

LNG FOCUSED SPECIAL EDITION OF FROSTBYTE FOR THE GASTECH SHOW IN LONDON OCTOBER 2012

Uniflo Fog Reduction Module

ryoquip has developed a modular vaporizer fan addition option for its range of Uniflo natural draft ambient vaporizers for use with atmospheric gases and LNG. The Fog Reduction Module (FRM), is an upgrade accessory which can be applied to existing installed Uniflo units to enhance multiple aspects of performance. The main advantages of this module are:

- Reduction in fogging and improvement in thermal performance
- Special fan blade design for low audible noise for quiet operation
- 10-20 horsepower (7-15 kW) electric motor
- VFD housed in NEMA 4 electrical cabinet

The FRM has enough space clearance so that the original natural draft performance will not be impacted. The fan blades are of special design that reduces the audible noise. The electric drive motor is a TEFC controlled

by a VFD, connected to a customer DCS control system or a manual system to vary rotational speed based on desired parameters.

One of the challenges associated with the use of ambient air as the heating medium for vaporization of cryogenic fluids and LNG is the formation of fog. This is especially true in an LNG send out station application when multiple AAVs are being used simultaneous to provide Natural gas to a pipeline. Air is a two-component mixture of dry air and water vapor and when it is cooled by heat exchange with the cold LNG the water vapor turns into fog and with multiple units operating a great deal of fog can be generated.

The FRM's main enhancement is reduction of fogging. By forcing a higher convective air flow rate through the vaporizer, the enthalpy change of the air becomes lower so the air does not drop in temperature nearly as much as in the natural draft conditions. A side benefit on the FRM is the improved thermal performance which provides higher outlet temperatures for the process discharge. A further benefit of the FRM is the shorter defrost time promoted by the fan when used in vaporizer switching applications.



*Above performances are general only. Actual performances are subject to many site-specific factors and may vary.

The fan motor can be connected to a variable frequency drive (VFD) which modulates the fan speed. With precise control of the fan rotation speed, a control system can be implemented to help dissipate fog at the bottom of the vaporizer as well as improve outlet temperatures for the process discharge.



Testing photos before and after controlled by an external DCS using the FRM







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Natural Gas Liquefiers... Simple, Efficient, Reliable

osmodyne's standard natural gas liquefiers use a closed loop gaseous nitrogen expansion refrigeration cycle (reverse Brayton cycle) for simple, safe, and efficient operation. This is the same process cycle and technology that's been provided by Cosmodyne to our customers since 1958 with over 400 plants word wide.

The simplicity of Cosmodyne's natural gas liquefier design allows for the equipment to be skid mounted and modularized for easy site erection, installation, and even relocation. Furthermore, the environmentally friendly nitrogen gas allows for simpler site permitting, eliminates the need for hydrocarbon refrigerant storage, and easier maintenance procedures (no in and out purging required). The nitrogen cycle is easy to operate and control since the nitrogen cycle is less sensitive to changes to feed gas composition and ambient conditions. The complexity of changing the mixture of several hydrocarbons to match the changing gas composition or ambient conditions to maintain optimal efficiency is eliminated. The energy available from near isentropic expansion of the nitrogen refrigerant is efficiently recovered for high efficiency performance. The nitrogen cycle has an operating range of 100% to 25% with proportionate energy savings. This operability range is important since most LNG plants have a steep ramp up period. The process further allows the operator the flexibility to easily change the sub-cool LNG product temperature setting when needed. Cosmodyne's natural gas liquefier can be fitted with fractionation step(s) to control the LNG product specification to meet vehicle grade LNG or other product requirements. The fractionation step(s) moreover can also recover other natural gas liquids such has HD-5 propane.

Cosmodyne also offers engineered cycles to meet specific customer requirements such as open loop nitrogen for smaller capacity plants and single mixed refrigeration process cycles for larger capacity plants.

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High-Pressure Gas Supply for Two-Stroke Dual Fuel Engines a new challenge using LNG as a marine fuel

D riven by economic and environmental factors, LNG propulsion is a quickly developing technology for the shipping industry. Starting with medium speed four-stroke engines using natural gas as propulsion fuel, a number of new technologies have been developed in recent years including those for twostroke engines. One of the major innovations was the introduction of slow speed, two-stroke diesel engines using dual fuel (natural gas & diesel mixture) technology by MAN Diesel & Turbo (MAN) in 2011.

