CXS chemical dry vacuum pump brings smart vacuum to the process industry

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Edwards' next generation CXS pumps continue to meet the industry's growing demands for clean, energy efficient vacuum that is highly reliable yet still flexible.

Advantages of dry pumps

Dry vacuum pumps are now well established around the world as an efficient, reliable option for demanding chemical processing industry applications. They are used to pump some of the most aggressive and problematic gases in a broad range of processes. Chemical processors are placing new demands on the market, driving an emerging trend for vacuum to be seen as a utility; highly reliable, flexible, and available on demand in a 'plug and pump' system that requires minimum set-up and maintenance. When processors are specifying a new vacuum system, cost-of-ownership and environmental impact are now key issues.

Selecting the right vacuum pump system

Although the vacuum system represents an apparently small part of any chemical or pharmaceutical processing plant, its role is highly significant to product quality, constancy and yield, and to the cost-efficiency of the process. Selection, sizing and system design are therefore crucial for manufacturers and processors, and expert guidance like that offered by Edwards and other major manufacturers is essential.

The main wet process vacuum technologies used in chemical and pharmaceutical processes are vapour pumps, steam ejectors, liquid ring pumps and oil sealed pumps, including rotary-piston and rotary-vane types.

	Chemical Dry Pump	Mechanical Booster	Rotary Piston Pump	Rotary Vane Pump	Liquid Ring Pump	Steam Ejector
Distillation, normal	✓✓	✓✓	✓	✓	✓✓	✓✓
Short path distillation	✓✓	✓✓	✓	✓		✓✓
Molecular distillation	✓✓	✓✓	✓	✓	✓	✓✓
Reactor service	✓✓	✓✓	✓		✓✓	✓
Central vacuum (flammables & corrosives	✓✓	✓✓			✓✓	
Fatty acid deodorisation, Biofuels	✓✓	✓✓			✓✓	✓✓
Drying, evaporation, crystallisation, concentration	✓✓	✓✓	✓	✓	✓	✓
Gas recovery/recirculation	✓✓	✓✓				
Degassing	✓	✓	✓	✓✓	✓	✓
Absorption, Adsorption, Desorption	✓✓	✓✓			✓✓	
Pervaporation	✓✓	✓✓			✓✓	
Solvent recovery	✓✓	✓✓			✓	
Isocyanates production	✓✓	✓✓		✓	✓✓	✓✓
Impregnation	✓✓	✓✓	✓✓	✓✓	✓✓	
Polymers and plastics production	✓✓	✓✓	✓	✓	✓✓	✓✓
Paints, pigments, coatings and ink production	✓✓	✓✓	✓	✓✓	✓	✓
Soaps/detergents production	✓✓	✓✓	✓			✓✓
Ethylene Oxide sterilisation	✓✓	✓✓		✓✓		
Oil treatment plants	✓✓	✓✓	✓✓	✓	✓	✓
Dewatering and filtration	✓				✓✓	
Flammable and corrosive gases	✓✓	✓✓		✓	✓✓	✓✓
	✓✓ - Preferred technology or widespread use ✓ - Some applications					
		Lowest cost of ownership, typically		High cost of ownership, typically		Highest cost of ownership, typically

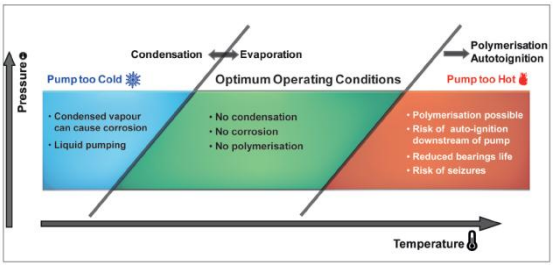
The key advantages of dry pumps, including roots, claw and screw technologies, over wet technologies are that they do not use water or oil in the vacuum stages. This

