BLACKMER
LP GAS PUMPS AND COMPRESSORS

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TRANSCRIPTION GENERATED SEPTEMBER, 1993

Welcome to the Blackmer LP Gas Pump and Compressor presentation. My name is David Simpson and I am the Manager of the Compressor Applications Group based in Oklahoma City, Oklahoma, USA. In this presentation we will introduce you to Blackmer and the pumps and compressors we manufacture for use in the transfer of liquefied petroleum gas.

PART I

BLACKMER / A DOVER RESOURCES COMPANY

Here is the Blackmer logo. This logo is designed to convey a couple of important points. The first is that Blackmer is a worldwide and worldclass company. The second is that Blackmer is a part of a much larger group called Dover Resources.

DOVER RESOURCES / DOVER CORPORATION

Dover Resources is, in turn, a part of an even larger group called Dover Corporation. Dover Corporation is a multi-billion dollar corporation comprised of over 100 industrial manufacturing facilities. Dover Corporation stock is traded over the New York Stock Exchange.

As I mentioned earlier, each of the Dover companies are involved in manufacturing a product for the industrial market. Every Dover company is committed to being a leader in its market and it strives to achieve this leadership via product quality and innovation and product design. Responsive service to customer request and customer problems is a key part of our strategy. Also, Dover stresses a long-term view to the market. You can be assured that when you buy a Blackmer product, support for that product will be there some years in the future when you need it.

BLACKMER - OVER 90 YEARS EXPERIENCE

Here is an abbreviated history of Blackmer, and as you can see, we have had over 90 years of experience as a manufacturer of rotary vane pumps. The company was started in 1901 and in 1925 relocated to its present location in Grand Rapids, Michigan. In 1954 Blackmer entered the liquefied gas pump market. In 1964 Blackmer became part of the Dover Corporation and continued to operate as an independent company. In 1980 the first Blackmer compressors were produced. These were for the liquefied petroleum gas market and in 1990 the Blackmer industrial compressor line, the HD series were introduced. In 1991 the company named changed from Blackmer Pump to Blackmer to reflect the growing product line. One other item not shown on this list is that Blackmer now has ISO-9001 certification for both its Grand Rapids and Oklahoma City facilities. This is a quality assurance standard that is recognized worldwide.

BLACKMER - A MANUFACTURER WITH TOTAL RESPONSIBILITY

Blackmer is responsible for the conception, design, manufacturing, sales and service of its products. The company is divided into four major groups; Engineering, which is responsible for the design of the products, the Blackmer Foundry, which produces most of the castings used in Blackmer products, the Manufacturing and Assembly group which actually builds the products, and the Sales and Marketing group which presents the product to the customer.

ENGINEERING - DESIGN OF THE PRODUCT

The Blackmer engineering group includes a number of professional engineers who have both the technical background and the practical experience to design our products. We use the latest in computer tools, such as computer aided design programs and finite element analysis programs that enable us to design and test components in the computer before committing them to the prototype stage. This speeds the design process considerably and helps eliminate potential weaknesses in the designs. We also use computer-aided drafting to allow fast and accurate drawings of the various components. And as a final check, all new products are tested in a laboratory setting to ensure that they do indeed meet predicted performance parameters.

FOUNDRY - CASTING PRODUCTION

After the Engineering Department has designed the parts, it is time to time to turn these designs into metal castings. The Blackmer Foundry produces sand castings of both cast iron and ductile iron from about 1/2 pound up to about 300 pounds, that is about 1/4 kilogram up to about 150 kilograms.

The Foundry uses three state-of-the-art electric furnaces that ensure a consistent product and are environmentally friendly. The Blackmer Foundry has its own test facilities and quality control department to ensure that the castings produced are of consistently high quality. Special tests or documentation requirements can usually be met to provide the appropriate quality assurance.

MANUFACTURING / ASSEMBLY - BUILDING THE PRODUCTS

Blackmer presently has two manufacturing plants in operation. The larger of the two is located in Grand Rapids, Michigan and builds all of Blackmer's liquid pumps. The Grand Rapids plant also houses the foundry and serves as Corporate Headquarters. The second plant is located in Oklahoma City, Oklahoma and is where the compressors are manufactured. Blackmer uses the latest in computer controlled machining centers that provide both fast and accurate work. All pumps and compressors are subjected to a battery of tests before shipment and all parts are also subjected to a variety of quality control checks to ensure consistently high quality of manufacture.

SALES / MARKETING - TO PRESENT THE PRODUCT TO THE CUSTOMER

The Blackmer Sales and Marketing Group consists of a number of people that work together to present and explain Blackmer products to our customers. Our Product/Market Managers are each responsible for certain markets that Blackmer serves and, in turn, responsible for certain products. These Managers work to ensure that the products that we manufacture meet the needs of the market we serve and also to find the best way to serve those markets. Our Applications Engineers help customers decide exactly which Blackmer product is best suited to the particular job at hand. Our Customer Service Group handles order entry and acknowledgement and expediting of existing orders. And last, but not least, is our Fields Sales Group who are the people that meet with our customers face to face on a daily basis to support their ongoing needs and find new customers.

BLACKMER MARKETS

Blackmer products are sold into four major markets. The first of these are government and large OEM products. Blackmer has supplied pumps to the U.S. Government since 1914 and has had a few contracts with other governments as well. In addition, Blackmer has a few large OEMs for which we build a variety of specialty products.

Our second major group is for mobile transfer equipment. These are for truck pumps and accessories designed especially for fuel oil and also for bulk liquid transports.

The third group is our fluid processing and transfer pumps. These are pumps for products like lubrication oil, asphalt, solvents, paints, abrasives, syrups, soaps and latex and other food and chemical products.

And the fourth group is the liquefied and compressed gas equipment group. This segment is concerned with the LPG and NH3 transfer pumps and compressors. This group is also responsible for pumps and compressors for the transfer and recovery of products such as carbon dioxide, refrigerants and other liquefied or industrial gasses. This last area is the segment responsible for the liquefied petroleum gas pumps and compressors that we are going to be talking about shortly.

INTERNATIONAL MARKETING - A GLOBAL NETWORK

As I mentioned at the start of this presentation, the Blackmer logo is designed to convey the fact that Blackmer is both a world class and a worldwide company. Although located in the USA, we have actively been seeking business and supporting customers in many other countries for many, many years. Blackmer has products in use in almost every country in the world and has a worldwide network of distributors and/or agents to support those customers.

SELECTED BLACKMER CUSTOMERS

Virtually all major companies worldwide that deal in tangible products have used Blackmer pumps or compressors. Virtually any company that is concerned with manufacturing, food processing or chemical transport or processing, has need for a Blackmer pump or compressors.

BLACKMER PRODUCTS

As I mentioned before, Blackmer is a manufacturer of pumps and compressors. The oldest of our lines are our rotary vane positive displacement pumps. These pumps are available with port sizes of 1-10" (2 1/2-25 cm) and are available in cast iron, ductile iron, steel, stainless steel or bronze. We offer packed pumps, mechanical seal pumps and sealless pumps and they are available with or without steam jackets.

