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NEWS LETTER

IEA heat pump center

PERIODICAL OF THE
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Hydroponics of trefoil in the greenhouse, 300 m², in the northern area (43° 46′). Heat pump can be advantageously utilized to keep the solution temperature at about 18 °C (cf. page 19).

Editorial by P. V. Gilli*

Trends in Heat Pump Technology

The point has often been made that the heat pump is competitive and is well established in markets where cooling is required, too. These markets are:

- simultaneous production of cold and heat (double utilization) such as in more recent HVAC applications or in the classical commercial cases of skating rink plus swimming pool, or refrigeration plus hot tap water production; and
- consecutive production of cold and heat in HVAC plants with the same equipment — the heating/cooling heat pump — that is, air cooling and dehumidifying in the hot season; heating and possibly humidifying during the winter period.

The question which is of paramount interest to the heat pump industry today therefore concerns the speed of market penetration of the heat pump in heating-only use, and its foreseeable ultimate limits. Major applications of this kind are: the residential/commercial heating-only heat pump for space heating and hot tap water production, the large heat pump for district heating, and the industrial heat pump. All of these employ electric drive, larger units sometimes gas or diesel engine drive, some applications y thermal drive (the sorption heat pump).

The IEA Conference on the Current Situation and the Future Prospects of the Heat Pump held in Graz, Austria, in May 1984 has helped to clarify questions of heat pump economics, prospects, and required policy actions. It has also shown the present trends of heat pump technologies, in particular in the field of heating-only applications.

The electrically-driven *residential/commercial heat pump* unit and system is in the process of becoming optimized in terms of reliability, first cost, and seasonal

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performance factor (SPF). There is a strong trend to ambient air as the heat source and to outdoor units.

Air/water units are being used in bivalent parallel mode of operation in existing buildings with water distribution system. For new buildings, the emphasis is either on bivalent and monovalent air/water units with a low temperature heat distribution system, or on air/air systems; the latter ones are slowly but steadily being considered even in European countries where so far only water distribution systems had been customary.

Much ingenuity has been put into indirect air systems (with brine as intermediate heat transfer agent), air/solar systems with and without storage, monovalent soil systems, and their combinations; such systems as well as the small gas and diesel engine driven systems have in many instances had technical, but not all of them commercial success.

Standardized integrated system control is not yet always available, although progress is being made with defrosting control and to some extent also with overall control of bivalent systems.

At the Graz Conference it has become clear that there may be a future market of the heating-only heat pump not only in Europe, but also in the northern part of the United States and in Canada as well as in the North of Japan. On the American continent, as well as in Japan where electricity rates presently are high the emphasis so far is almost entirely on the heating/cooling application. In the long term, at any rate, it seems that we will have to think of a world-wide North-South boderline between heating-only and heating/cooling heat pumps rather than the East-West borderline which, for some reason, we have been accustomed to think of. (The North-South boderline is of course the logical one from the climatic point of view.) By the way, the heating-only heat pump, even if based on air as the heat source, is well-suited to cold climates. The reason is that the heating season in countries like Canada or Sweden is much longer than in moderate climates and the utilization factor of the heat pump, at least in bivalent systems, is therefore better. From the economic point of view, another distinction to be made is whether or not gas is available at a particular location or not, and whether or not it is inexpensive relative to electricity.

The *large heat pump for district heating use* proves to be well-suited

- for base load coverage in systems without combined heat and power generation (CHP),
- for low load, low temperature summer operation for hot tap water production,
- where supply and/or return temperatures are low,
- where water is available as a heat source, for instance cleared sewage water, industrial waste water, lake or sea water. (There are also plants under construction with a heat capacity up to 2.5 MW using ambient air as a heat source.)

Sweden is the only country where electrically driven units with a total heat capacity in excess of 250 MW are in use. There electricity rates are low due to a large amount of hydro and nuclear power generation. Payback periods are therefore less than five years. In other countries electrically, as well as gas and engine driven units of this size are under construction. In Sweden, screw compressors are used up to 5 MW and dual-stage centrifugal compressors with economizers up to 30 MW heat output. Supply temperatures can reach up to about 80 °C. The COP is roughly 3.0.

In the case of the *industrial heat pump* usually a payback period of less than four years, sometimes even of two years is required. Applications are therefore limited to cases where temperature levels and therefore COPs are favorable and utilization factors are high. Four basic heat pump systems are in use, available, or are being developed for industrial low- and high-temperature applications:

- the closed-cycle compression heat pump, up to about 115 °C;
- the open-cycle heat pump (steam compressor) for much higher temperatures;
- the absorption heat pump "Type I", up to about 110 °C, and at present also
- the "Type II" absorption heat pump (heat transformer) for temperatures up to about 180 °C.

Heat pump technology and heat pump market penetration are, to some extent, interdependent. Sales will depend on future advances of the multitude of heat pump technologies vis-a-vis the advances of its competing technologies such as condensing boillers, pulse combustion furnaces, small-scale exhaust gas cleaning equipment, etc. Present sales for heating-only applications show a somewhat inconsistent picture. Despite the decrease in sales for some applications in some countries it is fair to say that the heat pump technology is rapidly developing.

The rate of technological development of the heat pump will in turn be influenced by the size of the market. Therefore policy actions as well as permanent effort to better inform policy makers, industry and the customer are necessarily, required. And it is not incidental that collection, evaluation, and dissemination of heat pump information are some of the major tasks of the IEA Heat Pump Center (see also page 16 of this Newsletter).

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J. F. van der Horst*

Heat Pump Status and Research Activities in the Netherlands

1. General Situation

1.1 The Climate

The Netherlands have a very mild marine climate and extreme weather conditions only occur for short periods of time. During the heating season, the average and minimum values of air temperature are 6 °C and −12 °C respectively. During 87% of the heating season, the outside air temperature is higher than 0 °C and throughout this period 78% of the annual heat demand has to be met. As a consequence of relatively mild winters, bivalent heat pumps sized at only a fraction of the heat capacity can meet a large part of the annual heat demand; this can be achieved with a high degree of efficiency and at relatively low investment costs.

The average relative humidity of the air is high. For air-source heat pumps, the condensation of the water vapor is an advantage at evaporator temperatures higher than 0 °C; at lower temperatures, however, the high humidity of the air causes evaporator freezing. During the summer the air temperatures are rather low, and

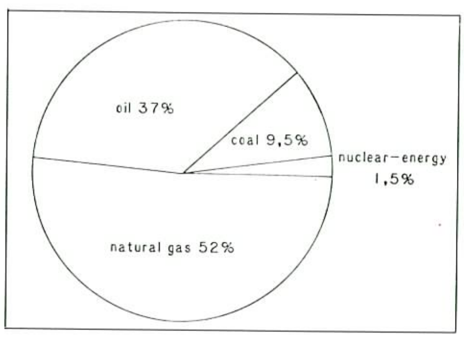

Fig. 1 Breakdown of primary energy consumption in the Netherlands in 1983. The total energy consumption is 2,600 PJ/a.

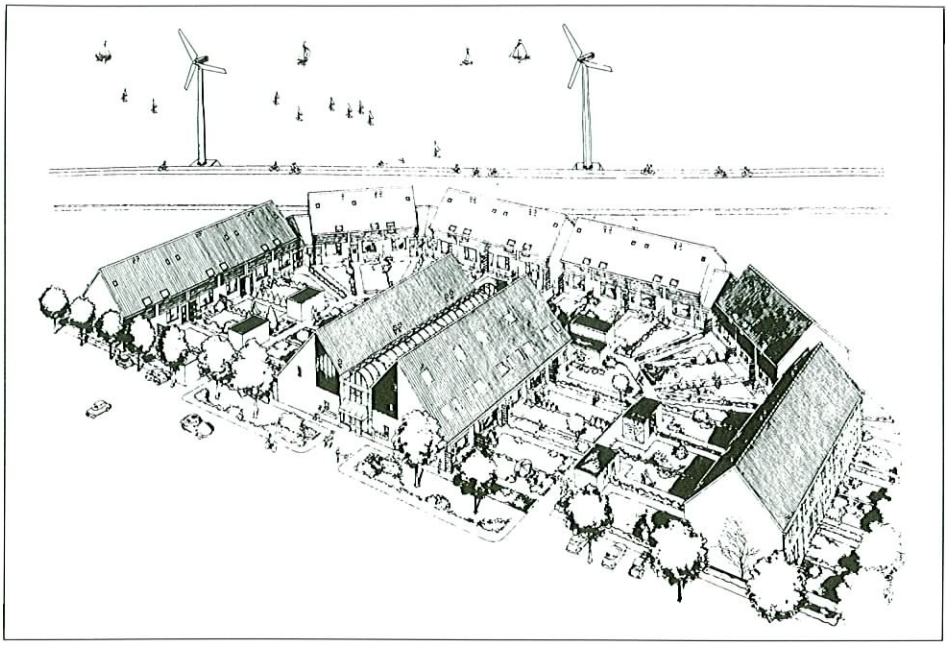

Fig. 2 35 dwellings heated by a heat pump/windmill system

apart from office buildings and hospitals there is no need to provide air-conditioning in the summer. Therefore, in general, heat pumps have to be designed and evaluated as heating systems only.

1.2 Heat Sources for Heat Pumps

In the Netherlands, practically all types of natural heat sources for heat pumps are applicable and all have specific pros and cons. Air is of course the most widely available source. Groundwater is an ideal source for heat pumps. The temperature level is nearly constant throughout the heating season (in the Netherlands it is 10 to 12 °C). The extraction of ground water is restricted by law, however, for the sake of reserving it mainly for drinking water purposes.

The ground itself is a source which is gaining more and more attention in Europe. This certainly applies to the Netherlands where the soil conditions are very favorable for the purpose due to high groundwater levels.

A relatively large part of Dutch territory surface (8.5%) consists of water which is suitable as a heat source, especially when waste heat from power generation of industrial plants raises its temperature level. The use of direct solar radiation as a heat source for heat pumps is very expensive at the present time and not a very attractive proposition to a country such as the Netherlands which is subjected to considerable cloud cover. Most calculations have indicated that the additional expenses involved therefore as compared with air-source heat pumps are hardly balanced by the additional savings in energy.

1.3 Energy Supply

Large reserves of natural gas are available in the northern parts of the Netherlands, the expected reserve amounts to $2{,}250 \times 10^9$ m^3 (79,000 PJ) [1]. Natural gas plays an important role in Dutch energy supply (see. Fig. 1). Gas availibility is high, supplying 95% of Dutch houses with natural gas.

The 1984 energy prices based on gross calorific value are given in Table 1.

Table 1 Energy prices in Dfl/kWh, tax included.

Natural gas	0.064
Gas oil	0.081
Electricity (average)	0.260

The price ratio between electricity and gas is about 4:1. Central heating boilers fired by natural gas compared to electric heat pumps means savings in energy costs are only possible if the COP of the electric heat pump is greater than 3.

2. Common Heating Systems and Housing

The majority of central heating systems comprise a gas-fired boiler and hot water radiators. So far, floor heating systems and central air heating systems have only found limited applications, but the interest in these systems, especially in air heating, is rapidly growing.

Typical values for the net volume of Dutch houses are 380 m^3 for single-family dwellings and 200 m^3 for dwellings in multi-family buildings. A great part of the Dutch housing accomodation consists of poorly insulated premises built before 1974. Insulation of these houses will result in lower flow temperatures in the heating systems which is favorable for heat pump applications. In the case of new houses, better insulation is of course provided for.

3. Heat Pump Status

From a technical point of view there are a number of electric heat pumps suited for the Dutch market, however, only a few electric heat pumps have been installed for residential heating purposes. With the ratio between gas and electricity prices as it stands at present, this type of heat pump cannot compete with conventional gas-fired boilers [2]. The prospects may improve if electric heat pumps are applied in systems cogenerating heat and electricity. In one demonstration project, the electricity for the heat pump is derived from a gas engine driven cogeneration plant. In two other demonstration projects, electric heat pumps are driven by electricity produced by a wind-driven generator, i.e. a windmill, see fig. 2.

As previously stated herein, the energy situation in the Netherlands is largely governed by natural gas, and as far as gas-fired heat pumps are concerned, the energy price situation is better than for elec-

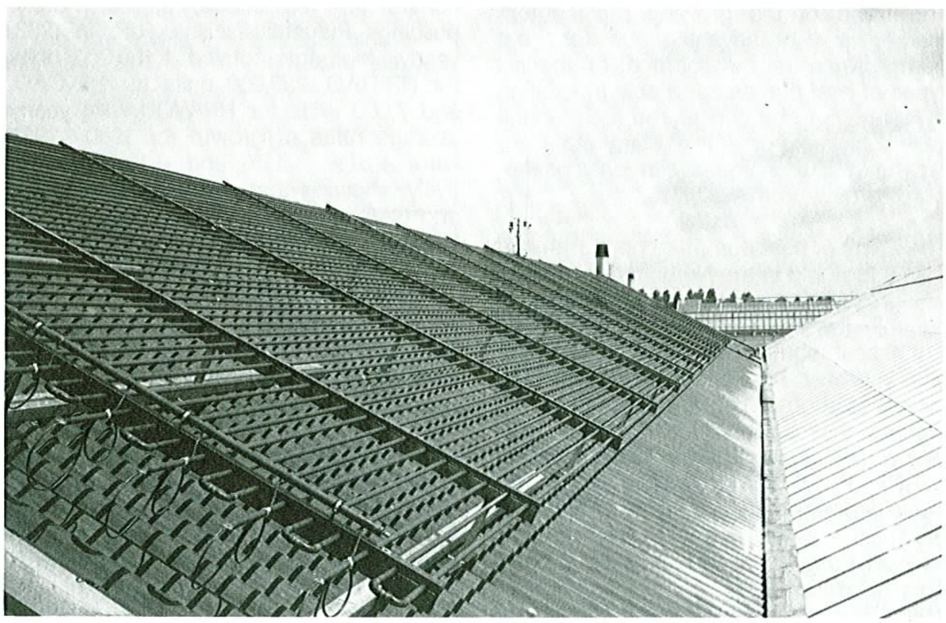

Fig. 3 Direct evaporating non-defrosting collector as an evaporator of a gas-engine driven heat pump for greenhouse heating and dehumidifying

tric heat pumps. Most activities have therefore been concentrated on gas-fired systems, there being about 40 gas-fired heat pump applications in the Netherlands. Nearly all of the projects are government-sponsored and serve for demonstration purposes.

Most of these heat pumps (33) are driven by a gas engine. There are 5 absorption heat pumps and one diesel engine driven heat pump. The capacities range from 85 to 1,000 kW. Outside or exhaust air is the most dominant heat source (22 systems) followed by groundwater or surface water. Waste water and ground as a heat source are applied each in one particular system.

The energy savings achieved in a number of heat pump projects are lower than forecasted. This is mainly a result of problems arising in the control of the complete system causing too low a number of heat pump running hours per year amongst other matters. These problems arise partially from the ever increasing yet still insufficient experience acquired with heat pumps by the majority of advisers and installers.

4. Market Prospects

Both in single and in multi-family dwellings a demand for new heating systems arises from new construction of houses and buildings, retrofitting and replacement of worn out installations. In recent years the demand set by new housing construction has fallen sharply whilst a growing replacement requirement can be now observed.

The expected demand for the period 1984—1995 amounts to some 200,000 installations per year (150,000 replacements and 50,000 new systems). The majority of the replacements will be in the heating capacity range from 15 to 25 kW.

The trend of the growing replacement market is very advantageous for heat pumps since the development of specific types of heat pumps applicable to existing dwellings is to be considered as a technically achievable objective. Many other energy saving techniques can only be applied to new premises.

