



Heat recovery systems

For hot air and hot water applications

Why recover heat?

The question should in fact be: Why not? Amazingly, practically 100 percent of the electrical energy input of every rotary screw compressor and blower is converted into heat.

Importantly though, up to 96% of this energy can be recovered and reused for heating purposes. This not only reduces primary energy consumption, but also significantly improves the total energy balance.

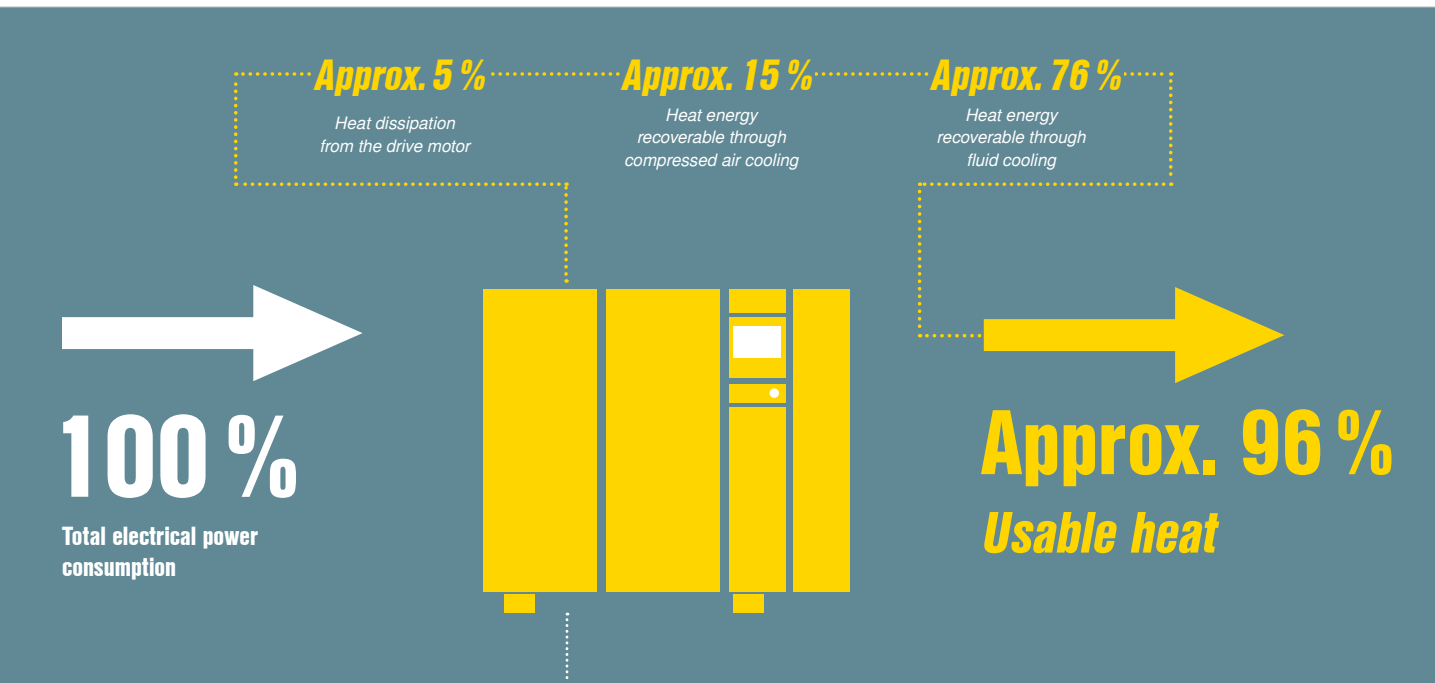
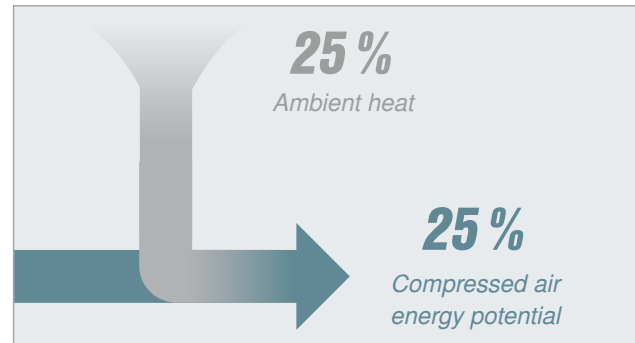
Heat in the compressor

Rotary screw compressors, boosters and blowers convert almost 100 percent of the electrical drive energy input into heat. The heat flow diagram (below) shows how this energy is distributed in the compressor system and how much of it is usable.

