Technical Information Bulletin

Flexicell® NBR: R-Value Calculation Summary – Australia

As per the requirements of National Construction Code (NCC) of Australia, thermal insulation thicknesses shall meet designed minimum of R-Values for specific types of applications such as pipes, vessels, heat exchangers and tanks. Below are presented detailed requirements of NCC 2019 that are mandatory to be fulfilled for insulation materials.

Requirement of NCC 2019, part J5.8. states as follows:

A. Piping, vessels, heat exchangers and tanks containing heating or cooling fluid, where the fluid is held at a heated or cooled temperature, that are part of an air-conditioning system, other than in appliances covered by MEPS, must be provided with insulation:
   I. complying with AS/NZS 4859.1; and
   II. for piping of heating and cooling fluids, having an insulation R-Value in accordance with Table J5.8a; and
   III. for vessels, heat exchangers or tanks, having an insulation R-Value in accordance with Table J5.8b; and
   IV. for refill or pressure relief piping, having an insulation R-Value equal to the required insulation R-Value of the connected pipe, vessel or tank within 500 mm of the connection.

B. Insulation must:
   I. be protected against the effects of weather and sunlight; and
   II. be able to withstand the temperatures within the piping, vessel, heat exchanger or tanks

C. Insulation provided to piping, vessels, heat exchangers or tanks containing cooling fluid must be protected by a vapour barrier on the outside of the insulation.

D. The requirements of (a) and (b) do not apply to piping, vessels or heat exchangers—
   I. located within the only or last room served by the system and downstream of the control device for the regulation of heating or cooling service to that room; or
   II. encased within a concrete slab or panel which is part of a heating or cooling system; or
   III. supplied as an integral part of a chiller, boiler or unitary air-conditioner complying with the requirements of J5.9, J5.1 0 and J5.11; or
   IV. inside an air-handling unit, fan-coil unit, or the like.

E. For the purposes of (A), (B), (C) and (D) —
   I. heating fluids include refrigerant, heated water, steam and condensate; and
   II. cooling fluids include refrigerant, chilled water, brines and glycol mixtures, but do not include condenser cooling water.

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Minimum insulation R-Values for pipes as per NCC 2019:

Fluid temperature range	Minimum insulation R-Value for nominal pipe diameter of:			
	≤ 40 mm	> 40 mm and ≤ 80 mm	> 80 mm and ≤ 150 mm	> 150 mm
Low temperature chilled — ≤ 2°C	1.3	1.7	2	2.7
Chilled — > 2°C but ≤ 20°C	1	1.5	2	2
Heated — > 30°C but ≤ 85°C	1.7	1.7	1.7	1.7
High Temperature heated — > 85°C	2.7	2.7	2.7	2.7

Minimum insulation R-Values for vessels, heat exchangers and tanks as per NCC 2019:

Fluid temperature range	Minimum insulation R-Value:
Low temperature chilled — ≤ 2°C	2.7
Chilled — > 2°C but ≤ 20°C	1.8
Heated — > 30°C but ≤ 85°C	3
High temperature heated — > 85°C	3

Calculations:

1. Statistical Calculations

Below table presents the result of statistical calculation done as per clause 2.3.3.5 of AS/NZS 4859 Part 1: 2018. The example detailed below refers to **Flexicell® NBR** Sheet (13mm), measured at the nominal thickness:

13 mm FLEXICELL® NBR		
s.no	Thickness	R value (resistance) (m^2.K)/W
1	13.26	0.42
2	13.34	0.43
3	13.45	0.43
4	13.49	0.43
5	13.23	0.42
6	13.34	0.43
7	13.49	0.43
8	13.59	0.43
9	13.62	0.43
10	13.69	0.44
Mean Values =		**0.43**
	Standard Deviation	0.004404198

According to Equation 2.3.3.5(1), the declared Material R-Value is calculated as follows:

Declared Material R-Value = 0.43– 0.393 x 0.004404198= **0.42** rounded downwards to the nearest 0.01.

