

Improving Efficiency in Air Distribution Systems (ADS)

ADVANCEMENTS IN ADS HAVE DRASTICALLY IMPROVED THE OVERALL EFFICIENCIES OF AIR-OPERATED DOUBLE-DIAPHRAGM (AODD) PUMPS, RESULTING IN GREATER RELIABILITY AND ENERGY COST SAVINGS

By Curtis Dietzsch

From humble beginnings more than a half century ago as a mining pump, the versatility of the air-operated double-diaphragm pump has allowed it to fit in a wide variety of applications, pumping everything from ceramic slurries and latex paint to tomato paste and pear halves.



Introduction

It has been 55 years since air-operated double-diaphragm (AODD) pump technology was invented and introduced to the market, and it is safe to say that the day in 1955 when the first AODD pump began operating remains a watershed moment in industrial pump history. AODD technology grew from humble beginnings, mainly as a way to pump waste water in mining applications.

AODD pumps are reciprocating, positive-displacement pumps. The wetted path (the area in which the pumping media is contained) consists of an inlet and discharge manifold and two liquid chambers. An air valve in the Air Distribution System (ADS) alternately directs compressed air behind the diaphragms in the air chambers. Fluid is drawn into one liquid chamber from the inlet manifold as fluid is expelled from the other liquid chamber through the discharge manifold.

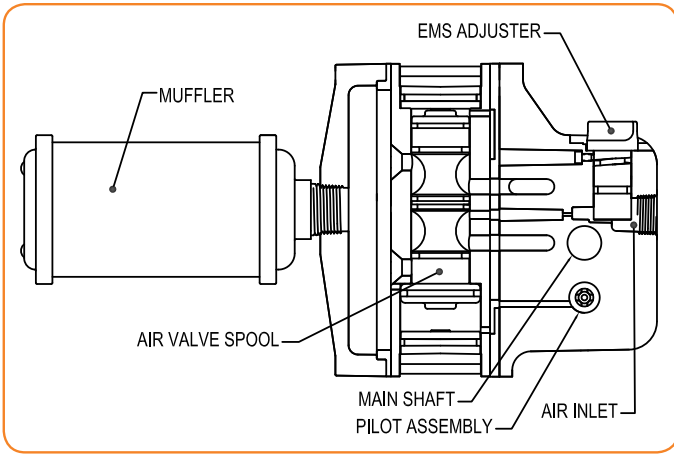
AODD pumps have many strengths. They don't require electricity, are self-priming, can pump fluids with solids in suspension (rocks and debris), can run dry or be "dead headed" without damaging the pump. In addition, their

performance can be tailored to specific needs by adjusting the inlet air pressure or restricting the discharge of the pump. AODD pumps were designed to operate in rugged applications. They were used in applications where most other pumps would fail and were designed to be an inexpensive, easy to maintain option for a variety of situations. They can transfer a wide range of media from waste water to more viscous substances like slurries or even cement.

Decades of research and design innovations have led to refinements and improvements to the air valve and wetted path. This resulted in a class of pumps that are tough and versatile enough to meet the stringent demands of the rough-and-tumble mining and heavy construction industries as well as the precise and sanitary requirements of the pharmaceutical and food processing industries.

The Challenge

Over the years, energy costs have increased substantially. As energy costs have increased, manufacturers have become more concerned about reducing operating costs and have



Cross-section of a Wilden® Pro-Flo X™ air distribution system (ADS) that incorporates an unbalanced spool to reduce the occurrence of stalling.

focused on improving the efficiency of the equipment in their plant.

Since their inception, one significant challenge in designing and producing an effective AODD pump has centered around providing the end user with a good fluid flow rate while at the same time minimizing air consumption (reducing energy costs).

All AODD pumps have an ADS in their design. Part of the ADS's job is to direct compressed air to one air chamber while exhausting air from the other air chamber. This task is performed by the air valve. This air valve can take many forms but in many cases is a "spool" that slides back and

