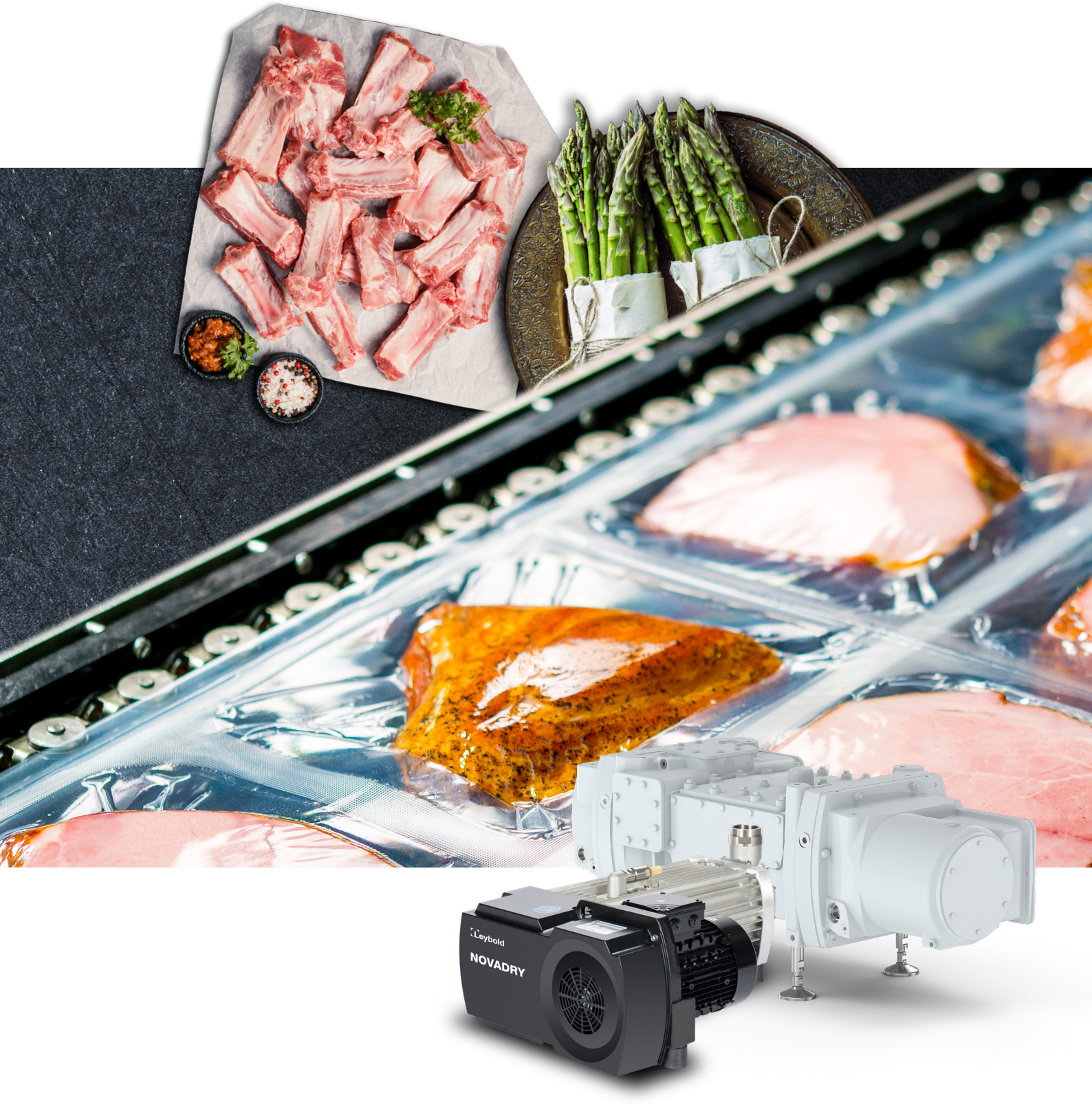
Leybold

Modern vacuum technology
Industrial food production



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Introduction

The global food production and processing industry has an incredibly important and challenging responsibility—feeding billions of people around the world. The ongoing COVID-19 crisis has highlighted this reality, but the primary role of the food industry has always been to provide its customers and communities with a safe, stable and affordable food supply.