The ability of heat pumps to penetrate and gain a foothold in the Netherlands' market will greatly depend on the availability of suitable low-cost gas-fired heat pumps. Such heat pumps will have to compete with improved high-efficiency boilers (efficiency at about 90%). A capacity-cost indicates that an analysis gas-fired heat pump (inclusive auxiliary boiler) having a SPF of 1.3 for a dwelling of 14 kW peak demand should cost no more than 5,500 Dfl.

This figure is based on the criterion of equal life cycle costs over a period of 10 years for both the heat pump and the competing high-efficiency boiler.

5. Heat Pump R & D Activities

As a consequence of the Dutch energy situation, research and development activities have been directed to gas-fired heat pumps.

As previously stated, a consumer market for the replacement of 150,000 domestic heating installations annually has been forecasted and a small competitive heat pump could gain an important share of this market. A project concerning design, construction and testing of a prototype of a gas-fired absorption heat pump of 7.5 kW heating capacity and a SPF of 1.3 has been finished. The cost-efficiency requirement of the prototype has not yet been achieved and this still remains a crucial factor. However, the prospects are favorable for the development of more economical designs.

Research into the development of new working pairs and on new designs of absorption heat pumps is also being carried out.

Specifically the application of water with an anti-freeze content as a working fluid in absorption air-to-water heat pumps is being considered. In this approach, the refrigerant water may be used at air temperatures below zero.

The efforts on gas engine driven heat pumps are being directed to applications and demonstration projects previously described herein.

Several projects deal with vertical ground heat exchangers which occupy about 30% less ground surface area than horizontal types. This is an advantage in densely populated countries such as the Netherlands.

More details of heat pump projects in the Netherlands are available via the R, D & D database of the IEA HPC as announced in the Newsletter of December 1983.

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K. Tanaka* / E. Miura*

Heat Pumps in Japan 1975—1990

1. General

In Japan, all types of heat pumps are available on the market and are being tested. This contribution, however, deals with mass-produced heat pumps, explains the present status, and gives future prospects.

Mass-produced heat pumps herein referred to are: Heat pump room air conditioners (HP-RAC), commercial heat pump air conditioners (HP-CAC), and heat pump water chilling units (HP-WCU).

These heat pumps are used as air conditioners for residences, stores, hotels, buildings, industrial facilities, etc. In 1983, yearly shipments totaled 1,160,000 units for HP-RAC, 232,000 units for HP-CAC, and 7,000 units for HP-WCU. The yearly average rates of growth for 1980—1983 were +31%, +11%, and −19%, respectively, showing that demand for HP-RAC and CAC increased sharply while that for HP-WCU decreased significantly.

2. Transition of HP-RAC

HP-RAC appeared in 1961 as a heating/cooling unit with a heating capability added to the cooling unit. At first, importance was attached to its convenience or effectiveness as a single unit capable of both cooling and heating only with electric power, rather than to excellent characteristics of the heat pump concerning the efficiency. Since 1963, serious marketing efforts began. However, the units somewhat failed to satisfy general load conditions. Many users complained of insufficient heating capability. Thus, the manufacturers were compelled to suspend production. In 1972, after about 4 years of suspension, production was resumed. In light of the bad experiences, each manufacturer had endeavored to improve the products, while proceeding with careful diffusion by limiting the market, by developing PR activity to have users understand heat pump performance and working conditions, and by training the distributors.

In the wake of the energy crisis in 1973, heat pumps have come in the lime-light as a product capable of satisfying the needs of the age of energy conservation. Coupled with cleanliness, safety, ease of handling, high energy efficiency, etc., there have been dramatic improvements in heating capacity, comfort, convenience due to utilization of electronic technology, and also in reliability related to installation and other services. Thus, the conditions for rapid growth have been continuously created.

2.1 Japan's climate and cooling/heating needs

Japan is a country composed of many islands, widely distributed from the subtropical zones at 25 °N to the frigid zones at 45 °N. Overall, these islands constitute an archipelago. Table 1 shows a classified breakdown by heating degree days (D18-18) of Japan's population, the number of business places distributed over those islands, and shipments of room air conditioners.

According to the table, in the regions with less than 2,500 heating degree days, 85% of the population, 85% of the business places, 98% of air conditioner sales (shipments), and 99% of heat pump air conditioner sales are concentrated, demonstrating that the main heat pump market in Japan is distributed in those relatively mild

Zones	Degree days (D18-18)	Population distribution (1983)	Distribution of places for business (1981)	Shipments of RAC		Market
				Total (1983)	Heat pump type	
Temperate zones	< 1250	1.0	1.0	1.2	0.1	Cooling/ heating market
	1250 —	4.6	4.6	4.0	4.0	
	1500 —	22.4	23.5	32.2	32.6	
	1750 —	44.0	42.5	51.9	53.8	
Subfrigid zones	2000 —	9.0	9.6	6.3	6.3	
	2250 —	4.3	4.7	2.6	2.1	
Frigid zones	2500 —	3.5	3.3	0.8	0.6	Heating market
	2750 —	3.9	4.1	0.7	0.4	
	3000 —	2.5	2.3	0.2	0.1	
	3500 —	4.8	4.4	0.1	0.0	
	Total	100.0	100.0	100.0	100.0	

Table 1 Breakdown (in percentages) of Population, Places of Business and Shipments of RAC by Degree Days — 1983 —

regions, and that heat pumps are developing as cooling/heating air conditioners.

2.2 Japan's houses and heating systems

Over a long period of time since WW II, Japan had to suffer from serious shortages of houses. In the year of the oil crisis, 1973, minimum housing standards, e.g., one dwelling per household, were satisfied.

Now, according to the housing census compiled by the Japanese government (1978) (Table 2), wooden houses accounted for 82%, while ferroconcrete houses accounted for 15%. According to the government notice based on the Act Concerning Rationalization of Energy Uses (1979 Act No. 49), heat loss standards for houses are as shown in Table 3. It is said that, actually, newly built houses have a thermal insulation structure whose heat loss standards exceed the stipulated level. Thus, Japan's houses which are mainly of wooden structure, have recently achieved considerable reductions in heat loss, thus preparing the ground for a full-scale diffusion of heating/cooling units.

	Total	Detached houses, semi-detached houses	Condominium	Others
Total	100.0	74.8	24.8	0.4
Wooden	81.7	70.0	11.5	0.2
Concrete	15.2	2.4	12.6	0.2
Block, etc.	3.1	2.4	0.7	0.0

Table 2 Structures of Japan's Houses (Breakdown in percentages) — 1978 —

Source: Statistical Bureau, the Prime Minister's Office

The European hot water central heating system appeared on the market in the mid-1960s as a substitute for the conventional individual system. In the wake of the two oil crises these systems suffered a serious blow. Consequently, apart from a certain degree of diffusion in the northern regions of Hokkaido, the rest of Japan remains mostly covered by the individual heating system.

According to a nationwide survey conducted by the government, Japan's houses are mainly heated by 'Kotatsu' electric heaters and kerosene heaters (Table 4). Recently, warm-air space heaters have drawn attention in place of stoves. The fact remains that the individual heating system is the main supply medium. This may be attributed not merely to the obvious facts, such as the decrease in real income, the soaring energy prices, and the fact that energy conservation has taken root in people's thinking, but also to the fact that Japan is blessed with plenty of sunlight and a high daytime temperature in winter (Fig. 2).

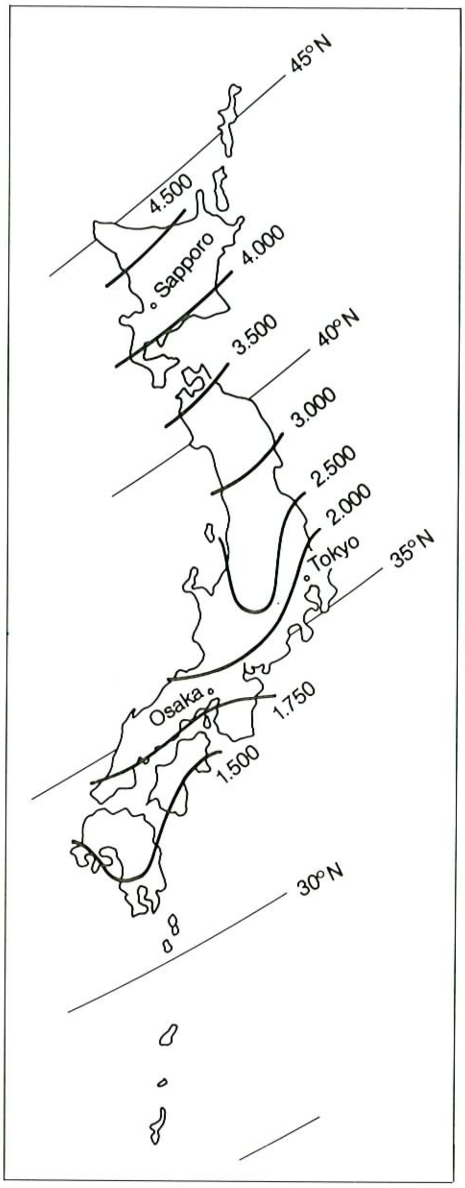

Fig. 1 Heating degree days in Japan

According to a survey conducted by the Institute of Energy Economics (1981), except for the northern regions in the frigid zones, many households in the temperate zones stop heating during the daytime (9.00—15.00 h).

As explained above, Japan's heating system in the main market is characterized by individual and intermittent heating, hence the high marketability of HP-RAC (HP-CAC as well).

2.3 Improvements in Heat Pump Performance

Obviously, HP-RAC must provide both heating and cooling capacities.

According to JIS 9612, depending on room conditions, the heating capacity must be 1.2—1.7 times as high as the cooling capacity (heating-cooling ratio) (Table 5). In the beginning of its market introducion heat pumps could not deliver such a high level of heating capacity. Therefore, HP-RAC in the 750 W category had to be provided with an electric heater

Degree days (D18-18)	< 1500	1500 —	2000 —	2500 —	> 3500
Detached/semidetached house	6.8	4.8	4.4	3.6	2.8
Condominium	5.7	4.4	3.8	3.2	2.3
Representative city		Tokyo Osaka			Sapporo

Table 3 Residential Heat Loss Standard — Heat Loss per Unit Floor Area (Kcal/m$^2 \cdot$h$\cdot$°C)

Source: 1980 Notification No. 1 of MITI and Ministry of Construction

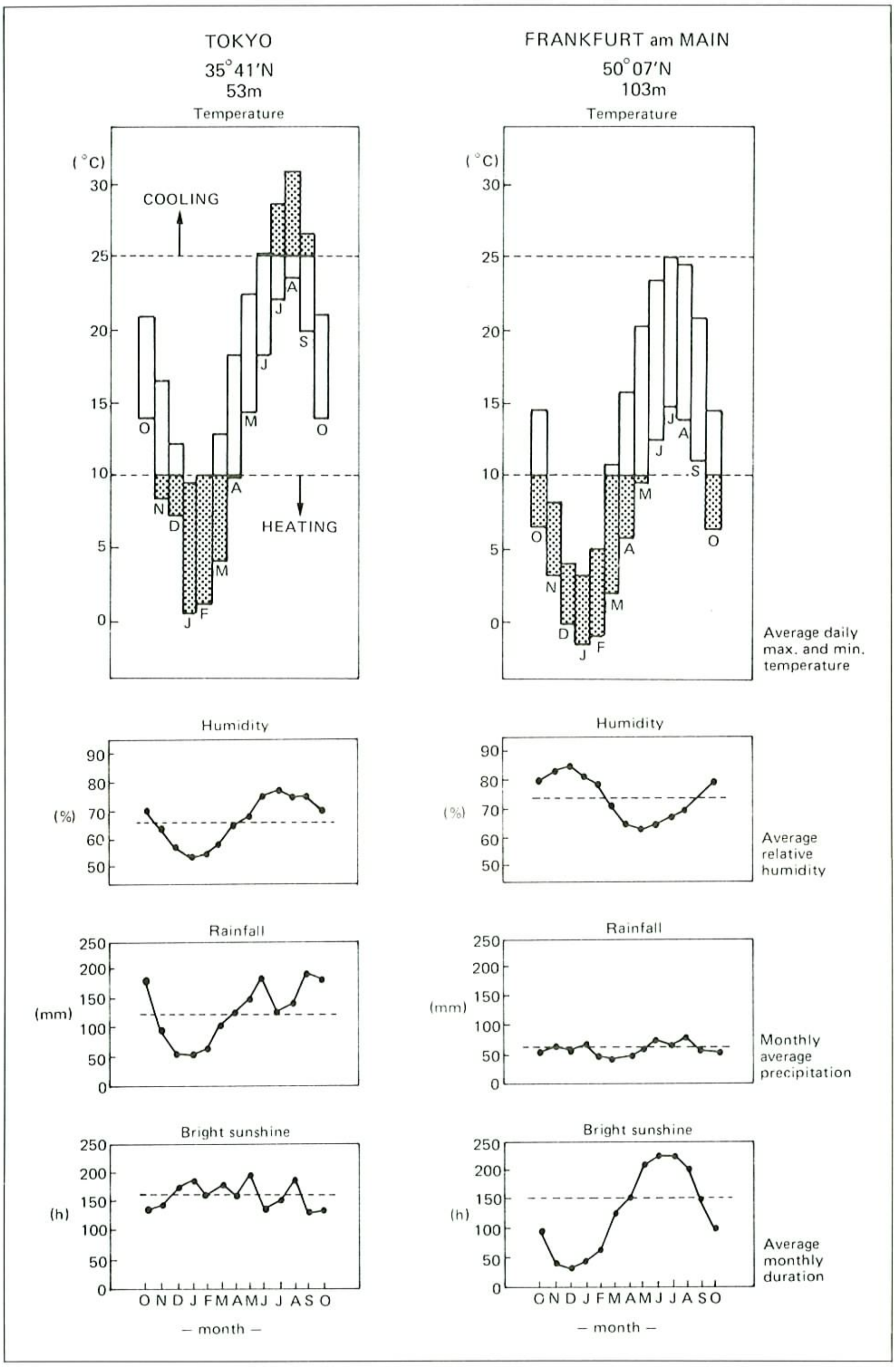

Fig. 2 Comparison of climate in Japan (Tokyo) and the European Continent (Frankfurt)

(600—700 W) to make up for the lacking heating capacity. Thereafter, however, thanks to the development of a rotary compressor and an injection system, the heating capacity has been rapidly improved since 1975. At present, even the models without an auxiliary heater can provide a heating capacity comparable to that of heater-assisted models. Thus, the target capacity levels as required by JIS have been attained (Table 6 — Fig. 3), facilitating the market penetration of HP-RAC.

3. Transition of HP-CAC

At present, HP-CAC comes in a commercialized range of models with 1.2 to about 30 kW of compressor motor output, occupying 66% of the total number of CAC shipped. There has been a considerable tendency of HP-CAC to be air-cooled, bringing the ratio of air-cooled units to total CAC shipments up to 87% in 1983 from 46% in 1976 (Fig. 4—5).

The water-cooled system is disadvantageous compared to the air-cooled system in that (1) it requires a higher initial investment; (2) its cooling water pump uses more power; (3) the COP of the water-cooled system has become relatively less advantageous, due to the steady improvements in that of the air-cooled system, and (4) it is handicapped by its need for maintenance of the cooling tower, the condenser, etc.

Small-size models with less than 3.75 kW of compressor motor output are used as commercial split type cooling/heating units for stores, offices, etc. having separate outdoor and indoor units. The indoor unit comes in a wide variety of types — floor, ceiling-suspended, wall, ceiling-concealed, etc. The ceiling-suspended and wall types, among others, have met with the demand in stores where space saving is required. An increasing number of units of these two types have been made available as heat pump units, thus contributing to the expansion of demand for HP-CAC. Medium- and large-size models with more than 5.6 kW of compressor motor output are air conditioners for building facilities. And they are available either as a direct blowout or duct system, mainly of the remote condenser type.