Approximately 96 percent of the energy can be recovered for reuse, 2 percent remains in the compressed air and 2 percent radiates away from the compressor package into the ambient surroundings. So where does the usable energy in compressed air come from?

The answer is actually quite simple and perhaps surprising: during the compression process, the compressor converts the input electrical drive energy into heat. At the same time, it charges the intake air with energy potential. This corresponds to approximately 25 percent of the compressor's electrical power consumption. This energy is only usable however when the compressed air expands at its point of use and, in so doing, absorbs heat energy from

the ambient surroundings. Of course the amount of energy available for use depends on the pressure and leakage losses within the compressed air system.



Approx. 2%
Heat dissipated by the compressor into the ambient air

Approx. 2%
Heat remaining in the compressed air

Approx. 4%
Non-usable heat

Saves money and benefits the environment

Savings

Gas heating
€ 284 to € 52,381 per year

Oil heating
€ 274 to € 50,570 per year

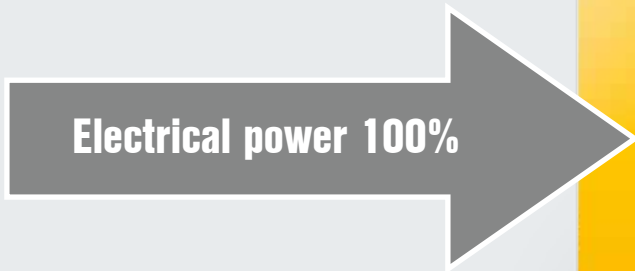
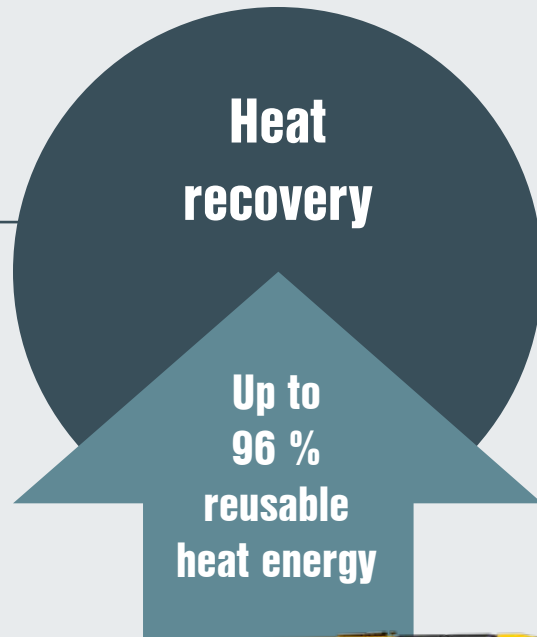


Plate-type heat exchanger systems	Compressor size		
	“Small”	“Medium”	“Large”
Compressor model	SM 15	BSD 83	FSD 475
Drive motor rated power	9 kW	45 kW	250 kW
Potential savings per year: fuel oil	€ 842	€ 5,422	€ 27,313
	3,826 kg CO ₂	24,644 kg CO ₂	124,138 kg CO ₂



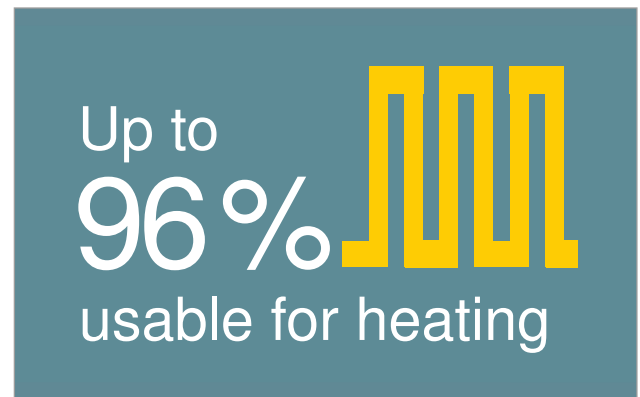
Image: DN 45 C booster with hot air heat recovery

Minimise primary energy consumption for heating

As self-contained complete systems, rotary screw compressors, boosters and blowers are particularly well suited for heat recovery.

