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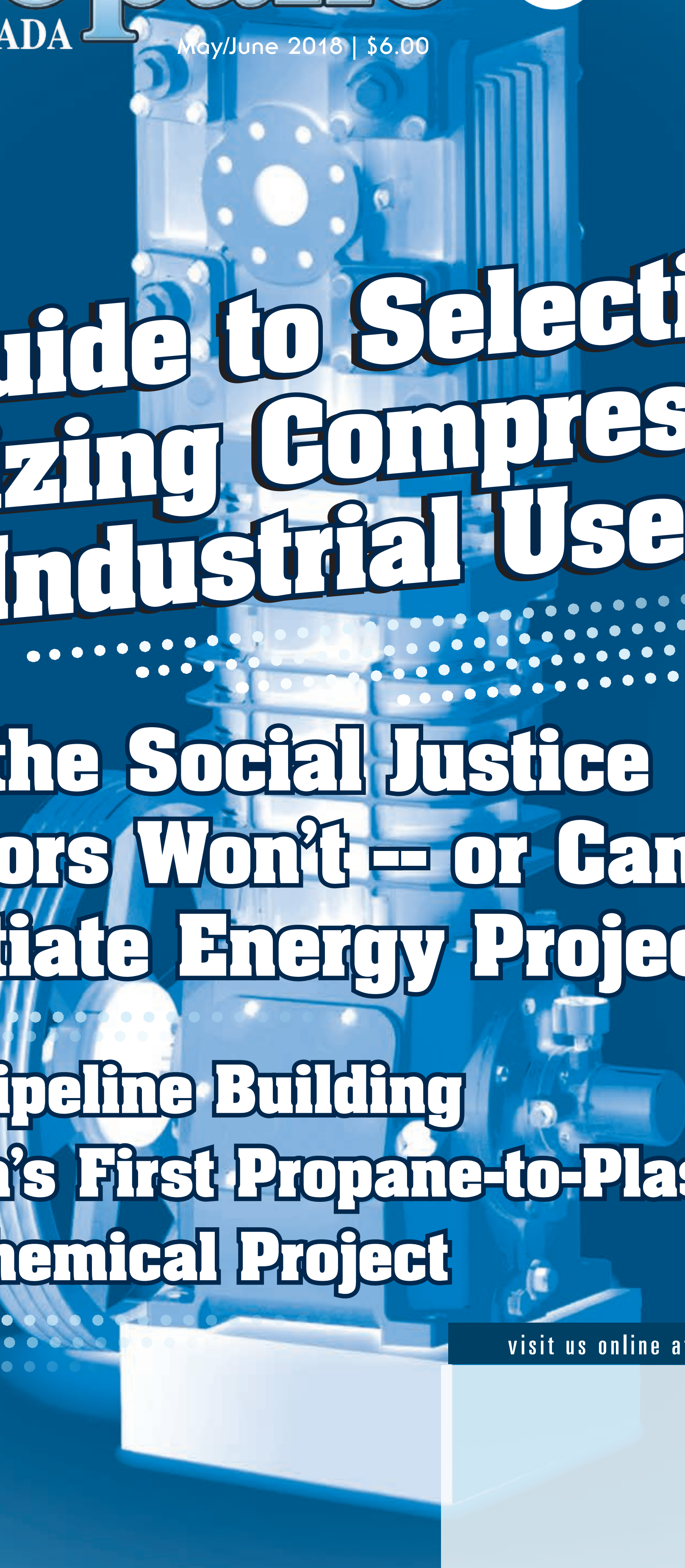