4. Transition of HP-WCU

As mentioned earlier, demand for water chilling units remains weak (Fig. 7). The stagnant demand for small-size models below 2.25 kW for the housing market may be mainly attributed to the following reasons:

— Stagnant start of construction
— Sharp decrease in demand for central air conditioning along with the soaring estate and building prices
— A shift to individual air conditioners and heaters, such as HP-RAC, small HP-CAC, etc.

Heating device	House-hold diffusion (%)	Number of units owned by 1,000 house-holds
Electric 'Kotatsu'*	93.2	1,527
Oil stoves	86.9	1,602
Electric blankets	56.0	1,091
Electric stoves	32.8	384
Gas stoves	22.6	308
Space heaters	16.8	197
Heat pumps	8.6	108
Central heating systems	2.9	29
Air conditioning equipment	**House-hold diffusion (%)**	**Number of units owned by 1,000 house-holds**
Fans	94.2	1,747
Room air conditioners	47.0	643
Cooling only type	41.3	535
Heat pump type	8.6	108

Table 4 Heating Devices and Air Conditioning Equipment in Japan — 1979 —

* 'Kotatsu': A foot warmer with a quilt over it.
Source: Statistical Bureau, the Prime Minister's Office

Meanwhile, the stagnant demand for medium- and large-size models may be attributed to the following reasons:

- Stagnant start of building construction
- Lack of promotion of HP-CAC and direct expansion systems for small and medium-size buildings, offices, etc.
- Governmental promotion of central cooling/heating by means of gas absorption chillers.

Compared to HP-CAC having the same capacities, HP-WCU reguire at least a 50% higher first cost than for HP-CAC. Originally, the HP-WCU has gained its foot in the market as a WCU + boiler system. Therefore, with respect to costs, it is extremely difficult for the HP-WCU to compete with the WCU + boiler system in the area of air conditioning. Apart from the cost disadvantages, HP-WCU is expected to be able to tap a market potential in the area of industrial hot water supply.

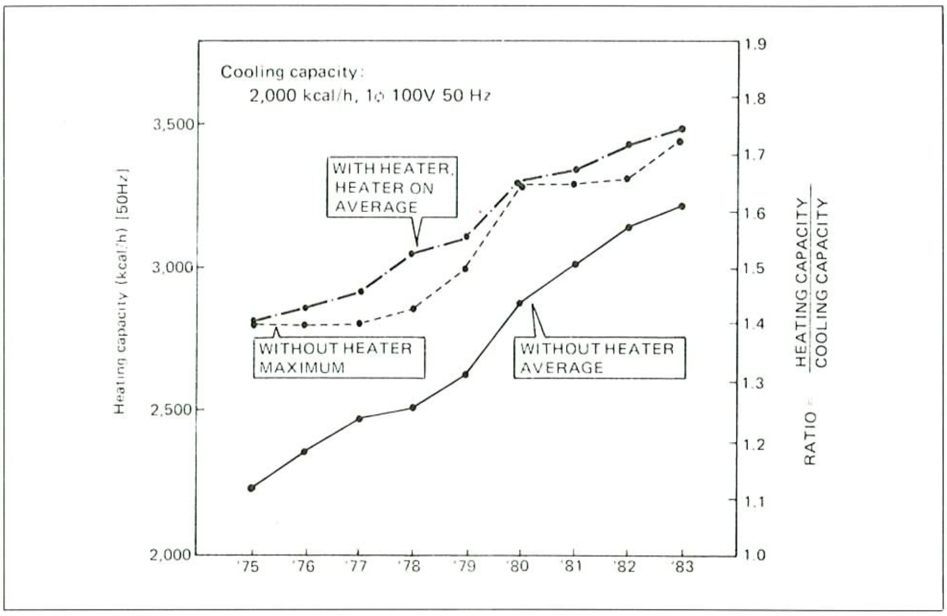

Fig. 3 Heating Capacity and Heating/Cooling Ratio of Heat Pump Room Air Conditioners

5. Future Prospect

Mass-produced heat pumps are available as both cooling and heating units. Therefore, their diffusion is limited to regions with both cooling and heating requirements.

According to Fig. 8, HP-RAC (HP-CAC as well) is suitable for regions with less than 2,250 heating degree days, and it seems that, commercially, about 2,500 heating degree days will be the limit in the north.

Regions with more than 2,500 degree days are characterized in winter by heavy snowfall and frigidity, including those areas where the lowest temperature is from −10 °C to −20 °C or even below.

Room condition \ Load and calculation condition			Load per unit floor area: Cooling kcal/hm² (W/m²)	Load per unit floor area: Heat pump heating, Air cooled kcal/hm² (W/m²)	Condition of calculating cooling/heating load per unit floor area: Circulation air changes per hour	Window area: Floor area %	The number of people staying in 10 m² of floor area persons/10 m²	Illumination (fluorescent lamp) W/m²
House (wooden/one-storied)	Japanese style	Facing south (1)	190 (220)	250 (290)	1.5	40	3	0
		Facing north (1)	140 (160)	240 (280)	1.5	20	3	10
	Western style	Facing south (1)	165 (190)	240 (280)	1	30	3	0
		Facing west (1)	200 (230)	240 (280)				
Western style room in apartment house facing south		Highest floor	160 (185)	225 (260)	1	30	3	10
		Intermediate floor	125 (145)	200 (230)				

Note (1): "Facing south" means that the window in touch with outdoor air is in the southern side alone; this is true for "Facing north" and "Facing west".

Remarks: General conditions of calculation for Table 2 (for reference):
(1) The inside temp. can be kept at about 27 °C, even when outside air temp. rises to 33 °C in summer.
(2) The inside temp. can be kept at about 21 °C, even when the outside temp. drops to 0 °C in winter.

Table 5 Cooling/Heating Load per Unit Floor Area (JIS C 9612)

	Heating capacity (kcal/h) 50/60 Hz	Cooling-heating ratio	COP 50/60 Hz	Retail price (in real terms)
1979	2670/2980	1.3	2.9/2.7	100
1983	3190/3670	1.6	3.6/3.4	86
1983/1979	+19/+23%	—	+25/+23%	−14%

Note: Trade's average for heaterless products at 100 V 50/60 Hz; Cooling capacity: 2000/2240 kcal/h

Table 6 Performance Improvements and Price Changes for HP-RAC

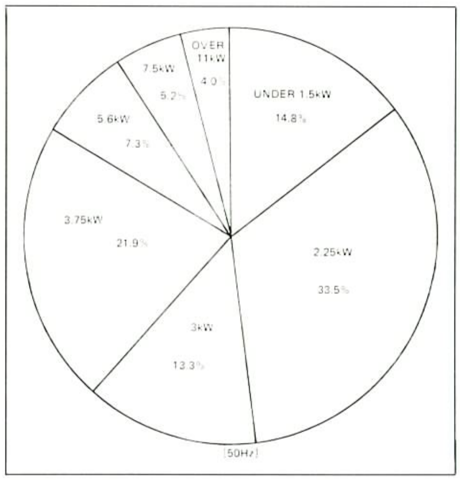

Fig. 4 Shipments Breakdown of Commercial Heat Pump Air Conditioners by Compressor Motor Output — 1982 —.

When the heating load sharply increases, the currently available heat pumps in Japan, which are mainly of the air source type, sharply decrease in COP, somewhat becoming incapable of performing their functions as a heating unit. Additionally, in these regions there is not much need for cooling units in the summer. The share of population and business places distributed in those regions is also about 15% of the nationwide total. Thus, for manufacturers, the models specifically designed for those regions are not profitable, facing the same difficulties as in the European countries. Thus, R & D efforts by manufacturers concerning the heat pump will be geared mainly towards higher efficiency, more compact and lightweight design, lower noise levels, etc. for cooling/heating units (Fig. 9).

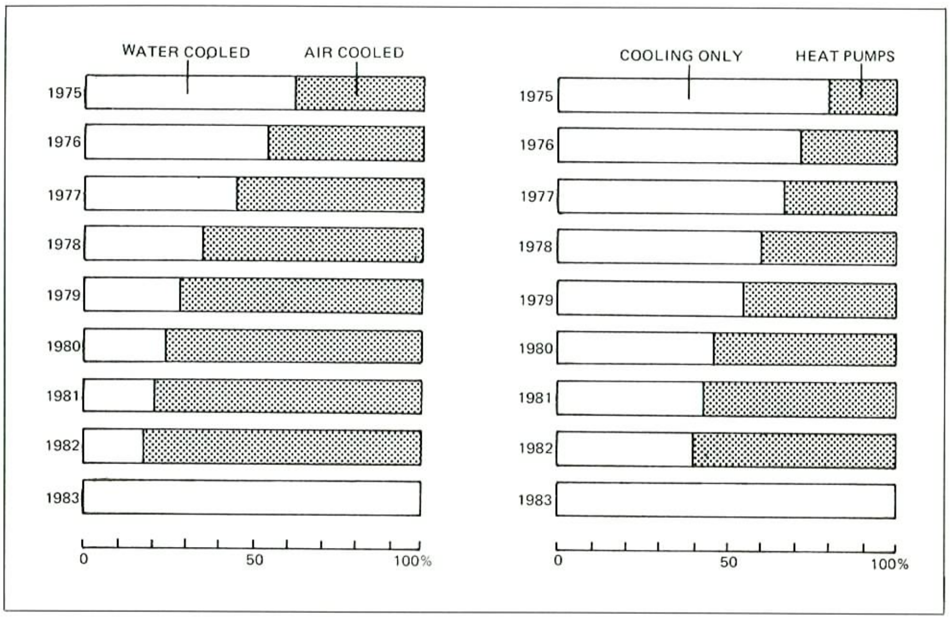

Fig. 5 Shipments Breakdown of Commercial Air Conditioners by Type

	Room air conditioner	Packaged air conditioner	Water chilling unit
Air source	Hermetic rotary 0.4—1.5 kW	Hermetic reciprocating 1.2—15 kW Hermetic rotary 1.5—2.2 kW Hermetic scroll 1.5—4.2 kW	Hermetic reciprocating 2.2—15 kW Semihermetic reciprocating 10.8—45 kW Semihermetic screw 22—45 kW
Water source		Hermetic reciprocating 0.75—10.8 kW	Hermetic rotary 0.6—2.2 kW Hermetic reciprocating 2.2—15 kW Semihermetic reciprocating 10.8—45 kW

Table 7 Typical Products and Compressor Output

Division	Refrig-eration year	Room air conditioner	Commercial air conditioner			Chiller unit		
			Total	Water cooled	Air cooled	Total	Water cooled	Air cooled
result	1975	348,000	35,000	5,400	29,600	3,830	130	3,700
	1976	343,000	60,700	7,500	53,200	7,330	130	7,200
	1977	361,000	77,000	6,500	70,500	9,020	120	8,900
	1978	407,000	113,000	7,500	105,500	9,610	110	9,500
	1979	539,000	159,000	7,600	151,400	11,430	130	11,300
	1980	514,000	171,000	9,500	161,500	13,100	100	13,000
	1981	553,000	173,000	9,000	164,000	9,910	110	9,800
	1982	768,000	190,000	6,500	183,500	8,720	120	8,600
	1983	1,160,000	232,000	7,700	224,300	7,030	130	6,900
estimate	1984	1,120,000	226,000	7,000	219,000	7,040	140	6,900
	1985	1,290,000	246,000	6,800	239,200	6,950	150	6,800
	1986	1,480,000	258,000	6,600	251,400	7,160	160	7,000
	1987	1,690,000	279,000	6,500	272,500	7,970	170	7,800
	1988	1,940,000	300,000	6,300	293,700	8,580	180	8,400
	1989	2,220,000	323,000	6,200	316,800	9,390	190	9,200
	1990	2,550,000	346,000	6,000	340,000	10,200	200	10,000

Table 8 Domestic Shipments of Mass Produced Heat Pumps Present Status and Future Prospect, 1975—1990

Consequently, Japan's mass-produced heat pumps will go along the path towards an overall expansion of demand, while raising the share of heat pump units for each type of air conditioner. According to an estimate, the ratio of HP-RAC to all RAC will rise from 48% in 1983 to 75% in 1990, while that of HP-CAC will expand from 66% to 82%, and that of HP-WCU from 45% to 56%. In 1990, the total number of shipments will reach 2,550,000 units for HP-RAC, 346,000 units for HP-CAC, and 10,200 units for HP-WCU (Table 8).

Major goals for the years to come will be:

a) to improve SEER, in addition to the conventional EER, by establishing ad-

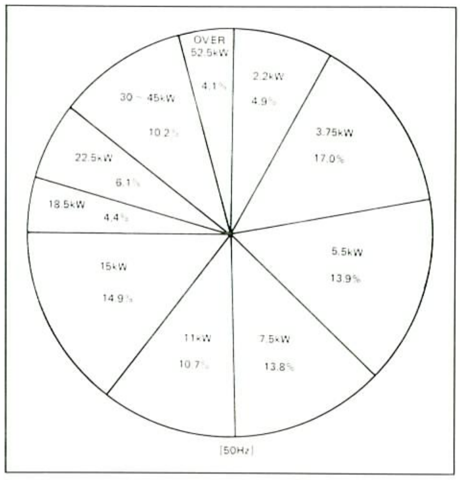

Fig. 6 Shipments Breakdown of Air Source Water Chiller Heat Pumps by Compressor Motor Output — 1982 —.

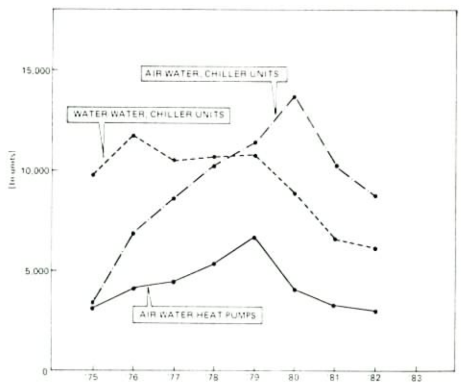

Fig. 7 Domestic Shipments of water Chillers in Japan

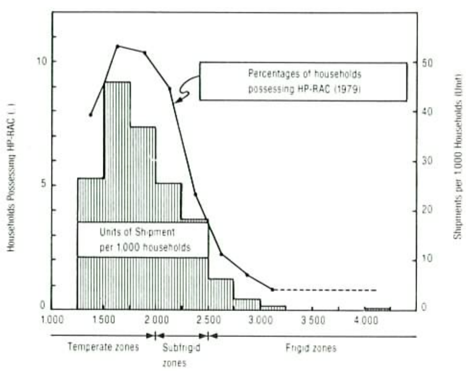

Fig. 8 Diffusion and Shipment of HP-RAC by Heating Degree Days (D18-18).

