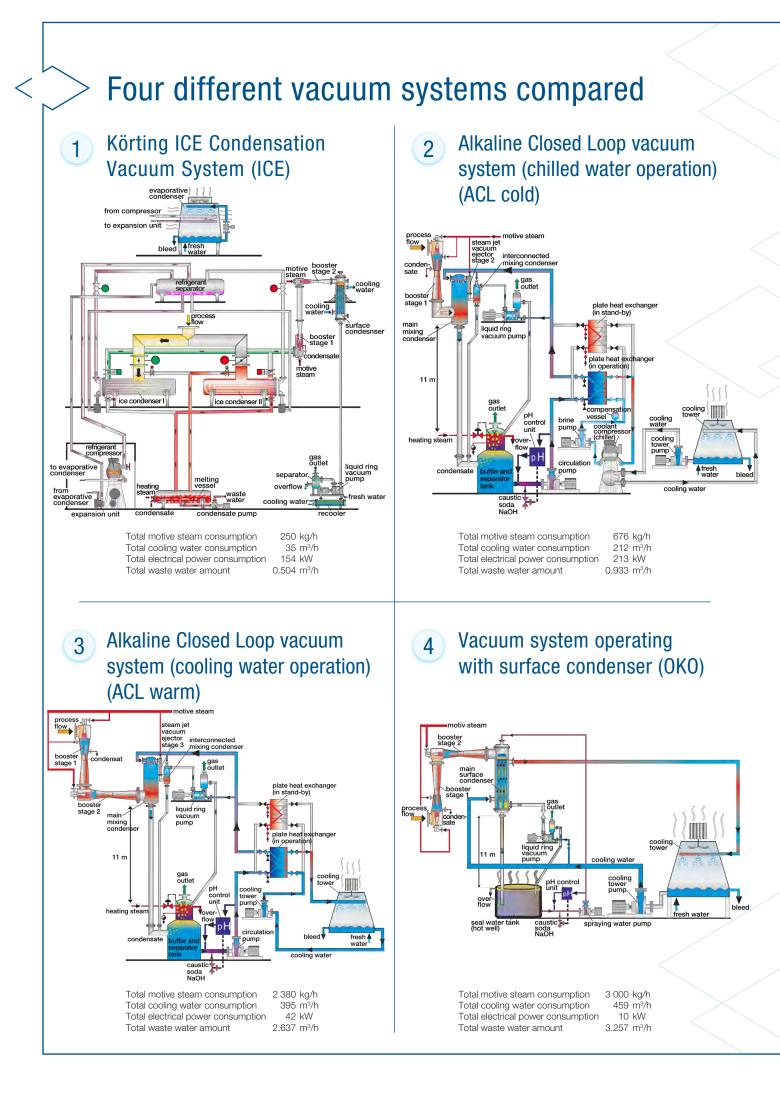
## Edible oil refining

<

## **Comparison of operation costs**

for different types of deodorising vacuum systems





suction pressure (mbar) I 1.5 1.5 1.5 1.5 1.5 1.5 1.5 Society water intel temperature (°C) 80 80 80 80 80 80 80 80 80 80 80 80 80							
Körting ICE Condensation Vacuum System (ICE)         Alkaline Closed Loop vacuum system (chilled water operation) (ACL cold)         Vacuum System operating with system (chilled water operation) (ACL cold)         Vacuum System operating with system (chilled water operation) (ACL cold)         Vacuum System operating with system (chilled water operation)         Vacuum System operating with system (chilled water operating water anount (m/h)         Vacuum System (chilling unit         Alkaline Close (chilled water anount (m/h)         Vacuum System (chilled water operating water anount (m/h)         Vacuum System (chilling unit         Vacuum System							
Loop vacuum Vacuum System (CE)Loop vacuum system (chilled water operation (ACL cold)Loop vacuum system (cooling vacuer operation (ACL warm)operating with surface con- vacuer (ACL warm)operating with surface con- <b< th=""><th></th><th></th><th>1</th><th>2</th><th>3</th><th>4</th></b<>			1	2	3	4	
suction flow: water vapour + 10 air + 4 FFA (kg/h) 250 250 250 250 250 250 250 250 250 250			Condensation Vacuum System	Loop vacuum system (chilled water operation)	Loop vacuum system (cooling water operation)	operating with surface con-	
cuton pressure (mbar)         1.5         1.5         1.5         1.5         1.5         1.5           suction flow temperature (°C)         80         80         80         80         80           Cooling water inlet temperature: 30 °C • Motive steam pressure: 10 bar (abs) • Wet bulb temperature: 21 °C         MOTIVE STEAM         1         <							
suction flow temperature (°C) Index set of the set of temperature 21 °C index set of tempera	suction flow: water vapour + 10 air + 4 FFA (kg/h)						
Cooling water inlet temperature: $30  ^{\circ}$ C • Motive steam pressure: $10  bar (abs)$ • Wet bulb temperature: $21  ^{\circ}$ CMOTIVE STEAMVet total motive steam consumption (kg/h)2506762 3803 000COOLING WATERVet total cooling water consumption (m²/h)35*212395459ELECTRICAL POWER (kW)Vet total cooling water consumption (m²/h)35*212395459ELECTRICAL POWER (kW)14617500colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2" <th cols<="" td=""><td colspan="2">suction pressure (mbar)</td><td></td><td></td><td></td><td></td></th>	<td colspan="2">suction pressure (mbar)</td> <td></td> <td></td> <td></td> <td></td>	suction pressure (mbar)					
MOTIVE STEAM         Image: Color of the steam consumption (kg/h)         250         676         2 380         3 000           total motive steam consumption (kg/h)         250         676         2 380         3 000           total cooling water consumption (m³/h)         35°         212         395         459           total cooling water consumption (m³/h)         35°         212         395         459           chilling unit         1146         175         0         0           liquid ring vacuum pump         8         7         4         8           contrifugal pumps         0         31         383         2           total electrical power consumption (kW)         154         213         422         10           caustic soda 25 % (kg/h)          0         3         3         3           WASTE WATER           0         3         3         3           total waste water amount (m³/h)         0.504         0.933         2.637         3.257           operation hours per year         30 Euro/t         61 875         167 310         589 050         74 2500           re-ooling costs for the cooling         0.1 Euro/tM³         288 875         174 900	suction flow temperature (°C)					80	
