Floating Vessel Stable Fluid (FVSF)

Mitigation of the Effects of Vessel Motion Using Active Compensation

for

Modular Floating LNG Pretreatment

As the debate concerning the future of the natural gas industry and the feasibility of Floating LNG continues, **Newpoint Gas, LP (www.newpointgas.com)** has been diligently investing in solutions to key issues. Minimizing weight and dimensions of a gas pretreatment plant have long been at the center of Newpoint's standard modular design for all gas pretreatment systems. In FLNG service the complication, for all companies, has been motion, or 6 Degrees of Freedom (6DoF) as referred to by the experts in this field.

Unique problems require unique solutions. To conquer the current FLNG challenge, Newpoint has brought together natural gas treating experts along with dynamic systems and controls experts. The combination of these Newpoint technologies provides the perfect solution to the FLNG industry.

Background: The gas liquefaction process of FLNG has been thoroughly researched and many great designs introduced, while Gas Pretreatment has been virtually ignored. Other than a presentation by BASF, July of 2008, which correctly stated that no company is concentrating on the pretreatment requirement for FLNG. There are no references or specific designs addressing all the concerns to this vital segment of the process.

Newpoint began investigating this issue as an extension of their modular gas treating systems beginning in 2006. This research began due to various requests received from clients around the world. When given specific information on the gas conditions, (i.e. carbon dioxide (CO2) and/or hydrogen sulfide (H2S), pressures and temperatures etc.) and the deck space available for the location of the unit, we were able to determine that Newpoint can provide a cost effective system meeting every requirement. The systems were not dramatically different than those designed for other Gas Pretreatment applications, which the principals of Newpoint have been designing for over 25 years.

Reality: Companies are investing vast sums on money and all of the issues have not been resolved. The problem is much more complicated than just space, weight, and gas conditions. The question is, "What effect does the movement of the ship have on the process, specifically the amine and/or physical solvent regeneration unit?" In a calm environment the answers are easy, in an environment with pitch and roll of 2 degrees or more, no one knows for sure.

Problem: Vessel Motion - Sea state induced vessel motion is a rigid body motion that is stochastic in nature. While bounds can be set on the maximum accelerations and/or displacements, the uncertainty of the actual motion makes passive control techniques impossible to guarantee. Maintaining fluid levels in this environment for vertical and horizontal vessels is just one issue that must be addressed. Gas and fluid flowing within the adsorption vessel must also be stabilized so that the gas pretreatment can be accurately simulated and the process can be guaranteed.

Concept: In using active compensation, the rigid body vessel motions can be compensated for based on the anticipated effects on the treating system. For example, roll and pitching motions are most often the motions of concern and, because there is little or no effect, horizontal translation motions and yaw are most often ignored. The heaving motion of the vessel can be significant and its effects can be reduced or eliminated using active control.

Solution: 5 Degrees of Stabilization (5DoS). The impacts of translational accelerations and roll and pitch angles are attenuated using active compensations. As shown in Figure 1, eight hydraulic cylinders are employed to provide 5 degrees of freedom. Yaw could be compensated for but is not due to its lack of impact on the process. The accumulators are employed to minimize the power requirements of the hydraulic system by "balancing" out the static loads in the system. The active control system is based on technology owned and licensed by a division of our company, Newpoint Offshore, and is currently in service in several locations.

Newpoint has designed a FVSF system, which creates the perfect environment, 5DoS, as required for FLNG Gas Pre-Treatment; see Figure 1. This system effectively decouples the motion of the ship from the treating vessel, isolating it from the effects of the sea state. This allows the system to meet the objective of creating an environment in which the treating fluids in the gas absorber and the fluid regeneration vessels are stabilized. In simple terms, while the structure outside of the vessel moves with the ship, the fluids inside the vessel are stable and perform at predictable levels.