Direct use of the recyclable heat via an exhaust air ducting system enables up to 96 percent of the total energy input to be recovered and used for heating purposes.

This is the case regardless of whether a fluid-injection cooled compressor, a dry-compression rotary screw compressor, a booster or a blower is in use.



Heating with hot air

Warmed compressor cooling air can be ducted away to provide highly effective space heating. With this method, up to 96 percent of the compressor's input energy can therefore be recovered as heat – either for space heating or for use as process heat.



Heat adjacent rooms

When using recyclable heat for space heating, exhaust air ducts simply feed the warmed cooling air to where it is needed, e.g. adjacent facilities, such as in warehouses or workshops.

Minimise primary energy consumption for warming of process, heating and service water



Using recyclable heat from the compressor, heat exchanger systems can provide on-demand heating and service water warmed to temperatures up to +70°C, or even +90°C, depending on requirements.

The heating of hot and service water using recyclable heat is performed by PTG plate heat exchanger systems. This is the standard application for recyclable heat.

Special fail-safe heat exchangers are recommended for applications that have no other interconnecting water circuits and where it is essential for the heated water to remain uncontaminated, as is the case with cleaning water in the food industry for example.

Hot water, up to +70°C, can be produced with reusable compressor heat from heat exchanger systems. Higher temperatures are possible in individual applications (please enquire).



Feed heat energy to a heating system

Up to 76 percent of the original input electrical energy for the compressor system can be recovered for use in hot water heating systems and service water installations. This significantly reduces primary energy demand required for heating purposes.



PTG plate heat exchanger

High quality stainless steel plate-type heat exchangers are the first choice when it comes to using recyclable heat from rotary screw compressors for warming process and service water, or for process heat production.



Equipment for rotary screw compressors



Hot air heat recovery

All KAESER rotary screw compressors can be fitted with exhaust ducting; the ducting is installed on-site. Adjacent rooms and warehouse space, for example, can be heated with the warmed cooling air. Possible applications: drying processes, heating of halls and buildings, air curtain systems, pre-heating of burner air.



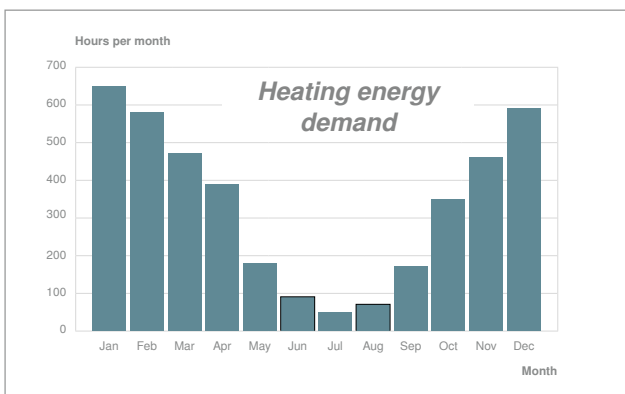
PTG plate-type heat exchangers

SM series rotary screw compressors (5.5 kW upwards) can be equipped with PTG systems. Depending on the size of the compressor system, the PTG heat exchanger is either integrated within the unit or installed externally. Possible applications: Feeding of heat into central heating systems, laundries, electroplating, general process heat. With special fail-safe heat exchangers: Cleaning water in the food industry, swimming pool heating, hot water for shower and washroom facilities.



Shell and tube heat exchangers

In case of inadequate cooling water quality (e.g. sea water or hard or contaminated cooling water), optional shell and tube heat exchangers are available. Our compressed air specialists can advise you regarding the right design for your particular application.



Heat is not only needed in winter

It goes without saying that heating is necessary during the winter months. However, it is also required to a greater or lesser extent at other times of the year, for example for the hot water supply. This means that heating energy is actually required for approximately 4000 hours per year.

