

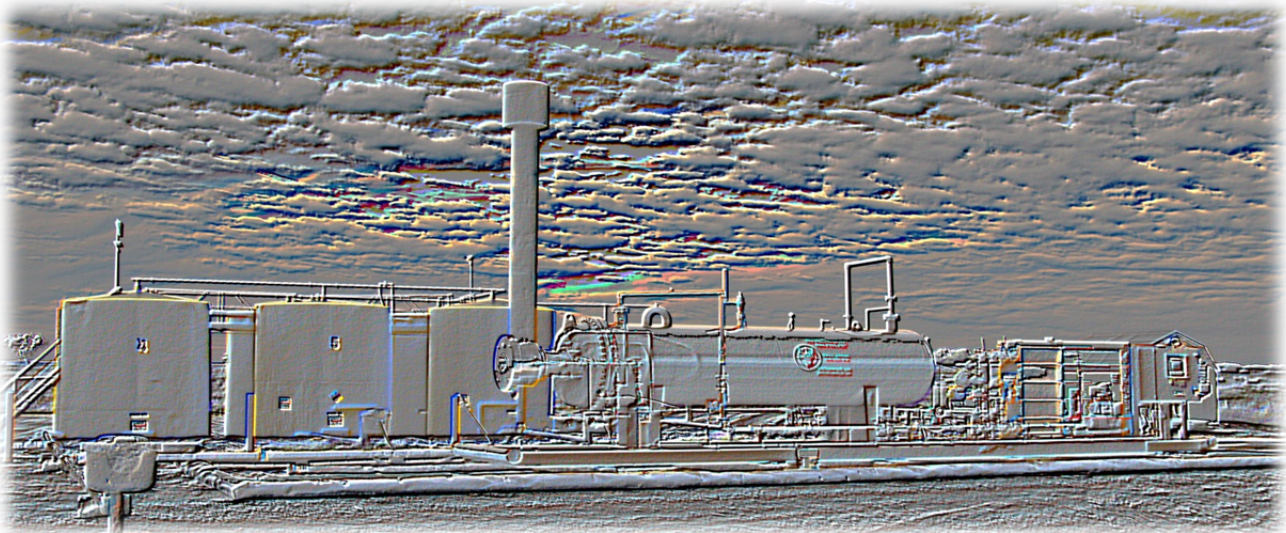
# L-POD<sup>®</sup>

*A Breakthrough Technology, Eliminating Crude Oil Rejects*

## FIELD TEST REPORT<sup>©</sup>

*Prepared For*

**All Customers and Prospective Customers of  
Red Stag Energy, LLC  
Tulsa, Oklahoma**



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## **L-POD<sup>™</sup> EXECUTIVE SUMMARY**

**An innovative “missing-link” technology known as L-POD<sup>®</sup> has been designed, developed and now proven to eliminate the need for labor and capital intensive blending of off-spec crude oil in the pipeline terminals. To prove the value of L-POD<sup>®</sup> the first L-POD<sup>®</sup> unit was field tested in a pipeline terminal in May, 2015. The results of that test prove L-POD<sup>®</sup> functions as expected, eliminating off-spec crude. That test is documented in this report.**

## **L-POD<sup>™</sup> BACKGROUND**

The concept of L-POD<sup>®</sup> was developed in September 2013 to fill a void in the pipeline sector of the oil industry. That void is the industry’s inability to process crude oil at pipeline terminals to remove entrained contaminants. L-POD was conceived to fill that void.

It all started innocently enough, in a conversation over lunch between a seasoned entrepreneur, an industry leading process equipment designer, and a senior pipeline company executive. The subject of that conversation was the huge volumes of off-spec crude oil in the marketplace, and the difficulty of the pipeline industry to deal with it in its traditional way, blending off-spec oil into high quality crude to render the mix saleable. “What if”, these men pondered, “... it was possible to remove contaminants at each remote pipeline terminal before they became an operational issue?”

No such system existed. But clearly, the need was there, and it was growing. The pipeline executive suggested that if such a system could be developed, and proven to work, it would be an industry breakthrough. The engineer suggested that the technologies necessary exist, though yet not combined into a format suitable for this application. The entrepreneur suggested that this concept presented a potentially viable business opportunity. So, work began immediately to combine known technologies into a format to fit this challenge and business opportunity.

