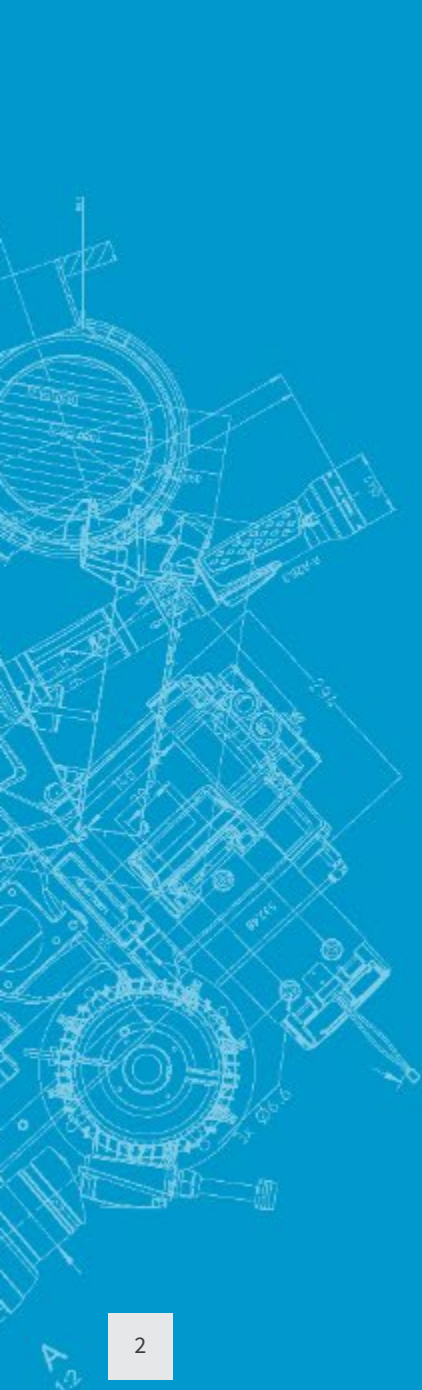


A blue technical drawing overlay is positioned on the left side of the image. It features a circular cross-section of a mechanical component with various dimensions and labels, including 'CC (1.3)' and '1.3'. The drawing is partially obscured by the text and other elements.

Vacuum in bottling application

Web Seminar Industrial vacuum

2022 – Global Applications Team

A technical drawing of a mechanical assembly, likely a vacuum pump or a similar industrial component, rendered in white lines on a blue background. The drawing shows various parts, including a large circular component at the top left, a central cylindrical body, and various smaller components and fasteners. Dimensions and labels are visible throughout the drawing.

Vacuum in bottling application

1. Market overview
2. The use of vacuum in bottling application
3. High speed filling machines in the beer industry
 - a. Process details
 - b. Process challenges
 - c. Environment/installation challenges
 - d. Typical LRP installation
4. The Atlas Copco approach
 - a. Focus markets and key selling points
 - b. Our product strategy
 - c. Competitor's outlook
5. Success stories



Market overview

Bottle filling machines

The manual methods of bottle filling cannot be applied in modern industries with bulk filling requirements as the process can consume considerable time, cause wastage of the product and lack of consistency in filling of the bottles. Special devices called **bottle filling machines** are employed in industrial packaging processes.

There are various reasons for why automatic filling machines are preferred for industrial bottle packaging processes.

- Faster processes for mass production.
- Automatic functionalities to reduces labor and production costs.
- Designed to meet the highest hygiene standards.
- PLC control which allows:
 - energy saving
 - reduction of product wastage during the process.
 - accurate and consistent filling operations.

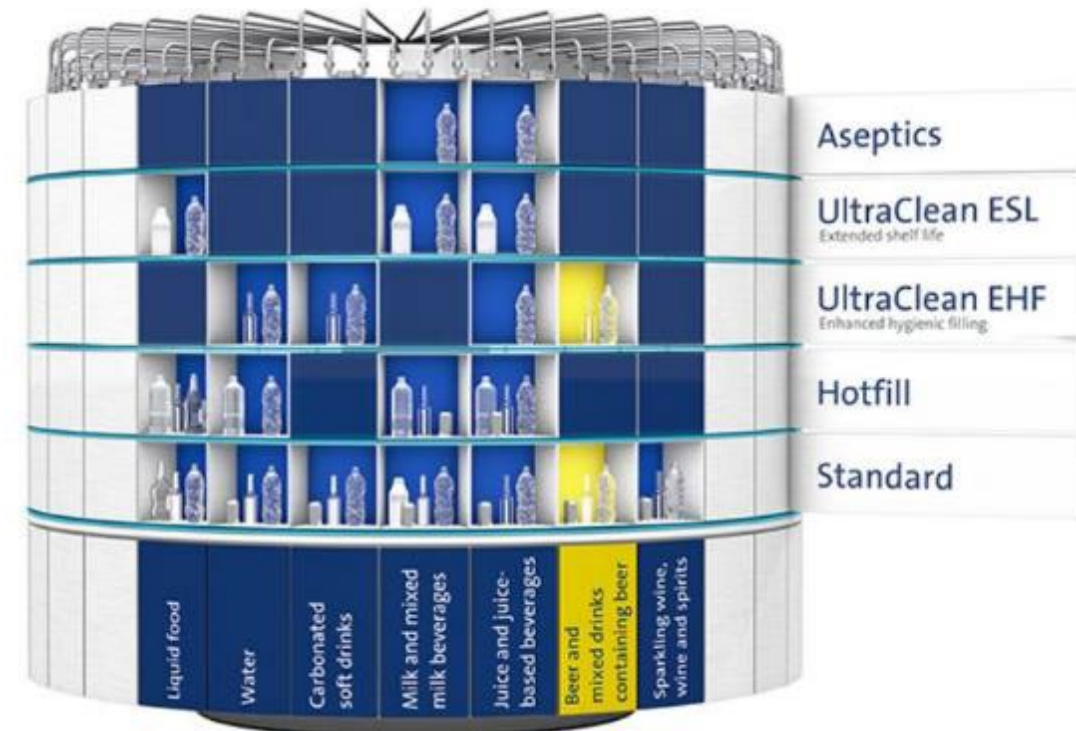


Market overview

Application description

Bottle filling machines are today available for meeting multiple requirements. There are filling machines available for filling bottles of different materials, shapes, sizes and designed for different speeds, features and specifications.

The bottle filling machines are available to suit various industries like pharmaceutical, chemical, **food and beverage**.....