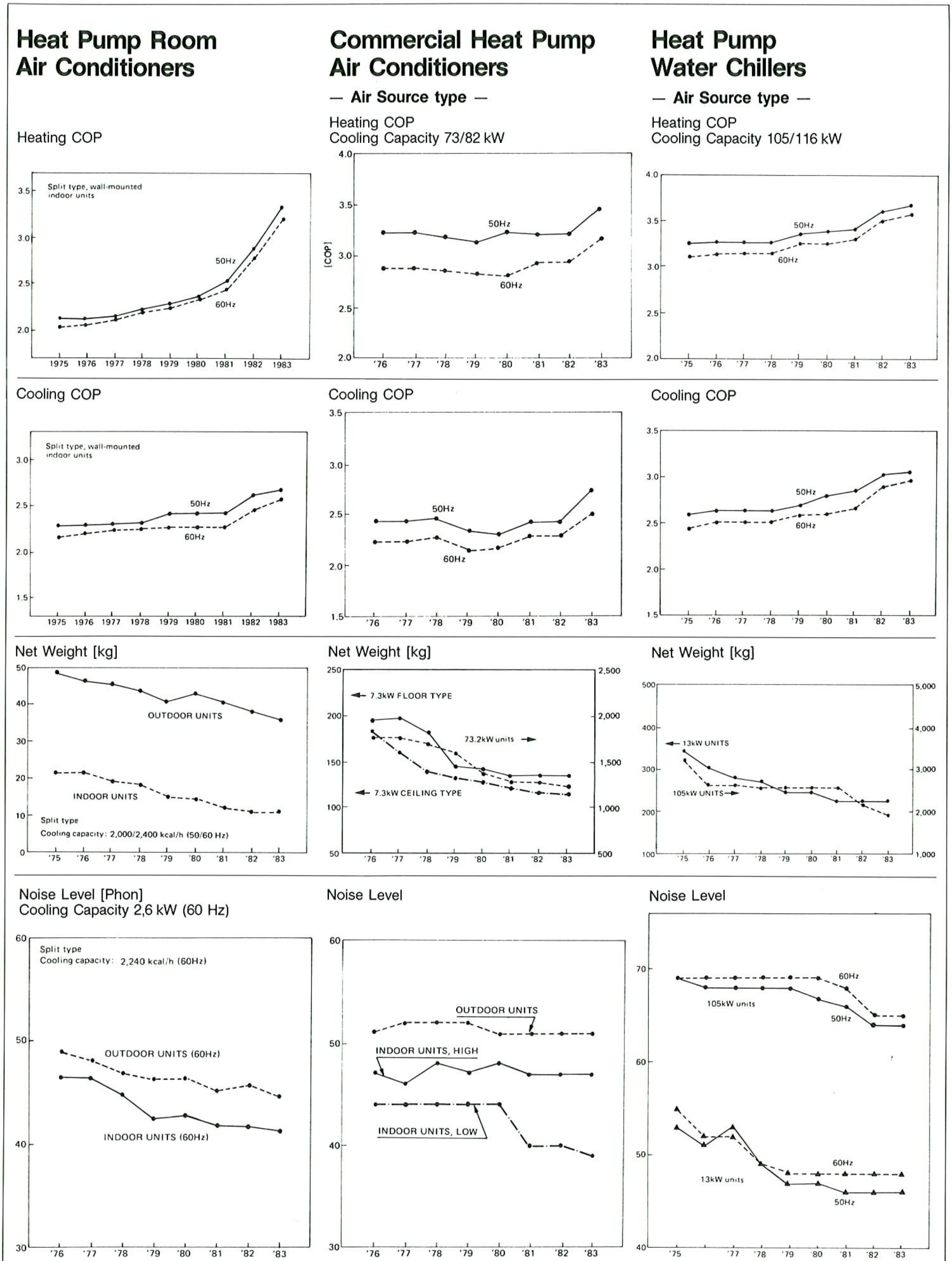

Fig. 9 Technical Improvements of Heat Pumps 1975—1983

vanced capacity control techniques, concentrating on frequency converters.

b) to establish the market position of intermediate models between the individual cooling/heating system and the central cooling/heating system. In order to bridge this gap, heat pumps designed to use multiple indoor units with a single outdoor unit should be put into production.

In the meantime, with the existing air-source system, it is difficult to extend the northern limit of heat pump applicability up to the frigid zones. Further expansion requires, among others, selection and securing of suitable heat sources. At present, utilization of ground water, cold/hot spring water, geothermal heat, solar heat, waste water, waste gas, etc. is being discussed. As for heat devices, diesel engine driven systems, gas engine driven systems, absorption systems, etc. are being commercialized. Application of heat pumps in sparsely populated, cold regions is somewhat liable to be neglected. However, it is important that technology, suitable for the regional characteristics is accumulated. In order to commercialize new products, manufacturers, users and research organizations must continue to cooperate in R & D for a long period of time.

** K. Tanaka: Daikin Industries Ltd., Osaka, Japan*
E. Miura: Japan Refrigeration and Air Conditioning Association

A Survey of Gas-Engine driven Heat Pump Installations in the Federal Republic of Germany

January 1984

As shown by the diagrams, a total of 445 gas-engine driven heat pumps are currently in operation for heating and cooling applications in the Federal Republic of Germany and in Switzerland.

A total of 99 gas-engine driven heat pumps were installed in 1983.

The growth in the number of gas-engine driven heat pumps installed since 1977 is shown in Fig. 1.

The installed capacity is shown in Fig. 2.

Following the installation of the first heat pumps at sports centers and swimming pools, new fields of applications have opened up, as shown in Fig. 3.

Fig. 3 shows that local government installations such as sports centers are the most frequent application. The next most frequent applications are in office blocks and large residential buildings. A respectable number of gas-engine driven heat pumps are also in operation at industrial and commercial premises.

The crucial condition of a heat pump project is the effectiveness of the heat source which determines the design and the cost of the system. Outdoor air is by far the most common heat source (Fig. 4). This trend is unlikely to change since air is a practically unlimited resource. In addition standardized heat pump packages have been developed for the use of outdoor air as a heat source, thus offering major technical and cost advantages.

Source: GWP

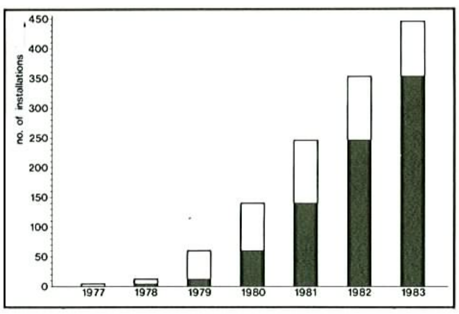

Fig. 1 Installed Units

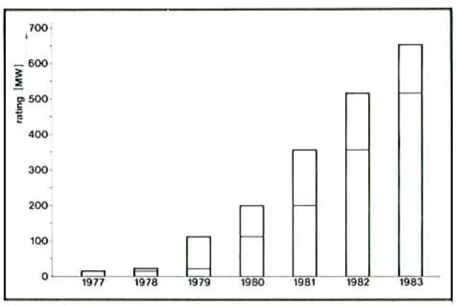

Fig. 2 Installed Capacity

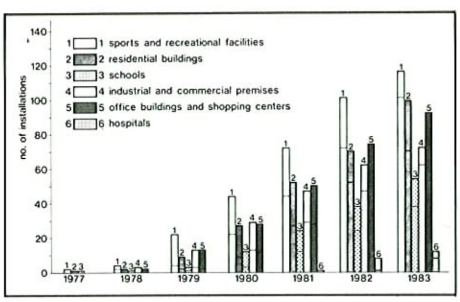

Fig. 3 Applications of Gas-Engine Driven Heat Pumps

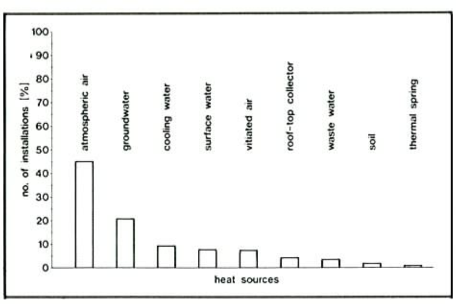

Fig. 4 Heat Sources for Gas-Engine Driven Heat Pumps

Gert Griesbach*

M.A.N. Heat Pumps in Industry and Municipalities

Two groups of heat pumps should be distinguished considering the annual operation time: first, the heating-only heat pump, in most cases extracting environmental heat, and second, the heat pump for industrial or commercial applications, frequently making use of waste heat.

The following contribution will present three different systems. These are:

1. Heating/cooling plant in industrial application
2. Heating plant for a school
3. Heating plant for a hospital.

The Siemens condenser factory at Heidenheim has a high energy demand. Up to now, buildings and workshops have been heated by oil-fired boilers, while large amounts of cooling water warmed up during the fabrication of condensers were wasted.

Simultaneous demands for heat and for cooling water were ideal conditions for the application of a gas engine driven heat pump. As a special feature, in this project the machine unit of a common gas engine driven heat pump was equipped with an asynchronous motor/generator between the natural gas driven engine and the compressor. Fig. 1 shows the combination of components of a multipurpose system (electricity, heat, cooling water).

The advantages of this variable system are the different combinations of energy supply, as it can be operated with various fuels: natural gas, diesel, electricity. Primary energy conservation for heating is of approximately 50%. Another feature is the possibility of power generation to cover an internal peak demand. Three modes of operation are possible:

— Gas engine driven heat pump; generator motor idling

— Cogeneration of heat and power; the generator covers peak demand and also serves as a backup power generator. Waste heat from the gas engine is utilized for heating, the compressor is disconnected.

— Electric heat pump operation; when cheap electricity (off-peak electricity) is available, the combustion engine is disconnected and the compressor is driven by the motor.

Table 1 lists the technical data of one unit. Connection of the three systems to the supply networks of cooling water, heating and electricity is shown by the flowsheet in Fig. 2.

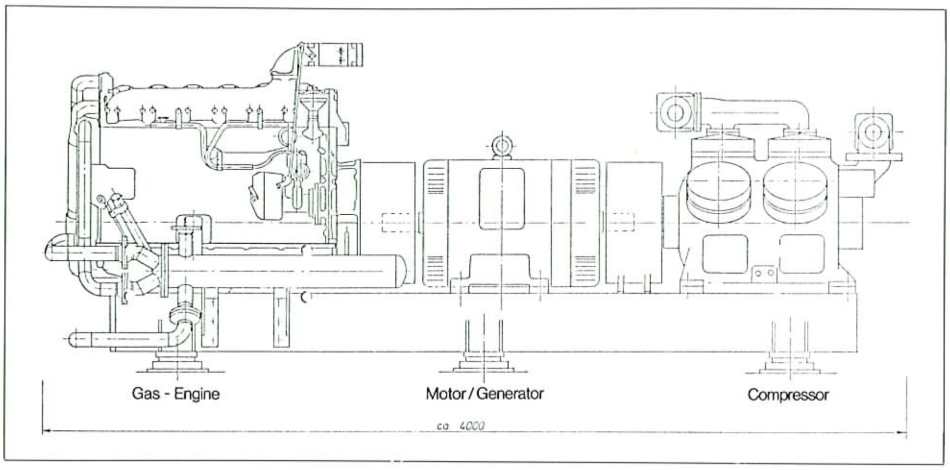

Fig. 1 'Tandem unit'

During the heating season 1982/83 the 'Tandem units' were in operation for approximately 9,000 hours, 43% of which were devoted to gas heat pump operation, 48% to electric heat pump operation and 9% to cover peak electricity demand. During this time, 5.3 million kWh of primary energy were necessary for the generation of 10.9 million kWh of usable heat, representing an energy conservation of 60% compared to a conventional boiler. Additionally, taking into consideration the gain of cooling water by the simultaneously effected production of cold, the efficiency rate is 3.3 times as high. Considering also the profit achieved by covering peak elec-

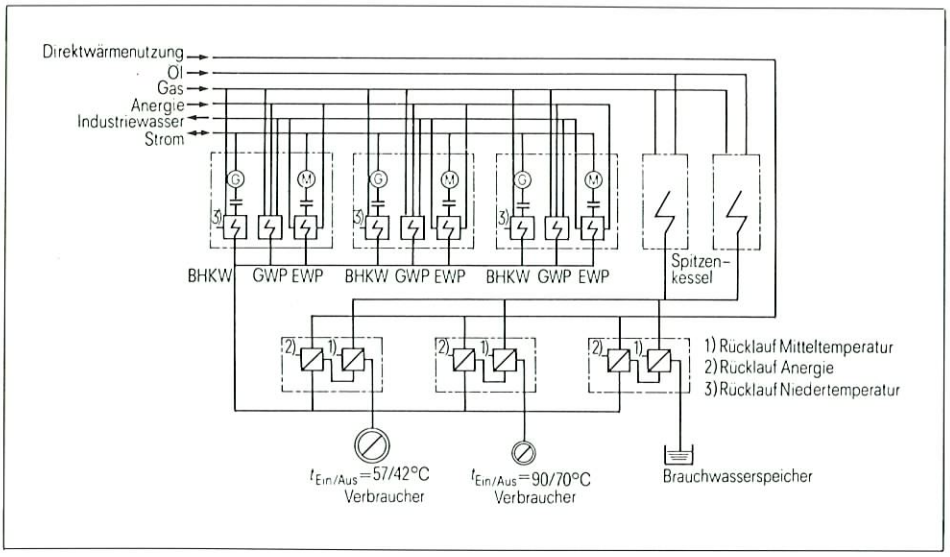

Fig. 2 Flowsheet of Heat Generation

Techn. Daten einer Tandemanlage		
Betriebsdrehzahl	1500 min^{-1}	1750 min^{-1}
Heizleistung Betriebsart GWP		690 kW
Heizleistung Betriebsart BHKW	~145 kW	
Heizleistung Betriebsart EWP	~450 kW	
Primärenergie Erdgas	~270 kW	320 kW
M.A.N.-Gasmotor E 2566 E	4-Takt-Ottomotor, 6 Zyl.	
Asynchronmotor mit durchgehender Welle: Fabrikat, Typ	SIEMENS, 1 RA 6253	
Heizwasservorlauf, maximal	55 °C	
Heizwasser-rücklauf, maximal	42 °C	
Kühlwasser-mischtemperatur	t_{Ein} ~25 °C	
Industriewasser-temperatur	T_{Aus} < 16 °C	

Table 1 Technical Data of one 'Tandem unit'

Essentially, the energy concept serves five main functions; these are:

- generating power
- supplying cooling water
- covering peak loads with two boilers for a total capacity of 6,000 kW
- utilizing waste heat directly via 6 plate heat exchangers with a total capacity of 1,400 kW
- finally the three 'Tandem units' supplying either 2,100 kW or 270 kW electric power and 450 kW heat.

Each of these units can be used independently of each other and each one is controlled individually by microprocessors. The optimum operation of the single components is controlled by an energy optimization processor depending on the availability of primary energy, the availability of waste heat, the demand of cooling water, and the utility rate structure. Heat is consumed at three levels: a low-temperature network (57/42 °C), a medium temperature network (90/70 °C), and a hot water network.

Fig. 3 Handelslehranstalt (School for Trade Training) in Rastatt

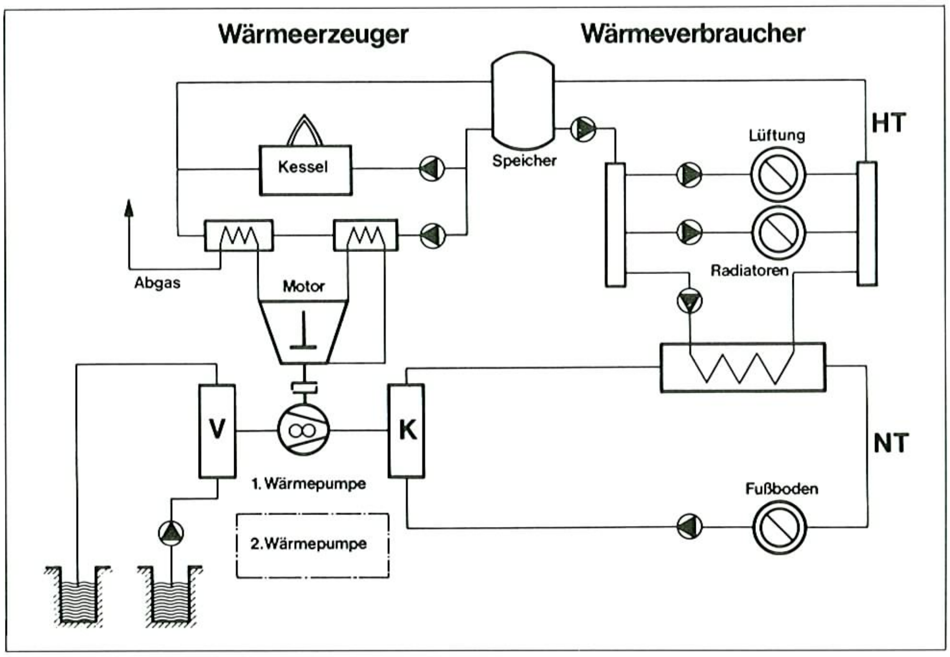

Fig. 4 Simplified Heating Scheme

Fig. 5 Hospital in Karlsruhe: Compact Heat Pump System

tricity demand, the amortization period for the plant in Heidenheim is about three years, based upon the present rates for gas, electricity and water.