By February 2014 what began as a casual concept over lunch was transformed into engineering drawings, process descriptions, and a formal patent application. Patent searches proved that no competing technology existed, patent application was filed with the US Patent Office, and patent pending status was granted under the name “L-POD<sup>™</sup>”. The trade name was applied for and granted soon thereafter creating the designation “L-POD<sup>®</sup>”.





Detail engineering began immediately, followed by the initiation of construction of the world's first complete L-POD<sup>®</sup> unit. The unit was finally completed in the third quarter of 2014, just as the oil industry experienced a repeat of the traditional boom-to-bust cycle.

Late in 2014 industry activity ground to a halt as all oil industry related firms reduced spending. During the next eight months no new activities were even contemplated. Finally, as the price of oil stabilized at half what it had been in early 2014, and as the industry's reaction to price reductions stabilized, the time came to install and test the world's first L-POD<sup>®</sup>.

In April 2015 the first L-POD<sup>®</sup> was shipped to a remote pipeline terminal in western Oklahoma, was installed and tested.

The results proved once and for all that L-POD<sup>®</sup> resolves even very difficult BS&W issues as expected, proving it has a practical and economically viable position in today's oil industry. L-POD<sup>®</sup> presents all pipeline terminals with a breakthrough technology that increases both terminal cash flow and operating profits. In addition, L-POD<sup>®</sup> promises to improve overall industry efficiency by eliminating crude oil contaminants before they enter the crude oil transmission systems transporting crude to the nation's refineries.

### **PROCESSING CRUDE OIL IN PIPELINE TERMINALS WITH L-POD<sup>®</sup>**

Most crude oil entering pipeline terminals has been processed in the field by the producer. This process often fails to achieve "pipeline quality" crude oil, so the crude is sent to a nearby terminal still containing contaminants known as basic sediment and water (BS&W). When analyzed the BS&W is most often a mixture of:

- Inert solids
  - Iron Sulfide
  - Scale crystals
  - Corrosion deposits
  - Formation fines
- Water
- Basic Sediment
  - Paraffin
  - Asphaltines
  - Stable emulsions

Whereas the majority of these contaminants may be removed at the oilfield processing site by conventional separation equipment, the remnant BS&W in crudes entering pipeline terminals is often not so easily removed from crude oil by conventional methods.





L-POD® is an unconventional system designed specifically for this purpose. It functions by circulating off-spec crude from off-spec crude oil storage tanks through L-POD® repeatedly until the desired results are achieved. A special L-POD® pump is used for this circulation; a pump unlike all others that is designed specifically to eliminate further quality deterioration of the crude and its contaminants. During each circulation cycle a portion of the contaminants are removed, until the crude reaches pipeline quality. During the circulation process the off-spec crude automatically rotates from storage to L-POD® and back to storage. When the crude being processed achieves the desired quality it is automatically sent to a dedicated LACT (or "Run") tank from which it is transferred (sold) into a pipeline at full commercial value.

### **A DETAILED DESCRIPTION OF L-POD®**

L-POD® is an acronym for "Lease Portable Oil Dehydrator". In layman's terms this means the system is designed to remove naturally occurring contaminants from crude oil streams arriving at pipeline terminals from all manners and types of crude oil producing or generating sources nationwide. L-POD® is the marriage of the industry's best, most widely proven individual technologies and systems, consolidated in a unique way into a modularized and system formatted to perform the distinct task of removing crude oil contaminants prior to the crude's entry into the pipeline, truck, or rail car transportation system that brings crude oil to the nation's chain of domestic refineries.

Since L-POD® is a grouping of various technologies, the first challenge the designers faced was to consolidate these technologies into a single physical structure. As is often the case in oilfield operations, this means the components are configured to physically fit on an oilfield skid. This structure is narrower than 8' wide and shorter than 40' whenever possible. This was possible, so L-POD® is a single skidded system.

Each of the major components of L-POD® is patented, and the assembly as a whole is also patented as a system.