Food and beverage market matrix by Krones

Two main principles with the use of vacuum for different reasons

Vacuum liquid filler and Counter pressure filler

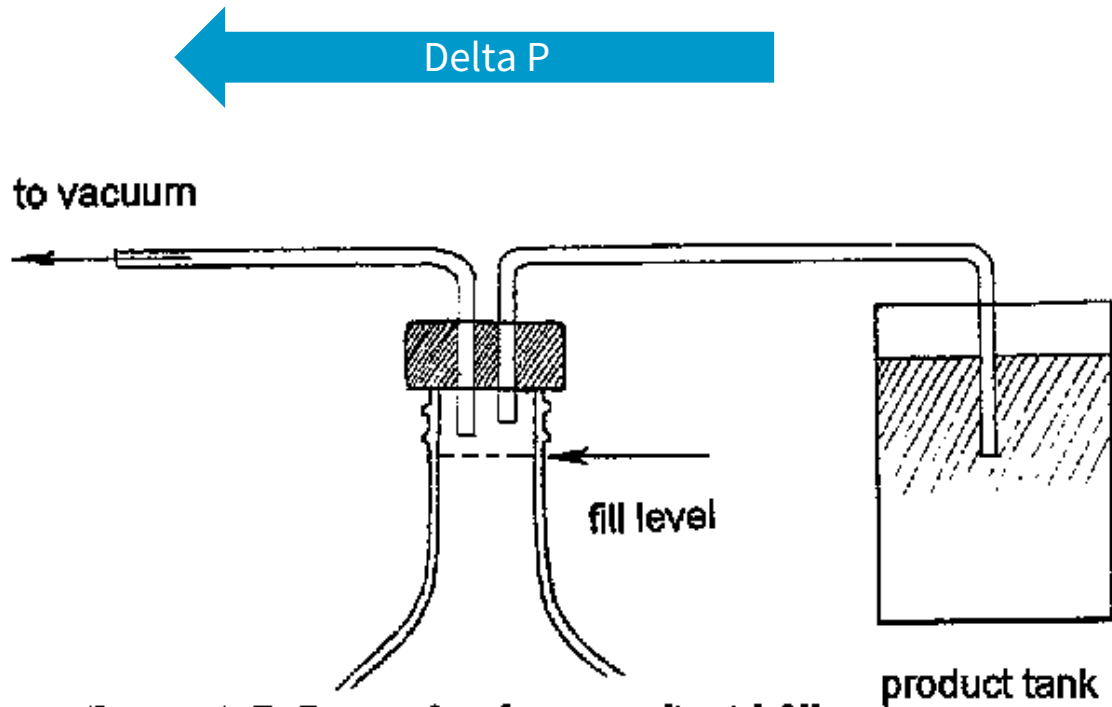
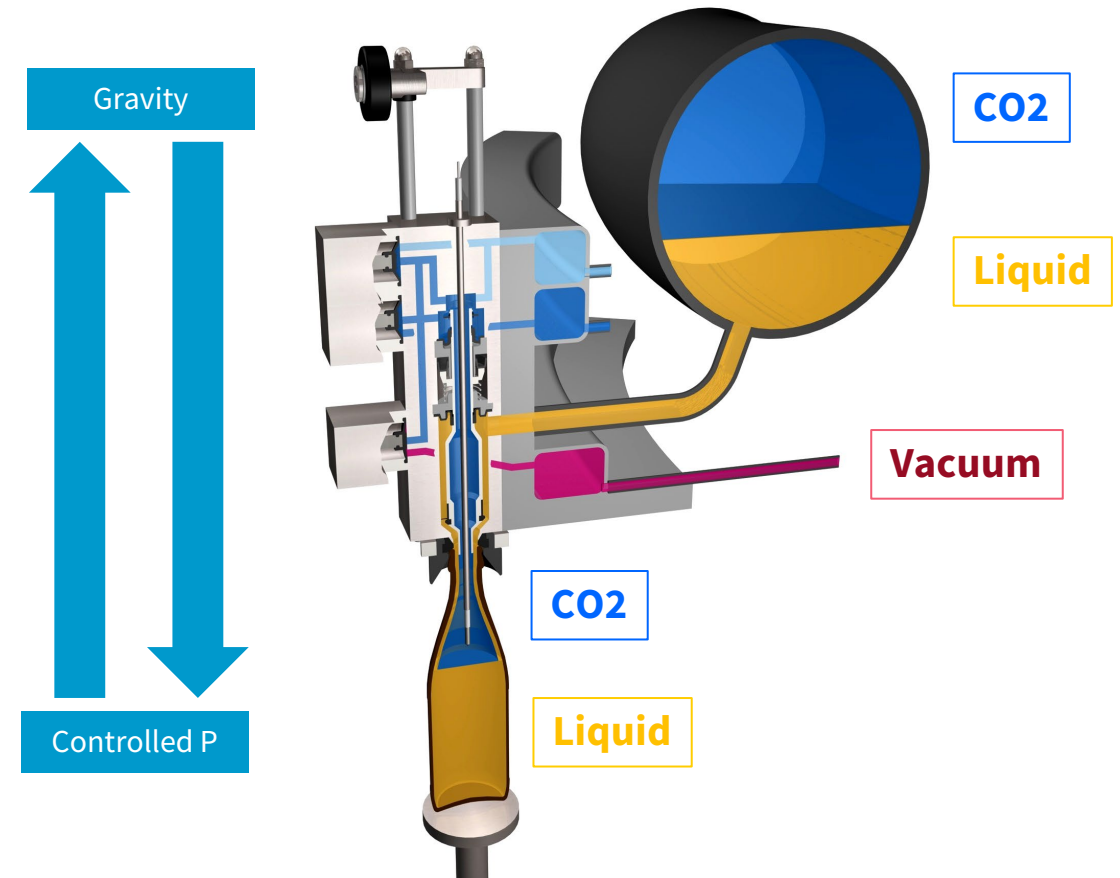
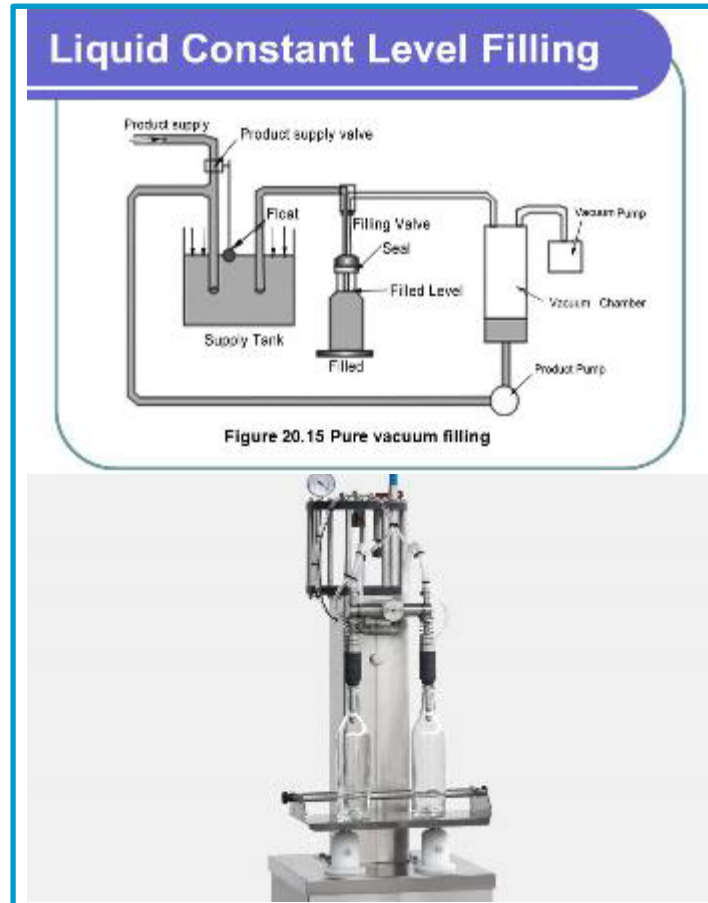


Figure 4-7: Principle of vacuum liquid filler



The use of vacuum in bottle filling

Vacuum filling



- These fillers use a double acting head connected to an overflow container (under vacuum) and to a supply tank. When the filling nozzle is inserted into an empty bottle, the sealer seals the bottle and air in the bottle is pulled out by a vacuum pump. The vacuum in the bottle then “sucks” liquid into the bottle. When the bottle is full and reaches the pre-set filling level, the filling nozzle bypasses the product into the collection tank (overflow container) where product will be transferred back to storage tank by a pump.

- Two types of vacuum filling machines: **Rotary; Linear.**
- Suitable for Glass bottles
- Products: oil, vinegar, brine, syrup, sauce, wine, liquor, etc...

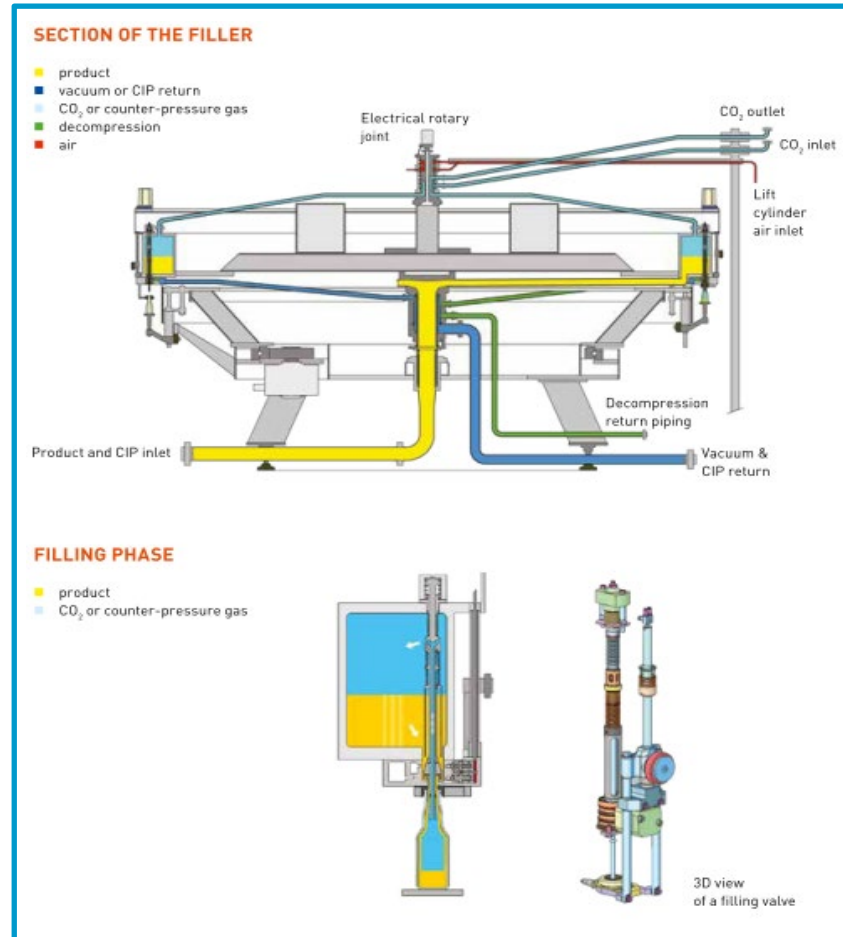
Advantages:

