New Concept in Vacuum System Design Allows for Increased Productivity and Reduced Energy Consumption

Peter Tell, inventor of the multi-stage ejector principle and the COAX® technology.

By Peter Tell, PIAB AB, Inventor of the multi-stage ejector principle and the COAX® Technology.

COAX® Technology takes the multi-stage ejector into a new dimension and offers industrial manufacturers the opportunity to achieve previously impossible gains in productivity and reductions in energy consumption.

In a more competitive world all industries have to maximize efficiency and flexibility and minimize costs and footprints. Vacuum, or negative pressure, operates in a variety of industries such as packaging, automotive, conveying and graphics. However the existing vacuum systems are not always optimized for their purpose due to physical format and system complexity.

Historically, Miniaturization and Decentralization Improve Cost Efficiency

Throughout time, miniaturization and decentralization have been used to improve cost efficiency in several different industries. For example, the first computers introduced were designed as mainframes—large, expensive, centralized computers that occupied a number of metal frames, the main one of which contained the processor and memory.

As smaller and more powerful processors were developed, it became possible to distribute computing power closer to the user, in order to optimize functionality and response time, and to make efficient use of network bandwidth.

Likewise, telephone networks have evolved from elaborate centralized switching equipment connected to phones that were nothing but simple input/output devices to modern mobile networks where most of the application functionality resides in handheld devices at the edge of the network.

Importance of Distance from Point-of-Use

The former cases illustrate how decentralized architectures that distribute processing power closer to the point-of-use are inherently more efficient because they remove the problems of distance. Removing distance as a factor simplifies the overall design and significantly improves response time, which contributes to improvements in productivity.

The COAX® vacuum cartridges have been reduced to the size of a pencil and made of light weight composite materials.

The issue of removing processing distance is especially relevant to vacuum technology, because the more distance there is between the vacuum source and the point-of-use, the more energy is consumed and thus, the more expensive the cost of production becomes.

Traditional Vacuum System Design and Energy Efficiency

Historically, many vacuum systems utilized centralized mechanical pumps. There was no other option. Typically, the vacuum pump would be mounted remotely, sometimes quite far from points-of-use, due to space constraints, maintenance issues, or the noise and heat generated by the pump. One vacuum pump may be dedicated to a single material handling machine (with multiple suction cups), or one pump can be relied on to provide the vacuum required by multiple machines or by an entire factory.

The centralized approach frequently employs mechanical pumps to produce the vacuum. These pumps usually have normally an electrical motor as a power source. A mechanical pump uses often the same pumping mechanism as a compressor, except that the unit is designed so that air is drawn from a closed volume and exhausted to the atmosphere.

Rotary vane pumps, are commonly used mechanical pumps, have individual rotors placed around a shaft and spun at high velocities. The rotary motion traps air entering the intake port and sweeps it through, creating a vacuum behind it.

Centralized Pumps Consume More Energy and Cost More Money

Traditional, centralized vacuum systems are inherently inefficient, because of the dead volume from tanks, manifolds and longer vacuum lines connecting the pump to the devices utilizing the vacuum. The pumps also have to be sized to accomodate for the “worst case scenario” and they must compensate for additional volumes. Because of these factors, mechanical vacuum pumps are often oversized, resulting in increased capital costs and energy consumption.

This additional volume needs to be evacuated, and then returned to atmospheric pressure, during each cycle. The longer evacuation and release time contributes to lengthening the overall cycle time for the application and thereby decreases productivity.

The COAX® vacuum cartridges are small enough to be directly integrated with suction cups or other devices.

COAX Optimizes Use of Energy and Shortens Cycle Times

The invention of COAX allows for small compressed-air-driven vacuum pumps to be placed directly at the point-of-use, associating a single pump with each terminal device (such as a suction cup) or small group of terminal devices.

In fact, the new COAX multi-stage vacuum ejector cartridges have been reduced to the size of a pencil and made of light weight composite materials, so they are small enough to be directly integrated with suction cups or other devices. By eliminating all tubing between the vacuum generator and the point-of-use, the ejector cartridges significantly improve performance and save energy.

COAX Yields Measurable Results

Furthermore, the ability of point-of-use vacuum generators to operate intermittently reduces energy consumption in two additional ways. First, a check valve or "vacustat" can be installed at each suction cup to shut off the supply of air to the dedicated vacuum pump when proper suction is reached. If the vacuum level drops due to leakage, the pump will turn back on at the start up level of the device.

Vacuum sensing devices, as the PIAB Cruise Control (PCC), allow for even greater energy savings.

Automotive Material Handling Example

A measurable illustration of the energy and cost-saving benefits of COAX was realized in a recent study of a typical material handling applications at a U.S. automobile manufacturer. Kingman Yee, Associate Professor of Mechanical Engineering at Lawrence Technological University, found that "simply by installing a vacustat, electricity consumption by the air compressors is reduced by ninety-eight percent, an astounding return on investment and an easy way to make a significant contribution to energy conservation."

Professor Yee found that state-of-the-art vacuum generators in a decentralized configuration can reduce annual energy consumption of a single suction cup from over $200 to less than $1. For manufacturing plants employing hundreds or thousands of suction cups or other vacuum-based devices, this energy savings can have a significant impact on the plant's margins, especially in this era of unpredictable and rising energy costs.

New Integrated Control Options save Even More Energy

Additionally, the introduction of COAX has ignited even more recent inventions of various integrated energy-saving control options, such as PIAB Cruise Control (PCC), and PIAB Automated Vacuum Management (AVM™). These vacuum sensing devices allow for even greater energy savings, depending upon particular industry applications.

Such energy savings, coupled with improvements in productivity and reduced maintenance costs, are the tangible benefits of the miniaturization and decentralization of industrial vacuum systems.

In addition to saving energy and increasing productivity in the automotive industry, this new concept in vacuum system design is also effective in the packaging, conveying and graphics industries, where vacuum systems are used for handling everything from cardboard boxes, to paper to sugar and flour.

In conclusion, just as information technology and telecommunications professionals were blessed once they adapted to the changing concepts of new data transmission technology, industrial manufacturers must be open to the benefits of miniaturization and decentralization in vacuum system design.