Wastewater Treatment Process

SOLVAQUA

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Focused Water Management Solutions

Contents

Introduction

It is estimated that well over 80 per cent of wastewater worldwide (over 95 per cent in some developing countries) is released into the environment without treatment (UNESCO, 2017, p. 10). A United-Nations backed study showed that annual treated wastewater in North America roughly equates to the volume of Niagara Falls; less than 4 percent is reused (Collins, 2013, para. 1).

The market for water and wastewater treatment technologies is likely to grow at a compound annual growth rate of 9% during the forecast period 2019 - 2024. One of the major driving factors of the market is the rapidly diminishing freshwater resources across the globe. However, lack of awareness on appropriate usage of water treatment techniques is likely to restrain the market ("Wastewater Growth Trends," 2019, para. 1). The demand for innovative treatments to enable reuse of water is on the rise as operators seek the most cost-effective strategies for handling the increasing volumes of oily and organic wastewater.

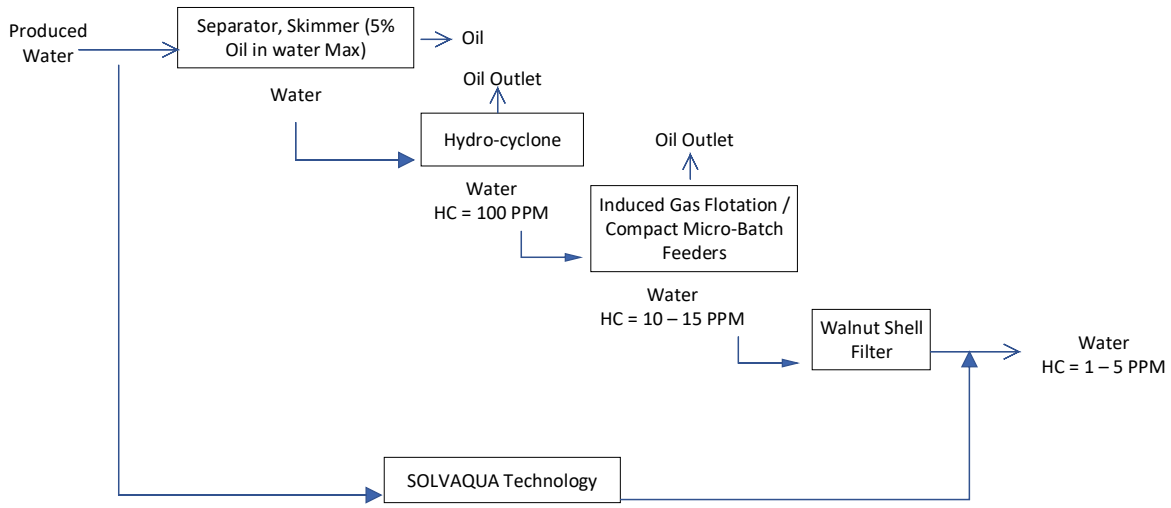
The demand for innovative treatments to enable reuse of water is on the rise as operators and municipalities seek the most cost-effective strategies to handle the increasing volumes of oily and organic wastewater and the effective recovery from a release of hydrocarbons to a waterway. It is sometimes the case where the most cost-effective strategy in the short-term is not always the most cost effective long-term. SOLVAQUA supports organizations in their short and long-term waste reduction goals by providing location specific and process specific solutions for the treatment of wastewater for reuse or repurposing.

The primary environmental benefit from our technology is to provide Clean Water for re-use in many sectors (not limited to) such as:

- Industrial
- Oil & gas operations
- Irrigation
- Municipal
- Reinjection
- Agriculture
- Recreation
- Disaster Recovery
- A preface for reintroduction into navigable water or for preparation of drinking water

The use of our technology results in environmental benefits by enabling increased volumes of produced water for re-use in fracking or by providing a more effective injection fluid and by reducing the amount of fresh water used for industrial and oil & gas purposes.

Enabling the processing of industrial wastewaters, existing wastewater storage, polluted lakes, rivers, streams and storage sites (tailings ponds). Reuse of wastewater reduces the continued use of freshwater while wastewater is being discharged.



The Technology

The baseline technology is one of physical force combined with chemicals to filter and separate the oil, grease and solids from produced water and wastewater. Our technology will displace or compliment the use of the current physical and chemical processes.