- Through vacuum operated filling, the product is bottled in a most natural way, allowing to maintain its original quality and features.
- No Product contact between product and pumps or mechanical components during filling

Small vacuum pumps required (often vane pumps)

The use of vacuum in bottle filling

Counter pressure filling



- These fillers are unique to the carbonated beverage industry. The head of these fillers have three parts: Vent line, gas needle (pressurized CO₂) and product stem (fill tube). Feeding tank and bottle are always pressurized. The purpose of the CO₂ is to keep the already existing carbonized beverage in solution and to minimize foaming. This type of machine is commonly used for mass production soft drinks and sodas in PET bottles but does not require vacuum.
- This machine is also used for beer because beer is a carbonated beverage and is very sensitive to oxidation therefore pressurized CO₂ is used to flush the bottle to remove air and minimize residual O₂. This flushing can be done against atmospheric P (common in can filling) or can be combined with evacuation of the bottle before CO₂ flushing and pressurization to reach very low O₂ residual content.

Our focus is on high speed machines that have one or more evacuation steps.



High speed filling machines in beer industry



High speed filling machines in beer industry

Specifications

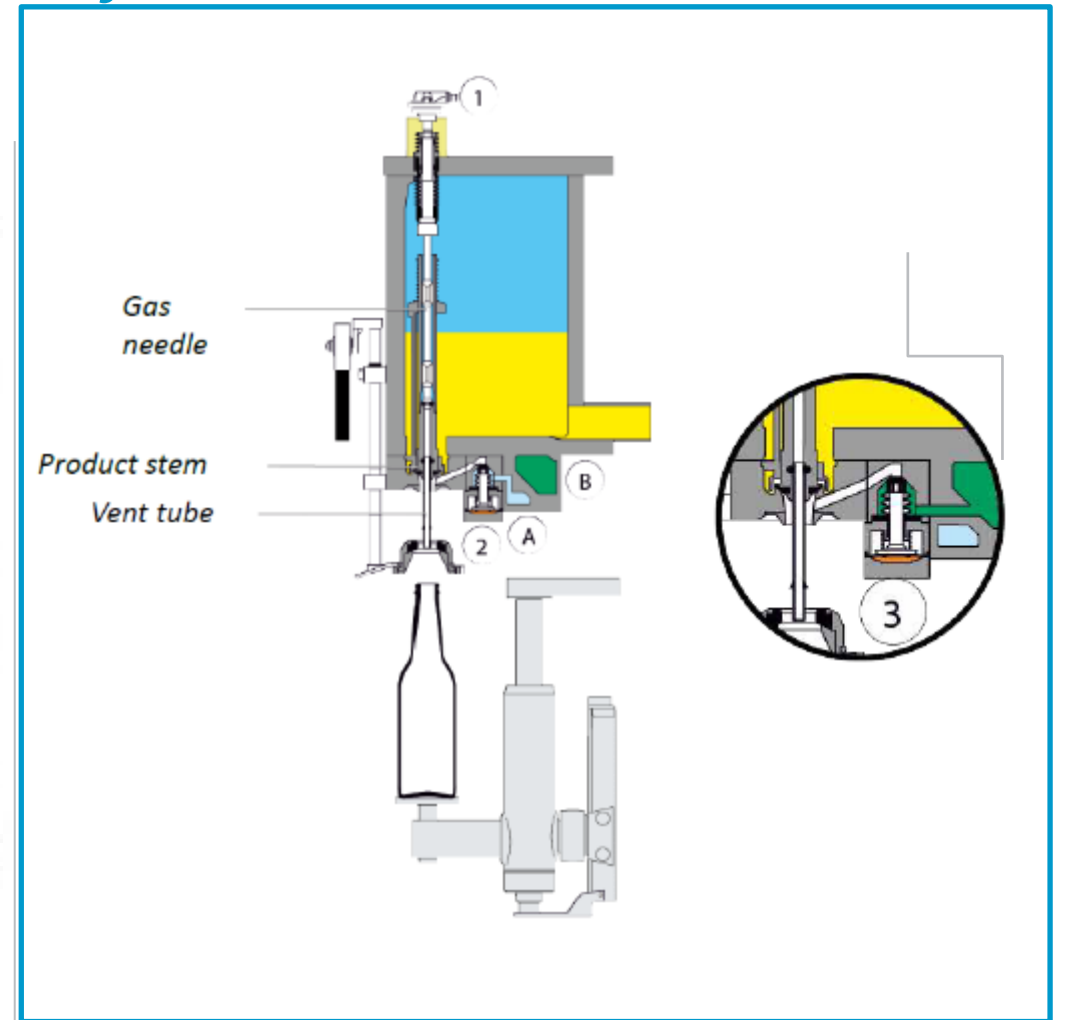
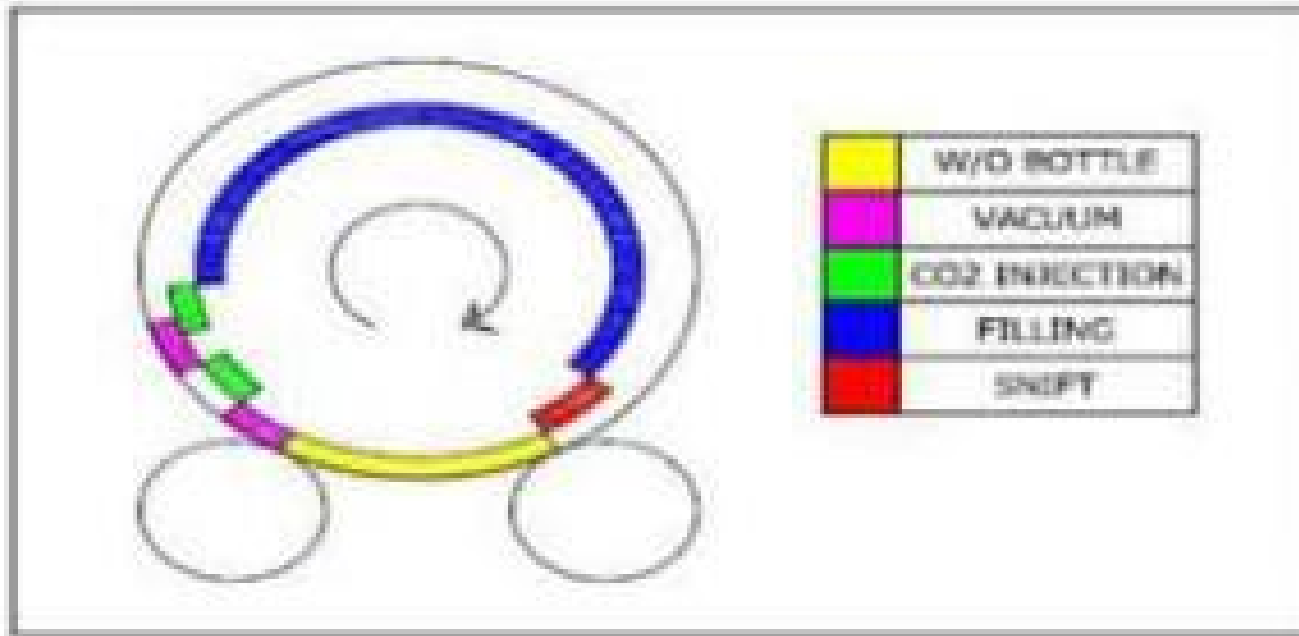


- High-speed carousels for 30, 000-up to 80,000 bottles per hour
- Vacuum is used to remove air (O₂) before CO₂ flushing and to control the venting.
- Operating pressures 50 to 250 mbar (normally around 100/150 mbar)
- Vacuum pump speeds between 100 m³/h up to 700 m³/h
- Suitable for rigid (glass) bottled products
- Significantly faster & consistent fill rates using vacuum
- Likelihood of product, foam & sugars carryover into the vacuum system
- CIP (clean in place) systems are common: Caustic or acid wash can enter the vacuum system



