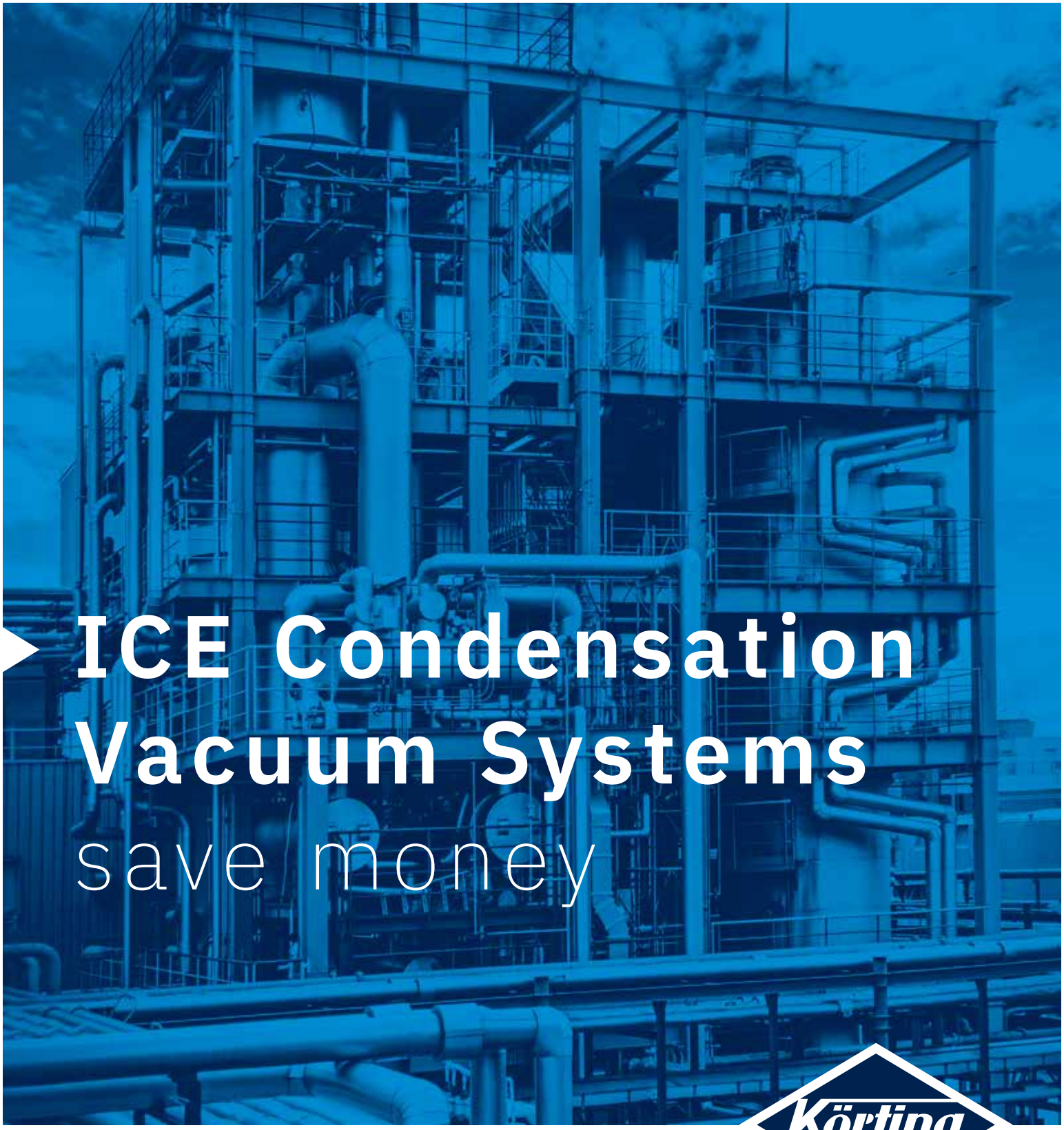