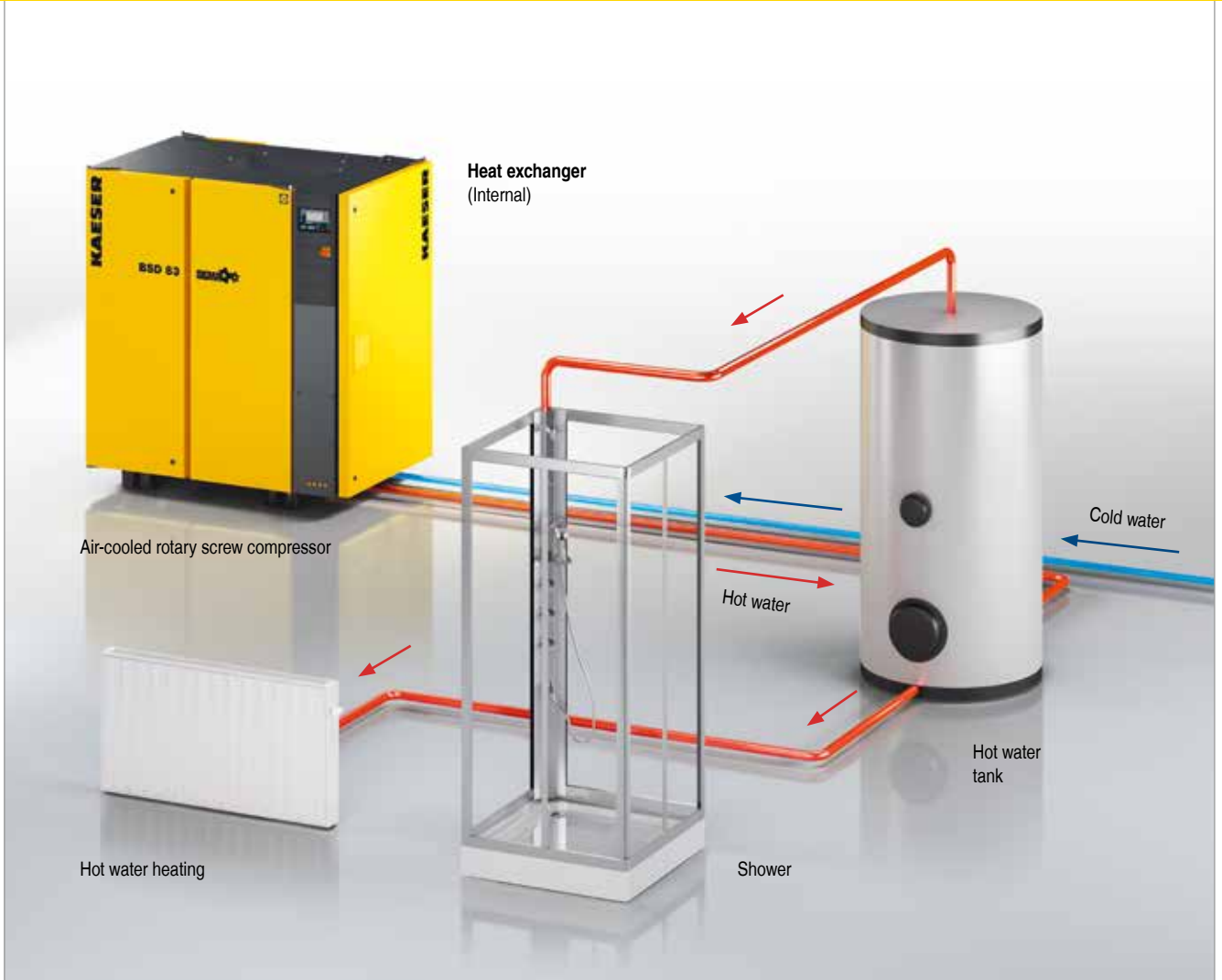


Image: Heat recovery process. Applications for potable water possible only in conjunction with safety heat exchanger (SWT)



Image: Internal layout of a compressor – system comprising plate-type heat exchanger, thermostatic valve and complete pipework

Technical specifications for...