High speed filling machines in beer industry

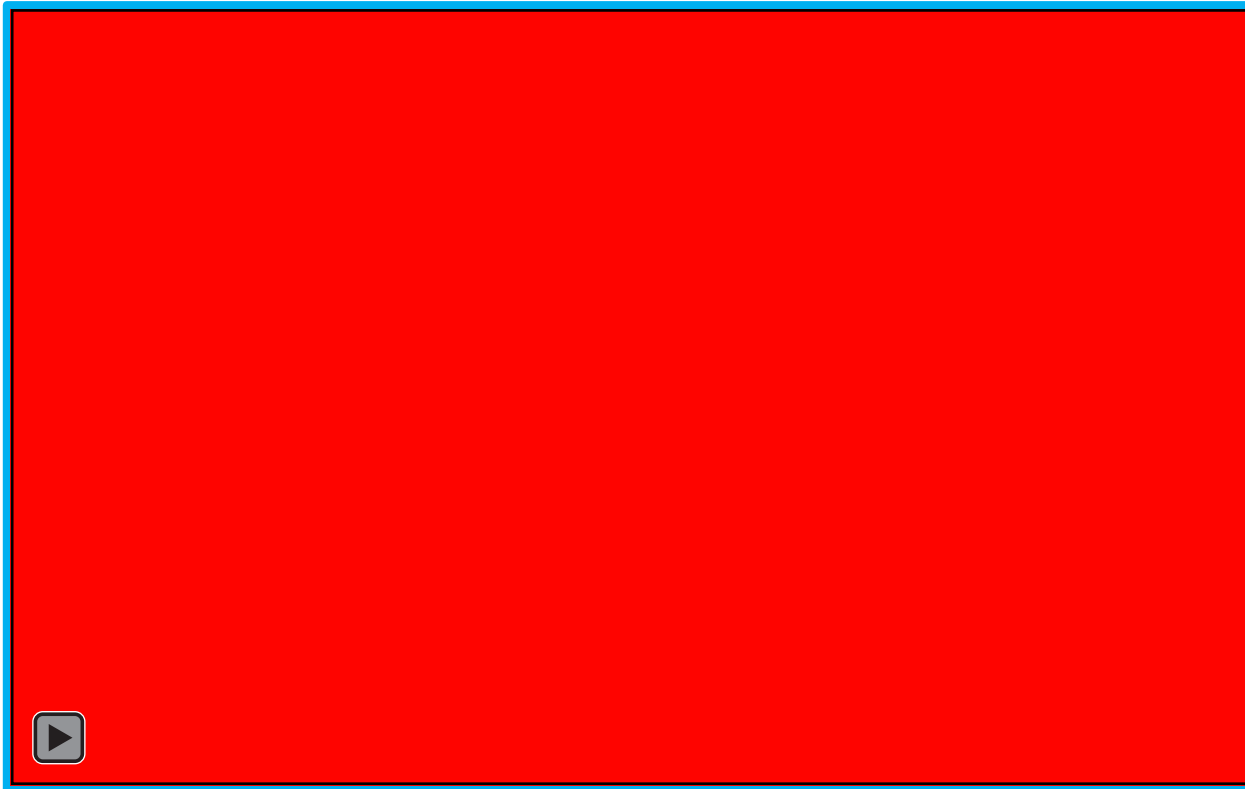
Counter pressure filling



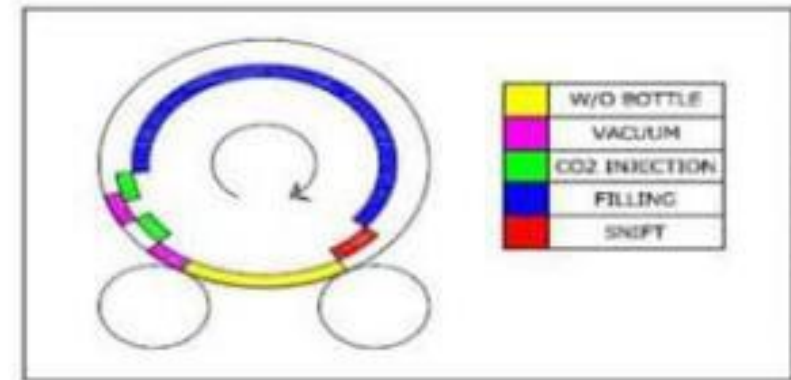


High speed filling machines in beer industry

Counter pressure filling



- Creating a vacuum in the bottle (2x)
- Flushing CO₂ to remove air from the bottle (2x)
- Pressurizing the bottle
- Filling the bottle
- Level out
- Depressurizing the bottle
- Sealing the bottle



High speed filling machines in beer industry

Typical LRP installation

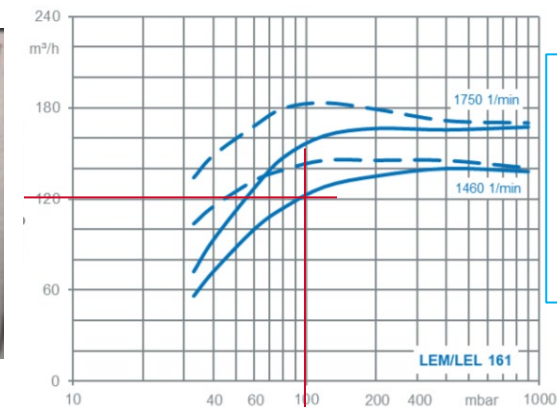
- Advantages
 - More tolerant to contamination and mist
 - Reliable and low maintenance
- Disadvantages
 - Large performance fluctuations
 - Water contamination (common OT config., some PR)
 - High energy consumption
- Sizes between 600 m³/h and 800 m³/h
 - Most common two stage units (AWD type)
 - Relatively compact, lower water consumption, better delta T
 - Sometimes multiple Mono-block systems
 - More energy efficient, more water consumption



High speed filling machines in beer industry

Typical OEM solution

- Example with multiple Mono-block system
 - Required shaft power 21 kW (30% more than a OIS)
 - Consumes between 0.5-1m³/h water per pump, depending on the operating mode
- Pumps are made of stainless steel and washable
 - CIP solutions and product spills end up in the drain together with the process water
 - Pumps are located near the filling line



@100mbar(a)
120Am³/h
P around 3,5KW
each pump

High speed filling machines in beer industry

Challenges

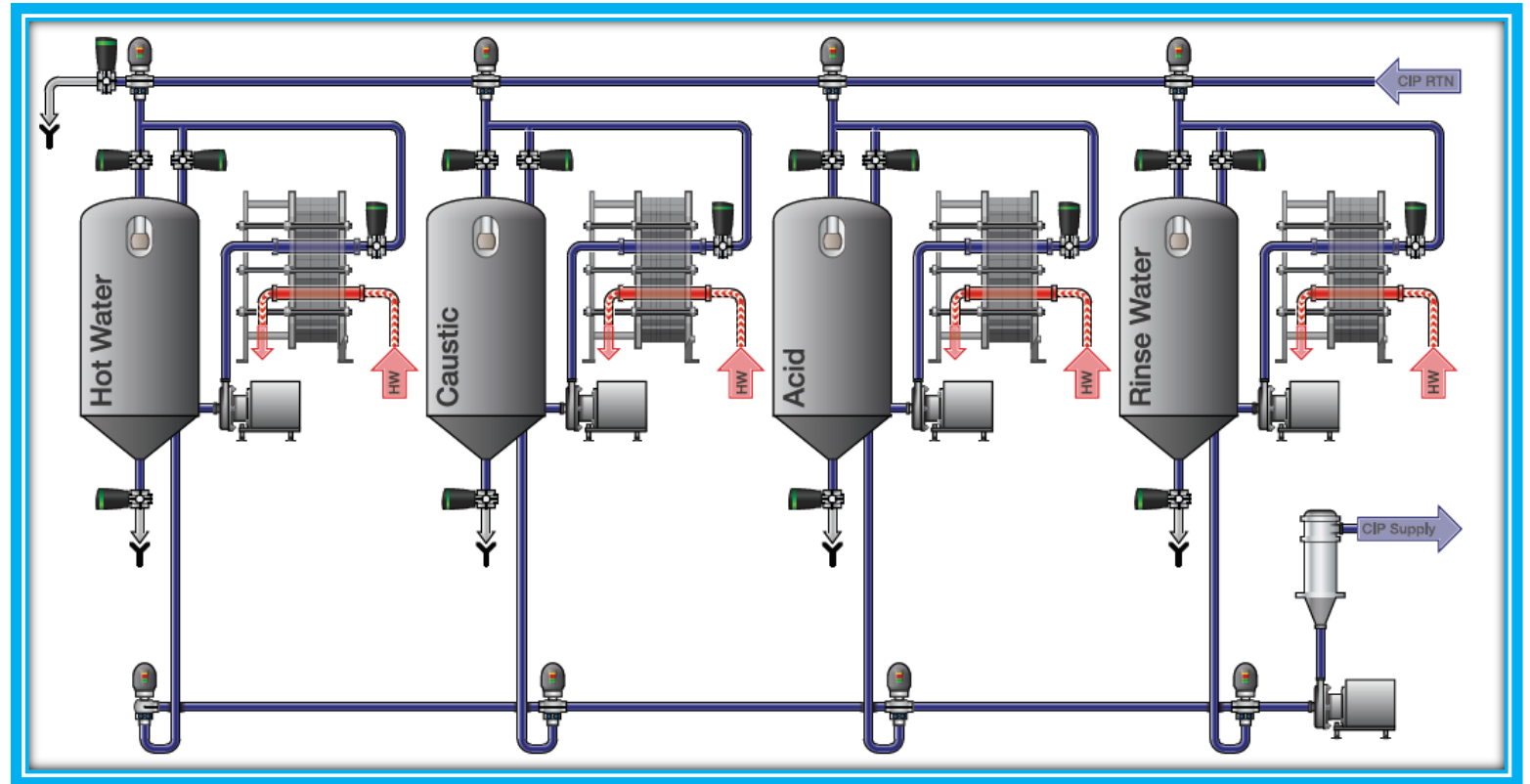
- Foam
 - Problematic for all types of vacuum pumps
 - Poorer performance, high maintenance costs (TCO)
- CO2
 - Leads to acidification of the oil in oil-lubricated pumps
 - A sure sign is the purple colouring
- CIP
 - All types of oil-immersed and oil-free pumps must be protected against this
 - LRP's with TR must be rinsed after CIP
- Working environment
 - Washable solutions directly at the filler are preferred
 - Stainless steel, protected electronics



