INFO

HTK

Hybrid dry cooler

The reference for
hybrid dry cooling

100 – 4,000 kW

JÆGGI Hybridkühler
Hybridcoolers

JAEGGI – The Original

Since 1929, JAEGGI has been engaged in the development, production and sale of heat exchangers. Since 1995, the company has been part of the Güntner Group, a worldwide established manufacturer of components for refrigeration, air-conditioning technology and industrial applications with a total workforce of 2,600 people. Our production centres in Europe, America and Asia secure us direct market access and spare parts service worldwide.

JAEGGI places efficiency and eco-friendliness on an equal footing. Our products and services make an active contribution to lowering your operating costs and conserving resources.

Our coolers are tested for hygiene conformity and aerosol emissions. The ISO 9001 quality management system, carried out by the Swiss Association for Quality and Management Systems SQS, guarantees our customers premium quality and maximum reliability anywhere in the world.

Hybrid dry coolers from JAEGGI

JAEGGI is not only the inventor of the hybrid dry cooler, the company is also the technology and market leader.

Innovative, technological details show: JAEGGI is consistently developing its intelligent technologies. As an expert in hybrid heat exchangers with a high level of system competence, JAEGGI delivers premium quality and outstanding service.

Hybrid dry coolers

The hybrid dry cooler is a combination of air-cooled dry coolers and closed evaporative cooling towers, thus combining the advantages of conventional dry and wet cooling in a single product.

Designing hybrid dry coolers

Design software optimises the dry cooler for each individual application – taking into account the annual temperature variation at the site and the plant's expected load profile.

The result: Plume-free hybrid dry coolers with minimal noise emission and low water and energy consumption. Thanks to its lower operating costs, the payback period is quite short.

Operating characteristics of hybrid dry coolers

JAEGGI hybrid coolers can be operated like conventional dry coolers without wetting the heat exchangers. The energy is dissipated to the ambient air via convection.

At high external temperatures or higher plant loads, wetting the heat exchangers increases the hybrid cooler's performance by a factor of two or three compared to dry operation: The system is then cooled by a combination of convection and evaporation.

Both modes offer an excellent dry cooler performance with a small footprint and low operating costs. The cooling limit, i.e. the theoretically best return temperature possible for the hybrid dry cooler, is 4 Kelvin higher than the wet bulb temperature of the ambient air.

When it needs to be quiet:
JAEGGI – The Original

Modular system for easy on-site assembly

– Pre-assembled unit
– Large-scale units are delivered with unmounted fan units
– Delivered on a low-bodied vehicle
– In inclement weather, the unit may be delivered in a plastic film wrapping
– Bringing-in procedure on the site requires only few crane lifts

Environmental Hygiene in Focus

Recognised Rules of the Technology

In Germany, the recognised technical regulations and the VDI guideline 2047-2 have been merged into one document. Furthermore, the latest findings and important notes and templates for the operation and documentation of such cooling systems have been incorporated into the revised VDMA Standard Sheet 24649. In UK and Ireland, the established guidelines of ACOP L8 have been supplemented by the issue of HSG274 Part 1. Similar to the VDI, HSG274 Part 2 has an increased requirement for risk-based assessment of each system based on their individual merits. It goes on to provide further differentiation between intrinsically safer dry/wet hybrid cooling systems and traditional higher risk cooling towers and advises that cooling systems should be designed and installed with features which minimise legionella risk.
These rules ensure that all the information necessary for the hygienically safe operation of cooling systems are available to plant designers, engineers and operators, but also to component suppliers.

Hygiene Compliance Testing of the Units

In pursuit of the highest possible safety compliance of its Hybrid Dry Coolers, JAEGGI had the sophisticated design of its units officially inspected by an independent body. As part of the hygiene compliance inspection, the Hygiene Institute of the Ruhr (Institute of Environmental Health & Toxicology) has confirmed the compliance of the units with the relevant requirements of VDI 2047-2.