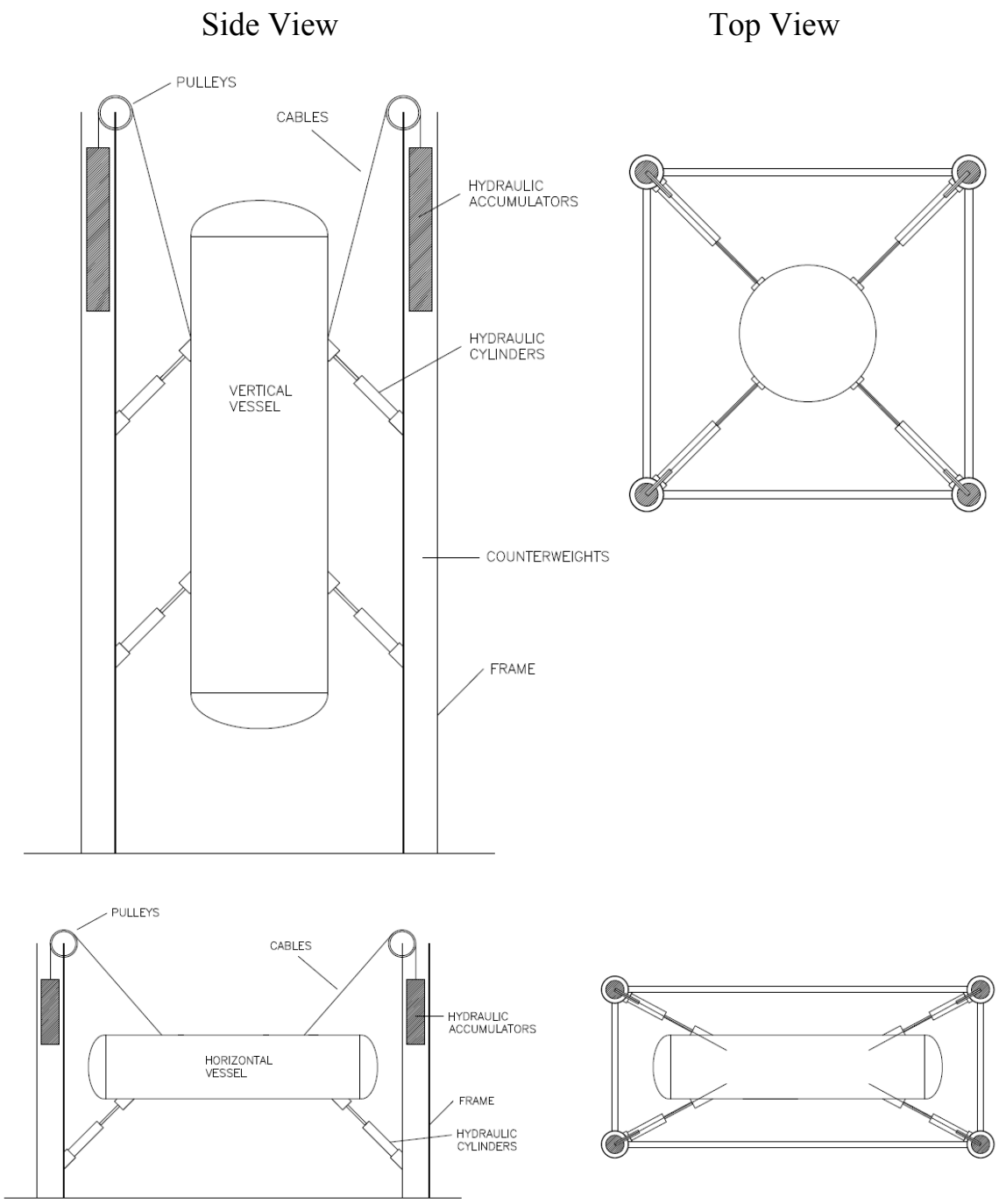
2 Degrees of Stabilization (2DoS). In this design only the impacts of roll and pitch angles are attenuated using active compensations. As shown in Figure 2, four hydraulic cylinders are employed to provide 2 degrees of freedom. In many cases maintaining the center of gravity in both vertical and horizontal vessels may be enough to insure proper operations in the gas pretreatment facility.

FVSF Designs: Two different models are used depending on the ship design and the anticipated sea states encountered during operation. The best solution for a specific application depends on the anticipated level of motion as well as the desired predictability of the Gas Pretreatment process.

Conclusion: Newpoint has built its reputation by delivering innovative gas pretreatment facilities on budget and on schedule. The focus of our company is "the removal of contaminates from natural gas." With the experience Newpoint has with processes such as CO2 and/or H2S removal utilizing amine and/or membrane technologies, mole sieve dehydration and treating, oxygen removal, mercury and organic arsenic removal; Newpoint can design and guarantee the entire gas pretreatment facility. We believe the FLNG pretreatment market is developing in a direction that will demand our designs, our technologies, and our philosophy for doing business. We look forward to serving this exciting market.

