BULLETIN: INSULATION FOR VRF BEING IMPROPERLY SPECIFIED

TAILORED FOR OKLAHOMA BASED ON 2006 IECC

OVERVIEW

Insulation is an often overlooked and misunderstood part of refrigerant piping systems, particularly VRF systems. Most engineering firms and contractors are not paying enough attention to insulation materials and thicknesses required from both manufacturers' installation instructions and energy codes.

- **Manufacturers' installation instructions:**
  - Insulation required to be closed-cell elastomeric foam and must be rated for 248°F. **EPDM** insulation should be considered for its continuous high-temperature rating.
  - Must also account for their minimum insulation thickness requirements
- **Insulation requirements for VRF per 2006 IECC:**

Line Size	Minimum Thickness
≤1-5/8″	1″
>1-5/8″	1.5″

- **Bonus – tax deduction for code compliance:**
  - Newly passed "Inflation Reduction Act" offers significant tax deductions for meeting ASHRAE 90.1 standards.
  - The following are *minimum* insulation thicknesses for VRF per 2019 ASHRAE 90.1:
    - **Liquid lines:**

Line Size	Minimum Thickness
≤ 1-1/8″	1″

    - **Suction lines** ***(do not use fiberglass insulation)*****:**

Line Size	Minimum Thickness	Notes
≤ 7/8″	0.5″	Manufacturers' instructions typically require thicker
≥ 1-1/8″	1″	

    - **Hot-gas lines** ***(may need to be thicker depending on refrigerant temperature)*****:**

Line Size	Min. Thickness	Notes
≤ 1-3/8″	1.5″	Also applies to small vapor lines supplying fan coil units
≥ 1-5/8″	2″	

MANUFACTURERS' INSTALLATION INSTRUCTIONS

VRF manufacturers' installation instructions all specify their own minimum insulation thicknesses. While these manufacturer thickness minimums are typically smaller than energy code requirements, the manufacturers' installation instructions should still be checked and considered.

All VRF manufacturers require the piping insulation to be closed-cell elastomeric foam with a temperature rated for at least 248°F. While 248°F is the safety shut off temperature for most VRF systems, they can still operate near 248°F for long periods when systems have refrigerant

charge issues, even in mild climates. This is important as most piping insulation materials such as NBR rubber and polyethene (PE) can fail at these temperatures. These insulations will either 1) shrink and tear open the glued seams and butt joints, 2) destroy the cellular structure of the elastomeric foam and crumble, or 3) simply melt. Many of these failing insulation materials publish **intermittent** temperature ratings of up to 248°F, but their continuous rating is typically much lower. Attention to this issue is critical. The ideal insulation material for VRF systems is EPDM (Ethylene Propylene Diene Monomer). EPDM is a rubber-based, closed-cell elastomeric foam having **continuous** max temperature ratings of at least 257°F. The product is manufactured domestically by several well-known manufacturers and is readily available.

Note: EPDM should also be considered on the lines supplying the fan coil units as they have the same 248°F requirement.

INSULATION REQUIREMENTS FOR VRF PER 2006 IECC

The 2006 International Energy Conservation Code has straight-forward insulation thickness requirements for refrigerant-based systems:

- 1" thick insulation for tubing sizes 1-5/8" or smaller
- 1.5" thick insulation for tubing sizes larger than 1-5/8"

BONUS – TAX DEDUCTION FOR CODE COMPLIANCE

The newly passed Inflation Reduction Act offers significant 179D tax deductions when the current ASHRAE 90.1 standards are met. All Architects and building owners need to be aware of this new rebate.

Shown in Tables 6.8.3-1 and 6.8.3-2, the 2019 ASHRAE 90.1 requires minimum insulation thicknesses based on both the size of the tubing and the temperature of the refrigerant:

Fluid Operating Temperature Range (°F) and Usage	Insulation Conductivity		≥Nominal Pipe or Tube Size, in.				
	Conductivity, Btu·in/h·ft^2·°F	Mean Rating Temperature, °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
>350	0.32 to 0.34	250	4.5	5.0	5.0	5.0	5.0
251 to 350	0.29 to 0.32	200	3.0	4.0	4.5	4.5	4.5
201 to 250	0.27 to 0.30	150	2.5	2.5	2.5	3.0	3.0
141 to 200	0.25 to 0.29	125	1.5	1.5	2.0	2.0	2.0
105 to 140	0.22 to 0.28	100	1.0	1.0	1.5	1.5	1.5

Table 6.8.3-1. Minimum Piping Insulation Thickness Heating Systems chart from 2019 ASHRAE 90.1.

Fluid Operating Temperature Range (°F) and Usage	Insulation Conductivity		Nominal Pipe or Tube Size, in.				
	Conductivity, Btu·in/h·ft^2·°F	Mean Rating Temperature, °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
40 to 60	0.21 to 0.27	75	0.5	0.5	1.0	1.0	1.0
<40	0.20 to 0.26	50	0.5	1.0	1.0	1.0	1.5

Table 6.8.3-2. Minimum Piping Insulation Thickness Cooling Systems chart from 2019 ASHRAE 90.1

VRF liquid lines reach temperatures above 105°F during heating and require minimum 1" insulation thickness.

VRF suction temperatures are very cold and can run near 32°F, especially if there are refrigerant charge issues or if the systems have any zones that are short on cooling, both of which drive down the entire system's suction temperatures. With temperatures this low,

ASHRAE 90.1 requires suction lines to have minimum insulation thicknesses of either 1” or 1.5”, depending on the line size.

Note: In more humid areas of the country, even thicker insulation is needed on the suction lines to prevent condensation from forming. It is highly recommended that fiber glass insulation NOT be used on VRF as the suction temperatures are so cold. Fiber glass insulation relies on a single vapor seal at the surface, which nearly always get punctured and allows condensation on the lines. Closed-cell elastomeric foam has a continuous vapor barrier throughout the thickness and is a must on VRF cold piping.

Assuming a peak normal operating temperature of less than 200°F for the hot gas line, 1.5” is the minimum insulation thickness to be used on the hot gas lines up to 1-3/8” tubing size (larger lines require 2” minimum thickness). If the normal operating temperature exceeds 200°F, a minimum thickness of 2.5” should be used.

Note: the vapor lines on the smaller line sets that supply the fan coil units have the same operating temperatures, and thus the same minimum insulation thickness requirement of 1.5” (or larger).

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