Independent from this, JAEGGI naturally takes the requirements of the relevant laws and standards of other countries into consideration when constructing their units. In particular, JAEGGI has engaged with independent advice from one of the co-authors of ACOP L8 to ensure that their Hybrid Dry Coolers remain fully compliant with all current UK guidelines. It has been confirmed, both in the laboratory and in measurements in the field, that JAEGGI units do not generate any measurable aerosols when used as specified, and are thus tested for legionella-safety.

Skilled Support through all Life Stages provided by Certified Staff

Moreover, the staff of JAEGGI are skilled in matters of hygiene advice. From the planning phase with technical advice and documentation through to a risk analysis for Hybrid Dry Coolers regarding hygiene and correct service and maintenance procedures, they are always available with help and advice throughout the lifetime of your equipment. JAEGGI not only attaches specific value to unit examination, but also to the expertise and consulting skills of its employees, not just in service but also in sales. In this regard, together with the service staff, numerous members of staff from the sales department have successfully undergone „hygiene training according to VDI 2047 Part 2“ to ensure the hygienic operation of these modern high-efficiency dry/wet cooling systems. This training is provided only by VDI and approved VDI training partners and is completed with a written exam according to the requirements of VDI.

Wet or dry operation

JAEGGI hybrid dry coolers can be used either wet or dry.

Dry operation

– With no wetting of the heat exchanger it operates like a conventional finned dry cooler
– Energy is dissipated to the ambient air by convection

Wet operation

– For high external temperatures or higher cooling loads
– Two or three times the performance by wetting the heat exchangers
– Energy dissipated by convection and evaporation

Both modes can provide excellent dry cooler performance with a small footprint and low operating costs. The laws of physics constrain the achievable coolant outlet temperature of the *HTK Hybrid High Performance* to approximately 4 Kelvin above the wet bulb temperature of the ambient air.

Benefit from our experience

Our experts will design the hybrid dry cooler specifically for your application and optimise it for its intended operation in the plant.

This takes into account:
– The climatic situation at the site,
– the annual temperature variation, and
– the plant's expected load characteristics.

This is the only way of ideally dimensioning the dry coolers and minimising the cost of operating the entire plant. If you wish, we will also supply you with an efficiency calculation.

When it needs to be efficient:
JAEGGI – The Original

View of a standard hybrid cooler system (without self-draining function)

1. Fan
2. Fan drive
3. Heat exchanger
4. Air flow
5. Flow
6. Return
7. Pump for primary circuit
8. Heat source
9. Make-up water
10. Low volume basin (used only in wetted mode)
11. Primary circuit
12. Blowdown
13. Wetting water circuit
14. Conductivity measurement

Operating characteristics hybrid dry cooler

Hybrid dry coolers dissipate thermal energy to the environment mainly as pure dry coolers. At higher thermal loads and external temperatures, the finned heat exchangers are wetted. The heat is then dissipated mainly via the evaporation of the wetting water.

Figure 1 exemplifies an annual temperature variation and the operating range of the hybrid dry cooler. In the changeover area, the hybrid dry cooler performs a load-dependent switchover to wet operation.

The greater the plant heat load, the earlier the heat needs to be dissipated by the evaporation of water. The switch-point from dry cooling to hybrid operation depends on the operating conditions and the unit design.

