KAESER COMPRESSORS®

Heat Recovery Systems

For hot air and hot water applications

www.kaeser.com

Why choose heat recovery?

In fact, the question should be: Why not? Amazingly, almost 100% of the electrical energy supplied to a rotary screw compressor is converted into heat energy.

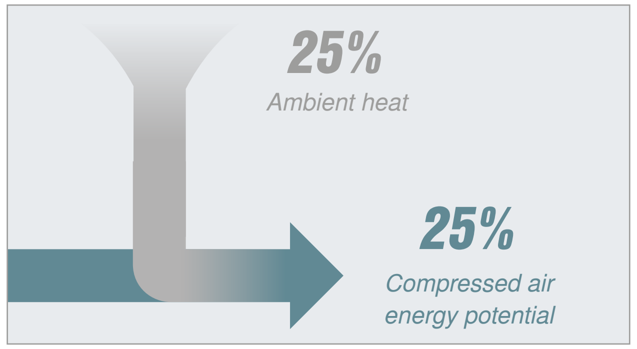
Up to 96% of this energy can be recovered and reused for heating purposes. This not only reduces primary energy consumption, but also significantly improves a company's overall energy balance.

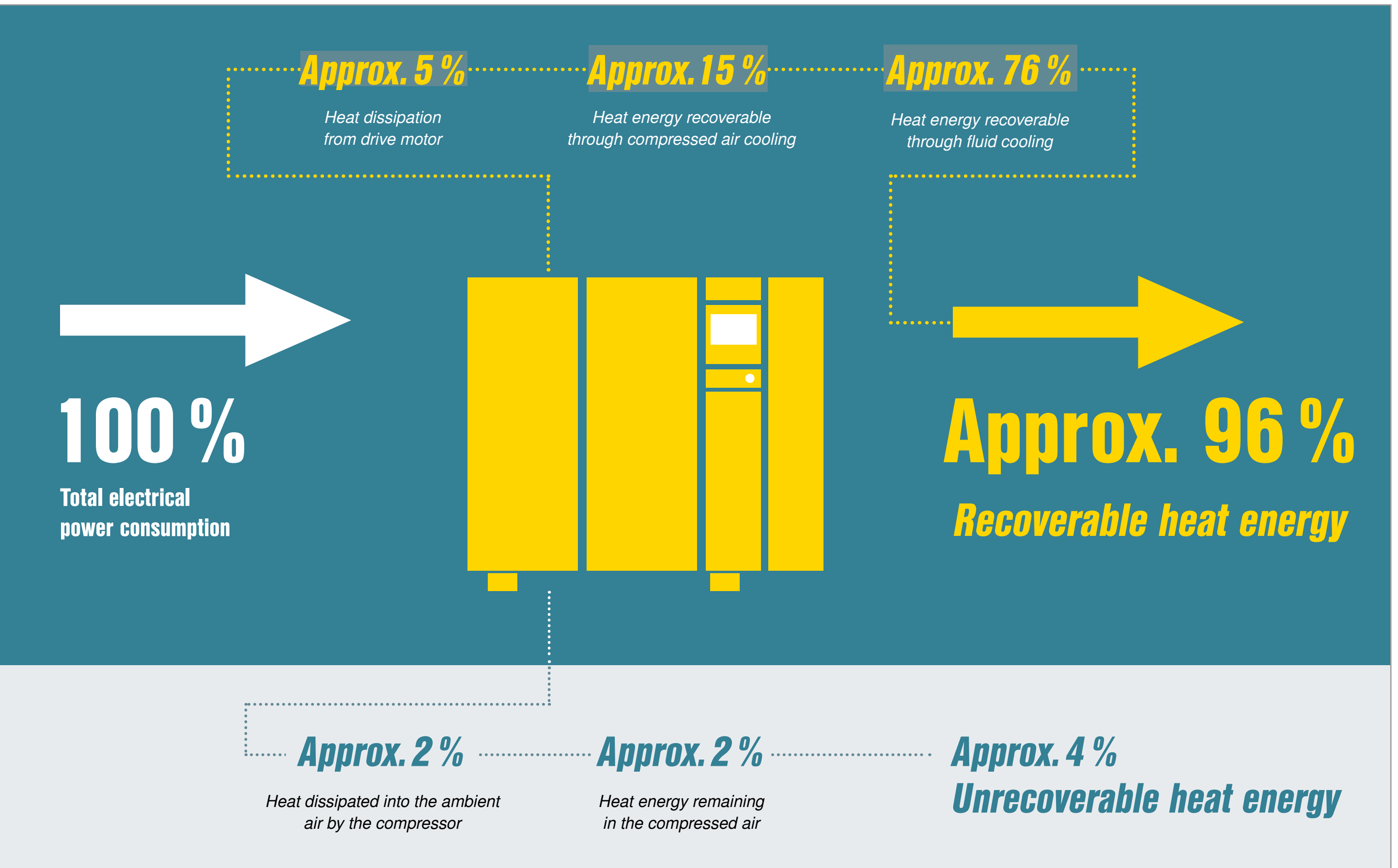
Compressor heat

Rotary screw compressors, boosters and blowers convert almost 100% of the electrical drive energy supplied to them into heat. The heat flow diagram (below) shows how this energy is distributed within the compressor system and how much of it is reusable.