Total motive steam consumption (kg/h)2506762 3803 000COOLING WATERII <td< td=""><td>Cooling water inlet temperature: 3</td><td>0 °C • Motive si</td><td>team pressure: 10 bai</td><td>r (abs) • Wet bulb te</td><td>emperature: 21 °C</td><td></td></td<>	Cooling water inlet temperature: 3	0 °C • Motive si	team pressure: 10 bai	r (abs) • Wet bulb te	emperature: 21 °C		
COCLING WATER         Image: consumption (m³/h)         35°         212         395         459           total cooling water consumption (m³/h)         35°         212         395         459           ELECTRICAL POWER (kW)         146         175         0         0           chilling unit         146         175         0         0           ilquid ring vacuum pump         8         7         4         8           centrifugal pumps         0         31         38         2           total electrical power consumptior (kW)         154         213         42         10           caustic soda 25 % (kg/h)         0         3         3         3         3           WASTE WATER         0         0         3         2.637         3.257           operation hours per year         30 Euro/t         61 875         167 310         589 050         7.42 500           re-cooling costs for the cooling water prevear         0.1 Euro/m³         28 875         174 900         325 675         378 675           electrical power costs per year         0.1 Euro/m³         0         0         0         0         0         0           ocustic soda costs 25 %         0.25 Euro/kg         0 <td colspan="2">MOTIVE STEAM</td> <td></td> <td></td> <td></td> <td></td>	MOTIVE STEAM						
total cooling water consumption (m³/h)       35°       212       395       459         ELECTRICAL POWER (kW)       Image: construct (kW)       Image: const(kW)       Image: construct (kW)       Image: c	total motive steam consumption (kg/h)		250	676	2 380	3 000	
ELECTRICAL POWER (kW)         Image: matrix and the second s	COOLING WATER						
chiling unitIn 14617500liquid ring vacuum pump <td colspan="2">total cooling water consumption (m<sup>3</sup>/h)</td> <td>35*</td> <td>212</td> <td>395</td> <td>459</td>	total cooling water consumption (m <sup>3</sup> /h)		35*	212	395	459	
Indicide ring vacuum pump       10	ELECTRICAL POWER (kW)						
Centrifugal pumps         0         31         38         2           total electrical power consumption (kW)         154         213         42         10           caustic soda 25 % (kg/h)         0         3         3         3         3           WASTE WATER          0         3         2.637         3.257           operation hours per year         8250         8250         8250         8250         8250           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/m <sup>a</sup> 28 875         174 900         325 875         378 675           electrical power costs per year         0.1 Euro/m <sup>a</sup> 217 800         0         0         0         0           water per year         0.25 Euro/kg         0         61 88         61 88         61 88         61 88           OPERATION COSTS (Euro/year)         217 800         524 123         955 763         1 135 613           savings compared to OKO system (Euro)         91 761 30         430 000         380 000         340 000           additional costs compared to OKO system (Euro)         760 000         90 000         40 000			146	175	0	0	
Interview         Interview <thinterview< th=""> <thinterview< th=""> <th< td=""><td colspan="2">liquid ring vacuum pump</td><td>8</td><td>7</td><td>4</td><td>8</td></th<></thinterview<></thinterview<>	liquid ring vacuum pump		8	7	4	8	