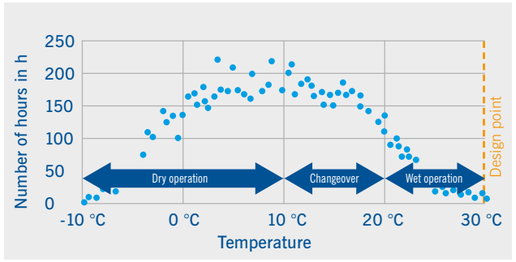


Figure 1: Average annual ambient temperature range (source: Zurich Metronom 1995 - 2005)

Hybrid dry cooler instead of cooling tower

Your advantages

- Low cooling water temperature
- Little space requirement
- No contamination of the primary circuit
- Up to 10 dB quieter than a cooling tower
- Hygienic operation with little maintenance work
- Perfect access for inspection and maintenance
- Plume-free throughout the year

Construction can be modified to suit your particular premises

- Modular series with a range of dimensions and heights
- Height: 2 – 5 m
- Length: 3 – 12 m
- Power range: 100 – 4,000 kW

	Closed cooling tower	Hybrid dry cooler	
Total capacity	1,000 kW	1,000 kW	
Cooling medium	30 % glycol/70 % water	30 % glycol/70 % water	
Cooling medium temperatures	34/29 °C	34/29 °C	
Design condition, wetted	34 °C/31.3 %	34 °C/31.3 %	
Design condition, dry	-	18 °C	
Concentration factor	3	3	
Power consumption in kWh per year	47,877	47,877	
Additional water costs in €/m³	3	3	
Wastewater costs in €/m³	1	1	
Electricity contract price in €/kWh	0.1	0.1	
Investment costs	35,000 €	120,470 €	**3.4 times the investment**
Water costs in € per year	41,068 €	3,884 €	**90 % saved**
Operating costs in € per year*	53,434 €	25,736 €	**52 % saved**

*Operating costs include costs for water and electricity according to the unit design and usual maintenance and depreciation costs

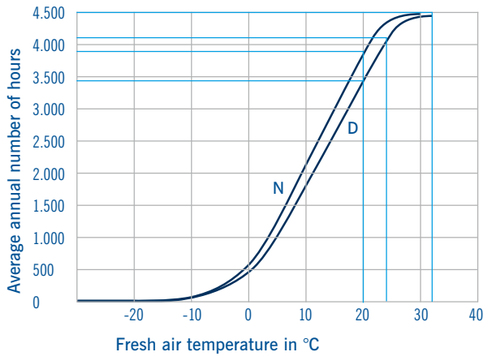
HTK optimised for resource-saving operation

Dry cooling plants are designed for specified installation conditions (installation site, design temperature and humidity). As the temperature variation on page 10 shows, these conditions occur only a few hours per year. This is why a meaningful comparison of unit or plant concepts based on design data is not possible.

For evaluating the annual operating costs, it is necessary to consider the actual external temperature conditions and their statistically occuring numbers of hours and the energy and water consumption of the components used.

Figure 1 shows a simple and clear representation of the temperature frequency. The average annual number of hours represents the occurring external ambient temperatures. The graphical representation of the annual temperature variation here differs from the one on page 10, figure 1.

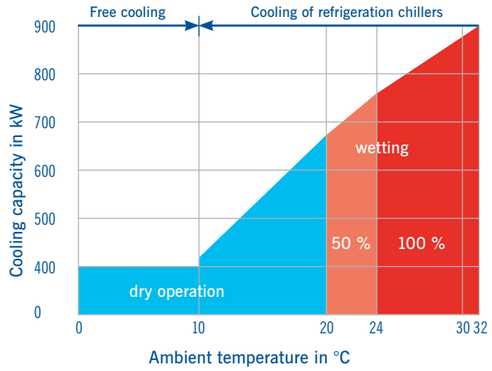
Temperature characteristics (Central Europe)



D = daytime 7 am – 7 pm
N = nighttime 7 pm - 7 am

Figure 1: Temperature frequency

Operating characteristics of the JAEGGI hybrid cooler (example)

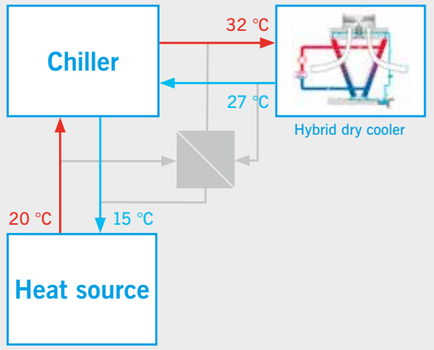


Free cooling: By temporarily switching off the refrigerating machine, a significant amount of electric energy can be saved

