The Compressed Air Industry Tries To Keep Pace with Change

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Although there is an abundance of publicly available information about most industrial equipment on a comparative basis, it is hardly the case with compressed air. Compressed air equipment manufacturers have a few things in common from the consumer's perspective:

- **All types and brands are adaptable to your needs regardless of the application specifics.**
- **Everyone's equipment and service is the best you can get.**
- **All user problems can be solved by adding more equipment with a minimum of problem definition.**
- **There is no independent source of performance certification.**

What is left is a confusing situation for the consumer. Provided with a bare minimum of information about the application and integration of the equipment to his unique requirements, decision-making gets tough. Absent of knowledge and faced with so much perfection, the buyer must guess at what will work for him. At best, most systems meet minimum acceptable results. Everything cannot be the best, yet the consumer has a responsibility to make choices, which reflect the most appropriate short – and long-term judgment for his company. There must be a balance of engineering and financial responsibility.

With an absence of standards and accountability, it is nearly impossible to compare equipment performance. Given the sales approach used, more often than not, the consumer will wind up making his decision based on one or both of the following:

1. **Which Presentation and presenter best represents his company's claims?**
2. **What is the lowest price?**

Market Conditions:

Most price-intensive markets are consumer driven with the equipment becoming commodity products. The compressor industry has become more of a commodity market in the last 20 years, with price being the primary driving force for decision-making. Despite this, confusion and a lack of information have kept compressed air equipment "industry driven". Sales and marketing skills equal industry leadership in this critical facilities utility. In this mature market, the development of improved performance has taken a back seat to manufacturing cost control in the compressed air equipment business because of the pricing issues in the marketplace.

The modern industrial plant is plagued with the constant challenge of making better quality products at lower costs. With a stronger focus on core business, facilities and maintenance departments are operating leaner. The lack of forthcoming consumer-focused support for these conditions is creating new business approaches to assist with problem solving an decision making. Performance contracting, consulting services and outsourced utilities have emerged as

a natural evolution in many technically under-serviced markets. Compressed air is a major focus area for these new independent businesses. Although it is difficult to specifically forecast how these new players will affect the market, it would be reasonable to assume that it will stimulate standards, certification, education and improved equipment performance. This will generate a totally different approach for equipment manufacturers and their representatives toward this market.

Background:

Compressors for air came into their own with the development of the steam turbine in the late 1800's. The performance hasn't changed significantly in the last 120 years. The multiple-stage, multi-step reciprocating compressor was the predominant workhorse of industry for more than 100 years. It has been the most efficient compressor, making more than five cubic feet of comp0resed air per brake horsepower. During the same time there were single stage, double-acting, and two-stage, single-acting compressors. These types of reciprocating compressors were more popular in smaller size compressors. The larger unit market for these compressors required less expensive manufacturing in order to generate competitive selling prices. Reciprocating compressors were sold primarily to the industrial and instrumentation markets. In the last few years, the most efficient of these types of compressors have been removed from the market and replaced with less efficient, lower cost, easier-to-install types of compressors.

The Early Years:

In the 1930's and 1940's centrifugal and axial air compressors came into their own, serving a need in the market for larger compressors primarily for the process and chemical markets. Lots of air was produced I a relatively small package compared to the reciprocating compressors which dominated the industrial market. Most of these compressors were built in three and four stage formats and were built one at a time for the application. These units were competitive with non-lubricated reciprocating class compressors. In more recent years, manufacturers have learned to package less expensive, less efficient two – and three – stage centrifugals to compete in the industrial marketplace. Axial compressors, which competed ineffectively with centrifugals, have all but disappeared from the market.

Prior to the 1960's each compressor was packaged for the requirements of the system it was being installed in. The motor, sheaves, bells, flywheels, filters, pipe, and coolers were carefully selected and assembled for specific performance. In the 1960's and early 1970's manufacturers introduced packaged compressors with all of these components mounted on a common frame at the factory. They included the motor starter and aftercooler/separator with the rest of the components if desired. This was done for the purpose of economies of scale. The result was a more price competitive package to sell, requiring less installation knowledge. The cost of electricity was quite low and the first price was a reasonable issue. The operating performance of these new compressors was 20% lower than the dominant reciprocating type. The rotary vane and screw compressors came into their own during this period because of their minimum unbalanced forces and adaptability to factory packaging.

This was also the introduction of air compressors, which operated as much as 10% into the service factor of the motor. As all previously built compressors were designed for at or under the nameplate of the motor, the units were rated at nameplate horsepower. We found ourselves comparing a 200 hp reciprocating compressor delivering 1,050 cfm with a rotary screw with a 200 hp motor delivering 970 cfm at the same pressure. At 25% - 35% less money, who could turn that down?

There were some other issues that were not discussed. For one thing, the recip probably used 195 hp of the 200 hp motor. The screw compressor will need 220 hp of the 200 hp motor. That's 12.8% more power. The difference in the delivered volume is 10.5%. The net difference in this case is more than 23.3% power to delivery. The manner in which compressor performance is presented still makes it difficult to evaluate the difference between compressors. Another issue is

that a considerable number of larger reciprocating compressors up to the 1960's used synchronous motors compared to the relatively inefficient induction motors that were used in the first packaged compressors. This could make more than 5% of additional performance in net energy. Today we are more thoughtful of motor efficiency primarily because of utilities, associations, and government agency education for consumers and the pressure they have exerted on the compressed air equipment industry.