A Guide to Selecting & Sizing Compressors for Industrial Uses

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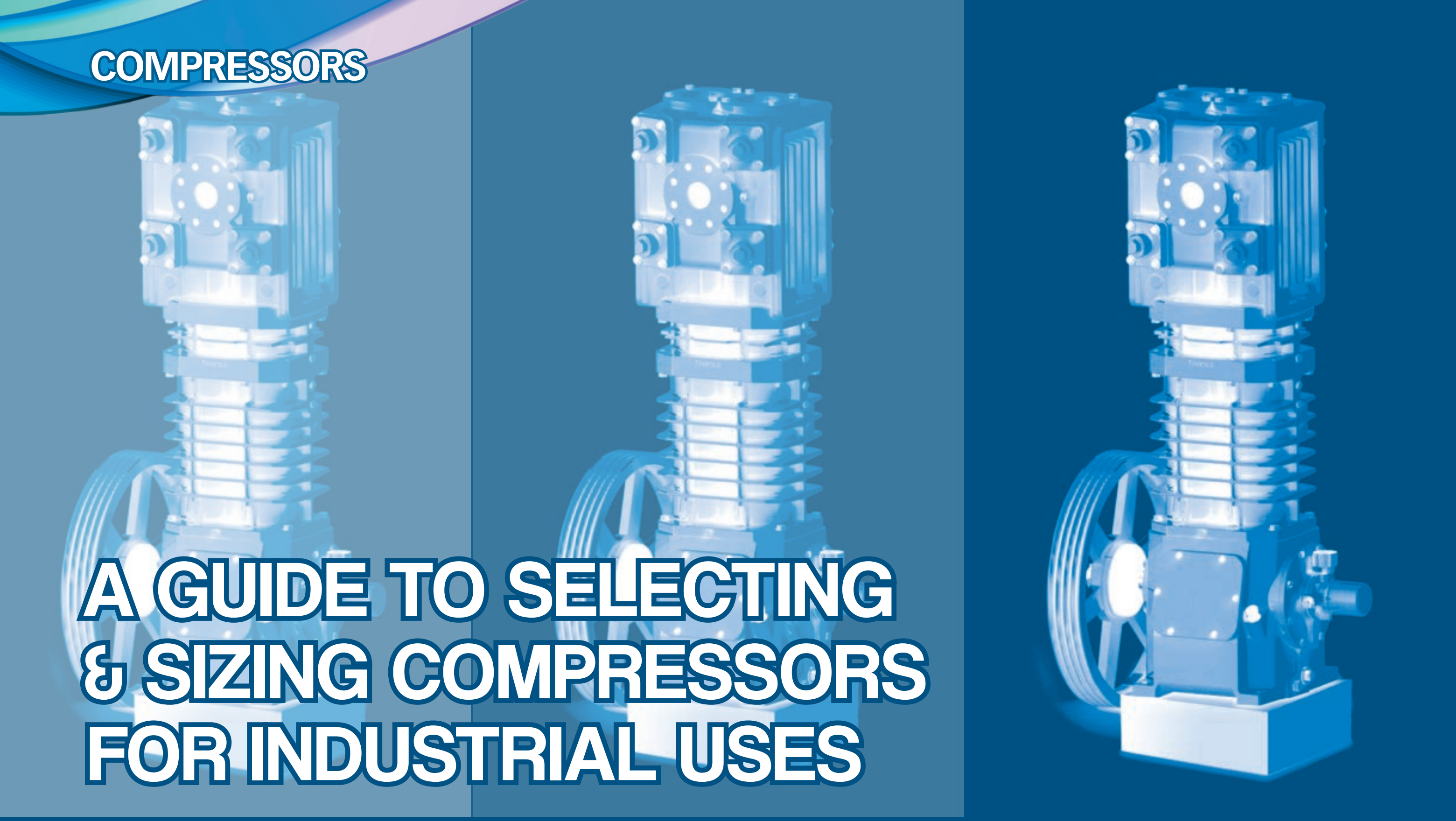

A GUIDE TO SELECTING & SIZING COMPRESSORS FOR INDUSTRIAL USES

RECIPROCATING PISTON COMPRESSORS ARE IDEAL FOR USE IN MANY INDUSTRIAL GAS TRANSFER APPLICATIONS, BUT ONLY IF THE BEST SOLUTION IS SELECTED FOR THE SPECIFIC OPERATIONAL PARAMETERS

Oil-free reciprocating piston compressor technology is just like any other. It only achieves its desired affect if it is utilized in the proper applications and, then, only after the proper amount of consideration and study has been performed before the final technology choice is made. In other words, there are no cookie-cutter solutions for any applications that involve the handling and transfer of industrial gases. Therefore, making assumptions based on experience, or what the other guy is doing, can only get you in trouble.

To help ease the burden of selecting the proper compressor technology for the handling of industrial gases, this article will lay out a general framework that can be used to help the end user identify and select the proper solution for all the unique applications.

KNOW YOUR APPLICATION

When a customer calls and says he has an application where he needs to move some product – which, in the industrial realm, can easily mean anything from ammonia to vinyl chloride – the first job of the equipment supplier's application engineer, and his overriding priority, is asking the most obvious question: Is this even a compressor application?

Attempting to define the application requires the operator to explain what needs to be accomplished through the product-transfer process. Only after the parameters of the operation are established will the application engineer know if a compressor is an appropriate technology for use in completing the process.