Approximately 96% of the energy input can be recovered for reuse, whilst 2% remains in the compressed air and another 2% is dissipated into the ambient surroundings. But 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 electrical drive energy into heat energy. At the same time, it charges the intake air with energy potential. This corresponds to approximately 25% of the compressor's electrical power consumption. However, this energy only becomes usable when the compressed air expands again at its point of consumption and, in doing so, absorbs heat energy from the ambient surroundings. Of course, the amount of energy available for reuse depends on the pressure and leakage losses within the compressed air system.





Save money whilst conserving the environment

Savings

Gas heating
€ 756 to € 209,525/year

Oil heating
€ 912 to € 252,848/year

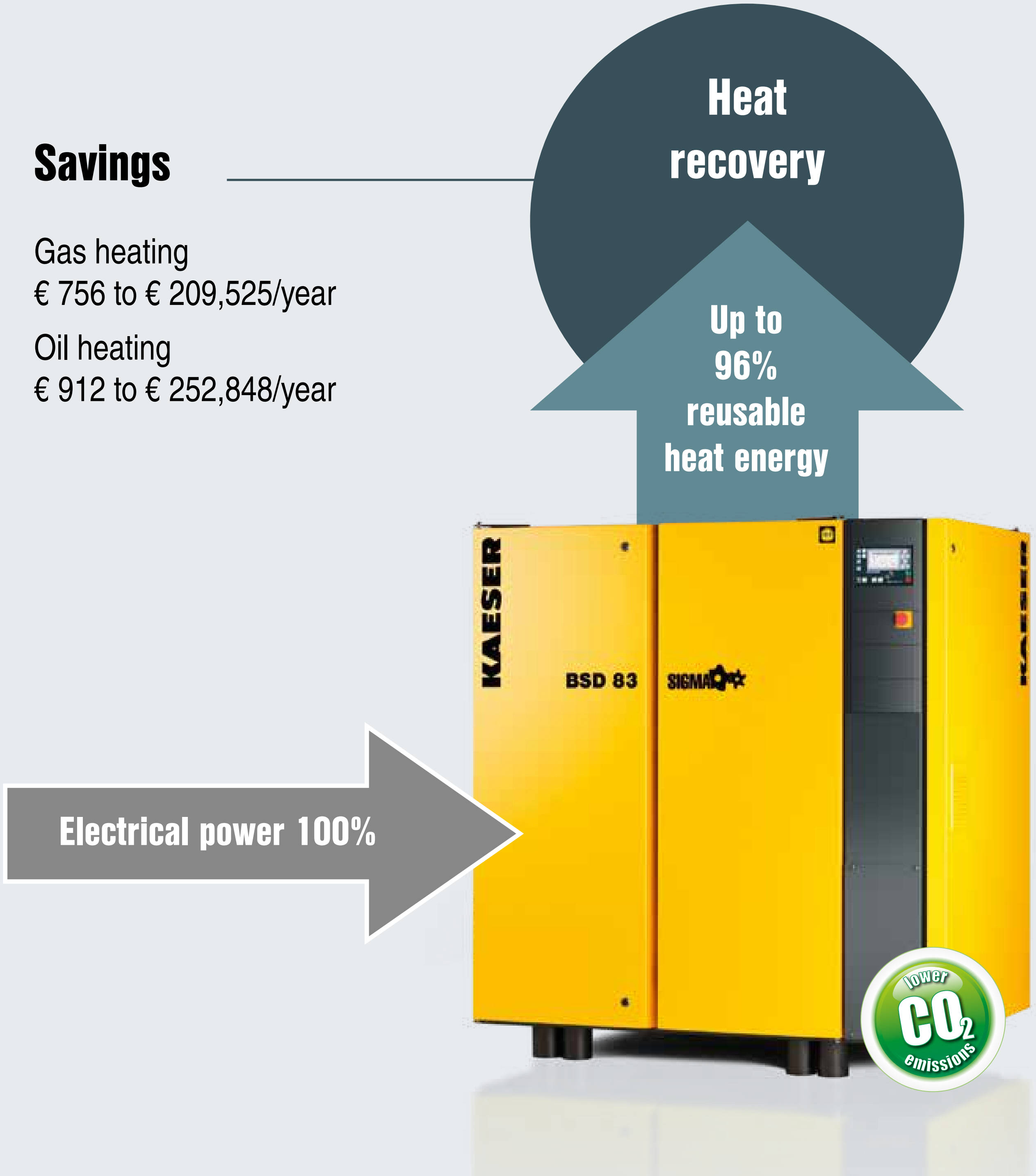


Plate-type heat exchanger systems	Compressor size		
	"Small"	"Medium"	"Large"
Compressor model	SM 16	BSD 83	FSD 475
Drive motor rated power	9 kW	45 kW	250 kW
Potential savings per year: Fuel oil	€ 2,570	€ 27,110	€ 136,565
	4,671 kg CO_2	49,285 kg CO_2	248,274 kg CO_2