The second example is a newly constructed school in Rastatt (Fig. 3). The heating system is a gas fired boiler combined with a gas engine driven heat pump (Fig. 4). The two heat pump aggregates consist of spark ignition engines for natural gas operation, gearbox, screw compressors, and of the necessary primary and secondary circuits for heat transportation in separate systems. The rooms are equipped with a floor heating system as well as with conventional radiators. The splitting of the system in a high- and low-temperature circuit ensures an economically efficient operation. The high-temperature for ventilation and radiators is supplied by the boiler and by waste heat from the gas engines. The low-temperature floor heating system is fed by the condenser water circuit of the heat pump.

The installed floor heating system responds to the demand for heat storage within the building which is designed for this purpose without ceiling insulation, but with external insulation of the building surfaces. The aim of the system is to use the building itself for heat storage, thus ensuring the necessary temperatures. Only when they cannot be maintained by this method, the boiler is put into service. Ground water as the heat source for the heat pump allows all-year operation with high efficiency. The technical data of the heat pump are given in Table 2.

Techn. Daten der Wärmepumpe	
max. Heizleistung	HT 2 × 70 kW NT 2 × 190 kW
Vor-/Rücklauftemperatur	HT 70/50 °C NT 36/28 °C
Motorleistung	2 × 43 kW
Kälteleistung	2 × 150 kW
Kondensatorleistung	2 × 190 kW
Motorabwärme	2 × 70 kW
Motortyp	E 0224 E
Verdichtertyp	CF 90
Kältemittel	R 12
Wärmequelle	Grundwasser

Table 2 Technical Data of the Heat Pumps

The heat generated from Nov 1982 to Nov 1983 was 950 MWh with a primary energy input of 500 MWh. The seasonal performance factor was 1.9, i.e. an energy saving of 58% could be achieved compared with a conventional boiler system (mean boiler efficiency, 80%).

The third example is a gas engine driven heat pump operating since 1981 together with the existing boiler system for a hospital in Karlsruhe-Rueppurr (Fig. 6). Control of the whole heating plant depends on a central storage unit. Cold fresh water is preheated by the return water, thus ensuring a low return temperature to the

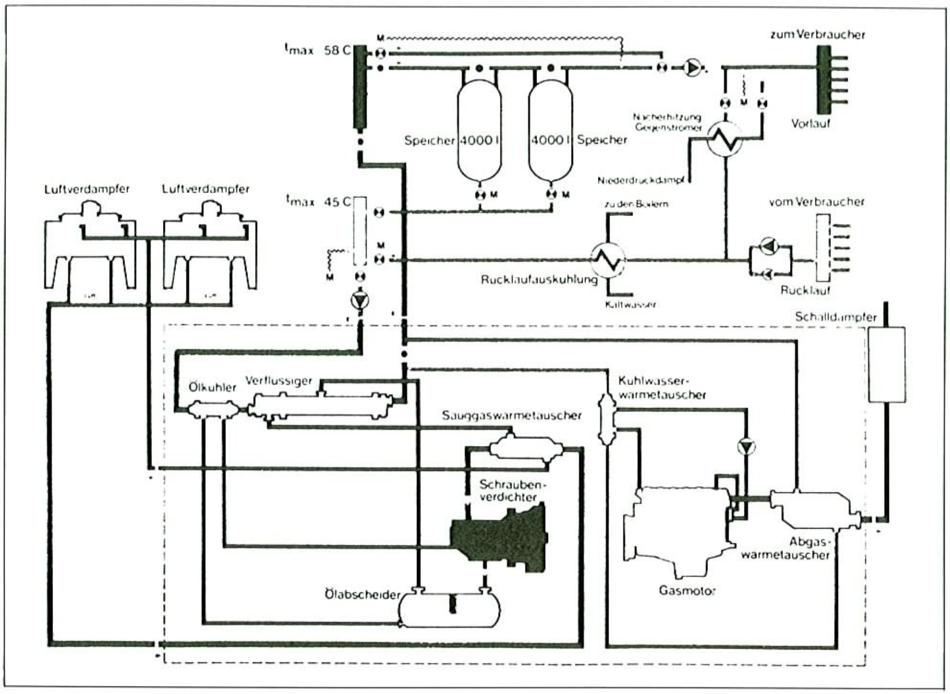

Fig. 6 Flow Sheet of the Gas-Engine Heat Pump System

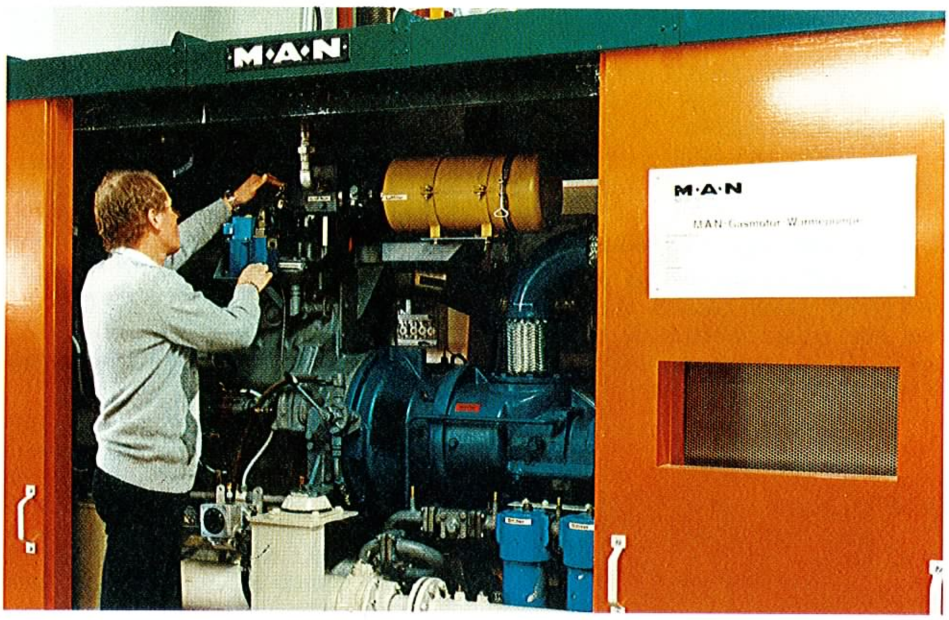

Fig. 7 Compact Heat Pump Unit

heat pump. In a second step, this water is heated by the boiler system to the desired end temperature. All components such as gas engine, screw compressor, oil separator and heat exchanger are mounted on a single frame (Fig. 7). The maximum heating capacity of the system is 450 kW, flow and return temperatures are 58/45 °C. The heat source is air which is cooled by evaporators installed in the garden. The system supplies the basic heat demand for the hospital down to external temperatures of −5 °C. Evaporator icing

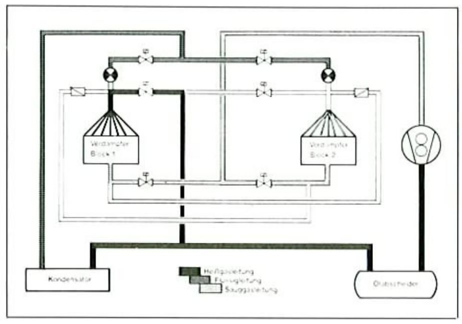

Fig. 8 Hot Gas Defrosting

generally occurs at temperatures below 5 °C. In this case the necessary defrosting is achieved by hot gas injection (Fig. 8).

Operational data of the heat pump are recorded daily: external temperatures, flow/return temperatures, defrosting cycles, evaporation and condensing temperatures, gas consumption, heat supplied, operation hours.

Between Jan and Jun 1983, the heat pump was in operation for up to 700 hours out of a possible 720 hours monthly. The running time of 3,550 hours and a SPF of 1.57 (related to 6 months) are very good values for air-to-water heat pumps. Heat supply amounted to 1,500 MWh for which an energy input of 955 MWh (natural gas) was necessary. The energy conservation achieved was 50% and the availibility of the system was 97% for the first half of 1983.

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T. Shimura*

Heat Pump Developed for "Waste Heat Utilization Technology System"

1. What is a "Waste Heat Utilization Technology System"?

In Japan, the mining and manufacturing industry as a whole, including iron and steel industry, consumes about 50% of the total energy. Additionally, about 50% of energy consumed in this sector is dissipated as waste heat. Since Japan is not blessed with energy resources, there is an eminent need for developing new technologies for effective utilization of waste heat. Such an effort has been undertaken in a demonstration project in an ironworks having the most various sources of waste heat. Over a period of 6 years from 1976 selected technologies (Fig. 1) were developed with an investment of about 4,000 million Yen.

2. Compression-Type Heat Pumps

It was aimed to develop a heat pump for a capacity of 10,000 kW capable of delivering 100—160 °C of high-temperature water from 30—60 °C waste water at a COP higher than 3. Since the temperature increase is large, a composite system consisting of a diesel engine driven compression heat pump and an absorption heat pump was adopted, and a 1/20 scale

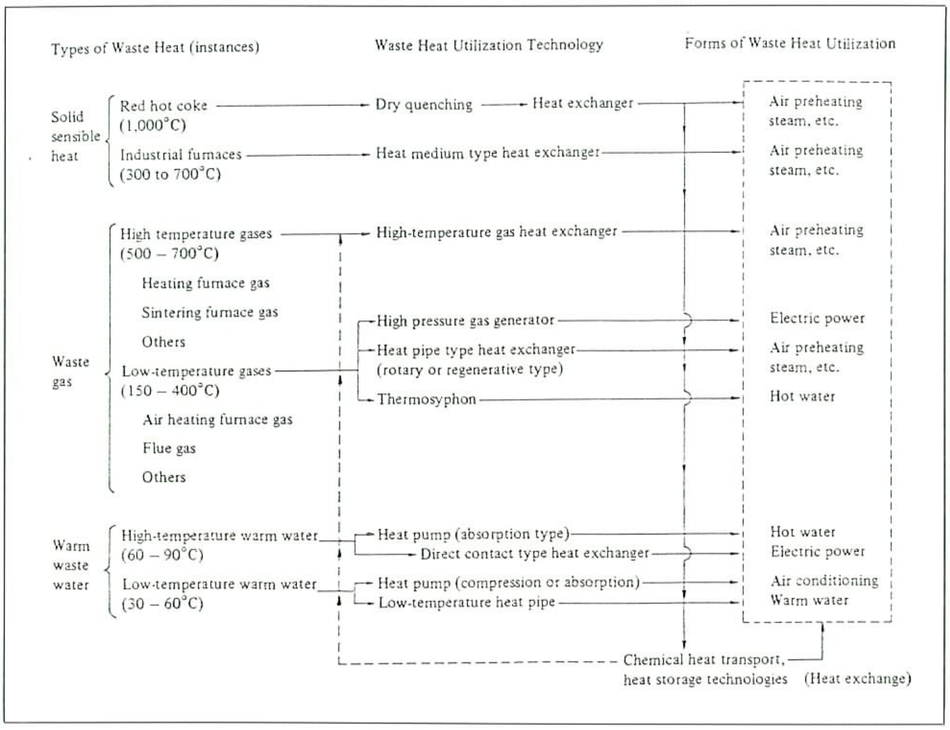


Fig. 1 A Summary of Waste Heat Utilization Technology

model (500 kW) was built for research purposes.

Since output temperatures of more than 120 °C are required, a screw compressor featuring complete separation of freon and oil systems was developed. Instead of using oil for sealing the rotor, freon (R114) is used so that the compressor is operable up to about 130 °C.

In order to enhance the compressor efficiency, a cascaded system was developed. It consists of a R12 unit with oil injection for the first stage and a R114 unit with freon liquid injection system for the second stage. This system is already in use at a brewery in France.

3. Absorption-Type Heat Pumps

It was aimed to develop an absorption heat pump system capable of recovering heat from waste water of 30—60 °C for use in district heating or cooling, with a brine temperature down to – 15 °C.

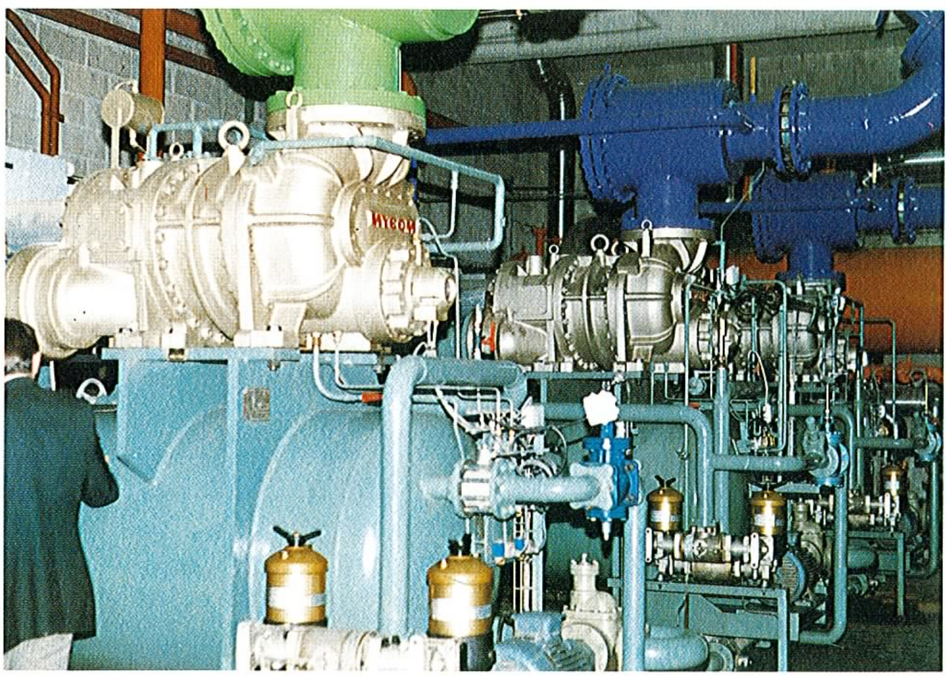


Fig. 1 Cascaded-Type Compression Heat Pump

For safety reasons, it was decided to develop an absorption heat pump using lithium bromide-water. For this purpose, Type I absorption heat pumps (with COP of 1.6 or higher) which require drive energy other than waste heat and Type II absorption heat pumps (with COP of 0.4 or higher) which operate wiith waste heat and cooling water, etc., were developed.

As for the Type I absorption heat pump, there are some 50 units in operation. Small-capacity units (~50 kW) recover heat from hot spring or geothermal water, medium-capacity units (~200 kW) are used to supply hot water to dyeing processes, etc., and large-capacity units (~400 kW) are used for heat recovery from industrial waste water.

