

SHALE PLAY WATER MANAGEMENT

[Jan/Feb 2019]

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Produced Water Treatment 'Virtually Free' of Solids

Lab Tests Show Process Extracts Solids,
Returns 'Near Distilled Quality' water

Photos by Kaizen Fluid Systems

Recently, an opportunity arose for our company to demonstrate the operation of our water treatment process for an oil and gas producer in the Marcellus. The producer was seeking an economical, safe process for treating mass volumes of produced water and flowback with a goal of meeting federal and state effluent standards.

The producer was also seeking a solution to the issues of water storage expense, transport and disposal. With only a few licensed water disposal facilities in Pennsylvania, the producer was facing water management costs of \$9 bbl or more and approaching a level of uneconomic operation.

Initial discussions showed the producer was facing a corporate mandate to select a treatment system that provided discharge options ranging from limited treatment, disposal-well quality to evaporation pond and "clean water" for drilling and fracing, as needed.

In order to meet state and federal discharge guidelines, the treated water had to be free of all chemicals, metals, salts and virtually free of all total suspended solids and total dissolved solids. Also, concentrations of naturally occurring radioactive materials had to be within regulatory guidelines.

After a review of Kaizen treatment systems developed for oil and gas producers in several active oil and gas basins, an agreement was reached to evaluate the producer's discharge requirements and establish a baseline of current produced water samples before recommending a treatment system.

Third Party Tests

The samples were tested by ALS Global, an independent testing service that has provided our company with more than 1,000 reliable test results. The test results, shown in the chart below, indicates the high levels of TDS, metals and chlorides in the baseline produced water samples as provided by the oil and gas producer.

In order to provide water pure enough to discharge back into the environment that complied with strict Pennsylvania Dept. of Environmental Protection and U.S. EPA

discharge guidelines, a water treatment solution was needed. A custom treatment process was developed using nine of the proprietary technologies deployed under license to Kaizen Fluid Systems that would address the producer's requirements.

As designed, the treatment system would extract the solids into a form considered benign and useable and therefore, the operator would have no disposal costs. The treatment process would be designed to destroy the object chemicals and change ionic metals back to their oxide form, thus render-

ing them benign. Chlorides would be extracted from the brine stream either into a concentrated heavy brine form usable in drilling fluid, or as high-quality dry salts suitable for other commercial or industrial uses.

The discharge from such a system is considered pure water that is at near-distilled water quality. At that level, the discharge is ideal for fracking, drilling use or to safely discharge into the environment without worry of discharge violations.

Once a treatment process was designed, the produced water showed

a substantial improvement in overall quality. Results from discharge water tests by ALS Global are indicated in the chart.

It should be noted that along with the greatly reduced levels for chloride and metals, turbidity indication dropped to 0.18 from 226. Water Ph was close to neutral and could be adjusted to the producer's specific needs.

Storage Excluded

To meet the producer's requirements, a protocol developed for the project required all water be processed

in real time except for a buffer capacity before intake, at certain strategic intervals within the system, and at the discharge stage. This greatly reduced the need for costly large-volume storage or transportation and helped reduce costs and environmental concerns for the producer.

Water treatment systems are operated by Kaizen. The use of real-time processing allows the company to monitor and control each phase in the process to ensure each step has met the predetermined process standards. And, by designing larger and smaller

treatment trains operating in tandem, the system can handle low- and high-volume requirements.

The Kaizen treatment process utilizes a number of proven technologies that have been licensed to the company. The process is classified as an electro-mechanical operation. In addition to cleaning produced water and flowback, it is designed to convert the extracted solids, liquids and gasses into useful commodities and virtually eliminate the need for any costly liquid or solid disposal.

All contaminant levels before and after treatment certified by ALS Global Laboratories.

	Before Treatment	After Treatment with Kaizen Technology	Percent of Contaminants Removed
Total Dissolved Solids	318,000 ppm	144 ppm	99.955%
Total Suspended Solids	297 ppm	5.4 ppm	98.182%
Chloride	181,000 ppm	3.98 ppm	99.998%
Barium	11,600 ppm	0.115 ppm	99.999%
Iron	102 ppm	0.01 ppm	99.990%
Magnesium	1,820 ppm	0.1 ppm	99.995%
Zinc	6.7 ppm	0.0039 ppm	99.942%
Aluminum	3 ppm	0.0031 ppm	99.897%
Strontium	7,270 ppm	0.113 ppm	99.998%

- All other minerals and metals are at a fraction from their starting point.
- Complete before and after treatment analytics are available for review.