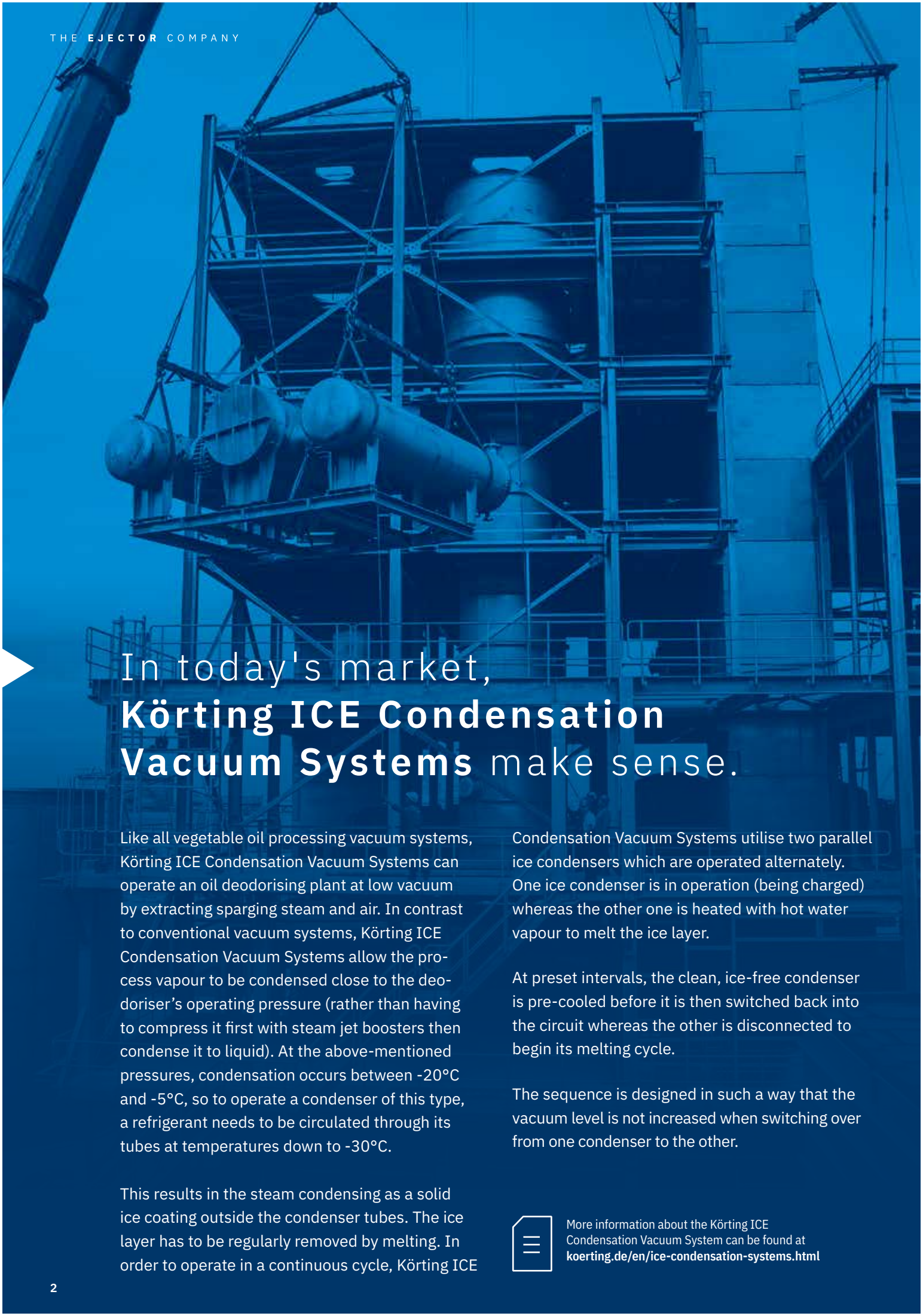