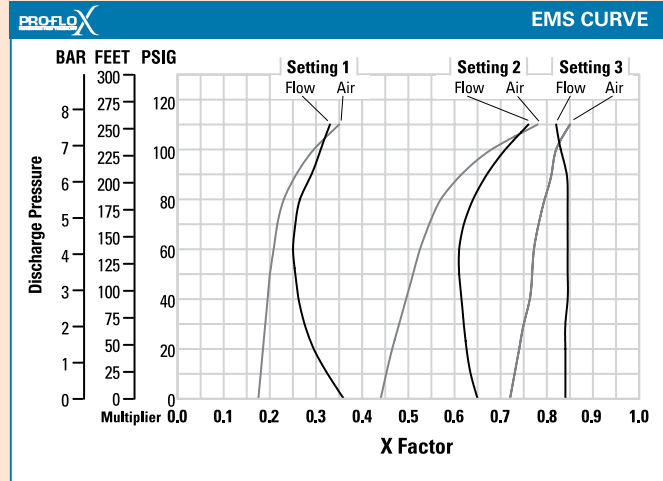
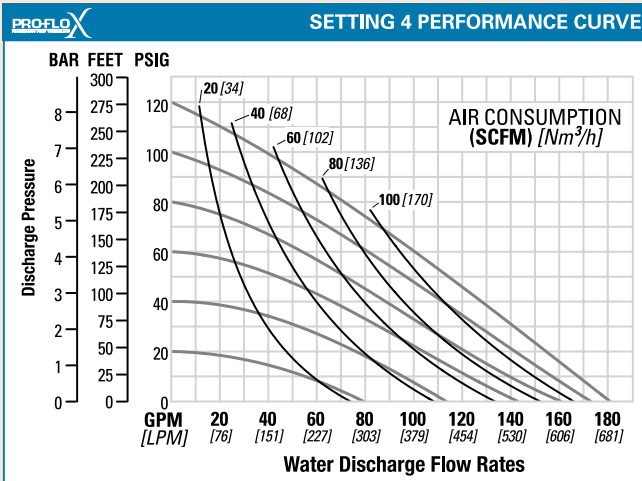
forth in a cylindrical bore in the pump housing. It uncovers and blocks ports so that compressed air is supplied to the appropriate chamber and exhausted from the other. These original spools had a single diameter and air pressure was supplied to both sides of the spool. The pressure would momentarily be removed from one end of the spool to make it "shift." The shift redirected the compressed air to the other chamber.

While this single-diameter spool in early AODD pump designs was innovative and effective, its shape meant that the ADS had a higher chance of stalling if the momentary signal did not completely shift the spool. This would lead to loss of production, inefficient operation and increased pump downtime.

The Solution

A number of improvements have been made to the AODD pump ADS over the years to improve performance, reliability, and efficiency.

One improvement was the introduction of a new "unbalanced" air valve spool. This new design does not rely on a momentary signal to shift the spool. Rather, it relies on an unbalanced signal to control the shifting of the pump. The new spool has two different diameters. The smaller of the two ends is constantly supplied with air pressure. The air pressure pushes the air valve in one direction. Alternately, the large end of the spool is pressurized. The larger area produces a higher force (than the small end) and shifts the spool in the other direction.



Example of EMS Efficiency

A test was conducted involving a 2-inch air-operated double-diaphragm (AODD) pump that did not have an Efficiency Management System (EMS) incorporated into its Air Distribution System (ADS) versus one that did. This test was conducted using water as the media.

The non-EMS AODD pump was run at 100 psig air inlet against a discharge pressure of 20 psig. At these conditions, the non-EMS AODD pump used 130 scfm to achieve a flow rate of 116 gpm.

When the same test was conducted using an AODD pump with an EMS ADS, the same flow rate of 116 gpm was able to be achieved while "dialing back" the air usage so that the pump was not running at maximum capacity. In this test, the AODD pump with an EMS ADS reduced the air consumption by 42% (or 54 scfm) at the desired flow rate of 116 gpm.



Wilden AODD pumps incorporate a Pro-Flo X™ Efficiency Management System (EMS) into the ADS. The Pro-Flo X™ allows the end user to adjust the size of the air inlet ports. Decreasing the size of the inlet ports restricts the air flow rate into the air chamber. It allows some control over how much and how quickly the air chamber is filled and can prevent the chamber from being “overcharged” with air.

The forces on the spool are always unbalanced and constantly push the spool in one direction or the other.

Another innovation resulting in increased efficiency and energy savings was the incorporation of “advanced porting.” Advanced porting introduced larger air ports to

