

Polyurea Uses in the Construction Industry

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Abstract - Polyurea coatings have become an essential technology in the construction industry due to their remarkable properties such as rapid curing, durability, chemical resistance, and waterproofing. They are widely used to protect surfaces, structures, and infrastructure from wear and tear, which minimizes downtime and enables shorter construction schedules. These coatings are ideal for roofing, basements, and water containment systems as they create a flawless, waterproof barrier. They are also suitable for chemical processing plants, industrial facilities, and containment areas due to their exceptional chemical resistance. Moreover, their flexibility allows them to withstand temperature fluctuations without fracturing, making them ideal for extreme climate regions. Polyurea coatings can be applied to various substrates, creating a seamless, uniform finish. They are also used in industrial and marine settings to protect steel structures from corrosion. These coatings offer customization options for decorative and architectural purposes and can be designed for slip-resistant safety. Their longer service life reduces maintenance costs, making them a cost-effective solution for the construction industry

fiber, were chosen for their low density and ability to dampen acoustic waves, making them commonly used as fillers in vehicle interior composite elements within the automotive industry. However, it is important to consider the temperature limit as a technological constraint in the natural fiber-reinforced composites industry, as it can lead to fiber degradation.

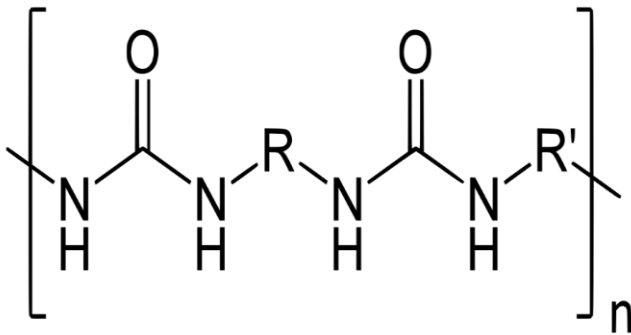
The study aimed to determine the adhesion force of polymeric coatings to steel bases, compare the impact resistance of multilayer coatings, and investigate the influence of the coating on static mechanical properties and fatigue lifetime. The most widely used strategy for fatigue lifetime improvement is strengthening metallic structures using CFRP (carbon fiber reinforced polymer) patches. Polyurea, also known as polyurea elastomer, is a modern construction material with extraordinary properties, such as high durability and strong resistance to atmospheric, chemical, and biological factors. Polyurea coatings are used to protect steel structures against corrosion from exposure to saltwater and other corrosive elements. They provide customization options for decorative and architectural purposes, including color, texture, and thickness. They can also be designed to be slip-resistant, enhancing safety in areas where traction is crucial. Polyurea coatings have a longer service life than other coating systems, resulting in reduced maintenance costs. In conclusion, polyurea coatings have revolutionized the construction industry by providing a robust and versatile solution for protective and decorative applications. Their exceptional properties, such as durability, rapid curing, and resistance to chemicals and environmental factors, make them an invaluable asset in constructing long-lasting, resilient, and safe structures.

Polyurea is a highly durable and elastic material that is created through a reaction of polyamine and isocyanate. It consists of a chain-type structure with "n" molecules that are strongly combined, giving it its exceptional properties. Originally used in ballistic systems and devices for its energy absorption capabilities, polyurea has found numerous applications in the construction field. It is commonly used as a hydro-isolation coating for industrial floors and as a strengthening coating for steel and concrete. This elaboration focuses on presenting polyurea as a construction material, considering both its advantages and disadvantages. Additionally, it summarizes the current research on the material and explores future directions and areas of use

Key Words: Polyurea coating, Rapid Curing Etc.

1. INTRODUCTION

Polyurea coatings are widely used in industries such as construction, automotive, and marine due to their durability, fast curing time, and versatility. These coatings, including polyurea, polyurethane, and polyurethane-polyurea resins, serve as effective anti-corrosive and anti-wear agents, protecting against abrasion, tearing, and scratches. They can be applied on various surfaces, including metal, wood, concrete, and plastics, offering both decorative and specific mechanical properties. Additionally, polymers like polyurea are utilized as cover layers for armored vehicles, ballistic shields, loading areas, and waterproof surfaces, while also providing vibration and sound absorption capabilities. To enhance the properties of polyurea coatings, modifications with glass fabric and hemp fiber are employed. The application process involves sandblasting or the use of an epoxy resin-based intermediate layer. In this study, an epoxy resin intermediate layer was utilized, and the primer was modified with glass fabric and hemp fiber to improve impact resistance and vibration absorption. Samples with and without the polyurea layer were prepared to assess the influence of each constituent. Natural fibers, such as hemp



1.2. AIM

This study on polyurea coatings aims to comprehensively understand the properties, applications, and potential benefits of this versatile coating material.