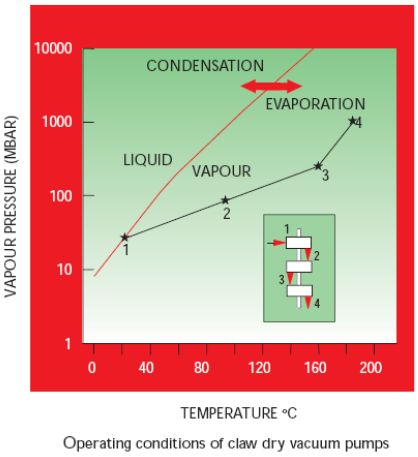
eliminates the risk of process contamination and the generation of effluent associated with the wet technologies (steam ejectors, liquid ring and oil sealed pumps). Dry pumps usually also offer clear savings in maintenance and running costs.

Dry pumps offer the best thermal efficiency of any process vacuum-producing system. Not only does the dry system use significantly less energy when it is running but, unlike a steam ejector, it can be switched off between cycles so that it uses no energy at all when it is not required. Inverters can also be used to minimise the power usage when in standby mode. Reduced power consumption results in lower carbon footprint and environmental impact.

Dry pumps have very similar performance characteristics to oil sealed pumps, typically covering the pressure range 1000 to 1 mbar at near constant volumetric efficiency with ultimate pressures of 10^{-1} to 10^{-2} mbar. Their operating range can be extended with the addition of one or two Roots pump stages thereby increasing the pump capacity to many thousands of m^3h^{-1} and decreasing the ultimate vacuum to 10^{-3} or 10^{-4} mbar. With the addition of one or more mechanical boosters in series, pump speeds up to nearly 40,000 m^3h^{-1} can be achieved in a single train. These trains can be combined in parallel to increase capacities even further. Inlet and inter-stage condensers and knock-out pots are also very efficient, non-polluting ways of increasing dry pump capacities.

Well-designed dry pumps do not suffer from problems of compatibility with process gases as wet pumps do. Even though dry pumps are made from ductile cast iron there is no corrosion when operating in the vapour phase. This is because the pressure and temperature profile inside the pump is maintained above the dew point of the process media, ensuring reliable operation even when pumping highly corrosive media. Solvents can be recovered relatively easily by inlet and/or exhaust condensation, and recycled without any need for further purification. For this reason, the dry vacuum pump system is a particularly good solution for processing organic solvents and very corrosive vapours. Keeping corrosive vapours in the vapour phase has proven successful for many years, making the need for coatings and special material unnecessary.





Operating conditions of claw dry vacuum pumps

Users of dry pumps report that the performance is more consistently reliable than that of wet pumps. This is because the presence of contaminants in an oil sealed pump can degrade its performance. Similarly, both LRPs and steam ejector pumps usually require large amounts of cooling water, which can become contaminated with process vapour as it condenses, or the temperature might be too high, with the effect that performance may be degraded. In a dry pump, no such contamination problems exist. The capital cost of a dry vacuum system is often higher than that of an equivalent cast iron wet pump, but there tends to be very little difference when the total installation costs are considered. When running costs are taken into account, the dry system often shows a considerably lower cost of ownership.

CXS: meeting industry demands

The latest in dry pump technology is the advanced discrete variable pitch tapered-screw technology developed by Edwards for the chemical industry, the CXS. These pumps meet industry demands for clean, highly reliable, flexible vacuum, with low cost of ownership.

The design refines earlier screw mechanisms to give smooth, gradual compression along the length of the rotor for improved thermal control and optimised pumping at all inlet pressures. Unlike some other screw pumps there is no cantilever rotor design or an end compression plate. The result is superior solids handling, as material is not compacted during the cooling down phase, thus reducing the risk of cold seizures when the pump stops.

The technology has excellent liquid handling capability, continuously pumping up to one litre of liquid per minute and up to 25 litre slugs without stopping, making it robust and reliable even in severe processing environments. This makes the pump robust in coping with process upsets but vacuum pumps should not be used to pump liquid routinely, especially dry ones.

