

Technical lifetime heat pumps

Industrial Heatpumps 1-50 MW



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Abstract:

1 Introduction

The Norwegian District Heating Association and Hafslund Oslo Celsio AS (Celsio) have asked Norsk Energi for a professional assessment to estimate the technical lifetime of industrial heat pumps between 1-50 MW.

The issue is related to a possible ban on synthetical refrigerants used in large scale industrial heat pumps used in district heating production.

Norsk Energi is an advisory consulting company with a focus on thermal energy plants. We are Norway's leading consultants on heat pump applications in district heating and cooling systems.

2 The difference between small heat pumps and industrial heat pumps between 1-50 MW

In order to determine the technical lifetime of a heat pump system, we suggest to differentiate between standard "shelf ready" heat pumps and large industrial heat pumps.

Large industrial heat pumps with duty 1-50 MW are normally module-based and made up of many different components that can be replaced, if necessary, without the entire heat pump having to be replaced. Large heat pumps are more to be seen as process plants assembled from commercially available parts. In addition, the components often hold industrial standard with high quality and

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sometimes better technology. An example is the turbo compressor which is more robust and long lived compared to other compressor technologies. This contributes to a long technical life.

Smaller heat pumps, e.g. below 1 MW, built by the HVAC industry, is different. The components might be unique, manufacturer specific, often unidentifiable, and not available over time. For such systems, it is normal to replace the entire heat pump assembly when the system does not function satisfactorily. The technical lifetime of smaller heat pump systems is normally around 15 years.



Figure 1 Industrial heat pump

3 Experienced lifetimes industrial heat pumps

In connection with our assistance in various projects, we have investigated operating experiences from existing industrial heat pumps in district heating systems.

Heat pumps installed in a district heating system are not necessarily operated all year round. Other energy sources can be prioritized as base load production, and the heat pumps might be stopped during the summer months when the demand for district heating is low. This means that the heat pumps does not get the same amount of wear and tear as if they were in operation all year round. Experience from investigated facilities shows that industrial heat pumps in district heating system are mainly operated between 50-80% of the time during a year.

Industrial heat pumps installed in the 1980s are still in operation and approaching 35-40 years of life. Through systematic maintenance and replacements, these heat pumps are expected to be in operation for another 15 years or longer. So, in total we expect these heat pumps to be in operation for 50 years.

Installation	Year of delivery	Year in operation	Approx. number of operating hours	Approx number of operation years (full time)	Operating years/year in operation	Source	Heating capacity
Stockholm Martensdal	1986	37				Sewage Water	2*20 000+ 2*30000 kW
Stockholm Solna	1986	37				Sewage water	4*30 000 kW
Ørebro	1985	38				Sewage water	21+20 000 kW
Stockholm Robsten	1986	37				sea water	4*25000 kW
Jarfalla Energi	1985	38				sea Water	2*20 000 kW
Värtan Ropsten	1984 (4)	39	180'000	20,8	0,5	Sea water	6 x 30'000 kW
	1986 (2)	37					6 x 20'000 kW*
Sandvika 1	1988	35	180000	20,5	0,6	Sewage water	2 x 7'000 kW
Kista Akalla	1998	25	120'000	13,7	0,5	District cooling	2 x 9'125 kW
Lysaker	1998	25	130'000	14,8	0,6	Sea water ind.	1 x 4'500 kW
Nimrod	2000-01	22	100'000	11,4	0,5	Sea water ind.	4 x 9'000 kW
Fornebue	2000	23	110'000	12,6	0,5	Sea water ind.	1 x 5'400kW
Fornebue 05	2005	18	90'000	10,3	0,6	Sea water ind.	1 x 8'300 kW
Sandvika 2	2008	15	100'000	11,4	0,8	Sewage water	8'000kW
Skoyen 05	2006	17	73'500	8,4	0,5	Sewage water	18'400 kW
Skoyen 07	2008	15	65'000	7,4	0,5	Sewage water	9'200 kW
Katri Vala	2005	18	100'000	11,4	0,6	Effluent ind.	5 x 18'110 kW
Turku I	2009	14	90'000	10,3	0,7	Effluent	18'000 kW

Figure 2 Industrial heat pumps- year of operation.

4 Our assessment of technical lifetime

Based on the fact that industrial heat pumps consist of replaceable components, normal operating hours in a district heating system, and operating experiences up to 40 years, our assessment is that the expected technical lifetime for such installations is approx. 30-35 years.

With proper maintenance and reinvestment in various individual components, you can expect to operate industrial heat pumps in a district heating system for up to 50 years.

If suitable refrigerants are banned, these heat pumps with turbo compressors cannot be converted to natural refrigerants and they will reach the end of their technical life.

Natural refrigerants are normally more toxic or flammable and require higher safety measures. As a result, the entire energy plant may have to be relocated.