KAESER COMPRESSORS®

Heat recovery systems

For hot air and hot water applications

www.kaeser.com

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.

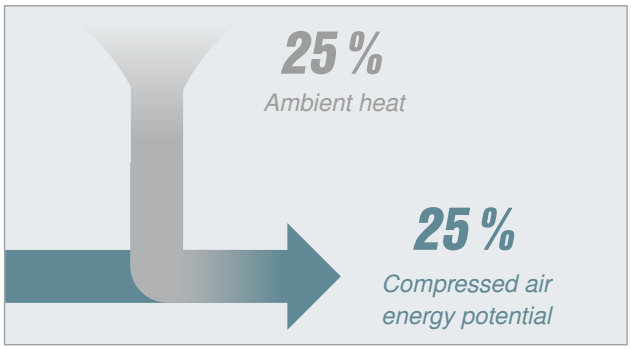
Importantly though, up to 96% of this energy can be recovered and reused for heating purposes. This not only reduces primary energy consumption, but also significantly improves the total energy balance.

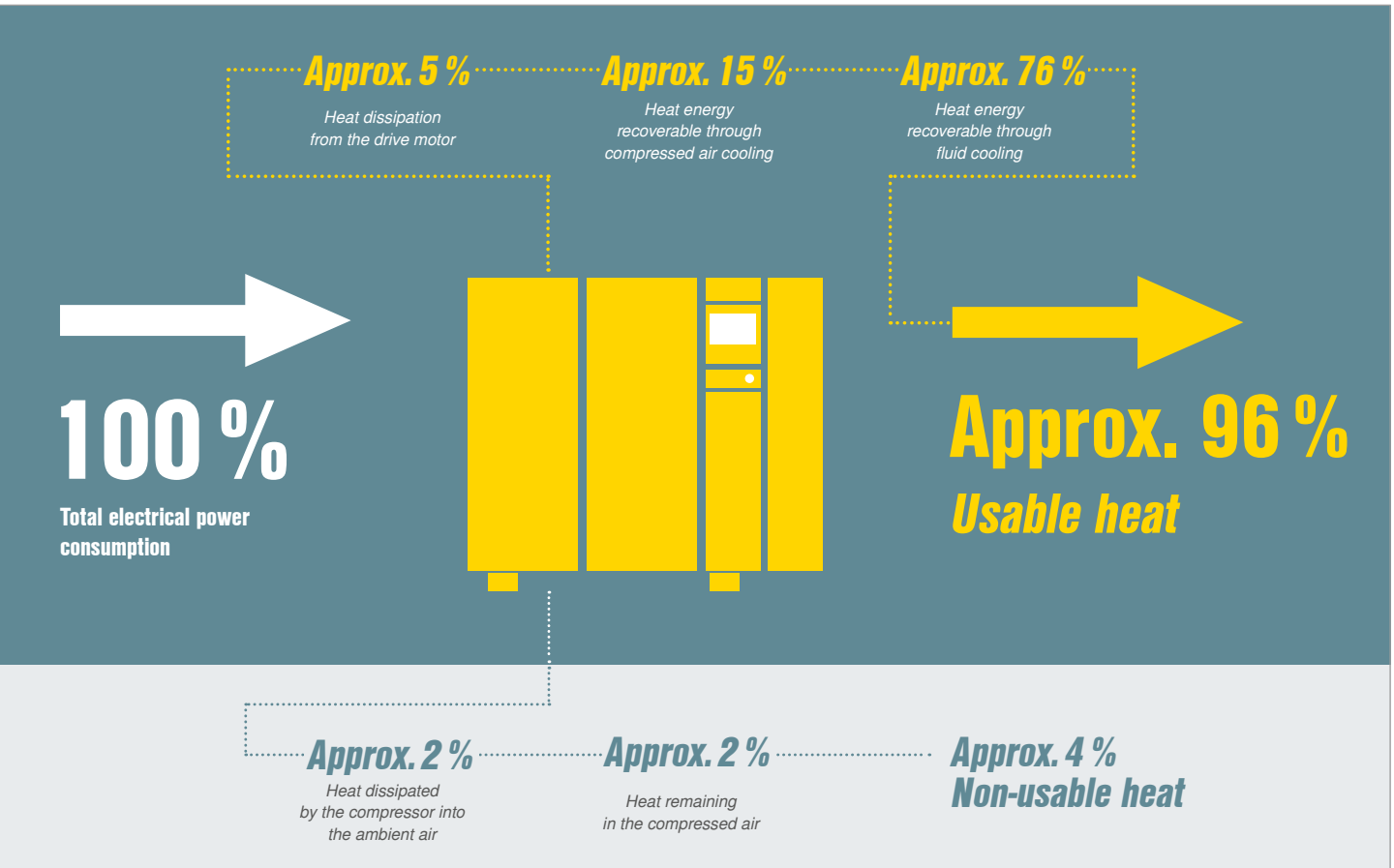
Heat in the compressor

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.