There are typically three product-transfer-based applications that will fit into the sweet spot for compressors:

- **VAPOR RECOVERY:** This process involves the capture of gases that remain in a storage vessel that would, in years past, have been vented to the atmosphere. Today, these gases must be recovered due to stricter environmental and safety regulations, or economic considerations since gases that escape into the atmosphere can also be quite valuable. Typical examples where vapor recovery is used are for liquefied gas vapors remaining in a vessel after the liquid has been transferred out, natural gas vapors in stock tanks, sulfur hexafluoride in electrical transformers, seal leakage from process compressors in larger plants and the emptying of storage vessels prior to their maintenance, reconditioning or replacement.

- **PRESSURE BOOSTING:** This process consists of moving a gas from one location to another. This is accomplished by boosting the gas pressure to a level that allows it to be transferred to another storage-tank location or process for use at that higher pressure. A simple example of this would be a nitrogen-boosting system that lifts the pressure of nitrogen gas that is stored at 125 psig (8.6 barg) to a boosted pressure of 300 psig (20.6 barg) to meet a customer's process demands. Pressure boosting can also be used for the transfer of refined natural gas from a low-pressure distribution line into a storage tank that feeds a burner in a heat-treating process. Compressors excel in the pressure-boosting process because they can handle a wide range of pressure-boosting conditions.

- **LIQUEFIED GAS TRANSFER:** This operation generally takes place during the loading, unloading or transloading of railcars and can involve both liquid transfer and vapor-recovery applications. Common products handled at this stage can include propylene, carbon dioxide, a large range of refrigerants, propane and a host of other liquefied gases. Basically, almost any liquid that is stored under its own vapor pressure in pressurized tanks is a candidate for the liquefied-gas transfer or vapor-recovery processes.

KNOW YOUR CONDITIONS

Once the actual process is identified, the application conditions must be determined. To ease this process, many equipment suppliers have created a Data Sheet that they will give to their customers to complete. In addition to general information like the site location and elevation, and whether the equipment is located indoors or outdoors and stationary or mobile, the questionnaire will ask for more specific operational parameters, which can include:

- **Required inlet and discharge pressures and temperatures;**
- **Ambient temperature range;**
- **Atmospheric pressure (determined by the site elevation);**
- **Electrical-area classifications, such as NEMA 1, 4, 7, 9 or 13;**
- **Operational noise levels that can be allowed (generally specified by a maximum decibel level);**
- **A gas analysis of the product being handled (including the molecular weight and molar percentage of the gas or liquid product(s) being handled);**
- **Required flow capacity;**
- **Number of production cycles per day. High-duty cycles will generally require the compressor to run continuously, or on some type of load/unload cycle;**
- **On-and-off cycle times and their duration/frequency;**
- **Types of control switches; and**
- **What safety switches and alarms are required to protect the equipment (compressor) and the customer's process.**

Once these operational parameters are compiled, they can be sent back to the application engineer, who will initiate the process of selecting the proper compressor for the operation. This does not mean that a definitive answer is ready to be communicated. In many cases, the operational parameters may have enough wiggle room that more than one size or type of machine could be safely recommended for the job.

As mentioned, though, this does not mean that there is a one-size-fits-all solution available. It pays to reiterate that every technology and every model design within that technology has very concrete limits on what its operational capabilities are. This can also require some outside-the-box thinking. For example, if an application requires a flow rate of 500 scfm (849 m3/hr.) at a pressure of 800 psi (55 bar), a single compressor may not be able to meet that standard, but if it is deployed in a series or parallel with a second compressor, the operational parameters may be able to be met.

SURVEYING THE FIELD

Let's take a moment to survey the compressor field. While the focus here is reciprocating piston compressor technology, there are many other options for the operator to consider. Reciprocating piston compressors are positive displacement machines, as are their diaphragm cousins. There are also positive displacement rotary compressors, such as the vane, screw, liquid ring and blower types. Finally, there are axial or radial turbo compressors. All excel in their own operational niche within the world of industrial-gas transfer, whether it be the ability to produce high flow at high pressure, high flow at low pressure, low flow at low pressure or low flow at high pressure. Again, the operational parameters of the process will provide a roadmap to the best compressor technology.

Another significant factor is cost – especially in today's world of highly scrutinized and controlled capital-investment and operating budgets. Reciprocating piston compressors are among the most cost-effective technologies available to the market. The operation's process parameters and requirements will play a large role in the final cost of the equipment required for the application. Machines that must meet API-618 design requirements, for instance, will have a much higher purchase price than a non-API-618 design.