Frame Sizing:

Another issue that is and is still overlooked is frame sizing of packages. We are not talking about airend size or speed although it is common to have the same airend common to a frame. Frame sizing was the primary purpose to packaging. You could put two to five different size compressors on one packaged frame size. The same basic package making different volumes of air. As the volumetric displacement increased in the package, the cost of the package did not increase linearly. The idea was to minimize the basic bills of material and reduce the inventory requirement while serving a wide range of sizes.

What goes along with frame sizing is efficiency losses. The bottom of the frame would have relatively good performance, while the top of the fr4ame would have poor performance. This includes packaged pressure losses. As the flow increases, the differential across the same components increases as a cube function of the flow increase. Remember that the differentials upstream of the signal location reflect in increased horsepower, which are absorbed by the drive motor to maintain the downstream signal pressure. The common manner of determining a frame is to compare the dimensions and weight of the various adjacent sizes. This information is usually on the sales literature. The weight difference will be the motor size.

One of the problems in evaluating this type of arrangement is that performance is not differentiated. It is stated as typical of the frame. Maintenance, filter life, operating temperatures and achievable pressures at rated flow can all be variables depending on where a particular compressor size falls in a frame size. Most manufacturers have different approaches to how they design for frames. Some will have a wide range of volume and pressure, while others are more conservative. Others will maintain conservative variations in flow and pressure. This would require more frame sizes and reflect in higher manufacturing costs. Different manufacturers will have the same offering in different frame positions.

An interesting problem for the consumer is that one manufacturer may have a particular size in the top of the frame, while his competitor has the same size in the bottom of his frame. The rated performance will appear to be similar, but the internal performance will be different. The one in the top of the frame will have a lower manufacturing cost and will be able to be more competitive in his selling price.

In the recent past there has been more effort to arrange frame sizes so that the most popular sizes sold are at the top of the frame for the sake of competitiveness. Some manufacturers who have found themselves noncompetitive in a size at the bottom of a frame will add a similar size compressor offering at the top of the next smaller frame. This is called "stretching a frame". Most compressor manufacturers have very different approaches toward this issue. The difficult part for the consumer and often the manufacturer's field representative is that the manufacturers do not discuss or provide information about frame sizing.

Controls:

A spin-off of manufacturing in frame sizes is the approach to controls. Most compressors sold prior to the early 1970's had to increase in pressure to unload. Most compressors operated load-no load up to this time. With the inherent packaged losses and the need to use a substantial portion of the service factor at rated performance, modulation became necessary to reduce the volume as the pressure rises. This was to protect the packages from electrical overloading. The load-unload compressors would increase in power an density at constant volume as the pressure

rises. This control approach increases in pounds of compressed air requiring more power. The modulating compressors would reduce flow as he density rises so that the power would not increase. Modulation was originally marketed as capacity control, while it is actually intended to protect the package from electrical overloading. What came of this feature in time was poorer performance and a need for more compressors. As systems demand increased, the pressure would drop.

The only way to increase pressure without changing the operating set points of the compressors was to install and operate another compressor. When the new compressor was installed and put in modulation, all of the compressors, which were on, would share the total demand increasing in pressure. All units that are on would also become more part loaded. The efficiency of the system would drop while the power increases. The part load inefficiency would keep the power high, giving the appearance of more loading than actually exists. Modulation can be applied more effectively, although it seldom is the case in the field. Service mechanics have encouraged the use of modulation in the name of lower maintenance and improved reliability while operating costs increase disproportionately. If you aren't tracking power, flow, pressure and cost none of this would be apparent.

Over the past 30 years, the mix of compressors has also changed. Rotary screws have become the predominant type in use. Reciprocating compressors have all but vanished in new sales in large sizes. Today, single and two stage rotary screws have replaced single and two stage double acting reciprocating compressors. Two stage non-lubricated screws have replaced larger non-lubricated recips. Two and three stage packaged centrifugals have replaced the largest sized recips and four stage centrifugal compressors. There are only a few vane compressors left in the market, which generally compete against smaller screws and two stage single acting reciprocating compressors.

Today's Compressor Business:

The current state of the union in the compressor business is a more commercial approach toward the market with a strong focus on controlling or reducing the manufacturing costs of products being sold. Technical integration, systems engineering and demand control are practically non-existent. A few manufacturers provide education and services in these areas, although they are the exception rather than the rule. At distribution levels, approaches vary widely fro one distributor to the next. It has become more difficult in time for end users to apply compressors, when cost effectiveness is an important issue. Utilities costs and global competitiveness are substantially higher, which has driven a need in the market that has only been fulfilled on a very limited basis.

There is currently a North American initiative to educate the consumer about compressed air and significant opportunities to reduce energy and operating cost while improving productivity. AFE is a key player in this initiative. We are hopeful that the best interest of the air using market will be served through this work.

Reprinted with permission from R. Scot Foss, president of Plant Air Technology, Charlotte, N.C., a company specializing in system auditing and design. This article is based on his book, "Compressed Air System Solution." A portion of the proceeds from sales of the book is donated to children's charities. To order a copy of the book, please contact Southern Corporation.