Saves money and benefits the environment

Savings

Gas heating
€ 284 to € 52,381 per year

Oil heating
€ 274 to € 50,570 per year

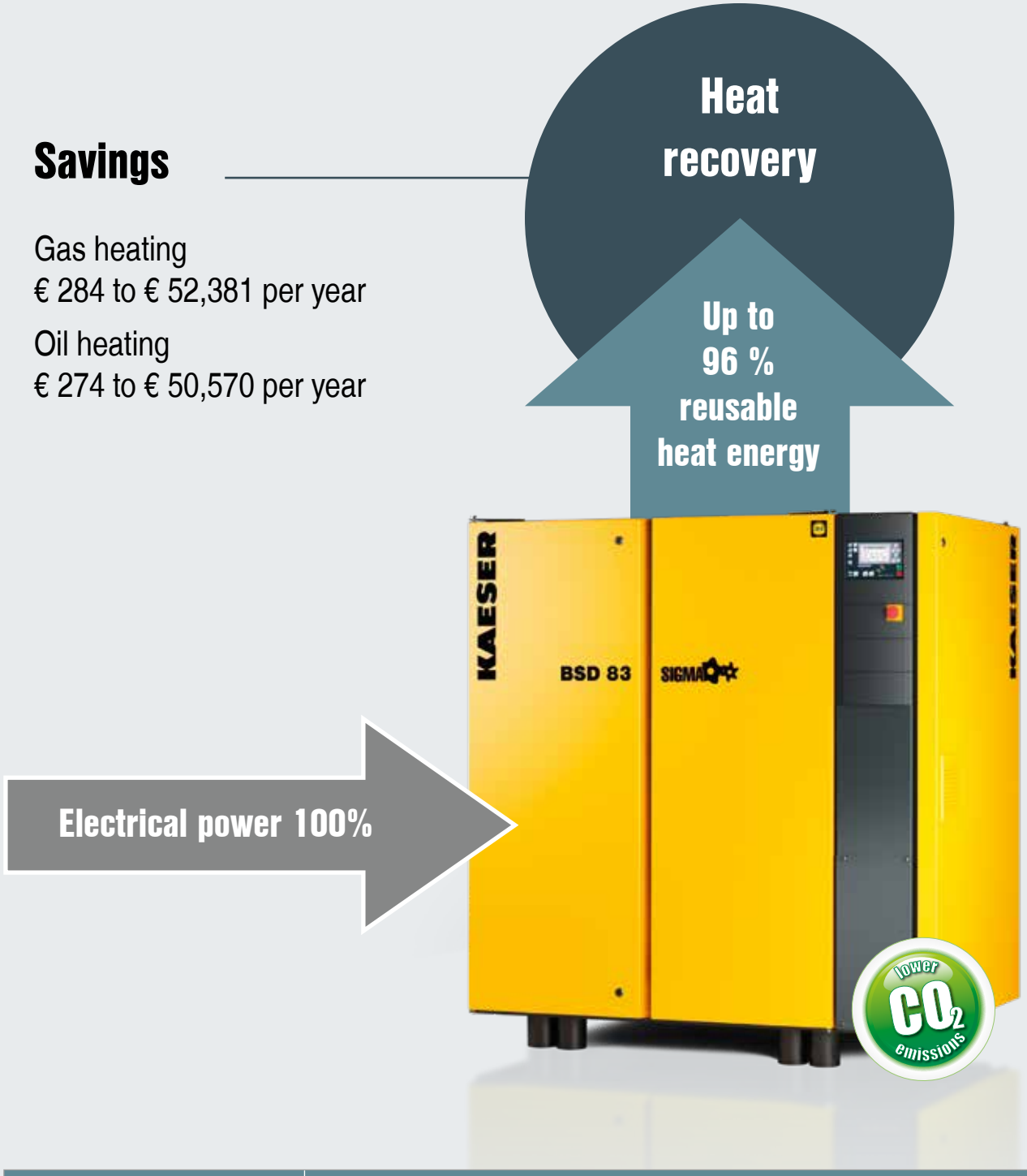


Plate-type heat exchanger systems	Compressor size		
	"Small"	"Medium"	"Large"
Compressor model	SM 15	BSD 83	FSD 475
Drive motor rated power	9 kW	45 kW	250 kW
Potential savings per year: fuel oil	€ 842	€ 5,422	€ 27,313
	3,826 kg CO_2	24,644 kg CO_2	124,138 kg CO_2

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.

Up to
96 %
usable for heating

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.


2
3
4
5

Equipment for rotary screw compressors

Hot air heat recovery

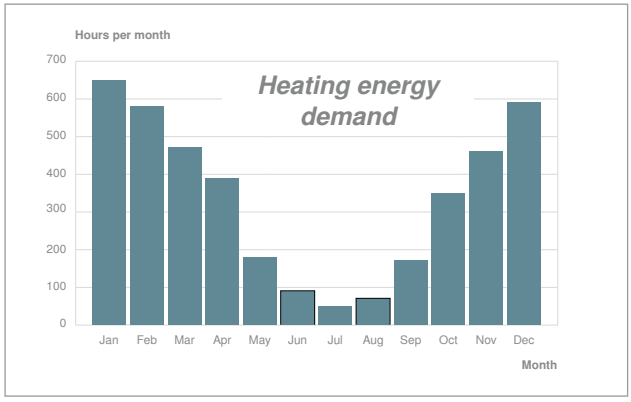
All KAESER rotary screw compressors can be fitted with exhaust ducting; the ducting is installed on-site. Adjacent rooms and warehouse space, for example, can be heated with the warmed cooling air. Possible applications: drying processes, heating of halls and buildings, air curtain systems, pre-heating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