Hot air

Type	At max. gauge pressure	Motor rated power	Maximum available heating capacity		Amount of reusable hot air	Amount cooling air is heated	Potential fuel oil savings			Potential natural gas savings							
							bar	kW	MJ/h ¹	m³/h	K (approx.)	Fuel oil	CO ₂	Heating cost savings	Natural gas	CO ₂	Heating cost savings
												l	kg	€/Year	m³	kg	€/Year
SX 3 SX 4 SX 6 SX 8	8	2.2 3 4 5.5	2.7 3.4 4.4 6.0	10 12 16 22	1000 1000 1000 1300	8 10 13 14	456 575 744 1014	1244 1568 2029 2765	Savings potential for 1500 hrs/yr	274 345 446 608	378 476 616 840	756 952 1232 1680	Savings potential for 1500 hrs/yr	284 357 462 630			
SM 10 SM 13 SM 16		8	5.5 7.5 9	6.8 9.1 11.1	25 33 40	2100	10 13 16	1149 1538 1876		3133 4194 5116	689 923 1,126	952 1275 1555		1904 2550 3110	714 956 1,166		
SK 22 SK 25			8	11 15	13.2 16.5	48 59	2500 3000	16 17		2231 2789	6084 7606	1,339 1,673		1849 2311	3698 4622	1,387 1,733	
ASK 28 ASK 34 ASK 40				8	15 18.5 22	18.4 22.8 26.8	66 82 96	4000 4000 5000		14 17 16	3110 3854 4530	8481 10,510 12,353		1,866 2,312 2,718	2577 3193 3754	5154 6386 7508	1,933 2,395 2,816
ASD 35 ASD 40 ASD 50 ASD 60	8.5	18.5 22 25 30	20.2 23.8 28.3 34.9		73 86 102 126	3800 3800 4500 5400	16 19 19 19	4552 5363 6378 7865	12,413 14,625 17,393 21,448	Savings potential for 2000 hrs/yr	2,731 3,218 3,827 4,719	3772 4444 5285 6517	7544 8888 10,570 13,034	Savings potential for 2000 hrs/yr	2,829 3,333 3,964 4,888		
BSD 65 BSD 75 BSD 83		8.5	30 37 45		35.2 43.4 52.0	127 156 187	6500 8000 8000	16 16 20	7932 9780 11,718		21,631 26,670 31,955	4,759 5,868 7,031	6573 8105 9711		13,146 16,210 19,422	4,930 6,079 7,283	
CSD 85 CSD 105 CSD 125			8.5	45 55 75	50 62 75	179 223 270	9400 9400 10,700	16 20 21	11,223 13,972 16,902		30,605 38,102 46,092	6,734 8,383 10,141	9300 11,578 14,006		18,600 23,156 28,012	6,975 8,684 10,505	
CSDX 140 CSDX 165				8.5	75 90	84 101	302 364	11,000 13,000	23 23		18,930 22,761	51,622 62,069	11,358 13,657		15,686 18,861	31,372 37,722	11,765 14,146
DSD 145 DSD 175 DSD 205 DSD 240	9 8.5 8.5 8.5	75 90 110 132			82 96 120 145	295 346 432 522	11,000 13,000 17,000 20,000	22 22 21 22	18,479 21,634 27,043 32,676	50,392 58,996 73,746 89,107	11,087 12,980 16,266 19,606	15,313 17,927 22,409 27,077	30,626 35,854 44,818 54,154	11,485 13,445 16,807 20,308			
DSDX 245 DSDX 305	8.5	132 160	143 176	515 634	21,000	20 25	32,226 39,662	87,880 108,158	19,336 23,797	26,704 32,866	53,408 65,732	20,028 24,650					
ESD 375 ESD 445		8.5	200 250	221 254	796 914	30,000 34,000	22 22	49,803 57,240	135,813 156,093	29,882 34,344	41,270 47,432	82,540 94,864	30,953 35,574				
FSD 475 FSD 575	8.5		250 315	274 333	986 1199	40,000	21 25	61,747 75,043	168,384 204,642	37,048 45,026	51,167 62,185	102,234 124,370	38,375 46,639				
HSD 662 HSD 722 HSD 782 HSD 842		8.5	360 400 450 500	21 23 25 26	74 82 88 94	10,000	6 7 7 8	4642 5116 5521 5904	12,659 13,951 15,056 16,100	2,785 3,070 3,313 3,542	3847 4239 4575 4893	7694 8478 9150 9786	2,885 3,179 3,431 3,670				

