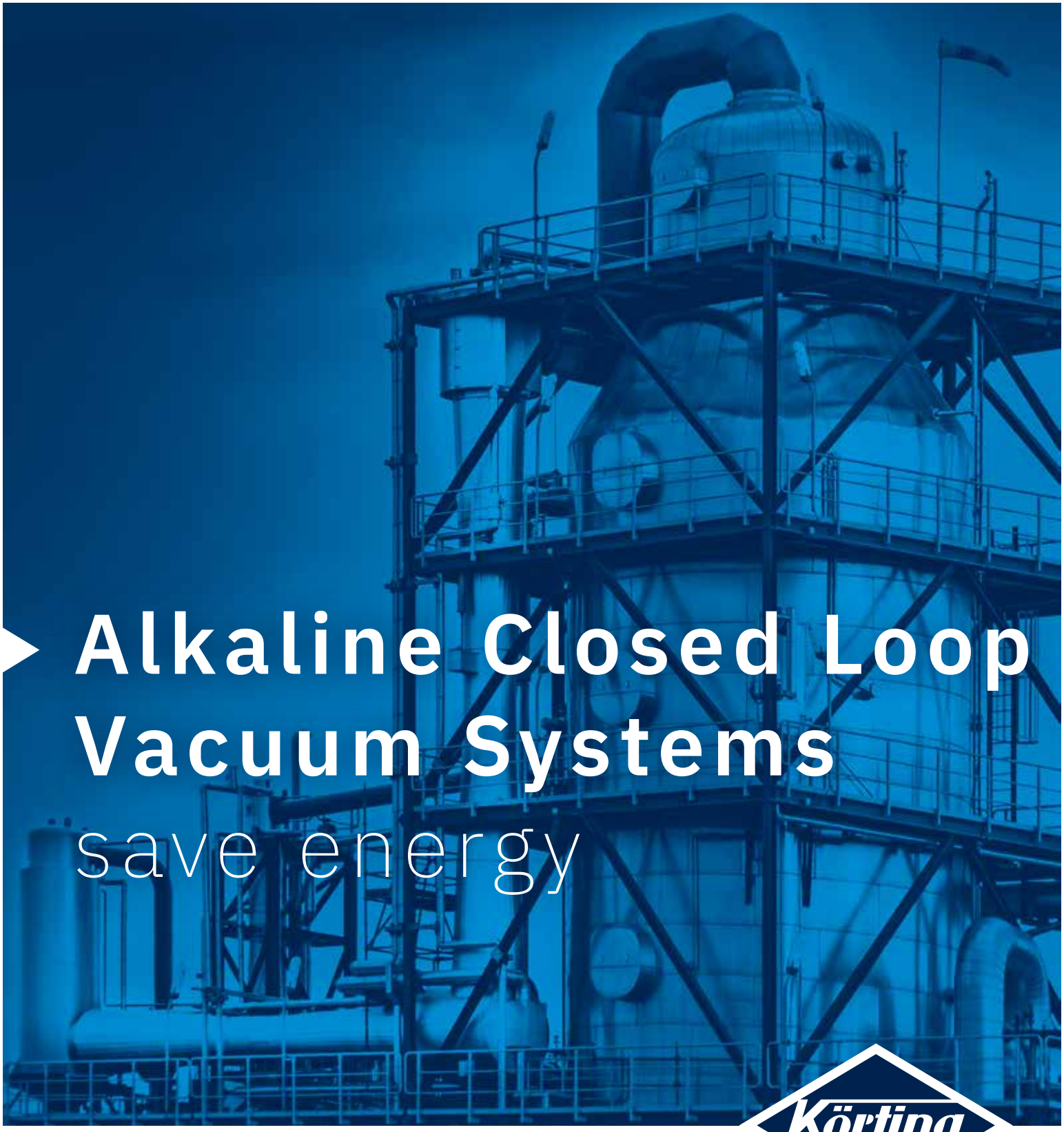


Alkaline Closed Loop Vacuum Systems

save energy

Körting

THE EJECTOR COMPANY

Körting multi stage vacuum systems

for edible oil applications

Körting multi-stage steam jet vacuum systems operating in an Alkaline Closed Loop (ACL)

Multi-stage steam jet vacuum systems are an integral part of a plant. They play a key role in the quality of edible oil, biodiesel and oleochemical applications. These types of vacuum systems can easily handle large mass flows in combination with a low absolute process pressure.

They consist of steam jet boosters with downstream condensers where most of the condensable vapours are liquefied. The subsequent ejector stage only has to compress the non-condensable wet gases, which minimises total motive steam consumption.