Figure 1.

FVSF - 5 Axes Hydraulic Motion Compensations System

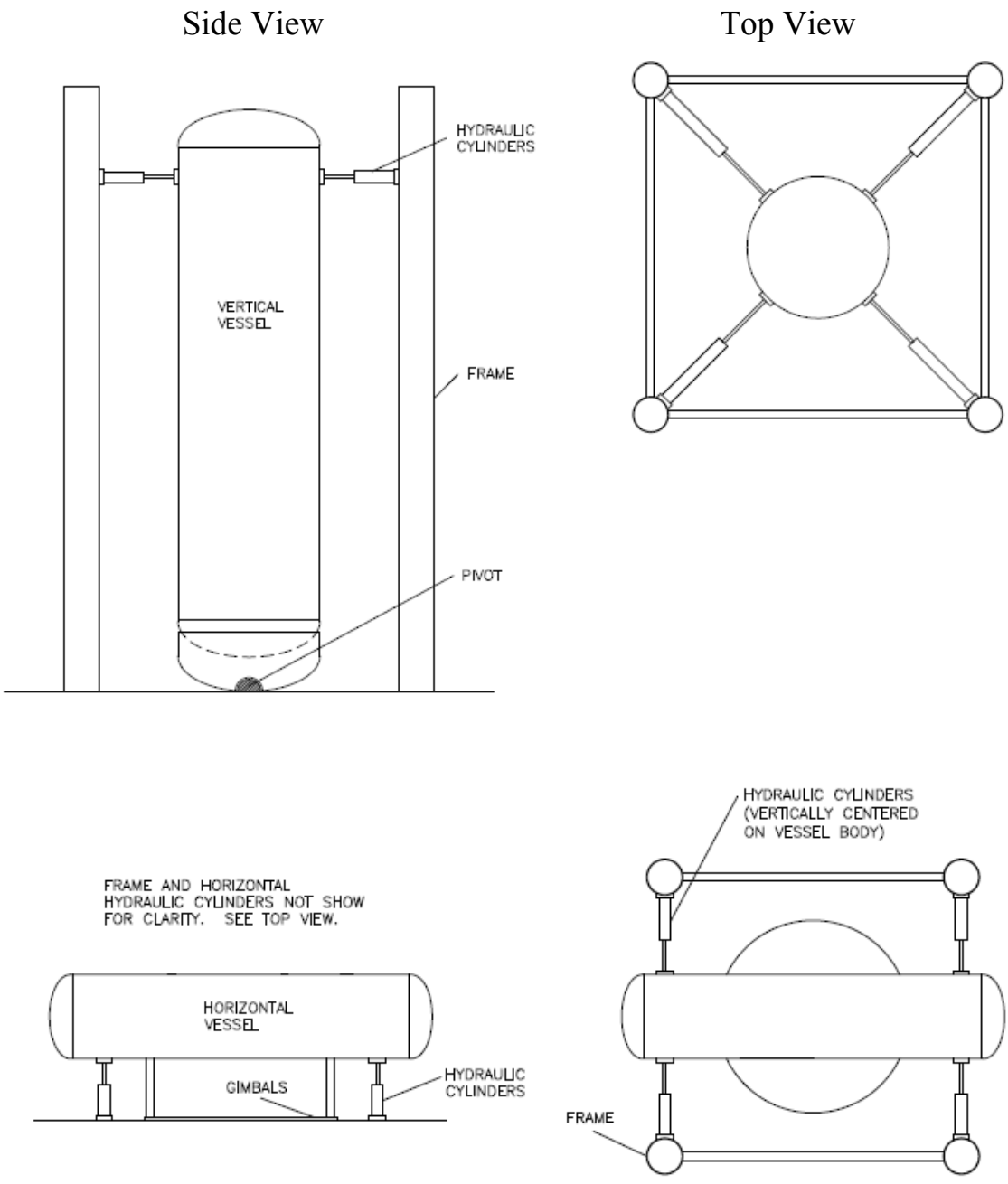


Design Criteria Figure 1.