Figure 2: Exemplified operating characteristics of the JAEGGI hybrid cooler

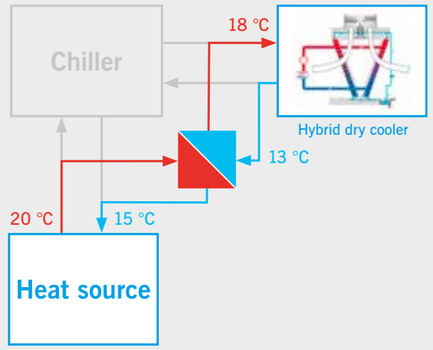
Refrigeration chiller cooling

– High external temperatures
– Efficient cooling of refrigeration chiller
– Energy savings for chiller operation
– Energy savings for evaporative cooling
– Water savings by hybrid dry cooler



Free cooling operation

– Low external temperature
– Energy-saving hybrid cooling
– Chiller switched off



Operating characteristics refrigeration chillers - free cooling

Ambient Air Conditions (Operating Conditions)			Operating hours	Cooler operation		Cooling water		Fan speed	Water consumption		*HTK* energy consumption	*HTK* cooling capacity	Energy consumption of chiller with free cooling	Energy consumption of chiller without free cooling
from [°C]	to [°C]	% RH	[h]	dry	wet	inlet [°C]	outlet [°C]	%	fresh water [m³]	wastewater (E = 3) [m³]	[kWh]	[kw]	[kWh]	[kWh]
-16	-14	0	14	1	0	18	13	42	0	0	20	1,000	0	2,324
-14	-12	0	39	1	0	18	13	45	0	0	68	1,000	0	6,474
-12	-10	0	53	1	0	18	13	48	0	0	115	1,000	0	8,798
-10	-8	0	105	1	0	18	13	53	0	0	292	1,000	0	17,430
-8	-6	0	227	1	0	18	13	58	0	0	831	1,000	0	37,682
-6	-4	0	329	1	0	18	13	64	0	0	1,648	1,000	0	54,614
-4	-2	0	500	1	0	18	13	72	0	0	3,572	1,000	0	83,000
-2	0	0	527	1	0	18	13	83	0	0	5,689	1,000	0	87,482
0	2	0	632	1	0	18	13	97	0	0	11,151	1,000	0	104,912
2	4	82	764	0	1	18	13	72	802	266	6,475	1,000	0	126,824
4	6	79	666	0	1	18	13	81	786	260	7,738	1,000	0	110,556
6	7	0	296	1	0	34	29	52	0	0	818	1,000	49,136	49,136
7	9	0	695	1	0	34	29	57	0	0	2,472	1,000	115,370	115,370
9	11	0	721	1	0	34	29	63	0	0	3,428	1,000	119,686	119,686
11	13	0	682	1	0	34	29	70	0	0	4,487	1,000	113,212	113,212
13	15	0	682	1	0	34	29	79	0	0	6,511	1,000	113,212	113,212
15	17	0	643	1	0	34	29	92	0	0	9,531	1,000	106,738	106,738
17	18	0	297	1	0	34	29	100	0	0	5,648	1,000	49,302	49,302
18	19	64	180	1/2	1/2	34	29	74	191	63	1,532	1,000	29,880	29,880
19	21	62	323	1/2	1/2	34	29	81	378	126	3,490	1,000	53,618	53,618
21	23	53	179	1/2	1/2	34	29	87	238	79	2,401	1,000	29,714	29,714
23	25	52	144	1/2	1/2	34	29	99	215	72	2,788	1,000	23,904	23,904
25	25.1	51	4	1/2	1/2	34	29	100	5	2	69	1,000	664	664
25.1	27	46	45	0	1	34	29	53	88	29	190	1,000	7,470	7,470
27	29	41	10	0	1	34	29	55	21	7	46	1,000	1,660	1,660
29	31	39	3	0	1	34	29	58	7	2	16	1,000	498	498
			8,760						2,731	906	81,026		814,064	1,051,444