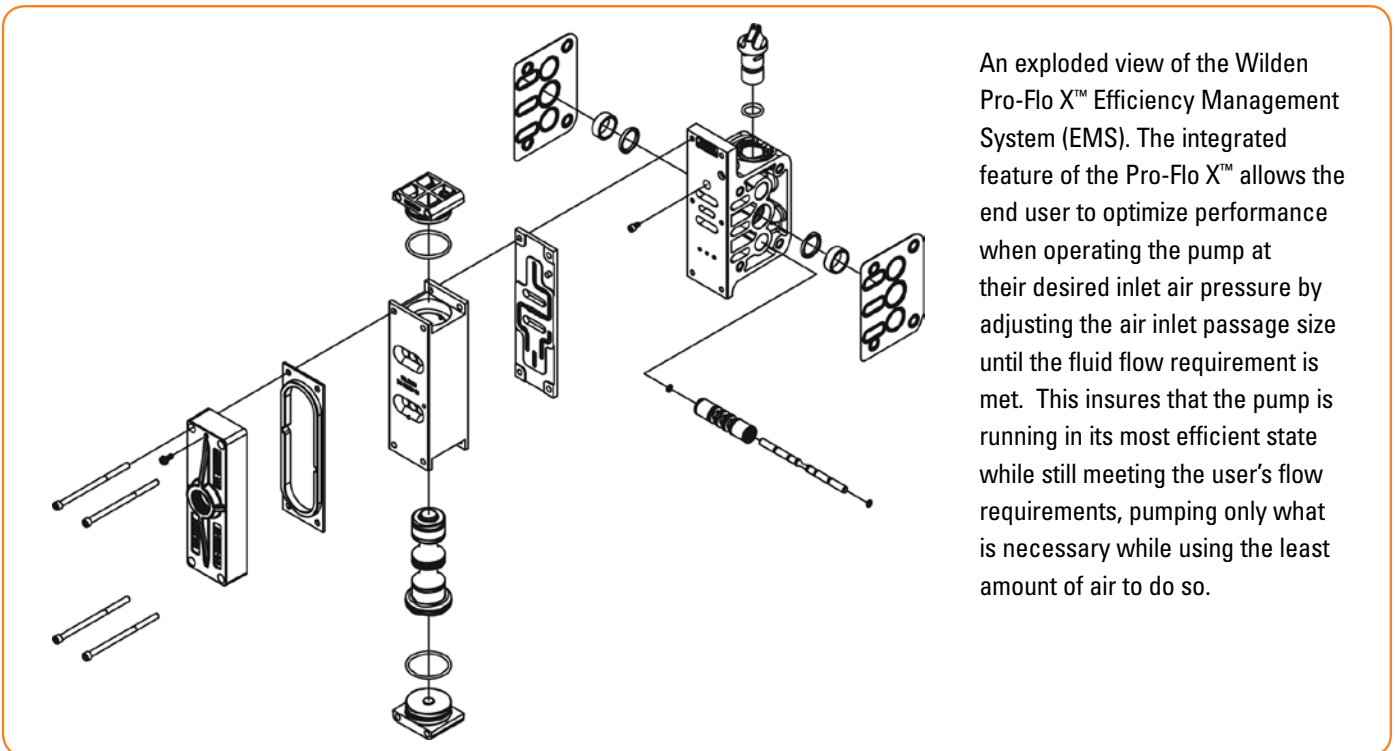
the ADS that allow exhaust air to leave the pumping chamber with as little restriction as possible. At the same time the size of the inlet air ports were optimized to maximize the flow rate and increase efficiency.

The latest generation of AODD pumps has added another level of adjustability to the ADS with the invention and incorporation of an Efficiency Management System (EMS). The EMS allows the end user to adjust the size of the air inlet ports. Decreasing the size of the inlet ports restricts the air flow rate into the air chamber. It allows some control over how much and how quickly the air chamber is filled and can prevent the chamber from being “overcharged” with air.

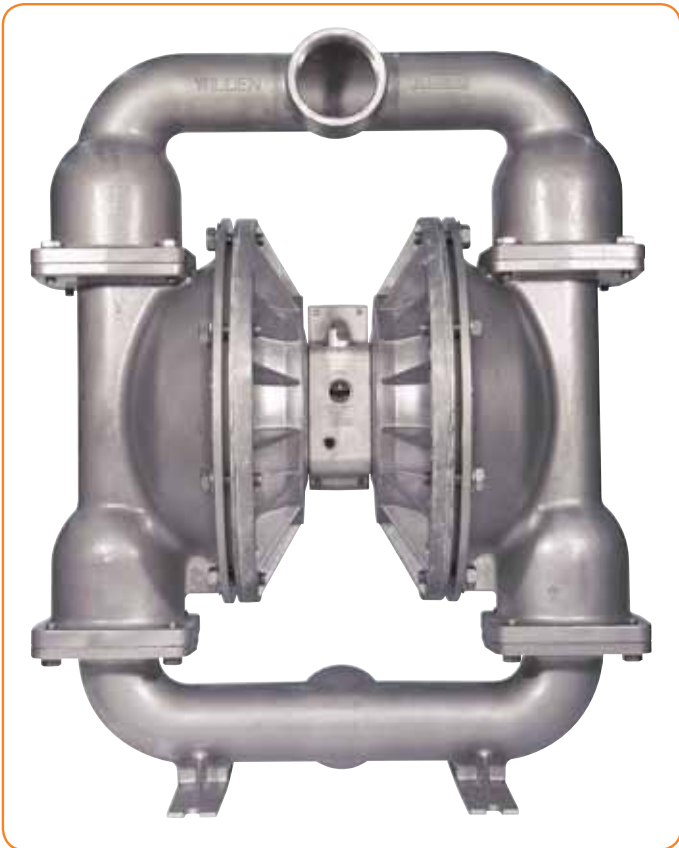
This integrated feature allows the end user to optimize performance when operating the pump at their desired inlet air pressure by adjusting the air inlet passage size until the fluid flow requirement is met. This insures that the pump is running in its most efficient state while still meeting the user’s flow requirements, pumping only what is necessary while using the least amount of air to do so. (See sidebar for example of savings.)

