ENGINEERING TOMORROW

White Paper

Risks and Benefits of using **Peroxide-Cured EPDM (EPDM-P)** vs. **Sulfur-Cured Chloroprene (CR)** in Data Center Water-Glycol Hose Applications

Peroxide-Cured EPDM (EPDM-P) vs. Sulfur-Cured Chloroprene (CR)

Executive Summary:

This white paper examines the critical risks and benefits of using peroxide-cured EPDM-P over sulfur-cured Chloroprene (CR) for hose applications in data centers, specifically in systems using water-glycol mixtures for cooling. While Chloroprene is often chosen for its flame resistance, the sulfur curing process introduces significant risks such as corrosion and ozone degradation, which can compromise the reliability of water-glycol systems. In contrast, peroxide-cured EPDM-P offers superior resistance to corrosion, ozone, and heat, making it a more suitable material for these demanding environments. The white paper highlights the unique benefits of EPDM-P and outlines why it should be the material of choice for both the tube and cover of data center cooling hoses.

Introduction:

Data centers rely on sophisticated cooling systems, often using water-glycol mixtures to regulate temperature and prevent overheating of critical equipment. The hoses used in these systems must withstand continuous exposure to aggressive conditions, including high temperatures, chemical exposure, and potential corrosive elements. Chloroprene (CR) and EPDM-P are commonly used materials in the manufacture of hoses for such systems. However, the curing methods used in these elastomers—sulfur curing for Chloroprene and peroxide curing for EPDM-P—result in significant differences in material performance. This paper will explore the unique risks associated with sulfur-cured Chloroprene and the advantages of peroxide-cured EPDM-P in the context of water-glycol cooling systems used in data centers.

Material Differences: Sulfur-Cured Chloroprene vs. Peroxide-Cured EPDM-P in Data Center Cooling Systems

1. Sulfur-Cured Chloroprene (CR):

Flame Resistance:
Chloroprene (CR) is widely used in environments where flame resistance is critical. In data centers, which often feature high concentrations of electrical equipment, CR may be selected for its ability to resist flames. However, its sulfur-cured version introduces a number of concerns in water-glycol systems.

Corrosion Risks:

• **Sulfidation Corrosion**:

One of the major risks associated with sulfur-cured CR is its potential to cause sulfidation corrosion. The elemental sulfur present in CR, when in contact with ferrous metals (such as in pipe fittings or connectors), can oxidize to form sulfur dioxide gas. This gas reacts with water vapor in the system to create sulfuric acid, which then condenses on metal surfaces, leading to significant corrosion over time. In a water-glycol system, where moisture levels are higher, this effect is particularly concerning as it can lead to failure of metal components.

• **Galvanic Corrosion**:

In addition to sulfidation, sulfur-cured CR filled with carbon black (which has low electrical resistivity) may contribute to galvanic corrosion. When in proximity to dissimilar metals, CR can act as the cathode in a galvanic corrosion cell, accelerating corrosion of metal parts in the system. This is a significant risk in water-glycol systems, where various metal components are in contact with the hose material.

Ozone Resistance:

Data centers often generate ozone due to high-voltage electronics and equipment. Chloroprene hoses, although potentially formulated for ozone resistance, rely on additives whose effectiveness can degrade over time. This makes CR less reliable in environments with high ozone concentrations, where hose degradation and failure are possible

2. Peroxide-Cured EPDM-P:

Chemical and Physical Properties:

Peroxide-cured EPDM-P offers a significant advantage over sulfur-cured CR in terms of long-term performance. The peroxide curing process results in a more stable and chemically resistant elastomer. The saturated chemical structure of EPDM-P (with alkane C-C bonds and no alkene C=C bonds) provides it with inherent resistance to ozone degradation, making it ideal for applications exposed to ozone, such as in data centers.

