L-POD® System Eliminates Rejects

"Where Engineering Meets Ingenuity"

EXECUTIVE SUMMARY

The L-POD® system is the industry's leading process system designed exclusively to eliminate rejects by automatically resolving oilfield emulsions. L-POD® was designed by the professionals at Breakthrough Engenuity and Red Stag Energy LLC (RSE).

Red Stag Energy LLC alone exclusively markets the L-POD® system to the oil and gas industry. As such, RSE is proud to introduce you to its unique and singularly efficient system to cost-effectively ***eliminate all rejects in the crude oil*** *in pipeline terminals everywhere.*

RSE's proven Lease Produced Oil Dehydrator (aka "L-POD®") is a completely self-contained BS&W elimination system. The heart of the system is a patented BS&W treating system developed for and successfully ***in use today in over 1300 applications*** *in the prolific Eagle Ford and Permian Basin oil fields of west Texas.*

The average LACT Unit documented BS&W cut in these 1300 units was documented by LACT Unit records at 0.0285% during the entire year of 2013!

L-POD® incorporates a select grouping of carefully selected and patented subsystems. These include a heating system that generates its own fuel, a crude oil water and solids removal system, the world's most efficient heat exchanger built to RSE's strict specifications and built by the world's most respected firm, and the industry's most efficient low shear oil pump, the "progressing cavity" pump used to move wet crude from storage into and through L-POD®, sending pipeline quality crude to sales.

Once L-POD® is placed in service in a typical pipeline LACT station it eliminates the labor intensive need for crude blending, the typical method of dealing with off-spec crude oil. This process satisfies all pipeline BS&W (basic sediment and water) requirements without the need for blending.

With L-POD® you can rest assured that your crude will once and for all time always be ready for sale with BS&W concentrations normally below 0.2%! This will reduce the heretofore ever-present juggling and blending of your crude. Doing so will simplify and streamline your crude handing ability. L-POD® will reduce the time, management, administration, and operations costs associated with BS&W management today, making Mercuria the most efficient crude oil storage company in its areas of operation. This will further distinguish you from your competitors, increasing your leadership, image, and reputation in the field.

Understanding the L-POD®

RSE recognizes that you may have limited or no experience in the field of crude oil dehydration or the operation of such systems. Therefore, RSE proposes to design, build, transport and supervise the operation of the L-POD® system for your crude oil storage facilities. This system will be is completely self-contained, skidded and trailer transported for ease relocation to your facilities. The purpose of L-POD® is:

1. *To prove the technical and economic viability of eliminating rejects.*
2. *To demonstrate the ease of operation in order to get "buy-in" from all involved.*

While proving the merits of L-POD® is important, RSE's management team knows that if the field people buy in from the beginning they will embrace the system, use it, and your operation will reap the benefits. However, we also know that if they don't buy in up front, the system can become an unwanted component of your operations, and in that case could be by-passed.

Therefore, RSE will supervise all facets of the L-POD® operation during startup, and RSE will remain in a hands-on posture, monitoring the L-POD® operation throughout your use of this new (to you) system.

The L-POD® Technology and System

L-POD® is a patented technology. It has its roots in the separate patents of its specialty components. Chief among these is Patent Number 8,465,572 which was granted for the unique heated horizontal oil-water-gas separation system and proven to outperform conventional systems in over 1300 current applications. L-POD® is generically described as a horizontal "heater treater", however it's internals (where the work is done, of course) are anything but generic. Various additional patents describe the internals and distinguish the L-POD® from its more truly generic counterparts. L-POD® outperforms all other such systems by a factor of at least two. This system is perfect for the elimination of reject oil in your operation.

L-POD® is a highly efficient heated crude oil BS&W elimination system designed to generate its own fuel once in operation. The heating is accomplished with a gas fuel similar to the approach used in a household gas water heater. An industrial burner is fitted with the normal oilfield flame safety components assuring safe and efficient heat generation. The safety burner efficiently mixes gaseous fuel with air creating a quiet flame which "licks" the inner walls of a steel pipe known as the "firetube" (again, like the firetube in a natural gas household water heater). The tube heats the oil and emulsion. Inside the treater, freely separable water separates below the firetube and exits the treater unheated to conserve fuel. The crude oil, with its inherent BS&W, rises across the firetube. As the mixture is heated its viscosity, a measure of "thickness", is reduced dramatically until the crude oil and emulsion are as thin as the water itself. This promotes rapid and complete separation, leaving the crude oil ready to sell for the highest posted price.

