AltelaRain^{SM} Produced Water Treatment & Re-use

Treating water naturally.

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ABSTRACT

Altela Inc. offers a fundamentally new water desalination product, the AltelaRain^{SM} System (ARS) that inexpensively removes nearly 100% of dissolved salts and other contaminants from industrial wastewaters and undrinkable brackish waters – representing the first new, low-cost water desalination technology in the last 50 years. These systems lower the cost of oil and gas production while dramatically decreasing the volume of waste that needs to be trucked away and disposed. It purifies the most highly challenged water using energy produced at the wellhead, in a simple, mobile and modular system located on-site. Altela has acquired several precedent-setting re-use permits to discharge and re-use the treated water. Such re-use of treated, clean produced water directly supports the 'energy/water/environment' partnership outlined in the *More Water, More Energy, Less Waste Act of 2007.*

Keywords: altelarain^{sm}, stewardship, produced water treatment, beneficial re-use, environmental sustainability.

1 THE PROBLEM

Produced water is trapped in underground formations that comes to the surface during oil and gas exploration and production. It occurs naturally in formations where oil and gas are found and, along with the oil and gas, is many millions of years old. When oil or gas is produced, it is brought to the surface along with this produced water as a combined produced fluid. Produced water contaminants vary across (and even within) formation basins, depending on the depth of the well, geology, and environment of the deposit. Overall, it is estimated that the United States oil and gas industry generates 15 to 20 billion barrels of produced water every year - greater than two-million acre-feet of water.

Produced water handling and treatment represents an $18 billion cost to the oil and gas industry in the U.S. alone. The cost of disposing of oil and gas produced water ranges from a low of $0.002 per gallon ($0.08/barrel) to a high of $0.30 a gallon ($12.00/barrel). By contrast, water for agricultural irrigation costs in the range of $0.0001 per gallon ($0.004/barrel) and municipal drinking water costs in the range of $0.003 per gallon ($0.13/barrel).

The price of cleaning produced water is therefore as much as 80 times greater than municipal water, and as much as 3,000 times greater than agricultural irrigation water. The separation, handling, and disposal of produced water represent the single largest waste stream challenge facing the oil and gas production industry.

2 A NEW APPROACH

Altela has taken the simplest of nature's processes for purifying water – i.e., mimicking thermal distillation in the water cycle for making rain – and recreates that process using readily available materials and very little energy compared with conventional thermal distillation or membrane separation. The internal heat transfer technology recaptures the energy needed to evaporate water, thus yielding about three times the amount of distilled water per energy input as traditional ambient pressure distillation/evaporation techniques. The AltelaRain^{SM} System technology yields energy costs that are approximately only 30% of comparable ambient pressure distillation/evaporation processes.

Since the treated water stream is distilled water, the quality of water from the AlelaRain^{SM} System is extremely high and can be used at the well site for frac/well completion water, irrigation, stock watering, or other clean water uses following applicable legal and regulatory permitting. Altela has been successful in acquiring several precedent-setting permits.

These systems are highly scalable in size and can be produced in a variety of configurations to fit individual on-site needs. The standard ARS-4000 system is delivered in a single portable 45-foot x 8-foot shipping container, and treats 4,000 gallons per day (~100 barrels per day, BPD) of produced water, decreasing disposal costs by 90% and extending the life of a well. For higher volume applications, stationary plants can be erected for increased capacity at a given location.

3 THE TECHNOLOGY

The Altela technology is a simple and elegant process, based on thermal distillation that desalinates and decontaminates salty and polluted water in a fundamentally different way than the more familiar reverse osmosis and other membrane-based desalination technologies. A scientifically complex, yet inexpensively implemented, internal heat transfer process allows the re-use of the latent heat of condensation over and over again to greatly offset the total heat of evaporation required in conventional thermal distillation. This internal heat transfer technology recaptures the energy needed to evaporate water, thus yielding approximately 3 times the amount of distilled water per energy input as traditional ambient pressure distillation/evaporation techniques.