Corrosion Resistance:

• **No Sulfidation Corrosion:**

Peroxide-cured EPDM-P does not contain elemental sulfur and, therefore, is not prone to sulfidation corrosion. This eliminates a critical concern in water-glycol systems, where the presence of sulfur in CR could lead to the degradation of metal parts, particularly in the presence of moisture.

• **Superior Galvanic Corrosion Resistance:**

EPDM-P does not exhibit the same electrical properties as sulfur-cured CR, meaning it does not promote galvanic corrosion. Its higher electrical resistivity helps prevent the formation of galvanic corrosion cells, which can be problematic in water-glycol systems with metal fittings and components.

Ozone Resistance:

EPDM-P is naturally resistant to ozone due to its chemical structure. This resistance is critical in data center environments where ozone levels can be high due to the operation of electronics. EPDM-P's ability to maintain its integrity in the presence of ozone ensures a longer lifespan for hoses in these systems.

Heat Stability:

Peroxide-cured EPDM-P offers superior heat stability (20-25% better than sulfur-cured CR). Given the high-temperature conditions often present in data centers, EPDM-P is better suited for maintaining its mechanical properties and resisting degradation over time.

Additional Benefits of Peroxide-Cured EPDM-P in Data Center Cooling Systems:

• **Improved Heat Stability:**
Peroxide-cured EPDM-P provides better heat resistance, which is essential in data centers where temperature fluctuations can impact system performance. EPDM-P's ability to withstand higher temperatures helps maintain system reliability over extended periods of use.

• **Expanded Chemical Compatibility:**
EPDM-P's superior chemical compatibility ensures that it can handle a wide range of substances, including the water-glycol mixtures commonly used in data center cooling systems. This reduces the risk of material degradation from chemical exposure.

• **Non-Staining of Metal and PVC:**
EPDM-P does not stain metal or PVC components, making it ideal for use in systems where visual integrity is important and avoiding the staining of sensitive components is critical.

• **Improved Compression Set and Fatigue Resistance:**
EPDM-P's resistance to compression set and superior fatigue resistance ensures that hoses maintain their sealing properties and flexibility over time, reducing the risk of leaks or failures in critical water-glycol systems.

• **Longer Lifespan and Reduced Maintenance:**
The superior performance of peroxide-cured EPDM-P in terms of corrosion resistance, ozone stability, and heat resistance leads to a longer service life for hoses in data center applications, reducing the need for frequent replacements and maintenance.

Conclusion:

In data center cooling systems, where the use of water-glycol mixtures is common, the material selection for hoses is crucial for ensuring long-term performance and reliability. While sulfur-cured Chloroprene (CR) is often chosen for its flame-resistant properties, the risks associated with sulfidation and galvanic corrosion make it a less suitable choice for systems that include metal components exposed to moisture. Furthermore, CR's vulnerability to ozone degradation further undermines its reliability in a data center environment.

Peroxide-cured EPDM-P offers a superior alternative, providing exceptional resistance to corrosion (both sulfidation and galvanic), ozone, and heat. Its overall durability and chemical compatibility make it the ideal choice for water-glycol cooling systems in data centers, ensuring a longer service life and minimizing the need for maintenance or replacement.

Recommendation:

Based on the critical factors of corrosion resistance, ozone stability, heat resistance, and chemical compatibility, we strongly recommend the use of peroxide-cured EPDM-P over sulfur-cured Chloroprene (CR) in both the tube and cover for hose applications in data center water-glycol systems.

References:

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[5] Chlorine and sulfur effects on copper-aluminum wire bond reliability | IEEE Conference Publication | IEEE Xplore
[6] Factors influencing Rate of Corrosion – Sealxpert

This draft presents the technical comparisons and advantages of using peroxide-cured EPDM (EPDM -P) over sulfur-cured Chloroprene in Data Center Water-Glycol hose applications. It can be further refined based on specific use cases or additional data, but it provides a comprehensive overview of the material differences and their implications in real-world applications.

About
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