L-POD® key components are:

- A special low sheer, speed controlled oil transfer pump designed to move inlet crude oil from storage into L-POD® at variable rates without adversely affecting its quality.
- A special heat exchanger designed to increase the thermal efficiency of the entire system to conserve fuel and minimize operating costs.





- A unique heating, separating, and metering vessel designed to efficiently remove contaminants from crude oil.
- A unique and automated control system designed to manage the crude oil quality improvement operation with minimal human intervention.
- An instrument air compressed air system to eliminate the environmental concerns over hydrocarbon emissions from the use of instrument gas.
- An automated chemical feed system to optimize the addition of oil quality improving chemicals if and when necessary.
- Dual Coriolis metering systems to accurately meter the inlet and outlet crude oil streams (same systems used on most oilfield LACT systems).
- Dual FMC/Invalco BS&W (basic sediment and water) electronic detectors (same systems used on most oilfield LACT systems).
- Dual redundant burner management control systems to safely manage the heating components of the L-POD<sup>®</sup> system.
- Turbine flow meter water metering system for the accurate recordation of all water separated from influent crude oil.
- All welded piping consistent with ANSI B-31.3 and 16.5 industry standards (as used in all USA refineries).
  - Steel flanged ball valves throughout, each with stainless steel and Teflon trim.
  - Industry standard Invalco, Kimray, and Norriseal instruments, valves, and controls.

## **L-POD<sup>®</sup> FIELD TEST**

Initial commissioning, start-up, and testing of L-POD<sup>®</sup> occurred in a small pipeline terminal in western Oklahoma in May, 2015.

In order to prove the functions of L-POD<sup>®</sup> all testing was conducted objectively using industry standard practices and referee methods to assure the irrefutable validity of the results. Even though L-POD<sup>®</sup> is fitted with automation and electronics capable of reporting continuous BS&W concentrations, physical samples were taken and centrifuged consistent with API standard procedures to prove the actual BS&W concentrations beyond a shadow of a doubt.





The test site can be seen here (below).



**GRAPHIC 1: L-POD<sup>®</sup> INSTALLED IN A PIPELINE TERMINAL IN WESTERN OKLAHOMA (5/2015)**

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During this period three widely varying qualities of crude were processed to prove L-POD<sup>®</sup>'s abilities to process a wide variety and representative cross section of produced off-spec crude oils. Oil was processed at a constant rate of 100 gallons/per minute or 3,428 barrels per day. Process temperatures were varied from ambient (roughly 40-55°F during the test period) to 165°F to test the unit's ability to process varied crudes at various temperatures using the real-time process results to vary the process temperature to achieve optimum results.

The commissioning of L-POD<sup>®</sup> was initiated using medium grade 36°API paraffinic crude with comparatively low levels of contaminants (BS&W). This crude initially contained 0.1% emulsion, 0.9% free water, 0.1% solids, and 1.2% BS (paraffin/iron sulfide) for a total of 2.3% BS&W.

During commissioning all automation components were calibrated, checked, and double checked. All operating set points were established and confirmed. All alarm and





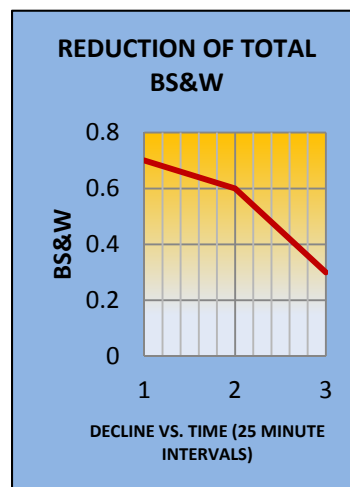
shutdown conditions were identified and proven to function, readying the system for the actual start-up.

The goal of the initial operation of L-POD® following commissioning was to prove that L-POD® either would or would not improve the quality of the crude oil being circulated through it.

During start-up the above mentioned crude oil was continuously circulated through L-POD®. This circulation continued uninterrupted for an initial period of three hours.

During this time the effluent crude oil was sampled every 30 minutes and quality checked using a pipeline centrifuge to determine and compare the actual quality of the influent compared to the effluent oil leaving L-POD®. The test results showed that crude oil quality continuously improved.