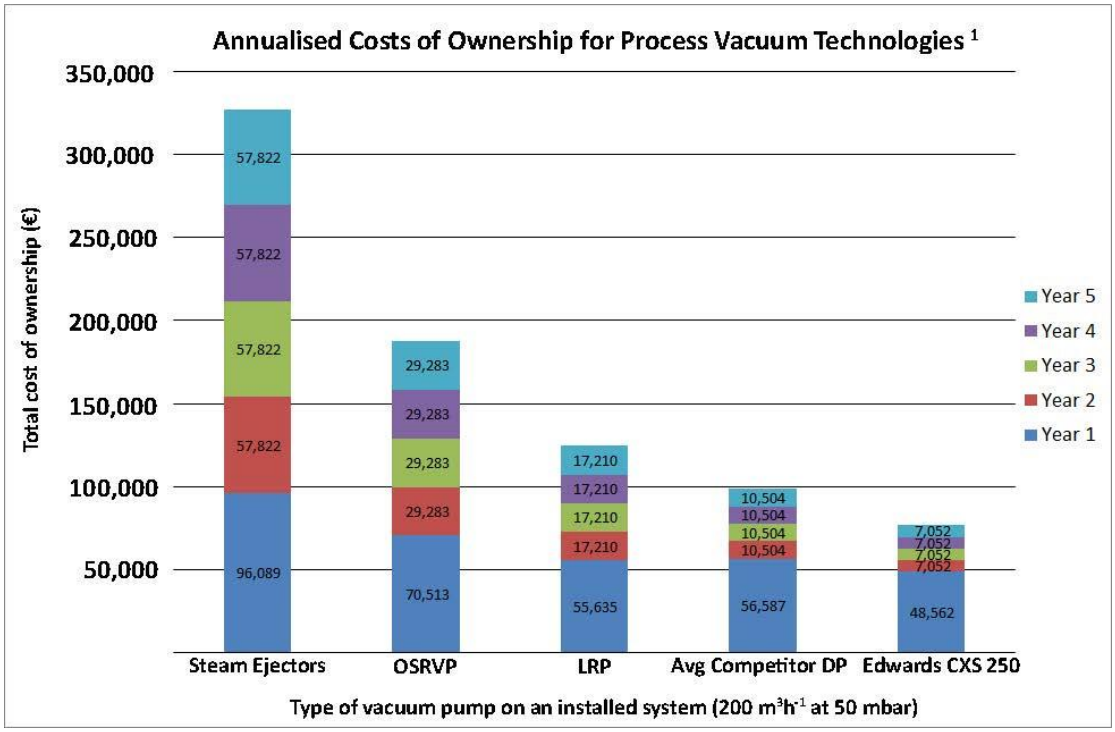
CXS has a built-in energy saving mode that minimises power consumption when vacuum is not required but maintains a pre-set minimum pump temperature so it is available for immediate use. This is better than switching-off the pump between

batches because it saves warm-up time (about 30 minutes) and reduces the chances of cold seizures and associated pump damage when restarting.

To reduce the cost and disruption of planned downtime, the new pumps have been developed to ensure long service intervals of up to five years and no routine maintenance requirements over a 25 year+ life expectancy.

All chemical dry pump systems require a control system for best performance. CXS uses integral drive and control systems to improve performance and lower the cost of ownership. Developments in the control system were a key area of focus in the design of the CXS - its onboard controller provides low-cost pump controls for a wide range of vacuum duties from simple straightforward set ups to very complex installations. The controllers are pre-engineered and tested and include the required hard wired safety interlocks and electrical switchgear.

The integral control and safety systems make installation and set-up quick, easy and inexpensive (often with savings of around €10,000 against other dry pumps).



CXS dry vacuum pump systems in operation worldwide

CXS technology is already installed at customer sites in UK, Italy, Germany, Switzerland, France, Israel and India on various pharmaceutical and fine chemical applications, and interest continues to grow from the rest of the world as the benefits of the technology are realised.