Conventional thermal distillation processes such as MSF and MED achieve energy re-use in a similar fashion; however, using pressure – which adds costs, requires expensive metal pressure vessels that corrode, and cannot be economically scaled-down in size to treat on-site volumes. Altela's uniqueness lies in its patented process to achieve this same "energy re-use factor" without pressure and expensive pressure vessels. The AltelaRain^{SM} process therefore requires no pressure pumps, or their use of large amounts of expensive, high-quality electrical energy. Instead, the AltelaRain^{SM} process operates on low-grade heat energy, which is much less expensive – and often free in the E&P sector.

In the AltelaRain^{SM} process, ambient pressure steam is supplied to the top of an inexpensive non-metallic column, or tower. The clean water vapor from the evaporation chamber is transferred to the condensation chamber by a carrier gas, with the ability to repeatedly absorb and desorb pure water from the produced water, Figure 1. Ambient air is brought into the bottom of the tower on the evaporation side of a heat transfer wall. The wall is wetted by saline produced water, which is fed into the evaporation side at the top of the tower. As the air moves from the bottom to the top of the tower, low-temperature heat is transferred into the evaporation side through the heat transfer wall, allowing the air to rise in temperature and evaporate water from the wet saline liquid which coats the heat transfer wall. Some of the original water, now concentrated in contaminates, leaves the bottom of the tower – and warm saturated air rises to the top of the tower. Heat is added to this hot air by an external heat source (low-grade, atmospheric pressure steam). This hotter saturated air is then sent back down through the tower on the condensation side of the heat transfer wall. The evaporation side of the tower, being slightly cooler than the condensation side, allows the air to cool and transfer the latent heat of condensation from the condensation side to the evaporation side. Pure distilled water condensate leaves the condensation side of the tower at the bottom of the tower.

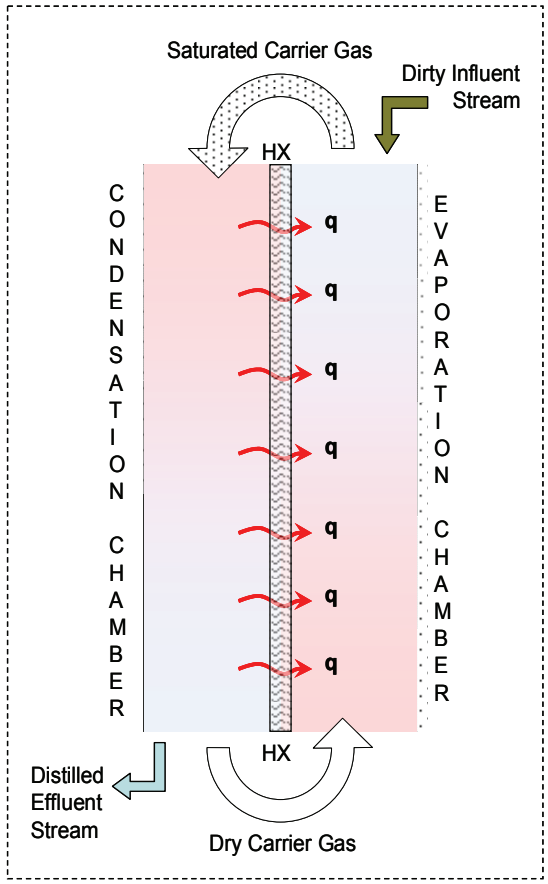

Figure 1: AltelaRain^{SM} Process

Individual AltelaRain^{SM} towers are the size of a residential water heater and are capable of processing approximately 340 gallons per day (8 BPD) of water with salt concentration in excess of 100,000 ppm. The AltelaRain^{SM} System can reduce effluent disposal volumes by as much as 90%. Since the treated water stream is distilled water, the quality of water from the AltelaRain^{SM} System is both extremely high and reproducible (regardless of the incoming water to be treated).