Heating crude not only lowers its viscosity, it increases its effective API gravity, making it even more light compared to the water droplets in it. Once the oil is heated the water, being considerably heavier than ever-lighter crude oil, readily separates from the crude oil.

Since water droplets nucleate around tiny particles of solids, as the water droplets fall out of the oil, they carry with them the solids component defined as "basic sediment". However, heat alone will not resolve the entire emulsion layer (the BS&W component) of the crude oil. The smallest droplets naturally remain suspended in the oil even though they are heavier than oil. As the crude and emulsion move through the L-POD® the flowing velocity of the crude may exceed the separation velocity of the water droplets, so they can remain suspended in the oil. This means something further is needed!

The "something" is a very special internal apparatus known as the "Lamella Serpentine Vane Pack", or "LSVP". This is a coalescing apparatus (also patented) located near the outlet end of L-POD®. The LSVP is a series of stainless steel corrugated parallel plates tilted at 30°, consistent with the Lamella principle. The LSVP accumulates the tiniest of the water droplets as the crude and BS&W traverse the torturous pathways through it. As the water flows through the LSVP the water droplets impinge on the surface of the plates where they grow together, or coalesce. As their size grows so does their mass weight, until they become so heavy they "slide" down the tilted plates into the water phase below. This reduction in water concentration is identified as "dehydration". The oil leaves the vessel free of the separated water. Oil, now cleaned of all BS&W, flows out of L-POD® and on to sales oil storage.

During the separation process inside L-POD® all solids fall to the bottom of the vessel. A specially designed inverted "V" shaped solids removal system known as the "sand pan" is designed to remove any/all sand and silt from the L-POD® vessel without having to take the vessel out of service, precluding the necessity to physically enter the vessel to remove the sediment.

The process begins with your BS&W containing oil from your storage tanks. It enters L-POD® cool or cold. The clean oil leaving L-POD® is hot. At this point if we sent the dehydrated hot crude to sales oil storage as-is, the heat it contains would be lost … wasted! L-POD® is designed to eliminate this waste! Let's see how …

The hot oil leaving L-POD® flows into one side of a carefully engineered heat transfer system known as a L-POD®'s "plate and frame" heat exchanger (P&FHE). The cold, incoming crude oil flows through the P&FHE on dedicated flow channels divided by vertical plates. The hot dehydrated crude oil exist L-POD® on the other side of the same plates. The plate adsorbs the heat of the hot oil and exchanges it into the colder incoming oil, thus reducing the amount of auxiliary heat needed to raise the temperature of the cold incoming oil.

Built to RSE specifications, this system can be compared to the pages in a book. In this analogy, the cold fluid flows between every other page while the hot fluid flows between the alternate pages. With hot on one side and cold on the other, the hot pages in this analogy conduct, or transfer (exchange), the cold into the hot and the hot into the cold. The result is that the heat in the hot oil is exchanged into the cold incoming oil and the cold of the incoming oil is exchanged in the outgoing dehydrated crude oil.

In aggregate, P&FHE exchanger is so efficient that it reduces or completely eliminates the auxiliary fuel consumption of L-POD®, easily justifying the cost of this highly system.

The P&FHE has one additional advantage over all other types of heat exchangers. The plates (like pages in a book) are held together by long bolts. These can be loosened allowing the plates to be separated and rapidly cleaned. While this is necessary on a frequent basis, having the ability to do so means the life of the exchanger is indefinite. Any other heat exchanger would have to be periodically replaced.

Finally, for crude oil to be moved from storage to the L-POD® and back to sales oil storage a pump is needed. However, most pumps tend to aggravate the BS&W content of crude, acting as blenders. L-POD® uses a non-blending, non-shearing pump known as a "progressing cavity pump", or "PCP". This pump is similar in design to an auger, or screw pump. However, the PCP design eliminates sharp edges and rotates at very low speeds, eliminating the "blending" effect of a typical oilfield pump.