Water phase clarification was observed for treated aqueous mixtures containing every oil or oily contaminant type tested including crude oil/produced water mixtures, bilge water, waste oil, oil from ground water remediation operations, refined oil, solvent extraction reagent carrier mixture, vegetable oil, mineral oil, edible oil, fish oil, essential oil, plant oil, non-dairy coffee creamer, milk, peanut oil, peanut butter, food residues, engine oil, lubricating oil, hydraulic oil, soluble cutting oil, silicone oil, bitumen, tar, drilling mud, coal tar, tar sand extract, animal oils and fats, soap, grease, butter, dairy product, paraffin, oil-based paint, linseed oil, DEET toluamide mixture, epoxy resin, alkyl amine, ethoxylated alkyl amine, ethoxylated alkyl phenol and so forth.

Our process has been tested in the United States, Canada and Mexico. Qualification programs have been carried out with operators both onshore and offshore.

Commercial projects

- River Rental Tools, Gulf of Mexico. Processing fluid from 20 pipelines.

- Crescent Point, Utah. Produced Water for reuse in Fracture Stimulation Treatments.
- Vecta, Montana USA. Produced Water. Ongoing.
- TCRI, Wyoming, Produced Water for reuse in Fracture Stimulation Treatments.
- IWM, Duchesne, Utah. Produced Water for disposal and reuse in Fracture Stimulation Treatments.
- Southwestern Production, Produced Water for reuse in Fracture Stimulation Treatments. Ongoing
- Almoloya del Rio, State of Mexico, Mexico. Municipal Wastewater treated for discharge and reuse.

The Water Treatment Process

Hundreds of "Jar Tests" have confirmed the Nano Polymer will work with oil & gas, industrial, and municipal wastewater streams.

This process will reduce; the discharge of untreated wastewater, injection of produced water and trucking of produced water. The unit of measure to show effectiveness is the volume of wastewater reuse in m3 per day. Reduction in the use of fresh water is based on volume combined with the number of times a wastewater is reused. Reduction in CO emissions can be multiplied by the reduction in the number of trucks utilized to transport water. It is area specific.

The SOLVAQUA Oil & Solids Removal unit (OSR) is a compact treatment package that provides efficient separation occurring within a substantially smaller footprint than a conventional separator. This process for treating water with residual oil grease and/or solids includes a source of intreated wastewater comprising residual oil grease and/or solids. The OSR is coupled to a tank or source water that propagates a flow of the untreated water to the OSR. The source fluid is driven through four inline mixers (Koflo®) where the source fluid is dosed with chemicals.

The **"first"** inline mixer is where the caustic is added to adjust the pH.

The **"second"** inline mixer, located in the piping, downstream of the first, is where the micro-encapsulating flocculating dispersion (MFD) flocculant is added to the water. The addition of the MFD flocculant at this point will cause flocculation of residual oil, grease and/or solids in the water to form a pin flocculant.

The **"third"** inline mixer located in the piping, downstream of the second inline mixer, is where the activator is added. Addition of the activator turns the MFD into a scavenger.

The **"fourth"** inline mixer, located on the piping downstream of the third, is where the conditioner is added and aids in the bulking of the flocculant.