Körting Hannover wanted to improve efficiency and performance, it took conventional multi-stage vacuum systems, which are reliable and have a good track record. Then it developed them to make Alkaline Cosed Loop (ACL) vacuum systems. These systems tap into new opportunities to boost sustainability, minimise the environmental impact and, ultimately, save running costs.

Particularly where cooling water is expensive or not available in sufficient quantities, the ACL vacuum system reduces fresh and waste water requirements.

The cooling water in the mixing condensers now circulates within a closed loop. The energy added to the closed loop by the motive- and suction vapour flows is removed via heat exchangers. Furthermore, a special buffer vessel (fat separator) is part of the closed loop to separate out and discharge fatty components. The pH-value of the closed loop water normally decreases and is kept at a neutral level via a pH-control unit to saponify fatty acids. This prevents fouling inside the heat exchangers.

The installation of a chilling unit in the ACL vacuum system generates low cooling water temperatures the condensers. This reduces motive steam consumption and cooling energy drastically and paves the way for a more environmentally-friendly operation.

Save money, minimise effluent and prevent odour by using ACL vacuum systems!

KEY BENEFITS OF KÖRTING ACL SYSTEMS

- Conventional and reliable vacuum technology
- Low maintenance
- Clean cooling tower (no maintenance and cleaning works due to absence of fatty acids in the cooling tower)
- Environmentally and governmental restrictions are observed
- No risk of pollution in the condensers (safe and reliable operation)
- Nearly no air pollution
- Reducing waste water
- Low operation costs by minimizing motive steam consumption and cooling water flow (by chilled water operation)
- Flexible design of the vacuum system

1) Buffer/separator vessel in a Körting ACL cold vacuum system
2) Plate heat exchangers in a Körting ACL cold vacuum system

ALKALINE CLOSED LOOP VACUUM SYSTEM WITH CLEAN COOLING TOWER (ACL WARM)

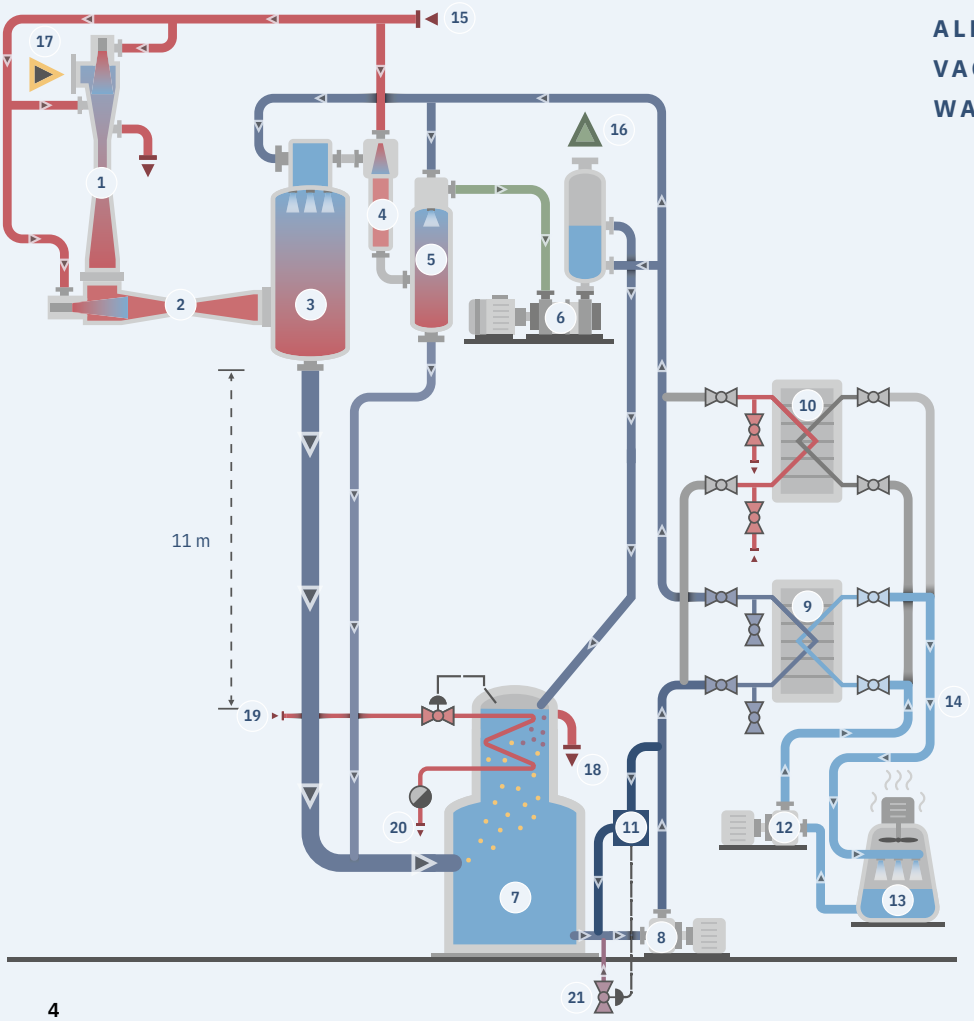
In the past, multi-stage steam jet vacuum systems with an open cooling tower were state of the art. Environmental aspects like air and water pollution and the need to save on running costs resulted in the alkaline closed loop vacuum system.