While many systems will be able to utilize a "standard" machine "as is," once the proper one has been selected, there will always be some applications in which a specially designed or configured machine is required. In this case, there are bound to be added system

The venerable oil-free reciprocating piston compressor is often the best choice for the transfer of a wide range of industrial gases, from ammonia to vinyl chloride, thanks to a design (left) that protects the commodity being handled while controlling leakage. However, like any technology, proper consideration must be given to the demands of the product-transfer application and operational parameters before an educated decision can be made (photo courtesy of Blackmer).

To ensure the best type of reciprocating piston compressor is selected, suppliers will ask their customers to complete a Data Sheet that details the specific operational conditions (photo courtesy of Blackmer).

costs as the compressor and/or system are modified to fit the unique needs of the operation.

NARROWING THE FOCUS

Even when it has been determined that a reciprocating piston compressor is the best choice for the operation, there are still other considerations to be made before making a final decision.

Within the family of reciprocating piston compressors there are oil-free, non-lube, lubricated and oil-less designs. Again, knowing the operational parameters and requirements will create a path that leads to the selection of the proper technology. For example, the transfer of crude natural gas may not require an oil-free compressor because there are already impurities in the gas itself so that any small amounts of oil carryover from the compressor that enters the gas stream will not harm the product or the process. Emission-compliance requirements, however, could mean that an oil-free design might still be the best solution due to its leak-control capabilities.

In other words, why offer the customer a technology he doesn't need? Also, oil-free compressors are normally more expensive due to the elevated technical requirements of the oil-free design. An oil-free machine will usually always be required if the gas purity of the customer's process gas must not be contaminated by the compressor. In these kind of application requirements, an oil-free compressor is usually an excellent choice.

Another growing environmental consideration that may lead to the use of an oil-free compressor design is a fugitive-emissions requirement that will require more comprehensive leakage control. Some lubricated compressor designs that require oil lubrication in the upper cylinder and valve area do not have a gas-sealing section (distance piece). This design can be prone to significantly higher leakage rates, which can be an environmental hazard. With the increased scrutiny being given by regulatory agencies to fugitive emissions and leaks, operators must be aware of the repercussions. These can include significant fines and, in the worst-case scenario, shutdowns if their operations continue to run afoul of any regulatory mandates.

So, if the choice is an oil-free reciprocating piston compressor the actual environmental operating conditions must also be considered. Oil-free designs have very specific discharge-temperature limitations. In this instance, the top end of the machine is designed to operate without lubrication, so it has non-metallic wear parts (e.g., piston rings, packing seals, etc.) that become sacrificial wear parts because they operate without any lubrication. By design, those parts will need to be serviced and replaced on a regular basis. Typically, this is done as an annual "preventative maintenance" program. That's the nature of the beast.

By asking the right questions that result in the selection of the compressor type that meets the needs of the application, operations that require the handling and transfer of industrial gases can be more easily optimized, resulting in an increased level of operational reliability, safety and cost-effectiveness (photo courtesy of Blackmer).

In some applications where operating temperatures are low, and operating pressures and compressor rpms are in a moderate range, a user can see the compressor operate for a few years without any need for significant maintenance. In other applications where temperatures are high and pressures more demanding, the operator may only get 2,000 hours of service out of the compressor before it needs to have those top-end wear parts serviced. Note that this situation typically occurs in applications that have very high discharge temperatures that are driven by the overall compression ratio of the application. The bottom line here is that these possibilities must be communicated to the operator on the front end of the selection process to minimize complaints or recriminations on the back end.

The increased demands of stricter environmental regulations regarding the control and release of fugitive emissions into the atmosphere are now a critical consideration when selecting a compressor technology (photo courtesy of Blackmer).

The different types of reciprocating piston compressors – oil-free, non-lube, lubricated and oil-less – give the user options that can lead to optimized performance in the field (photo courtesy of Blackmer).

Finally, and most importantly, the performance of the reciprocating piston compressor must meet or exceed the requirements of the process that it is operating in. Oftentimes, this can mean that the compressor manufacturer will need to reach out to other professionals in the field – distributors, fabricators, system integrators, etc. – for assistance in completing a turnkey gas-compressor system for the application. In the end, everyone involved has the same result in mind – getting the job done reliably, efficiently, safely and cost-effectively.

CONCLUSION

In the end, reciprocating piston compressors – like any comparable technology – are only effective in performing their duties if they are put able to be successful. Reaching a state of ideal operation can be attainable if the proper legwork is done to ensure that the compressor can satisfy the many unique and varied needs of the application. By asking the right questions, performing the required research and working closely with the customer and other channel partners the unknowns will be removed from the compressor-selection process, resulting in an optimized operation and contented clients.

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