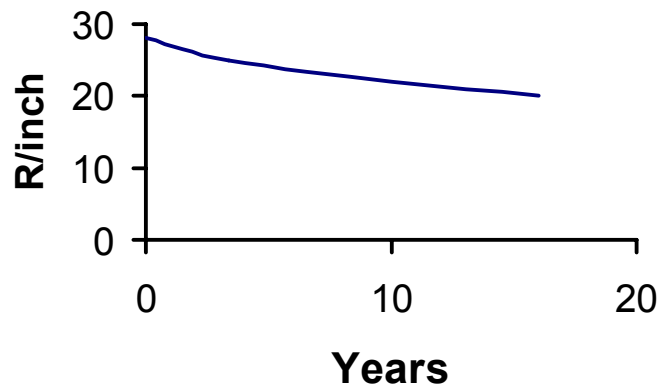


Ultra Thin VIP's for Accelerated Aging



Long Term VIP Performance

- The thermal resistance of VIP's very slowly change over time
- Some applications require only a year or two
- Many applications require 10 to 20 years
- **Some construction applications require 40 or more years**



Variables Affecting VIP Life

- Barrier film performance
- Heat Seal material and width
- Use of getters
- Temperature and humidity around the panel
- **Panel volume**
 - ◆ The above parameters as well as some others governs the amount of gas and water vapor that gets into a panel over time
 - ◆ Panel volume determines the pressure rise in the panel caused by the gas and water vapor that gets in

Some Reasons for Thinner VIP's

- Many panels are 25.4 mm (1 inch) thick and many are becoming thinner
- Many application such as refrigerators only need the equivalent of 25.4 mm (1 inch) or maybe 50.8 mm (2 inches) of additional urethane foam (7 to 14 additional R)

Some Reasons for Thinner VIP's

- Due to the property of diminishing returns, it is often better to reduce the increase in R value due to VIP and cover more wall area
- Some new VIP's have higher R/inch than in the past
- All these reasons are resulting in more thin VIP's

Previous Work to Accelerate VIP Life Testing

- May 1999 VIA symposium presentation by Ken Wilkes of Oak Ridge National Laboratory
 - ◆ Metal plate in barrier pouch (reduces internal volume) and evacuated
 - ◆ Patented procedure for measuring internal gas pressure
 - ◆ Could accelerate life testing by 20 times

Previous Work to Accelerate VIP Life Testing

- May 1999 VIA symposium presentation by Jeff Bonekamp of Dow chemical
 - ◆ Thinner and smaller VIP (0.18 liter)
 - ★ Increased surface area to volume by about 2 to 3 and increased the seal length to volume
 - ◆ Pressure was indirectly measured by measuring conductivity

Ultra Thin VIP's for Accelerated Aging

- During this last year we began using Ultra Thin VIP's to accelerate the aging
- The ultra thin VIP's are only 1.65 mm (0.065 inch) thick
- This gave us the advantages of the Bonekamp method with nearly the acceleration rate of the Wilkes method

Ultra Thin VIP's for Accelerated Aging

- Compared to a 25.4 mm (1 inch) thick panel we obtained 15 times faster aging
- Since it is an actual VIP, we can measure the change in conductivity and infer a change in internal pressure

Ultra Thin VIP's for Accelerated Aging

- The core of the Ultra Thin VIP was a fine glass fiber mat
- The barrier film used in the test was a commercially available multi-layer high performance VIP barrier

Ultra Thin VIP's for Accelerated Aging

- To facilitate the conductivity testing, the ultra thin VIP's were placed on top of a known conductivity test control panel during the test
- The change in conductivity is solely due to the change in the performance of the ultra thin VIP
- The very high acceleration of the life testing allowed the panel aging to occur at more realistic temperature and humidity conditions

Ultra Thin VIP Test Considerations

- The core material when tested in 12 mm (0.47 inch) thick panel yielded a conductivity of 3.115 mW/m-K (0.0216 BTU-inch/Hr-Ft²-F)
- The core material when tested in an Ultra Thin (1.65 mm or 0.065 inch thick) VIP yielded a conductivity of 6.995 mW/m-K (0.0485 BTU-inch/Hr-Ft²-F)
- Very thin insulations often show higher conductivity
 - ◆ The insulation is too thin to effectively block much of the radiation heat transfer

Test Results

- Initial conductivity 6.995 mW/m-K (0.0485 BTU-inch/Hr-Ft²-F)
 - ◆ Aged at a temperature of 22.2° C (72°F) and 50% Relative Humidity
 - ◆ Average of 4 panels, less than a 1% spread in performance of the 4 samples

Test Results

- Two week test point, conductivity 7.082 mW/m-K (0.0491 BTU-inch/Hr-Ft²-F)
- Three month test point, conductivity 6.793 mW/m-K (0.0471 BTU-inch/Hr-Ft²-F)

Discussion of Results

- The Ultra Thin VIP accelerates the effect of the permeance of the barrier by a factor of about 15 compared to 25.4 mm (1 inch)
- So the 3 months should be like 45 months or almost 4 years
- However, the release of any moisture from the core and adsorption by the desiccant of moisture is **NOT** accelerated.
 - ◆ A slow adsorption over three months is realistic

Conclusions

- Because of this initial stabilization period, we can not yet draw any conclusions about the barrier performance
- A modified test procedure where the core is much more carefully dried may reduce the stabilization period
- Further research will show whether this test method will proof to be a way to easily obtain much accelerated VIP life performance