caustic soda 25 % (kg/h)         0         3         3         3           WASTE WATER         0         0         3         2.637         3.257           Operation hours per year         30 Euro/t         61 875         167 310         589 050         742 500           operation hours per year         30 Euro/t         61 875         167 310         589 050         742 500           re-cooling costs per year         30 Euro/t         61 875         174 900         325 875         378 675           electrical power costs per year         0.1 Euro/m <sup>3</sup> 28 875         175 725         34 650         8 250           waste water costs per year*         0.0 Euro/m <sup>3</sup> 0         0         0         0         0           caustic soda costs 25 %         0.25 Euro/ky         217 800         524 123         955 763         1 135 613           savings compared to OKO syster/ Euro)         217 800         524 123         955 763         1 135 613           equipment price (Euro)         1 100 000         430 000         380 000         340 000           additional costs compared to OKO syster/ Euro/         76 0000         90 000         40 000         340 000           additional costs compared to OKO syster (Euro)         157 813	centrifugal pumps		0	31	38	2	
WASTE WATER       0.504       0.933       2.637       3.257         operation hours per year       30 Euro/t       61 875       167 310       589 050       742 500         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/m <sup>3</sup> 28 875       174 900       325 875       378 675         electrical power costs per year       0.1 Euro/kWh       127 050       175 725       34 650       8 250         waste water costs per year*       0.0 Euro/kg       0       0       0       0       0         caustic soda costs 25 %       0.25 Euro/kg       0       61 88       61 88       61 88       61 88         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       340 000         additional costs compared to OKO system (Euro)       760 000       90 000       40 000       340 000         savings after 1 year (Euro)       157 813       521 490       139 850       450 000         savings after 2 years (Euro)       1075 626       1 132 980       319 700       450 000       319 700<	total electrical power consumption (kW)		154	213	42	10	
Total waste water amount (m³/h)         0.504         0.933         2.637         3.257           operation hours per year         30 Euro/t         8 250         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           electrical power costs per year         0.1 Euro/m³         28 875         175 725         34 650         8 250           waste water costs per year*         0.0 Euro/m³         0	caustic soda 25 % (kg/h)		0	3	3	3	
Total waste water amount (m³/h)         0.504         0.933         2.637         3.257           operation hours per year         30 Euro/t         8 250         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           electrical power costs per year         0.1 Euro/m³         28 875         175 725         34 650         8 250           waste water costs per year*         0.0 Euro/m³         0         0         0         0           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         340 000           additional costs compared to OKO system (Euro)         760 000         90 000         40 000         340 000           savings after 1 year (Euro)         157 813         521 490         139 850         41 32 880           savings after 2 years (Euro)							