As for Type II absorption heat pumps, there are 5 units in operation. With outputs up to 1,000 kW, they are mainly incorporated in chemical plants and used to recover heat from distillation towers, etc.

4. Examples of Actual Installation

4.1 Compression-Type Heat Pump System

At a malting works in France, a cascaded-type heat pump system (Mayekawa Mfg. Co., Ltd., Japan) is in service in the malt drying process. It consists of 2 compressors, one that utilizes R12 as refrigerant, and a second compressor that utilizes R114. It heats incoming air to some 85 °C. This system (Fig. 2) has about 5,000 kW of heating capacity and its COP is about 3.9 for one batch (20 hours).

4.2 Absorption-Type Heat Pump System

— Type I absorption heat pump
Type I units are used to generate hot water of about 80 °C or steam from waste water of a paper mill, textile works, etc. Those units with a capacity of 800 kW have COPs of 1.67. With hot waste bleaching water from a paper mill (50 °C) as a heat source, boiler replenishing water is heated up to 80 °C. Fig. 3 shows a system at the Miyazu Works in Kyoto, Japan (by Tokyo Sanyo Electric Co., Ltd., Gumma, Japan).

— Type II absorption heat pump
The units with a capacity of 1,800 kW generate low-pressure steam of about 110 °C by recovering heat from the top of a distillation tower (about 80 °C) of a chemical plant and have a COP of 0.47 (Fig. 4). At the Toray Industries Inc., Tokai Chemical Plant, Aichi, Japan (by Hitachi Zosen Corporation, Tokyo, Japan).

* *Takehiko Shimura, National Chemical Lab. for Industry, Agency of Industrial Science and Technology, MITI.*

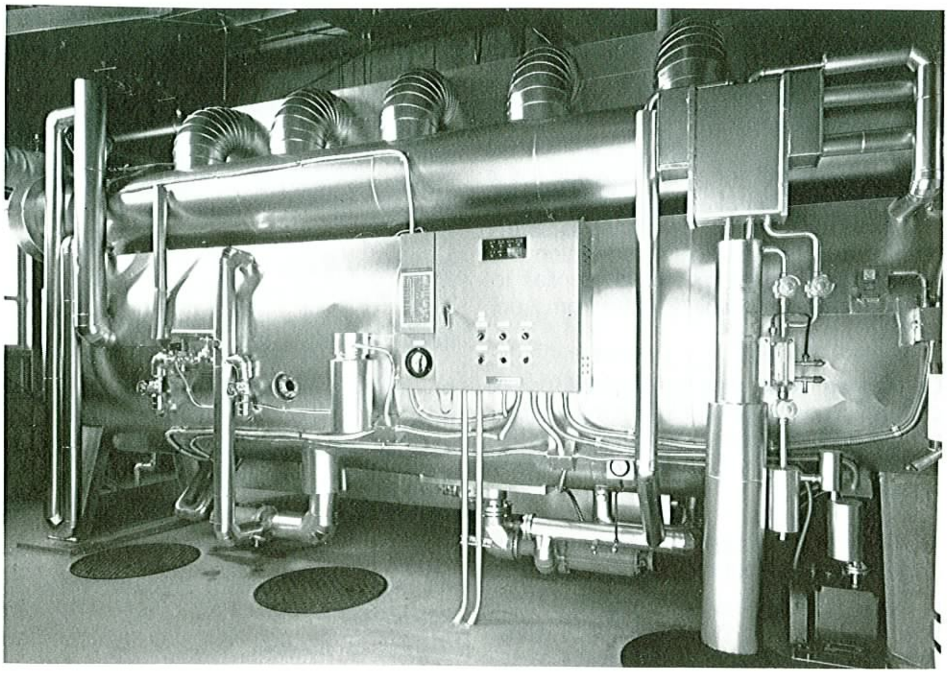


Fig. 3 Type I Absorption Heat Pump at Gunze, Ltd., Miyazu Works, Kyoto, Japan (Mfg.: Tokyo Sanyo Electric Co., Ltd., Gumma, Japan)

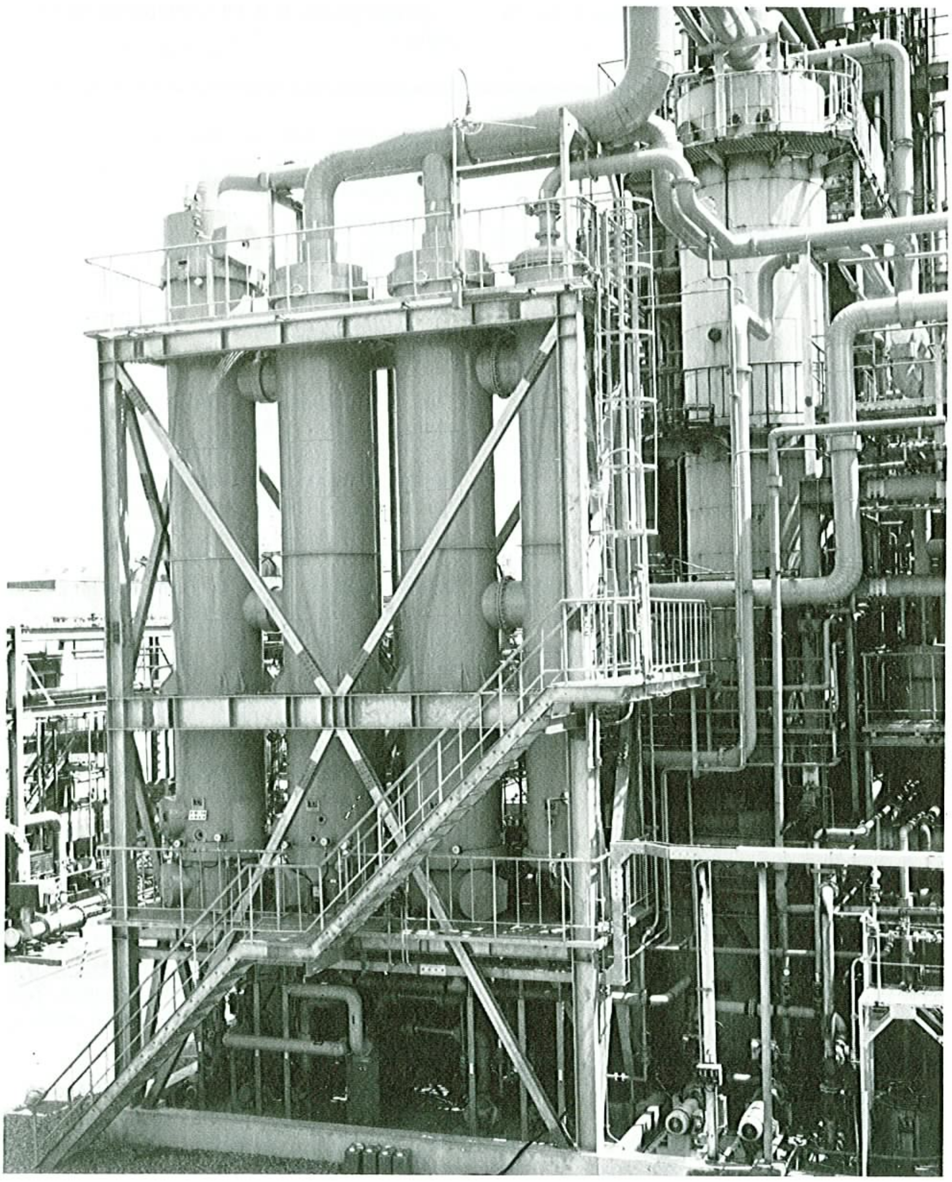


Fig. 3 Type II Absorption Heat Pump at Toray Industries Inc., Tokai Chemical Plant. Aichi, Japan (Mfg.: Hitachi Zosen Corporation, Tokyo, Japan)

E. Miura*

Incentive Programs for Heat Pumps in Japan

For Japan, which must depend upon imported oil to meet the vast majority of its energy requirements, it is an eminent national task to ensure a stable supply of energy and achieve an effective utilization of energy for a stable social life and healthy development of economy and society.

As a step in this direction, energy conservation must be fostered. Therefore the Japanese Government has implemented subsidies, preferential taxation programs, and other financial measures for heat pumps. The incentives are explained below.

1. Subsidy for Important Technical R & D Projects

Under this subsidy program, the government grants subsidies to private R & D projects concerning important technologies. Applications are accepted by the Agency of Industrial Science and Technology of the Ministry of International Trade and Industry. In the sector of energy saving technology development which includes the heat pump, research and development projects requiring one to several years to accomplish development, and several tens of millions to several hundreds of million yen in total, are subsidized. Subsidies can be obtained up to 50% of total project cost with 16 million yen being the lower limit. The results remain in the property of the respective developing enterprise, but when profit is made based on the results of the subsidized project within 7 years from the end of the subsidy, a certain ratio of the profit must be repayed to the government with the amount of the subsidy as an upper limit. 367 million yen were appropriated to this sector for 1984.

2. Financing

In order to facilitate energy conservation measures for the industrial sector which consumes about 60% of Japan's total energy, the government is implementing financial support measures through its three financial institutions, to support large-scale equipment investments, including changes of production lines.

2.1 Loans obtainable for Resource and Energy Projects from 'Japan Development Bank'

From this institution, loans are available to enterprises installing equipment which will greatly contribute to effective utilization of energy and whose installation is deemed very important and therefore must be supported by the state for more energy conservation in Japan. Firms who lease such equipment are also considered. In the case of conventional heat pumps, the requirements are as follows:

(i) The energy utilization efficiency must improve by more than 10%, and the use of heat pumps must result in a conservation of energy corresponding to more than 50 m³ in terms of oil/year.

(ii) The energy utilization efficiency must improve by more than 5%, and the use of heat pumps must result in a conservation of energy corresponding to more than 1,000 m³ in terms of oil/year.

In the case of heat-storage-type heat pumps with more than 10 kW of rated power consumption, the requirements are as follows:

(i) The energy utilization efficiency must improve by more than 20%.

(ii) The power load required for heating/cooling, etc. in the daytime can be shifted by more than 5% into the night-time.

The loan is less than 40% of total cost. In the case of conventional heat pumps, the interest is 7.6% per annum for heat pumps with more than 20% of energy utilization improvement, 7.9% for heat pumps with less than 20%, while it is 7.3% for heat-storage-type heat pumps.

2.2 Small Business Finance Corporation's Loan for Energy Saving Facilities

This system provides small business with funds necessary to facilitate effective utilization of energy.

Covering heat pumps with more than 10% of energy saving effect, applicants for this loan can be granted equipment funds needed to install such heat pumps. The limit for a direct loan is 300 million yen in addition to a regular loan. In case of an agency loan, the limit is 40 million yen, in addition to a regular loan. The interest is 7.9% per annum, with the loan period less than 10 years, and the period of deferment less than 2 years.

2.3 National Finance Corporation's Loan for Energy Saving Facilities

Except fo the loan limit being 30 million yen, this subsidy is the same as 2.2.

3. Preferential Taxation

3.1 Taxation System for Investment Promotion for Improvement of Energy Efficiency, etc.

When an enterprise has obtained and installed equipment conducive to effective utilization of energy and put into service,

(i) 7% of the said equipment's acquisition price can be written off up to a limit of 20% of the total corporation tax of the said income.

(ii) the special redemption system can be utilized in which up to 30% of the said equipment's acquisition price can be redpayed in addition to ordinary redemption.

Either of the above two measures can be chosen so that it may be implemented in the year when the equipment was put into service use. In both cases, one year's carry-over is admitted.

The program can promote the following types of heat pumps:

a) Type II absorption heat pumps
b) Heat pumps with more than 30 kW of rated power consumption, or those heat pumps with a multiple-compressor control system.

Those who install either of them and file a tax return can benefit from this program. In the case of small and medium size enterprises, all heat pumps in operation are covered by this program which applies to those to be taxed within 2 years from April 1, 1984.

Certificates which may be required for tax declaration concerning heat pump specifications, etc. are issued by the Japan Refrigeration and Air Conditioning Industry Association.

3.2 Special Redemption System for Energy Saving Equipment

In case energy saving equipment has been acquired and put into service within one year, the company is allowed to redeem 18% of the acquisition price in addition to ordinary redemption. This program applies to individuals or corporations which install heat pumps and file a tax return.

3.3 Exceptions to Tax Rates for the Fixed Property Tax Related to Energy Conservation

According to this program, when an individual or a corporation files a tax return and the same individual or corporation has installed a heat pump, the tax rate may be reduced to 4/5 of the fixed property tax for three years. In the fiscal year 1984, it is applied to the fixed property tax on those heat pumps acquired in the four years following April 1, 1980, concerning the tax from 1981 onwards.

For more detailed information please contact:

(Subsidy) Technology Promotion Division
Agency of Industrial Science and Technology, MITI,
1-3-1 Kasumigaseki, Chiyoda-ku
Tokyo 100 Japan
(Finance and Taxation) Energy Conservation Division,
Agency of Natural Resource and Energy, MITI.

** Etsuji Miura, IEA-HPC National Team of Japan*

NEWS

We Are Getting Closer to Our Goals

Anybody involved in heat pump research and development should have it: The IEA Heat Pump Center "Bibliography on Non-Azeotropic Mixtures". A comprehensive, up-to-date compilation of all relevant publications concerning this field of investigation, is broken up into the following chapters:

- Application of Non-Azeotropic Mixtures as Working Fluids in Compression Heat Pumps
- Investigations on Non-Azeotropic Mixtures for Use in Refrigeration Machinery
- Thermodynamic Properties of Non-Azeotropic Mixtures
- Patents on the Use of Non-Azeotropic Mixtures.

An index of authors, institutions, and investigated refrigerant mixtures round up the compilation. Updates are envisaged to be made until May 31, 1985, and December 31, 1985.

The HPC is making this compilation available to interested parties in countries participating in the IEA-HPC only.

The first HPC project was the collection of R, D & D projects in the field of heat pumps and related technology in the member countries and the European Community. The printed version will appear in 4 distinct parts covering various main topics:

- Heat Pumps
  Basic Research Projects
- Residential/Commercial Applications of Heat Pumps
- Industrial Applications, District Heating
- Index

The next envisaged project to be completed is the collection of product data, which is aimed at giving an overview of available heat pump equipment, to be a guide easing the choice of the best-suited system for each individual need, and simultaneously to offer the HPC the opportunity to keep track of heat pump developments and the available range of products and capacities. The HPC invites industry to participate in this effort by sending in their sales literature, product information and technical specifications on their heat pump line. The HPC would appreciate being continuously informed of any changes in the product.

A further project of the HPC soon to be completed is the collection of the national standards covering the field of heat pump technology in HPC member countries. In its final published form this HPC product will provide translations of the standards, comparisons of their characteristic features and an analysis of the most striking differences.

