

## MyCelx Polishers as an Intermittent Use, Tertiary Polishing System for Produced Water

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Deepwater production facilities in the Gulf of Mexico (GoM) and other regions periodically experience short intense upsets of their produced water treatment. These upsets are due to many factors inherent in their geological formation and physical location.

1. Hydrate formation and associated chemical dosing procedures (LDHI, Methanol, etc.)
2. Frequent startup/shutdown of production wells due to weather threats, new wells, tiebacks etc.
3. Large motions on board the platform from adverse weather conditions
4. Frequent rate changes in fluid production (slugging, debottlenecking)

In many facilities, these upsets happen with enough frequency and severity that excursions of hydrocarbons in produced water overboard or to disposal occur many times a year.

Operational excellence, HSE guidelines, regulatory pressure and other factors magnify the focus of facilities engineers on addressing the problem from the root cause and often putting procedures/equipment in place to mitigate the negative effects of these upsets. This is especially true after the Macondo spill and implementation of SEMS and enforcement by BSEE.

When experiencing intermittent upsets, focus for mitigation usually turns to both production chemicals and adding additional equipment. A typical response in the form of adding equipment to the produced water treatment system (tertiary treatment) is limited by many factors existing in the facilities and climate including the below.

1. Limited deck space
2. Limited housing for contractors / personnel
3. Expense of large lifts/crane ops

There are several well established companies in the tertiary treatment market that offer equipment and service to mitigate excursions. They generally require a large amount of deck space, and frequent lifting/rigging operations. To combat a negative image of frequent intervention, the companies offering the equipment generally require their own operators/personnel to run the equipment. This further takes up facility resources for accommodations and drives the cost to the customer up. Additionally, because of the cost and complexity of mobilization and demobilization associated in these types of facilities; coupled with the unpredictable nature of the produced water upsets – the equipment is left on board and operated even in periods where the permanent water treatment train is performing satisfactorily. This “solution” has a negative effect of creating a large recurring cost for the producer, and strain on limited facility resources.

MyCelx Technologies’ tertiary produced water treatment system, the MyCelx Polisher, is able to offer the advantages of tertiary treatment of produced water, without the negative burdens of large space requirements, operational complexity, and unnecessary recurring cost. MyCelx’s technology utilizes the chemical differences

inherent in hydrocarbons and water, and employs chemical cohesion to remove oil & hydrocarbons to extremely low concentrations and droplet sizes, using very compact and easily operated equipment. With low complexity, operators already on board can be trained how and when to use the system, allowing for cost to be accrued only when necessary.

MyCelx polishers consist of vertical pressure vessels housing easily accessible and replaceable internals that perform hydrocarbon filtration from the produced water stream. MyCelx’s unique polymer chemistry allows for functionalization of a surface to accumulate and agglomerate liquid bound hydrocarbons into a cohesive amorphous solid mass. Then, when the holding capacity of the system is reached, a simple operation using a single operator to manually replace spent filtration internals with fresh internals is required. MyCelx’s Polisher offering consists of 2 x 100% specified flow capacity, to allow for varied schedules of maintenance or downtime while still offering complete redundancy. A typical operator can remove old internals and replace with new in under 4 hours (20,000 bbl./day size). The operator only needs to be able to lift 10 lbs manually, and use general hand tools to complete the process. Because of the MyCelx polymer, the oil accumulated permanently remains on the spent internals, allowing for a clean changeout and easy disposal into already existing waste stream on the platform (oily rags).

In general, normal facility operations call for minimum twice daily testing of the overboard water quality (daily IR). The operation of MyCelx can be tied to the results of this water testing. When poor performance of the produced water train is noticed or predicted, MyCelx can easily be put into service by the actuation of only two valves. Furthermore, late trends in the offerings of oil analyzers that require very little maintenance allow for further automation of the polishing system. When operators notice differential pressure buildup in the solids pre-filtration, replacement of solids filter elements are required. When single pass oil removal drops below 20% of initial efficiency (inflection point) the polishing internals are near spent. This can be monitored via grab sampling or online oil monitors.

Using the MyCelx Polisher only when needed allows for the lowest possible operating expenditure. The MyCelx Polishing technology is not sensitive to hydrocarbon concentration, but droplet size. Because of this, it is still possible to be using the finite holding capacity of the polishing internals when flowing produced water through the MyCelx even at very low inlet concentrations (<10 ppm).

The table below shows system footprint size for various flow rates. Each system represents solids protection via bag filtration, three stages of MyCelx Polishers and 2 x 100% flow capacity (mounted on a single ready to tie in skid).

Flow Rate	Footprint, ft.	Weight, lbs. (dry/operating)
2 x 5,000 bpd	11' L x 7' W x 10' H	13,000 / 18,000
2 x 25,000 bpd	16' L x 10' W x 12' H	28,000 / 36,500
2 x 50,000 bpd	20' L x 12' W x 13' H	47,000 / 60,000

The benefits MyCelx offers operators have been received well in the GoM. There are two new major installations on deepwater platforms this year. This builds on the continued success of another deepwater installation in the GoM, commissioned 11/2011. Over 2,000 data points of this installation using on board grab sampling have been collected and collated. The results are summarized in the table below.

Total Data Points (n)	2,057
MyCelx Data Points (n <sub>1</sub> )	512
Timespan of Data Set (days)	413
Percentage of Time MyCelx Deployed	16%
Average MyCelx Deployment Period (hours)	18.5
Maximum MyCelx Deployment Period (hours)	161
Average Water Overboard Flowrate (bbls./day)	6,500
Average MyCelx Inlet (ppm)	39.8
Maximum MyCelx Inlet (ppm)	418
Average MyCelx Outlet (ppm)	3.75
Total Operating Expenditure	\$125,150
Cost to Treat (\$/bbl.)	0.07
Total maintenance (man hours)	59
System Design Flowrate (bbls./day)	25,000
System Footprint (ft.)	14' L x 10' W x 8' H

During the period of operation with the MyCelx system as a safeguard (line 2), the platform has never discharged water with sheen or violated NPDES guidelines. This has occurred with no extra contractors on board, because of the simplicity of operation. Also, because of the manual hand tool only maintenance there was no additional demand placed on the facility to perform crane operations for equipment exchange. The MyCelx polisher offering was small enough to fit 2 x 100% capacity into the limited space available making the retrofit a permanent solution to the facility's recurring problem. Before the implementation of MyCelx at this location, there was a previous tertiary polishing system from a service company in place. Three operators from the service company remained on the platform at all times. The deployment of this service approach cost the facility owner approximately \$6,000/day averaged over 18 months. During the first year of operation of the MyCelx tertiary polisher after commissioning, the average cost was \$350/day. After process improvement and increased automation, the second year cost has fallen to \$195/day. This leads to a ROI on the capital expenditure for the MyCelx system of less than 180 days!

The MyCelx Polisher offers an alternative to facilities engineers in the GoM who need a solution for temporary upsets to the produced water treatment technologies available. The small footprint, low capital cost, extremely simple operation and proven results offered by the MyCelx Polisher are welcome changes to help overcome the traditional drawbacks of tertiary treatment.

MyCelx offers fully designed, engineered and fabricated skids for new build facilities, as well as offering an expanding fleet of rental equipment. Rental equipment is available for short and long term rental with a low monthly equipment fee. MyCelx also offers rent to own programs and capital recovery of rental costs towards

new build systems specifically for a customer facility. This effort has significantly sped MyCelx's ability to deploy its equipment to operators in need of immediate produced water treatment.