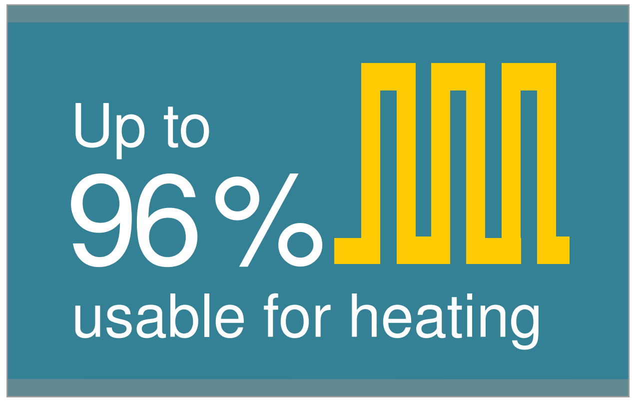
Image: DN 45 C booster with hot air heat recovery

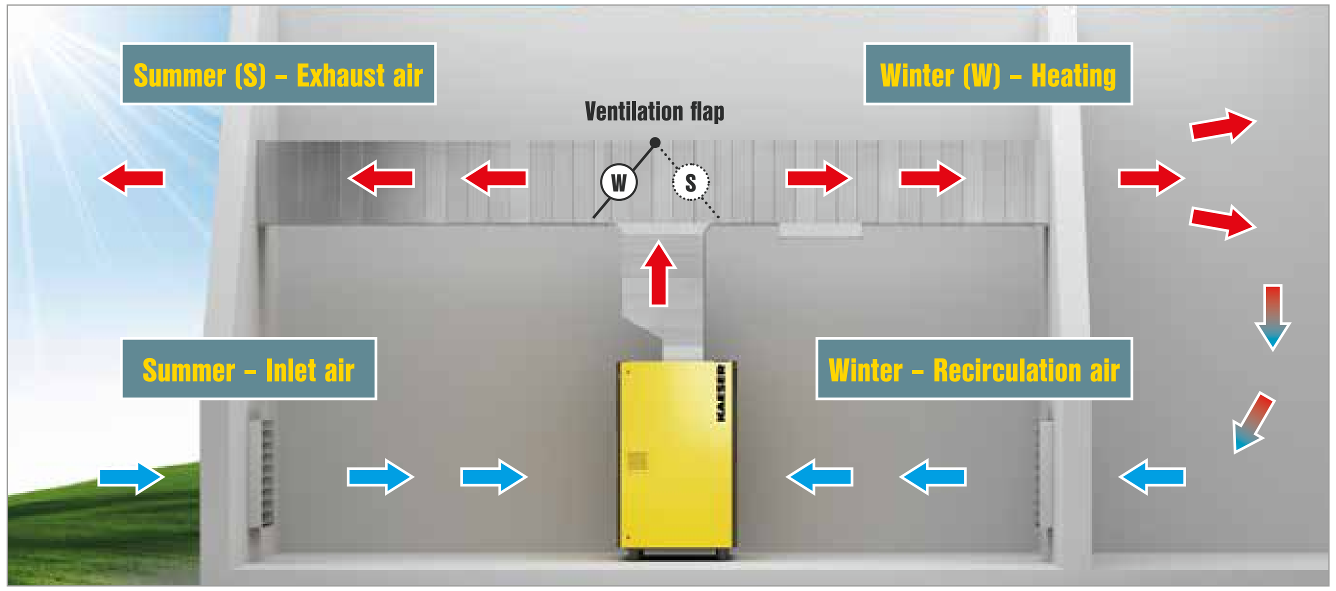
Minimise primary energy consumption for heating

As self-contained complete systems, modern rotary screw compressors, boosters and blowers are especially well suited to heat recovery systems.

In particular, direct use of the recoverable heat via an exhaust air ducting system enables up to 96% of the total energy input to be recovered and reused.

This is the case regardless of whether a fluid-injecting or a dry compression rotary screw compressor, a booster or a blower is involved.

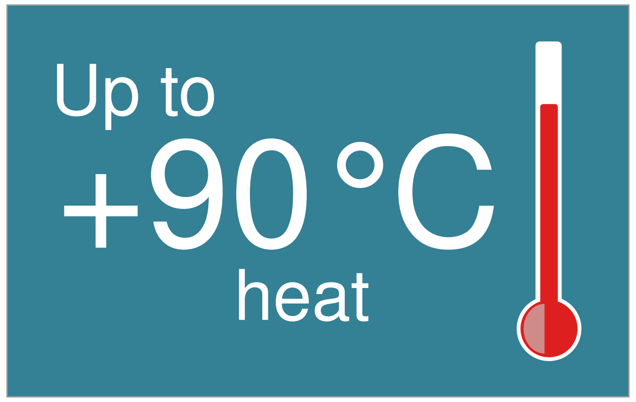




Heating with hot air

By using heated cooling air from the compressor, neighbouring spaces can be heated simply and effectively via exhaust air ducting. In this way, up to 96% of the electrical power supplied to a compressor can be reused – either for the purposes of space heating or for use as process heat. When using recovered compressor exhaust heat for space-heating purposes, exhaust air ducting simply feeds the heated cooling air to wherever it is needed, thereby allowing such spaces as storage areas or workshops to be heated free of charge. A ventilation flap allows the heated cooling air to be conveyed outside during summer operation (S) or to the areas that require heating during winter operation (W).