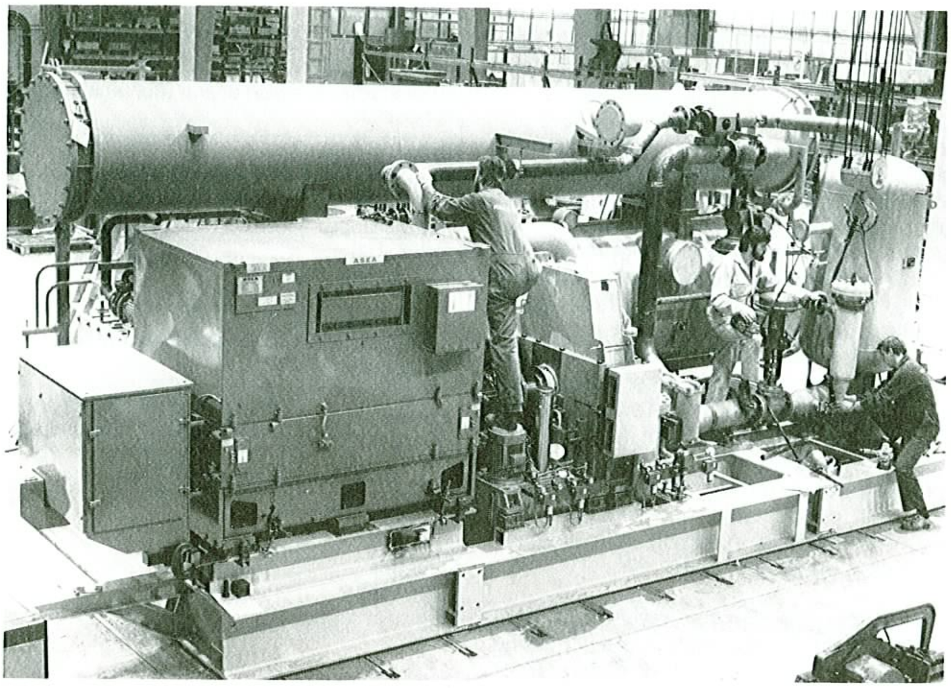
Distributors of imported heat pump equipment and manufacturers wishing to export their products will find the necessary technical specifications to conform with the national regulations for target markets in the HPC member countries.

PR NEWS

ASEA STAL Receives Finnish Order for Heat Pump Plant

ASEA STAL AB (formerly STAL-LAVAL), Finspong, Sweden, has received an order from the Finnish power company Imatran Voima Oy for a 7-MW heat pump for a district heating installation in Uusikaupunki (Nystad) on the south-west coast of Finland. This will be the first heat pump ASEA STAL has supplied to a customer outside Sweden and it will form part of a complete $ 2.62 million project. Heat will be extracted from a combination of purified sea- and sewage-water.

The district heating plant is being built on a turnkey basis, with the ASEA STAL subsidiary in Helsinki (Oy ASEA STAL), acting as main contractor. In addition to the ASEA STAL heat pump, the contract includes a Zeta electric boiler, the auxiliary equipment and the building itself. The district heating plant, which will have a thermal output of 10 MW, will cover 85% of the heat requirements of Uusikaupunki with a population of 13,000. Delivery is scheduled for spring 1985.



A 7 MW heat pump unit under construction at ASEA STAL factory in Finspong, Sweden. Larger units are assembled on site

ASEA STAL Receives Orders for Three Heat Pump Plants for District Heating

The Heat Pump Division of ASEA STAL AB, Finspong, Sweden, has received turnkey orders for three large heat pump plants to be installed in the district heating systems of Oerebro, Trollhaettan, and Borlaenge. The total value of these orders is about $ 6.55 million.

In Oerebro, a town of about 90,000 inhabitants 200 km west of Stockholm, about 90% of the urban area is covered by the district heating network. The heat pump plant which has now been ordered by the municipal energy supply company, Oerebro Kraftvaerme AB, is rated at 40 MW and will provide a quarter of the total heat requirement of 1,000 GWh/year.

The plant will consist of two heat pump units which will extract waste energy from treated sewage water. This water will be taken through a 6-km-tunnel from the sewage works to the Aby district heating power station, where the heat pump plant is to be built. The heat pumps will produce enough energy to make possible a saving of oil amounting to 20,000 to 25,000 m^3/year.

The municipal energy supply company is investing about $ 6.22 million in the heat pump project, including the pipelines and electric power equipment. The project is expected to amortize in about two and a half years. The plant is to be ready for commercial operation in February 1985.

In Trollhaettan, a town of 45,000 inhabitants 75 km north of Gothenburg, the municipal district heating company, Trollhaettans Fjaerrvaerme AB, has ordered a 7-MW heat pump plant to extract the heat from industrial effluent which consists of cooling water from the metalworks of Ferrolegeringar AB.

At the moment, Trollhaettan produces its district heating energy from refuse and oil. The heat pump plant will cover the base load, in conjunction with the refuse incineration plant, and will eliminate the need to burn fuel oil. The heat pump plant will be installed at the Stallbacka district heating station and delivery will be completed in November 1984.

In Borlaenge, a town of 50,000 inhabitants 220 km north-west of Stockholm, the municipal energy authority, Borlaenge Industriverk, is continuing its major investment program in heat pumps. In February 1984, the authority inaugurated its first large heat pump plant which consisted of two 12-MW units. A third unit of the same size has now been ordered, and this will be set up at the same place at the Kvarnsveden Paper Mill, on the outskirts of the town.

The heat pumps will extract energy from the treated waste water leaving the paper mill and this will be used for district heating. A 2.6 km culvert will link the heat pump plant with the consumers in the town.

The existing heat pump installation is already saving 16,000 m^3 of oil per year and is consequently reducing sulphur dioxide emission from 590 to 263 tons per year. The introduction of a third heat pump will mean that a further important step has been taken to improve the environment and in reducing the need for oil. The new heat pump plant is expected to come into operation beginning 1985.

So far, ASEA STAL have delivered 20 large heat pump plants which are now in operation, while a further 10 are under construction.

Geothermal Plant at Lund, Sweden

ASEA STAL AB, Finspong, Sweden, has formed a new company, ASEA STAL Geoenergy AB in Lund, Sweden. The company will supply plants to exploit geothermal energy for various applications, both in Sweden and abroad.

The first project will be a plant in Lund designed to supply district heating energy from subterranean water. The plant will be completed in two stages, the first of which has an estimated cost of $ 7 million with a 20-MW heat pump supplying about 140 GWh of energy per year. The geothermal water of 26 °C will be captured at a depth of less than 800 m. This method differs from previous practice, but it results in reduced drilling cost, less likely dry wells and easy control of water chemistry. Stage I is scheduled to start operation in January 1985.

Sulzer Heat Pumps will Supply 86 MW Heat at Vartan-Ropsten, Stockholm

The Stockholm Energyworks have placed an order for the worldwide so far largest heat pump installation with the Swedish contractor consortium ELAJO Varmepupar AB, Finspong — ABV AB, Stockholm, itself partner of Sulzer Bros. Ltd., Winterthur, the supplier of the actual heat pumps.

The total installation has a value of about $ 11.55 million and will go into operation in fall 1985. The order comprises three Sulzer centrifugal heat pumps 'Unitop' 50 with a total drive power of approximately 25,000 kW and an overall heating capacity of 86,000 kW. Over 70% of this heating capacity is extracted from brackish sea water by means of flat-plate refrigerant evaporators. The heat pumps serve to reheat district heating water, thus reducing significantly the consumption of fuel oil. This reduction is even more, because the heat pumps operate throughout the whole year also for consumable and industrial hot water production, resulting in a payback time of roughly two years.

Up to now, Sweden has ordered 50 centrifugal heat pumps with a total heating capacity of 600 MW, out of which 37 or 400 MW are equipped with Sulzer compressors.

Heat Pump Type Household Clothes Drying Unit

Jointly with Tokyo Power Co., Ltd., Hitachi, Ltd. has been engaged in R & D of a "household heat pump power-saving clothes dryer". Recently, Hitachi has set about the marketing of a ceiling-concealed "Dehumidifying/Drying Unit" intended to utilize the bathroom as a clothes drying room, capable of achieving a 30—40% energy saving. Characteristic features of the "Dehumidifying/Drying Unit" are as follows:

(1) A heat pump system in which moisture from the wash is dehumidified by the cooler, and the dehumidified air is heated by the reheater, then circulated to dry the wash. Power consumption is as little as 380/420 W (50/60 Hz).

Ceiling-Concealed Heat Pump Clothes Drying Unit

Specifications

Type		RD-BC1400L
Room temp. at which drying (dehumidifying) is possible		about 1 °C or higher
Power source		single phase 100 V 50/60 Hz
Performance (50/60 Hz)	Dehumidifying capability (room temp. 27 °C; humidity 60%)	12/14 l/day
	Volume of ventilation	1.5/1.7 m³/min (at 7 mmAq of static pressure)
Type of compressor		Rotary type
Refrigerant		R12
Power consumption (50/60 Hz)	When drying (dehumidifying) (room temp. 27 °C; humidity 60%)	380/420 W
	When ventilating	40/40 W
Weight of the unit		21 kg
External dimensions	The unit itself	495 W × 495 D × 215 H mm
	Decor cover	550 W × 590 D × 55 H mm

(2) Since clothes are suspended from a clothesline in the bathroom, in contrast to being tumble-dried in the conventional clothes drier, clothes are not damaged. Additionally, large garments like sheets can be dried.

The drying time differs depending on the type of clothes. When the ambient temperature in the bathroom is 25 °C, it takes about 2 hours and 45 minutes to dry 2 kg of clothes, and about 4 hours and 10 minutes to dry 3 kg.

Schedule of Conferences and Trade Fairs

Oct 17—21, 1984, Saarbruecken (Federal Republic of Germany), Energie + Umwelt '84, Exhibition and Congress, Contact: Saarmesse GmbH, Messegelaende, D-6600 Saarbruecken (FRG)

Oct 18—21, 1984, Florence (Italy), Tuscany Thermo-Hydraulics Exhibition — Heating, Refrigeration, Air Conditioning, Solar Energy, Insulation, Bathroom and Kitchen Equipment, Contact: SENAF srl, Via della Moscova, 46/1, I-20121 Milano (Italy)

Nov 8—11, 1984, Copenhague (Denmark), National Fair for Heating, Ventilation, Air Conditioning and Sanitary Equipment, Contact: Exhibition Organization DK, DK-2920 Charlottenlund (Denmark)

Nov 12—17, 1984, Lyon (France), Expotherm, Contact: Foire Internationale de Lyon, Quai Achille Lignon, F-69459 Lyon Cedex 3 (France)

Nov 15—16, 1984, Malmoe (Sweden), International Workshops and Study Tour: Energy Strategy for Community Systems, Contact: Swedish Council for Building Research, Att. Britt Olofsdotter, St. Goeransgatan 66, S-11233 Stockholm (Sweden)

Nov 21—24, 1984, Hamburg (Federal Republic of Germany) SHK '84, Northern European Trade Fair HVAC, Contact: Promotor Verlag, POB 211053, D-7500 Karlsruhe 21 (FRG)

Apr 15—19, 1985, Washington, DC (USA), International Symposium Moisture and Humidity, Contact: Charles T. Glazer, Instrument Society of America, 67 Alexander Drive, Research Triangle Park NC, 27709 (USA)

May 8—10, 1985, Vienna (Austria), 2nd Workshop on Solar-Assisted Heat Pumps with Ground-Coupled Storage, Contact: JRC, Att. D. van Hattem, I-21020 Ispra (VA), (Italy)

I. Kuga*

Application of Heat Pumps to Greenhouse Conditioning

Greenhouses in Japan

Since 1965, greenhouse horticulture has rapidly expanded and has reached a sevenfold growth in the last 20 years, being now the world's largest, covering about 320 km^2.

The rapid development is attributable to the increased diversification and sophistication of trends in consumption of vegetables, flowers, etc. along with the socio-economic developments. At present, almost all kinds of vegetables are available year round so that the supply can satisfy a variety of consumers' tastes.

The main products of greenhouse horticulture are vegetables, fruit, and flowers, their respective shares being 75%, 15%, and 10%.

About 40% of the greenhouses need heating. Oil used as a heating fuel for greenhouses accounts for only 0.5% of Japan's total oil consumption. For greenhouses, however, energy saving measures have become a central issue since the oil crisis.

Utilization of heat pumps is one of the energy saving measures, and at present, about 600 heat pumps are used for greenhouse conditioning across Japan. The commonly used heat pump system uses groundwater at about 15 °C as heat source, and circulates warm water for heating.

Compared to boilers, heat pumps are at a disadvantage by their high installation cost and low number of yearly operational hours. Nevertheless, heat pumps have been accepted not merely for the purpose of efficient heating; they have been employed also by accounting the following merits from an overall point of view:

- Simple to handle, can be automated;
- No overheating or fire;
- Clean, no odor;

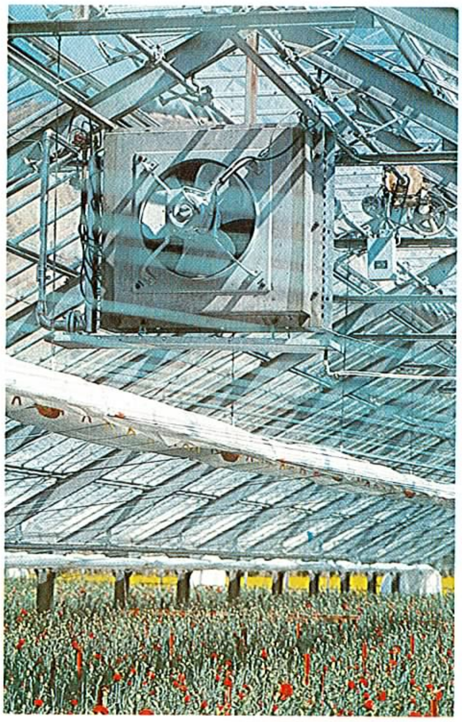


Photo 1a Carnation Cultivation in the Greenhouse. As a Result of Heat Pump Utilization, its Expense for Energy Supply reduced by about 40%.
Kyonanmachi (N 35° 06′) Chiba, Japan.

- Capable of heating, cooling and dehumidifying with a single unit;
- Easy control of temperature and humidity.

Besides other advantages, heat pumps dispense with boiler operation, and are capable of precise temperature/humidity control. Thus they are very attractive to greenhouse owners.

Case I. Carnation Cultivation

Here is an example for heat pump utilization in underglass cultivation. Photo 1 shows a heat pump applied to carnation cultivation which has achieved favorable results.

The optimum cultivation temperature is 15—25 °C. Carnations grow well in a somewhat dry environment. The system is as shown in the conceptual drawing (Fig. 1).

In the summer, since it becomes very hot and humid, the heat pump is used for cooling and dehumidifying the house at night. In wintertime, in order to maintain the carnation growing temperature, the heat pump is used for heating. For this purpose, hot water is circulated in three piping systems:

— on the ground surface,
— just under the surface,
— 1 m underground.