1. Characterization of Material Properties: Understanding the fundamental properties of polyurea, including its mechanical, thermal, chemical, and adhesion properties, is a key aim of such studies. This characterization provides insights into the material's suitability for various applications.
2. Application Techniques and Methods: Researchers aim to explore the different application techniques and methods for polyurea coatings, including spray application, hand application, and various equipment used. A comprehensive study can help identify the most effective application methods for different scenarios.
3. Performance Evaluation: Researchers often aim to evaluate the performance of polyurea coatings in various environmental and operational conditions. This may involve testing their durability, resistance to abrasion, chemical resistance, and ability to withstand extreme temperatures.
4. Waterproofing Capabilities: Many studies focus on the waterproofing properties of polyurea coatings. The aim is to assess their effectiveness in preventing water infiltration in applications such as roofing, basements, and water containment systems.
5. Corrosion Protection: For applications involving metal substrates, researchers aim to assess the corrosion protection capabilities of polyurea coatings, particularly in marine and industrial settings.
6. Environmental Impact: Understanding the environmental impact of polyurea coatings is a growing concern. Studies aim to evaluate their sustainability, potential for VOC (volatile organic compound) emissions, and long-term environmental effects.
7. Customization Options: Researchers aim to explore the customization options available with polyurea coatings, such as color, texture, and thickness. This provides insights into the versatility of these

coatings for various applications, including decorative and architectural uses.

8. Cost-Effectiveness: Studies may aim to assess the cost-effectiveness of using polyurea coatings in comparison to alternative coating materials. This evaluation can help project planners and engineers make informed decisions regarding budget allocations.
9. Safety Considerations: Research can aim to identify safety considerations when working with polyurea coatings, particularly in terms of handling, ventilation, and potential health hazards during application.
10. Comparative Analysis: Aims of studies often include comparing polyurea coatings to other coating materials to understand their advantages and disadvantages in different scenarios.
11. Innovations and Advancements: Keeping pace with the latest advancements in polyurea technology is an essential aim of research. Researchers aim to identify new formulations, application techniques, and emerging trends in the field.

The study aims to provide a comprehensive understanding of polyurea coatings, their applications, and their suitability for various industries, aiding in informed decision-making in construction and industrial settings.

1.3. SCOPE

The future of polyurea coatings in the construction industry is promising, with sustainability being a key focus. Research into low-VOC formulations and recyclable materials is crucial for advancements in UV degradation resistance, flexibility, and chemical resistance. Nanotechnology integration is also growing, enhancing UV resistance, hardness, and self-cleaning capabilities. The Internet of Things (IoT) may lead to smart coatings with embedded sensors for real-time monitoring. Customization options in color, texture, and design are expected to expand. Polyurea coatings can address issues surrounding aging infrastructure repair and rehabilitation, providing innovative solutions for restoring and protecting critical infrastructure. Polyurea coatings are expected to become more efficient and precise in the future, with automation and robotics expected to play a more significant role in spray application.

Hybrid coatings with unique properties, such as self-healing polyurea, are being developed to address minor damages and prolong structures' lifespan. These coatings are particularly useful in niche areas like cultural heritage sites and historic buildings. The global expansion of polyurea coatings is expected to drive innovation and standardization, while stricter environmental regulations will necessitate stricter standards for future coatings.

The future of polyurea coatings in construction is marked by innovation, sustainability, and expanding applications.

Advanced formulations, customization options, and smart coatings will contribute to their versatility and sustainability.

2. LITERATURE REVIEW

Polyurea is a polymer material which offers dynamic properties resulting from the specific structure of the material. Considerable tests, as well as developed scientific procedures, which allow for unequivocal statements about the properties of the polymer structure material, have been performed in recent years.