Blackmer also makes a line of hand pumps for the transfer of solvents and various hydrocarbons from barrels.

In addition, we offer a number of items related to pump use. These include relief valves, gear reduction drive systems and hydraulic oil cooling systems for use in hydraulically driven pumps.
Since 1980 Blackmer has also manufactured a line of reciprocating gas compressors. These are available in the 2-50 hp range (1 1/2-37 kw) and are all of ductile iron construction. We offer both two-stage and single-stage models, most are air cooled, although selected models are water cooled.

Although our primary business is to manufacture the basic pump or compressor, we also offer unit packages, which are a pump or compressor, complete with drive system and control system built per the customer specification.

PART II

LPG PUMPS

Welcome to the second part of the Blackmer, LP Gas Pump and Compressor Presentation. In this section we are going to talk about the transfer of liquefied petroleum gases with Blackmer liquid pumps. On this page is a diagram of a typical bulk plant that shows most of the uses for both a pump and a compressor. In the center of the picture are the storage tanks, which are often called bullets in the USA and these are typically 10-30 thousand gallon tanks (38-114 cubic meters). To the upper right of that is the railcar unloading station. Railcars are typically 11-33 thousand gallons in size (42-125 cubic meters). To the right of the storage tanks is a transport truck, and these trucks are typically in the 10 thousand gallon (38 cubic meter) range. The smaller truck shown in the lower left of the picture is a delivery truck, or what is known in the U.S. as a bobtail. Bobtails are typically in the 2-5 thousand gallon range (7 1/2-19 cubic meters). To the left of the picture is the cylinder filling area. Cylinders of, roughly, 5 pounds to 500 gallons capacity (2 kilograms to 1900 liters) are emptied then refilled here before being returned to the customer site.

When LPG is being delivered to the plant, Blackmer liquid pumps may be used to transfer from the transport truck into the storage tanks or from the bobtail truck into the storage tanks. When LPG is to be transferred out from the plant, the pumps are often used to move LPG from the storage tanks into the transport truck, from the storage tanks into the bobtail truck, or from the storage tanks to fill the cylinders. If this plant happens to be used as a storage site for fuel for an industrial plant, the liquid pumps may also be used to move LP Gas from the storage tanks to the LP Gas vaporizer.

WHAT IT LPG?

LPG stands for Liquefied Petroleum Gas and usually refers to specific products such as propane or butane or a mixture of propane and butane. LPG is used as a fuel in homes, businesses and industries. It may be used for cooking or heating or as a feed stock for various industrial processes.

One of the real advantages of LP Gas is that it can be transported and stored as a liquid but can easily converted from a liquid to a gas or back to a liquid if needed. As a liquid, LP Gas is a very dense energy source. By this I mean that a large amount of energy may be stored in a small amount of space. This liquid can be easily converted to a gas, which can then be used as a fuel. In fact, LP Gas can be mixed with air to act as a substitute for natural gas if desired.

The bottom of the page shows a chart outlining some of the physical properties of propane and butane. As you can see, the molecular weight of propane is about 44 while that of butane is about 58 and that the specific gravities of the liquid of both propane and butane is just over half of that of water. This means that a gallon of propane or butane will only weigh about half of what a gallon of water would weigh. It is worth pointing out that both propane and butane have a viscosity of about .1 centipoise, which make them about 10 times thinner than water. Both propane and butane are a type of product known as a liquefied gas. For these products to exist as a liquid at normal outdoor temperatures, they must be stored in enclosed containers under pressure. If these products were placed in an open container such as that might be used to hold water or gasoline, they would quickly boil away leaving only vapor in the container. The pressure required to maintain the product as a liquid will change as the temperature changes and from this chart you can see that as the temperature goes up the pressure also goes up. You can also see that for any given temperature, the pressure for a propane vessel will be higher than a butane vessel.

TYPICAL LPG PUMP SYSTEMS

Propane pumps may be stationary, as shown in the middle picture, or mounted on the truck, as shown on the top and the bottom pictures. The middle picture of the stationary pump shows a typical storage tank with the pump mounted directly below it. This pump can be used either to empty or fill the tank.

The top picture shows a typical bulk plant delivery truck, or bobtail. This type of truck will normally have a pump mounted on it and is used to deliver LPG to the customer's location.

The bottom picture shows a LPG transport truck which often has a pump mounted on them which is either driven by PTO or hydraulic motor drive system.

The sketch shows a typical pump system. The pump is normally located below the tank with the suction line coming from the bottom of the tank through a valve and a strainer to the pump suction. The pump discharge line should always be fitted with a bypass valve that returns any bypassed liquid to the storage tank. In addition, a manual bypass line may also be fitted.

HOW ROTARY VANE PUMPS WORK

Rotary vane pumps are a type of pump known as a positive displacement type. This means that every time the pump turns one complete revolution, a fixed volume of fluid is displaced from the suction side of the pump to the discharge side of the pump. A rotary vane pump consists of a slotted rotor that is fixed to a shaft that rotates. A series of vanes fit in the slots. These vanes are allowed to slide in or out of the slot alternately retracting into the rotor or projecting out of the rotor as shown in the diagram. This entire assembly, consisting of the rotor and the vanes, fits inside a liner. The rotor is set off center to the liner so that at one side the rotor and the liner are almost in contact with each other, while a space exists on the other side. As the rotor turns, the vanes slide outward at the intake port creating an expanding space into which liquid is drawn from the suction line.

As the rotor continues to turn, liquid is eventually trapped between two vanes and carried from the inlet port to the outlet port.

At the outlet port, the space between the two adjacent vanes is decreased and the liquid is squeezed out from between the two vanes into the discharge side of the pump. The vanes are forced back into their slots by the liner until they are allowed to extend again at the suction side of the pump.

HOW SLIDING VANES ARE ACTUATED

In order for a sliding vane pump to work properly, the vanes must stay in contact with the liner throughout the pump's rotation. To do this, three different means are employed. First is the centrifugal force of the rotor's rotation. The weight of the blade itself and the rotation of the rotor will tend to force the vane outward.

Secondly, push rods between opposite sets of vanes are used on most pumps. This way as one vane is pushed into its slot by the liner, a force is transmitted via the push rod to the back of the opposite vane pushing it out of its slot.

And thirdly, liquid at discharge pressure is introduced into the bottom of the slot underneath the blade, which also provides a force to push the blades outward against the liner. Pressure grooves are provided on the face of each vane to allow this pressurized liquid to move freely in and out of the cavity beneath the vanes.

HOW SLIDING VANES SUSTAIN HIGH LEVEL PERFORMANCE

One of the key reasons for using a Blackmer sliding vane pump for LP Gas transfer is that its performance stays very constant throughout the entire life of the pump. As the end of the vane in contact with the liner slowly wears, the vane simply slides a little farther out of the slot. The vanes self compensate for wear and operating clearances change very little throughout the life of the pump. The result is that even after thousands of gallons of product transferred, the pump will still perform like new.