This greenhouse was constructed in 1981, and since that time has been operating favorably. Compared to oil boilers, the annual energy cost (electric power charges)

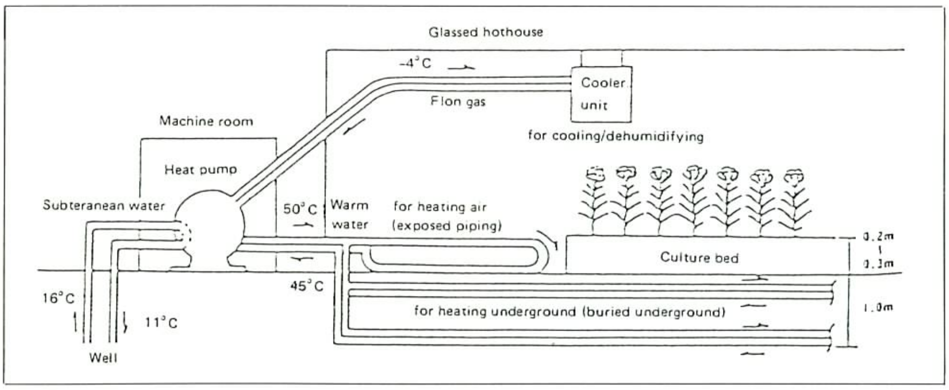


Fig. 1 Greenhouse air conditioning system

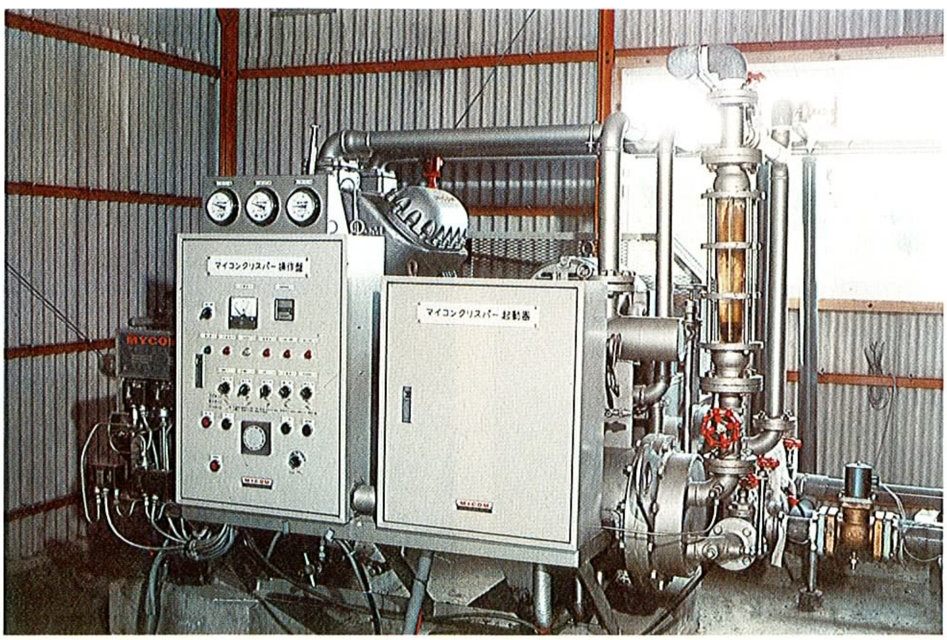


Photo 1b Water-Source Water Chiller Heat Pump with a Capacity of 63 kW for the Carnation Greenhouse

Photo 2 Interior View of Begonia Greenhouse. Air-Source Water Chiller Heat Pump with a Heating Capacity of 44 kW can be Seen on the Left. Momou-Cho (N 38° 33′), Miyagi, Japan

declined by about 40%. Moreover, real income has increased due to the following reasons:

- The flowers were sold at high prices, since they were excellent in color, quality and shape.
- The quantity of production per unit area increased.
- Shipments have become flexible, allowing shipping of products when market prices are high.

Case 2: Begonia Cultivation

Photo 2 shows an example of cultivation of flowers used for room decoration during the winter. So far, boilers were used for heating, but for more energy saving, power saving, improved production efficiency, etc. the boiler system was replaced by a heat pump system. This led to a 40% saving of energy, and there was an increase in production frequency from five times a year to eight times a year. Additionally, by providing a heat storage tank (4 m^3), the heat pump capacity could be reduced. The COP is 3.8 when the outside temperature is 7 °C. Actually, however, since the outside temperature drops to −3— −5 °C, the annual average COP is about 3.

Cases 3 and 4: Vegetable Cultivation

Photos 3 and 4 show examples of cultivations in the cold region located in the northern end of Japan. The average winter (Dec.—March) temperature is −6 °C. In order to supply fresh vegetables to this region, hydroculture is in practice, since it needs a relatively short maturing period. Example 3 shows an airsource heat pump; beneath the solution bed, warm water piping is provided to keep the solution temperature at about 18 °C. This heat pump is used from Oct.—Dec. and March—May. In January and February,

Photo 3 Air-Source Water Chiller Heat Pump with a Heating Capacity of 21 kW for the Trefoil Greenhouse. Asahikawa, Hokkaido, Japan.

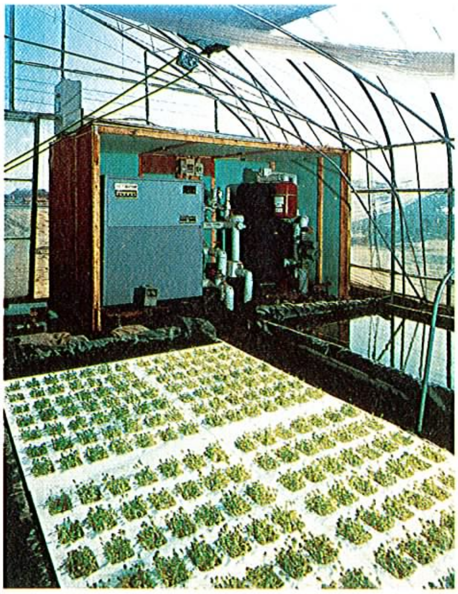


Photo 4a Water-Source Water Chiller Heat Pump with a Heating Capacity of 18 kW for the Salad Greenhouse in the Cold Region.

Photo 4b Tray Agriculture of Kaiware-Daikon (Salad) in the Greenhouse, 330 m², utilizing Heat Pump. Asahikawa (N 43° 46′) Hokkaido, Japan.

since the outside temperature drops below −7 °C, boilers are used for heating.

Example 4 shows a water-source heat pump used for heating during the whole winter.

Thus, a variety of systems have been devised to meet different cultivation requirements with favorable results. However, compared to heating with oil boilers, the share of heat pump utilization is very small (less than 1%).

		(Example 1) Kyonanmachi, Chiba Prefecture	(Example 2) Momou-cho, Miyagi Prefecture	(Example 3) Asahikawa City, Hokkaido	(Example 4) Asahikawa City, Hokkaido
North latitude		35° 06′	38° 33′	43° 46′	43° 46′
Object of culture		Flower: Carnation	Flower: Reagan begoniya	Vegetable: Trefoil	Vegetable: Kaiware-daikon[1])
Method of culture		Soil	Potted plant	Water	Water
House area (m²)		880	990	330	330
	Kind	Water-water	Air-water	Air-water	Water-water
	Refrigerant	R12	R22	R22	R22
	Compressor	Reciprocating	Reciprocating	Reciprocating	Reciprocating
	Heating capacity (kW)	62.8	43.6	21.2	17.8
	Power consumption (kW)	15.0	11.5	6.5	4.5
	COP	4.2 Heat source water: 16 °C Discharged hot water: 45 50 °C	3.8 Outside temp.: 7 °C Discharged hot water: 40 45 °C	3.3 Outside temp.: 7 °C Discharged hot water: 40 45 °C	4.0 Heat source water: 16 °C Discharged hot water: 40 45 °C
Remarks			COP is 3.0 when outside air is 0 °C	COP is 2.5 when outside air is 0 °C	

From now on, in order to increase diffusion, higher efficiency and reduced cost of installation must be achieved for heat pump systems. Thus, the manufacturers are busy working towards these improvements. Our company also is engaged in R & D of higher-efficiency air-source heat pump systems for greenhouses.

** Isamu Kuga: Marketing Development Engineering Div. of Tokyo Electric Power Co., Inc., Tokyo 100 (Japan).*

Call for Papers

Second Workshop on Solar-Assisted Heat Pumps with Ground-Coupled Storage

The CEC and the IEA will hold a second workshop on "Solar-Assisted Heat Pumps with Ground-Coupled Storage" in Wien, Austria, May 8—10, 1985. It is planned for 50 to 100 participants. In order to assure a systematic and meaningful exchange of information, a Reporting Format has been prepared. Papers should be written according to this format.

The workshop will cover the following subjects:

A) Performance of Solar Assisted Heat Pumps with Ground-Coupled Storage, systems in operation.

B) Subsystems & Components: solar, storage, heat pumps
— performance of system components
— heat transfer fluids
— ecological aspects
— testing of ambient energy collectors
— reliability and maintenance
— investigations into soil characteristics

C) System Analysis — Optimization — Sensitivity Studies

D) Economics and Market Prospects

To obtain the required Reporting Format for the presentation of papers, authors must send in a completed questionnaire together with an abstract of their contribution (250—300 words). Questionnaires and further information are available from the address below.

D. van Hattem
JRC
I-21 020 Ispra (VA)
Italy
Tel. 0332-789449
Telex. 380042 eur i

Timetable:

Nov 1st, 1984 — Abstracts due
Dec 1st, 1984 — Reporting Format will be sent to authors
Mar 1st, 1985 — Full papers should have reached the Organizing Committee.

DEAR READER!

Our NEWSLETTER is designed to become an international information forum for whoever is concerned with heat pumps - in research, development, installation, production and marketing. Our Readers' Column will be an important section for exchange of opinions, collection of new ideas, or criticism of present procedures.

We need your cooperation!

Please send in your drafts (contributions in the languages of participating countries will also be accepted) - together with a photograph if you like - up to half page DIN A 4 to:

IEA Heat Pump Center
c/o Fachinformationszentrum GmbH
D-7514 Eggenstein-Leopoldshafen 2

Our next topic will be: "Should Tap Water Heating be separated from the Heat Pump for Space Heating?"

Deadline for your contributions: Nov. 30, 1984

E. Piantoni

What is your experience with absorption heat pumps?

Absorption heat pumps are relatively new in Italy and their introduction into the market started about one and a half years ago. The activities of commercialization (marketing, organization of maintenance network, demonstration units, etc.) are slowly growing according to the interest of the users and to the Government's energy policy promoting the utilization of natural gas.

Up to now, an Italian production of absorption heat pumps does not exist and the commercialization is based on imported equipment mainly from Germany and Japan. In the recent international exhibition on heating and air conditioning equipment 'Expoclima' held in Milano, in February, no absorption heat pump ready for commercialization was available.

To stimulate for the manufacturers' interest, the National Agency for Nuclear and Alternative Energy ENEA (Ente Nazionale Energia Nucleare ed Alternativa) is financing and technically supporting a development program of a small to medium size gas-fired absorption heat pump for residential heating.

Up to now, practical experience in Italy is limited to a few demonstration units operating since 1983.

** E. Piantoni, repr. CNR Progetto Finalizzato Energetica 2, c/o CISE, P.O. Box 12081, I-20 100 Milano.*

Selected Book and Report Reviews

Hochegger, W. (ed.); IEA Heat Pump Center, Analysis Center Graz; Proceedings of the IEA Heat Pump Conference — Current Situation and Future Prospects; Graz, Austria, May 22—25, 1984, Verlag für die Technische Universität Graz; 514 p. (in English)

The following main questions were addressed during the conference:

- Can heat pumps compete with conventional technologies in major markets?
- How can heat pumps be made more competitive?
- What type of heat pump products are selling best in Europe, North America, and the Pacific?
- How are heat pump prospects influenced by electric and gas utility pricing policies? By government actions?
- What performance have heat pumps really achieved in private, residential, commercial, and industrial installations?

In session A Residential and Commercial Applications were covered: with 3 papers giving an overview, 5 papers addressing the economic competitiveness, 7 papers presenting results and experience from field tests and 4 papers covering the demand projections for heat pumps in residential/commercial applications.

Session B covered Industrial and District Heating Applications with 5 papers dealing with heat pump prospects in industry, 7 papers covering prospects in district heating/cooling and block central applications, and 4 papers presenting field experience.

Session C covered the policy with 10 papers addressing the role of government and utilities and the role of urban planning in stimulating the heat pump market, and 3 papers on Conclusions from the last 5 years of heat pump R & D.

Non-Azeotropic Refrigerant Mixtures as Working Fluids in Compression Heat Pumps; Oct. 1984, IEA Heat Pump Center Karlsruhe (in English)

This bibliography is the first edition of a series of IEA Heat Pump Center bibliographies on various topics. It contains 275 citations, 110 of which are described with an abstract.

The abstracted publications are presented in 5 chapters:

Chapter one covers the application of non-azeotropic refrigerant mixtures in compression heat pumps; chapter two covers the use in refrigeration machines;

chapter three covers investigations on thermodynamic properties of non-azeotropic mixtures; chapter four presents 15 patents and a last chapter contains descriptions of research projects in this field. Listings of investigated refrigerant mixtures, institutions sorted by country, and authors, complete the bibliography.

Publications from all over the world have been compiled for this bibliography including Russian investigations as well as Japanese, or publications from the United States.

An update will be provided in March and December 1985.

VDI-Berichte 539: ORC-HP-Technology — Proceedings of the International VDI-Seminar held in Zürich, 10—12 Sept., 1984. Verein Deutscher Ingenieure, Düsseldorf, 1984; 1059 p. (in English)

Working fluid problems and new working fluids for energy engineering were the main topics of an international seminar held in Zürich. The covered fields of application were: Organic Rankine Cycles (ORC), Heat Pumps (HP), and Alternative Heat Power Processes (AHP). The VDI-Report comprises a number of more than 60 papers presented at this seminar. Besides the design of power plants and its components the presentations deal with thermodynamic properties of working fluids and their use in HP and ORC. Concerning heat pumps, the papers are concentrating on the use of non-azeotropic refrigerant mixtures in compression heat pumps, new working pairs for the application in absorption heat pumps, and waste heat recovery.

Takada T.; Yosomiya T.; Industrial Heat Pumps, Energy Conservation Center, 39—3, Nishi-Shinbashi 2-chome, Minato-Ku, Tokyo 105 (Japan); Fundamentals of Industrial Heat Pumps, Applications in Industry, Procedure of Planning and Designing Heat Pump Systems, Systems Evaluation Methods and Case Studies on Energy Consumption, 1984, 217 p. (in Japanese)

This report describes the fundamentals of industrial heat pumps, planning and design, evaluation of economic performance, application possibilities, and future topics of technological development in detail. Comprehensive Information on advantageous applications of heat pumps in the various industrial sectors is provided and the limits of the presently available techniques are pointed out.

Study Report for New Fields and Possibilities of Heat Pumps; Japan Refrigeration and Air Conditioning Industry Association (JRAIA), Kikai-Shinko Bldg. 201, 5—8, Shibakoen 3-chome, Minato-Ku, Tokyo 103; 1984, 250 p. (in Japanese)

This book comprises the results of one year research and survey conducted by the Heat Pump Committee, JRAIA. In the first part, it presents a perspective view of new fields and possibilities of heat pump applications in the housing, commercial, industrial, and district heating/cooling fields. The second part covers the present situation and future prospect of heat source units, control techniques, working fluids and lubricating oil, systems, heat sources, heat storage, and other techniques. Each of these topics are described and presented by competent experts.

Nakanishi, T.; Furukawa, T.; Nakauchi, K.; Baba, H.: Industrial High-Temperature Heat Pump; Hitachi Zosen Technical Report 1984, PP 60—66; Hitachi Zosen Corporation, Osaka 554 (Japan); (in English)

This study covers the research and development of large-scale absorption heat pumps which work at temperatures ranging from 5 to 150 °C, utilizing waste heat from industrial processes. Since industrial waste heat is expected to be cooler in the future, the performance of heat exchangers must be improved. One method to improve this performance is to adopt vertical shell and tube type heat exchangers for carrying out counter-current flow heat exchange in both the absorption and concentration processes. Another method is to use special tubes in the absorber where the heat transfer coefficient is expected to be low. We have shown that the heat transfer coefficient can be doubled using the special tubes in the absorber. The effectiveness of two types of operation, Type I and Type II, will be explained and practical uses outlined. We will also show that the use of a heat pump is a most effective way to save energy.

In our next issue you will find contributions to the following topics:

1. Editorial: Competitiveness of Electric Heat Pumps in Heating-only Markets
2. New Development in Electric Heat Pumps for Small Residential Buildings in Europe
3. ISH 1985
4. Heat Pump Sales in Member Countries
5. Heat Pumps in Austria
6. Sample Installations of Bivalent Electric Heat Pumps
7. Recent Performance Investigations on Heat Pumps
8. Schedule of Conferences and Trade Fairs

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