1. Yi j. - The study examined the behavior of a single polyurea sample and three polyurethane samples under compressive force using a Hopkinson pressure bar system, revealing a non-linear stress-strain relationship significantly influenced by strain rate.
2. Sarve SS.- Sarva SS. et al. conducted a study on polyurea and polyurethane behavior at various strain rates. They used various testing methods, including a Zwick screw drive mechanical tester for low strain rates, an enhanced servo-hydraulic axial testing machine for medium strain rates, and two configurations of the Hopkinson pressure bar for high strain rates.
3. S. N. Raman - S. N. Raman and colleagues conducted a study on a polyurea sample to gather data for calibrating a material model in software using a finite elements model like ANSYS® AUTODYN®, emphasizing the importance of polyurea.
4. D. Mohotti - D. Mohotti et al. conducted experiments on polyurea samples subjected to high strain rates using the INSTRON® VHS 8800 device. They proposed a novel model called Rate Dependent Mooney Rivlin (RDMR) to predict nonlinear, hyper-elastic polyurea behavior. The model requires only one set of material parameters for a specific strain rate and automatically calculates values for other parameters for different strain rates. This model is expected to simplify simulations and have potential applications in finite element methods.
5. Arunkumar T. - Arunkumar T. et al. conducted a study on polyurea adhesion to steel using AISI 1018 steel due to its strength, elasticity, and high mechanical characteristics. They applied varying thicknesses of polyurea coatings to steel samples, spraying them at a distance of 50 mm from the steel. The study aimed to understand the interaction between polyurea and various materials and the impact of temperature on the substance's properties and structure. The research aimed to provide insights into the properties and structure of polyurea.
6. Thirumal M. - Thirumal M. et al.'s 2010 study found that adding oxidized phosphorus to polyurea and epoxy resin significantly improved thermal stability

and fire resistance. Triphenyl phosphate was found to be most effective in enhancing fire resistance in polyurea.

Year	Progress
1981	Developed for automotive RIM Parts
1987	Polyurea Spray technology introduced by Texaco
1988	First commercial usage as a Field Coating
1993	Several Formulators enter the market

3. METHODOLOGY

Polyurea elastomeric coating, used since the late 1980s, is a remarkable product for construction due to its exceptional tensile strength and ability to move with the substrate up to 90%. It creates a seamless, high-abrasion liner that can withstand harsh environments and is chemically resistant, UV tolerant, and resistant to H₂S gases.

APPLICATION MANNER –

The application of polyurea on the isolated surface is a very complex process. It consists of three technological stages: preparation of the surface, mixing of the components, and application.

1. Surface Preparation –

Surface preparation is crucial for applying material, ensuring the surface is clean, dry, and free from contaminants like oil and grease. If contamination is detected, blast cleaning or sand-blast cleaning may be necessary. Chemical agents should be used to remove oil stains or other contaminants. Priming paints can enhance adhesion. These steps ensure the material coating is securely attached to the surface, impacting the resulting material quality. Surface preparation is the most critical stage in the process.

2. Mixing the components-

Polyurea is a two-component composite material that requires a suitable apparatus to create optimal temperature and pressure conditions. The blending occurs in a heated environment using a specialized pneumatic or electric device. Accurate mixing and dosing are crucial for successful polyurea spray application, as they ensure the proper application of the composite material.

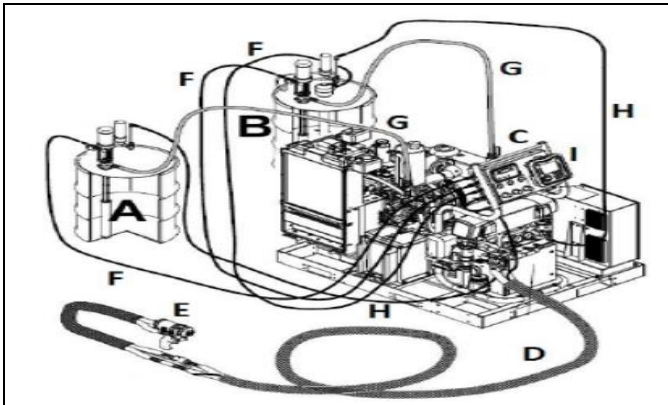
The spraying parameters, including temperature and pressure, must be closely monitored and matched to the manufacturer's specifications in the Product Data Sheet (DPS). Continuous monitoring of component volume and weight ratios is also crucial for ensuring the highest quality polyurea coating outcome.