The vacuum system usually consists of two steam jet boosters (connected in series), a main mixing condenser, an air evacuation ejector as well as a mixing condenser and a liquid ring vacuum pump or an ejector as the final stage.

The ACL warm vacuum system operates in a closed loop in which the circulation water required for the mixing condensers and the liquid ring vacuum pump are cooled down by two plate heat exchangers (one in operation, one on stand-by).

From time to time, the plate heat exchangers need to be cleaned without any disruption to the main process. In order to prevent the circulation water from being polluted, the vacuum system includes a sealed separator vessel.

Furthermore, a pH-control unit neutralises the circulation water and prevents fouling of the plate heat exchangers.

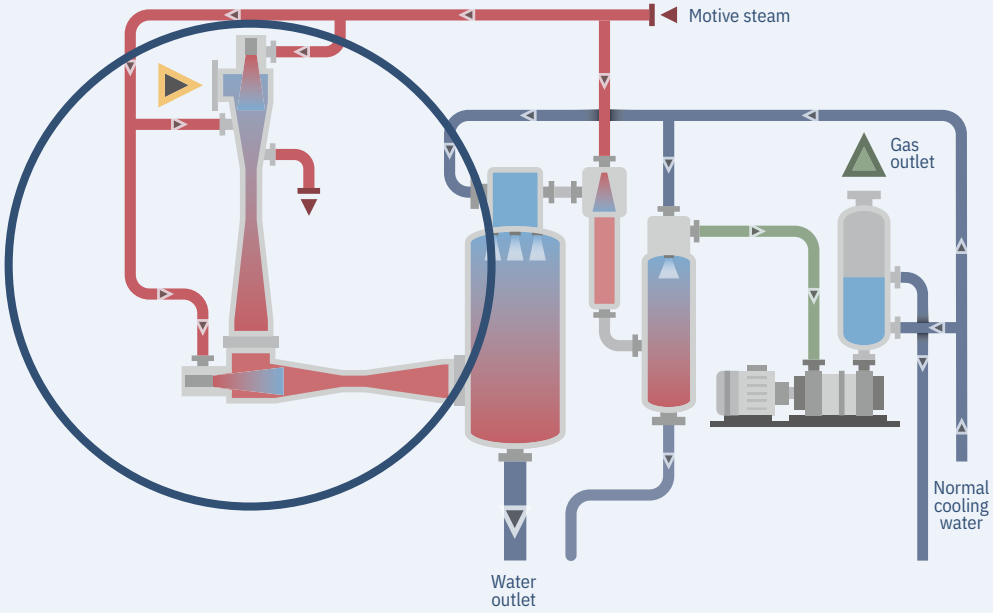


ALKALINE CLOSED LOOP VACUUM SYSTEM WITH COOLING WATER OPERATION (ACL WARM)

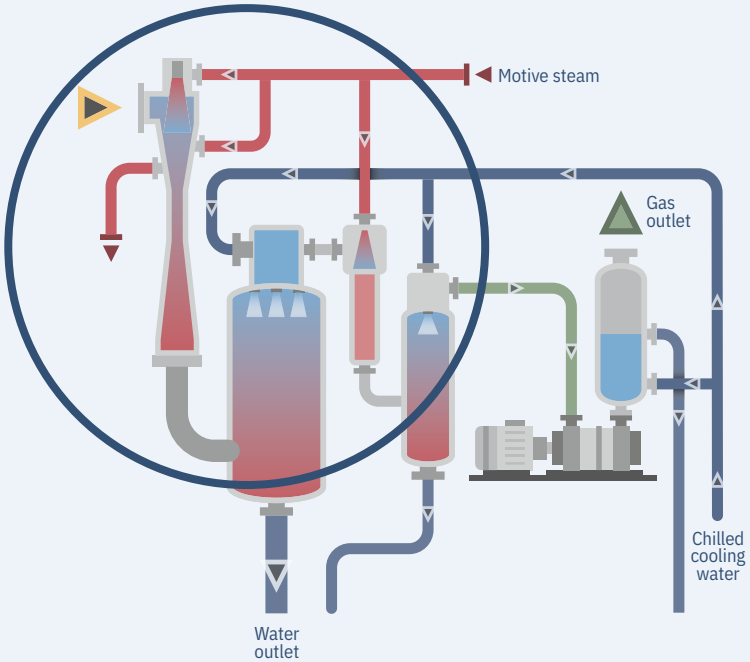
1 Booster (stage 1)
2 Booster (stage 2)
3 Main mixing condenser
4 Ejector (stage 3)
5 Interconnected mixing condenser
6 Liquid ring vacuum pump (stage 4)
7 Buffer/separator vessel
8 Circulation pump
9 Plate heat exchanger (in operation)
10 Plate heat exchanger (on standby)
11 pH-control unit
12 Cooling tower pump
13 Cooling tower
14 Cooling water
15 Motive steam
16 Gas outlet (liquid ring vacuum pump)
17 Stripping steam from deodoriser
18 Overflow of contaminated liquid
19 Heating steam
20 Condensate
21 Caustic soda (NaOH)