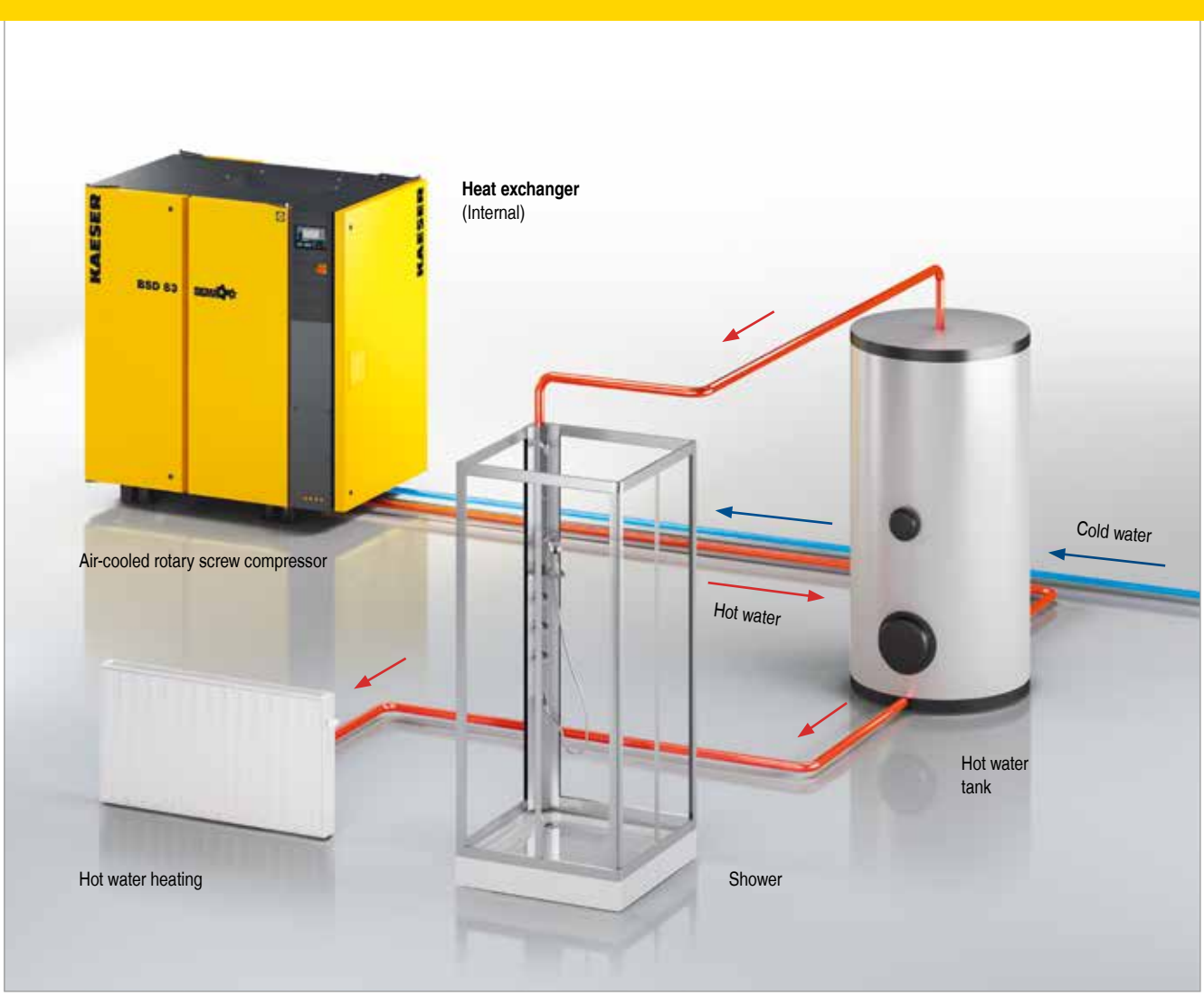


Image: Heat recovery process. Applications for potable water possible only in conjunction with safety heat exchanger (SWT)

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		
							Fuel oil	CO_2	Heating cost savings	Natural gas	CO_2	Heating cost savings
	bar	kW	kW	MJ/h *)	m³/h	K (approx.)	l	kg	€/Year	m³	kg	€/Year
SX 3	8	2.2	2.7	10	1000	8	456	1244	274	378	756	284
SX 4		3	3.4	12	1000	10	575	1568	345	476	952	357
SX 6		4	4.4	16	1000	13	744	2029	446	616	1232	462
SX 8		5.5	6.0	22	1300	14	1014	2765	608	840	1680	630
SM 10	8	5.5	6.8	25	2100	10	1149	3133	689	952	1904	714
SM 13		7.5	9.1	33		13	1538	4194	923	1275	2550	956
SM 16		9	11.1	40		16	1876	5116	1,126	1555	3110	1,166
SK 22	8	11	13.2	48	2500	16	2231	6084	1,339	1849	3698	1,387
SK 25		15	16.5	59	3000	17	2789	7606	1,673	2311	4622	1,733
ASK 28	8	15	18.4	66	4000	14	3110	8481	1,866	2577	5154	1,933
ASK 34		18.5	22.8	82	4000	17	3854	10,510	2,312	3193	6386	2,395
ASK 40		22	26.8	96	5000	16	4530	12,353	2,718	3754	7508	2,816
ASD 35	8.5	18.5	20.2	73	3800	16	4552	12,413	2,731	3772	7544	2,829
ASD 40		22	23.8	86	3800	19	5363	14,625	3,218	4444	8888	3,333
ASD 50		25	28.3	102	4500	19	6378	17,393	3,827	5285	10,570	3,964
ASD 60		30	34.9	126	5400	19	7865	21,448	4,719	6517	13,034	4,888
BSD 65	8.5	30	35.2	127	6500	16	7932	21,631	4,759	6573	13,146	4,930
BSD 75		37	43.4	156	8000	16	9780	26,670	5,868	8105	16,210	6,079