The PCP pump is fitted with a variable frequency drive to allow us to vary the speed of the pump and thus the fluid flow through the L-Pod® to optimize its performance, regardless of the quality (BS&W content) of the incoming crude oil.

These carefully selected components are skid mounted and pre-piped into the L-POD® assembly. Piping is extended to skid edge where hammer union connections allow for easy and rapid hook-up.

L-POD® is delivered on a flatbed trailer making offloading and setting it simply and quick. L-POD® is therefore fully portable. Once the system has completed its task, it can be easily relocated to your next facility where it will repeat its dehydration of crude oil there.

RSE will manage the delivery of your L-POD® system to your desired location. Your only responsibilities are:

- *Safe and secure site for L-POD®.*
- *Local installation services to interconnect the L-POD®.*
  - *Oil lines from and to your wet/dry oil storage.*
  - *Water line to your water holding storage.*
  - *Electrical connections to L-POD® (60 amp service for 480 VAC, 3-ph, 60 Hz)*
- *Right of ingress and egress for L-POD® and RSE's personnel.*
- *Fuel source*
  - *Natural gas connection to local source.*
    - *Minimum 25 psig.*
  - *Alternate temporary propane fuel.*
    - *Two (2) 500 gallon propane tanks with regulators.*

Intended Applications

The L-POD® is designed for applications created primarily by the development of oil shale production in the 21st century. This production is enhanced by horizontal completions and multi-stage fracking, the combination of which results in highly prolific wells. Since many of these

well have high initial shut-in and flowing pressures, the L-POD® is designed 275 PSIG MAWP, a working pressure higher than standard 50-150 PSIG heater treater design working pressure for wells produced from and within conventional completion horizons.

While the L-POD® was designed for the comparatively prolific shale oil wells responding to 21st century completion technologies, it is perfectly suitable for more conventional production processing in as well. These may exist in older fields where the more traditional conventional completion practices existed, or in new applications where conventional completion techniques are still being used.

Process Conditions

The L-POD® was designed to increase produced fluid process capacities in a single vessel in order for the owner/operator to use fewer vessels to accomplish the process needs. By using fewer vessels, capital equipment costs, and facilities installed costs, may be significantly reduced. In smaller field development project this approach is easily justified, and in larger field development operations like the Eagle Ford, Permian, Baaken, Utica, Marcellus and many others, this approach is extremely beneficial in reducing the overall capital cost of surface facilities.

L-POD® is commonly used today to lower the RVP/TVP of light crude oils. This may be necessary to eliminate oil price penalties in crude oil streams where the C5+ hydrocarbon fractions exceed the local pipeline specifications.
As is the case with all process vessels, the process capacity of the L-POD® depends on the API gravity of the crude oil, the specific gravity of the water, and the viscosity of the crude oil.

The development work on the L-POD® was conducted in the Eagle Ford oil shale producing area of south west Texas. Eagle Ford production can be characterized as follows:

API Gravity ..... 44-48°API
Water Specific Gravity 1.02-1.12
Viscosity ..... <5 Centipoise @ 150°F
Paraffinic or Asphaltic ..... Paraffinic
Paraffinic Cloud Point ..... ±130°F
Produced Solids ..... <0.1%

At the above conditions, a conventional horizontal heated separator (aka horizontal heater treater) would normally be expected to process and dehydrate 1,200-1,600 BOPD, remove 500-1,000 B/D of low effluent quality water, and separate up to 750-1,250 MCFD of produced gas with small quantities of mist carryover. Four such vessels would normally be required for 6,000 BOPD.

The L-POD® was successfully tested in the Eagle Ford, where it effectively processed up to 7,000 BOPD, 1,500 BWPD, and 2.5 MMSCFD of gas under the above conditions.

L-POD® Components

It is the proper combination of the right internal components that make the L-POD® so much more efficient than other vessels designed for this service. Therefore, what follows is a process related description of each of these components.