Few industries are as essential as the food packaging and processing industry. Nevertheless, like most other industries, we are facing constant business pressures in the form of increased production costs, fluctuations in the availability of raw materials and ever-evolving food safety regulations. Add to that a shrinking workforce and increased negative media attention, and it becomes clear that the food production and processing industry must evolve and adjust if it wants to remain profitable in 2021 and beyond.

A number of the above factors are out of the control of employees on the operational and/or facility level, but others are not. One of the most impactful and controllable aspects of remaining competitive is the way in which companies utilize their food processing and packaging equipment. Faulty, outdated and inefficient equipment have slower cycle times and can cause maintenance-related downtimes which can, in turn, can have a direct negative impact on profitability.

Vacuum equipment is critical to food processing and packaging, so we must focus on optimizing it in order to maximize production and minimize maintenance and downtimes.

Key focus areas for optimizing industrial vacuum equipment:

- Reduction of equipment cycles times
- Increases in the efficiency of existing
- Implementation of advanced and more efficient vacuum technologies

Reduction of downtime caused by vacuum equipment

Reduction of equipment cycle times

In the food processing industry, one of the quickest and easiest ways to achieve higher productivity is to first focus on equipment upgrades with the greatest impact. Vacuum-based food packaging is a prime example of how a small change in existing equipment can have a significant impact on reducing cycle times and improving productivity.

For example, Rotary Chamber Packaging Machines are very commonly used to package cuts of meat, and the most popular brand boasts a maximum operating speed of 40 packages per minute. However, due to limitations in the default OEM vacuum systems installed on many of these machines, they very seldom run at more than 34 packages per minute, which is significantly less than the promised output.

Working with a leading food packaging company on upgrading their existing OEM vacuum pumps to Leybold vacuum pumps, we were able to speed up their operations to a consistent rate of 38 packs per minute. In just one year of production, this amounts to an output of more than a million additional packages on that same piece of equipment.

Similar results have already been repeated across a number of meat packing plants in the US. The initial cost of the upgraded Leybold vacuum pump is recovered within a few months of operation, making the extra production over the life of the packaging machine pure profit. Interestingly, the loss of productivity and related revenue that results from underperforming legacy vacuum equipment is rarely considered as a cost to the company, even though it can amount to much more than all other costs combined.

Reductions in maintenance and repair costs

Maintaining and repairing typical OEM oil-sealed vacuum pumps can be costly and time consuming. Depending on the application and type of product being packaged or processed, changing oil in vacuum pumps can be a monthly occurrence with filter changes approximately every three months. Improper maintenance or process upsets can lead to pump failures. This, in turn, leads to high pump repair costs, and if unplanned, it interrupts the production line, causing significant downtime.