Minimise primary energy consumption for process, service and hot water heating



By reusing the exhaust heat from the compressor, heat exchanger systems can provide heating and service water on demand at temperatures up to +70 °C, or even +85 °C if required.

For standard applications using heat recovery systems for the production of hot water and service water, PTG plate-type heat exchangers are used.

Special, fail-safe heat exchangers are used in the case of operations without an interconnected water circuit, or for applications with the highest demands of purity for the heated water, such as with cleaning water in the food industry.

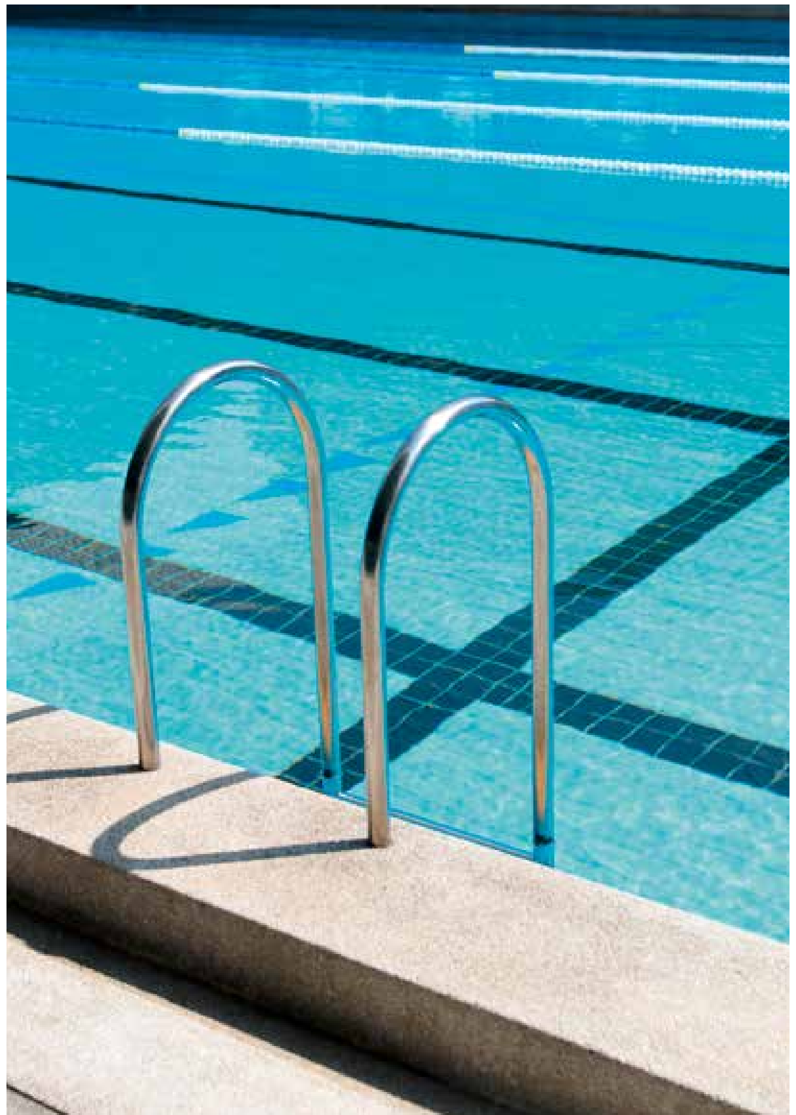
Hot water with temperatures up to +70 °C can easily be produced using a heat exchanger system, with even higher temperatures available upon request.

Feed heat into your heating systems

Up to 76% of the electrical power originally supplied to a compressor can be recovered for use in hot-water heating systems and service water installations. This significantly reduces the amount of primary energy required for heating purposes.

PTG plate-type heat exchanger

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



Equipment for rotary screw compressors

Hot air heat recovery

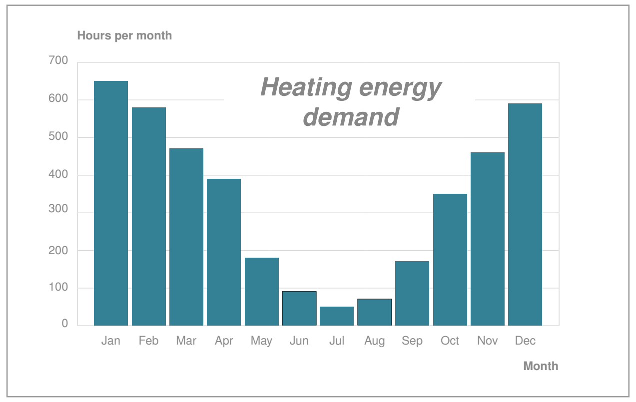
All KAESER rotary screw compressors can be connected to user-provided exhaust air ducting, allowing the heated cooling air to be used for the purposes of space heating. Possible applications include drying processes, heating of halls and buildings, air curtain systems and the preheating of burner air.