Inlet Fluid Distributor

The inlet fluid diverter-distributor is quite unique. The inlet fluids are physically and completely separated from the rest of the vessel in this uncommon inlet flow directing assembly. It first allows all freely separating gas to exit the liquid stream and enter the main gas phase separation area of the vessel without being "washed" through a liquid layer. This minimizes the entrainment of liquids in the gas, increasing the gas-liquids separation efficiency in the primary gas separation section of the vessel, and reducing the load on the gas mist eliminator downstream.

The degassed liquids then fall in a confined, pre-heat annular area between the firetube and the vessel ID. The heat transferred here reduces the viscosity of the crude oil, thus increasing the separation velocity of any water entrained in the crude oil.

The pre-heated oil and water flow and settle downward into the liquid section of the vessel. Freely separable water flows directly into the water layer (water phase) without having to flow through the oil layer (oil phase) above. This reduces the degree of oil exposure the water encounters, thus reducing the amount of oil entrained in the water, and thereby increasing overall water quality. It also reduces exposure between oil and bulk water, minimizing the degree to which water is re-entrained into the oil layer as the oil exits the inlet fluid distributor and enters the bulk fluid area of the vessel. In is doing, the dehydration efficiency is enhanced initially, thus maximizing the overall crude oil dehydration efficiency of the vessel.

The Gas Pre-Heat System

The L-POD® is designed to use either dry instrument gas, a combination of dry instrument air and wet gas, or 100% wet gas for the burner, valves, and controls. In the case of 100% wet fuel and instrument gas, the gas is preheated in an internal, dedicated gas preheat line inside the fired section of the heat area near the firetube. The pre-heat tube is immersed in the oil phase to avoid the issues of scaling, hot spots, and corrosion. It is sized for a 50°F temperature rise.

Pre-heating the instrument and burner gas minimizes the likelihood of hydrocarbon and/or water liquids condensing inside the instrument or burner air piping or tuning, or the instruments, valves, and controls themselves. This maximizes the reliability of all gas fed pneumatic instruments, valves, and controls.

The Oil Immersed Firetube

Nearly all owner/operators of fired oilfield equipment complain about the cost, frequency, and safety issues associated with firetube failures. Premature firetube failures have a few common causes. They are:

- *Firetubes are not designed in accordance with the ASME Code.*
  - *One easy way to tell is to observe the mitered end of a firetube. If it is a square miter, the tube is not designed in accordance with the ASME pressure vessel code.*
- *Firetubes are manufactured from sub-standard grades of steel, and or with weld procedures and/or weld materials that are not suitable for fired service.*
- *Fired vessels are designed with the firetubes immersed in the water phase where mineral deposits can/will form on the surfaces of the firetube causing hot spots.*
  - *Hot spots may cause overheating, metal fatigue, and metal failure.*
- *Firetubes immersed in produced oilfield water are susceptible to severe external galvanic corrosion. The corrosion rate is accelerated by the repeated heat-cool heating cycles which accelerate the dissociation of hydrogen in the corrosion cells, thus reinitiating high rates of corrosion.*

The L-POD® is designed to avoid the above issues, as follows:

- *The L-POD® firetube is completely immersed in the oil phase by design. Since there is little or no water in the area of the firetube, water related scaling, hot spots, and corrosion are virtually mitigated.*
- *The L-POD® firetube is designed in accordance with the ASME Code using only materials of construction recommended therein. This avoids the issue of sub-standard vessel steel or weld metal type/quality altogether.*
- *The L-POD® firetube is ASME Code designed and AI approved/stamped in accordance with the Section VIII of the ASME Code.*

The Heat Deflection/Redistribution Baffle

It is a well-known fact that longitudinal flow dynamics tend to move, "cone", or migrate fluid flow into the center of any vessel where fricti9on loss is minimized. This is typified by the general 80/20 rule which states that 80 percent of the longitudinal flow in a cylindrical vessel will migrate into 20% of the cross section in the center of the vessel. Since 20% of the cross section represents only a small fraction of the vessel volume and its potential settling time, a key feature in improving process efficiency is to offset this natural phenomenon. This is accomplished in the L-POD® with a perforated redistribution baffle.

The redistribution baffle is perforated in such a way to divide and redistribute the flow from the upstream side where it tends to cone, to the downstream side where it is redistributed uniformly across the entire cross section of the vessel. This is accomplished by designing the redistribution holes in this baffle such that the fluid cannot flow through any one hole, or any small group of holes, but must instead distribute upstream and flow uniformly though all redistribution holes. This action is a function of the cross section of the holes which create a small pressure drop restriction, thus forcing the desired redistribution.