BLACKMER LPG PUMP DESIGN FEATURES

Here is a drawing showing the features of a typical Blackmer LP Gas pump. Starting at the right side of the drawing, we are shown the bearing lock nut and washer, which are used to precisely position and hold the shaft in position. Next is the ball bearing, which is placed outside of the mechanical seal and is used to support the shaft. At the top of the pump case is the built in internal relief valve and inside the case is the replaceable liner. The rotor and shaft assembly is shown here complete with the vane and the push rod behind it. The end discs are replaceable to extend the life of the pump. Also, all Blackmer LPG pumps are fitted with mechanical seals that are easily installed and provide extremely long life.

BLACKMER MECHANICAL SEALS

Seals are a critical component in an LP Gas pump. Because of this, seals used in our pumps are designed and built exclusively for use in Blackmer pumps. As I mentioned earlier, both propane and butane are approximately 10 times thinner than water and place great demands on the seal's design. The seal's design minimizes both axial and radial movement but allows the seal faces to remain precisely aligned even as the pump wears. The seal is located for maximum flushing and cooling of the seal faces and sized with low pressure and velocity factors to ensure extremely long life. No set screws are used and the seal is quite easy to replace should the need ever arise.

REPLACEABLE LINER AND END DISCS

A key feature of all Blackmer Series LGL pumps for LPG service, are that they are easily rebuildable. A replaceable liner and end discs are used to protect the expensive pump casing and heads. Replacement of these parts allows an older pump to be restored to new efficiency. These parts are relatively inexpensive when compared to the price of a new pump and, if necessary, may even be replaced while the pump is still installed in the piping.

RUGGED CONSTRUCTION

All Blackmer pumps for LPG service feature ductile iron cases. Ductile iron is noted for its high strength and high resistance to thermal and mechanical shocks. Working pressures are rated for 350 psi (24.1 bar) which is well above any pressure expected in a LPG transfer operation. The shaft used in Blackmer LP Gas pumps are made of steel and are oversized to allow the operation up to 150 psi on differential pressures on many models. All models feature ball bearings that are externally located outside of the mechanical seals. These bearings are grease lubricated and are easy and inexpensive to replace. Lock collars are used to precisely position the rotor and shaft between the end discs. This allows for operation at higher differential pressures and for longer life in abusive operation situations.

UL LISTED

All Blackmer LP Gas pumps are listed by Underwriters Laboratories for service on both LP Gas and Anhydrous Ammonia. A UL Listing is required for most pieces of equipment used in propane bulk plants in the United States and is also widely recognized in many other countries. To obtain this listing, each pump is subjected to a thorough design review and a test at extreme pressures and temperatures to ensure that the pump will survive an emergency situation.

BLACKMER SLIDING VANE PUMP ADVANTAGES

Blackmer pumps have gained their number one ranking in the LPG marketplace because they offer a number of advantages over other types of pumps. As I mentioned earlier, the sliding vanes self adjust for wear so that the pump's performance stays extremely high throughout the life of the pump. In addition, there is no metal to metal contact within the pump, which leads to quieter operation as well as eliminating most sources of wear in the pump. Since the pumps are a positive displacement design that will always attempt to move fluid from the suction through the discharge side of the pump, they will transfer LPG under very adverse conditions. Tightly controlled internal clearances allowing very little slippage and no metal to metal contact, both result in extremely high efficiency. This means that more gallons, or liters, are transferred for every kilowatt used. Lastly, thousands of Blackmer LP Gas pumps in service worldwide have proven to be quite easy and inexpensive to maintain in normal use. In addition, when needed, can be easily repaired.

MOTOR SPEED PUMPS

The smallest of Blackmer's LP Gas pumps are directly driven by 1750 or 1450 rpm motors. These pumps are typically used for cylinder filling, motor fueling operations or as vaporizer feed pumps and are available in 1-1 1/2" sizes. They will transfer approximately 3-35 gallons per minute (11-130 liters per minute) and are typically driven by 1/2-5 hp motors (.4-3.7 kilowatts). One feature used on the 1" models, is that the internal safety relief valve may be used as a
back-to-tank bypass valve if desired.

These pumps are available in two basic mounting styles. The first is a flange mounting in which the pump is bolted directly to the face of the motor. In this mounting style a C-face type motor must be used. In the second style, the pump is mounted on a baseplate and is driven by a motor via a flexible coupling. In this case, most any type motor of the appropriate rpm may be used.

STATIONARY TRANSFER PUMPS

Blackmer stationary pumps are widely used in bulk plants for general transfer service and in terminal operations for transfer to and from transport trucks. They are also used as vaporizer feed pumps on larger vaporizers and for large scale cylinder filling operations, particularly those operations that use a carousel type system. Two, three and four inch pump sizes are available for transfer rates of 20-300 gallons per minute (75-1135 liters per minute). All of these pumps are driven in the 350-980 rpm range and will require 2-28 hp (1 1/2-21 kilowatts). All of them feature internal safety relief valves. Most stationary LPG pumps are driven via a V-belt drive system, although gear reduction drives are also widely used.

TRUCK PUMPS

Blackmer pumps are available for use on both smaller "bobtail" delivery trucks and on larger transport trucks. Two, three and four inch sizes are available in both chassis mounted and flange mounted arrangements. The flange mounted pumps are bolted directly to the bottom of the tank via an internal valve. This arrangement eliminates suction piping and many of the problems associated with an improperly designed suction line. Chassis mounted pumps are bolted to the frame rails of the truck and are piped to the bottom of the tank on the truck.

Most of these pumps are driven via PTO (Power Take Off) shafts. However, hydraulically driven pumps are becoming more popular. A hydraulic motor system provides for safer operation and allows greater freedom in the placement of the pump. Like the stationary pumps, these pumps are typically driven in the 350-980 rpm range and are capable of transferring 20-300 gallons per minute (75-1135 liters per minute). All of the pumps are fitted with double shafts so that the pump may be installed regardless of the direction of rotation of the PTO.

BYPASS VALVES

All positive displacement pumps such as those supplied by Blackmer should be fitted with an external bypass valve in addition to the internal safety relief valve fitted inside the pump. These external bypass valves are used to bypass excess pump capacity from the discharge side of the pump back to the storage tank. Blackmer bypass valves are available in 3/4-2" sizes and all feature a hydraulically cushioned closing action that prevents hammering of the valve and extending its life considerable. All of the valves feature ductile iron bodies and are available for flow rates of 5-250 gallons per minute (19-950 liters per minute).

PROPER PUMP INSTALLATION

In this section of the presentation we are going to talk about proper installation of the pump. LPG is a difficult product to handle and proper installation of the pump can make the difference between a system that works well and one that may not work at all. Properly installing the pump can provide a number of benefits. The first is a trouble free and consistent transfer of the product, and the pumping system must be able to cope with both extremes. Secondly, proper installation for repairs will be much less frequent.

A properly installed pump will operate much more quietly which is always important on pumps that are installed in urban areas. Properly installed pumps cost less to operate because they transfer more product per kilowatt of electricity used. A properly designed system will transfer product faster, allowing your delivery trucks and transports to deliver more product per day. Also, proper installation will result in a safer operation protecting your employees and plant.

