Unveiling the Science Behind PVC KEE and KEE Membranes:

A Closer Look at KEE-HP661 vs. KEE-741 Polymers and Formulations

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Keywords

PVC KEE membranes, KEE-661, KEE HP661, KEE 741 Copolymer, KEE-741, KEE content, KEE membrane, KEE roof, PVC KEE roof, PVC KEE membrane, UV resistance, thermal stability, plasticizer migration, dimensional stability, roofing membranes, high-performance roofing, membrane durability, resistance to chemical exposure, long-term performance, single-ply roof membrane, chemical exposure.

Introduction to PVC KEE and KEE Membranes

Polyvinyl chloride (PVC) roofing membranes are commonly chosen for their durability, protection against chemicals, and ability to withstand harsh environmental conditions. When enhanced with KEE (ketone ethylene esther) polymer, the performance of these membranes improves in terms of protection against UV degradation, high temperatures, and chemicals.

However, not all KEE polymers are created equal. This white paper explores the differences between KEE-HP661 and KEE-741, two key grades of KEE polymer, and discusses how utilizing KEE-HP661 helps achieve

a superior balance of performance and durability in PVC KEE membranes. Specifically, we will examine how membranes with 27% KEE polymer content (by total membrane weight) are optimized through the use of KEE-HP661, a higher molecular weight polymer, and the potential benefits this brings compared to other market options.

What is KEE Polymer and Why Does It Matter?

KEE polymer is a high-performance copolymer of ethylene, vinyl acetate, and carbon monoxide, known for its flexibility, UV resistance, thermal stability, and protection against chemical exposure. These characteristics are important for roofing membranes that must endure potentially damaging environmental conditions, such as UV radiation, chemical exposure, and temperature cycling (Dow, 2021).

The type and percentage of KEE polymer used in the membrane formulation can have a significant impact on the overall performance of the roofing system.

KEE-HP661 vs. KEE-741: Performance and Weight Considerations

There are notable differences in the molecular weight and chemical composition between KEE-HP661 and KEE-741:

- KEE-HP661 has a higher molecular weight compared to KEE-741, which means it is heavier per unit of material. This higher molecular weight provides better thermal stability, UV resistance, and dimensional stability, which may help in roofing applications subjected to potentially damaging environmental conditions (Dow, 2021).
- KEE-741 has lower molecular weight than KEE-HP661, meaning it is lighter per unit of material. As a result, to meet the desired polymer content target, more KEE-741 would typically be required compared to KEE-HP661. While KEE-741 provides good performance, it may not offer the same level of long-term durability and UV resistance as KEE-HP661 when used in higher quantities (Dow, 2021).

Liquid Plasticizers in PVC KEE Membranes

All PVC KEE membranes, including Siplast's, contain liquid plasticizers that are added to enhance the flexibility of the membrane, allowing it to better accommodate ordinary building movements and temperature fluctuations. While liquid plasticizers help improve the membrane's flexibility, there are some considerations to be aware of.

Key Points on Liquid Plasticizers:

- Plasticizer Migration: Over time, liquid plasticizers can gradually migrate out of the membrane, especially when exposed to UV light and higher temperatures. This migration is a natural process that

can lead to reductions in flexibility as the membrane ages. However, this typically occurs gradually and does not cause significant adverse effects in most applications.

- Impact on Long-Term Performance: While plasticizer migration can influence the membrane's flexibility over time, it is important to note that it does not necessarily result in degradation of the membrane. The effect of plasticizer migration is often gradual and may not significantly impact membrane performance during the service life of the roof.
- Correlation with Soiling: There is a loose correlation between plasticizer migration and the tendency for membranes to attract more dirt or soiling. As plasticizers migrate, the surface of the membrane may become more susceptible to the accumulation of dirt and debris in certain conditions. This is more likely in membranes with very low slope-to-drain, and those exposed to extreme weather conditions, including UV radiation and high temperatures (Forgeway Ltd, 2021).

Soiling Mechanisms in PVC Roofing Membranes

Soiling refers to the accumulation of dirt, dust, and other contaminants on roofing membranes. The presence of plasticizers in PVC, PVC KEE, and KEE membranes can influence the tendency for soiling, as plasticizers impact the membrane's surface properties. Since all of these membrane types contain plasticizers, they are susceptible to the same soiling mechanisms. The primary mechanisms through which soiling occurs are adhesion, diffusion, and leaching.

Contaminants can adhere to the PVC surface due to the plasticizer's effect on surface properties. Some contaminants can diffuse into the plasticizer, altering the surface's appearance and properties. As plasticizers leach out, they can leave behind a residue that can attract and retain contaminants (Forgeway Ltd, 2021) (Yi et al., 2022).