Increases in the efficiency of existing equipment

Reductions in operating costs

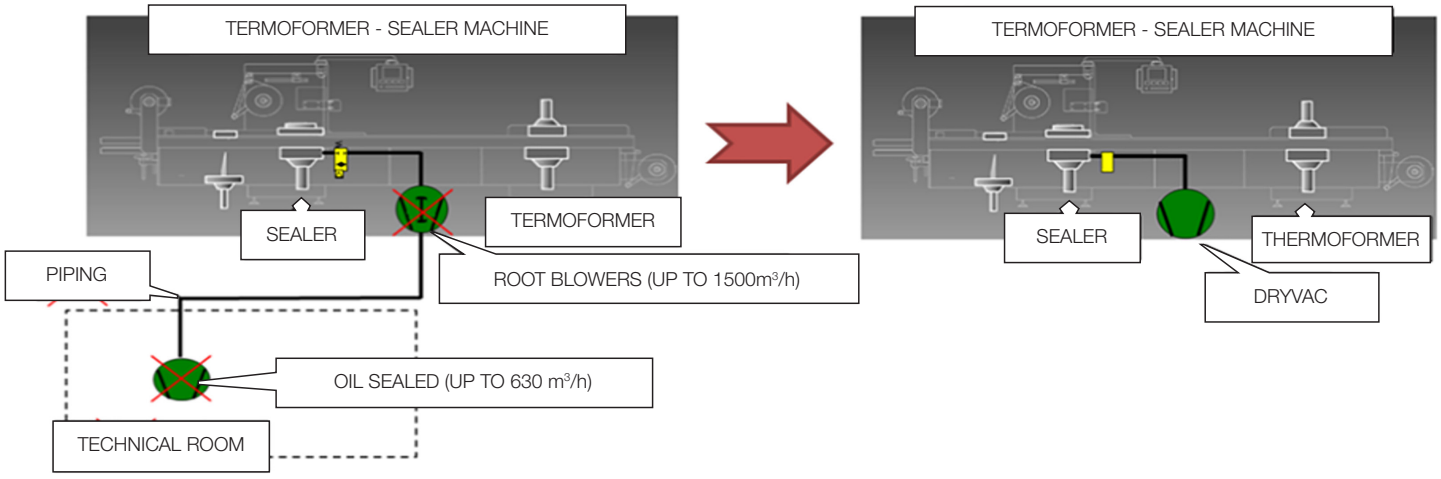
More efficient vacuum pumps reduce operating costs since they can achieve higher productivity with fewer resources. There is a drive for modern industrial equipment to consume less power, and some vacuum pumps have made great strides towards this goal. Furthermore, pumps that reduce power consumptio also reduce the heat load into your HVAC-controlled space. Modern vacuum pumps also radically reduce oil consumption and eliminate oil coalescing filter use, which eliminates the frequent oil changes required by traditional rotary vacuum pumps. Vacuum pump oil is not cheap, and the contaminated oil requires appropriate disposal.

Most packing companies today locate their vacuum pumps remotely due to noise, footprint, heat generation and potential oil mist emanating from the pumps. It's not uncommon to see pumps 30 to 150 feet from the actual packaging equipment - in a hallway, a mezzanine or a room somewhere with three inch pipes and three or more 90 degree elbows. Flow is adversely affected by diameter, length, elbows and a pipe's roughness. Roughness is difficult to change, but the other three factors can be addressed. With the right pump, you can eliminate the positioning of pumps remotely and achieve significant gains in equipment productivity.

Leybold's pump/blower design allows you to position the pumps adjacent to the food packing line. Close proximity greatly reduces suction line length and complexity, resulting in a faster pump down to lower pressures which results in a significant increase to packages per year on the same production line. Our pumps have stainless steel enclosures that make the pumps washdown-ready which, again, eliminates the need to house them remotely.

Maintenance cost reductions: rollstock and dry vacuum pumps

Another common packaging machine in the food industry is the rollstock thermoformer, and while there are a few versions, a typical machine layout is shown below. It features a roots blower located near the thermoformer on the production floor with an oil-sealed rotary vane pump located outside the production area for reasons explained earlier. However, you can run the same thermoformer using a single **DRYVAC** DV 650 pump. We have eliminated the blower but are outputting the same work and, in some cases, improving cycle times and vacuum levels. Energy needs are reduced, and the maintenance burden is also significantly diminished.



Modern vacuum technology

Reductions in product contamination

Product contamination is always a risk when oil-filled vacuum pumps are used in food production. An easy way to eliminate the risk of oil contamination related to vacuum equipment is to replace oil-sealed pumps with modern dry vacuum pumps. As the name implies, oil-sealed pumps use oil and other internal lubricates/sealants to achieve vacuum and have the potential to contaminate the food that's being processed.

