CRYOGENIC INDUSTRIES

LNG as a marine fuel has shown great potential as a clean, safe, reliable, and cost effective alternative to diesel fuel in an ever changing global environment " ɣ ' implement the use of liquefed light hydrocarbons – LNG being the most common – as marine fuels. ACD has experience with both low pressure (approximately 8 bar) port injected engines, and high pressure (approximately 300 bar) direct injected engines, the more intricate of which is the high pressure variety.

High pressure fuel gas systems vary somewhat in design from one application to another, however they typically consist of several primary components, namely the reciprocating high pressure pump, drive motor, A positive displacement pump is aptly called so because it creates fluid motion through the repeated increasing and decreasing of its internal volume. In the case of a reciprocating piston pump, this increase and decrease in volume comes from the extension and retraction of a piston into and out of a cylinder. In operation, pump flow is dictated by the demand of the engine using pump discharge pressure as control feedback, and adjusted by managing the speed of the pump accordingly.

Drive Systems

ACD has used several varieties of drive systems over the course of many years of manufacturing reciprocating pumps. Depending on operating conditions, these pumps will be driven by either an electric or a hydraulic motor, either directly or through a speed reducer such as a gearbox or a

This is advantageous as it forces lubricant into the bearing surfaces in the drive, allowing for higher relative drive load and life ratings. These drives are well suited for intermittent duty at relatively high loads. As with the splash lubricated drives, they do require a certain amount of down time to properly cool, and are best suited to static environments, as dynamic environments could potentially starve the oil pump pickup. These systems are well suited to operating conditions with narrow speed ranges, as the oil flow and pressure are dependent on the speed of the pump drive.

Externally pressure lubricated drives have the distinct advantage of being able to condition the lubricating oil under all conditions. Relative load and life ratings on these drives are high, and their physical size is relatively small for their output ratings. Oil is constantly filtered, and is maintained at optimum temperature using cooling and heating systems that are built into the lube pack, helping to extend the life of the pump drive to its maximum potential. The lube system provides consistent oil pressure, regardless of pump drive speed. The addition of subsystems requiring lubrication, such as gearboxes, becomes a simple task, as lubricant can be piped to these subsystems with relative ease. The reservoirs of externally lubricated systems increase the retention time of the oil and provide a total aversion to oil pump starvation, regardless of the list and roll of the environment. These characteristics make externally pressure lubricated drives very well suited to continuous duty applications in dynamic environments.

There are many determining factors to be considered when selecting a lubrication system. There is not a correct and incorrect way, per se, as there are likely multiple options available as solutions to each application, however for each application there is always a 'better' or 'best' way. For example, there are many features from an external lube system that can be integrated directly into a drive, but would not be for practical purposes such as cost and physical size. Building a drive with the size and complexity necessary to accomplish all of these things is likely far less cost effective, as well as much larger and heavier, than building a purpose built lube system that achieves the same things.

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Although each application takes a somewhat different approach, the goal is always the same: delivery of high pressure natural gas to the fuel rail of an ME-GI engine. Installations are typically applied in two distinct ways, the first being aboard a ship as a fuel supply system for the main engine, and the second being a land based unit as a fuel supply system for engine testing at an engine manufacturer's test stand. In the case of shipboard systems, ACD has worked very closely with several EPCs to build a high pressure fuel gas pumping system that integrates well with the ships fuel storage, engine, control system, and overall architecture.

Shipboard systems are required to comply with marine classification society rules, the largest of which are the American Bureau of Shipping (ABS), DNV-GL, Bureau Veritas (BV), and Lloyd's Register (LR). Each classification society puts forth a set of rules that must be complied with before they will grant classification for a vessel. These rules are focused primarily around the safety and reliability of the vessel. ACD works closely with representatives from each of these class societies, and has manufactured approximately twenty-five high pressure fuel gas systems, being granted practices, particularly for pressure vessels and piping, material selection, and electrical devices. Pressure vessel and piping design is subject to review by the classifcation societies, each having their own specifc sets of rules to comply with. As an example, one of the most signifcant departures from typical high pressure piping design for reciprocating pumps came from the requirements of DNV-GL, which specifcally disallow screwed connections in the main process line in favor of butt welded piping and weld neck fanges, resulting in a new piping design that ACD has since employed on all of its shipboard high pressure fuel gas systems. Materials are carefully selected to combat exposure to marine environments, resulting in many components being manufactured from specifc grades of low carbon austenitic stainless steel. Electrical components, such as motors, transmitters, and conduit fttings, are subjected to heightened levels of testing to prove their robustness against the harsh environment of a ship. [See fgure 3]

While not a requirement of classifcation societies, shipboard systems typically (although not always) utilize two identical pumps, each capable of meeting 100% of the engines fuel demand. This is done purely for redundancy, and the pumps do not operate at the same time. Once