Free cooling operation

Refrigerating machine operation

-23% cost reduction

HYBRIMATIC – Intelligent control saves operating costs

The efficient operation of hybrid dry coolers depends very much on the intelligence and strategy of their functional control. The built-in control continually controls all the significant parameters and automatically adapts the operating mode to the current system state. This guarantees a smooth and efficient unit operation and compliance with the predicted consumption values.

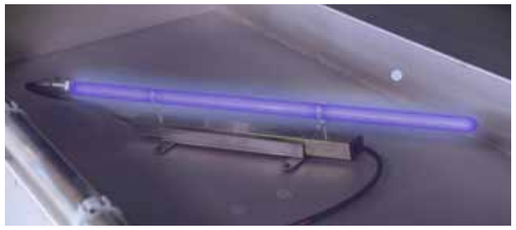
The *HYBRIMATIC* is designed as a programmable logic controller and allows for:
– Control the cooling water outlet temperature
– Wetting water management
– Output of operational and fault signalling
– Communication with building management systems

In addition, the *HYBRIMASTER* controller also maximises energy efficiency and water conservation for hybrid coolers installed in parallel, thus contributing to reducing your operating costs.

Customer benefits from our controller

– Optimised operation of individual units
– Optimised joint operation of up to eight individual units
– Parameters can easily be set for ideal use in a variety of applications
– Low operating costs
– Easily integrated into your building management system by conveying operational messages via contacts or a bus system
– Easy to install, supplied ready for connection
– Compact, adaptable and expandable

Optional equipment for your *HTK*



UV sterilisation

To minimise biological growth in the low volume basin, also includes basin covers. The alternative to biocides.

Anti-pollen filter

To minimise the introduction of biological contaminants into the heat exchanger and the low volume basin

Exhaust attenuators

To further reduce noise emissions

Exhaust air/air side louvres

– Minimises the introduction of contamination when the unit is unused for long periods
– Minimises emergency heating capacity for non-frost-free units

Heater for low volume basin	– Allows for wet operation also during lower external temperatures
Manual or automatic winter curtains	– To minimise the introduction of contamination when the equipment is unused for long periods – To minimise the emergency heating capacity for non-frost-free units
Insulated headers	– To minimise the thermal capacity of non-frost-free units
Draining design	– Used for circuits which are to be drained in case of emergency (plant downtime, danger of freezing...)
Frost protection heating	– Used in cooling circuits which do not have an anti-freeze/glycol filling and, in case of emergency, need to be heated

High-yield investment

Saves money, saves resources

In contrast to conventional, open cooling towers, choosing self-draining *HTK* dry coolers from JAEGGI gives you a resource-efficient unit that rapidly pays for itself.

This unit uses around 70 to 90 % less water than a conventional open cooling tower, which represents a worthwhile saving – particularly for such a long-term durable product. A representative comparison between a wet cooling tower and a hybrid dry cooler from JAEGGI was compiled on the basis of a system in use at a production facility in Frankfurt a. M., operating three shifts for a year-round constant load of 1,000 kW. In this system the coolant temperature was cooled from from 38 °C to 28 °C.