¹ 1 MJ/h = 1 kW x 3.6

Calculation example for ASD 35

For fuel oil	
Maximum available heating capacity:	20.2 kW
Fuel value per litre of fuel oil:	9.861 kWh/l
Fuel oil heating efficiency:	0.9
Price per litre of fuel oil:	0.60 €/l
Cost savings:	$\frac{20.2 \text{ kW} \times 2000 \text{ hrs/yr}}{0.9 \times 9.861 \text{ kWh/l}} \times 0.60 \text{ €/l} = \text{€ 2,731 per year}$

For natural gas	
Maximum available heating capacity:	20.2 kW
Fuel value per m³ natural gas:	10.2 kWh/m³
Natural gas heating efficiency:	1.05
Price per m³ of natural gas:	0.75 €/l
Cost savings:	$\frac{20.2 \text{ kW} \times 2000 \text{ hrs/yr}}{1.05 \times 10.2 \text{ kWh/m}^3} \times 0.75 \text{ €/l} = \text{€ 2,829 per year}$

Note: The indicated potential energy savings are based on compressors (8.0 / 8.5 / 9.0 bar) at operational temperature and at max. working pressure. Values may differ for other pressures.

...rotary screw compressors

Hot water

Type	At max. gauge pressure bar	Motor rated power kW	Maximum available heating capacity kW MJ/h [†]		Heated water volume Heated to 70 °C (ΔT 25 K) m³/h (ΔT 55 K) m³/h		Installation of the PTG system Int./ext.	Potential fuel oil savings			Potential natural gas savings						
								Fuel oil	CO ₂	Heating cost savings	Natural gas	CO ₂	Heating cost savings				
								l	kg	€/Year	m³	kg	€/Year				
SM 10 SM 13 SM 16	8	5.5 7.5 9	4.8 6.6 8.1	17 24 29	0.16 0.21 0.29	0.07 0.10 0.13	External	811 1116 1369	2212 3043 3733	Savings potential for 1500 hrs/yr	487 670 821	672 924 1134	1344 1848 2268	Savings potential for 1500 hrs/yr	504 693 851		
SK 22 SK 25		8	11 15	9.4 12.0	34 43	0.32 0.41		0.15 0.19	External		1589 2028	4333 5530	953 1,217		1317 1681	2634 3362	988 1,261
ASK 28 ASK 34 ASK 40			8	15 18.5 22	13.6 16.9 19.8	49 61 71		0.47 0.58 0.68			0.21 0.26 0.31	Internal	2299 2856 3347		6269 7788 9127	1,379 1,714 2,008	1905 2367 2773
ASD 35 ASD 40 ASD 50 ASD 60	8.5	18.5 22 25 30		15.2 18.1 21.6 26.6	55 65 78 96	0.52 0.62 0.74 0.92	0.24 0.28 0.34 0.42	Internal	3425 4079 4868 5994	9340 11,123 13,275 16,346	2,055 2,447 2,921 3,596		2838 3380 4034 4967	5676 6760 8068 9934	2,129 2,535 3,026 3,725		
BSD 65 BSD 75 BSD 83		8.5		30 37 45	27.1 33.5 40.1	98 121 144	0.93 1.15 1.38		0.42 0.52 0.63	Internal	6107 7549 9037		16,654 20,586 24,644	3,664 4,529 5,422	5061 6256 7488	10,122 12,512 14,976	3,796 4,692 5,616
CSD 85 CSD 105 CSD 125			8.5	45 55 75	38.6 48.4 59.0	139 174 212	1.33 1.67 2.03		0.60 0.76 0.92		Internal	8699 10,907 13,296	23,722 29,743 36,258	5,219 6544 7978	7208 9038 11,018	14,416 18,076 22,036	5,406 6,779 8,264
CSDX 140 CSDX 165				8.5	75 90	66 80	238 288		2.30 2.80			1.03 1.25	Internal	14,873 18,028	40,559 49,162	8,924 10,817	12,325 14,939
DSD 145 DSD 175 DSD 205 DSD 240	8.5	75 90 110 132			61 71 88 107	220 256 317 385	2.10 2.40 3.00 3.70	0.96 1.11 1.38 1.68	Internal	13,747 16,000 19,831 24,113		37,488 43,632 54,079 65,756		8,248 9,600 11,899 14,468	11,391 13,259 16,433 19,981	22,782 26,518 32,866 39,962	8,543 9,944 12,325 14,986
DSDX 245 DSDX 305		8.5	132 160	105 130	378 468	3.60 4.50	1.64 2.04	Internal		23,662 29,296	64,526 79,890	14,197 17,578	19,608 24,276	39,216 48,552	14,706 18,207		
ESD 375 ESD 445			8.5	200 250	162 187	583 673	5.6 6.4			2.54 2.93	Internal	36,507 42,141	99,555 114,919	21,904 25,285	30,252 34,921	60,504 69,842	22,689 26,191
FSD 475 FSD 575		8.5		250 315	202 246	727 886	7.0 8.5	3.16 3.85		Internal		45,522 55,437	124,138 151,177	27,313 33,262	37,722 45,938	75,444 91,876	28,292 34,454
HSD 662 HSD 722 HSD 782 HSD 842	8.5		360 400 450 500	291 323 348 374	1048 1163 1253 1346	10.0 11.1 12.0 12.9	4.56 5.06 5.45 5.86	Internal	65,578 72,790 78,423 84,283		178,831 198,498 213,860 229,840	39,347 43,674 47,054 50,570	54,342 60,317 64,986 69,841	108,684 120,634 129,972 139,682	40,757 45,238 48,740 52,381		