PTG plate-type heat exchanger system

Rotary screw compressors from the SM series (from 5.5 kW) and upwards can be equipped with PTG systems. Depending on the size of the system, the PTG heat exchanger can either be integrated into the compressor or installed externally. Possible areas of application: Supplying heat for central heating systems, laundry facilities, 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 exchanger

For cases where the cooling water quality is inadequate (e.g. hard, contaminated cooling water or seawater with high salt content), special shell and tube heat exchangers are optionally available. Our compressed air specialists can advise you regarding the right design for your particular application.



Heating – not just 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 throughout the year, e.g. for supplying hot water. This means that the energy demand for heating is actually approximately 4000 hours per year.

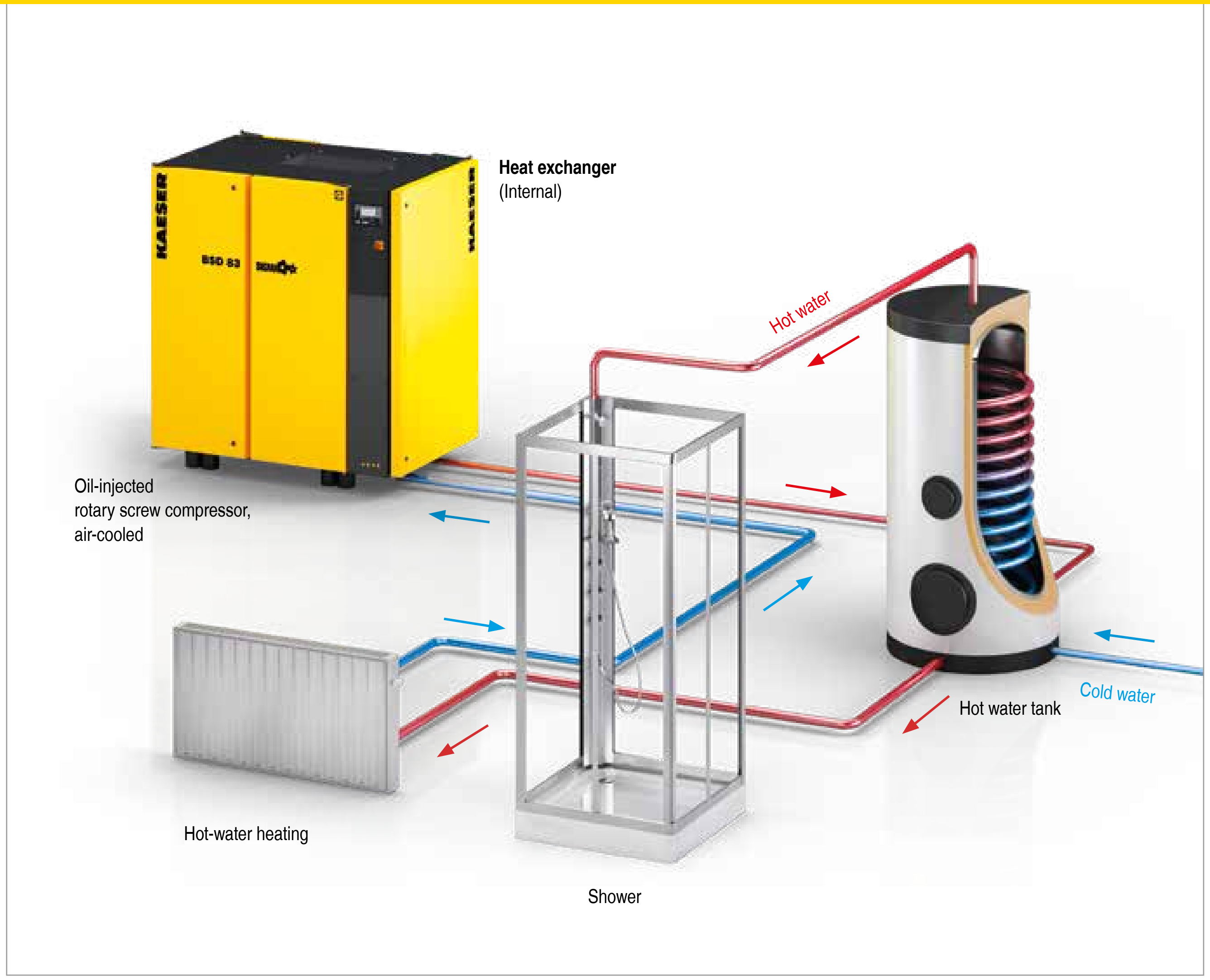


Image: Heat recovery process. Potable water applications only possible in conjunction with special, safety heat exchanger