Improvements to work environments

Typical rotary vane vacuum pumps can be very noisy, which often contributes to employee stress and hampers shop floor communications. Rotary vane vacuum pumps can also leak oil onto the shop floor and inject smoke-like vaporized oil into the production areas, creating an unnecessary safety hazard.

As mentioned above, our pumps and blowers were designed to be compact, quiet and cool, which allows you to locate them adjacent to the food packing line without no adverse impacts on the health and safety of your production floor personnel.

Reductions in environmental impact

When oil is eliminated from the swept volume of the vacuum pump, the potential for oil spills, oil mist emissions, and oil disposal is also eliminated. All of these benefit the environment and reduce the number of potential findings on EPA audits.

Our dry screw vacuum pumps, including the **DRYVAC** DV 650, are so quiet they can't be heard next to the other equipment, and they don't leak oil, as the only oil used is for lubricating the gear box.

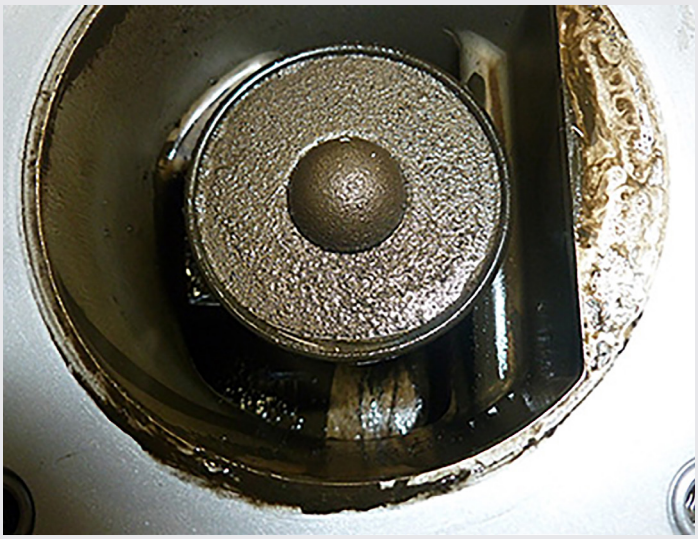
Leybold has also recently released a completely oil-free dry screw vacuum pump, the **NOVADRY**. This pump is incredibly quiet and is 100% oil-free, giving you all the benefits of modern vacuum equipment as explained above with none of the noise and oil concerns of older pumps.

Implementation of more advanced and efficient vacuum technologies

Painting with a very broad brush, current vacuum technology in the food processing industry can basically be divided into two equipment categories: **oil-sealed vacuum pumps and water-sealed liquid ring pumps.**

This technology has been around for over 50 years and has established a “norm” or a status quo that most food packing and processing operations have accepted, even with their limitations.

Neither of these vacuum pumps are great options for today's food production and processing industry and should be replaced with a more efficient and maintenance-free **dry vacuum technology.** Before we address the benefits of dry vacuum technology, let’s quickly review the differences in the existing, commonly-used vacuum pumps.



Pump leaking oil

Oil-sealed rotary pumps

Oil-sealed rotary vacuum pumps are still the legacy technology in most food processing and packaging operations, and these pumps have changed very little over the past 50 years. While these pumps have proven to be a suitable solution for food processing in the past, this outdated technology has a few noteworthy downsides, in terms of their efficiency and their harmful impact on the environment. Since these pumps require oil to operate, the quality of the oil can influence the degree of vacuum levels, thereby requiring regular oil changes. These oil changes take time and can be very expensive over the life of the pump.

Oil-sealed rotary pumps generally require significant amounts of time-consuming maintenance and repairs and are also prone to breakdowns that can cause production line downtimes. These unexpected downtimes are often managed by storing back-up pumps onsite, which means added space and expense as well as time. Lastly, oil can leak out of the vacuum pump, especially if the pump is older or hasn’t been maintained well, and these leaks can pose significant food con- tamination, workplace safety and environmental risks.