ICE Condensation Vacuum Systems save money

THE EJECTOR COMPANY

Körting ICE Condensation Vacuum Systems

for edible oil applications



In today's market, **Körting ICE Condensation Vacuum Systems** make sense.

Like all vegetable oil processing vacuum systems, Körting ICE Condensation Vacuum Systems can operate an oil deodorising plant at low vacuum by extracting sparging steam and air. In contrast to conventional vacuum systems, Körting ICE Condensation Vacuum Systems allow the process vapour to be condensed close to the deodoriser's operating pressure (rather than having to compress it first with steam jet boosters then condense it to liquid). At the above-mentioned pressures, condensation occurs between -20°C and -5°C, so to operate a condenser of this type, a refrigerant needs to be circulated through its tubes at temperatures down to -30°C.

This results in the steam condensing as a solid ice coating outside the condenser tubes. The ice layer has to be regularly removed by melting. In order to operate in a continuous cycle, Körting ICE Condensation Vacuum Systems utilise two parallel ice condensers which are operated alternately. One ice condenser is in operation (being charged) whereas the other one is heated with hot water vapour to melt the ice layer.

At preset intervals, the clean, ice-free condenser is pre-cooled before it is then switched back into the circuit whereas the other is disconnected to begin its melting cycle.

The sequence is designed in such a way that the vacuum level is not increased when switching over from one condenser to the other.

More information about the Körting ICE Condensation Vacuum System can be found at **koerting.de/en/ice-condensation-systems.html**

Significant energy savings with virtually zero pollution

ADVANTAGES OF KÖRTING ICE CONDENSATION SYSTEMS

- first-class product quality due to optimum vacuums
- a reduction in the energy costs of the whole process (less motive steam needed)
- lower cooling water requirements
- much lower running costs compared with other vacuum systems
- eco-friendly operation (little waste air and waste water)
- high levels of reliability and availability
- easier cleaning and maintenance
- multi-purpose use for physical refining and deodorisation of all edible oils
- customisable design of the vacuum system

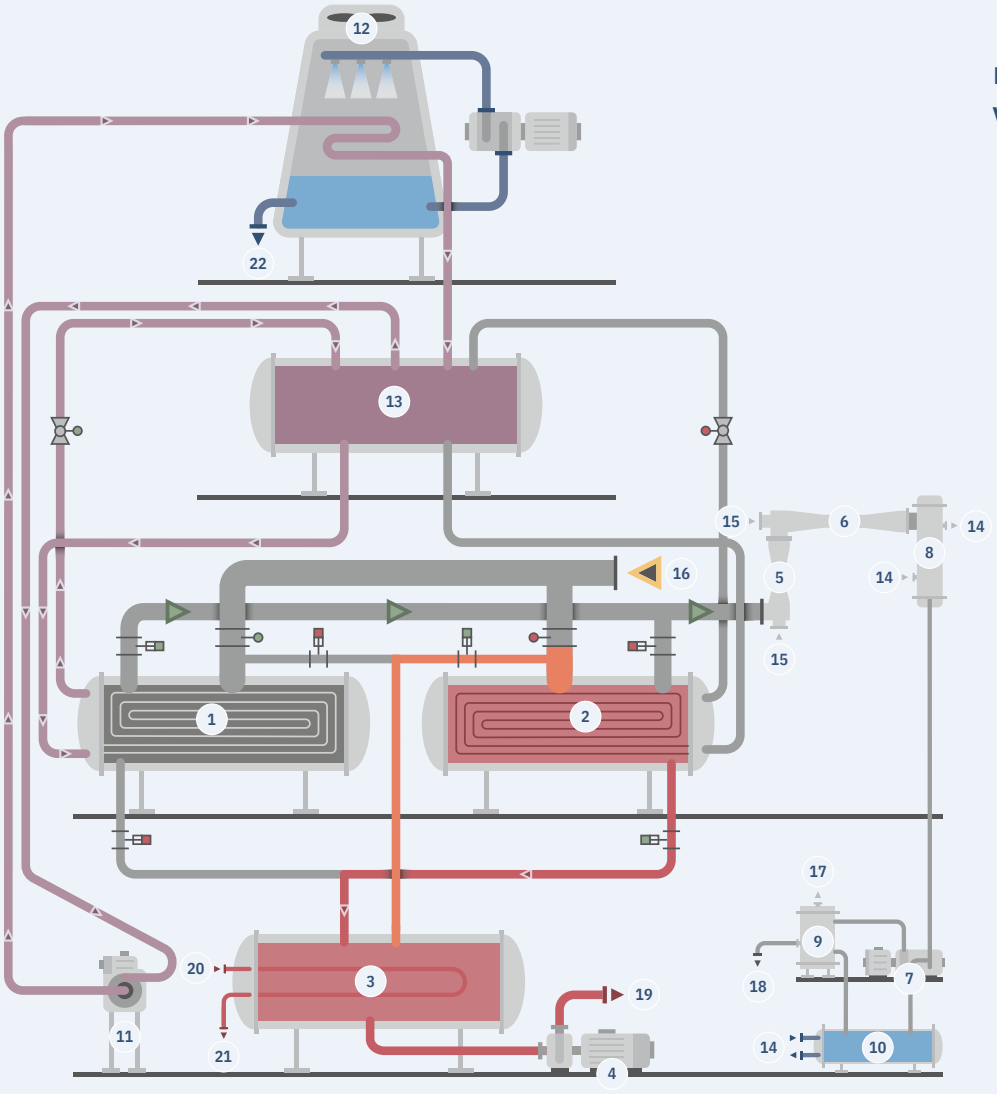
The original concept was proposed by G. B. Martinenghi (1964) but at that time the high capital cost of the system compared to conventional vacuum systems proved uneconomical.