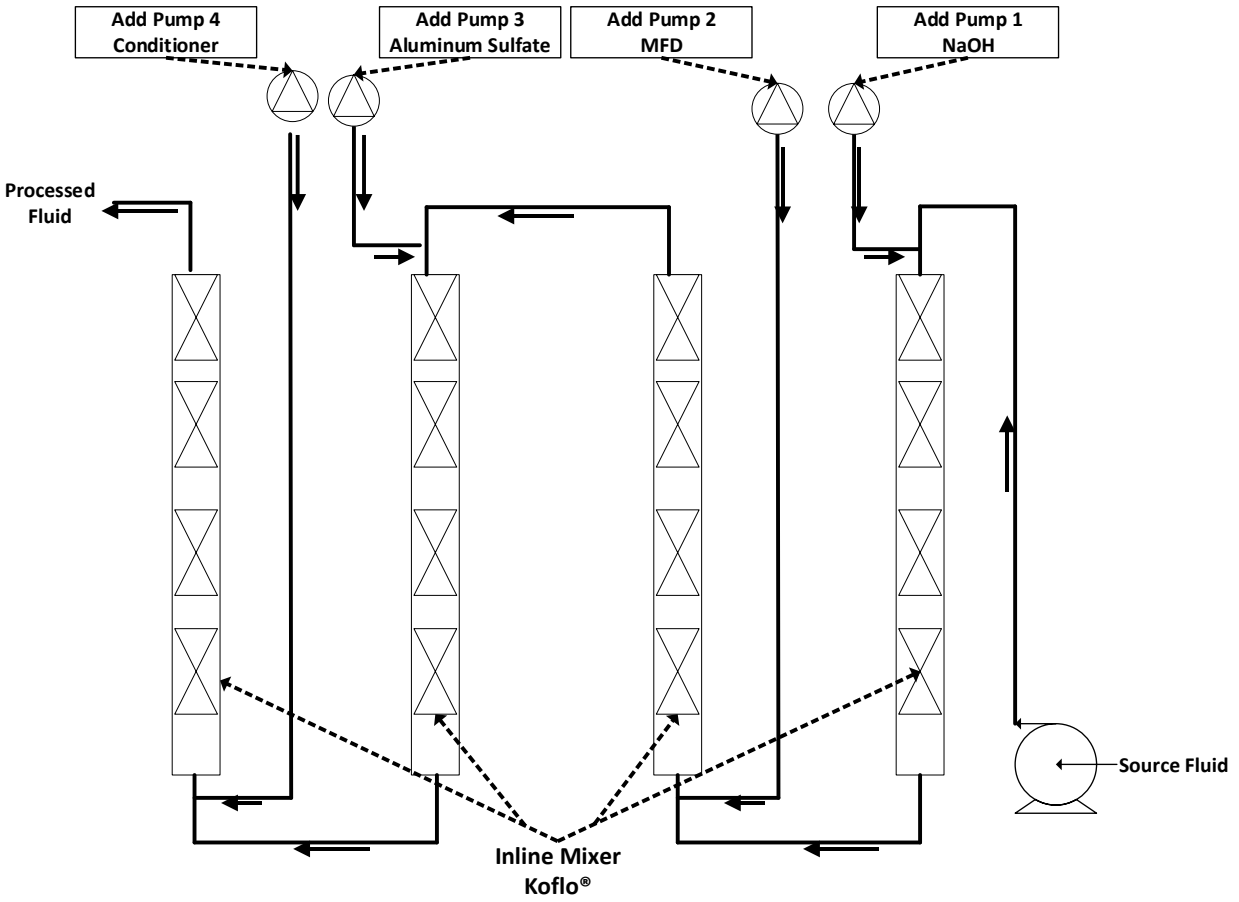


Figure 1

Dosing Volume Examples							
Chemical	**Concentration**	**Dosing Concentration**	**Treated Volume**		**Chemical Usage**	**Chemical Usage**	**Blended Chemical Usage**
	%	ppm	bbl	M3	gal	Liters	Liters
NaOH	50%	50	25,000	4,000	105	397.5	397.5
MFD	20%	30	25,000	4,000	157.5	596.2	2384.8
ACTV	48%	100	25,000	4,000	218.75	828.1	828.1
COND	100%	3	25,000	4,000	3.15	11.9	2384.8
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Chemical	**Concentration**	**Dosing Concentration**	**Treated Volume**		**Chemical Usage**	**Chemical Usage**	**Blended Chemical Usage**
	%	ppm	bbl	M3	gal	Liters	Liters
NaOH	50%	50	10,000	1,600	42	159.0	159.0
MFD	20%	30	10,000	1,600	63	238.5	953.9
ACTV	48%	100	10,000	1,600	87.5	331.2	331.2
COND	100%	3	10,000	1,600	1.26	4.8	953.9

Figure 2

Lab Results Examples

Client A Produced Water	Untreated		Treated	Difference
Oil & Grease	667.0	mg/l	8.00	98.80%
Fe	24.44	mg/l	0.072	99.71%
Client B Produced Water	**Untreated**		**Treated**	**Difference**
Oil & Grease	14	mg/l	2.70	81%
Fe	11	mg/l	0.88	92%
Client C Produced Water	**Untreated**		**Treated**	**Difference**
Oil & Grease	<5	mg/l	<5	100%
Fe	8.267	mg/l	0.0037	100%
Client D Produced Water	**Untreated**		**Treated**	**Difference**
Oil & Grease	21	mg/l	<5	100%
Fe	8.843	mg/l	1.784	80%
Client E Produced Water	**Untreated**		**Treated**	**Difference**
Oil & Grease	157	mg/l	<5	100%
Fe	8.843	mg/l	2.791	68%

Figure 3

A processed source water is pumped to a settling tank where the water is collected allowing flocculants (bulk and/or pin) to settle out from the collected water to produce separated treated water and flocculant in the settling tank. This is primarily due to the high active absorptive surface area of the Nano-Polymer.

The SOLVAQUA treatment process can manage much higher oil, grease and solids concentration and accommodate the flow rate fluctuations in comparison to the other separation technologies such as the DAF, Hydro cyclone. There are no restrictions to flow rate as the OSR is designed to meet requirements. The OSR are manufactured to meet the requirement of the project or, the Nano-Polymer technology can be incorporated into the current on-site wastewater process.

The additive dosing is optimized for each application and represents minimal impact on the working life of the unit.