Redistribution is important in improving separation efficiency because it has the effect of reducing the flow velocity of the bulk fluids. This allows the separation velocity of the contaminants to become the dominate aspect, thus improving separation efficiency.

The Lamella-Style Vane Demister

The industry standard demister is a material known as "wire mesh". This sort of demister ranges in quality from a collection of metal lathe shavings to woven wire, cloth layered to form a thick enough form to force gas to flow in a tortuous path, thus forcing entrained liquids to impinge upon the wire, thus separating it from the gas. As the liquid concentration increases, heavy liquids tend to migrate in a counter-flowing path out of the wire mesh where they can free-fall or separate back into the liquid layers below. When the gas and liquid streams are clean, wire mesh may be one of the most cost effective demister systems known.

However, when the traversing fluids are contaminated with solids, rapid plugging may occur in wire mesh. This often results in a sufficient pressure drop to allow the wire mesh to rip itself apart, sometimes sending large portions downstream. Once this level of damage occurs in wire mesh, its demisting function is totally invalidated.

Since the Eagle Ford crude oil is known to 1) be paraffinic, and 2) to have a paraffin cloud point at or near 130°F, the use of wire mesh is thought to be inappropriate. This is the case because as paraffin precipitates from solution it accumulates on all surfaces, particularly those which are colder or where the flowing pressure is reduced. This can cause wire mesh to be sacrificed altogether, and often, quite prematurely.

Therefore, wire mesh was not considered for application in the L-POD®.

Instead, the designers turned to a form of corrugated parallel plates known as serpentine vanes; "serpentine" because the flow path occurs in a weaving (back and forth) pattern, and "vane" because the plates are separated and parallel.

Serpentine vanes are normally configured vertically to maximize the downward flow of impinged liquids. In this configuration the drainage paths are the shortest, so drainage occurs in the shortest possible time. However, the plate surface area is also the least in this configuration, which means the contact efficiency between entrained liquids and the plates is also minimized. In this configuration the typical vane pack will demist droplets sizes in the 6-8 micron range, whereas properly designed wire mesh in new condition will remove 4-6 micron droplets of mist.

Given the above, the L-POD® design incorporates a serpentine vane pack with a Lamella-type plate configuration. In this design, the entire plate pack is reconfigured so all plates are tilted at 60° from vertical. This increases the total surface area of the plates thus improving separation efficiency at or near that of wire mesh, while avoiding the plugging issues associated with wire mesh. Finally, because of the known paraffin condition in the Eagle Ford, the vane spacing has been adjusted slightly to account for the fact that paraffin is present.

The Water, Oil, and Gas Vortex Breakers

Fluids exiting vessels tend to form a tornadic vortex flow path for immiscible fluids in the proximity of the fluid outlets. This tornadic effect can draw adjacent fluids into what should be a single fluid outlet, mixing the two (or more) fluids and defeating the separation process.

In order to mitigate the vortex effect devices known as vortex breakers are installed over or around the fluid outlet nozzles. The devices known as "vortex breakers" are designed to keep vortices from forming in the first place, thereby eliminating the comingling of otherwise separated fluids.

The L-POD® design includes vortex breakers on all normal fluid outlets, including the gas outlet and the solids outlet.

The Oil Spillover Weir

The oil immersed firetube remains oil covered because of a fixed elevation oil spillover weir. This weir plate is seal welded on both sides to assure that no leakage ever occurs, at least to the maximum ability of the design. The elevation of the top horizontal portion of the oil spillover weir is above the top of the firetube OD, maintaining it in a liquid-covered state at all times.

In order to assure the fact that the firetube is always immersed only in oil, an oil-water interface controller is placed just below the lowest part of the firetube. This interface device assures that the water can never be above the bottom of the firetube. The oil weir assures that the oil layer cannot be lower than the top of the firetube.