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

Technical specifications for... ...rotary screw compressors

Hot air

Type	At max. gauge pressure	Rated motor power	Maximum available heat output		Usable hot air volume	Cooling air heated by	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
Savings potential for 2000 hrs/yr												
SX 3	8	2.2	2.7	10	1000	8	608	1658	912	504	1008	756
SX 4		3	3.4	12	1000	10	766	2089	1149	635	1270	953
SX 6		4	4.4	16	1000	13	992	2705	1488	822	1644	1233
SX 8		5.5	6.0	22	1300	14	1352	3687	2028	1120	2240	1680
SM 10	8	5.5	6.8	25	2100	10	1532	4178	2298	1270	2540	1905
SM 13		7.5	9.1	33		13	2051	5593	3077	1699	3398	2549
SM 16		9	11.1	40		16	2501	6820	3752	2073	4146	3110
SK 22	8	11	13.2	48	2500	16	2975	8113	4463	2465	4930	3698
SK 25		15	16.5	59	3000	17	3718	10,139	5577	3081	6162	4622
ASK 28	8	15	18.4	66	4000	14	4147	11,309	6221	3436	6872	5154
ASK 34		18.5	22.8	82	4000	17	5138	14,011	7707	4258	8516	6387
ASK 40		22	26.8	96	5000	16	6040	16,471	9060	5005	10,010	7508
Savings potential for 4000 hrs/yr												
ASD 35	8.5	18.5	19.9	72	3800	16	8969	24,458	13,454	7432	14,864	11,148
ASD 40		22	23.5	85	3800	19	10,592	28,884	15,888	8777	17,554	13,166
ASD 50		25	28.0	101	4500	19	12,620	34,415	18,930	10,458	20,916	15,687
ASD 60		30	34.6	125	5400	19	15,595	42,528	23,393	12,923	25,846	19,385
BSD 65	8.5	30	35.2	127	6500	16	15,865	43,264	23,798	13,147	26,294	19,721
BSD 75		37	43.4	156	8000	16	19,561	53,343	29,342	16,209	32,418	24,314
BSD 83		45	52.0	187	8000	20	23,437	63,913	35,156	19,421	38,842	29,132
CSD 90	8.5	45	51	184	8000	19	22,986	62,683	34,479	19,048	38,096	28,572
CSD 110		55	61	220	9500	19	27,493	74,973	41,240	22,782	45,564	34,173
CSD 130		75	74	266	11,000	20	33,352	90,951	50,028	27,638	55,276	41,457
CSDX 145	8.5	75	84	302	11,000	23	37,860	103,244	56,790	31,373	62,746	47,060
CSDX 175		90	101	364	13,000	23	45,522	124,138	68,283	37,722	75,444	56,583
DSD 145	9	75	82	295	11,000	22	36,958	100,784	55,437	30,626	61,252	45,939
DSD 175	8.5	90	96	346	13,000	22	43,268	117,992	64,902	35,854	71,708	53,781
DSD 205	8.5	110	120	432	17,000	21	54,085	147,490	81,128	44,818	89,636	67,227
DSD 240	8.5	132	145	522	20,000	22	65,353	178,218	98,030	54,155	108,310	81,233
DSDX 245	8.5	132	143	515	21,000	20	64,451	175,758	96,677	53,408	106,816	80,112
DSDX 305		160	174	626		25	78,423	213,860	117,635	64,986	129,972	97,479
ESD 375	8.5	200	221	796	30,000	22	99,607	271,628	149,411	82,540	165,080	123,810
ESD 445		250	254	914	34,000	22	114,480	312,187	171,720	94,865	189,730	142,298
FSD 475	8.5	250	274	986	40,000	21	123,494	336,768	185,241	102,334	204,668	153,501
FSD 575		315	333	1199		25	150,086	409,285	225,129	124,370	248,740	186,555
HSD 662	8.5	360	21	76	10,000	6	9465	25,811	14,198	7843	15,686	11,765
HSD 722		400	24	86		7	10,817	29,498	16,226	8964	17,928	13,446
HSD 782		450	25	90		7	11,268	30,728	16,902	9337	18,674	14,006
HSD 842		500	28	101		8	12,620	34,415	18,930	10,458	20,916	15,687

*) 1 MJ/h = 1 kW x 3.6

Savings calculation example for ASD 50

For fuel oil

Maximum available heat output:	28.0 kW
Calorific value per litre of fuel oil:	9861 kWh/l
Fuel oil heating efficiency:	90%
Price per litre of fuel oil:	€ 1.50/l

Cost savings: $\frac{28.0\text{ kW x 4000 hrs/yr}}{0.90\text{ x 9861 kWh/l}}$ x € 1.50/l **= € 18,930 per year**

For natural gas

Maximum available heat output:	28.0 kW
Calorific value per m³ of natural gas:	10.2 kWh/m³
Natural gas heating efficiency:	105 %
Price per m³ of natural gas:	€ 1.50/m³

Cost savings: $\frac{28.0\text{ kW x 4000 hrs/yr}}{1.05\text{ x 10.2 kWh/m}^3}$ x € 1250 /m³ **= € 15,686 per year**

Note: The potential energy savings indicated are based on compressors at operating temperature and max. gauge pressure (8.0 / 8.5 / 9.0 bar). At other pressures, values may vary.