Less steam consumption thanks to chilled water

The coolant and its temperature play a pivotal role in the design, in other words, total consumption and the number of stages the steam jet vacuum system has. Importantly, more than 80% of the total motive steam consumption is used for the boosters upstream from the main condenser because compression from the process vacuum to a condensing state is high. If this compression ratio is lowered by using chilled cooling water, only one booster stage is needed upstream of the main condenser. The vacuum system changes from a 4-stage to a 3-stage system and uses substantially less motive steam.



4-STAGE STEAM JET VACUUM SYSTEM WITH TWO BOOSTERS CONNECTED IN SERIES UPSTREAM OF THE MAIN CONDENSER

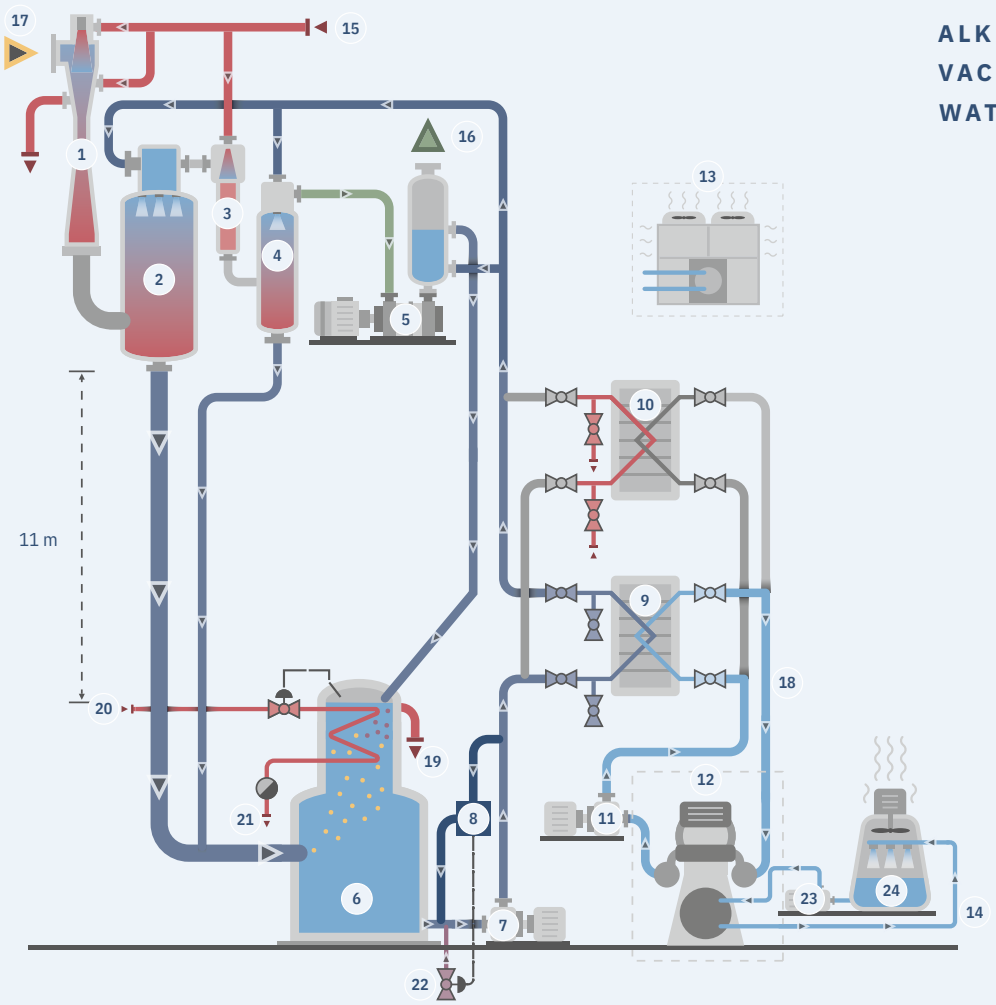


3-STAGE STEAM JET VACUUM SYSTEM WITH ONLY ONE BOOSTER UPSTREAM OF THE MAIN CONDENSER

ALKALINE CLOSED LOOP VACUUM SYSTEM (ACL) WITH CLEAN COOLING TOWER USING CHILLED WATER (ACL COLD)

Environmental regulations plus financial and sustainability factors are the key reasons for developing the ACL cold vacuum system.

