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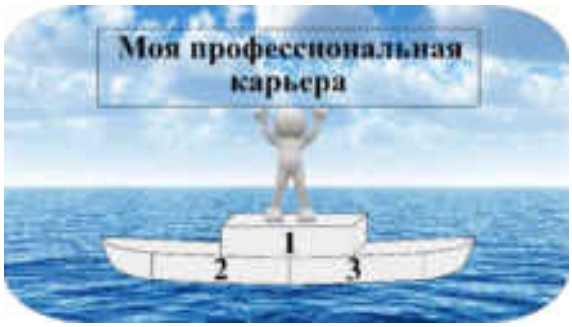

Международный научно-образовательный электронный журнал «ОБРАЗОВАНИЕ И НАУКА В XXI ВЕКЕ»

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Содержит научные работы отечественных и зарубежных авторов по экономическим, техническим, философским, юридическим и другим наукам.

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Introduction

Polyurethane-based moisture resistant sprays are widely used in modern industry and construction because of their excellent waterproofing, corrosion resistance, chemical stability, and strong adhesion properties. These coatings create a protective barrier on surfaces, preventing moisture penetration and increasing the durability of materials. Today, polyurethane sprays are applied in automotive manufacturing, electronics, aerospace engineering, construction materials, textiles, and wood protection systems.

Moisture is one of the most destructive environmental factors affecting metals, polymers, wood, and concrete structures. Continuous exposure to water and humidity can cause corrosion, fungal growth, oxidation, and mechanical degradation. Polyurethane-based coatings provide an effective solution by forming dense polymer films that resist water absorption and environmental damage.

The development of polyurethane chemistry began in the 1930s with the work of German chemist Otto Bayer. Since then, polyurethane materials have evolved into versatile industrial products with applications ranging from flexible foams to high-performance protective coatings.

Chemical Structure of Polyurethane

Polyurethane is a polymer formed through the reaction between polyols and isocyanates. The general chemical reaction can be represented as:

R−NCO+R′−OH→R−NHCOO−R′R{-}NCO + R'{-}OH \rightarrow R{-}NHCOO{-}R'R−NCO+R′−OH→R−NHCOO−R′

In this reaction:

- **R–NCO** represents an isocyanate group
- **R'–OH** represents a polyol group
- The product contains a urethane linkage

The urethane bond provides flexibility, chemical resistance, and strong adhesion to surfaces. Depending on the formulation, polyurethane coatings may be rigid, elastic, thermoplastic, or thermosetting.

Polyurethane moisture resistant sprays usually contain:

- Polyurethane resin
- Solvents
- Catalysts
- Pigments
- Additives for UV resistance and anti-corrosion performance

Some advanced formulations also include nanoparticles such as silica or titanium dioxide to improve hydrophobicity and surface durability.

Mechanism of Moisture Resistance

The primary function of polyurethane spray coatings is to create a hydrophobic protective layer. Hydrophobic materials repel water molecules and reduce water absorption. Polyurethane coatings achieve this through their dense cross-linked polymer network.

The water absorption process can be minimized according to Fick’s diffusion principle:

J=−DdCdxJ = -D\frac{dC}{dx}J=−DdxdC

Where:

- JJJ = diffusion flux
- DDD = diffusion coefficient
- dC/dxdC/dxdC/dx = concentration gradient

A lower diffusion coefficient means reduced water penetration into the material. Polyurethane coatings significantly decrease diffusion rates because of their compact molecular structure.

Additionally, moisture resistant sprays:

- Prevent oxygen penetration
- Reduce corrosion rates
- Protect against microbial growth
- Increase thermal insulation
- Improve surface lifespan

Types of Polyurethane Moisture Resistant Sprays

1. Solvent-Based Polyurethane Sprays

These coatings contain organic solvents that evaporate during curing. They provide:

- Excellent adhesion
- High gloss finish
- Strong chemical resistance

However, they may release volatile organic compounds (VOCs), which can affect the environment and human health.

2. Water-Based Polyurethane Sprays

Water-based systems use water instead of organic solvents. Advantages include:

- Lower toxicity
- Reduced VOC emissions
- Environmental friendliness

These coatings are increasingly used in sustainable industrial processes.

3. Two-Component Polyurethane Systems

These systems contain:

- Polyol component
- Isocyanate hardener

Mixing initiates polymerization and forms highly durable coatings suitable for industrial and marine environments.

4. Spray Polyurethane Foam (SPF)

SPF materials expand during application and provide:

- Moisture resistance
- Thermal insulation
- Air sealing capability

They are commonly used in building insulation and roofing systems.

Industrial Applications

Construction Industry

Polyurethane moisture resistant sprays are extensively used for:

- Roof waterproofing
- Basement protection
- Concrete sealing
- Bridge coatings
- Pipe insulation

These coatings protect structures from rain, humidity, and chemical exposure.

Automotive Industry

In automotive manufacturing, polyurethane sprays protect:

- Car bodies
- Chassis components
- Interior surfaces

The coatings improve resistance to moisture, road salt, and mechanical wear.

Electronics

Electronic devices are highly sensitive to moisture. Polyurethane conformal coatings protect:

- Printed circuit boards
- Sensors
- Electrical connectors

These coatings prevent short circuits and corrosion.

Wood and Furniture Protection

Wood absorbs moisture easily, leading to swelling and fungal attack. Polyurethane sprays provide:

- Water repellency
- Surface hardness
- Decorative appearance

Furniture manufacturers widely use transparent polyurethane coatings for long-term durability.

Advantages of Polyurethane Moisture Resistant Sprays

Polyurethane coatings possess several important advantages:

1. Excellent water resistance
2. Strong adhesion to different surfaces
3. High flexibility and toughness
4. Chemical and corrosion resistance
5. UV stability
6. Long service life
7. Fast curing properties

The mechanical durability of polyurethane coatings can be associated with stress-strain relationships:

σ=Eε\sigma = E\varepsilonσ=Eε

Where:

- σ\sigmaσ = stress
- EEE = Young’s modulus
- ε\varepsilonε = strain

This relationship explains the elastic behavior and flexibility of polyurethane materials under mechanical loads.

Environmental and Safety Considerations

Despite their benefits, polyurethane sprays require careful handling because isocyanates may cause respiratory irritation and skin sensitivity. Proper ventilation and personal protective equipment are essential during application.

Modern research focuses on:

- Bio-based polyurethanes
- Low-VOC formulations
- Recyclable polymer systems
- Eco-friendly additives

Scientists are also developing nanocomposite polyurethane coatings with self-cleaning and self-healing properties.

Conclusion

Polyurethane-based moisture resistant sprays represent an important technological advancement in protective coating systems. Their superior waterproofing ability, mechanical strength, and chemical resistance make them valuable in construction, automotive engineering, electronics, and furniture manufacturing.

The combination of polymer chemistry and advanced material engineering continues to improve polyurethane performance. Future developments are expected to focus on environmentally sustainable formulations with enhanced durability and multifunctional protective properties.

As industries continue to demand high-performance materials capable of resisting moisture and environmental degradation, polyurethane coatings will remain a critical component of modern industrial technology and material science.

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