The gas supply to MAN's dual fuel ME-GI engine is quite different from other fuel supply processes including those run on gas carriers. New challenges are:

- High pressure (up to 350 barg) natural gas supply to the engine
- Converting low pressure LNG to high pressure gas during the ship's voyage
- Designing a Fuel Gas System (FGS) to meet load ramps / shut down scenarios

TGE Marine Gas Engineering GmbH, in a joint effort with ACD llc, engineered a FGS utilizing integrated system controls and a combination of low pressure centrifugal (booster) and high pressure reciprocating cryogenic pumps. Using the combination of pumps ensures the FGS achieves 100% reliability and meets the challenges of this new application. The required FGS is a compact, skidded design and easily installed on seagoing vessels. The FGS can be installed in an open shelter within the cargo area of a gas carrier or below deck of other cargo vessels.

Pumps are a key component of the Fuel Gas System. The submerged vertical centrifugal pumps (see figure 1) are mounted inside the cargo tank and supply LNG at needed pressures and flow rates. The submerged pumps are often referred to as "boost" pumps which simply transfer LNG to the suction end of the high pressure (HP) pumps. Boosting of the LNG pressure eliminates issues associated with cavitation. Cavitation reduces HP pump life and must be avoided to achieve required operational life of the HP pumps. Using a "boost" pump



FIGURE 1 - Submerged vertical MSP-34 "boost" pump

guarantees sub-cooled liquid is properly fed to the high pressure pumps and gives operators assurance the FGS meets all challenges operating at sea.

TGE and ACD have transferred the submerged pump technology to the shipping industry. ACD recently delivered the first MSP-34 (Marine Supply Pump-

Submerged) pumps to be installed in an Anthony Veder 15,600 m3 LNGC ship also using LNG as the propulsion fuel. (*See Figure 2*)



FIGURE 2: Anthony Veder, 15,600 M3 LNG cargo vessel.

The reciprocating pumps (see figure 3) increase low pressure (minimum 2.5 - 4.0 barg) LNG supplied from the boost pumps to high pressure (350 barg) LNG. High pressure LNG is then discharged to a heat



FIGURE 3: High pressure MSP-SL reciprocating dual pump skid. Single MSP-SL skids also available

exchange system which vaporizes the liquid to gas. The high pressure natural gas is then fed to the engine's high pressure fuel control valves through a manifold system designed by MAN. TGE and ACD have put much effort into developing the Fuel Gas System and validating system design using simulation based on actual operation of a typical voyage. Given the size and complexity of the ship's engines, and the fact that duplicating 'real-world' operations in multiengine applications is difficult, the dynamic simulation model is a practical and reliable solution that investigates various aspects of the system's design through multiple operational processes.

TGE uses UNISIM[™] modeling for steady state and dynamic process simulation. Very detailed modeling of the components including all piping sections, control elements and ACD's cryogenic pumps form the basis for thorough investigation of liquid (LNG) composition from the cargo/

fuel tank to the engine. The simulation program shows how pressure and temperature changes of LNG impact FGS reliability and why a boost pump is required. The boost pump simply ensures a positive means to counter potential problems due to normal voyage situations that threaten sub-cooled liquid conditions to the high pressure pumps.

The critical aspect during operation is to avoid cavitation of the high pressure pump. Marine applications introduce new factors that impact cavitation scenarios



FIGURE 4: Flow deviation in quick switchover scenario.

compared to on-shore processes. These variables have been investigated in detail using the UNISIM[™] model. Simulation has shown that cavitation does not occur using a booster pump, which always supplies sufficiently sub-cooled liquid to the high pressure pump.

Figure 4 shows how TGE's FGS maintains fuel pressure requirements to the engine during a quick switchover scenario. The simulation proves the FGS is designed to achieve optimal performance should a switchover (from natural gas back to diesel or vice versa) be required during the voyage.



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FIGURE 5: Heavy weather load scenario for engine

Figure 5 shows one aspect of demanding requirements in a heavy weather scenario. The black line shows the very dynamic behavior of the engine fuel index. The FGS must follow this fuel index to ensure proper engine operation. Dynamic simulation has clearly shown that TGE/ACD system fulfills such requirements.

Process simulation has been used extensively to verify the control strategies are adequate to meet various operational requirements. The simulation also proves the FGS's behavior throughout the voyage will meet basic system requirements for the ME-GI engine using low and high pressure pumps.

