toxic, earth-abundant materials that are currently mined in millions of metric tons per year. *Status:* Provisional US applications filed in November 2012 and March 2013. |
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1. [] R. Bradshaw, D. Brosseau, “Low-melting point inorganic nitrate salt heat transfer fluid,” U.S. Patent 7,588,694, September 2009. [↑](#footnote-ref-1)