Before and after water sample test results show a significant reduction in TDS, metals and chlorides. Graphic by: Kaizen Fluid Systems.

Some of the valuable metals can be marketed as a commodity and return a profit higher than the oil and gas itself.

▼ Second stage in Kaizen's treatment design includes a non-conventional desalinization process.





▲ Components of a Kaizen fluid treatment system include separators such as this.

The water treatment systems designed for oil and gas producers have successfully removed or destroyed all chemicals present in the stream and are not limited by high concentrations of silts, clays, chlorides, bacteria, fungus, and parasites.

Valuable Extract

The constituents in produced water can widely differ from one region to the next and even from one well to the next. Often, the water to be treated contains metals and chlorides that, once extracted and collected, can be marketed as a valuable commodity.

In many instances, the value of precious minerals extracted from produced water is overlooked by the producer. Our experience has shown that some of these valuable metals can be marketed as a commodity and return a profit higher than the oil and gas itself.

Treatment systems can be designed to treat produced water with TDS concentrations up to 400,000 mg/L or higher

As an example, the company has treated produced water that contained sufficient levels of lithium, cobalt or vanadium, all considered valuable commodities, to make marketing them separately as a commodity an economical proposition. Depending on market conditions, these minerals can sell for \$20,000 to \$90,000 per ton, enough to provide a return that offsets the cost of produced water treatment.

Two-stage Process

Our Advanced Water Recycling System operates in two stages. The first involves a Ph adjustment, solids removal, chemical destruction and metals removal using eight of the nine technologies used in the full process. The second stage involves removal of salts using a non-conventional desalination process.

The two-stage process is designed to remove all solid and chemical impurities from the produced water input stream and create a “pure brine” for the second stage feedstock where the salts are removed. The discharge water is classified as high grade and close to distilled quality.

Because fully treated discharge water is so clean, producers looking for frac-level brine may require an additional, final step in the process. This involves outflow dilution with some level of pre-treated water to meet their requirements. Because water treatment costs are charged per barrel, this final step can help reduce costs because fewer barrels are being treated.

The water treatment systems produced by Kaizen are custom designed for each producer. Systems can be

designed for very high TDS levels and water volumes as low as 50 g/m. Designs can be customized to treat produced water with TDS concentrations up to 400,000 mg/L or higher. We believe that as long as the column is somewhat fluidic and can be pumped, we can treat it to clean discharge standards.

By working with the producer, a custom water treatment facility can be designed with only the equipment needed to meet the specific requirements of the project. For treating water with no TDS removal required, less equipment is deployed. For producers with high-volume, high-TDS water treatment requirements, a system can be developed that is capable of processing high volumes of water with TDS of 350,000 ppm or higher.

Water treatment systems have been supplied to producers that reliably treat TDS levels exceeding 400,000 ppm and that return water with TDS levels below 200 ppm, which is within federal and state standards. Chemical compounds and metals in the returned water are generally at a fraction of the levels permitted for potable water and pure chlorides can be extracted for reuse commercially or as brine in well drilling and completions.

Water treatment systems designed by Kaizen have been shown to return water with TSS and TDS levels at one percent; near-complete removal of bacteria, organics, silica, and heavy metals; most NORM and radioactive elements neutralized and removed; a near-complete removal of salts and sulfates; and complete removal of free and emulsified oils, dissolved hydrocarbons and biocides.

Depending on the content of the produced water, Kaizen can design a program to collect, remove and market economic quantities of precious minerals extracted in the process and provide a revenue return to the producer.

Operating since 2013, Kaizen Fluid Systems can provide custom, confidential water treatment services to producers in all active oil and gas production regions in the U.S. With near distilled-quality water output and potential for revenue from metals marketing, our systems provide a different perspective on water treatment. ■

About the Author

Sandy McDonald, Chief Executive Officer at Kaizen Fluid Systems, is an entrepreneur and independent



real estate developer with experience in more than \$800 million in projects. His work includes schools, shopping malls, residential sub-divisions, industrial complexes and waste water treatment plants. His interest in developing projects that benefit communities has led him to secure licenses to a variety of technologies, including those used in the Kaizen water treatment process. Mr. McDonald holds a seat on professional and industry boards, including Alberta Electric System Operator, Alberta Real Estate Insurance Exchange, and several other real estate and community assistance boards.