L-POD®

Combining “Artificial Intelligence” and the “Internet of Things” in Today’s Production Facilities

This technical paper describes one of the industry’s first applications of artificial intelligence (AI) and the internet of things (IOT) used to optimize process efficiency in a production facility.

Prepared for all Facility Engineers

A Technical Paper By

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INTRODUCTION

Nearly every oil industry periodical we pick today up has an article touting the intrinsic value of “Artificial Intelligence” (AI) and the “Internet of Things” (IoT). After all, automation cuts costs! But these 21st century concepts focus entirely on refinery plant automation. Their application in production facilities is not even suggested. One wonders why. Are production facility operations too wrapped up in the paradigms of the past? Cannot today’s facility engineers effectively bring facilities into the 21st century? Is the focus out of whack?

Let’s see! There are over 1.1 million active oil and gas wells in the US today but only 141 refineries. It seems we could conclude that the potential for production operations far outweighs any opportunity in refining. After all, the ratio is 7800:1. And, if AI and the IoT could do some good things in refining, how much more good could they do in our production facilities?

Maybe we should shift the focus! Can we?

A new process system known as L-POD® does just that! It incorporates IoT and AI in a completely self-managed, self-contained, skid mounted production process system that’s unlike anything ever before! It automatically dehydrates crude … completely, period! It’s exciting, it’s innovative, it’s ingenious, and it works! It’s a real “game changer”!
THE INTERNET OF THINGS

The subject of the Internet of Things is hot! The October 2016 edition of the Journal of Petroleum Engineering magazine was entirely devoted to this subject for the first time ever! IOT is truly the “flavor of the month” today.

You might ask, “What’s it all about? “ IoT is the subject of joining common industry devices together into a network of data gathering systems. Managed properly the management system, a PLC with dedicated software, is capable of understanding how each relates to the other. The software optimizes the performance of each component as it relates to all others to maximize the performance of the overall system. This is so easy today, and so affordable, one wonders why we are not bombarded with doing it everywhere!

L-POD® DOES IT!

The L-POD®, or “Lease Production Oil Dehydrator”, was first developed and tested in oilfield pipeline gathering stations in 2012. The goal of the L-POD® was to focus on resolving the tough emulsions present in most so-called “off-spec” oil trucked or pipelined into these large gathering tank farms.

Most bulk crude oil pipeline plants have no way to process off spec oil, so they concentrate it into dedicated storage tanks, and then blend it slowly into on-spec crude to concentrations below the maximum pipeline oil quality specification. In most of industry we all say, “Dilution is not the solution to pollution”, but in crude oil pipeline stations dilution is the ONLY solution. It is a common byword and the normal method used to blend off-speck crude with clean crude to get it out of the facility and into someone’s pipeline … the same pipelines that feed our refineries.

This practice legally moves the off-spec crude oil downstream to the refiners. The result is reduced pipeline capacities throughout the industry, and increased process costs at the refineries.

L-POD® was originally conceived for the industry’s pipeline stations o off-speck crude could be resolved before it enters the pipeline infrastructure. This would free up pipeline capacity, add refining efficiency, and since most of what defines off-speck crude is water, eliminating it would drastically reduce pipeline corrosion. If L-POD® units were installed at pipeline stations, contaminants could be removed BEFORE the crude enters the pipeline network. Difficult emulsions would be eliminated. And, the BS&W (basic sediment and water) that identified the off-spec crude would no longer be present in the crude oil entering the pipeline or arriving at a refinery.
Once L-POD® units become a standard of the pipeline industry, the nation’s pipeline network will be debottlenecked by at least 5%. Costs would come down to! It is estimated that the pipeline industry spends about $0.125/barrel segregating, storing, and blending off-spec crude into the mainstream crude they handle. At this writing oil production in the USA is at 0.8445 million barrels/day, bringing the cost of off-spec crude in at roughly $1.056 million per day! When L-POD® units process the off-spec oil, pipeline capacity will increase by at least 42,225 barrels per day, pipeline firms profitability will increase by that $1.056 million per day, and refineries will have at least 42,225 barrels per day fewer contaminants to remove prior from the crude they receive.

But, this is just the tip of the iceberg!

PRODUCERS GET THE BIGGEST BENEFIT FROM L-POD®

The cost of off-spec crude to US oil producers is extraordinary! When oil prices hovered around $100/barrel off-spec crude penalties reached as high as $40/barrel. Today’s (5/22/2017) price is $50.73, and has averaged $49.80 for the past 12 months. At this price the producer experiences off-spec oil penalties from a low of $6.50 to a high of $22/barrel. Even if the average penalty is only $14/barrel, the estimated 4% (337,800 B/d) off-spec crude the industry handles each day costs the producers $4,729,200/day. That’s a whopping $1,726,156,000 annually!

So, while pipeline companies stand to save over a million dollars a day by using L-POD® units in their tank farms, oil producers stand to save over four million dollars each day from the widespread use of the L-POD®!

L-POD’S IoT AND INTELLIGENCE SYSTEMS

L-POD® was first introduced over just five years ago. The first units were prototypes built to prove value and functionality, and to identify ways to improve their performance and return on investment. Early field trials and testing proved that the L-POD® unit does indeed resolve even the most difficult of emulsions. Those efforts also identified the need for and values of increased communication between L-POD®’s instruments, valves, and controls. Clearly there was a need to develop a level of artificial intelligence within its IoT that could allow L-POD® to manage itself and optimize its overall performance without outside influence.