Today, with increasing energy costs and rigorous environmental emission controls (waste water, air pollution), the ice condensation system is the most economical vacuum system for this application.

Körting ICE Condensation Vacuum Systems are based on many years of experience with a lot of installations world wide since 1988. It's computer controlled and designed to be both simple and reliable to operate.

Körting Ice condensation block fully assembled

How do Körting ICE Condensation Vacuum Systems work?



KÖRTING ICE CONDENSATION VACUUM SYSTEM

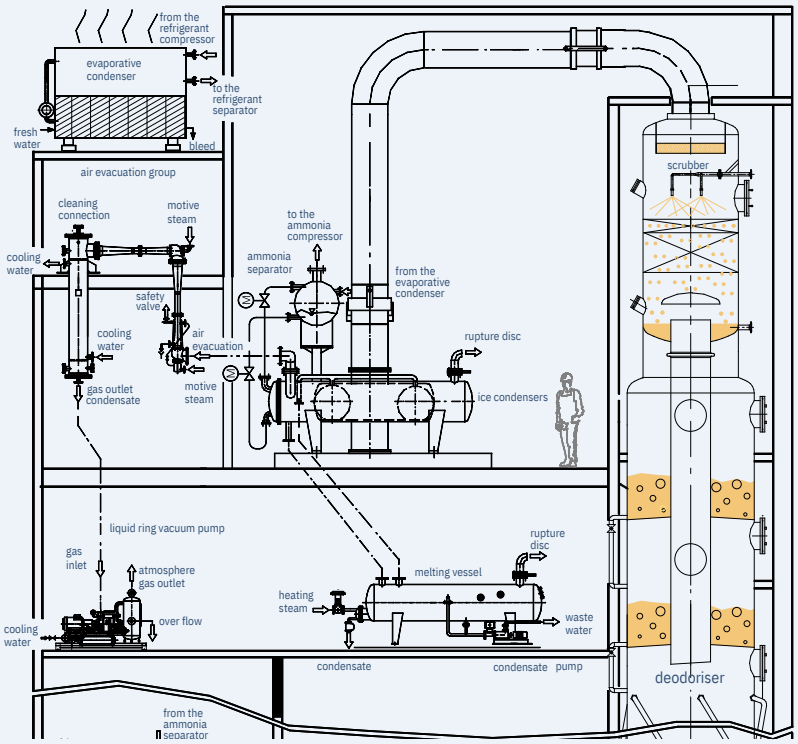
1 ice condenser I
2 ice condenser II
3 melting vessel
4 condensate pump
5 ejector stage 1
6 ejector stage 2
7 liquid ring vacuum pump
8 air evacuation condenser
9 separator (liquid ring vacuum pump)
10 re-cooler (liquid ring vacuum pump)
11 refrigerant compressor
12 air-cooled evaporative condenser
13 refrigerant separator
14 cooling water
15 motive steam
16 process flow
17 gas outlet (liquid ring vacuum pump)
18 overflow (liquid ring vacuum pump)
19 overflow (melting vessel)
20 heating steam (melting vessel)
21 condensate (melting vessel)
22 bleed air-cooled evaporative condenser

CONDENSING

The sparging steam from the deodoriser, polluted by fatty acids and other impurities and fatty substances, is alternately supplied to ice condenser A or B. High performance butterfly valves are used to isolate the ice condenser from the process during melting. The condenser being charged is kept at low temperature by circulating the refrigerant through the tubes and evaporated in the condenser tubes by absorbing the sparging steam's condensation heat. Typically, this process is regulated to produce surface temperatures of around -15°C to -25°C on the tubes.