CIP Clean in Place

A challenge for the vacuum equipment

- Cleaning in Place (CIP) has been around for a while and refers to the cleaning of systems on site
- The cleaning process is carried out without disassembly or significant changes compared to the operating state.
- CIP is therefore often used in hygiene-critical industries such as the food, beverage and pharmaceutical industries



Atlas Copco vacuum solution for beer bottle filling

With GHS VSD+

Beer Market overview

Trends and regional outlook

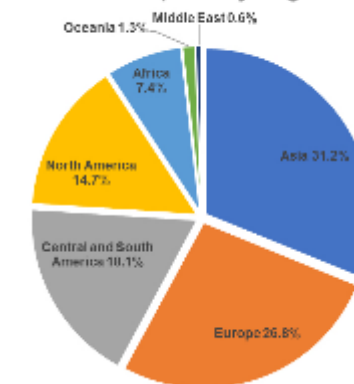
By Packaging

The market is segmented as glass beer bottles and metal can beer bottles. The glass segment is dominating and is expected to grow with fast pace. As consumer initial and primary choice is imperishable living in which glass beer fulfill the need of consumer preference which lead to increasing demand in the market. **The reusability of a glass** beer bottle is the key factor dominating the market growth. On the other hand, metal can be recycled but takes more time to get back and to melt & reform it. Because of such factors, glass beer bottles are considered to drive the market in terms of volume.

Beer Bottle Market Regional Outlook:

The Asia Pacific region is expected to dominate the global beer market during the forecast period, as there is high adoption of various technology and high number of young demographics in the region, which is expected to adhere the growth of the highest market share of global beer bottles. There is also a very large urban population in this region and also consumption of beer is very high compared to other regions. However, China also remains to hold the highest market share of beer bottles because of their population and high amount of consumption of beer. Whereas the European region is expected to hold the highest CAGR during the forecast period. Beer consumption in the countries like UK, Germany, and France may create a great opportunity for the growth of the beer bottle market in the forecast period. As result, the consumption of beer in these countries is so high and it creates even higher demand. Whereas the North American region beer comes to the most popular alcoholic beverage. The growth of beer is so high in this region and creates substantial growth in the future as well. North American region countries like Canada and U.S are also expected to be in the high growth ratio while in terms of considering the market share of beer. These countries are expected to register the high growth rate of beer bottles in the forecasting period as well

2020 Global Market Share of Beer Consumption by Region



Country	2020		
	Total Consumption (thousand kl)	Global Market Share	Growth Rate 2019-2020
China	36,088	20.3%	-8.0%
United States of America	24,105	13.6%	0.8%
Brazil	13,847	7.8%	4.2%
Russia	8,646	4.9%	4.1%
Mexico	8,287	4.7%	-11.1%
Germany	7,746	4.4%	-5.1%
Japan	4,416	2.5%	-9.3%
United Kingdom	4,088	2.3%	-13.2%
Vietnam	3,845	2.2%	-19.1%
Spain	3,815	2.1%	-9.8%
Poland	3,633	2.0%	-1.4%
South Africa	3,284	1.9%	-11.0%
Colombia	2,246	1.3%	-9.0%
France	1,984	1.1%	-7.8%
Canada	1,979	1.1%	-1.4%
Czech Republic	1,946	1.1%	-2.6%
South Korea	1,936	1.1%	-8.6%
Italy	1,886	1.1%	-10.3%
Ukraine	1,881	1.1%	-1.3%
Romania	1,828	1.0%	-2.1%
Australia	1,825	1.0%	-3.2%
Argentina	1,797	1.0%	3.0%
India	1,686	0.9%	-39.8%
Thailand	1,680	0.9%	-11.3%
Philippines	1,462	0.8%	-34.2%
Global Total	177,499	100.0%	-6.7%

Beer Market overview

Size, main players and drivers

Targetable market

- Nearly 180B litres annual consumption = 300/350B bottles and cans
- 40.000 botl/h machine gives 320M botl/y → **> 1000 machines** to have 350B bottles/y

Major players and their drivers

- Market is dominated by large corporations with AB Inbev and Heineken covering 40%
- Large groups will have Energy reduction and Environment impact reduction programs, look for people responsible for these programs at their sites. Success stories are normally distributed at corporate level
- Small players can be interested in water savings

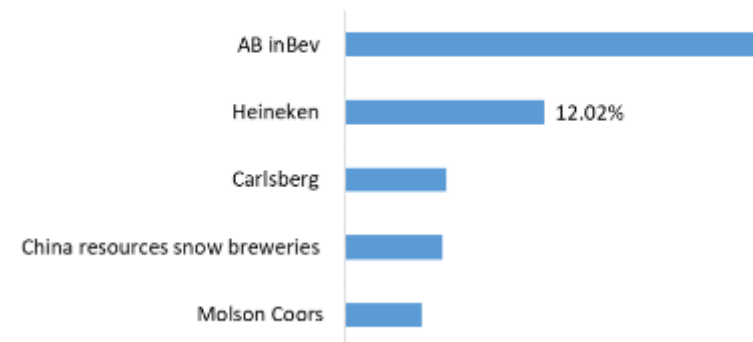
OEMs

- There are a few, but will be very difficult to penetrate due to high cost of the solution. We need to generate strong end user pull first.

Region	2020 Total Consumption (thousand kl)	633 ml Bottle Equivalent (million bottles)
Japan*	4,416	6,976.0
Asia (excluding Japan)	50,894	80,401.8
Asia	55,310	87,377.8
Europe	47,517	75,066.8
Central and South America	32,146	50,783.9
North America	26,084	41,206.7
Africa	13,130	20,742.9
Oceania	2,231	3,524.2
Middle East	1,080	1,706.5
Global Total	177,499	280,408.7

> 300 fillers
> 250 fillers
> 400 fillers

Global Market Share of Beer Companies in 2020, based on Volume Sales (in %)



The major OEMs

Krones
SACMI
SIPA
SIDEL
GEA Procomac
KHS
Guangzhou Tech-Long
OCME
Serac
E-PAK Machinery
Shanghai Precise Packaging
Newamstar
Greatview Aseptic Packaging
Langfang Best Crown
Nanjing light group
Xunjie Packaging Machinery
Jiangsu Jinrong Machinery

ACV solution for beer industry

Key selling points

Water saving

- With smart pump (LRP VSD+) flushing cycles can be set
 - Reduction from 2 m³/h to 0.4 m³/h (80% reduction)
- With foam separator we can:
 - Use a LRP with total recirculation, reducing by 98% water consumption
 - Use other pump technologies with zero water consumption

Improve efficiency

- Energy saving
 - GHS delivers same performance with 40% energy savings
 - Set point control allows to optimize flow
- Reduction of CO₂ consumption
 - Set point control reduces the use of CO₂ for backfill



ACV solution for beer industry

Key selling points

Water saving

- With smart pump flushing cycles can be set
 - Reduction from 2 m³/h to 0.5 m³/h (75% reduction)
- With foam separator we can:
 - Use a LRP with total recirculation, reducing by 95% water consumption
 - Use other pump technologies with zero water consumption