3. Coating application –

The mixture is applied on a dust-free surface, with two layers of coating applied, one directly onto the surface and the other perpendicular to it, to ensure complete impermeability and absence of seams or joints.

4. Device for spraying polyurea coating system –

The system employs aggregates machines, capable of generating pressure between 120 and 210 bar and heating resin to temperatures between 650C and 800C. These complex machines have real-time monitoring controls for pressure and temperature, with numerous sensors placed in key parts for operator control.



The diagram depicts a set of machines for spraying polyurea coating or foams, including a combustion engine, electricity generator, and air compressor, enabling real-time control of mixture parameters.

- A – barrel with Polyamate component,
- B – barrel with polyisocyanate component,
- C – reactor feeder (the place where high-pressure pumps with heaters used to provide A and B ingredients are located)
- D - heated hose (a hose equipped with heaters used for maintaining an appropriate temperature of the ingredients),
- E - spray gun (a device where ingredients A and B are mixed and then instantly sprayed onto the surface at a very high pressure),
- F - hoses providing air (the hoses providing air for the pumps and the stirrer),
- G - hoses providing the ingredients A and B to the reactor feeder,
- H - recirculation ducts (used for moving ingredients A and B around heaters),
- I - Main control module of the device.

The polyurea coating application process is complex and requires manufacturers to provide product data sheets and manuals. These documents provide detailed information on mixture parameters, surface preparation, and application systems.

1. Curing - Polyurea coatings cure quickly, sometimes in seconds or minutes. Follow the manufacturer's instructions for curing and make sure the environment is suitable for curing, including temperature and humidity.
2. Quality Control - Check the coating for defects like pinholes, air bubbles, or inconsistencies. Fix any

problems right away. Also, measure the coating's thickness to make sure it meets the required standards.

3. Topcoat (Optional) - A topcoat can be added to improve UV resistance, colour retention, or other properties, depending on the application and performance needs.
4. Clean Up - Clean spray equipment and tools right after use with the suggested solvents and cleaning methods.
5. Safety - During the entire process, make sure to follow safety guidelines. This includes wearing the right personal protective equipment (PPE) and ensuring there is proper ventilation in enclosed spaces.

Polyurea coating application varies based on product and project needs, necessitating manufacturer instructions, project conditions, and professional training for successful application.

4. **ADVANTAGES OF POLYUREA COATING**

Polyurea coatings present numerous benefits that render them a favored option for a diverse array of applications across various industries. The following are the primary advantages of polyurea coating.

1. Exceptional durability -Polyurea coatings have gained recognition for their exceptional durability and remarkable resistance to wear, abrasion, and impact. These coatings exhibit an impressive ability to endure heavy traffic and endure harsh conditions, rendering them highly suitable for environments that demand the utmost performance.
2. Rapid curing time - Polyurea coatings exhibit an exceptionally rapid curing time, frequently ranging from mere seconds to minutes. This expeditious curing process facilitates prompt project finalization, thereby minimizing downtime and curtailing labor expenses.
3. Waterproofing properties -Polyurea coatings exhibit exceptional efficacy as waterproofing agents, effectively establishing an unbroken and impervious shield against moisture. These coatings find widespread application in roofing, foundation, and containment scenarios, effectively thwarting the infiltration of water.
4. Chemical resistance - These coatings are highly resistant to various chemicals, making them ideal for use in chemical processing plants, industrial facilities, and containment structures.
5. Versatility - Polyurea coatings are used on different surfaces like concrete, steel, wood, and more. They

are used in construction, industrial maintenance, automotive, marine, and other industries.

6. Customization - Polyurea coatings offer the flexibility to tailor colour, texture, and thickness, enabling architects and builders to meet their specific design and aesthetic goals. This customization allows for the accomplishment of both functional and visual objectives.
7. Corrosion protection - Polyurea coatings shield structures and equipment from corrosion in harsh environments like marine structures and chemical facilities. They form a protective barrier that prolongs the lifespan of these assets.
8. Reduced maintenance - Polyurea coatings possess exceptional durability and exhibit remarkable resistance to wear and damage, thereby necessitating only minimal maintenance. Consequently, this characteristic leads to substantial cost savings over an extended period and a notable reduction in downtime.
9. Seamless finish - Polyurea coatings offer a seamless and high-build finish, thereby mitigating the potential for coating failure at seams or joints. This seamless characteristic significantly enhances the overall performance of the coating.
10. Environmental consideration - Numerous polyurea coatings exhibit minimal volatile organic compound (VOC) emissions, rendering them ecologically sound and secure for manipulation. These coatings adhere to environmental regulations, ensuring compliance with prevailing standards.