This vacuum system usually consists of three compression stages e.g. one booster (stage 1), a main mixing condenser, an interconnected air evacuation ejector (stage 2) with a mixing condenser and a liquid ring vacuum pump (stage 3) as the final stage. The system comprises a sealed separator vessel, two plate heat exchangers, a pH-control unit, a circulation pump and a chilling circuit. The chilling circuit mainly consists of a brine pump, compressor and cooling medium. The chilling unit cools the closed loop water to a supply temperature of 5 to 10°C. The main mixing condenser now operates at 13 to 20 mbar instead of 50 to 70 mbar when normal cooling water is used. Due to the reduced compression ratio, the vacuum system can operate with one booster. The closed loop water is cooled via the plate heat exchangers (one in operation, one on stand-by). The chilling unit itself is cooled by cooling tower water or ambient air. The plate heat exchangers are cleaned regularly without interrupting the main process. The separator vessel separates fatty material from the closed loop water. A pH-control unit keeps the water neutral by adding caustic soda solution (NaOH) to reduce fouling.



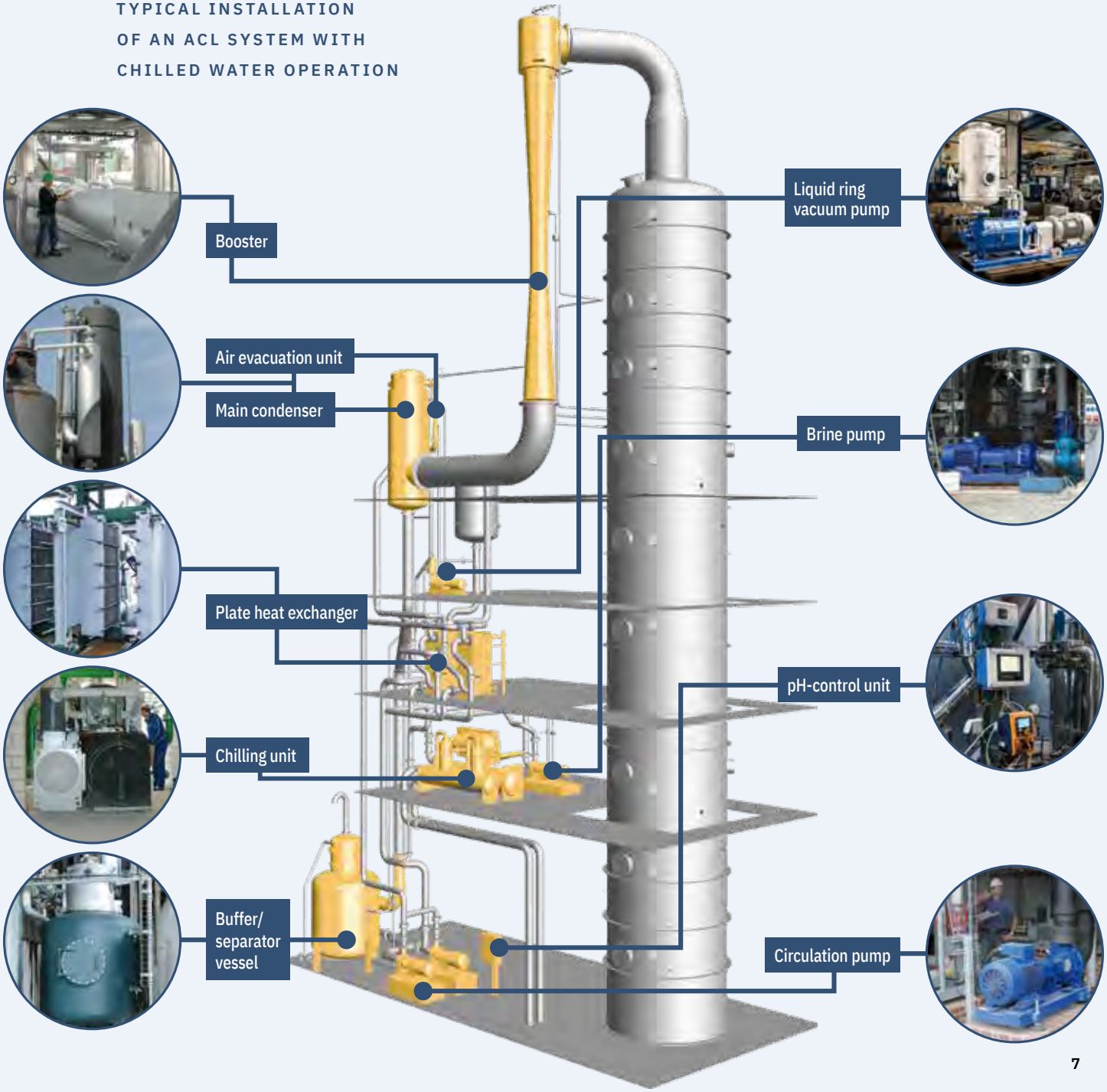
ALKALINE CLOSED LOOP VACUUM SYSTEM WITH CHILLED WATER OPERATION (ACL COLD)

