MECHANICAL SERVICES PIPE AND VESSEL INSULATION

INTRODUCTION

This TECHnote addresses the selection of appropriate levels of insulation for piping, vessels and heat exchangers with curved surfaces. Piping is insulated for a variety of reasons including mandatory National Construction Code (NCC) requirements, energy conservation (for environmental and economic reasons), condensation prevention, protection from contact with hot surfaces and prevention of unwanted heating or cooling of adjacent spaces.

NCC PROVISIONS

The insulation of central heating water piping systems in Class 1 buildings is referred to in NCC (2022) Volume Two clause H6D2(2) and covered in ABCB Housing Provisions clause 13.7.3. For Class 2 to 9 buildings, insulation of piping for heating and cooling systems is contained in NCC (2002) Volume One clause J6D9. This covers chilled water, heated water, refrigerants, brines and steam. The NCC also sets minimum insulation for vessels, heat exchangers and tanks containing these fluids.

Piping and heat exchangers in chillers, boilers and unitary air conditioning plant complying with NCC (2022) J6D10, J6D11 and J6D12 are exempt from these insulation provisions.

INSULATION R-VALUE

The NCC mandates insulation performance for pipes and vessels in terms of insulation R-Value. Insulation R-Values exclude air spaces and surface thermal resistances. That is, insulation R-Value is the R-Value of the bulk insulation alone. Specification by insulation R-Value instead of insulation thickness introduces some problems since insulation R-Value varies inversely with the thermal conductivity of the insulation and non-linearly with the thickness and pipe diameter.

- BCA Table J6D9a sets out the minimum insulation R-Values for pipes carrying fluids at various temperatures.
- BCA Table J6D9b sets out the minimum insulation R-Values for vessels, heat exchangers and tanks.

NATSPEC PROVISIONS

NATSPEC worksections that come within the scope of the NCC provisions adopt the NCC provisions without qualification.

CALCULATING THE REQUIRED THICKNESS OF INSULATION

Unlike flat insulation which has a fixed insulation R-Value, the insulation R-Value of preformed (curved) pipe insulation usually has to be measured or calculated on a case-by-case basis. Most manufacturers provide tables based on this formula showing insulation R-Value related to insulation thickness and nominal pipe diameter. If using manufacturer's tables, make sure they are for insulation R-Value (mandated by NCC) not Total R-Value.

The many variables arising out of the NCC requirements, insulation properties and the effect of pipe size expressed in the formula (see sidebar) mean that it is not possible to create a simple table of NCC compliant pipe insulation thicknesses, but the following illustrates the effect.

Example 1:

For a chilled water system, NCC (2002) Volume 2 Table J6D9a requires all piping to have an insulation R-Value of 1.0 to 2.0, depending on the pipe nominal diameter. For chilled water pipes between DN40 and DN80, the minimum R-Value is R1.5. For insulation with conductivity of 0.037 W/(m.K), a pipe with an outside diameter of 40 mm requires 38 mm thick insulation (R1.7) but at 80 mm outside diameter requires 50 mm thick insulation (R2.0).

Example 2:

A packaged split air conditioning system with its suction line above 2°C must comply with BCA Table J6D9a. If the suction line is DN32, it requires a minimum insulation R-Value of R1.0. This can be met with 25 mm thick closed cell elastomeric insulation which has an insulation R-Value of R1.1. This is thicker than the 19 mm that has been customary in the industry.

Example 3:

For a chiller not covered by NCC (2022) Volume 2 J6D11, BCA Table J6D9b requires the evaporator (a heat exchanger) to be insulated to R1.8. On a chiller with, say, an 800 mm diameter evaporator, this would require 65 mm of insulation (R1.9), significantly more than the 19 mm provided as standard by most manufacturers.

Formula for calculating the required thickness of insulation

AS/NZS 4859.1 clause 2.3.3.7 provides the following formula for calculating the R-value of curved pipe insulation using the planar thermal conductivity.

$$R = (r_2 \log_e(r_2/r_1))/k$$

where:

R = Insulation R-Value of the preformed pipe insulation section

r_1 = Inner radius of the pipe insulation

r_2 = Outer radius of the pipe insulation

k = Thermal conductivity of the insulation in planar flat form

Relevant NCC clauses

BCA J6D9 Energy efficiency – Air-conditioning and ventilation – Pipework insulation

Table J6D9a Piping – Minimum insulation R-Value

Table J6D9b Vessels, heat exchangers and tanks – Minimum insulation R-Value

BCA J6D10 Energy efficiency – Air-conditioning and ventilation – Space heating

BCA J6D11 Energy efficiency – Air-conditioning and ventilation – Refrigerant chillers

BCA J6D12 Energy efficiency – Air-conditioning and ventilation – Unitary air-conditioning equipment

BCA H6D2 Class 1 and 10 buildings – Energy efficiency – Application of Part H6

Relevant documents

AS/NZS 4859.1 *Thermal insulation materials for buildings - General criteria and technical provisions*

Relevant worksections

0710 Mechanical services tanks, vessels and heat exchangers

0712 Water heating boilers

0715 Chillers - combined

0744 Ductwork insulation

0752 Mechanical piping insulation

0802 Hydraulic design and install

0823 Cold and heated water