5. DISADVANTAGES OF POLYUREA COATING

1. Cost - Polyurea coatings are pricier than traditional coatings, especially for small projects. The cost of materials, equipment, and skilled applicators can make polyurea coatings less cost-efficient for smaller-scale projects.
2. Skills and equipment requirements - Using polyurea coatings requires special tools and trained workers. It can be hard for smaller construction firms or DIY projects to find the right equipment and skilled labor.
3. Short pot life - Polyurea coatings dry quickly, which is good in some ways, but it can also be a problem because they don't stay workable for long after mixing. This means they need to be applied fast and efficiently, which might not be possible for big or complicated projects.

4. Temperature and humidity sensitivity - Polyurea coatings are affected by the environment. They need specific temperature and humidity levels to be applied correctly, which means they may not be suitable for certain climates or bad weather.

Adhesion to certain substrates - Polyurea coatings stick well to many surfaces, but they may not stick as well to some surfaces if they are not prepared properly.

6. POLYUREA IS A GREEN PRODUCT

Polyurea coatings are environmentally friendly, high-strength, and environmentally friendly, providing protection against threats to human life, environment, and infrastructure.

1. Polyurea is an eco-friendly material for many reasons. Those reasons are as follows:
2. Low VOC Emission - Polyurea coatings, with minimal VOC emissions, are environmentally friendly and comply with air quality rules, reducing the risk of air pollution and health issues.
3. Reduce Waste - Polyurea coatings are usually applied as a liquid that dries fast. This helps to minimize waste since very little material is left unused or thrown away while applying it.
4. Longevity and durability - Polyurea coatings last a long time and provide great protection to the surface they cover. Because of this, there is less need for maintenance, repairs, or replacements. This helps save resources and energy in the long run.

7. USES OF POLYUREA IN THE CONSTRUCTION INDUSTRY

1. Water Proofing
 - a. Roofing: Polyurea coatings are used on rooftops to create a seamless and super-effective waterproof layer. They shield against water seepage and increase the lifespan of the roof.
 - b. Foundation and Basements: Polyurea coatings stop moisture from entering foundation walls and basement floors, making them dry and livable.
2. Secondary containments - Polyurea coatings are used to make secondary containment systems for tanks, pipes, and chemical storage areas. They create a strong barrier that prevents leaks, which helps protect the environment in case of chemical spills or leaks.
3. Parking garages - Polyurea coatings are used on parking garage decks to shield them from vehicles, de-icing chemicals, and moisture. They boost the strength of the structure and prolong its lifespan.
4. Bridge Protection - Polyurea coatings protect bridges from corrosion due to moisture, de-icing agents, and environmental factors. They offer durable protection for important infrastructure.

6. Infrastructure rehabilitation - Polyurea coatings are used to repair and protect aging infrastructure such as bridges, tunnels, and wastewater treatment plants. They enhance the strength and longevity of these structures.
7. Concrete Protection - Polyurea coatings safeguard concrete surfaces from damage caused by wear and abrasion. They are utilized on concrete floors, decks, and walls in industrial facilities, parking structures, and other similar settings

8. CONCLUSION

Polyurea coatings are a valuable asset in the construction industry due to their exceptional durability and resilience, which can withstand harsh environmental conditions, wear and tear, chemical exposure, and heavy traffic. They offer quick project completion, reducing downtime and labor costs, making them suitable for various construction needs. Polyurea coatings can be customized in terms of color, texture, and thickness, allowing architects and builders to achieve specific design and aesthetic goals. They also provide a protective shield against corrosion, extending the lifespan of structures and equipment. Polyurea coatings require minimal maintenance, leading to long-term cost savings and reduced downtime. They are environmentally friendly and safe to handle, with many having low VOC emissions. Reflective polyurea coatings can reduce heat absorption, reducing cooling costs in urban environments. They are suitable for various applications, including roofing, flooring, tank linings, bridge protection, and architectural enhancements. Proper application and maintenance contribute to the durability and performance of construction projects

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