BSD 83		45	52.0	187	8000	20	11,718	31,955	7,031	9711	19,422	7,283
CSD 85	8.5	45	50	179	9400	16	11,223	30,605	6,734	9300	18,600	6,975
CSD 105		55	62	223	9400	20	13,972	38,102	8,383	11,578	23,156	8,684
CSD 125		75	75	270	10,700	21	16,902	46,092	10,141	14,006	28,012	10,505
CSDX 140	8.5	75	84	302	11,000	23	18,930	51,622	11,358	15,686	31,372	11,765
CSDX 165		90	101	364	13,000	23	22,761	62,069	13,657	18,861	37,722	14,146
DSD 145	9	75	82	295	11,000	22	18,479	50,392	11,087	15,313	30,626	11,485
DSD 175	8.5	90	96	346	13,000	22	21,634	58,996	12,980	17,927	35,854	13,445
DSD 205	8.5	110	120	432	17,000	21	27,043	73,746	16,266	22,409	44,818	16,807
DSD 240	8.5	132	145	522	20,000	22	32,676	89,107	19,606	27,077	54,154	20,308
DSDX 245	8.5	132	143	515	21,000	20	32,226	87,880	19,336	26,704	53,408	20,028
DSDX 305		160	176	634		25	39,662	108,158	23,797	32,866	65,732	24,650
ESD 375	8.5	200	221	796	30,000	22	49,803	135,813	29,882	41,270	82,540	30,953
ESD 445		250	254	914	34,000	22	57,240	156,093	34,344	47,432	94,864	35,574
FSD 475	8.5	250	274	986	40,000	21	61,747	168,384	37,048	51,167	102,234	38,375
FSD 575		315	333	1199		25	75,043	204,642	45,026	62,185	124,370	46,639
HSD 662	8.5	360	21	74	10,000	6	4642	12,659	2,785	3847	7694	2,885
HSD 722		400	23	82		7	5116	13,951	3,070	4239	8478	3,179
HSD 782		450	25	88		7	5521	15,056	3,313	4575	9150	3,431
HSD 842		500	26	94		8	5904	16,100	3,542	4893	9786	3,670

