Tips for Installation of Air-to-Water Heat Pumps

*K. Sato

Introduction

Field experiences show that air-to-water heat pumps require special attention to the entire system when installed in cold climates. Generally, equipment manufacturers provide installation and start-up instruction manuals on their factory-assembled heat pumps. Most manuals describe installation methods, precautions and warnings as to unit handling for example, but they normally cover only limited information about special applications of the units.

Neglect of manufacturer's instructions will often lead to such serious troubles as repeated compressor failures and insufficient heating. This article discusses a few examples of important design considerations and recommendations gained by Toyo Carrier's field experience, which would be of practical use in designing a trouble-free system with air-to-water heat pumps.

Sound Barrier Installation

Many situations require sound barriers around an outdoor heat pump unit to prevent noise problems. When erecting sound barriers, consideration must be given to providing sufficient air flow space around the unit (see Figure 1). Insufficient air flow to the unit causes major problems. Compressor failures can occur due to extremely low suction pressures in the heating cycle causing excessive superheating of the refrigerant vapour and reducing the motor cooling effect. Table 1 gives the minimum recommended distance (L) between a typical air-to-water heat pump and sound barriers with effective openings.

The maximum height of the barrier or fence is shown in Figure 1. If distance "L" is not available between the unit and the barrier, the shortage (α) should be compensated by providing an opening on the lower part of the fence (see Figure 1).

The height of the barrier should not exceed 0.5 m above the unit top. If the barrier or fence exceeds this limit, a discharge air duct should be installed at least 0.5 m higher than the top of the fence.

Discharge Air Duct

The discharge air duct should be designed so that the maximum static pressure loss is kept within the available static pressures of the unit fans. The air duct needs a partition for each fan or each group of fans per circuit (Figure 2) to prevent operating fan(s) from interfering with inoperative fan(s).

Enclosed Unit

When enclosing the unit with sound barriers and overhead roofs, an adequate area of opening must be provided on the lower part of the barrier. The effective area of opening should be equal to or greater than the value shown in Table 1. As mentioned above, the discharge air duct should be partitioned for each fan or each circuit to prevent interference among fans.

Protection from Ice Build Up

When determining the height of the unit base, the potential depth of snowfall in the location must be considered. Concrete base and curbs should be used to raise the unit above the ground.

Table 1: Sound Barrier Dimensions.

Unit size		Distance "L"	Effective opening
kW	nom. hp	(m)	area (m)
57	20	0.8	6.0
85	30	1.0	7.4
113	40	1.5	11.9
133	50	1.5	11.9
169	60	1.9	14.8
247	80	1.9	14.8
285	100	2.0	20.8
350	120	2.0	20.9

Table 2: Minimum System Water Volume.

Unit size		System water	Unit water
kW	nom. hp	volume (l)	volume (l)
57	20	600	30
85	30	900	40
113	40	1,200	60
133	50	1,200	60
169	60	1,800	80
247	80	2,400	109
285	100	3,000	107
350	120	3,600	116