[†] 1 MJ/h = 1 kW x 3.6

Calculation example for ASD 35

For fuel oil		For natural gas	
Maximum available heating capacity:	15.2 kW	Maximum available heating capacity:	15.2 kW
Fuel value per litre of fuel oil:	9.861 kWh/l	Fuel value per m³ natural gas:	10.2 kWh/m³
Fuel oil heating efficiency:	0.9	Natural gas heating efficiency:	1.05
Price per litre of fuel oil:	0.60 €/l	Price per m³ of natural gas:	0.75 €/l
Cost savings:	$\frac{15.2 \text{ kW} \times 2000 \text{ hrs/yr}}{0.9 \times 9.861 \text{ kWh/l}} \times 0.60 \text{ €/l} = \text{€ } 2,055 \text{ per year}$	Cost savings:	$\frac{15.2 \text{ kW} \times 2000 \text{ hrs/yr}}{1.05 \times 10.2 \text{ kWh/m}^3} \times 0.75 \text{ €/l} = \text{€ } 2,129 \text{ per year}$

Note: The indicated potential energy savings are based on compressors (8 / 8.5 / 9 bar) at operational temperature and at max. working pressure. Values may differ for other pressures.

Heat recovery systems for...

Hot air

The Air-Cooled Aftercooler (ACA) is an air/air heat exchanger. The process air is cooled in a cross-flow process in which ambient air is warmed via the heat exchanger. For the cooling medium supply, only an electrical connection for the fan is needed. At an ambient temperature of 20 °C, for example, the process air entering the cooler can be cooled from 150 °C to 30 °C. The ACA offers advantages especially in the pneumatic conveying of temperature-sensitive bulk goods. Furthermore, if a production hall needs to be heated in the winter, the ACA can do that too. The exhaust air flow from the cooler contains up to 75% of the electrical power as blower heat. For optimal energy gains or cooling efficiency, the maximum pressure loss is a mere 35 mbar. To monitor the unit's function, an integrated thermostat detects the process air discharge temperature and activates a floating contact via an adjustable activation point.



Application examples

- Cooling of process air from blowers
e.g. for bulk goods conveying
- Heating of production halls

Hot water

The water-cooled WRN aftercooler is a bundled-tube heat exchanger in which the process air flows through several cooling pipes surrounded by water. The water serves as a cooling and heat transfer medium. This type of heat exchanger is customised for each project to ensure that the drop in the process air temperature and rise in water temperature precisely match the requirements. To minimise the pressure loss resulting from the additional power consumption of the blowers and to maximise the heat transfer, various cooling pipe geometries are used. Moreover, various materials are available for the cooling pipes as dictated by the water quality. The cooler shrouding is enamel-coated. The maximum achievable temperature drop in the return water flow below the process air inlet temperature in the heat exchanger is approx. 5°K.



