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Abstract

Concerns about energy security and environmental sustainability have increased the preference for renewable energy sources. Biodiesel, a renewable alternative to conventional diesel, has gained interest as a potential solution. However, biodiesel's stability during storage and susceptibility to oxidation are significant challenges. Antioxidants are essential to enhance biodiesel's oxidation stability, ensuring fuel quality and sustainability. While various studies have examined the effects of different antioxidant concentrations on biodiesel oxidation stability on trial and error bases, a consensus on the most effective dosage range has yet to be established. This review emphasizes the importance of predictive models for estimating antioxidant amounts in biodiesel. Using mathematical formulations, statistical analyses, and computational simulations, predictive models offer efficient and accurate approaches to understanding the complex relationships between antioxidants, biodiesel properties, and oxidation stability. The review examines the link between antioxidants and biodiesel stability, discusses predictive models' role in determining optimal antioxidant dosages, and identifies factors influencing these decisions. It also highlights the limitations of predictive models and suggests future research directions. The conclusion is that systematically integrating data-driven strategies through predictive models facilitates the cost-effective optimization of antioxidant dosages, advancing high-quality and sustainable biodiesel.