Water-sealed liquid ring pumps

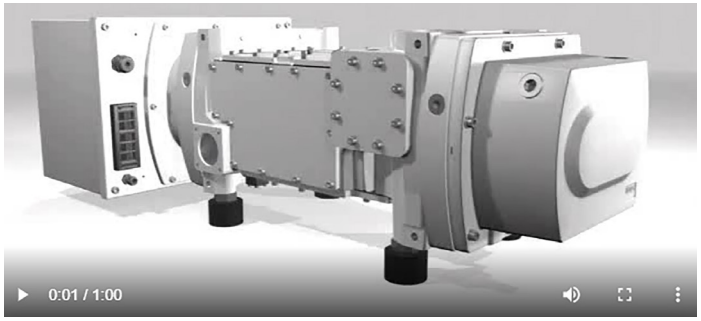
Water-sealed liquid ring vacuum pumps use water internally to create a vacuum, but this process can cause several issues, including a level of water usage and some of the highest energy consumption levels in the market (e.g., highest KW per cubic feet per minute).

Another major drawback of water-sealed liquid ring pumps is the fact that they are extremely temperature sensitive and can have considerable fluctuations in their vacuum levels, depending on the time of year due to seal water temperatures. For example, vacuum performance can drop by 30% if the seal water temperature increases from 60 degrees Fahrenheit during cooler months to approximately 85 degrees Fahrenheit in the summer.

Hybrid oil-sealed liquid ring pumps also exist, but those are less popular because of their higher up-front costs. They also require more maintenance, as they contain oil coolers and heat exchangers and require costly oil changes.

Dry vacuum technology

Dry vacuum technology is a relatively new approach to achieving high degrees of vacuum efficiency without some of the drawbacks of traditional liquid pump technology. At its most basic level, dry vacuum technology is a non-contact, non-wear design that doesn't rely on sealing fluids or lubricants to achieve and maintain desired vacuum levels, thereby eliminating or reducing the elements required to keep 50 year-old technology operating.



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The use of oil in vacuum pumps has always resulted in the presence of some degree of condensation-related vapor in the vacuum chamber, which puts a significant internal vapor load on pumps and can reduce their operating efficacy by up to 30%. Oil vacuum pumps also run very loudly and generate high levels of heat and oil mist, which results in these pumps being typically placed in areas outside the immediate production area. By eliminating the need for oil, dry vacuum pumps operate much faster, cleaner, cheaper and quieter than their predecessors, and they can be placed directly on the production floor.

Dry vacuum technology was first introduced in the 1990s in the semiconductor industry, as there was a need to effectively eliminate the potential of oil contamination from the manufacturing process for semiconductor chips.

As a new technology, early dry vacuum pumps were significantly more expensive than traditional liquid vacuum pumps (often 3-5 times more expensive), and only high-margin sectors like the semiconductor industry could absorb the extra costs of this revolutionary new technology. Over the past two decades, however, the cost of dry vacuum technology has aligned much more closely with that of traditional vacuum equipment, and given the fact that dry vacuum pumps run more efficiently and increase production, the return of investment on dry vacuum pumps is now quicker than on traditional oil-sealed pumps.

Dry vacuum technology in industrial food production

In some respects, the food production and processing industry shares similarities with the semiconductor industry. First, much like the semiconductor manufacturing process, food production and processing also must avoid contamination of the end product from oils and sealants, both through direct contamination or from ambient contact with environmental contaminants like oil mist or vapor.