MINIMIZE LOSSES IN THE SUCTION LINE

At the bottom of this page we see a pump sitting below the tank. The suction line comes out of the bottom of the tank through a valve to the strainer and to the pump suction. The pump discharge piping includes a bypass valve that goes back to the tank. When installing such a pump, the suction line should be adequately sized. Normally this would be at least one pipe diameter bigger than the pump inlet port size. Wherever possible, the tank should be as high above the pump as is feasible. Also, the pump should be placed as close to the tank as possible. In fact, if it is allowed, the pump can be set directly underneath the tank. The valve used on the suction side of the pump and other fittings, such as elbows and excess flow valves, etc., should all be of low restriction types. The strainer should be kept clean. Restrictions in the pump suction will result in slower transfer rates, noisy operation and increased wear and tear on the pump.

DON'T LET VAPOR FORM

The next series of installation tips that we are going to talk about are designed to stop the formation of vapor. Vapor in the suction line of a pump does a number of things - all of them bad. As I mentioned earlier, one of the key features of LPG is that it is readily converted from liquid to gas. This process can easily happen in the suction line of the pump if proper care is not taken. Any vapor that the pump must handle reduces its liquid capacity. The pump's mechanical seals are designed to run with a film of liquid between the seal faces. If too much vapor is present in the pump, this liquid film may break down allowing the seal faces to touch. This will cause extremely rapid wear and lead to premature seal failure.

As the pump rotates, the vanes are designed to stay in contact with the liner. Excessive vapor in the pump can cause the pressure loading on the vanes to fluctuate wildly thus allowing the vanes to bounce on and off the liner.

Excessive vapor in the pump will reduce the maximum differential pressure that the pump is capable of generating.

Vapor in the pump will also increase the noise. This is because the vanes are not in continuous contact with the liner and considerable noise is generated.

STOP VAPOR FORMATION IN THE SUCTION LINE

Valves and fitting used on the pump suction line should all be of a low restriction type. Use long radius ells, if possible.

Strainers, or any other fitting upstream of the pump, should be at least 10 pipe diameters from the pump.

Paint the suction lines white or silver so that they absorb as little of the sun's heat as possible.

If possible, place the suction lines in the shade.

ELIMINATE VAPOR POCKETS IN THE SUCTION LINE

We mentioned earlier that the suction line to the pump should be one pipe size larger than the pump connection. This means that a reducer would have to be used just upstream of the pump. This reducer should be an eccentric type with the flat side up. A concentric type, as shown in the diagram on the right, will allow vapor to collect in the suction pipe.

Virtually all pumps will be installed with a horizontal run feeding to the pump. This horizontal pipe run should be level or slope slightly downward toward the pump. Never allow the horizontal pipe run to slope upwards to the pump.

The pump should always be placed below the liquid level in the storage tank. A system installed as shown at the bottom of the page is almost guaranteed not to work.

Obviously, if the storage tank is underground, the pump will always be placed above the liquid level of the tank. Trying to pump from an underground vessel is a difficult proposition. However, if it must be done there are techniques to help ensure a workable system.

USE A BACK-TO-TANK BYPASS VALVE

All positive displacement pumps, such as those supplied by Blackmer, should be fitted with a back-to-tank bypass line. This bypass line should not return to the suction line of the pump as shown in the lower left diagram. A bypass line returning to the suction line of the pump creates a very small recirculation loop in which the liquid LPG will reheat and turn to vapor. In fact, the pump may run completely dry greatly increasing the wear on the vanes and seals of the pump. A back-to-tank bypass line greatly extends the size of the recirculation loop allowing the heat of the recirculated liquid to dissipate.

The back-to-tank bypass line may go to either the bottom of the tank, the liquid section, or to the vapor section at the top of the tank.

Set the back-to-tank bypass valve about 25 psi (about 1.7 bar) lower than the pump's built in safety relief valve. This will ensure that the back-to-tank bypass valve is the first to open. The pump's internal valve should open only in unusual situations as a final protection for the pump and the system. The pump's internal valve routes discharged liquid directly to the pump suction creating a very small recirculation loop which will quickly cause wear and tear on the pump if used excessively.

USE VAPOR RETURN LINES

If at all possible, vapor return lines should be installed as this will greatly enhance the system's overall performance. As liquid is withdrawn from the storage tank, the size of the vapor section, in the storage tank, will increase and the pressure in the storage tank will decrease slightly. Meanwhile, the vapor section of the tank being filled is being compressed due to the incoming liquid thus raising the pressure in that tank. A vapor return line will allow the pressures in the two tanks to equalize and eliminate the pressure decrease in the storage tank and pressure increase in the tank being filled mentioned above.

The vapor return line will thus reduce the differential pressure across the pump, which in turn, will reduce the power required to operate the pump and increase the flow rate across the pump.

ROUTINE MAINTENANCE

Once the pump has been properly installed, it will only require minimum maintenance to ensure top system performance. Of course, if routine maintenance is neglected, the potential for expensive pump repairs increases greatly.

V-belt drive units should have both the alignment and the tension of the V-belts checked monthly.

The pump inlet strainer must be cleaned and the element checked at least every six months. New systems, or recently recommissioned systems, should have the strainers checked immediately after start up.

All bearings in the systems should be lubricated regularly. This would include the pump bearings, motor bearings and PTO drive bearings.

EASY PUMP MAINTENANCE

Of course, there will come a time when the pump will have to be serviced. Luckily this is a relatively straight forward procedure on all Blackmer pumps.

The vanes are quite easy to remove for replacement or inspection. Once the pump head is removed, the vanes slide in and out of the rotor easily.

All of the LGL series pumps feature replaceable liners and end discs. Replacement of these parts will restore like new performance in efficiency, but at a cost much less than for that of a new pump.

One of the key features of Blackmer pumps are that they can be repaired in the field if necessary. Pump bearings, seals, vanes, end discs and liner can all be replaced without disconnecting the pump from the piping.

Last but not least, Blackmer pumps can be repaired without the need of special tools.

PUMP PICTURE

Here is a picture of a typical pump installation. The pump suction lines are coming from the left side of the picture and the pump discharge lines come out of the top of each pump and towards the right of the picture. Both the suction and discharge lines are fitted with flex connectors that help make up for minor piping misalignments. Also note that both pumps are solidly mounted on concrete foundations and that all of the lines are color coded. The back-to-tank pump bypass valves can be seen in the discharge lines.

PART III

LPG TRANSFER WITH A COMPRESSOR

Welcome to the third part of the Blackmer LP Gas Pump and Compressor Presentation. In the last section we talked about using liquid pumps to transfer LPG. In this section, we are going to talk about using a vapor compressor to transfer LPG.

In this picture, we see the same bulk plant we saw at the start of the pump section of the presentation. And in the bulk plant, you can see the storage tanks (or bullets), the railcar, the transport, the bulk tank truck (or bobtail) and the cylinder filling dock. You can also see the compressor room. At the bottom of the page are a couple of typical compressor installations. Note the sketch showing the compressor next to the railcar. This is the recommended placement of the compressor out next to the vessel to be unloaded.