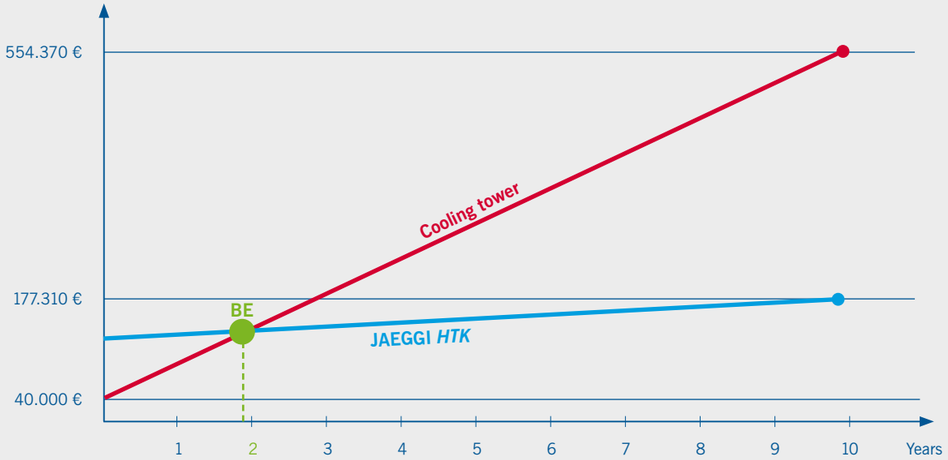
During cooler periods or operation at partial load, the JAEGGI *HYBRIMATIC* controller operates the heat exchangers entirely dry, i.e. with convective heat transfer to the ambient air. Only when dry operation is unable to achieve the required cold water temperature, it switches automatically to the secondary wetted mode. In this particular example, the switchover point for dry operation is at an ambient temperature of 18 °C.

At the Frankfurt a. M. site, the water consumption of the hybrid dry cooler (lost to evaporation and for blowdown at 3-fold concentration) over a period of one year was 1,210 m³ with a wastewater volume of 403 m³. If a wet cooling tower had been installed instead, this would have consumed 15,060 m³ of fresh water and generated 5,020 m³ of wastewater. As you see, in this example, using hybrid dry cooling reduced the water consumption by over 90 %.

Conclusion

Purchasing a hybrid dry cooler not only saves enormous operating costs, it also protects the environment and our dwindling resources such as water. In this example, investing in the *HTK* has already paid for itself after 2 years.

