Artificial Lift R&D Council

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Using A Hydraulic Sheave Lock Versus Traditional Methods to Safely Lock Out A Beam Pumping Unit

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Hydraulic Sheave Lock Development Timeline

Artificial Lift R&D Council

Invented in the field

2013 US Patent filed
Gen I Prototyped

2014 – 2018
21 Gen I units
Installed in the Field

KUDO ENERGY .COM

2019 KUDO
Acquired IP
Gen II Prototype

2020 Canadian
Patent Issued
Gen II Installed in
the Field

Beam Pumping Unit Lockout/Tagout (LOTO) Events

- **Frequency**: Completed on daily basis in field operations across North America for routine maintenance, counterweight adjustment, rod string adjustment, wellhead or downhole pump maintenance, workovers, etc.
- **Time:** Manufacturers' recommended lockout procedures take a significant amount of time. Estimates range between 20 to 30 minutes to properly complete the task following manufacturer's guidelines.
- **Risk**: Even when manufacturers' guidelines are followed, personnel are required to enter the swing zone of the counterweights and are exposed to danger. Key elements in the lockout process, such as chains, are not engineered solutions and require regular inspection/certification.

Regularly Occurring Lock/Unlock Events

- scheduled visual inspections & maintenance (greasing, belt inspection or replacement)

- packing changes

- counterweight adjustments

-stroke length adjustments

-rod string adjustments

-flush by operations

-workover rig work (e.g. rod/pump repair)

-brake maintenance/replacement

-bridle cable inspection/ replacement

-horse head removal/ install/ alignment

-beam pumping unit repair

Traditional Method of Lockout/Tagout (LOTO)

1) Select Pumpjack to be worked on
2) Witness customer representative perform loaded brake check and/or receive verification that the brake check has taken place
3) De-energize pumpjack including disconnection of Presco switch
4) Customer representative to perform bump test on pump jack verify power to pump jack has been de-energized
5) All workers must place their personal lock on the associated breaker in the MCC building for the pump jack to be worked on.
6) Remove cages from around pumpjack
7) Enter cage area and install chain on flywheel and chain back to frame
8) Install boomer on chain and tighten
9) Complete necessary documentation that pumpjack is locked out
10) Perform subsequent task as required
11) Once task is completed, enter caged area to loosen chain and remove from flywheel
12) Put fences back in position to protect workers from swing path of weights
13) Pull locks from breaker and complete lockout documentation
14) Inform operations that work is complete

Hydraulic Sheave Lock Method of Lockout/Tagout (LOTO)

1) Select Pumpjack to be worked on
2) De-energize pumpjack including disconnection of Presco switch
3) Actuate hydraulic sheave lock as per manufacturer's instructions.
4) Install personal locks on hydraulic sheave locking rail on pump box.
5) Complete necessary documentation that pumpjack is locked out
6) Perform subsequent task as required
7) Once task is completed de-actuate hydraulic sheave lock as per manufacturer's instructions.
8) Remove locks from lockbox and complete documentation
9) Inform operations that work is complete

Test Case: Implement a Hydraulic Sheave Lock to reduce safety risk and assess operational impact

- First hydraulic sheave lock unit (Gen I) installed in 2014.
- 21 Gen I units installed between 2014 – 2018 on a beam pumping units ranging in size from 160's to 912's from variety of manufacturers including National Oilwell, Lufkin, and LeGrand.

Key Learnings:

Engineered solution was a safe & effective method of lockout

Weight of hydraulic sheave lock was prohibitive for easy field install

Hydraulic pump to engage sheave lock needed to remain at well site

Field Install procedure required streamlining

Hydraulic Sheave Lock Gen I Installs

Hydraulic Sheave Lock Gen I INSTALLS

Evolution from Gen I to Gen II to Improve Field Performance and Scalability

Key Element/ Attribute	GEN I	GEN II
Modular Construction	X	✓
Operated with Hydraulic Pump	✓	✓
Constructed with T1 Steel	X	✓
Under 500lbs Constructed	X	✓
Mounted on Gearbox	✓	✓
Mounted with Existing Holes	X	✓
Measured with sub mm accuracy	X	✓
Installs in 2 Hours or Less	X	✓

How The Hydraulic Sheave Lock Operates

- Simple, but robust design is engineered to prevent crank movement, even if the brake is released and power is engaged.
- Hydraulic hand pump engages/ releases the hydraulic sheave lock from **outside the swing area** to avoid any hazard exposure from counterweights. Locks can then be applied directly to the locking rail on the pump box.
- Simple field installation uses existing mounting brackets.
- Minimize downtime and optimize operational maintenance efficiency versus traditional approach
- Brackets for most common beam pumping units are in the design phase. Locking hardware is standardized for most units.

How The Hydraulic Sheave Lock Is Engaged

- simple hand pump engages and disengages the hydraulic sheave Lock from OUTSIDE the danger area.
- With the hydraulic fork engaged, there is zero crank movement - even with NO BRAKE and FULL POWER applied to the unit.
- 100% non-toxic and environmentally-friendly fluid is utilized in our closed loop system.