Hot water

Type	At max. gauge pressure	Rated motor power	Maximum available heat output		Hot water volume (heating to 70°C)		PTG system location	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
Savings potential for 2000 hrs/yr													
SM 10	8	5.5	4.5	16	0.16	0.07	External	1014	2765	1521	840	1680	1260
SM 13		7.5	6.2	22	0.21	0.10		1397	3810	2096	1158	2316	1737
SM 16		9	7.6	27	0.29	0.13		1713	4671	2570	1419	2838	2129
SK 22	8	11	9.4	34	0.32	0.15	External	2118	5776	3177	1755	3510	2633
SK 25		15	12.0	43	0.41	0.19		2704	7374	4056	2241	4482	3362
ASK 28	8	15	13.6	49	0.47	0.21	Internal	3065	8358	4598	2540	5080	3810
ASK 34		18.5	16.9	61	0.58	0.26		3808	10,384	5712	3156	6312	4734
ASK 40		22	19.8	71	0.68	0.31		4462	12,168	6693	3697	7394	5546
Savings potential for 4000 hrs/yr													
ASD 35	8.5	18.5	15.2	55	0.52	0.24	Internal	6851	18,683	10,277	5677	11,354	8516
ASD 40		22	18.1	65	0.62	0.28		8158	22,247	12,237	6760	13,520	10,140
ASD 50		25	21.6	78	0.74	0.34		9735	26,547	14,603	8067	16,134	12,101
ASD 60		30	26.6	96	0.92	0.42		11,989	32,694	17,984	9935	19,870	14,903
BSD 65	8.5	30	27.1	98	0.93	0.42	Internal	12,214	33,308	18,321	10,121	20,242	15,182
BSD 75		37	33.5	121	1.15	0.52		15,099	41,175	22,649	12,512	25,024	18,768
BSD 83		45	40.1	144	1.38	0.63		18,073	49,285	27,110	14,977	29,954	22,466
CSD 90	8.5	45	39.9	144	1.37	0.62	Internal	17,983	49,040	26,975	14,902	29,804	22,353
CSD 110		55	48.8	172	1.65	0.75		21,544	58,750	32,316	17,852	35,704	26,778
CSD 130		75	57.8	211	1.99	0.91		26,051	71,041	39,077	21,587	43,174	32,381
CSDX 145	8.5	75	66	238	2.30	1.03	Internal	29,747	81,120	44,621	24,650	49,300	36,975
CSDX 175		90	79	284	2.70	1.24		36,606	97,098	53,409	29,505	59,010	44,258
DSD 145	9	75	61	220	2.10	0.96	Internal	27,493	74,973	41,240	22,782	45,564	34,173
DSD 175	8.5	90	71	256	2.40	1.11		32,000	87,264	48,000	26,517	53,034	39,776
DSD 205	8.5	110	88	317	3.00	1.38		39,662	108,158	59,493	32,866	65,732	49,299
DSD 240	8.5	132	107	385	3.70	1.68		48,226	131,512	72,339	39,963	79,926	59,945
DSDX 245	8.5	132	105	378	3.60	1.64	Internal	47,324	129,053	70,986	39,216	78,432	58,824
DSDX 305		160	129	464	4.40	2.04		58,142	158,553	87,213	48,179	96,358	72,269
ESD 375	8.5	200	162	583	5.60	2.54	Internal	73,015	199,112	109,523	60,504	121,008	90,756
ESD 445		250	187	673	6.40	2.93		84,283	229,840	126,425	69,841	139,682	104,762
FSD 475	8.5	250	202	727	7.00	3.16	Internal	91,043	248,274	136,565	75,444	150,888	113,166
FSD 575		315	246	886	8.50	3.85		110,874	302,353	166,311	91,877	183,754	137,816
HSD 662	8.5	360	291	1048	10.00	4.56	Internal	131,156	357,662	196,734	108,683	217,366	163,025
HSD 722		400	323	1163	11.10	5.06		145,579	396,994	218,369	120,635	241,270	180,953
HSD 782		450	348	1253	12.00	5.45		156,847	427,722	235,271	129,972	259,944	194,958
HSD 842		500	374	1346	12.90	5.86		168,565	459,677	252,848	139,683	279,366	209,525

*) 1 MJ/h = 1 kW x 3.6

Savings calculation example for ASD 50

For fuel oil

Maximum available heat output:	21.6 kW
Calorific value per litre of fuel oil:	9861 kWh/l
Fuel oil heating efficiency:	90%
Price per litre of fuel oil:	€ 1.50/l

Cost savings: $\frac{21.6\text{ kW x 4000 hrs/yr}}{0.9\text{ x 9861 kWh/l}}$ x € 1.50/l **= € 14,603 per year**

For natural gas

Maximum available heat output:	21.6 kW
Calorific value per m³ of natural gas:	10.2 kWh/m³
Natural gas heating efficiency:	105 %
Price per m³ of natural gas:	€ 1.50/m³

Cost savings: $\frac{21.6\text{ kW x 4000 hrs/yr}}{1.05\text{ x 10.2 kWh/m}^3}$ x € 1.50 /m³ **= € 12,101 per year**

Note: The potential energy savings indicated are based on compressors at operating temperature and max. gauge pressure (8.0 / 8.5 / 9.0 bar). At other pressures, values may vary.