Unlike the semiconductor or other high-tech industries, food processing plants typically operate on very narrow margins and use highly-perishable raw materials that require a high degree of productivity and operational efficiency. The food production and processing industry is particularly suited for this new type of clean and efficient dry vacuum technology for the following reasons:

- Higher production efficiency and output
- Significantly lower maintenance requirements
- Significant reduction of food contamination risks
- Significant workplace safety & environmental benefits
- Very easy technology shift/OEM replacement

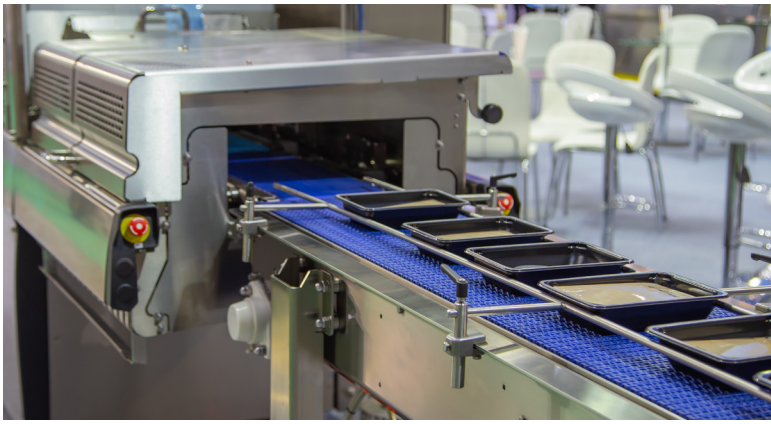
High production efficiency and output

Dry vacuum technology represents a significant leap forward for the food production and processing industry, both in terms of operational efficiency and increased production. The advent of this technology has enabled food processing and packaging operations to dramatically reduce equipment cycle times, thus increasing productivity and output.

Leybold worked with a large food processing and packaging client who was looking to make their meat packing operation more efficient and productive. With the original, OEM-supplied pumps on their Rotary Chamber Packaging Machine, they could only run at about 30 cycles per minute and were achieving 3.4 torr in the sec ond stage chamber.

After upgrading their original rotary vane pumps with Leybold **DRYVAC** systems, the second chamber reached 1.5 torr vac uum at the same 30 cycles per minute. We also found that the Leybold solution enabled the line to run up to 39 cycles per minute with a second chamber pressure of 2.3 torr or 32.5% lower pressure than what was achieved with oil-sealed pumps at 30 cycles per minute.

Since there are 8,000 hours of production per year, nine additional packages per minute translates into more than four million additional packages per year. You can achieve this while also ending up with final package pressures that are 30% greater.



Washdown environments and dry vacuum pumps

As mentioned earlier, **DRYVAC** pumps can be made wash-down ready by enclosing them in stainless steel enclosures. If you have severe space constraint issues, we have a streamlined epoxy-coat ed pump that will take a bit more installation effort but may also fit. The benefits make the effort well worth it.

Cryovac 8600-14E Upgrade with Leybold DRYVAC Systems

- XYZ Pumps: 3.4 torr @ 30 cycles per minute
- Leybold **DRYVAC** pumps: 1.5 torr @ 30 cycles per minute
- Leybold **DRYVAC** pumps: 2.3 torr @ 39 cycles per minute
- Saving on maintenance spending (no more significant oil amount to change and discharge, no exhaust filter)
  Just minimal maintenance required (1.2 l of oil annually in each **DRYVAC**)
- Decrease of the electrical total consumed power:

	XYZ bombas	Leybold
1st stage	2x 773 m^3hr	2x DV 650
2nd stage	1x 1800 m^3hr + 1x 773 m^3hr	1x WHU2500 + 1x DV650
1st stage installed power	2 x 15kW = 30kW	2 x 15kW = 30kW
2nd stage installed power	15kW + 5,5kW = 20,5 kW	1 x 15kW + 7,5kW = 22,5 kW
Total installed power	50,5 kW	52,5 kW
1st stage consumed power	25,5 kW	
2nd stage consumed power	14kW (2kW for Roots)	
Total consumed power	**39,5 kW**	**28,2 kW (Pascal calculated)**

Other advantages: The customer reduced their maintenance spending. For this particular production line, they no longer had barrels of vacuum pump oil for oil changes (which they also needed to dispose of). There were no exhaust mist filters to replace, and there was also a decrease in total power consumption. The original pumps use 39.5 KW, while the dry pumps did more work for less power (just 28.2 KW).