1 Booster (stage 1)
2 Main mixing condenser
3 Ejector (stage 2)
4 Interconnected condenser
5 Liquid ring vacuum pump (stage 3)
6 Buffer/separator vessel
7 Circulation pump
8 pH-control unit
9 Plate heat exchanger (in operation)
10 Plate heat exchanger (on standby)
11 Brine pump
12 Coolant compressor (chiller) water cooled
13 Coolant compressor (chiller) air cooled
14 Cooling water
15 Motive steam
16 Gas outlet
17 Stripping steam from deodoriser
18 Brine cycle
19 Overflow of contaminated liquid
20 Heating steam
21 Condensate
22 Caustic soda (NaOH)
23 Cooling tower pump
24 Cooling tower

DESIGNING A VACUUM SYSTEM IN AN ALKALINE CLOSED LOOP OPERATING WITH CHILLED WATER (ACL COLD)

An ideal installation of a 3-stage ACL vacuum system is shown below. The booster stage 1 is located at the highest level in any position. The main condenser is placed at barometric level (> 11 m) above the separator vessel. The leg pipes are directly connected to the separator vessel. The liquid ring vacuum pump is placed anywhere above the separator vessel. The plate heat exchangers are to be installed in a maintenance-friendly way. The separator vessel, custom designed by Körting for its reliable operation and good separation is located on the base level below the main condenser. The heating section and discharge nozzle for condensate and fatty matter are located at the head of vessel. The circulation pump and the pH-control unit are nearby. The caustic soda dosing system and pH measurement unit are integrated in the closed loop.

TYPICAL INSTALLATION OF AN ACL SYSTEM WITH CHILLED WATER OPERATION



Körting Alkaline Closed Loop (ACL) vacuum systems save money!

Cost-effectiveness is a crucial factor to consider when choosing a vacuum system. Alongside the system's size and efficiency, striking the right balance between operating and investment costs is the key. Rising prices of raw materials and utilities, including steam, water, and electricity, are important considerations when assessing a vacuum system. Choose Korting Hannover's Alkaline Closed Loop vacuum systems to save costs and obtain a top-notch solution for refining or deodorising edible oil processes.

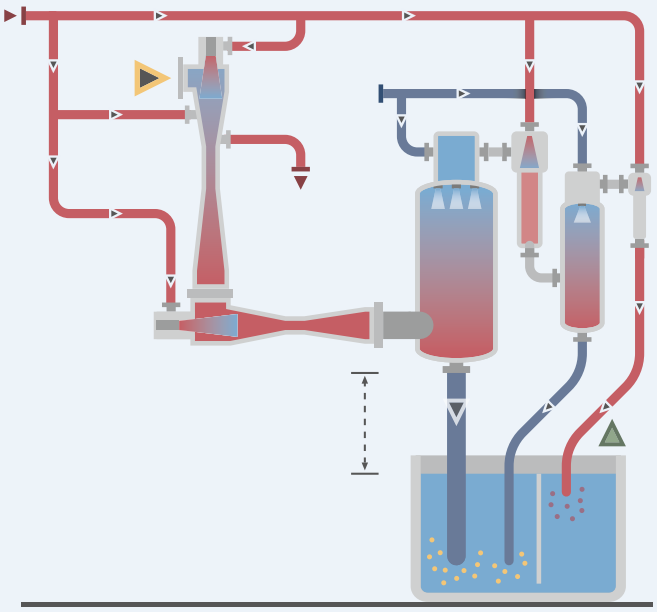
See how much you can save for yourself.