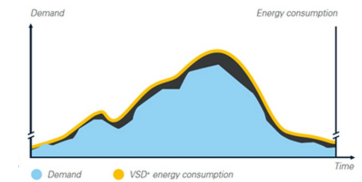
Improve efficiency

- Energy saving
 - GHS delivers same performance with up to 40% energy savings
 - Set point control allows to optimize flow
- Reduction of CO₂ consumption
 - Set point control reduces the use of CO₂ for backfill



Variable speed

- Vacuum on demand means the motor speed and power consumption changes as per process demand
- Set point control means stable vacuum level



Connectivity

- Set point controlled by the machine
- All parameters under control
- Planned maintenance



ACV solution for beer industry

Vacuum solutions

New products and technologies:

- LRP VSD+
 - Variable flow to match bottling speed, LRP is suited to sugary carryover or foaming products
- GHS VSD+
 - Best in class efficiency solution
- VSD 4All
 - GVS-A or DZS offering savings through set point control on smaller installations or vacuum fillers



LRP VSD+



VSD 4 all



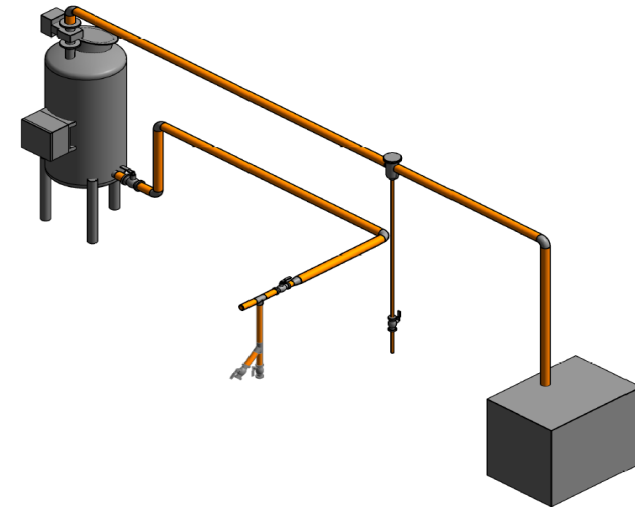
GHS VSD+

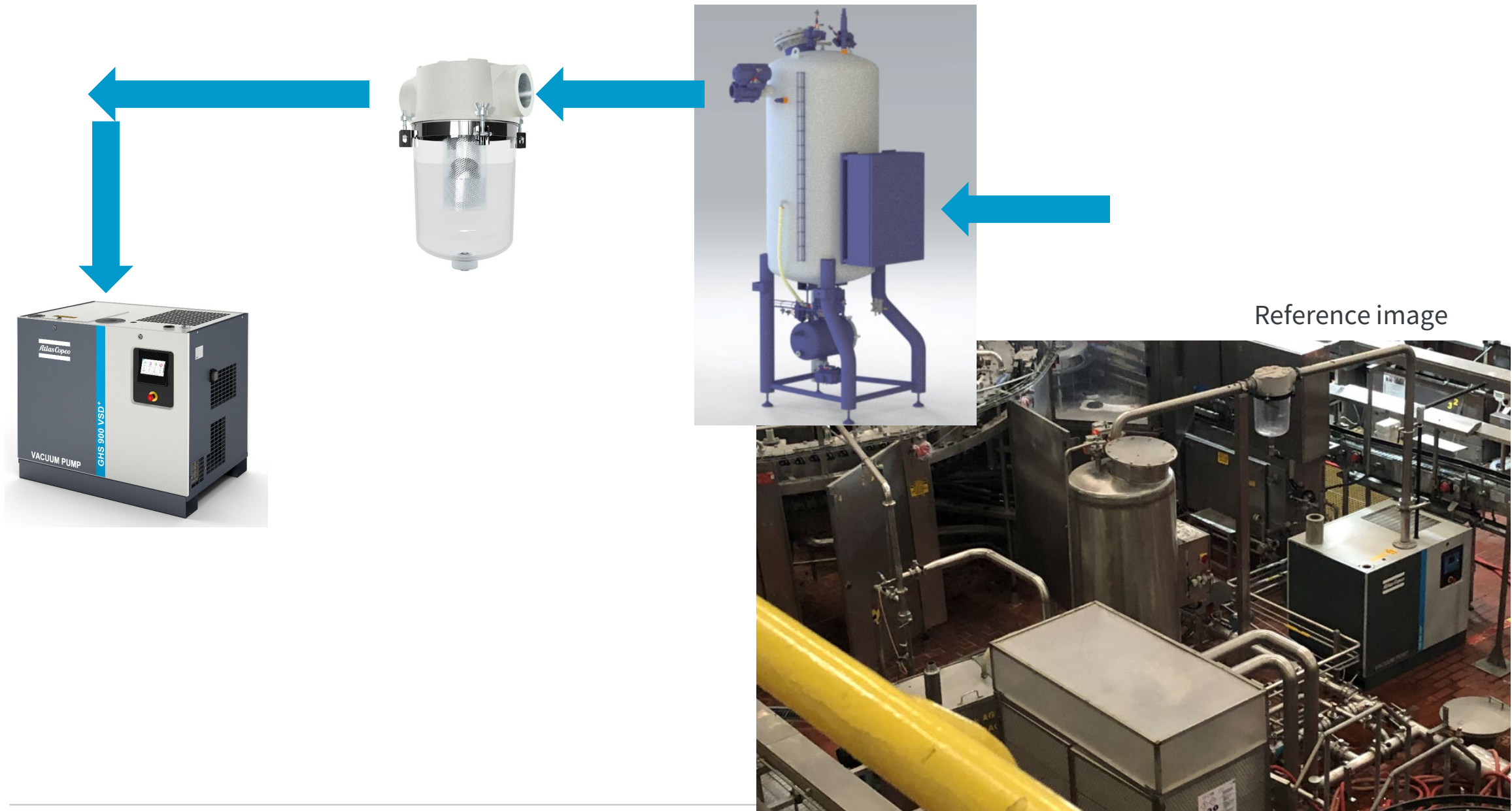
Examples of GHS installation



GHS solution with foam separator

- Our approach for customers looking at zero water consumption and efficiency is:
 - GHS 900 VSD+ to cover all ranges
 - Pump should be a Humid version to have the right setup as always a little mist will find it's way to the pump
 - Humid versions with Synthetic Oil to deal better with CO2 and residual mist from the filling process
 - Protected by a Foam separator
 - STS liquid knock out pot to stop any mist

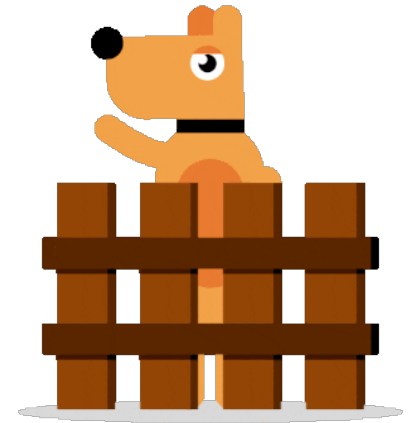




ACV solution for beer industry

Foam separation system – a guard for the vacuum pump

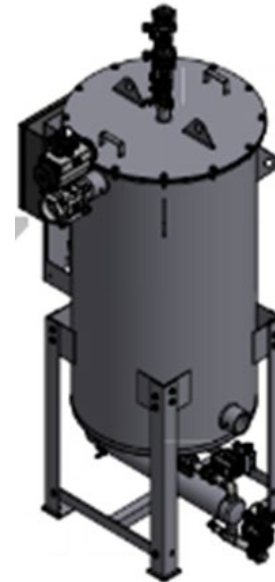
- Foam is a problem for oil sealed vacuum pumps due to its nature... the foam elimination is key
 - There is already some equipment on the market that basically follows the same principle
1. Deceleration container with big volumes
 - So that the foam collapses naturally
 2. Drainable, Cleanable (also with CIP → SS)
 3. Fill level control
 - For the liquid as well as for the foam
 - Liquid must be drained, foam level needs to be under control as a safety function



ACV solution for beer industry

Foam separation system -The Atlas Copco approach

- Designed by Atlas Copco
- Developed through site experiences.
- AISI 316 construction.
- Large diameter for foam settling
- Auto-drain setup and function with control valves.
- Proprietary control logic.
- Upgradable in the future
 - CIP logic
 - Connected to Hex@