Lower maintenance needs

In addition to quicker and more efficient operation, dry vacuum pumps also have significantly lower maintenance needs and a longer lifespan.

Food processing technicians are not vacuum pump experts, and maintenance work that results from faulty vacuum equipment often requires work stoppages and outside assistance from third parties. Even when a replacement pump is stored onsite, the food processing equipment must still be stopped and cleared, and the installation of a new pump can take hours. Each minute of downtime is lost revenue. Dry vacuum pump technology can eliminate much of the maintenance burden and allow in-house technicians to focus on their main role—keeping their food processing and packaging equipment going.

The elimination of oil from the vacuum process also eliminates the high costs of frequent oil changes and related costs, such as filters and oil disposal. In a medium-sized operation, this alone can save more than $250,000 annually.

Modern vacuum technology

Significant reduction of food contamination risks

Product contamination and large-scale recalls are a major risk fac tor and significant potential cost for any industrial food producer or processor. An easy way to eliminate the risks of contamination related to vacuum equipment is to replace older oil-sealed pumps with more modern dry vacuum pumps. As the name implies, oil-sealed pumps use oil and other internal lubricates/sealants to achieve vacuum. These fluids are always a potential source of contamination for the food that's being processed.

Oil-based vacuum pumps can also emit an oil vapor which is a danger to food products. Dry vacuum pumps don't use oil or other liquids in their operation, which eliminates the risk of food contamination. It's just one more benefit of adopting this clean new technology.

Significant workplace safety and environmental benefits

By their nature, food processing and packaging plants are not always the most pleasant work environments. Depending on the production process, conditions can range from very cold to hot and humid, and work-related injuries do happen. While these conditions are a fact of life in our industry, it doesn't mean there aren't ways to improve working conditions. Careful stewardship of employees is becoming more and more important for industrial food producers and processors.

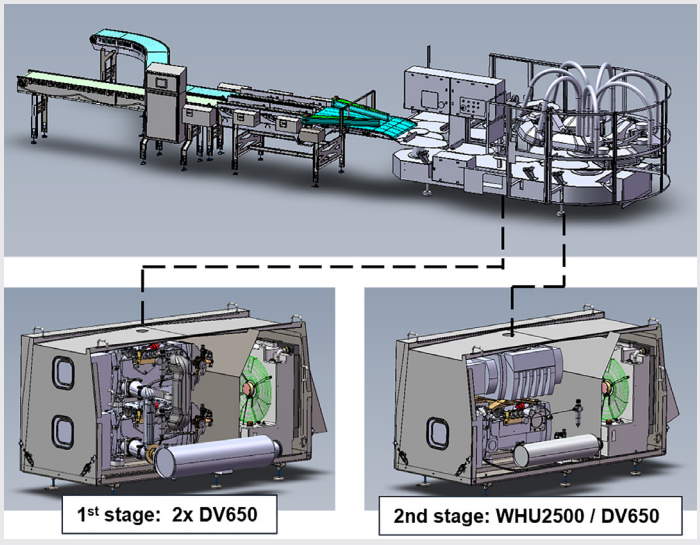
Legacy rotary vane vacuum pumps are loud and can add high levels of noise pollution (and stress) to the work environment. Since these pumps also hamper communication on the shop floor, they pose a safety risk, as verbal commands or warnings may not be heard over the noise of the machine.