Users worldwide regularly report significant process and cost benefits as a result of the installation of CXS dry vacuum pump technology. The following examples from around the world are typical:

Germany's first CXS installation

The first CXS dry vacuum pump system running in Germany is with Birken AG, a highly innovative pharmaceutical company, specialising in products which are used to treat skin conditions. The pump is on house vacuum duty on applications such as drying, distillation and flash crystallisation.

Delivery of the pump took just six weeks, whilst competing manufacturers were quoting three months. Installation was completed in January 2012 and after initial testing and calibration the pump was fully integrated into the production process during the spring of 2013.

When the engineer responsible for installing and operating the pump was asked why he chose the Edwards CXS pump, he answered: "We were looking for an easy to install, low noise and energy saving solution based on advanced technology with a strong backbone of application knowledge in the supporting organisation."

Prior to the installation of the CXS pump there had been issues with poor vacuum supply resulting in downtime and ultimately a loss of production. With batches of product valued at €15,000 these were serious consequences. Birken AG also confirmed that since the CXS pump was installed they have never suffered a loss of production as a result of poor vacuum supply and they also now achieve superior control at both high and low pressures. They also appreciate how quiet the CXS pump is during operation because noise emissions are less than 64 dB (A).

Two years after the CXS was installed, Birken have confirmed that they are still impressed with its performance and that it continues to deliver clean, reliable vacuum with minimal maintenance.

Setting the vacuum pump standard at an API manufacturing plant, Italy

One such early adopter of dry vacuum pumping is an Italian manufacturer of active pharmaceutical ingredients (APIs). The company standardised on dry pumps and has about 50 vacuum pumps installed for reactor service and distillation applications and about a further 20 pumps for drying applications.

Like other leading chemical processors around the world this Italian API manufacturer was very interested in the new "plug and pump" technology because of its ease of installation, integral control, very low noise level and low maintenance requirements. This company tested the CXS advanced screw technology pump for almost a year, and on the basis of the trial results, purchased two more.

Increasing reliability, reducing maintenance and simple installation, global manufacturer

One of the problems with existing dry pump technologies is that some chemicals can solidify when the pump cools down, leading to pump seizures. This was the case for a major global manufacturer of specialty chemicals operating dry vacuum pumps and mechanical boosters on an evaporation process that included a phenol condenser, a receiver and knock-out pot ahead of the vacuum equipment. This led to undesirable plant stoppages and high maintenance costs.

Traces of triphenyl phosphate (melting point 49-51 degrees Celcius) were also causing problems. Another problematic chemical handled by the pump is phosphorous oxychloride. The pumps also suffered from irregular liquid slugging caused by problems with the draining of the knock-out pot.

Edwards evolved operating and recovery strategies to minimise the amount of pump cold seizures and damage. However, the maintenance costs were higher than the ideal as the liquid slugging and subsequent cold seizures could not be completely eliminated without expensive pipework changes.

As one of the toughest dry vacuum pump applications in the world, this company was keen to trial the latest generation of chemical dry vacuum pumps. The new pump design incorporates superior liquid and solid handling capabilities to reduce the chances of cold seizures and any internal pump damage when restarting. The new pump has been running for nearly a year without any stoppages caused by liquid slugs or any restart damage and with no maintenance costs. The customer is very satisfied with the pump's performance.

Looking to the future

Dry pumps are clean, reliable, provide low to high vacuum and require minimal maintenance. Importantly, they can be used quite safely even when pumping flammable and corrosive vapours.

Innovation in this sector continues, with CXS delivering even more 'utilitarian' high performing, highly controllable vacuum equipment that allows processors to minimise energy costs and reduce environmental impact.

Edwards plans to launch a US variant of the CXS chemical dry pump in November of 2015.

Edwards is a leading manufacturer of sophisticated vacuum products and a leader in vacuum technology for industrial, pharmaceutical, chemical, scientific, process, glass coating and food packaging industries, as well as a wide range of R&D applications.