Using the EMS to reduce the size of the inlet air ports and restrict air flow into the air chambers has the added benefits of increasing diaphragm life (reducing maintenance costs) and increasing dry vacuum.

In addition to improvements to the ADS, advancements are being made to the wetted path to reduce friction losses. The reduced friction losses result in an increased fluid flow rate without necessarily increasing air consumption. These



An exploded view of the Wilden Pro-Flo X™ Efficiency Management System (EMS). The integrated feature of the Pro-Flo X™ allows the end user to optimize performance when operating the pump at their desired inlet air pressure by adjusting the air inlet passage size until the fluid flow requirement is met. This insures that the pump is running in its most efficient state while still meeting the user’s flow requirements, pumping only what is necessary while using the least amount of air to do so.



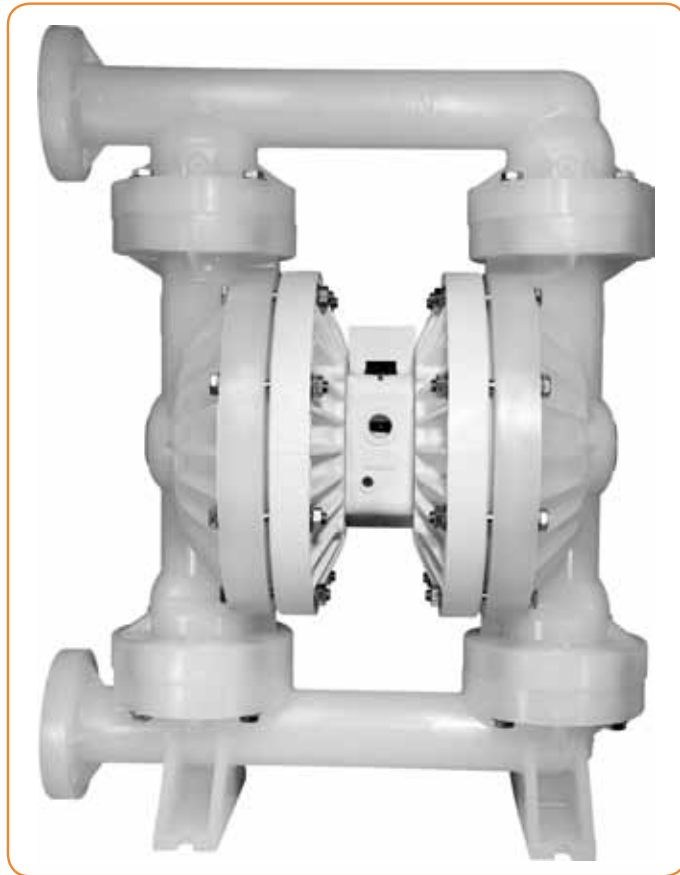
Wilden PX1500 stainless steel AODD pump with integrated Pro-Flo X™.

improved wetted paths have been designed to “drop-in” to existing applications by employing common mounting footprints and fluid connections.

Conclusion

In these days of shrinking budgets and threatened bottom lines, finding the most efficient way to run a manufacturing operation is of the utmost importance. One way that savvy facility managers are doing that is replacing older AODD technology with new pumps that feature advanced ADS systems, preferably one that makes use of cutting edge EMS technology.

There are many real-world examples of manufacturers who have taken the time to evaluate their operations, isolate the areas of inefficiency and then enhance their return on investment through the introduction of pumping technologies that promise increased efficiency and lower energy costs. A side by side comparison of an AODD pump that utilizes an EMS versus one that does not can readily show where the EMS can reduce operating/energy costs and allow for more pumps in the same factory without increasing compressor capacity, providing long-term benefits to the manufacturing operation.



Wilden PX800 Advanced Plastic AODD pump with integrated, “tool-less” Pro-Flo X™.

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