Later in the presentation we will talk about the advantages of using a compressor and the advantages of using a pump and give you some guidelines on which device to use in any given particular application. However, the primary purpose of a compressor in a bulk plant would be for railcar unloading to transfer the contents of the railcar into storage. If needed, it can also be used for general liquid transfer in the plant, such as storage tank to transport or storage tank to bulk truck or from transport or bulk truck back to storage. Also, a compressor is extremely useful for vapor recovery. Compressors are also useful in emptying cylinders so that they may be serviced or refurbished.

WHAT IS LPG?

As we mentioned in the earlier section, LPG stands for liquefied petroleum gas and is generally referring to specific products such as propane, butane or a mixture of these two. While LPG is stored and transported as a liquid, it is readily converted from a liquid to a gas and back to a liquid if need be. Also, every LPG vessel has a vapor section on top of the liquid section of the tank. Compressors take advantage of these facts to transfer LPG from one tank to another. The chart at the bottom of the page shows some of the physical differences between propane and butane. The primary thing to note here, with respect to transferring these products with a compressor, is that at any given temperature, the vapor pressure of butane is quite a bit lower than the vapor pressure of propane. These pressures have a significant effect on the compressor's performance and need to be taken into account when a compressor is sized for a particular application.

TYPICAL LP GAS COMPRESSOR TRANSFER SYSTEM

In the sketch at the top of this page, we can see the basic components of an LPG compressor transfer system. This includes: the tank being unloaded (in this case, the railcar at the left of the picture), the tank being filled (the storage tank at the left of picture), and the compressor with its four-way valve at the center of the picture. The major thing to note at this point is that both a vapor line and a liquid line are used when a compressor is being used to transfer the product. At the bottom of the page, is a sketch showing a typical liquefied gas transfer compressor with typical accessories. You can see there is a compressor mounted on a baseplate complete with motor and beltguard. Also shown are a four-way valve, an inlet strainer, the liquid trap and the discharge relief valve. Virtually every compressor used for LPG transfer will have these items and we will discuss them in more detail later on in the presentation.

WHY TRANSFER LPG WITH A COMPRESSOR?

A liquid pump could never truly empty a LPG vessel. Even if it pumps all of the liquid out, the vessel would still be full of vapor at vapor pressure. This remaining vapor can equal about 3% of the tanks total capacity. This means, that if a plant were to receive its product via transport, 97 transports unloaded with a compressor would be the same amount of product as 100 transports unloaded with a liquid pump. Also, if a vessel needs to be opened to the atmosphere for service or repair work, venting the vapor to atmosphere can be expensive and may pose a safety hazard. Using a compressor to recover these vapors before opening the tank to atmosphere can minimize both of these problems.

Many vessels only have openings on the top of the tank and none on the bottom of the tank. The most common example of this would be an LPG rail tank car. If you will remember back on the pump presentation, all of the suggestions for a proper pump system showed the inlet line coming out of the bottom of the tank. Trying to pump out of a tank with only top openings will result in very poor pump suction conditions. This will result in very short vane and seal life and the operation of the pump would be very noisy. Also, as the liquid is withdrawn from such a vessel, the pump suction conditions continually worsen throughout the process until eventually the pump can no longer function. Considerably liquid will be left in the vessel and, depending upon installation, this might be 20 or 30 percent of the vessel's capacity.

Some vessels have no openings at all into the liquid section of the tank. Typical home delivery tanks of under 500 gallons (2,000 liters) and typical small cylinders, such as the 20 pound (5 kilogram) cylinders, only have a single opening in the top of the vessel. Also, trucks or railcars that have been involved in accidents may be lying on their side such that none of the normally used openings into the tank connect to the liquid section in the tank. In any of these situations, a liquid pump would be totally useless in trying to empty the vessel. Compressors, on the other hand, can easily handle all of these situations while the very best that a pump can do is to empty a vessel of liquid but would still leave it full of vapor. A compressor can always empty a tank of all of the liquid and then proceed to empty the tank of virtually all of the vapor.

While pumps must be provided with properly designed suction lines, that may be impossible to do with many vessels. A compressor is not subject to these limitations. A compressor can recover both the liquid and the vapor from virtually any vessel under virtually any situation.

LPG LIQUID TRANSFER WITH A COMPRESSOR

The sketch at the bottom of the page shows a typical LPG liquid transfer system with compressor. The compressor, in this case, is to be used to transfer the contents of the rail tank car on the left side of the picture into the storage tank on the right side of the picture. The compressor and the four-way valve are shown in the center of the picture, and note that a vapor line connects the top of the storage tank through the four-way valve in the compressor system to the top of the rail tank car. Also note the liquid withdrawal line with a dip tube connecting the top of the tank car to the bottom of the storage tank.

In order to transfer the liquid from the railcar to the storage tank, the compressor will draw vapors off of the top of the storage tank and into the compressor where they are compressed slightly. These compressed vapors, which are at a slightly elevated pressure, will be discharged into the top of the rail tank car. This action of pulling vapors from the storage tank, compressing them slightly, and then putting them into the top of the rail tank car, will slightly reduce the pressure in the storage tank while raising the pressure in the rail tank car. This difference in pressure will then push the liquid through the liquid line from the railcar over to the storage tank.

VAPOR RECOVERY WITH A COMPRESSOR

Once all of the liquid is pushed out of the railcar, the transfer operation can then continue to recover the vapor remaining in the railcar as well. At the bottom of this page, we see the same installation as shown in the liquid transfer operation, except that we have changed the setting of some of the valves so that we may perform the vapor recovery operation. First, the four-way valve has been rotated 90^0 so that the compressor will now draw vapor from the railcar and discharge it into the storage tank, which is just the opposite of what it was on the liquid transfer operation. Also, the discharge of the compressor is now routed back to the liquid section of the storage tank. This will allow the vapors from the discharge side of the compressor to bubble up through the liquid in the storage tank, which in turn will condense the vapors back to liquid. This will prevent the pressure in the storage tank from rising abnormally. Also, the liquid line valve is closed.

Now that the valves have been properly set, the compressor can withdraw vapor from the top of the railcar, compress them slightly and discharge them into the liquid section of the storage tank. The liquid in the storage tank will then condense these vapors back to liquid form. In this operation the pressure in the railcar will gradually drop, while the pressure in the storage tank will rise only slightly. This operation should continue until the pressure in the railcar is at about 25-30 percent of the original tank car's pressure. Of course, this pressure is going to vary throughout the year and with the actual product being transferred, whether it's propane or butane, because the vapor pressure of the product varies throughout the year. Attempting to go beyond the 25 or 30 percent cutoff point is, generally, not economical since the time and energy involved versus the amount of product recovered generally makes it unworthwhile.