Siplast's Approach: Minimizing the Impact of Plasticizer Migration

Siplast's PVC KEE formulation aims to minimize the use of liquid plasticizers, helping to maximize the polymer content while ensuring long-term performance. The combination of KEE-HP661, a higher molecular weight polymer, and reduced liquid plasticizer levels helps to mitigate some of the potential effects of liquid-plasticizer migration, contributing to a membrane that will retain its flexibility, dimensional stability, and chemical resistance over time.*

The higher KEE content in Siplast's membranes—27% KEE polymer—helps to balance flexibility with long-term performance, ensuring the membrane provides protection while maintaining its structural integrity.

Siplast's Exceptional Formulation: Leveraging KEE-HP661

Siplast's PVC KEE membranes are formulated with 27% KEE polymer content using KEE-HP661, a higher molecular weight polymer. This formulation offers the following potential advantages:

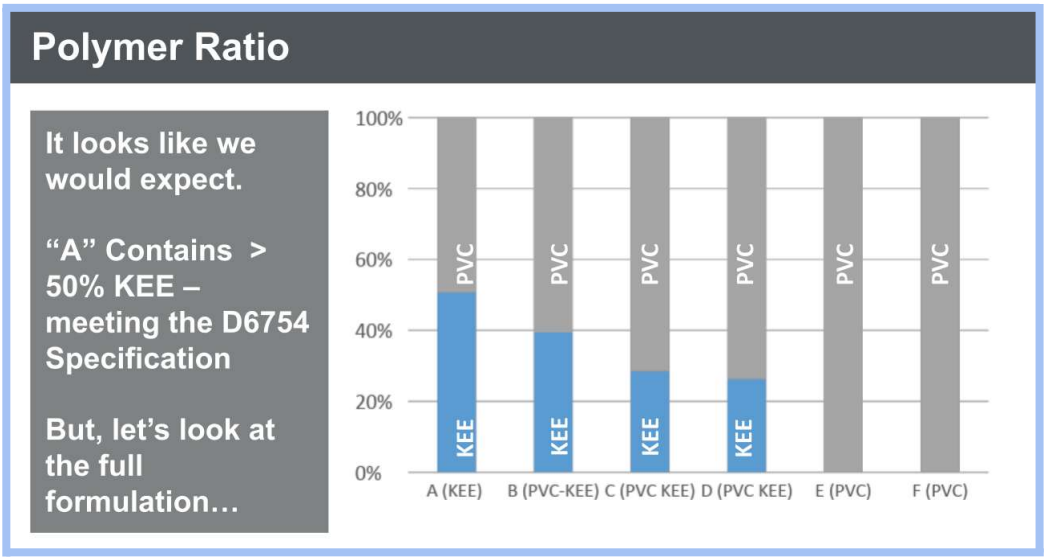
- Strong UV Resistance: KEE-HP661's robust UV resistance can help maintain membrane integrity and color over time, particularly in applications with prolonged exposure to sunlight.
- Improved Thermal Stability: The higher molecular weight of KEE-HP661 can contribute to better performance in high-temperature environments by maintaining performance metrics over the service life of the roof.
- Enhanced Dimensional Stability: The higher KEE content, combined with KEE-HP661's performance characteristics, can result in better dimensional stability, potentially minimizing the risk of warping or deformation during typical rooftop temperature fluctuations (Dow, 2021).
- High Reflectivity: Siplast's initial reflectivity value for KEE-HP661 membranes is 0.87, which can help reflect more sunlight and reduce heat absorption. After 3 years, the reflectivity remains high at 0.82, indicating that the membrane retains its reflective properties over time (Siplast, 2022). Reflectivity is one of the key components of a cool roof, and cool roofs stay cooler and reduce the amount of heat conducted into a building (www.coolroofs.org).
- Minimal Plasticizer Migration: The high KEE content and low liquid plasticizer levels in KEE-HP661 formulations help mitigate the potential effects of plasticizer migration, helping to provide long-term flexibility and dimensional stability of the membrane.
- Robust Protection Against Chemicals*: KEE-HP661 provides protection against the damaging effects of chemical exposure, making it a suitable choice for industrial and commercial environments where exposure to chemicals is expected.*
- Long-Term Performance: With KEE-HP661, Siplast membranes are designed to provide improved durability over time, ensuring protection against inclement weather elements throughout its service life.