Quantitative Learnings: Evaluating Economic Impact of Hydraulic Sheave on Field Operations

Lockout Per Year	Avg Cost/Hr	Description
		Pumpjack Visual Inspection PM's
		Packing Changes
		Counter Weight Weight Adjustment
		Stroke Length Adjustment
		Flushby Operations
		Service Rig Work
		Brake Maintenance/Replacement
		Bridle Cable Inspection/Replacement
		Regular Maintenance (Ie. Greasing, Oils, Etc)
		Belt Inspection/Replacement
		Horse Head Removal/Install
		Horse Head Alignment
		Beam/Horse/A Frame Head Crack Repair
		Seal Repairs
0	----------	(x2 for Lock and Unlock)
0	----------	Total Lock/Unlock Events
0	----------	Average Lock/ Unlock Event per Month
		Average Cost of Conventional Lockouts
		Avg. Cost Per Hour
	30	Average Time Per Lock/ Unlock Event (Mins)
	0	Avg. # Lock/ Unlock Events per month
	$ -	Total Cost of Lock/ Unlock Events per Month
		Average Cost of Lockouts with Atabec installed
	5	Average Time Using Atabec for Lock/ Unlock Events (Mins)
	$ -	Total Cost of Lock/ Unlock Events per month using AtaBec
	$ -	Cost Savings per Month
	$ -	Atabec MSRP (early adopter discount)
		Months to 100% ROI on MSRP
		Pilot Program RPO Options
	$ -	Price per month to RPO 24 Months @ 0% per unit
	$ -	Cost Savings Per unit per month
	$ -	Net Positive Monthly Cash Flow per unit
	0	Minimum Number Of units in Pilot
	$ -	Gross RPO/ Month for Pilot
	$ -	Cost Savings Per Month for Pilot
	$ -	Net Positive Monthly Cash Flow for XX unit Pilot
	$ -	Price per month to RPO 36 Months @ 0% per unit
	$ -	Cost Savings Per unit per month
	$ -	Net Positive Monthly Cash Flow per unit
	0	Minimum Number Of units in Pilot
	$ -	Gross RPO/ Month for Pilot
	$ -	Cost Savings Per Month for Pilot
	$ -	Net Positive Monthly Cash Flow for XX unit Pilot
	$ -	Price per month to RPO 48 Months @ 0% per unit
	$ -	Cost Savings Per unit per month
	$ -	Net Positive Monthly Cash Flow per unit
	0	Minimum Number Of units in Pilot
	$ -	Gross RPO/ Month for Pilot
	$ -	Cost Savings Per Month for Pilot
	$ -	Net Positive Monthly Cash Flow for XX unit Pilot

- Based on maintenance activities in thermal heavy oil operations, typically infrequent LOTO the ROI was between 16-18 months

- Avg Cost/Hr should include all contractors, operational staff, HSE staff, maintenance staff and a % of NPT for all well site personnel & equipment

- Does not consider increase in uptime and incremental production

How does the hydraulic sheave lock method accommodate requirements for annual LOTO equipment certification?

- The hydraulic sheave lock has been designed to meet the requirement of ANSI/ASSP Z244.1-2016 (R2020) The Control of Hazardous Energy Lockout, Tagout and Alternative Methods or CSA Z460:20 (Control of Hazardous Energy – Lockout and other methods). Although there is no requirement in these standards for annual inspection, it is recommended that the hydraulic sheave lock be visually inspected annually for common items like the beam pumping unit (fasteners tight, hoses, oil level, pump, condition of steel). At this point if there are any concerns regarding the unit's construction, then warranty repairs/repairs and/or general maintenance would be performed.
- Current acceptable methods of locking out include using chains which are rated at 125% of their capacity. The hydraulic sheave lock is designed and engineered with a minimum 3-1 safety factor for forces that can be produced by the flywheel, so the prospect of failure is nominal.
- Given the quality of materials and engineering design standards, we do not anticipate any issues with achieving certification in the US, outside the time and expense required to acquire the certification as needed.

Qualitative Learnings: Impact on Safe Work Practices, Time, Environmental footprint & Liability

Safety: Steps required to complete the task was reduced; risk when working alone was reduced; engineered solution eliminated need for personnel to enter the swing zone

Time: Time required was reduced by approximately 25 minutes for each lock/ unlock event

Environmental: Reduced traffic at the wellsite for personnel & equipment reduces fuel consumption & carbon footprint

Liability: Proper use of hydraulic sheave lock eliminates risk of struck-by incidents by counterweights

Field Install
June 2020
Lufkin 1824

Patented – US & Canada
Field Tested by Large Operator
Market Ready

https://www.youtube.com/watch?v=soUQGDk0EPM
youtube.com/watch?v=soUQGDk0EPM

Questions?

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