INSIDE THE COMPRESSOR

This is an exploded view of what is inside a typical LP Gas compressor. Starting at the bottom of the page, we have the compressor flywheel, the crankcase, and in the crankcase we have the crankshaft and at the end of the crankshaft is the oil pump. Working upwards, we see the connecting rod assembly and the crosshead assembly complete with the wrist pin, which hold the two together. The crosshead assembly then rides in a crosshead guide that also contains the packing box and the rod seal inside the packing box. Next are the cylinders. In the cylinders you can see the pistons, and at the top of the machine is the cylinder head, complete with the suction and discharge valve assemblies.

COMPRESSOR CRANKCASE

All Blackmer compressors are fitted with ductile iron crankshafts and have roller bearings on each end of the crankshaft. The entire crankcase is lubricated via an oil pump, which is driven off the end of the crankshaft. No external power source is needed to drive the oil pump. The oil is distributed throughout the crankshaft area via drilled ports in the crankshaft.

CROSSHEAD / SEAL DETAILS

Working our way upward through the machine, we can see the connecting rod at the bottom of the page. The connecting rod is made of ductile iron and is fitted with an automotive type split babbitt bearing on the big end and a bronze wrist pin bushing on the small end. A drilled port through the connecting rod allows pressurized oil to lubricate the wrist pin bushing.

Next up is the crosshead and wrist pin. The wrist pin is made of steel and joins a connecting rod to the crosshead. The crosshead has a piston rod mounted in the top of it. This is an assembly and the crosshead and the piston rod should be considered as a single piece. The face of the crosshead has small oil grooves that aid lubrication while the piston rod is chrome-plated steel. The casting shown in the picture is the crosshead guide, which is made of ductile iron. The crosshead and the crosshead guide straighten the rocking motion of the connecting rod into a true straight up-and-down motion so that the pistons and piston rod seals will be properly aligned. An inspection plate is fitted to the side of the crosshead guide to allow inspection of the piston rods. At the top of the sketch is a packing box that contains the rod seal. These seals are a series of Teflon V-rings that are spring-loaded and require no adjusting. The entire seal assembly is assembled in the packing box so that the entire packing assembly may be installed easily.

CYLINDER AND PISTON RING DETAIL

The cylinders used in Blackmer compressors are all of ductile iron and all current models feature O-ring seals on both the top and the bottom of the cylinder. The pistons are either steel or ductile iron and are of a simple one-piece design. The piston rings are Teflon, which allow them to be operated without lubrication. The expander rings, which are used behind the piston rings, are stainless steel.

VALVE AND CYLINDER HEAD DETAIL

The cylinder heads on Blackmer LPG compressors are all of ductile iron and O-rings are used for all external sealing areas.

Both the suction and the discharge valves used are expressly designed for non-lubricated service. The suction valves are normally fitted with a liquid relief device. This device will help protect the compressor in the event that some liquid does enter the compressor. The valves in most Blackmer LPG compressors can be rebuilt either as a suction valve or a discharge valve. This can come in handy if you need a discharge valve but have only suction valves in stock. Also, the valves are easily removed for inspection or replacement. The compressor does not have to be disconnecting from the piping, nor do any major castings have to be removed in order to gain access to the valves.

TYPICAL COMPRESSOR PACKAGES FOR LIQUID TRANSFER AND VAPOR RECOVERY

Here we are going to look at the various components that make up a typical LPG liquid transfer and vapor recovery package. At the top of the page you will see a sketch of an LB361A-LU. The compressor model is the LB361, and a 15 hp (11 kilowatt) motor typically drives it. The mounting arrangement is the LU mounting arrangement. The LU mounting arrangement consists of the compressor, complete with pressure gauges, a baseplate, the beltguard and the beltdrive system. It also includes the four-way valve shown and the liquid trap as well as the inlet strainer. The relief valve, motor and liquid level switch shown on this drawing, are all extra cost options.

The bottom of the page shows a larger LB942A-LC. A 40 or 50 hp motor (30-37 kilowatts) typically drives the model LB942. In this sketch an LC mounting configuration is shown. The big difference between the LU and LC configuration is the size of the liquid trap, otherwise the basic features are all here: compressor with baseplate, beltguard and drive system, the liquid trap, the four-way valve and the strainer. As I mentioned earlier, this liquid trap is considerably larger than that used in the LU configuration and has provisions for the mounting of two liquid level switches.

FOUR-WAY VALVE

As I mentioned earlier, one of the real advantages of using a compressor is that both the liquid and the vapor may be recovered out of a vessel. The four-way valve makes this process both practical and easy. The four-way valve reverses the flow of gas through the system without changing the direction of rotation of the compressor.

The sketches at the bottom of the page show what happens inside of the four-way valve. The left drawing shows the four-way valve's position during a liquid transfer operation. In this phase, liquid is drawn off the top of the storage tank and into the top of the four-way valve where it is routed to the liquid trap and into the compressor suction. The gas is then compressed slightly and comes from the compressor discharge into the opening at the right of the four-way valve and out the bottom of the four-way valve to the railcar. So you can see, in this position gas is drawn off the top of the storage tank and into the top of the four-way valve and then is eventually routed to the railcar out the bottom of the four-way valve.

In order to perform vapor recovery, the four-way valve is then rotated 90^0. In this position, vapor is drawn from the railcar into the bottom of the four-way valve and out the left side of the four-way valve to the liquid trap to the compressor suction. The compressor then discharges into the right side of the four-way valve and the gas is routed to the top of the four-way valve and then to the storage tank. During a vapor recovery operation, you can see that the gas comes from the railcar into the bottom of the four-way valve and is eventually routed to the top of the four-way valve to the storage tank. The flow direction is just the opposite of that during liquid transfer.

LIQUID TRAPS

Liquid traps are fitted to the suction side of the compressor and should be used on all LPG compressor installations. The purpose of liquid trap is to trap liquid before it can enter the compressor. Even though the compressor is connected only to vapor lines, these lines will contain some liquid due to changes in temperature causing some condensation inside the line. Also, on many systems an incorrectly positioned valve may allow liquid into a vapor line.

Liquid traps provide a volume, or space, for liquid to collect before it enters the compressor. This way, small amounts of liquid, such as that would normally occur due to condensation in the vapor lines would be collected before they enter the compressor. This small amount of liquid will eventually boil off during the course of the transfer operation and usually poses no significant problems.

Additionally, a liquid trap may be fitted with a mechanical float that will physically block the suction line between the trap and the compressor if too much liquid collects within the trap. Also and electrical float switch may be used to actually stop the compressor's motor in the event of high liquid level in the trap.

STANDARD LIQUID TRAPS

In this sketch we can see the components of a typical liquid trap. The inlet to the trap is on the side and the outlet, which is connected to the compressor suction, is at the top. Inside the trap is a stainless steel float. If the liquid level rises too high the float will rise and physically block the outlet at the top of the trap. In this way, the compressor is protected. The vent valve at the top of the trap is used to vent the line between the trap and the compressor to allow the float to return to its normal position if needed. The trap is fitted with a drain valve so that the liquid may be drained if needed.

Shown on the side of the trap is an electrical float switch. This switch will actuate on high liquid level and can be used to stop the compressor motor or sound an alarm as needed. These traps may be fitted with both the mechanical float and the electric level switch if desired.

