



ASTM D6754 Standard and Polymer Content Analysis in Single Ply Roof Membranes

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Abstract

Single ply roof membranes are widely used in the construction industry due to their versatility, ease of installation, and durability. ASTM D6754, “Standard Specification for Ketone Ethylene Ester Based Sheet Roofing,” has served as the benchmark for single ply membrane formulated with KEE but it is important to understand how polymer content is measured and what it means for the overall chemistry. This paper will provide an in-depth analysis of ASTM D6754 and its requirements for polymer content in KEE formulated single ply roof membranes. It explores the methods employed in polymer content determination and the importance of polymer content and other compounds in membrane performance.

Keywords: ASTM D6754, single ply roof membranes, polymer content, roofing industry, performance evaluation, PVC, KEE.



Introduction

Single ply roof membranes play a pivotal role in modern construction, offering a lightweight, cost-effective solution for various roofing applications. These membranes are typically composed of synthetic polymers such as ethylene propylene diene terpolymer (EPDM), thermoplastic polyolefin (TPO), or polyvinyl chloride (PVC). The polymer content

“A higher polymer content generally corresponds to improved durability and weatherability...”

within these membranes significantly influences their mechanical properties, durability, and overall performance.

PVC roofing membranes contain liquid plasticizers and/or solid plasticizers. Ketone Ethylene Ester (KEE) is a polymer, and is also known as a solid plasticizer. KEE sheets are roofing membranes that are co-polymer based membranes utilizing a blend of KEE and PVC polymer, thus why some single ply manufacturers use PVC KEE as a descriptor for this membrane type.

ASTM D6754, titled “Standard Specification for Ketone Ethylene Ester Based Sheet Roofing,” provides a comprehensive framework for evaluating the quality and characteristics of KEE roof membranes, primarily focusing on the polymer content (KEE to PVC ratio) versus the overall chemistry of the membrane. This standard outlines specific requirements and test methods to ensure that the membranes meet industry standards and performance expectations.

Liquid Plasticizers versus Solid Plasticizers

Because liquid plasticizers are liquid, they tend to leach out of the roofing membrane over time. This leaching slowly degrades the overall performance of the membrane. Solid plasticizers, because they are solids, do not leach out of the roofing membrane, thereby the physical properties are retained. Importantly, the KEE plasticizer is also considered to be a polymer within the formulation of the sheet.

Methods of Polymer Content Determination

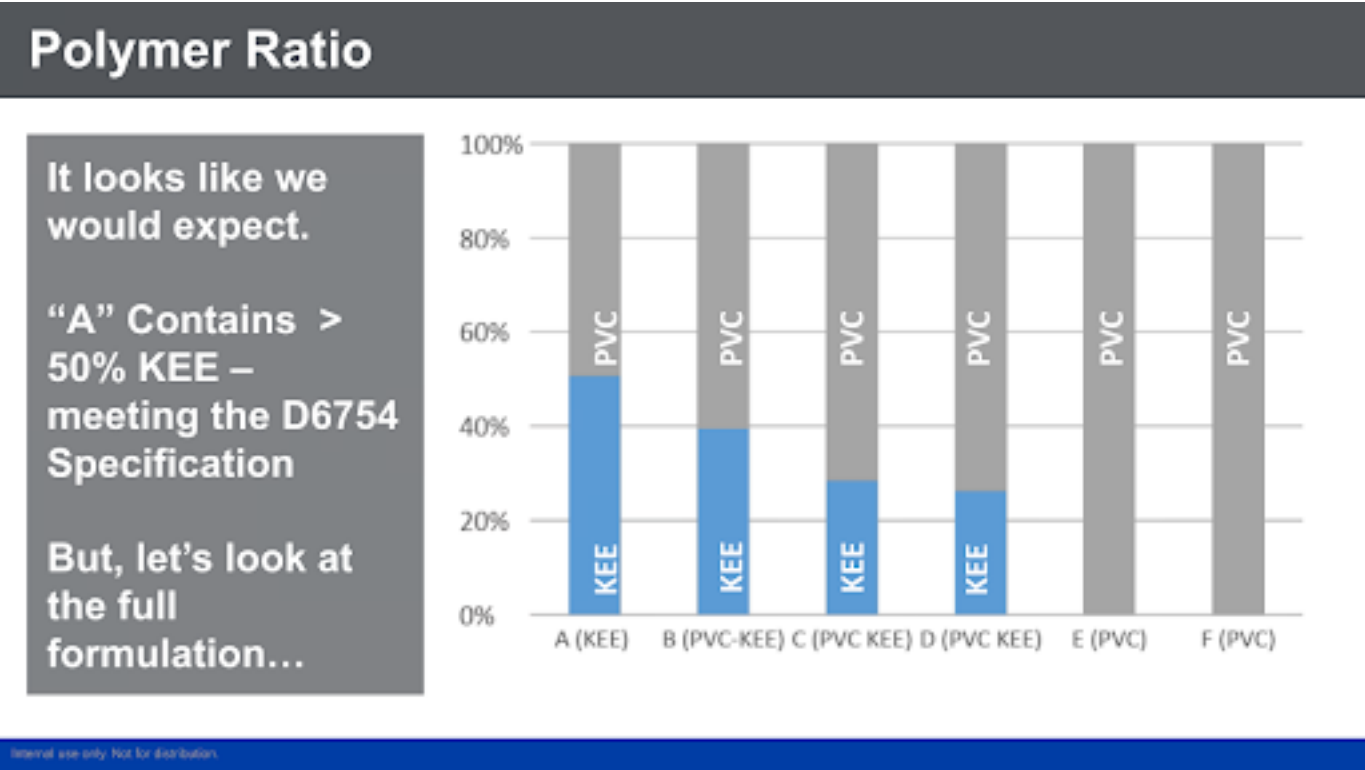
ASTM D8154, “Standard Test Methods for H-NMR Determination of Ketone-Ethylene-Ester and Polyvinyl Chloride Contents in KEE-PVC Roofing Fabrics,” is an NMR test used to determine KEE and PVC contents in KEE and PVC roofing membranes. ASTM D6754 outlines several methods for determining the polymer content in single ply roof membranes. These methods primarily involve solvent extraction followed by gravimetric analysis. The standard specifies the use of certain solvents and procedures to ensure accurate measurement of polymer content. Additionally, infrared spectroscopy techniques may be employed to supplement or verify the results obtained through solvent extraction methods.