GHS solution with foam separator

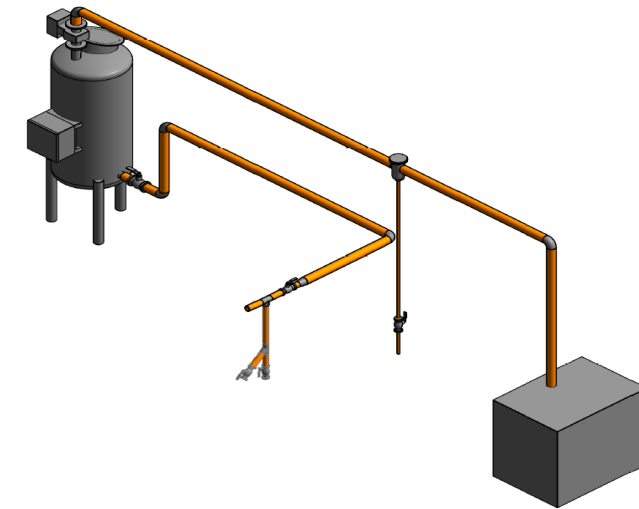
Key selling points

- Zero water consumption
- Energy saving up to 40%
- More tolerant to contamination (vs. Dry screw)
- Smart and easy control system
- Low maintenance costs



Points to consider

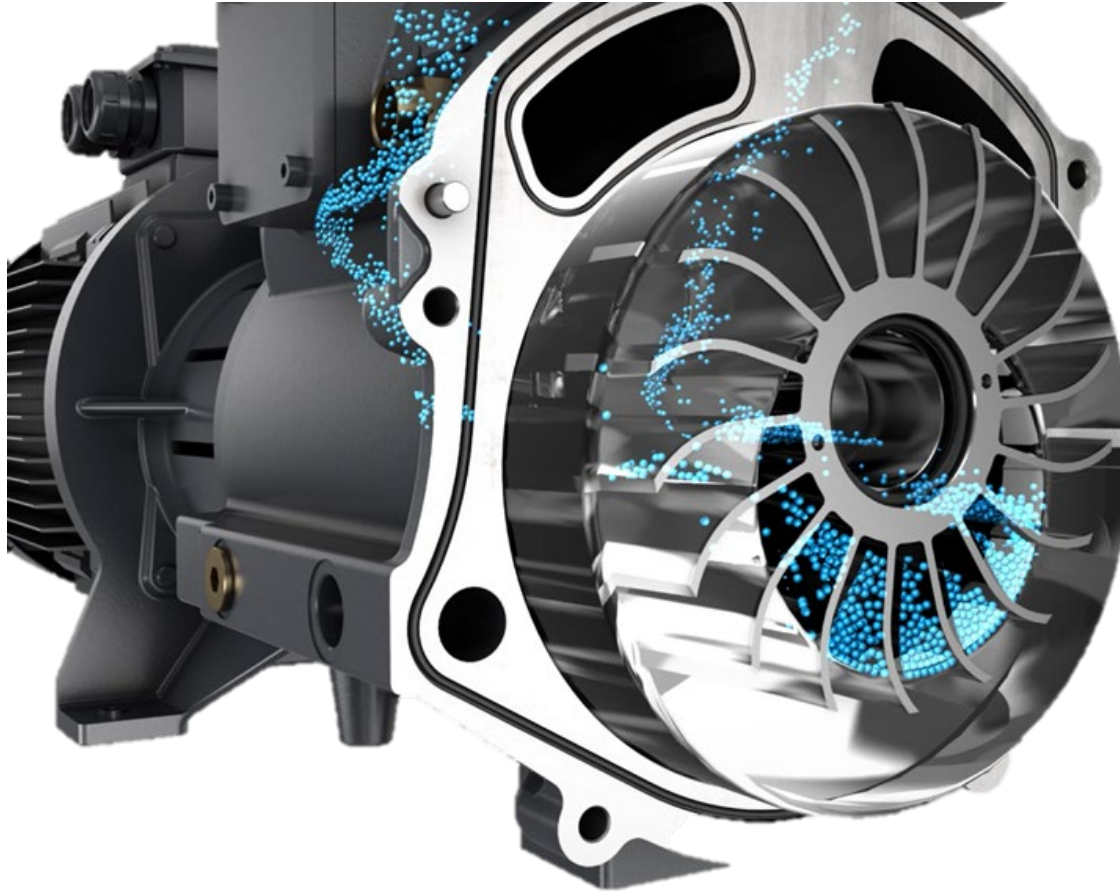
- The foam separator is the biggest part of the investment!
- It is important to clarify the environmental conditions in advance.
 - It is advisable to install the pumps in protected room or make sure correct procedures are in place.





LRP VSD+ solution

Innovative Liquid Ring pump as an enabler for water savings



LRP VSD+ solution

How do we tackle the foam issue ?

- The amount of foam in the operating liquid must be kept under control
- The operating liquid on the intake side is kept free of foam by punctual fresh water injection
 - This is realised by the intelligent pump control. Thus, only as much fresh water is needed as is required to efficiently maintain the sealing liquid
- Even greater water savings can be achieved by installing a foam separator upstream →



Trade-off between investment costs and TCO



LRP VSD+ solution

For the beer bottling industry some extra features are developed

- SS Equipped variant
 - SS 316 element now available
 - PTFE Lip seals
 - Resistant against CIP solutions
- Level sensor update:
 - Impedance spectroscopy measuring principle
 - Reliable suppression of deposits or foam detection.
 - Fitted on LRP VSD+ as standard – January 2022 as replacement for the old level tube sensor
- Integrated controller and VSD :
 - Allows automated flushing cycles (>80% water saving)
 - VSD control grants energy savings



DZS200 VSD+ solution with foam separator

Key selling points

- Zero water consumption
- Energy saving up to 30%
- Smart and easy control system
- Low maintenance costs

Points to consider

- Contamination is very problematic because it cooks on the rotors
 - In line flushing may be required but requires controller
 - Need of demister in the separator
- Separator and controller may boost the investment!



ACV Solution for beer industry

Comparative table

Existing LRP solution

- Speed
 - Typ. 700 m3/h (412 cfm)
- Power consumption
 - 22 kW (30Hp)
- Water consumption
 - 3 m3/h (14 gpm)
- Water cooling
 - Included above
- Foam separator
 - No
- P control
 - No

LRP900 VSD+ solution

- Speed
 - Up to 700 m3/h (412 cfm)
- Power consumption
 - Up to 25 kW (33Hp)
- Water consumption
 - 0,2/0,5 m3/h (1,4 gpm)
- Water cooling
 - 2,5 m3/h (clean circuit)
- Foam separator
 - No
- P control
 - Yes

GHS900 VSD+ solution

- Speed
 - Up to 800 m3/h (470 cfm)
- Power consumption
 - Up to 15 kW (20Hp)
- Water consumption
 - Zero
- Water cooling
 - zero (Air cooled)
- Foam separator
 - Yes
- P control
 - Yes

DZS200 VSD+ solution

- Speed
 - Up to 200 m3/h (470 cfm)
- Power consumption
 - Up to 5,5 kW (7Hp)
- Water consumption
 - Zero
- Water cooling
 - zero (Air cooled)
- Foam separator
 - Yes
- P control
 - Yes

Competitors outlook

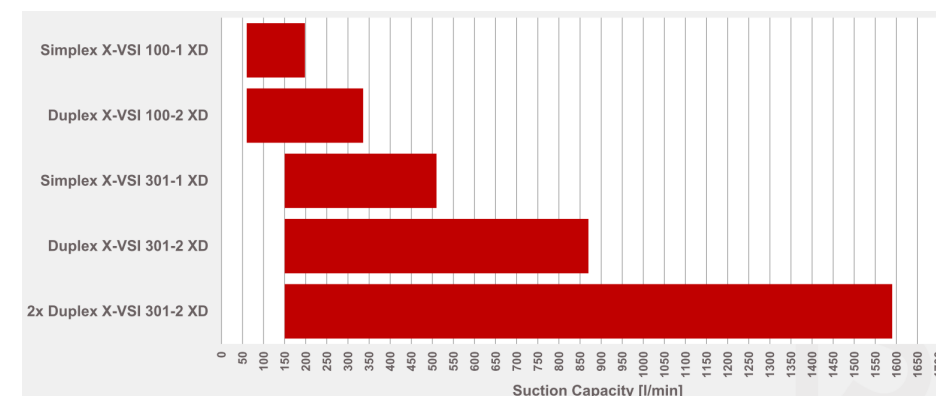
Gardner Denver dry screw proposition

- GD is our strongest competitor due to their brand position in beer industry.
- Developing global dry strategy through Elmo Rietschle brand based on:
 - Zero water consumption
 - 50% energy saving
 - Improved process control (CO2 savings)
- Known two pilot installations with different layouts.
- Has decided Global approach to large corporations (ABInbev) with “configured package” modular approach based on:
 - VSI 100 or VSI 300 dry screw pump air cooled
 - Standard separator design with drain tank, pneumatic valves, level sensors/switches, air flush and CIP flush.
 - Control box for all logic functions of pumps and separator