The Standard Instruments, Valves, and Controls

A full complement of oilfield standard instruments, valves, and controls accompanies the L-POD®. These include:

- *Kimray T-12 Temperature Controller*
- *Fuel Valve and Thermowell*
- *3/4" Thermometer 50-250°F Range with Thermowell*
- *0-200 PSI Range Pressure Gauge with 1/2" Isolating Valve*
- *Oil Level Controller*
- *Interface Controller*
- *Low Level Controller*
- *Kimray Oil and Water Dump Valves*
- *ASME Code Relief Valve*
- *2 - Sets 1/2" Gauge Cocks with 5/8" x 36" Gauge Glasses*
- *14" OD x 8' Long Mitered "U" Tube Removable ASME Code Firetube with Flanged Stack*
- *14" X 650,000 BTU/Hour Flamco Flanged Flame Arrestor Burner and Pilot Assembly*
- *10" X 24" X 150 PSIG MAWP ASME Code Fuel Gas Scrubber with Internal Fuel Shutoff Float Valve and Drain.*
- *Fuel Gas Regulator*
- *Pilot Gas Regulator*
- *Instrument Gas Regulator*
- *Fuel Gas, Pilot Gas, and Instrument Gas Shutoff Valves*

- *Pressure Gauges for Vessel Pressure, Instrument Gas, Burner, and Pilot Gas*
- *All equipment mounted on a Structural Steel Skid with interconnecting piping and fittings*

The latest generation L-POD® uses all electronic controls to accommodate its fully automated, self-managed control system. This brings L-POD® into the 21st century.

ABOUT RED STAG ENERGY'S OWNER

Gary Johnson is the founder and owner of Red Stag Energy LLC. Gary has a long and responsible oilfield past. Early in Gary's career he built and managed a large salt water disposal and oil reclaiming site in central Oklahoma. He later managed and administrated a very large oil reclamation site just south of Seminole, Texas.

If anyone understands the challenges of reclaiming waste oil and resolving oilfield tank bottoms and other stable emulsions, it is Gary.

Today, Gary owns a majority interest in, and is president of Red Stag Energy LLC (RSE). RSE is based in Tulsa, Oklahoma. Gary and Gary's minority partner, Bill Ball, are co-patent holders of the L-POD® product and method patents.

CONTACT US

If all else fails, or if you just have a question, don't hesitate to call Gary Johnson. Gary can be reached at 918-630-1616.

ABOUT BREAKTHROUGH ENGENUITY'S OWNER/INVENTOR

Bill Ball is the founder and owner of Breakthrough Engenuity LLC. He has a distinguished history of oilfield separation system designs, and a comprehensive list of related patents. Bill's hands-on oilfield experience and career portfolio, make him one of the industry's leading separation authorities today. After his university studies he launched his career in a 1,000,000 b/d waterflood operation where he was responsible for the evaluation and performance improvement of all surface facilities. He sent most of his work days crawling through the process equipment of the day, making improvements wherever possible.

This hands-on experience was the foundation Bill needed to improve, develop, and advance the technologies necessary to improve process equipment efficiencies across the board. In the early years Bill learned what works, and what doesn't! In the decades since his accumulated separation knowledge and experience led to his many patents, each of which speaks for itself.

The result is a unique approach; one where, "Engineering meets ingenuity!"

Today, Breakthrough Engenuity is one of the industry's leading low-cost engineering and design firms. We specialize developing designs for the industry's most efficient high and low pressure,

two and three phase heated and unheated separators, as well as providing general engineering services geared to specialty subjects like:

- *Natural gas handling to optimize income and liquids recovery.*
- *Proper line sizing to avoid turbulence, erosion-corrosion, and mixing energies.*
- *Specialty vessel internals designed to maximize separation performance.*
- *The application optimization of oilfield chemicals geared to reduce cost and improve performance.*
- *3D modelling to avoid costly facility installation delays.*

Now, more than ever, Breakthrough Engenuity can be found in every sector of the oil and gas industry, adding cash flow to operators and efficiency to their operations. We're a full service engineering firm. We pledge to meet and exceed every client expectation.

CONTACT US

If all else fails, or if you just have a question, don't hesitate to call Bill Ball at Breakthrough Engenuity for assistance. You can reach Bill at the office at 918-298-6841, or on his cell phone at 918-231-9698.