Heat recovery systems for... ...blowers

Hot air

The Air-Cooled Aftercooler (ACA) is an air/air heat exchanger. Process air is cooled in a cross-flow process, whereby ambient air is heated via a thermal energy exchange. In terms of a medium supply, only an electrical connection for the fan is needed. At an ambient temperature of +20 °C, for example, the process air flowing into the cooler can be cooled down from +150 °C to +30 °C. The ACA offers particular advantages when it comes to the pneumatic conveying of temperature-sensitive bulk materials. Furthermore, should a production hall need to be heated during the winter, the ACA can do that as well. The exhaust air flow from the cooler contains up to 75% of the electrical power in the form of blower heat. To maximise the energy gain and ensure optimum cooling efficiency, the maximum pressure loss is no more than 35 mbar. An integrated thermostat monitors operation of the unit by detecting the process air discharge temperature and activates a floating contact by means of an adjustable trigger point.

Application examples

- Cooling of process air from blowers, e.g. for bulk materials conveying
- Space heating for production halls

Image: DC 236 C with ACA compressed air aftercooler

Hot water

The water-cooled WRN aftercooler is a shell and tube heat exchanger. With this system, the process air passes through multiple cooling pipes, around which water flows. The water serves as both a cooling and a heat-transfer medium. This type of heat exchanger is individually customised for each project, in order to ensure that the drop in process air temperature and the increase in water temperature match the operator's requirements precisely. To minimise pressure loss resulting from the additional power consumption of the blower and achieve maximum heat transfer, a variety of cooling pipe geometries are used. Furthermore, several different materials can be used for the cooling pipes, depending on the quality of the water supply. The cooler shrouding is enamel coated. The maximum achievable water temperature for the return flow is approx. 5K below the process air inlet temperature inside the heat exchanger.

Application examples

- Integration into heating circuits to raise return air temperature
- Integration into heat pump circuits
- Floor heating
- Sludge drying

Image: FBS 660 S SFC with shell and tube heat exchanger

Technical specifications: Heat recovery systems...

Hot air

Model	Max. process air flow rate	Max. pressure loss	Max. fan flow rate *)	Fan power supply (400V)	Fan power *)	Total weight	Dimensions W x D x H	Connection nominal width
	m³/min at STP	mbar	m³/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

*) At max. thrust

Savings calculation example for ACA 350 (production hall heating)

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

ACA 350	
Heat output:	25 kW
Air heating capacity:	2200 m³/h from 0 to +35°C
Process air pressure loss:	35 mbar = 2.2 kW

Cost savings approx. € 16,900 per year*

* Calculation as per rotary screw compressors for fuel oil heating

...for blowers

Hot water

Model	Connection nominal width	Max. flow rate, blower air	Max. flow rate, hot water	Connection dimensions		Dimensions		Weight
	DN	m³/min at STP	m³/h	Air	Water	∅ Shrouding	Length *)	kg
WRN 50 smooth	125	15	1	DN 125, PN 16	1 ¼	168	1410	71
WRN 90 smooth	200	30	1.5	DN 200, PN 16	1 ¼	245	1430	145
WRN 130 smooth	250	42	2	DN 250, PN 10	1 ½	273	1441	225
WRN 170 smooth	300	57	2.5	DN 300, PN 10	2	324	1441	280
WRN 250 smooth	350	75	3	DN 350, PN 10	DN 65, PN 16	375	1641	400
WRN 350 smooth	450	108	3.5	DN 450, PN 10	DN 80, PN 16	450	1649	590
WRN 450 smooth	500	145	4.5	DN 500, PN 10	DN 100, PN 16	519	1655	690

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

Savings calculation example for WRN 170 (supplementary heating)

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

WRN 170	
Heat output:	14 kW
Hot water generation:	600 l/h water from +25°C to +45°C
Process air pressure loss:	20 mbar = 2 kW (approx. 1.2 kW more at blower)

Cost savings approx. € 9,460 per year*

* Calculation as per rotary screw compressors for fuel oil heating

More compressed air for less energy

The world is our home

As one of the world's largest manufacturers of compressors, blowers and compressed air systems, KAESER KOMPRESSOREN is represented throughout the world by a comprehensive network of wholly owned subsidiaries and authorised distribution partners in over 140 countries.

By offering innovative, efficient and reliable products and services, KAESER KOMPRESSOREN's experienced consultants and engineers work in close partnership with customers to enhance their competitive edge and to develop progressive system concepts that continuously push the boundaries of performance and technology. Moreover, decades of knowledge and expertise from this industry-leading systems provider are made available to each and every customer via the KAESER group's advanced global IT network.

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

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