ASME CODE LIQUID TRAPS

These traps are considerably larger than the standard liquid traps presented on the previous slide and are capable of collecting quite a bit of more liquid. These traps are constructed a little differently as can be seen in this drawing. The drain is fitted at the side of the trap. The inlet is at the side of the trap and the outlet is also at the side of the trap, but near the top. One of the big differences between this vessel and the smaller liquid traps is that no mechanical float is fitted to these traps. Instead, a stainless steel mist pad is placed inside the trap between the inlet and the outlet connections. This mist pad allows small liquid droplets to collect together into larger liquid droplets, which will then fall through the bottom of the trap.

Another major difference is that these traps may be fitted with two level switches instead of just one. This allows a separate alarm and shutdown signal to be generated.

As this vessel is larger, it is built per the ASME code for unfired pressure vessels and shows the required ASME data on its nameplate.

An opening is provided at the top of the trap for a relief valve that should be fitted. Also, openings are provided on the side of the trap for pressure gauges and a liquid level gauge if desired.

RELIEF VALVES AND STRAINERS

All Blackmer LPG compressors must be fitted with a discharge pressure relief valve. These valves should be located near the compressor discharge opening and must be located upstream of the first valve in the discharge line. For most LPG services, a relief valve setting of 250-265 psig (17.2-18.3 bar gauge) is typical. Care should be taken to ensure that the proper relief valve for the service is chosen. Valves used for LPG, such as propane and butane service, should be brass. Valves used for anhydrous ammonia service should be aluminum.

Inlet strainers. Inlet strainers should always be used with compressors. Clearances inside the compressor are quite small and any foreign material allowed into the compressor will quickly cause severe wear and tear and expensive repairs will be needed soon. A 30 mesh screen is generally adequate. Strainers should be cleaned regularly. Cleaning of the strainer is especially important on any new systems or recently recommissioned systems.

SWITCHES AND DRIVERS

Low crankcase oil pressure switches and high discharge temperature switches are both highly recommended. The low oil pressure switch will monitor the crankcase oil pressure and stop the compressor motor in the event of a crankcase lubrication failure. Although such failures are quite rare, the result damage can be quite expensive to repair. These switches are typically set at about 12 psig (.8 bar).

A high discharge temperature switch may be used for early detection of quite a number of problems. Blocked lines, closed valves, clogged strainers, worn valves or piston rings, etc., will all cause the normal operating temperature of a compressor to increase. If the temperature switch is set to trip at a temperature slightly higher than normal operating temperature, then many of this type of problem can be detected before any expensive damage has occurred. The discharge temperature switch should be placed as close to the compressor discharge as possible and a thermal well should always be used.

Drivers. V-belt drive systems are used on most LPG compressors; however, gear reduction drives may also be used. Electric motors are used on most stationary applications, while engines with clutches are often used for mobile units.

BLACKMER LPG COMPRESSORS

Blackmer offers four basic sizes of LPG compressors. The chart at the top of the page shows the various compressor data in English units while the chart at the bottom of the page shows the same data in metric units. All four of these Blackmer compressors have two cylinders and all have working pressures well above that typically encountered in an LPG transfer system. All of the units operate in the 350-825 rpm range.

The major item to note on this page are the relative sizes of the units, which is most clearly shown by the maximum motor size allowed. The LB161 is rated for use with up to a 7.5 hp (5.5 kilowatt) motor, while the 361 is essentially twice that being rated for a 15 hp (11 kilowatt) motor. Next up is the LB601 at 30 hp (22 kilowatts). And the largest of the line is the LB942, rated for 50 hp (37 kilowatts).

PERFORMANCE

At the top of the page is the LB161, which is the smallest unit offered while at the bottom of the chart is the LB942, the largest of the units offered. As can be seen, approximate transfer rate for propane ranges from roughly 50 gallons per minute up to 650 gallons per minute (185-2,460 liters per minute). Also, the driver size required varies considerably. The three columns represent performance on propane, butane and anhydrous ammonia and it can be seen that for a given motor size the approximate capacity is about the same for the three products. However, the compressor speed required to produce that capacity varies with each of the products. This is primarily due to the differing vapor pressures of propane, butane and anhydrous ammonia. This chart is based on typical liquid transfer rate of 70^0F (21^0C) assuming proper system design such as pipe sizes, line lengths, valving, etc. The driver size shown is for both liquid transfer and vapor recovery in moderate climates up to about 80^0F (27^0C).

Charts such as this should only be used as a general reference. If needed, Blackmer can easily provide a computer generated report of compressor performance at a particular set of conditions.

PROPER COMPRESSOR INSTALLATION

As with any piece of mechanical equipment, the proper installation of a compressor will yield considerable benefits. These would include trouble-free, consistent transfer of the product and less wear and tear on the compressor. Operating costs will be lower because energy costs will be lower and fewer repairs will be necessary.

Proper installation will produce significantly faster transfer rates as well as providing a safer operating environment.

MINIMIZE LINE LOSSES

While pipe and fitting size is not nearly so critical as on a pump suction, a properly designed system will perform better. In general, lower pressure losses will require less power to drive the compressor and will result in a faster transfer rate. Typically, total system losses should be in the 20-25 psi (1.5 bar) range. Higher pressures up to about 40 psi (3 bars) may be okay in some situations.

Installing piping or fittings that are too small will increase the system differential pressure and will seriously degrade system performance. In general, use larger line sizes and keep them as short as possible. Eliminate any unneeded fittings, particularly on the liquid line, as this is where most of the pressure losses will occur. Use low restriction fittings and valves that will minimize pressure losses. And make sure that all strainer elements are clean.

MINIMIZE HEAT LOSSES

The compressor should always be placed next to the vessel being emptied. As can be seen in the sketch at the middle of the page, the compressor is placed near the railcar that is being emptied into the storage tank. At the bottom of the page is a typical compressor railcar unloading station. If the compressor discharge line length is excessive too much heat will be lost before reaching the vessel being emptied. The hot compressed gasses will then start to condense. Any gas that condenses back to a liquid is essentially useless to the transfer process and the net effect is that the overall transfer rate will decline.

It may be desirable to insulate discharge lines that are longer than is typical.

WATCH OUT FOR LIQUID

Allowing liquid to enter a compressor can result in an extremely expensive failure. Therefore, considerable care should be taken that liquid does not get inside the compressor. As I mentioned earlier, a liquid trap should always be used with a LPG compressor system.

If the distance between the two vessels is longer than normal, a larger liquid trap should be considered. For most such installations, the optional ASME trap will provide sufficient volume, although in some cases, an even larger vessel may need to be used.

Whenever possible, the compressor should be placed so that it is physically a little higher than most of the piping used in the system. This will cause any liquid that does collect in the lines to drain away from the compressor.

INSTALL THE COMPRESSOR PROPERLY

Since compressors are a reciprocating rather than rotating devices, a proper foundation for the compressor and support for the piping is very important. 10" deep (20-25 cm) is recommended.