FIGURES COMPARING DIFFERENT VACUUM SYSTEMS

		1) Conventional multi-stage ejector vacuum system with mixing condensers	2) Alkaline Closed Loop vacuum system (chilled water operation) (ACL cold)	3) Alkaline Closed Loop vacuum system (cooling water operation) (ACL warm)	4) Vacuum system operating with a surface condenser
Design parameters					
suction flow: water vapour + 10 air + 4 FFA (kg/h)		250	250	250	250
suction pressure (mbar)		1.5	1.5	1.5	1.5
suction flow temperature (°C)		80	80	80	80
cooling water inlet temperature: 30°C • motive steam pressure: 10 bar (abs) • wet bulb temperature: 21°C					
Motive steam					
total motive steam consumption (kg/h)		2066	676	2 380	3 000
Cooling water		polluted	clean	clean	clean
total cooling water consumption (m³/h)		280*	212	395	459
Electricity (kW)					
chilling unit			175	0	0
liquid ring vacuum pump			7	4	8
centrifugal pumps		0	31	38	2
total electricity consumption (kW)		0	213	42	10
caustic soda 25% (kg/h)		0	3	3	3
Waste water**					
total waste water quantity (m³/h)		2.320	0.933	2.637	3.257
operational hours per year		8 250	8 250	8 250	8 250
steam costs per year	30 euro/t	511 335	167 310	589 050	742 500
re-cooling costs for the cooling water per year	0.1 euro/m³	369 600	174 900	325 875	378 675
electricity costs per year	0.1 euro/kWh	41 250	175 725	34 650	8 250
caustic soda costs 25%	0.25 euro/kg	0	6 188	6 188	6 188
Operational costs (euros/year)		922 185	524 123	955 763	1 135 613
savings compared to OKO system (euro)		213 428	611 490	179 850	
equipment price (euro)		130 000	430 000	380 000	340 000
additional costs compared to OKO system (euro)		- 210 000	90 000	40 000	
savings after 1 year (euro)		423 428	521 490	139 850	
savings after 2 years (euro)		636 856	1 132 980	319 700	
savings after 3 years (euro)		850 284	1 744 470	499 550	

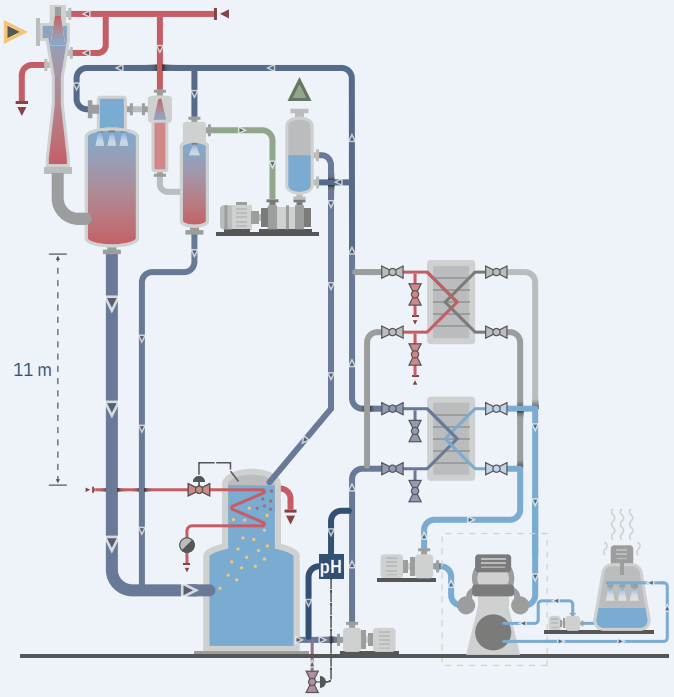
* Fresh water for the evaporative condenser is included.
** Waste water costs are excluded. Should be taken into account in each case.

1. CONVENTIONAL MULTI-STAGE EJECTOR VACUUM SYSTEM WITH MIXING CONDENSERS



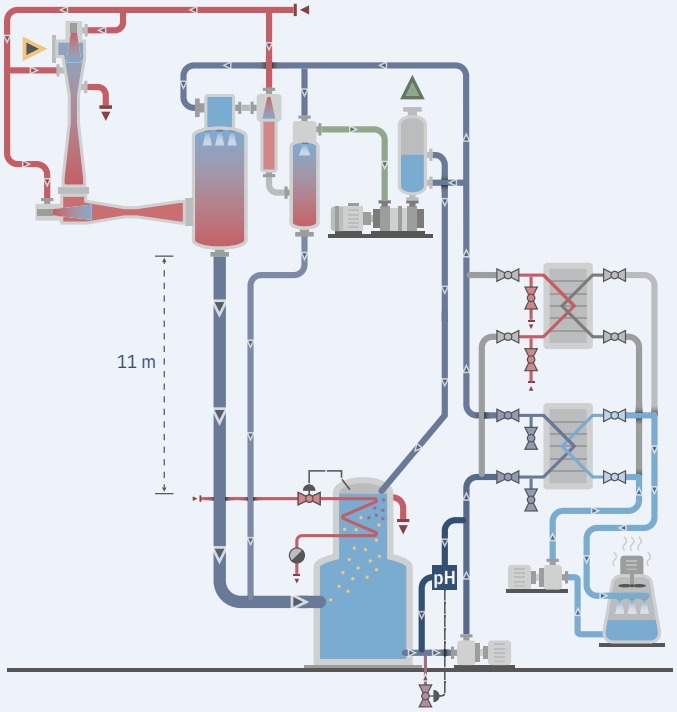
total motive steam consumption	2 066 kg/h
total cooling water consumption	280 m³/h
total electricity consumption	0 kW
total waste water quantity	2,32 m³/h