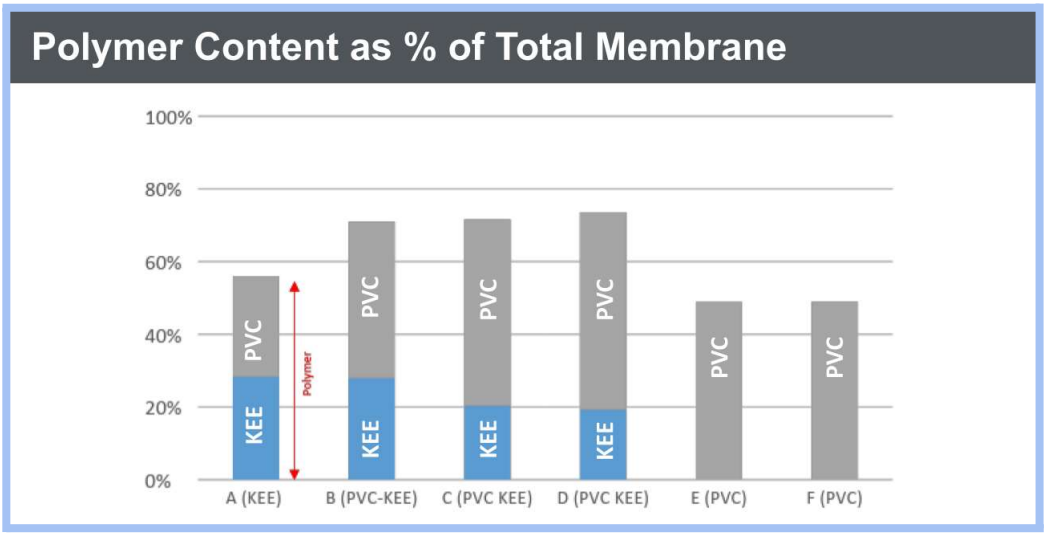
By using KEE-HP661, Siplast aims to optimize the performance of its roofing membranes, ensuring that the desired balance of durability and flexibility is maintained. This efficient use of high-quality polymer helps optimize performance without compromising on material use or formulation.

Polymer Content in the Industry: A Key Differentiator

When calculated as a percent by weight of total membrane, Siplast's PVC KEE membranes contain 27% KEE polymer. Other PVC membranes contain as little as 10% KEE polymer or as much as 24% in their formulations. This difference in polymer content can have a direct impact on the membrane's ability to resist UV degradation, temperature fluctuations, and chemical exposure. A number of years ago, six (6) PVC, PVC KEE, and KEE

membranes from major manufacturers were tested to determine polymer content ratios by a third-party nationally recognized test lab. This was a one-time test regimen of a limited sample of single-ply membranes. Your results may vary.





It's essential for industry professionals to understand the polymer chemistry behind the roofing membranes they specify. The 2 graphics above show two different methods of analysis for calculating the KEE polymer content in membranes.

- ASTM D6754 weighs only the polymer content in the membrane, which gives a partial view of the KEE polymer ratio (greater than 50% KEE).
- The membrane polymer content weight ratio method considers the total membrane weight (including polymer, plasticizers, fillers, and UV packages) and provides a complete picture of how much KEE polymer is actually used relative to the entire formulation of the membrane.

By requesting documentation on the type of KEE polymer and the percentage of KEE by total membrane weight, building owners, architects, and contractors can make informed decisions, ensuring that the roofing system's performance and durability are accurately understood. More information on this topic is available in Siplast's white paper titled, ASTM D6754 Standard and Polymer Content Analysis in Single Ply Roof Membranes.

The Impact of Using KEE-HP661 in Siplast Membranes

The use of KEE-HP661 in Siplast's formulations can contribute to the following:

- Potential for Strong Performance Throughout the Service Life of the Membrane: The enhanced UV resistance and thermal stability provided by KEE-HP661 can contribute to strong performance under harsh environmental conditions.
- Increased Durability: By improving dimensional stability and reducing the likelihood of material degradation, KEE-HP661 can help the membrane maintain its performance over time (Dow, 2021).
- Optimized Performance: The combination of KEE-HP661 and PVC can offer an optimized balance of flexibility and protection against environmental stresses, potentially contributing to better long-term roofing performance (Dow, 2021).

Conclusion

The quality and quantity of KEE polymer used in PVC roofing membranes can play a key role in the membrane's overall performance. Siplast's use of 27% KEE polymer content, utilizing KEE-HP661, provides a combination of strong UV resistance, thermal stability, and dimensional stability, which can help to ensure long-lasting performance for commercial roofing systems.

Given some PVC membranes contain as little as 10% KEE polymer or as much as 24%, it is important for industry professionals to request documentation on the type and percentage of KEE polymer used in roofing membranes. This can help ensure that the selected membrane is properly suited to meet the performance needs of the building, providing the best long-term value.

For more information or to request samples of Siplast PVC KEE membranes, please contact us today at https://www.siplast.com/about-siplast/contact-us.

** Siplast warranties and guarantees do not provide coverage against exposure to chemicals. Refer to siplast.com for more information on warranty and guarantee coverage and restrictions.*

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