Because the systems continuously monitor the TDS level of both influent and treated effluent streams, there is a high degree of control and certainty over the clean water that is discharged or utilized by the customer. The technology is designed to minimize maintenance and operation costs. Use of plastics reduces maintenance issues related to scaling, fouling or corrosion of metal systems. Moving parts are few, and consist of proven, robust, off-the-shelf components, such as low-pressure water pumps and air blowers. The system operates at ambient pressures and modest temperatures, and as such, has few mechanical failures in plumbing and related systems. A remote monitoring ability also allows field operators to detect system problems early and take remedial action before major failures take place.

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AltelaRain[SM] Systems have been deployed at natural gas wells throughout the Rocky Mountain region – ranging from the San Juan Basin near Farmington NM, to the Piceance Basin of CO, to the Alberta gas fields of Canada. The produced water treated is often very high in total dissolved solids (> 40,000 ppm), and also contains organic compounds and trace amounts of radioactive elements and other heavy metals. Because the technology is a distillation process, none of these constituents travel through the carrier gas, so none of them re-condense in the cleaned distilled water stream. According to extensive independent-laboratory testing over multiple months in the field, TDS levels of the AltelaRain[SM] system's distillate water is very low (typically about 20 ppm; more than 10 times less than drinking water), and the levels of organics, metals, and radioactive compounds are either undetectable or several orders of magnitude below even the strictest drinking water standards.

The water quality test results received from an independent water quality lab demonstrate the very high quality of treated water obtained from this simple technology for the treatment of highly challenged produced water. Total dissolved solids were reduced from 32,600 mg/L to an undetectable level. Chloride was also reduced to an undetectable level from a starting point of 20,200 mg/L. Similarly, benzene levels were reduced from 150µg/L to non-detectable following AltelaRain[SM] treatment.

The detailed water quality data outlined in Table 2 show the raw and treated water quality of an AltelaRain[SM] System operating in the field since early 2007 at a natural gas well in northwestern New Mexico.

4 CONCLUSION

Oil and gas companies need lower cost methods for handling and disposing of produced water. Produced water handling and disposal is generally very expensive due to the large volumes of water that must be lifted to the surface, separated from the petroleum product, transported, and then re-injected into the ground or disposed of in surface evaporation/storage ponds. In addition, environmental concerns are making it increasingly difficult to permit new surface ponds or injection wells. Altela's ARS-4000 field systems have successfully demonstrated the technology's ability to economically purify highly-challenged produced water into clean water for valuable re-use. By recognizing that produced water can be a valuable asset that can be treated for re-use, new environmental opportunities develop between the environment and the oil and gas industry in direct support of the 'energy/water environment' partnership outlined in the *More Water, More Energy, Less Waste Act of 2007.*

	Water Contaminant (Analyte)	**Symbol**	**Before Altela (mg/L)** *except for Radium 226 and 228 which is in pCi/L	**After Altela (mg/L)** *except for Radium 226 and 228 which is in pCi/L
	Salts:			
1	Total Dissolved Solids	TDS	32,600	0
2	Chloride	Cl	20,200	0
3	Sulfate	SO4	9	0
	Metals:			
4	Arsenic	As	0.009	0
5	Barium	Ba	66.5	0
6	Cadmium	Cd	0	0
7	Chromium	Cr	0	0
8	Cyanide	CN	0	0
9	Lead	Pb	0	0
10	Total Mercury	Hg	0	0
11	Nitrate	NO3	0	0
12	Selenium	Se	0.04	0
13	Silver	Ag	0	0
14	Uranium	U	0	0
15	Copper	Cu	0.6	0
16	Iron	Fe	19.2	0
17	Manganese	Mn	0.21	0
18	Zinc	Zn	0.29	0
19	Aluminum	A	0.3	0
20	Boron	Ba	3.3	0
21	Cobalt	Co	0	0
22	Molybdenum	Mo	0	0
23	Nickel	Ni	0.08	0
	BTEX:			
24	Benzene		0.15	0
25	Toluene		0.078	0
26	Ethyl benzene		0.0076	0
27	Total Xylenes		0.059	0
	Radiological:			
28	Radium 226		68.3	0
29	Radium 228		68.3	0
	Other:			
30	Ph	pH	7.67	8.95

Table 2: AltelaRain[SM] Produced Water Quality