Importance of Polymer Content in Membrane Performance

The polymer content in single ply roof membranes directly impacts their performance properties, including tensile strength, elongation and tear resistance. A higher polymer content generally corresponds to improved durability and weatherability of the membrane. Moreover, adequate polymer content is essential to the overall waterproofing performance of the roofing system. Polymer content of a membrane whether it be TPO, PVC or KEE is not the only determinant of performance though. How much of the other compounds are being used and what is the ratio of polymer in the membrane in relation to these other compounds in a D6754 sheet? This is particularly important for PVC and KEE membranes that use liquid plasticizer. Liquid Plasticizer is known to migrate out of single ply membranes over time so understanding the amount of liquid plasticizer and solid plasticizer (i.e., KEE) in any given single ply could be indicative of performance concerns such as mil thickness loss or algae/fungi growth over time.

Implications for the Roofing Industry

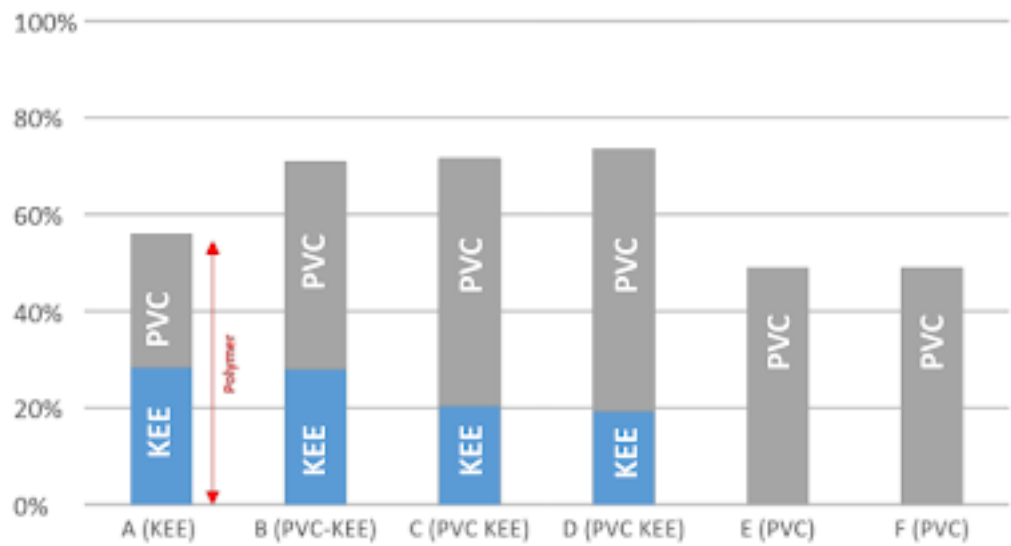
ASTM D6754 is accepted as a standard for KEE-based single-ply roofing membranes. To be considered a KEE sheet meeting D6754, the polymer content within the sheet must have more than 50% KEE polymer by weight, but a single ply sheet is made up of much more than just polymer. It is possible, because of how the standard stipulates the measurement of polymer content, to create a membrane that meets the D6754 standard but does not necessarily have a significant percentage of KEE relative to the makeup of the overall sheet.