Savings potential for 1500 hrs/yr

Savings potential for 2000 hrs/yr

*) 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: $\frac{\text{20.2 kW x 2000 hrs/yr}}{\text{0.9 x 9.861 kWh/l}}$ 0.60 €/l **= € 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: $\frac{\text{20.2 kW x 2000 hrs/yr}}{\text{1.05 x 10.2 kWh/m³}}$ x 0.75 €/l **= € 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	Motor rated power	Maximum available heating capacity		Heated water volume Heated to 70 °C		Installation of the PTG system	Potential fuel oil savings			Potential natural gas savings			
								Fuel oil	CO_2	Heating cost savings	Natural gas	CO_2	Heating cost savings	
	bar	kW	kW	MJ/h *)	(ΔT 25 K) m³/h	(ΔT 55 K) m³/h	Int./ext.	l	kg	€/Year	m³	kg	€/Year	
SM 10	8	5.5	4.8	17	0.16	0.07	External	811	2212	487	672	1344	504	Savings potential for 1500 hrs/yr
SM 13		7.5	6.6	24	0.21	0.10		1116	3043	670	924	1848	693	
SM 16		9	8.1	29	0.29	0.13		1369	3733	821	1134	2268	851	
SK 22	8	11	9.4	34	0.32	0.15	External	1589	4333	953	1317	2634	988	
SK 25		15	12.0	43	0.41	0.19		2028	5530	1,217	1681	3362	1,261	
ASK 28	8	15	13.6	49	0.47	0.21	Internal	2299	6269	1,379	1905	3810	1,429	
ASK 34		18.5	16.9	61	0.58	0.26		2856	7788	1,714	2367	4734	1,775	
ASK 40		22	19.8	71	0.68	0.31		3347	9127	2,008	2773	5546	2,080	
ASD 35	8.5	18.5	15.2	55	0.52	0.24	Internal	3425	9340	2,055	2838	5676	2,129	Savings potential for 2000 hrs/yr
ASD 40		22	18.1	65	0.62	0.28		4079	11,123	2,447	3380	6760	2,535	
ASD 50		25	21.6	78	0.74	0.34		4868	13,275	2,921	4034	8068	3,026	
ASD 60		30	26.6	96	0.92	0.42		5994	16,346	3,596	4967	9934	3,725	
BSD 65	8.5	30	27.1	98	0.93	0.42	Internal	6107	16,654	3,664	5061	10,122	3,796	
BSD 75		37	33.5	121	1.15	0.52		7549	20,586	4,529	6256	12,512	4,692	
BSD 83		45	40.1	144	1.38	0.63		9037	24,644	5,422	7488	14,976	5,616	
CSD 85	8.5	45	38.6	139	1.33	0.60	Internal	8699	23,722	5,219	7208	14,416	5,406	
CSD 105		55	48.4	174	1.67	0.76		10,907	29,743	6544	9038	18,076	6,779	
CSD 125		75	59.0	212	2.03	0.92		13,296	36,258	7978	11,018	22,036	8,264	
CSDX 140	8.5	75	66	238	2.30	1.03	Internal	14,873	40,559	8,924	12,325	24,650	9,244	
CSDX 165		90	80	288	2.80	1.25		18,028	49,162	10,817	14,939	29,878	11,204	
DSD 145	9	75	61	220	2.10	0.96	Internal	13,747	37,488	8,248	11,391	22,782	8,543	
DSD 175	8.5	90	71	256	2.40	1.11		16,000	43,632	9,600	13,259	26,518	9,944	