Oil-based vacuum pumps can also leak oil onto the production floor and cause contamination and accidents. Oil mist emitted from equipment also adds to environmental and safety issues. To counter these risks, traditional vacuum equipment is often located 50 – 150 feet from the actual food processing equipment in a separate equipment area. As a result, vacuum efficiency is often significantly reduced by pumps operating from afar.

Benefits of close proximity pumping

Most food processing and packing companies today locate their vacuum pumps remotely due to noise, footprint, heat generation, and potential oil mist exhausted from the pumps. Most are 50 to 150 feet away in a hallway, in a mezzanine, or in a room somewhere with three inch pipe and three or more 90 degree elbows. Flow is adversely affected by diameter, length, elbows, and roughness of a pipe. Roughness is hard to change, but the other three factors can be addressed. With the right pump choice, you may be able to eliminate locating pumps remotely.

The Leybold pump/blower design is compact, quiet, and cool, which allows you to locate the pumps adjacent to the food packing line. The proximity radically reduces suction line length and complexity resulting in faster pump down to lower pressures, which results in huge numbers of extra packages per year on the same production line. Wash down? No problem, steel enclosures make the pumps washdown ready.



As outlined above, dry vacuum pumps eliminate these concerns, as they operate quietly enough to be placed right on the production floor and don't use oils or other sealants that can become environmental or safety hazards.

Extremely easy technology shift and OEM replacement

Most of the vacuum pumps found on food production and processing equipment are provided by OEMs (Original Equipment Manufacturers) as part of a larger system. Unfortunately, an OEM's main concern is usually the price of their equipment, and in a very competitive market, the pressure to sell equipment at the lowest possible price often overrides the need to provide the best possible product. As a result, most of the vacuum pumps installed on food process ing equipment are in place because they're inexpensive; not because they're the best solution.

OEMs generally only sell equipment and do not maintain or service it. These tasks are generally handled by the buyer or outsourced to third parties. Because of this, OEMs have little incentive to provide their customers with high-quality vacuum pumps that are maintenance free and designed to improve the overall efficiency of operations. As outlined in the earlier example of the Rotary Chamber Packaging machine, the fact that it was originally equipped by the OEM with an outdated pump resulted in significant losses in production: 34 vs. 38 packages per minute.

Fortunately, the retrofitting of highly efficient dry vacuum pumps on food processing equipment is relatively easy and straight-forward, and a Leybold technician can install a new pump into most food processing equipment in a single site visit. And as noted earlier, the cost of replacing an outdated OEM vacuum pump with a modern dry vacuum pump is usually a fraction of the extra revenue gained by significant productivity improvements.

Conclusion

Considering the importance of providing all of us with a safe and stable food supply in an industry that's increasingly competitive and regulated, it's a bit surprising that the technology used in the food processing industry has not changed much over the past 50 years.

Narrow margins and cost pressures have certainly played a role in the slow adoption of new technologies, especially as it relates to vacuum equipment used in food production and processing equipment. However, modern dry vacuum technology has shown to increase the production and efficiency of modern food processing operations with a quick return on investment, so the adoption of this new technology is a vital step for food producers seeking to remain competitive and profitable in today's global food economy.

For more than 170 years, Leybold has been on the forefront of helping companies around the world modernize their operations and achieve significantly higher levels of productivity and profitability. We look forward to continuing to do the same for the food production and processing industry.

Product highlights

As an example of our technical leadership in this industry, we have just launched the **NOVADRY** line—a new series of small dry screw pumps designed specifically for food applications. Combining the efficiency of dry screw pumping with an extremely cost-effective, no-frills design, the **NOVADRY** delivers superior performance to food packagers at a much lower cost.

This series of small pumps are a great replace- ment for smaller pumps on roll-stock, massagers, tumblers, mixers and stuffers. It's an all-aluminum pump which means that it won't rust up when it gets moisture in it (which is most of the time). It's also compact and air-cooled, making it an easy upgrade.

Leybold

Pioneering products. Passionately applied.

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