Chapter 8
An Ecofriendly Polymer With Significant Properties, Extensive Modification Potential, and Sustainable Industrial Applications: Hydroxyethylcellulose

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ABSTRACT

Hydroxyethylcellulose (HEC) is a water-soluble derivative of cellulose, obtained by reacting cellulose with ethylene oxide. This chemical transformation imparts distinctive characteristics to HEC, such as enhanced water solubility, increased viscosity, and optimized stability under various pH and thermal

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conditions. These properties make HEC an essential polymer in various industrial sectors. In the cosmetic and pharmaceutical industries, HEC is mainly used for its thickening, stabilizing, and moisturizing properties. It is also employed in the paint and coatings sector as a viscosity modifier, and in the food industry for its emulsifying and stabilizing functions. Additionally, cellulose is used in water treatment processes. Chemical modifications of HEC, such as the control of substitution degree and crosslinking, enable its properties to be tailored for specific applications. The methods of HEC modification, its physical and chemical properties, and its numerous industrial applications are examined in this article, emphasizing its versatility and advantages over pure cellulose.

INTRODUCTION

Fossil-based compounds are widely utilized in various industrial applications, primarily due to their availability and cost-effectiveness. Approximately 90% of global fossil hydrocarbons are consumed as fuels for electricity generation, transportation, and heating, while the remaining 10% serves as feedstocks in the chemical industry for producing plastics, fertilizers, and other essential chemicals (Jiang et al., 2024). However, fossil-based materials are known to be non-biodegradable, which poses significant challenges for environmental sustainability. Their persistence in the environment contributes to long-term pollution, as these materials do not break down naturally over time. This lack of biodegradability results in the accumulation of plastic waste in landfills and oceans, adversely affecting wildlife and ecosystems. Additionally, the toxicity of some fossil-based compounds can lead to harmful effects on human health and biodiversity, as these substances can leach into soil and water sources (Thompson, Swan, Moore, & Vom Saal, 2009). In response to these environmental concerns, a shift towards biodegradable alternatives, such as bioproducts and biopolymers, has been initiated in various industries(Jha et al., 2024; Moshood et al., 2021). Hydroxyethyl cellulose (HEC), a biopolymer derived from renewable resources, has gained attention for its biodegradability and versatility in applications ranging from pharmaceuticals to coatings. This chapter provides a comprehensive overview of hydroxyethyl cellulose (HEC), as an eco-friendly polymer derived from cellulose that exhibits significant properties, such as its water solubility and ability to form clear viscous solutions, making it a versatile material for various industrial applications, including cosmetics, pharmaceuticals, and food industries. The chapter delves into the chemical modifications of HEC, such as etherification and esterification, which enhance its functionality and adaptability for specific uses. Additionally, it explores the environmental benefits of using HEC in applications like water treatment, highlighting its role in sustainable practices. The discussion also emphasizes the importance of HEC in the construction industry, where it improves the performance and durability of cement mortars by enhancing moisture retention and adhesion. Furthermore, the chapter addresses ongoing research into HEC modifications, revealing new functionalities that can meet contemporary challenges across diverse fields. The objectives of this chapter are to examine the methods of HEC modification, analyze its physical and chemical properties, and discuss its numerous industrial applications.

Background

Hydroxyethyl cellulose (HEC) is one of the most important commercially available cellulose derivatives (Diao et al., 2017). This compound is obtained by the etherification of cellulose with ethylene oxide, which generates a white to light yellowish powder that dissolves easily in hot and cold water