First pilot installation in Brazil



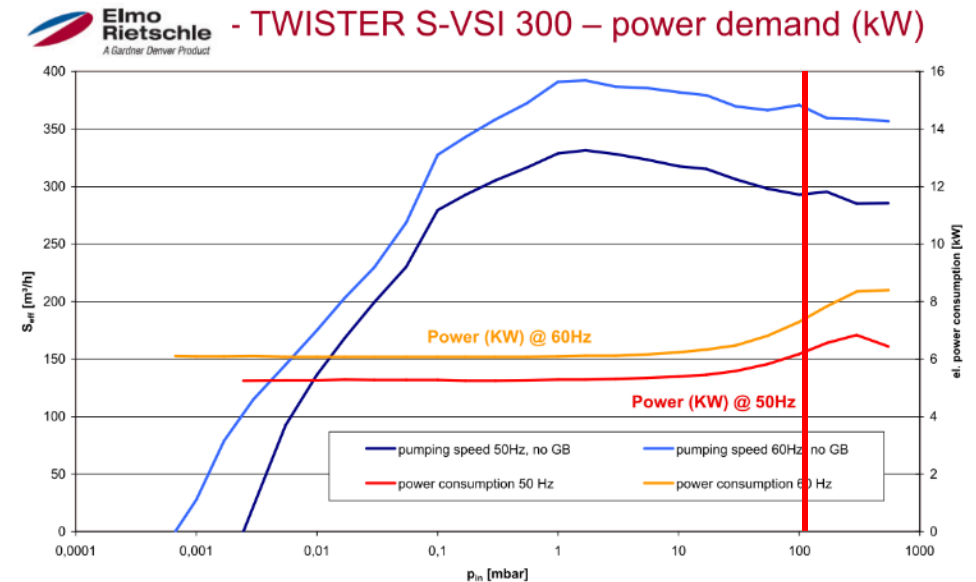
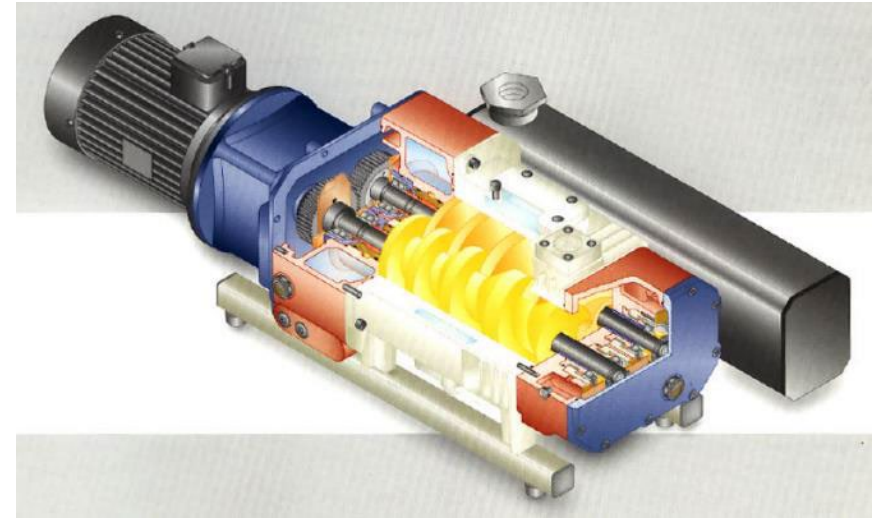
Second pilot installation Belgium



Competitors outlook

Disadvantages of dry solution

- Pump runs very hot (exhaust gas temp > 200°C)
 - Operation of air blast cooler is critical (maintenance required)
 - Any carry over cooks on the rotors (requires flush cycles)
 - Shorter lifetime of seals and bearing (compare real service costs)
- Real speed is 295 m³/h at working point with 6,5 kW power
 - Peak speed 2x < 600 m³/h @ 50hz (GHS can cover up to 780 m³/h)
 - SER for 590 m³/h is 22 W/m³ (GHS is 19,7)
- Separator requires demister to stop any mist/foam carry over
 - More maintenance requirement
 - Contamination = performance losses
- Can only be competitive with a «pre packaged» solution



Competitors outlook

Disadvantages of dry solution

- According to this Service flier found in the web they can offer:
 - 4 years full service plan @ 10.700 € per pump
 - All service interventions included
 - All consumables included
 - All spares included
 - Exchange pump available in 24h (to be check if this is in every country)

Interesting plan for a pump sold virtually 0 maintenance.

Trouth is that with 4 years pump requires ovehaul:

- Cost around 5k €
- Pump needs to be removed and sent to Service center
- Back up unit mandatory

Customer experience beer indusstry -> unsustainable running costs.

Garantiamo il completo controllo dei costi
per 4 anni – con il pacchetto di assistenza **FLAIR** opzionale

1° e 2° anno	3° anno	4° anno	Offerta "tutto compreso"
Costo della macchina comprensivo di assistenza e manutenzione	Pacchetto di assistenza opzionale	Pacchetto di assistenza opzionale	Offerta in 4 anni – senza nessun costo ulteriore!
Versione per ossigeno € 10.400	Versione per ossigeno € 1.500	Versione per ossigeno € 1.950	Versione per ossigeno € 13.850
Versione senza ossigeno € 7.950	Versione senza ossigeno € 1.200	Versione senza ossigeno € 1.550	Versione senza ossigeno € 10.700

Il prezzo del pacchetto per una pompa per vuoto a vite comprende per i primi due anni:

- Tutti gli interventi di manutenzione e riparazione
- Tutti i pezzi di ricambio
- Tutti i componenti usurabili e a consumo
- Tutti i tempi di trasferta e di intervento
- Pompa di ricambio disponibile entro 24 ore

FLAIR
è il nostro pacchetto di assistenza opzionale e comprende

- Tutti gli interventi di manutenzione necessari
- Tutti i componenti usurabili e a consumo
- Nessun costo aggiuntivo per riparazioni o per interventi di assistenza
- Pompa di ricambio disponibile in 24 ore (compresi i costi di trasporto)

Se decidete di approfittare dell'offerta "tutto compreso", avrete il controllo totale dei costi del ciclo di vita della vostra pompa per vuoto.

Considerando un numero di ore di funzionamento medio, i costi totali per la tecnologia a valvola rotativa in applicazioni con ossigeno ammontano a circa 29.000 €!

Costo del ciclo di vita per la tecnologia a valvola rotativa con lubrificazione a olio oxy 29.000 €

Costo del ciclo di vita per generatori di vuoto con tecnologia

Success stories LRP VSD+

Two installations running and one in start up

- 1 x LRP VSD+
 - Brewery in **Egypt** – bottle filling – in 2019
- 1 x LRP VSD+
 - **Moscow** Brewery – bottle filling – in 2020
- 1 x LRP VSD+
 - Haacht Brewery **Belgium** – bottle filling – in 2021

Keys to success

- What were the customer pain points
 - Water consumption / no control / fixed speed
- Who was the decision maker
 - Production manager
- How did we convince & close
 - Comparisons and showing the added value



Success Story 1 GHS VSD+

The Modelo group in Mexico (ABInbev) Zacatecas plant Mexico

- SIDEL make Eurostar Bottle filler machines x 20 nos
- 33.000 bph top capacity each machine
- 30 HP two stages LRVP pump with each filler machine
- Three sizes of bottle with different styles of beer.
 - “Caguama” is a 1lt bottle which requires a deeper vacuum level of 40mbar(a). This is the one that has given us more foam issues.
 - “Mega” is a 1.2Lt bottle that is being filled successfully with 150mbar(a).
 - The smaller 350ml bottles are being filled successfully with 285mbar(a).
- **KEY driver for the project → Water reduction of the plant**



Success Story 1 GHS VSD+

The Modelo group in Mexico (ABInbev) Zacatecas plant Mexico

- GHS900 VSD+ with inlet foam filter and liquid trap
- Auto-drain with onboard programmable functions
- Installation support, set up and monthly visits to inspect
- 0 water emissions vs. approximately 15gpm water consumption from the liquid ring units
- <26BHP depending on the pressure setpoint and speed
- Vacuum system all in one box with controller, pressure control, speed variation and self protecting features vs. “dumb” pump
- Ability to interface with central control and offer the maintenance team information
- Atlas Copco brand and support



Success Story 2 GHS VSD+

Widmer Brothers Brewery in Portland, Oregon



Link: <https://www.blowervacuumbestpractices.com/system-assessments/vacuum-systems/engineered-vacuum-solution-saves-oregon-brewer-5000-gallons-water->

Thank you



Atlas Copco

The logo consists of the brand name 'Atlas Copco' in a white, italicized serif font, centered between two horizontal white bars.