Application examples

- Integration into heating circuits to raise return air temperature
- Integration into heat pump circuits
- Floor heating
- Drying sludge

...blowers



Image: DC 236 C with ACA compressed air aftercooler



Image: FBS 660 S SFC with bundled-tube heat exchanger

Technical specifications of heat recovery systems...

Hot air

Model	Max. process air flow rate	Max. pressure loss	Max. fan flow rate ¹⁾	Fan power supply (400V)	Fan power ¹⁾	Total mass	Dimensions W x D x H	Connection nominal width
	Nm ³ /min	mbar	m ³ /h	A	W	kg	mm	DN
ACA 53	5	15	1700	0.24	110	58	980 x 650 x 610	50
ACA 88	7	25	1700	0.24	110	58	980 x 650 x 610	65
ACA 130	12	25	3100	0.43	210	97	980 x 650 x 610	80
ACA 165	14	30	3100	0.43	210	97	980 x 650 x 610	100
ACA 235	22	30	6200	0.43 (2x)	210	193	1900 x 850 x 1200	100
ACA 350	30	35	6200	0.43 (2x)	210	199	1900 x 850 x 1280	150

¹⁾ at max. pressure

Sample calculation for ACA 350 (for heating of production halls)

Blower (37 kW)	
Flow rate:	30 m ³ /min
Pressure differential:	600 mbar
Inlet temperature:	0 °C
Discharge temperature:	52 °C

ACA 350	
Heat emission:	25 kW
Air heating output:	2200 m ³ /h from 0 to +35 °C
Pressure loss, process air:	35 mbar = 2.2 kW

...for blowers

Hot water

Model	NW	V max (air)	V max (H ₂ O)	Connection dimensions		Dimensions		Weight kg
		Nm ³ /min	m ³ /h	Air	Water	∅ cabinet	Length *)	
WRN 38 smooth	125	11	1.3	DN 125, PN 16	1 ¼	168	1415	45
WRN 60 smooth	150	16	5	DN 150, PN 16	1 ¼	194	1416	100
WRN 90 smooth	200	28	6	DN 200, PN 16	1 ¼	245	1430	135
WRN 130 smooth	250	38	8	DN 250, PN 10	1 ½	273	1441	220
WRN 170 smooth	300	53	10	DN 300, PN 10	2	324	1441	275
WRN 200 smooth	350	65	12	DN 350, PN 10	2	356	1441	365
WRN 250 smooth	350	67	12	DN 350, PN 10	DN 65, PN 16	375	1641	390
WRN 350 smooth	450	100	13	DN 450, PN 10	DN 80, PN 16	450	1649	580
WRN 450 smooth	500	130	15	DN 500, PN 10	DN 100, PN 16	519	1655	685

*) With welded counterflange (included within scope of delivery)

Sample calculation for WRN 170 (heating boost)

Blower (37 kW)	
Flow rate:	30 m ³ /min
Pressure differential:	600 mbar
Inlet temperature:	0 °C
Discharge temperature:	+52 °C

ACA 350	
Heat emission:	14 kW
Air heating output:	600 l/h (water) from +25 °C to +45 °C
Pressure loss, process air:	20 mbar (approx. 1.2 kW more at the blower) = 2 kW

The world is our home

As one of the world's largest compressed air system providers and compressor manufacturers, KAESER KOMPRESSOREN is represented throughout the world by a comprehensive network of branches, subsidiary companies and authorised partners in over 100 countries.

With innovative products and services, KAESER KOMPRESSOREN's experienced consultants and engineers help customers to enhance their competitive edge by working in close partnership to develop progressive system concepts that continuously push the boundaries of performance and compressed air efficiency.

Moreover, the decades of knowledge and expertise from this industry-leading system provider are made available to each and every customer via the KAESER group's global computer network.

These advantages, coupled with KAESER's worldwide service organisation, ensure that every product operates at the peak of its performance at all times and provides maximum availability.



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