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If thermal measurements have been performed on specimens at greater than nominal thickness, as permitted by Clause 2.3.3.4 $R_{50/90}$ shall be calculated at nominal thickness from the following equation.

$R_{declared} = d_n / \lambda_{50/90}$ Where d_n = nominal thickness, in metres.

Therefore, 13mm Planar thickness / 0.032 = R Declared Value **0.40** rounded downwards to the nearest 0.01.

2. Pre-formed Pipe Insulation Calculations

Clause 2.3.3.7 of AS/NZS 4859 Part 1: 2018 has been used to calculate the results for pipe insulation detailed in the Material R-Value table. The thermal conductivity of **Flexicell® NBR** in planar form, of the same specification as **Flexicell® NBR** Tube, was measured to Clause 2.3.3.5 of the Standard. The following formula was then applied to determine the Material R-Values of **Flexicell® NBR** Tube:

$$R = (r_o \ln(r_o/r_i)) /k,$$

Where R = Material R-Value of the preformed pipe insulation section, m2.K/W
r_o = insulation outer radius, m
r_i = insulation inner radius, m
k = thermal conductivity of the insulation in planar form, W/m.K.

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Below table presents selection of minimum thickness of insulation to be able to achieve minimum required R-Values for **Flexicell® NBR** Tube in accordance with NCC 2019.

Pipe ID (mm)	R-Value					
	1	1.3	1.5	1.7	2	2.7
6.35	19	19	25	25	32	32
9.5	19	25	25	25	32	40
10.3	19	25	25	32	32	40
12.7	19	25	25	32	32	40
15.9	19	25	32	32	32	50
19.1	25	25	32	32	40	50
21.3	25	25	32	32	40	50
22.2	25	25	32	32	40	50
25.4	25	25	32	32	40	50
26.7	25	32	32	32	40	50
28.6	25	32	32	32	40	50
31.8	25	32	32	40	40	50
33.4	25	32	32	40	40	50
34.9	25	32	32	40	40	50
38.1	25	32	32	40	40	50
41.3	25	32	32	40	40	57
42.2	25	32	32	40	40	57
48.3	25	32	32	40	50	57
50.8	25	32	40	40	50	57
54	25	32	40	40	50	57
60.3	25	32	40	40	50	57
63.5	25	32	40	40	50	57
66.7	25	32	40	40	50	57
73	25	32	40	40	50	57
76.2	25	32	40	40	50	57
79.4	25	32	40	40	50	64
88.9	32	32	40	50	50	64
101.6	32	40	40	50	50	64
110.2	32	40	40	50	50	64
114.3	32	40	40	50	50	64
127	32	40	40	50	50	64
139.7	32	40	40	50	50	64
141.3	32	40	40	50	50	64
152.4	32	40	40	50	57	69
161.9	32	40	40	50	57	69
168.3	32	40	40	50	57	69
203.2	32	40	50	50	57	69
219.1	32	40	50	50	57	69
254	32	40	50	50	57	75
273.1	32	40	50	50	57	75
304.8	32	40	50	50	57	75
323.9	32	40	50	50	57	75
355.6	32	40	50	50	57	75
406.4	32	40	50	50	57	75
457	32	40	50	50	64	82
508	32	40	50	50	64	82

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Notes:

- For all pipes with outer diameter greater than 144mm a sheet shall be used to insulate the pipe due to limitation of diameters that can be manufactured in tubular form.
- In all cases where the r-value requires thickness of insulation equal or smaller 64mm and greater than 32mm, a combination of more than one layer shall be used in accordance with the below conditions:
    - For pipe OD less than or equal to 114mm: tube + sheet.
        - Example:
            - Pipe OD 114mm and r-value 2: Flexicell NBR Tube ID 114mm and 25mm thick + Flexicell NBR sheet 25mm thick.
    - For pipe OD greater than 114mm: sheet + sheet.
        - Example:
            - Pipe OD greater than or equal to 254mm and r-value 2: Flexicell NBR sheet 25mm thick + Flexicell NBR sheet 32mm thick.