DSD 205	8.5	110	88	317	3.00	1.38		19,831	54,079	11,899	16,433	32,866	12,325	
DSD 240	8.5	132	107	385	3.70	1.68		24,113	65,756	14,468	19,981	39,962	14,986	
DSDX 245	8.5	132	105	378	3.60	1.64	Internal	23,662	64,526	14,197	19,608	39,216	14,706	
DSDX 305		160	130	468	4.50	2.04		29,296	79,890	17,578	24,276	48,552	18,207	
ESD 375	8.5	200	162	583	5.6	2.54	Internal	36,507	99,555	21,904	30,252	60,504	22,689	
ESD 445		250	187	673	6.4	2.93		42,141	114,919	25,285	34,921	69,842	26,191	
FSD 475	8.5	250	202	727	7.0	3.16	Internal	45,522	124,138	27,313	37,722	75,444	28,292	
FSD 575		315	246	886	8.5	3.85		55,437	151,177	33,262	45,938	91,876	34,454	
HSD 662	8.5	360	291	1048	10.0	4.56	Internal	65,578	178,831	39,347	54,342	108,684	40,757	
HSD 722		400	323	1163	11.1	5.06		72,790	198,498	43,674	60,317	120,634	45,238	
HSD 782		450	348	1253	12.0	5.45		78,423	213,860	47,054	64,986	129,972	48,740	
HSD 842		500	374	1346	12.9	5.86		84,283	229,840	50,570	69,841	139,682	52,381	

*) 1 MJ/h = 1 kW x 3.6

Calculation example for ASD 35

For fuel oil

Maximum available heating capacity:	15.2 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: $\frac{15.2 \text{ kW} \times 2000 \text{ hrs/yr}}{0.9 \times 9.861 \text{ kWh/l}} \times 0.60$ €/l **= € 2,055 per year**

For natural gas

Maximum available heating capacity:	15.2 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: $\frac{15.2 \text{ kW} \times 2000 \text{ hrs/yr}}{1.05 \times 10.2 \text{ kWh/m}^3} \times 0.75$ €/l **= € 2,129 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 Nm³/min	Max. pressure loss mbar	Max. fan flow rate *) m³/h	Fan power supply (400V) A	Fan power *) W	Total mass kg	Dimensions W x D x H mm	Connection nominal width 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

*) at max. pressure

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

Blower (37 kW)	
Flow rate:	30 m³/min
Pressure differential:	600 mbar
Inlet temperature:	0 °C
Discharge temperature:	52 °C

ACA 350	
Heat emission:	25 kW
Air heating output:	2200 m³/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_20)	Connection dimensions		Dimensions		Weight
		Nm³/min	m³/h	Air	Water	∅ cabinet	Length *)	kg
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 m³/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.

LGA InterCert
Certified
QM/EM System
DIN EN ISO 9001:2015/
14001:2015

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