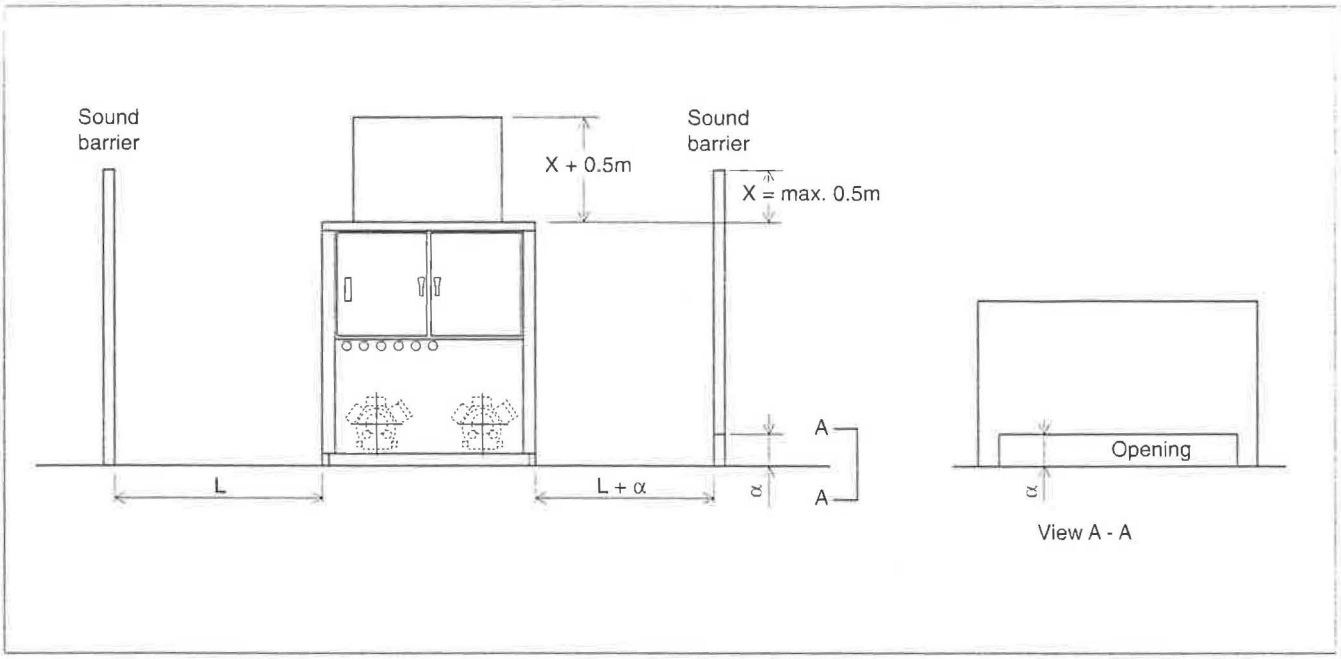

Figure 1: Air Flow Space.

System Water Volume

Figure 3 shows a typical air-to-water heat pump system. The entire system must maintain sufficient water volume to prevent a rapid cycling of the compressor and provide enough energy to defrost the coils. Table 2 shows the minimum water volume to be held in the system according to unit size.

The system water volume is the minimum amount of water needed to maintain proper operation of the heat pump circuit (above the broken line in Figure 3).

Even when the 3-way valve completely closes, the heat pump circuit must hold enough water volume to allow the unit to run for 5 minutes without load.

When the heat pump is inoperative, e.g. due to too low an ambient temperature, the hot water from the boiler must not be allowed into the heat pump unit. Standard air-to-water heat pumps are normally designed to be used for constant water flow with an allowance of ± 10% and therefore, should never be used for variable water flow.

Water Temperature Control

On general principles, the factory-installed temperature controller should always be used. The controller is normally factory-set to control the temperature of return water to the unit. The field-supplied controllers should sense the return water and the thermostat differential must be set so that one

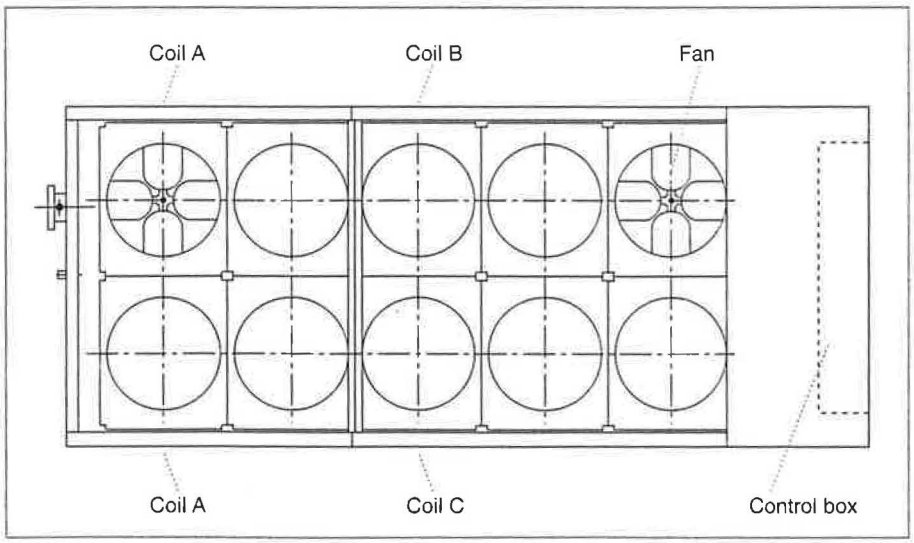

Figure 2: Multiple-Fan Unit.