This is below the condensation temperature of the sparging steam drawn from the deodoriser, so the steam and most of its impurities is condensed on the outside of the tubes as a coating of ice mixed with fatty crystals.

1) Typical installation of an ICE Condensation Vacuum System at an oil deodorising column
2) Front view of an ice condensation unit installed at site



1

2

MELTING

After a loading time which, according to the design, may be between one and two hours, the process flow is switched to the other ice condenser. The charged ice condenser (now with its cooling elements thoroughly coated with ice) is eparated from the deodoriser and heated to approx. 60°C to 80°C with vapour originating from the polluted condensate in the heated melting vessel. The molten ice, which is a mixture of water, oil and fatty substances, runs off the tubes and back into the melting vessel.

CONDENSATE DISCHARGE

The surplus liquid from the melting vessel, which contains most of the original sparging steam's impurities, is discharged from the melting vessel by a condensate pump.

STEAM JET EJECTORS

In order to evacuate all non-condensables from the ice condensers, a small 2-stage steam jet ejector vacuum group combined with a liquid ring vacuum pump is used. Cooling water for the interconnected small surface condenser as well as ejectors and the liquid ring vacuum pump will be kept clean. Only the small amount of condensate leaving the small surface condenser is slightly polluted and will leave the system via the liquid ring vacuum pump's separator. At this point, the exhaust gas from the process is also discharged into the atmosphere.

COOLANT REFRIGERATION

To minimise maintenance costs and ensure reliable operation, the Körting ICE Condensation Vacuum System operates with twin-shaft screw compressors (refrigerant compressor).

Why do Körting ICE Condensation Vacuum Systems produce virtually zero pollution?

Körting ICE Condensation Vacuum Systems produce virtually no pollutants. This is primarily because the cooling water is kept strictly separated from the polluted sparging steam's condensate.

As condensation takes place at low temperature and at the pressure level in the deodoriser, the melted condensate flowing from ice condenser A and B is undiluted. It's also highly concentrated (almost 100% of the high-boiling oil components, i.e. fatty acids, which are exhausted during deodorisation can be found in the condensate).

Only some low-boiling substances such as aldehydes and ketones are exhausted from the ice condensers by the steam jet ejectors together with the non-condensable gas.

The motive flow of the ejectors as well as the condensable parts of the suction flow are condensed in a downstream surface condenser. There is no contact with the cooling water.

For the atmospheric stage of the air evacuation unit, a liquid ring vacuum pump is used. To remove the condensation and compression heat, the service water (polluted with low-boiling oil substances) is passed through a heat exchanger in a closed loop so that no oil substances can enter the cooling water.

Non-condensable gases from the process and the leakage air, which enter the deodoriser, are polluted with low-boiling oil substances. This gas mixture is the only exhaust flow discharged from the unit by means of the liquid ring vacuum pump via the liquid separator. This exhaust gas can be treated by combustion in a steam boiler or in a biological filter plant.

For special applications mechanical vacuum pumps (roots blowers) can be used alternatively of the steam jet vacuum ejectors. However, the higher requirements for operation conditions and maintenace of the mechanical vacuum pumps have to be considered.

Two water ring pumps connected in parallel as the atmospheric stage for venting

A Körting ICE Condensation Vacuum System's melting vessel

Körting ICE Condensation Vacuum Systems save money

Efficiency governs the decision on which vacuum system to pick. In addition to the size and efficiency of the system, operating and investment costs also play an important role. Rising costs for utilities such as steam, water and electricity are factors that need to be taken into account when a system is assessed.

Körting Ice Condensation Vacuum Systems reduce costs. Which makes them the first choice for vacuum generation when edible oil is refined or deodorised.