JAEGGI *HTK* soon pays for itself



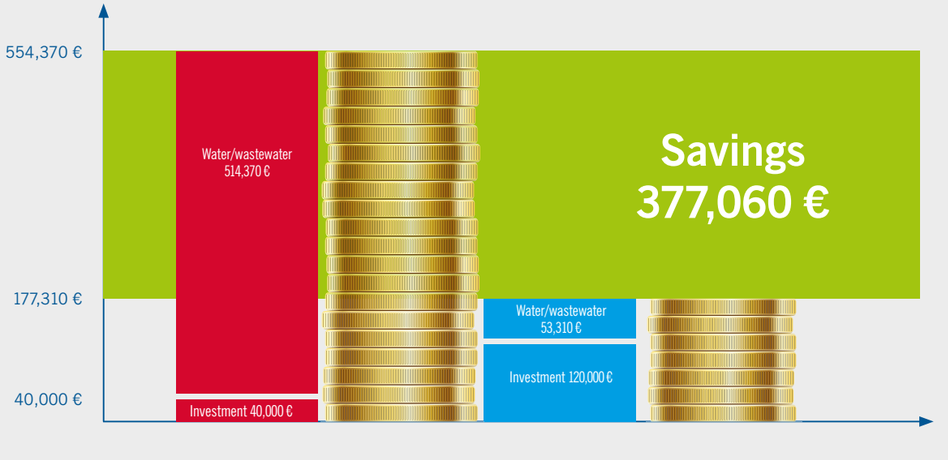
Operating characteristics over one year

Ambient air temperatures (operating state)			Operating hours	Cooler's operating mode		Cooling water		Fan speed	Water consumption		Total energy consumption	Cooling capacity *HTK*
from [°C]	to [°C]	Rh %	[h]	dry	wet	inlet [°C]	outlet [°C]	%	fresh water [m³]	wastewater (E = 3) [m³]	[kWh]	[kw]
-17	-14	0	0	1	0	38	28	29	0	0	0	1,000
-14	-11	0	8	1	0	38	28	31	0	0	4	1,000
-11	-8	0	48	1	0	38	28	33	0	0	32	1,000
-8	-5	0	101	1	0	38	28	36	0	0	84	1,000
-5	-2	0	459	1	0	38	28	39	0	0	488	1,000
-2	4	0	1,854	1	0	38	28	47	0	0	3,435	1,000
4	7	0	1,142	1	0	38	28	52	0	0	2,938	1,000
7	10	0	1,156	1	0	38	28	59	0	0	4,370	1,000
10	13	0	1,068	1	0	38	28	70	0	0	6,498	1,000
13	16	0	1,087	1	0	38	28	85	0	0	12,092	1,000
16	18	0	594	1	0	38	28	100	0	0	10,688	1,000
18	19	66	226	1/2	1/2	38	28	79	226	75	2,156	1,000
19	22	58	497	1/2	1/2	38	28	91	586	194	7,183	1,000
22	23.5	53	189.5	1/2	1/2	38	28	100	244	81	3,542	1,000
23.5	25	50	136.5	0	1	38	28	52	248	83	537	1,000
25	28	41	130	0	1	38	28	55	265	88	563	1,000
28	31	44	57	0	1	38	28	64	131	44	345	1,000
31	34	32	7	0	1	38	28	64	18	6	42	1,000
34	35	32	0	0	1	38	28	67	0	0	0	1,000
			8,760						1,720	571	54,997	

Operating characteristics: 1,000 kW, cooling from 38 to 28 °C with WBT = 21.5 °C

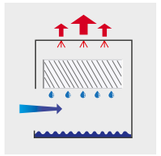
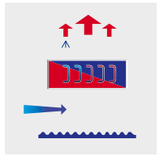
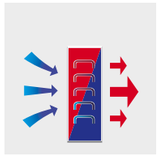
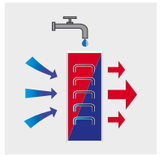
Cost of additional water €/m³	3
Cost of wastewater €/m³	1
Electricity contract price €/kWh	0.1

377,060 € saved in 10 years



System comparison

Comparison and evaluation of the available cooling technologies according to a number of criteria:

	 open cooling tower	 closed cooling tower	 dry cooler	 JAEGGI *HTK*
Low cooling water temperature	⊕ ⊕ ⊕ ⊕	⊕ ⊕ ⊕ ○	⊕ ○ ○ ○	⊕ ⊕ ⊕ ○
No introduction of contamination	⊕ ○ ○ ○	⊕ ⊕ ⊕ ⊕	⊕ ⊕ ⊕ ⊕	⊕ ⊕ ⊕ ⊕
Low energy consumption	⊕ ⊕ ⊕ ○	⊕ ⊕ ⊕ ○	⊕ ⊕ ○ ○	⊕ ⊕ ⊕ ⊕
Low water consumption	⊕ ○ ○ ○	⊕ ○ ○ ○	⊕ ⊕ ⊕ ⊕	⊕ ⊕ ⊕ ○
No aerosols or plumes	⊕ ○ ○ ○	⊕ ○ ○ ○	⊕ ⊕ ⊕ ⊕	⊕ ⊕ ⊕ ⊕
Low sound level	⊕ ○ ○ ○	⊕ ○ ○ ○	⊕ ⊕ ○ ○	⊕ ⊕ ⊕ ○
Investment costs	⊕ ⊕ ⊕ ⊕	⊕ ⊕ ⊕ ○	⊕ ○ ○ ○	⊕ ○ ○ ○

⊕ ○ ○ ○ not so good ⊕ ⊕ ⊕ ⊕ very good

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