An Overview on the Biodiesel Oxidative Stability: Its Causes, Consequences, and Inhibition

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ABSTRACT

Poor oxidative stability of biodiesel has been considered one of the major threat for its sustainable production and commercialization. Due to poor oxidative stability, degradation of biodiesel occurs on storage as well as its applications. The storage stability of biodiesel varies with the nature and proportions of chemical functional groups present in the fatty acid esters (FFAs) constituting the biodiesel. The chemical composition of biodiesel imparts crucial role on its storage behavior. The degree of unsaturation and the available allylic and bis-allylic positions are highly prone to oxidation, which leads to the formation of gums, acids, and polymer deposits that causes fouling or plugging problems in the engine and filter. Although, the auto-oxidation of biodiesel cannot be prevented completely, however, it can be slowed down by using additives called antioxidants. These additives prevent the propagation of oxidation processes by scavenging the free radicals that are formed by the attack of oxygen on reactive sites of fatty acid esters (FFAs). The present mini review emphasizes on the major causes that are primarily responsible for poor oxidation stability of biodiesel, its impact on the fuel characteristic of biodiesel, and available techniques for its prevention.

1. Introduction

The 'fuel stability' is the virtue of resistance of its degradation under storage, engine operating and environmental conditions. Degradation can changes the fuel properties and also form undesirable species that cause the formation of gums, acids, and polymer deposits that causes fouling or plugging problems in the engine and filter. [1-3] Any fuel that readily undergo such changes is considered as unstable. Biodiesel is also an unstable fuel since it can degrade by one or more of the following reasons: (*i*) oxidation or auto-oxidation caused by its contact with oxygen present in air; (*ii*) thermal oxidative decomposition caused by excess of heat; (*iii*) hydrolysis caused by the presence of water or moisture in tanks and fuel lines; (*iv*) microbial contamination in fuel caused by the dust and water droplets containing bacteria or fungi. [1-3]. Among those, the oxidation or auto-oxidation processes are the most frequent processes that involve degrading the biodiesel. The oxidation stability is the affinity of fuel towards oxygen at ambient temperatures and describes the relative susceptibility of the fuel to degradation by oxidation. The storage stability is the commonly used term that refers to the general stability of a fuel during long-term storage. The oxidative degradation is one of the primary degradative process of concerns of storage stability along with others as stated above. [4] Biodiesel is obtained by the transesterification of fatty acid or oils using methanol or ethanol in the presence of homogeneous/heterogeneous acidic or basic catalysts.[5,6] During the transesterification process, the fatty acid chain remains unchanged in the biodiesel obtained. Therefore, the oxidation chemistry of

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