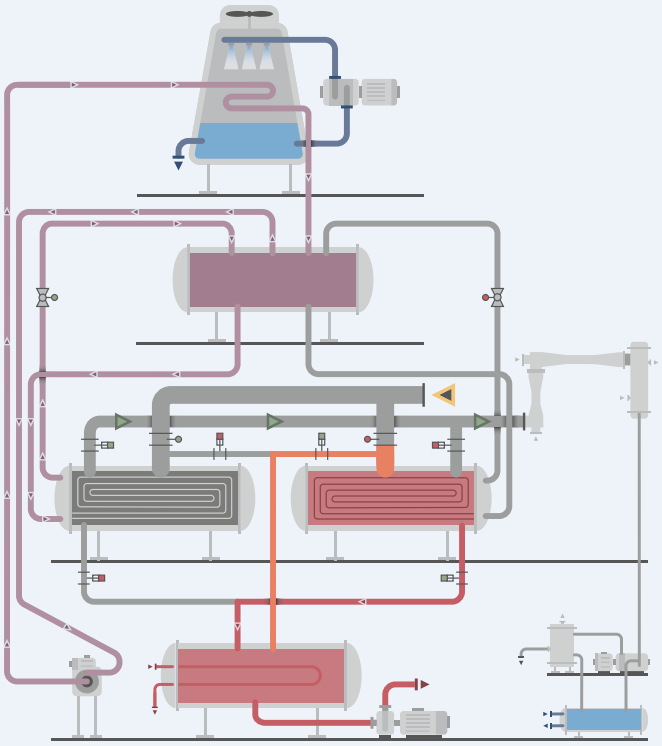
Compare the costs for yourself!

FIGURES COMPARING DIFFERENT VACUUM SYSTEMS

	1) Körting ICE Condensation Vacuum System (ICE)	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 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)	250	676	2 380	3 000
Cooling water				
total cooling water consumption (m³/h)	35*	212	395	459
Electrical power (kW)				
chilling unit	146	175	0	0
liquid ring vacuum pump	8	7	4	8
centrifugal pumps	0	31	38	2
total electricity consumption (kW)	154	213	42	10
caustic soda 25% (kg/h)	0	3	3	3
Waste water**				
total waste water amount (m³/h)	0.504	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	61 875	167 310	589 050	742 500
re-cooling costs for the cooling water per year 0.1 euro/m³	28 875	174 900	325 875	378 675
electricity costs per year 0.1 euro/kWh	127 050	175 725	34 650	8 250
caustic soda costs 25% 0.25 euro/kg	0	6 188	6 188	6 188
Operation costs (Euro/year)	217 800	524 123	955 763	1 135 613
savings compared to OKO system (euro)	917 813	611 490	179 850	
equipment price (euro)	1 100 000	430 000	380 000	340 000
additional costs compared to OKO system (euro)	760 000	90 000	40 000	
savings after 1 year (euro)	157 813	521 490	139 850	
savings after 2 years (euro)	1 075 626	1 132 980	319 700	
savings after 3 years (euro)	1 993 439	1 744 470	499 550	

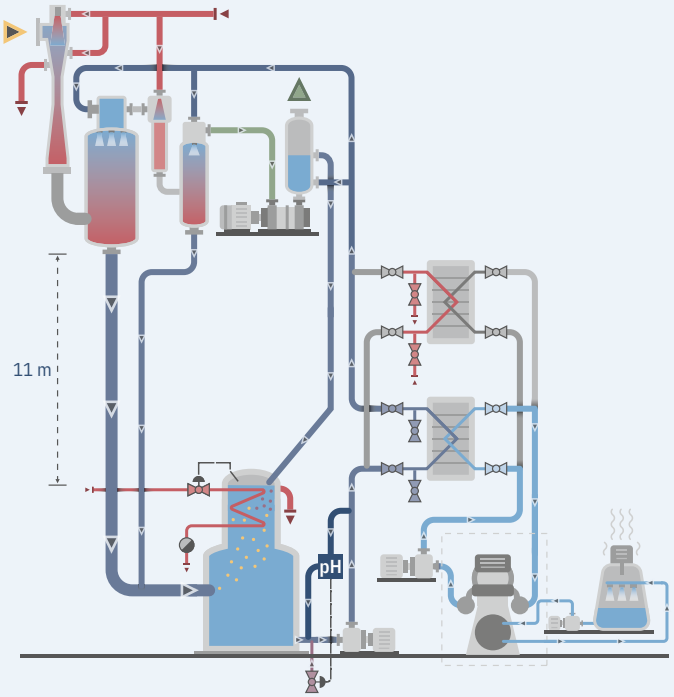
* Fresh water for the evaporative condenser is included.
** Waste water costs are excluded. Should be taken into account individually.