The results after only 75 minutes of circulation showed that the oil quality was considerably improved to 0.2% emulsion, 0.0% free water, 0.5% solids, and 0.0% BS (paraffin/iron sulfide), a 70% improvement, proving that even slightly contaminated medium grade crudes can be successfully processed through L-POD®.



GRAPHIC 2: L-POD® PERFORMANCE

At this point the inlet stream was changed to a more difficult stream of lower gravity high paraffin content Kansas crude. This crude had been pre-treated at the source by boiling off the light ends and water by raising the temperature to above 212°F. This sort of treatment generally creates a precipitation of mineral salts and organic asphaltine crystals which become the catalyst for a stable, difficult or impossible to resolve emulsion.

This batch was circulated for 120 minutes to determine whether or not L-POD® would have any effect on this difficult crude. Inlet concentrations were 0.3% water, 0.3% solids, and 2.0% emulsion (a mix of oil and water droplets smaller than 30 microns).

At the conclusion of this brief test period centrifuged samples proved that L-POD® can and does positively impact the quality of even this most difficult to treat oil. The effluent oil showed a 90% reduction of the emulsion and a 33% reduction of the solids component!





## TEST RESULTS

During the initial test of L-POD<sup>®</sup> it performed as expected on a difficult 32° API Kansas crude and a more typical 36° API Oklahoma crude, showing the expected trend to continuously reduce BS&W concentrations in both cases. While more testing will be performed as more L-POD<sup>®</sup>s are placed in service, the success of this testing confirms the value L-POD<sup>®</sup> brings to the pipeline terminals and other oil industry facilities where resolving off-spec crude oil to pipeline quality crude generates additional cash flow via a non-discounted WTI sale price, at last!

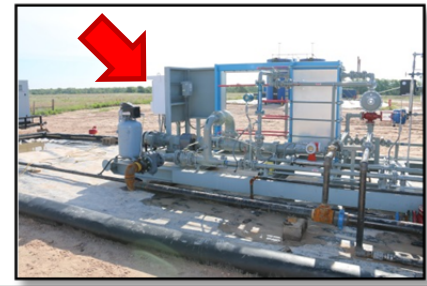
## L-POD<sup>®</sup> COMPONENTS (THEY MAKE IT "TICK")



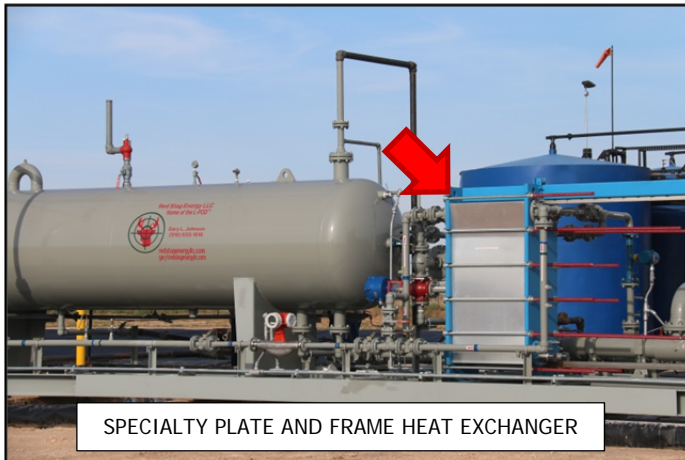
BS&W MONITOR



HIGHLY ACCURATE CORIOLIS METER



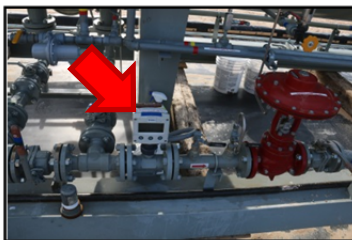
AUTOMATION: RESULTS TO THE "CLOUD"



SPECIALTY PLATE AND FRAME HEAT EXCHANGER



AUTOMATIC SEPARATION VESSEL LEVEL CONTROLS (UNATTENDED SERVICE)



WATER OUTLET TURBINE FLOW METER DOCUMENTS VOLUME



OIL OUTLET CORIOLIS METER FOR MAX. ACCURACY