The graphic above shows examples of polymer ratios that are used to call a sheet KEE, or PVC-KEE, or PVC. It can be seen that when measuring only polymer content in single ply membranes, KEE polymer by weight must be at least 50% of the total polymer weight to meet D6754. KEE and PVC-KEE sheets both include a hybrid co-polymer blend—the KEE is simply the solid plasticizer used within both types of sheets. An analysis of just the polymer does not reflect the overall chemistry of the membrane though.

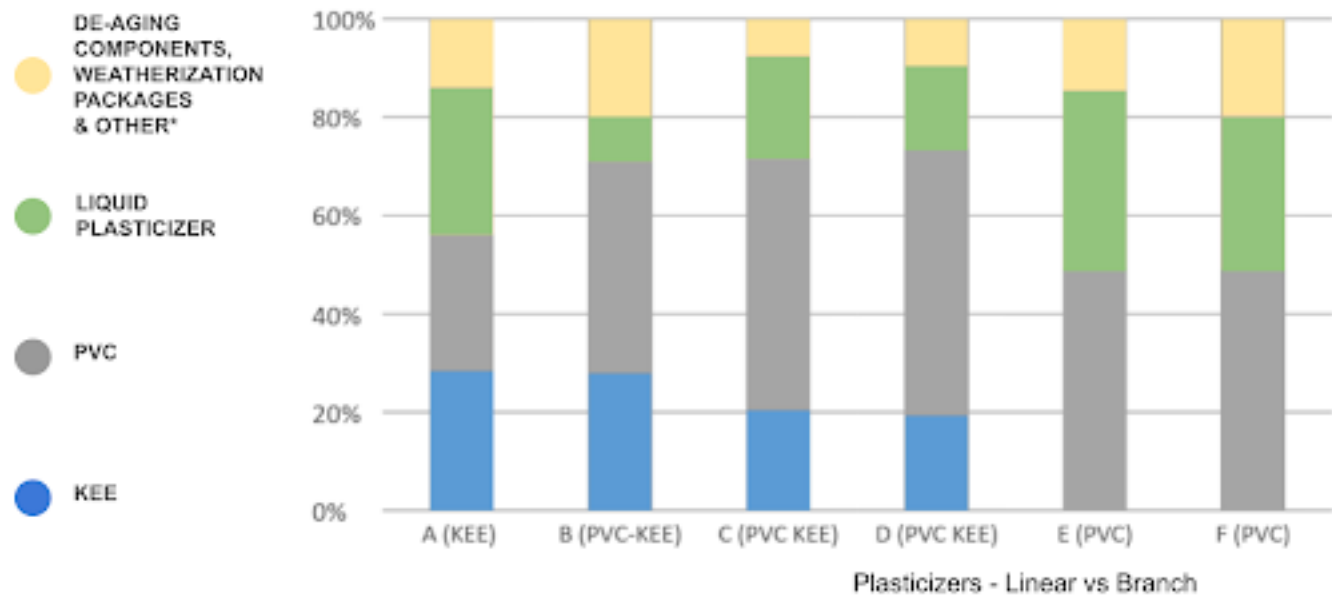
As you can see in the graphic below, one’s perception of membrane A, which meets ASTM D6754, may change when looking at the total polymer content as a percent of the overall composition of the membrane. For example, membrane B – a PVC KEE sheet – has the same amount of KEE as sheet A, but Membrane B cannot say it meets D6754 because less than 50% of the polymer is KEE. Membrane B, however, has more total polymer in the sheet than Membrane A.

Polymer Content as % of Total Membrane



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The Full Formulation



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Taking the concept of the overall chemistry into account, one's perception of membrane A, which meets ASTM D6754, may change even further when you recognize how much liquid plasticizer is used in the membrane as compared to competitors. Remember, liquid plasticizer tends to leach out of the sheet over time. It is important to also recognize, while membrane B does not meet ASTM D6754, it does have the same amount of KEE polymer as membrane A and significantly less liquid plasticizer to leach out of the membrane. The reason membrane B does not meet ASTM D6754 is the increased PVC content, rendering the amount of KEE less than 50% of the total polymer content. Therefore, by definition with ASTM standards, membrane B needs to be called a PVC-KEE membrane. But, if you are looking for a sheet that has more KEE and PVC polymer than other ingredients like liquid plasticizer, you may prefer membrane B even though it does not meet the requirements to be called a KEE membrane under ASTM D6754.

Conclusion

While ASTM D6754 serves as the standard for KEE polymerized single-ply roof membranes, recognize the method within the standard to characterize these membranes as KEE sheets is based strictly on analysis of the polymer content. Other sheets—such as PVC-KEE sheets meeting D4434, Standard Specification for Poly(Vinyl Chloride) Sheet Roofing, may have more KEE polymer and less liquid plasticizer. The overall chemistry of the membrane is important.

Additionally, there are many other factors to consider when specifying a PVC-, PVC-KEE-, or KEE-based membrane for a project, such as overall system design, detailing, quality of the installation, and attention to service from the manufacturer.



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