1. KÖRTING ICE CONDENSATION VACUUM SYSTEMS (ICE)



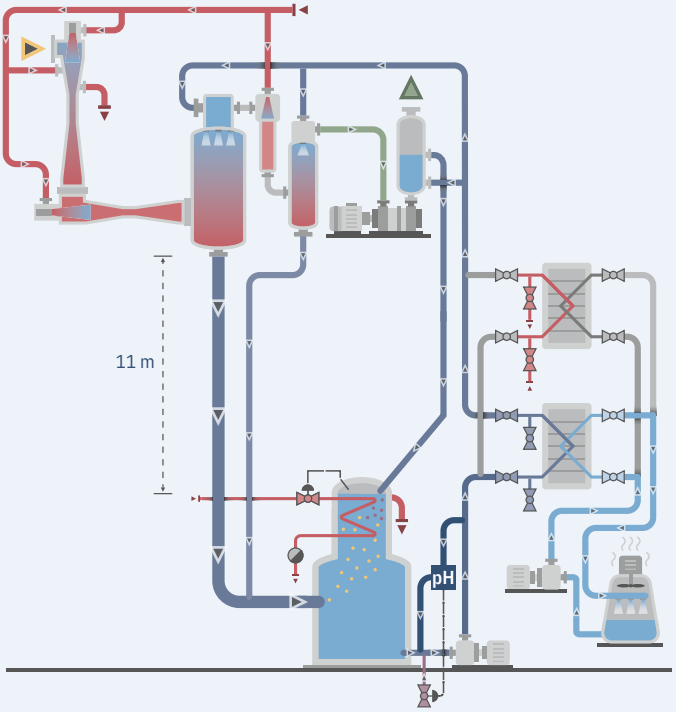
total motive steam consumption	250 kg/h
total cooling water consumption	35 m³/h
total electricity consumption	154 kW
total waste water amount	0.504 m³/h

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



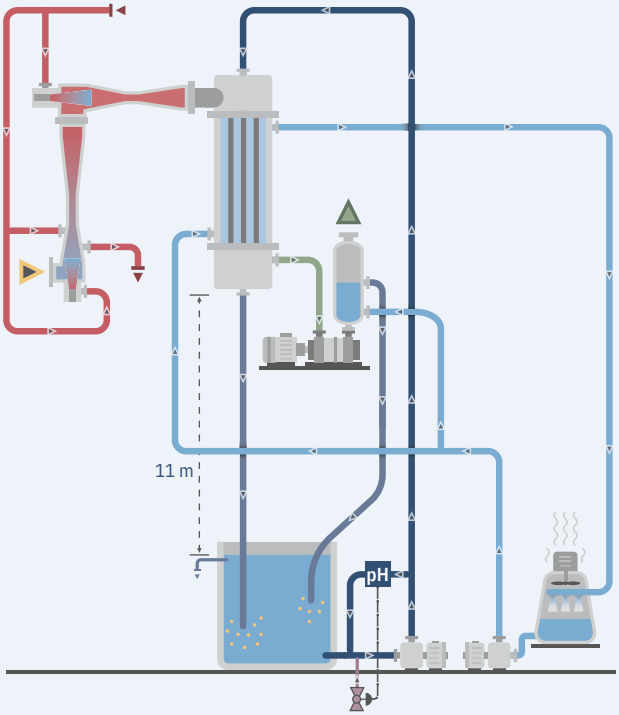
total motive steam consumption	676 kg/h
total cooling water consumption	212 m³/h
total electricity consumption	213 kW
total waste water amount	0.933 m³/h

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 amount	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 amount	3.257 m³/h

An example of a completed project

A PERFECT SYSTEM FOR HIGH CAPACITY

One of the largest edible oil production plants is located in the port area of Rotterdam (Maasvlakte). Körting supplied the ICE Condensation Vacuum System made of 30 tons of stainless steel. This impressive system's dimensions are 8 x 7 x 6 metres.

AT A GLANCE

edible oil production	2 500	tons/day
stripping steam / vacuum level	950	kg/h / 2.0 mbar
total motive steam consumption	320	kg/h
total cooling water consumption	308	m^3/h
total electrical power consumption	590	kW
total waste water	1.3	m^3/h

Körting ICE Condensation Vacuum System installed at an oil deodorising column

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