operation hours per year         30 Euro/t         61 875         167 310         589 050         742 500           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           electrical power costs per year         0.1 Euro/kWh         127 050         175 725         34 650         8 250           waste water costs per year*         0.0 Euro/m³         0         0         0         0           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         340 000           additional costs compared to OKO system (Euro)         760 000         90 000         40 000         340 000           savings after 1 year (Euro)         157 813         521 490         139 850         521 490           savings after 2 years (Euro)         1075 626         1 132 980         319 700         521 490         319 700			0.504	0.000	0.007	0.057	
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           electrical power costs per year         0.1 Euro/m³         28 875         174 900         325 875         378 675           waste water costs per year         0.1 Euro/kWh         127 050         175 725         34 650         8 250           waste water costs per year**         0.0 Euro/m³         0	I otal waste water amount (m%n	1)	0.504	0.933	2.637	3.257	
re-cooling costs for the cooling water per year       0.1 Euro/m³       28 875       174 900       325 875       378 675         electrical power costs per year       0.1 Euro/kWh       127 050       175 725       34 650       8 250         waste water costs per year**       0.0 Euro/m³       0       0       0       0         caustic soda costs 25 %       0.25 Euro/kg       0       6 188       6 188       6 188         OPERATION COSTS (Euro/year)         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       340 000         savings after 1 year (Euro)       157 813       521 490       139 850	operation hours per year		8 250	8 250	8 250	8 250	
water per year         Image: Construct of the second	steam costs per year	30 Euro/t	61 875	167 310	589 050	742 500	
waste water costs per year**       0.0 Euro/m³       0       0       0       0       0         caustic soda costs 25 %       0.25 Euro/kg       0       6188       6188       6188       6188         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       340 000         savings after 1 year (Euro)       157 813       521 490       139 850       Image: Figure Fi		0.1 Euro/m <sup>3</sup>	28 875	174 900	325 875	378 675	
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       40000         savings after 1 year (Euro)       157 813       521 490       139 850       40000         savings after 2 years (Euro)       1075 626       1 132 980       319 700       40000	electrical power costs per year	0.1 Euro/kWh	127 050	175 725	34 650	8 250	
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       40000         savings after 1 year (Euro)       157 813       521 490       139 850       40000         savings after 2 years (Euro)       1 075 626       1 132 980       319 700       40000	waste water costs per year**	0.0 Euro/m <sup>3</sup>	0	0	0	0	
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)         1075 626         1 132 980         319 700	caustic soda costs 25 %	0.25 Euro/kg	0	6 188	6 188	6 188	
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	OPERATION COSTS (Euro/year)		217 800	524 123	955 763	1 135 613	
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 compared to OKO system (Euro)		917 813	611 490	179 850		
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	equipment price (Euro)		1 100 000	430 000	380 000	340 000	
savings after 2 years (Euro) 1 075 626 1 1 32 980 319 700	additional costs compared to OKO system (Euro)						
savings after 2 years (Euro) 1 075 626 1 1 32 980 319 700	savings after 1 year (Furo)		157 813	521 490	139 850		
	savings after 2 years (Euro)						

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



## FED s.r.l.

Via dei Valtorta, 2 20127 MILANO Italy

Tel.: +39 02 26826332 Fax: +39 02 26140150

E-Mail: fed@fed.it

## www.fed.it