In summary, the UNI-SIMTM model has shown that advanced controls and the use of dynamic process simu-

lation has proven useful to develop a FGS that meets ALL marine requirements: safe and reliable operation, engine demands and special challenges due to the marine environment. TGE's system, using ACD pumps, meets all marine conditions and proves the system design meets operational requirements for MAN's ME-GI engine and ensures reliable performance throughout the ships voyage.

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BALLAST NEDAM-IPM is a Big Name in the "Gas" Station Business

allast Nedam is one of the leading construction and infrastructure companies in the Netherlands and one of the topfive largest Dutch construction and engineering companies operating around the world. Ballast Nedam International Product Management (BN-IPM) is a division specializing in installation technology for energy and mobility and is a turnkey supplier of service and filling stations for traditional fuels, LPG, Compressed Natural Gas (CNG), Liquefied Natural Gas (LNG), Biomethane and Hydrogen.

Background

LNG and LCNG are clean energy sources used for vehicle fueling applications. Natural gas lowers the carbon footprint and significantly reduces overall vehicle emissions. Because LNG has a high concentration of methane (95%-99% on average), it is an ideal fuel to meet Europe's stringent 2020 environmental targets. In addition to the environmental benefits, LNG's lower cost, compared to conventional fuels, improves the bottom line for operators. For these reasons, LNG is considered to be the logical future fuel alternative and BN-IPM's "gas" station technology provides a solution to meet the emission reduction objectives.

What BN-IPM is doing

BN-IPM's mission is, "working together for a better environment, for now and the future" while focusing on providing "lasting quality". BN-IPM is at the forefront of the construction industry working to create a network of LNG stations for cars and trucks running on LNG. BN-IPM plans to build more than 60 LNG filling stations within the next 5 to 10 years, to serve an estimated 10,000 Heavy-Duty Vehicles. Three LNG stations are expected to be completed in 2012, with the first one online in Zwolle, Netherlands.

This Zwolle LNG station is a unique filling station - it can fuel all types of LNG vehicles at saturated pressures (from 6 to 24 bar) from one dispenser – the first of its kind in Europe.

BN-IPM's Zwolle LNG station is also a fully automatic, unmanned public station that is equipped with a vehicle recognition system that tells the station control system what saturation setting and fueling system is required for each vehicle. This information is compared to the driver's DKV card (a fuel card used throughout Europe) that is scanned at the pay terminal to ensure safe dispensing as well as proper fueling speed and quality.

All of BN-IPM's new LNG stations will also include:

CNG/LNG Petrochemie Wastechniek





- Vapor collapse filling and vapor return filling as well as on-the-fly saturation heater
- A dispenser equipped with a counterwork specially adapted for LNG fuel. (Metering method is currently being tested for MID certification.)
- All necessary certifications: CE, PED, ATEX and conformity to all applicable standards. (The permitting process was very extensive and thorough and will be used as the standard for Dutch national regulations on LNG filling stations).
- Automatic overfilling protection by weight measurement
- Filling rates up to 150 l/min depending on vehicle type
- An ACD TC-34 4-stage pump which is the only pump available for attaining high LNG pressures
- A remote control and Supervisory Control and Data Acquisition (SCADA) system where all the data from the station is con-

tinuously uploaded to a SCADA server.

The 60 LNG filling stations that BN-IPM plans to build are expected to serve the public as well as various domestic goods transport companies, large supermarket chains, waste-collection firms and other HDV fleets. At this moment several Dutch logistic companies are planning to have LNG trucks in their fleet very soon.

ACD, as a major global manufacturer of cryogenic pumps, has been involved in the design and realization of early LNG facilities in the USA and around the world over the past several years. ACD has acquired extensive knowledge and valuable experience with the pumps required for LNG and LCNG filling stations. The TC-34 submerged LNG pump was particular successful due to its multi-tasking capabilities, tanker unloading and vehicle filling. Submerged motor pumps are gastight and therefore the safest and most reliable pump solution possible. TC-34 pumps start immediately which is a requirement for unattended filling stations, and it is the most widely used pump for vehicle re-fuelling in the world.

BN-IPM conducted an extensive study in LNG vehicle re-fueling before any projects were accepted or construction began. A major contributor to BN-IPM's research was ACD through its European subsidiary ACD Cryo. Combining the strengths of both companies creates a low-cost solution and provides the needed infrastructure to safely and reliably use LNG as a vehicle fuel.

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