2. ALKALINE CLOSED LOOP VACUUM SYSTEM WITH CHILLED WATER OPERATION (ACL COLD)



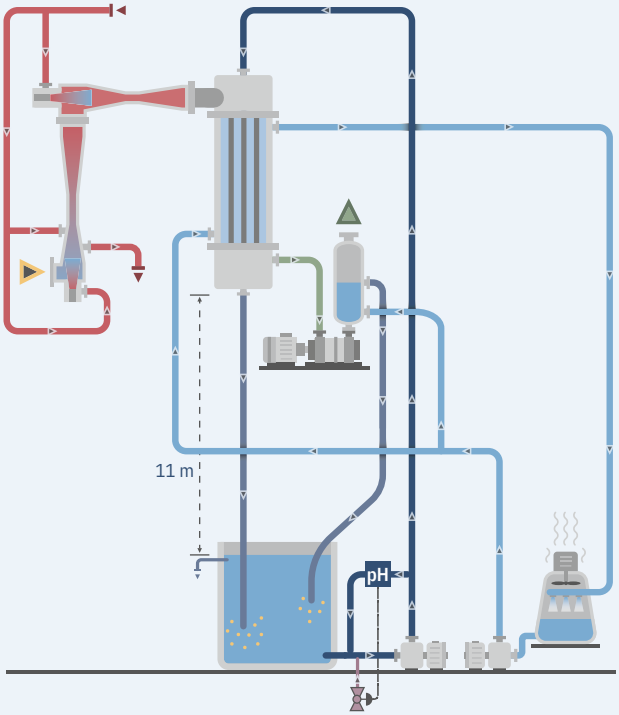
total motive steam consumption	676 kg/h
total cooling water consumption	212 m³/h
total electricity consumption	213 kW
total waste water quantity	0.933 m³/h

3. ALKALINE CLOSED LOOP VACUUM SYSTEM WITH COOLING WATER OPERATION (ACL WARM)



total motive steam consumption	2 380 kg/h
total cooling water consumption	395 m³/h
total electricity consumption	42 kW
total waste water quantity	2.637 m³/h

4. VACUUM SYSTEM OPERATING WITH SURFACE CONDENSER



total motive steam consumption	3 000 kg/h
total cooling water consumption	459 m³/h
total electricity consumption	10 kW
total waste water quantity	3.257 m³/h

Reference projects

Körting have been supplying Alkaline Closed Loop vacuum systems for more than 30 years. They have been installed all over the world.

For more information about the projects we've implemented worldwide please ask for our list of reference projects by contacting:
sales@koerting.de | +49 511 2129 - 306

Examples of Körting ACL cold vacuum systems installed

MAIN BENEFITS OF ALKALINE CLOSED LOOP SYSTEMS (ACL) USING CHILLED WATER

- **Substantial cost savings**
- **Motive steam reduction up to 75%**
- **Low energy requirements**
- **Minimal waste water**
- **Reliable operation due to two-plate heat exchangers (one in operation, one on standby)**
- **High efficiency due to the mixing (direct contact) condensers**
- **Clean cooling tower, no air pollution and odours prevented**
- **Low maintenance**
- **Statutory operational regulations e.g. for waste water and odours are met**

For more information about these systems go to **koerting.de/en/ACL-vacuum-systems.html**

HOW ACL SYSTEMS MEET ENVIRONMENTAL REGULATIONS

Vacuum systems in all countries and regions worldwide must comply with an increasing number of environmental regulations. The alkaline closed loop vacuum system is ideal in terms of compliance with these regulations. The closed loop means that neither odours nor polluted cooling water occur. To reduce your carbon footprint, the combination with chilled water enables enormous energy savings.

For even higher environmental demands and for further reduction of operating costs an alternative might be the Körting ICE Condensation Vacuum System: **koerting.de/en/ice-condensation-systems.html**

Körting Hannover GmbH
Badenstedter Str. 56
30453 Hannover | Germany

+49 511 2129 - 306
sales@koerting.de

KOERTING.DE

221-ACL-EN-250214