The compressor baseplate should be well supported along its entire length and should be firmly bolted to the concrete foundation. Pipes leading to and from the compressor should be well supported as near to the compressor as feasible. Flex connectors may be used to help dampen any vibrations induced by the compressor and to correct any minor misalignment problems.

ROUTINE SERVICE SCHEDULE

If a compressor is properly installed and routine maintenance performed, repairs should rarely need to be done.

On a daily basis, the compressor should be observed for any unusual noise or other occurrence Also, the pressure gauges for crankcase oil pressure, suction pressure and discharge pressure should all be checked.

About once a week the liquid trap drain should be opened slightly to ensure that no build up of liquid is occurring in the liquid trap and the compressor cooling fins should be cleaned.

Check the crankcase oil level and the V-belt tensions on a monthly basis.

Every six months, the oil should be changed. If the location happens to be unusually dirty or dusty or the compressor is used more than 1,000 hours, the oil change interval should be shortened accordingly. Also every six months, clean the inlet strainer element. It is probably a good idea to look at the valves on a six month or a yearly basis. When the valves are removed, you will be able to look down inside the cylinder area. The motor bearings will need to be lubricated per the motor manufacture suggestions.

COMPRESSOR MAINTENANCE REPAIR

The normal repair parts or wear parts on a compressor are the valves, piston rings and seals. The valves may be easily inspected or replaced without disturbing the piping. The valves fit in the top of the cylinder head and removal of the valve covers allows easy access to the valves themselves. If the piston rings need replaced, the cylinder head must be removed, which will require that the piping be disconnected. The seals on the piston rods are also easily accessible.

COMPRESSOR PICTURE

This picture shows a typical compressor installation. In this picture you can see that the lines to and from the compressor are lower than the compressor suction and discharge. Also note that pipe supports are located quite near the compressor and that flexible connections are also used. The compressor is sitting on a concrete foundation and the entire area is neat and tidy.

PART IV

Welcome to the fourth part of our discussion on Blackmer LPG Pumps and Compressors.

USE A PUMP OR A COMPRESSOR?

In the last couple of sections we talked about using liquid pumps or vapor compressors to transfer LPG. In this section we are going to talk about the relative merits of each piece of equipment and describe the situations best suited to each.

This page shows a couple of charts outlining the advantages and disadvantages of using both pumps and compressors. One of the advantages to using a pump is that a vapor return line is not mandatory. Pump systems are often installed without vapor return lines to work quite well, although a vapor return line will enhance the system's performance. On the other hand, compressors require both a vapor line and a liquid line in order to function.

Pumps are suitable for operation on systems at higher differential pressures. Most pump transfer systems are at 30-50 pounds. However, systems 80 or 100 pounds differential or even higher are not out of the question. On the other hand, compressors are best suited to lower differential systems, typically in the 20-30 psi differential pressure range.

Pumps can be used with meters, which is an important consideration in many applications. However, a compressor can only be used with a meter if one were placed on both the liquid line and vapor line.

A pump will usually be less expensive to purchase and a little simpler to repair when compared to a compressor. This is generally because a pump has fewer parts in it.

Compressors have their own set of advantages. The first of which is that NPSH or pump suction concerns are eliminated. If a few general guidelines are followed when installing a compressor piping system, the system will work very well. However, pump suction piping must be carefully designed to ensure a reliable operating system.

Compressors can always remove all the liquid from a tank regardless of the location of the openings in the tank. A pump will almost always leave some liquid in the bottom of the tank. If the tank's openings are not properly located, the amount of liquid left by the pump may be significant.

After the liquid has been transferred out of the tank, a compressor can then be used to recover the vapors. These vapors can be as much as 3% of the tank's capacity. A pump cannot recover vapors.

Compressors are usually quieter than pumps. This can be a concern in urban areas.

WHEN TO USE A PUMP

Any time the product is to be metered, a pump is generally the preferred way to transfer the product. This would include delivery trucks, such as that shown in the picture at the top of the page which is used for delivery to individual homes and businesses. Each of these deliveries must be metered so that the homeowner can be properly billed. Also, motor fueling operations would require that the product be metered and so is almost always done via a pump.

Whenever adequate NPSH is available, a pump will often be the best choice. In most cases this will be vessels with bottom openings such as those pictured on this page. Delivery trucks, stationary above ground storage tanks and transport trucks all typically have bottom openings on tanks. This will allow for proper pump suction design.

High differential pressure applications such as used on many truck pumps for home delivery applications and for cylinder filling applications will almost always require that a pump be used.

WHEN TO USE A COMPRESSOR

Situations that have low NPSH available will virtually always require that a compressor be used. These would include typical railcars or other tanks with top openings or possible overturned vessels that have been involved in some sort of accident. All of these situations will prevent a pump's use due to poor pump suction conditions. On the other hand, a compressor would handle these situations with ease.

After removing all of the liquid from a vessel, a compressor can then also remove vapor from a vessel. This extra vapor can account for up to 3% of the total vessel's capacity. This means that fewer loads will be required for the same overall capacity when compared with using a pump to do the transfer operation.

Anytime a vessel must be opened to atmosphere, a compressor is the method of choice. If the vessel is going to be opened for inspection or repair, then all of the liquid or vapor must be removed from it before any work can proceed. Due to environmental, safety or economic concerns, this product cannot be vented to the atmosphere nor can a pump be used to recover the product. A compressor will handle these situations quite readily.

WHEN TO USE A PUMP AND COMPRESSOR TOGETHER

In the proceeding sections we have talked about using a pump or compressor to transfer LPG. However, there are situations where the best solution is to use both a pump and a compressor working together to transfer the LPG. The most common situation requiring both and pump and compressor would be where the pump would be faced with poor suction conditions and the compressor would be faced with high differential pressure conditions.

A typical installation requiring both a pump and a compressor, would be a railcar unloading operation in which the railcar and the storage tank are separated by a longer than normal distance. Also, the storage tank might be located at a higher elevation than the railcar, or undersized piping might already be installed. In this situation, a compressor could be used to push the liquid out of the tank car easily enough, however, it would have a very difficult time achieving reasonable flow rates due to the high pressure losses in the liquid line from the railcar back up to the storage tank. On the other hand, a pump could easily overcome the pressure losses in the liquid line, but would have an extremely difficult time in withdrawing the liquid from the top of the railcar.

The solution in this case is to use both a pump and a compressor utilizing the advantages of each piece of equipment. In this case, vapors would be drawn off of the storage tank, compressed slightly and discharged into the vapor section of the railcar. This increased pressure in the railcar would then push the liquid into the pump, thus providing good suction conditions for the pump. The pump can then be used to build high differential pressures needed to push the liquid up to the storage tank. Of course, after all of the liquid has been removed from the railcar then the compressor can be used by itself to recover the vapors.

CONCLUSION

This concludes our presentation of Blackmer LPG Transfer Pumps and Compressors. Whenever you have an application, we would be happy to apply our expertise in order to ensure that you obtain the proper piece of equipment and install it properly. We appreciate your time and interest in attending our seminar and look forward to doing business with you. Thank you very much.