The process for operation was designed with a Variable Frequency Drive and Magnetic Flow Meter to enable changes to flow based on the volume of source fluid provided. The OSR is programmed for automatic operation with additives adjusted via the unit control panel based on separation results which when programmed effectively are instantaneous. Validation of regulatory and contract deliverables, and analysis are completed to ensure the wastewater processing is matched to operational and environmental conditions based upon local conditions year around. There are

planned assessments completed that factor in client as well as local industry requirements, as none of them alone mitigates risk to an acceptable level. An agreed upon "Quality Plan" includes; Contract Deliverables, Service Execution Plan, Service Line and Product Risk assessments, Service Design, Contingency planning, Control over Critical Purchases and Services, Critical Task Assessments, and the Service Performance Validations.

"Performance Matters"

Figure 4

Figure 5

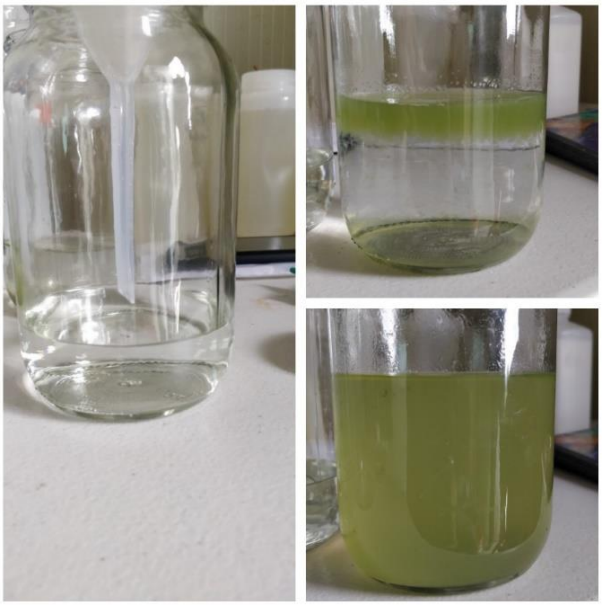

Figure 6

Preliminary Treatment (or pre-treatment)

A pre-treatment, or polishing stage, albeit physical and chemical, have been evaluated for this application and have been found to provide no benefit to the process. The SOLVAQUA process and technology is extremely effective as a pre-treatment or polishing stage for desalination, fluid injection and re-use in fracture stimulation treatments.

Secondary Filtration

Filtration may also be applied as a part of the final stages of treatment in the process. This is most commonly referred to as a polishing operation. Filtration equipment selection depends upon the specific operation that the equipment must perform.

Conclusion

Although wastewaters vary in composition, there are ranges of properties that enable the SOLVAQUA processing equipment and chemical technology to be specified. This is important to realize because although we incorporate a physical process, it depends upon and is integrally a part chemical treatment process that enables effective separation of oil, grease and solids. The chemical treatment dosing must be properly specified to i) enable effective separation and ii) be economically feasible. The addition of a secondary filtration and processing must be properly designed to ensure system

applied meets both customer and regulatory requirements.

The SOLVAQUA treatment process is utilized to separate oil/water in in a continuous process, 500 m3 to 4,000 m3/day, and in batch treatments 50,000 m3 to 1,000,000 m3. The process has proven to remove 99.99% of Hydrocarbons. The processed water stream can in most cases be discharged or injected without further hydrocarbon treatment. Our technology also removes total suspended solids (TSS) along with the hydrocarbon. This separation and removal technology where both the Hydrocarbon and TSS are removed by using the Nano-polymer dispersion is unique and represents a significant cost reduction to the management of produced water and wastewater processes.

Figure 7

References

Collins, T. (2013). Rising reuse of wastewater in forecast but world lacks data on "Massive Potential Resource". Retrieved from https://unu.edu/media-relations/releases/rising-reuse-of-wastewater-in-forecast-but-world-lacks-data.html

UNESCO. (2017). *Wastewater The Untapped Resource* [Development Report]. Retrieved from https://www.unwater.org/publications/world-water-development-report-2017/

Water and wastewater treatment technologies market - growth, trends, and forecast (2019 - 2024). (2019). Retrieved from https://www.mordorintelligence.com/industry-reports/water-and-wastewater-treatment-technologies-market

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Our Solutions Based Philosophy

We believe Energy Self Sufficiency drives industrial and infrastructure development.

We must be progressive and forward thinking in how we produce hydrocarbons as well as develop and enhance our industrial infrastructure. The communities where we work are demanding it. Government are mandating it. Why shut in production when cost effective operationally efficient and environmentally responsible solutions exist.

At SOLVAQUA we have the solution for your company's wastewater management – either water for industrial reuse, agriculture and community infrastructure, or it can even be clean, fresh water for reuse. We can even help provide surface discharge or a reusable Frac quality fluid.