1. Treating will occur in a vertical vessel which is compensated using 8 stabilizing hydraulic pistons, upper and lower, to keep the vessel vertical in up to 7 degrees of pitch and/or roll.
2. The hydraulic cylinder system may also be employed on a horizontal vessel as shown if necessary to stabilize fluid.
3. Minimize the effect of heave on the fluids and/or gas traveling through the vessel by giving the system the ability to rise and fall with the ship.
4. This system can also compensate for lateral accelerations caused by the surge and sway of the ship and the treating vessel.
5. Safety being an area of concern, the treating vessel is enclosed in a frame that eliminates the chance of the unit breaking loose and/or personnel being near the moving vessel.
6. Depending on the weight of the vessel, while Figure 1 has 8 hydraulic cylinders on the vertical vessel and 4 on the horizontal vessel, the system can be designed using as many hydraulic cylinders as needed. The control system is easily scaled to accommodate as many cylinders as required.
7. Hydraulic accumulators are utilized (not required) to minimize the power requirements of the hydraulic systems.

Figure 2

FVSF - 2 Axes Hydraulic Motion Compensations System



Design Criteria Figure 2.

1. Treating will occur in a vertical vessel, which is compensated using 4 stabilizing hydraulic pistons near the upper end of the vessel to keep the vessel vertical in up to 7 degrees of pitch and/or roll.
2. The hydraulic cylinder system may also be employed on a horizontal vessel as shown if necessary to stabilize fluid.
3. Heave and lateral accelerations are not compensated in this design.
4. Safety being an area of concern, the treating vessel is enclosed in a frame that eliminates the chance of the unit breaking loose and/or personnel being near the moving vessel.
5. Depending on the weight of the vessel, while Figure 2 has 4 hydraulic cylinders on the vertical vessel and 6 on the horizontal vessel, the system can be designed using as many hydraulic cylinders as needed. The control system is easily scaled to accommodate as many cylinders as required.
6. Using a pivot design anchors the vessel.

Company History: Newpoint was founded in 1999 with a vision of providing the natural gas industry with the finest, most efficient gas pretreatment facilities. The principals of our company have natural gas treating experience dating back to 1966 with operations in amine treating and sulfur recovery systems.

We are the only company focusing ***exclusively*** on contaminate removal from natural gas with expertise in the following processes.

- Amine Treating
- Membrane Treating
- Membrane / Amine Hybrid Treating
- Mole Sieve and Glycol Dehydration
- Mercury Removal
- Oxygen Removal
- Arsenic Removal

Newpoint designs and manufactures a full range of modular gas processing and treating units. Our unique design provides:

- Superior equipment built to the highest industry standards.
- The lowest combined installation and construction costs due to our modular designs with the interconnecting piping fabricated in the shop not the field.
- Ease of operations with Newpoint's patent pending start-up and process recovery systems.
- Increased runtime to maximize revenue for our customers.

Newpoint provides unmatched lead and delivery times by pre-engineering gas treating facilities. We pride ourselves on our workmanship where 'QUALITY IS NEVER AN ACCIDENT' and are continually developing a global network of quality assured fabricators.

Newpoint currently has operations in the United States located in Texas, Oklahoma, Arkansas, West Virginia, Colorado, Wyoming, New Mexico, Louisiana and Kentucky.

Newpoint continued to grow with the addition of sales and engineering offices in London and Brussels, Belgium in 2007 and Mumbai, India in 2008.

The Newpoint Companies expanded to include Newpoint Thermal and Newpoint Manufacturing. Newpoint expanded into the Process Heating industry by purchasing the assets and hiring the Sales, Engineering, Manufacturing and Service personnel formerly of GTS Energy forming Newpoint Thermal, LP. Newpoint Thermal supplies a variety of Process Heating Systems for industrial applications including Gas or Oil Fired Process Heaters, Convection Process Heaters, Process Bath Heaters, Thermal Fluid Heating Systems, High Pressure Steam Generators, and Waste Heat Recovery Systems.

Newpoint Manufacturing occupies a 134,000 sq ft purpose built facility and is headquartered in Orangeburg, South Carolina. Certified with R, U, and S ASME stamps, Newpoint Manufacturing supports and enhances the Newpoint Companies fabrication and assembly processes globally.

Please let us know if Newpoint can be of service.

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