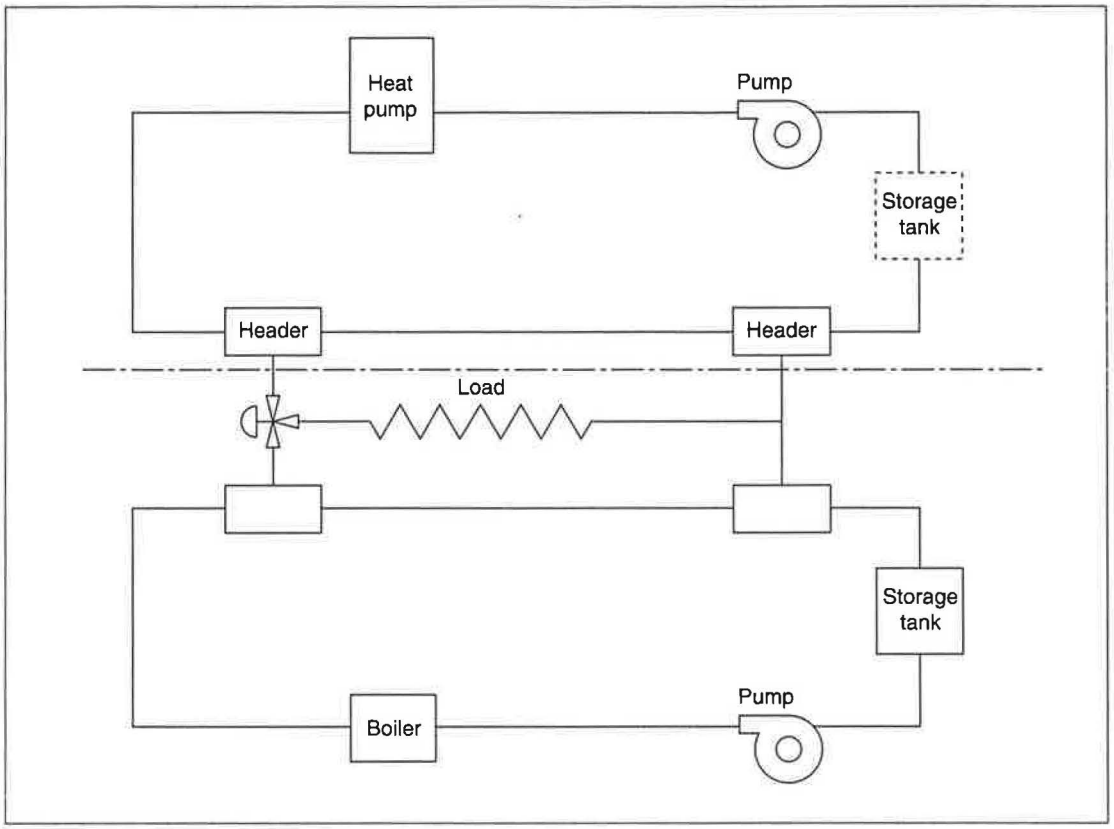

Figure 3: Air-to-Water Heat Pump System.

cycle (ON-OFF-ON) will be over 15 min. (OFF for 3 min. or longer, ON for 5 min. or longer) under any load condition. The thermostat should not be set for too narrow temperature differentials. The ON-OFF differential within a thermostat stage should be greater than a temperature value obtained from the formula below:

$$\text{Differential} \geq \frac{\text{Design Temperature Difference } (\Delta t)}{\text{No. of steps of controller (Max. 4)}}$$

Where Δt = Leaving water temp. − return water temp. (in heating cycle)

It is strongly recommended that the use of a field-supplied controller be authorized by the unit manufacturer on presentation of design documents.

Power Interruption

After unit stoppage due to power interruption or extremely low ambient temperature, automatic resetting or restarting of the unit is not recommended. Before restarting the unit, the oil level and temperature in the compressor crankcase must be checked. This should be done by a qualified service engineer.

Conclusion

Any air-source heat pump should be able to operate under severe winter conditions such as experienced in hilly and coastal areas of northern Japan. In such districts, air-to-water heat pumps should be installed with the greatest possible care to prevent unit failure or unsatisfactory operation of the unit. Field experiences of Toyo Carrier show that sufficient air flow is one of the most important factors for a satisfactory operation of air-to-water heat pumps. Also, maintenance of the water volume in the entire system is essential, and is often neglected or belittled. Control system maintenance is no less vital for thermal storage operation with a heat pump, especially when the water system is in common with a supplementary boiler.

*Author:
K. Sato, Toyo Carrier Eng. Co., Ltd., Tokyo, Japan.