The newest generation L-POD® is an IoT system using fully electronic interactive instruments, valves, pumps, and controls, all coordinated with a level of intelligent software that interfaces with each one to optimize the results of all of them.
L-POD®’S INTERNET OF THINGS AND INTELLIGENCE INTERFACE

The latest L-POD® is simply amazing! It is stand-alone; completely self-managed. The self-managing software coordinates each variable, managing each interconnected component through an on-board intranet of things that optimizes the end results; the resolution of any and all oilfield emulsions.

Here’s how it works.

The inlet emulsified crude oil is pumped into L-POD® using an on-board low shear pump which avoids further complication of any emulsion. This pump is speed controlled via a VFD. The pump moves the fluid through a LACT–style BS&W monitor and Coriolis meter to measure the emulsion concentration, total volume, and API gravity. The higher the emulsion concentration and/or lower the API gravity the slower the inlet crude oil feed pump feeds incoming crude into the system while conversely the concentration of the chemical demulsifier is increased to assist in coalescing the sub-30 micron emulsion droplets so they can separate. The crude then enters the world’s most efficient plate and frame heat exchanger which exchanges the temperature of the exiting hot crude oil with the colder inlet crude, heating the inlet crude and cooling the exiting crude. This has two very positive consequences:

1. The inlet crude is preheated, lowering its viscosity and dramatically increasing the potential for emulsion resolution.
2. The outlet crude is cooled, stabilizing it as lighter hydrocarbon fractions are encouraged to condense back into the crude, increasing its volume and API gravity (the two conditions that determine the ultimate price received by the producer).

The preheated and pre-treated emulsion then enters a horizontal emulsion resolution vessel commonly referred to as a horizontal heated separator, or heater treater. However, this is no common heater treater. This patented treater is unique to the industry, and over 1600 of these marvelous and unique treaters are in service in virtually all US oil basins today. L-POD® is so innovative that L-POD® carries both apparatus and method patents (see Patent Numbers 9,157,035 B1 and 9,550,945 B1).

L-POD® is a unique blend of special components. It incorporates an isolated inlet preheat shrouded area that imparts additional heat transfer to the incoming crude to further reduce its viscosity. Since high viscosity is a chief deterrent to separation, reducing viscosity greatly enhances separation and emulsion resolution. This promotes more rapid oil-water-gas separation. The shroud also distributes the inlet crude oil and emulsion just underneath a horizontal firetube, distributing the warmed emulsion into the...
emulsion layer rather than allowing it to flow through the water phase as is more common. By keeping the emulsified oil in the emulsion layer the water quality of the effluent water is greatly improved, and the resolution of inlet emulsions is greatly increased. You see, when the inlet emulsion flows into the emulsion layer in the treater it encounters the maximum concentration of demulsifier chemicals which naturally concentrate in the emulsion at the oil-water interface. This maximizes the effects of the chemical demulsifier on the inlet emulsion.

While the firetube in many heater treaters is partially or completely immersed in water, the firetube in this treater is completely oil-covered. This helps to mitigate corrosion and scaling. As the preheated crude rises across the firetube the tubes 8,000 BTU/hr. flux rate gently heats the crude to further lower its viscosity and assure that the emulsion droplets separate more rapidly. Next, a redistribution baffle immediately downstream of the firetube prevents flow coning and redistributes all heated crude and remnant emulsion throughout the vessel cross section, thereby slowing its lateral velocity and maximizing its retention time, further aiding separation. Next, the slower moving hot crude flows through a matrix of special coalescing plates which shorten the maximum vertical fall separation dimension of any water droplet to less than 1” which forces the micro-droplets of water to impact the plates and thereby separate, polishing the exiting crude free of all or nearly all remnant emulsion droplets.

Treater interfaces are managed using smart interface controllers generating intelligent 4-20ma outputs to the computer software providing the intelligence interface. Water is discharged and measured using an accurate turbine flow meter. Treated oil is pumped out of the treater with a second on-board ump and through a second BS&W monitor which assesses its purity and signals that purity to the computer software which adjusts the inlet pumping rate, the chemical demulsifier injection rate, and the treating temperature to maximize net clean oil throughout at the ideal crude oil feed rate, the ideal chemical feed rate, and the ideal treating temperature. The crude leaves through a second Coriolis meter and flows out through the plate and frame exchanger to the client’s clean oil run tank for sale at the highest possible WTI price and volume.

As inlet flow continues this intranet of things continues to feed critical quantity and quality information to the computer so its artificial intelligence can continue to optimize the overall results, making constant adjustments, learning which should be increased or delayed in the process, and applying what it learns.

All of this takes place without human intervention.

Moving forward we anticipate that L-POD® users will transmit the readings, adjustments, and changes to a remote server or into the Cloud to develop an even more intelligent and predictive level of operation, maintenance, and troubleshooting.
CONCLUSION: L-POD® IS AFFORDABLE, ECONOMICAL, AND COST EFFECTIVE MEANS RAPID PAYOUT

As more and more crude oil producers look at the ways in which “artificial intelligence” and the “internet of things” can work together, L-POD® leads the way. As more AI combines with the rapidly improving list of IOT controls, L-POD® may even become a “standard of the industry”.

L-POD® is designed to process crude throughout the life of a field. A single L-POD® can process up to 2,000 BOPD on a stand-alone basis, and up to 5,000 BOPD given a fluid preheat add-on. In a 2,000 BOPD operation currently suffering from a $14/bbl off-spec crude pricing penalty an L-POD® would pay out in just 30.35 days!

These economics should drive facilities engineers throughout the industry to specify and use L-POD® for production facilities whenever processing 75 BOPD or more.

L-POD® P&ID

L-POD® is completely automated with a state-of-the-art IoT, PLC, instruments, and dedicated AI software. Yet, it’s familiar, easy to install, and very user friendly as you can see from its P&ID.