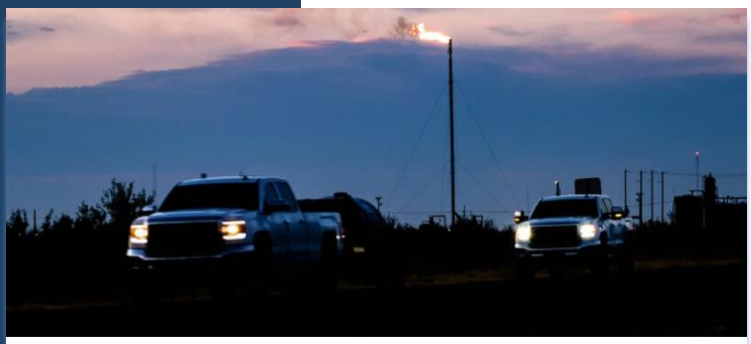
ENCLINE
Artificial Lift Technologies

Liquid Piston Vapor Recovery Unit

Reliable vapor recovery system for 0 to 10 MCFPD



A gas flare near Coyanosa, Texas, in August. Jessica Lutz for The New York Times

By Coral Davenport

April 28, 2021

WASHINGTON — The Senate voted on Wednesday to effectively reinstate an Obama-era regulation designed to clamp down on emissions of methane, a powerful, climate-warming pollutant that will have to be controlled to meet President Biden's ambitious

Today's vapor recovery systems are designed for the high rates associated with gas flashing from crude oil as it enters atmospheric stock tanks. Low rates of vapor have traditionally been incinerated, hence there exists a lack of reliable low rate vapor recovery equipment.

Due to heightened regulation of Greenhouse Gas Emissions, low volume vapor recovery is more desirable than incineration. Consequently our industry needs low rate vapor recovery options. The Liquid Piston Compressor is such an option that utilizes highly reliable equipment and few moving parts, namely a water pump that fills up a vertical pipe. As this pipe fills, gas above the liquid is compressed and flows out the top through a check valve. The pump takes suction through a second cylinder with fugitive vapors filling the void created as the water leaves. Swap sides and repeat.

The Liquid Piston Compressor dates back to 1906, but has few if any current uses due to the availability of other types of compression. Pump and valve control and over-displacement of working fluid were also problems that are now solved by current technology, some of which Encline has patented. One result is 99% volumetric efficiency, and 100% turndown ratio.

DESIGN FEATURES

Fresh water working fluid

Valves electrically actuated

Freeze protection auto bypass

ISOTHERMAL COMPRESSION

Working fluid takes most of heat eliminating gas cooler

POWER OPTIONS

Operate on compressor engine alternator output or grid power

TOLERANT OF INLET LIQUIDS

Unlike many VRU's, handles water or hydrocarbon liquids

For more information on Liquid Piston Vapor Recover, please visit us on the Web at: www.enclinelift.com

Why not sell your vapors instead of burning them?

Could be too costly, but just like any new technology, the costs are initially high until mass production begins.

Encline will support industry with both engineering and our patented control technology, and looks for development partners to jointly design, build, and test Liquid Piston VRU's.

From Elsevier article in March 2008 Applied Energy by Dr. Perry Li

The liquid piston is certainly not a new concept. The earliest known use, dating back to 1906, was in an internal combustion engine used for pumping water known as the Humphrey pump [15]. The Humphrey pump ran on an Atkinson cycle and demonstrated efficiencies between 5% and 10% [16]. Another water pumping engine has utilized a liquid piston is the fluidyne Stirling cycle. The primary research related to this engine has focused on tuning the oscillating frequency of the liquid piston columns and design for dependable operation for remote environments [17–19]. Further Stirling engine concepts [20,21] and Stirling heat pump concepts [22,23] can be found in patents. None of these works have discussed exploiting the liquid piston to improve the heat transfer between the gas and the working chamber.

One work that utilized a liquid piston to improve heat transfer in a Stirling engine is by Gerstmann and Hill. Their work recognized the need to improve the surface area to volume ratio in the working chamber. They proposed using an auxiliary pump to

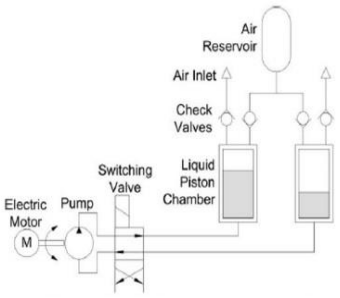


Fig. 1. Liquid piston configuration where a hydraulic pump drives two liquid piston chambers using a switching valve. In this setup, one chamber is always filling while the other is emptying.

Smartphone Monitoring

- View calculated gas rates and historical output volumes
- View inlet gas. working fluid, VFD cabinet and ambient temperatures
- Viiew / edit alarm setpoints (discharge pressure, working fluid temp, compressor utilization, etc)

VRU Designs:

2 MCFPD at 70 psi / 1 HP / 24 VDC power

3.6 MCFPD at 70 psi / 1.5 HP / Single or Three Phase

7.2 MCFPD at 70 psi / 3 HP / Single or Three Phase

Rates 60% less at 100 psi unless pump upsized

Scada / MQTT

Like other Encline products, the Liquid Piston VRU will utilize a controller that is an Edge Computing device, and speaks all popular Modbus protocols. It also features newer MQTT capability.

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