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Corrosion behavior of copper, aluminium, and stainless steel 316L in chicken fat oil based biodiesel-diesel blends

A. Shehzad [a], A. Arslan [b,*], F. Rehman [c], M.M. Quazi [d], S.I. Butt [e], M. Jamshaid [f]

[a] Department of Mechanical Engineering, COMSATS University Islamabad, Sahiwal Campus, 57000, Pakistan
[b] Department of Mechanical Engineering, COMSATS University Islamabad, WAH Campus, 46000, Pakistan
[c] Department of Chemical Engineering, COMSATS University Islamabad, Lahore Campus, Pakistan
[d] Faculty of Mechanical and Automotive Engineering Technology, Universiti Malaysia Pahang, Pekan 26600, Pahang, Malaysia
[e] School of Mechanical and Manufacturing Engineering, National University of Sciences and Technology, Islamabad, Pakistan
[f] Department of Mechanical Engineering, Bahauddin Zakariya University, Multan 60000, Pakistan

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ABSTRACT

This study investigates the corrosion behavior of automotive materials in bio-based fuels. The Response Surface Methodology is employed to evaluate the corrosion rates of materials such as copper, aluminium, and stainless steel when they are exposed to chicken fat-based biodiesel. Copper, aluminium, and stainless steel showed minimum corrosion rate at a blend percentage of 5.86 % when they were immersed for 920 h and maximum corrosion rate at blend percentage 34.14 % when these were immersed for 920 h. Meanwhile, the maximum corrosion rate was observed at a blend percentage of 34.14 % corresponding to the same immersion period. Optimum values indicated by RSM for copper and aluminium were noted at a blend percentage of 10 % and an immersion period of 720 h. Similarly, for stainless steel 316 l, these were 10.91 % and 754.44 h, respectively. Additionally, trials using the B100 for 920 h were conducted on copper, aluminium, and stainless steel 316 l, and the results showed considerably higher corrosion rates than those previously found. The surface morphology of the materials was investigated by X-ray Diffraction and Scanning Electron Microscopy, and it was revealed that copper was the most corrosive material in chicken fat oil-based biodiesel followed by aluminium and stainless steel 316 l.

Introduction

The world's need for energy is increasing day by day due to the increase in population and technological development. Most of the energy requirement is fulfilled by fossil fuels [1]. Fossil fuels are expensive and most importantly their wide consumption is causing the reduction of resources. It is expected that the world is going to face a severe energy crisis in near future [2]. Biodiesel is gaining importance as it can be directly used as a fuel or as a blending component in commercial diesel [1]. Biodiesel is also biodegradable and non-toxic. Compared to petroleum diesel, biodiesel possesses a higher flash point and lower exhaust emissions [2]. The automobile industry has been using biodiesel by making its blends with petroleum diesel [3]. However, there are few challenges that biodiesel needs to overcome. These challenges include corrosive and hygroscopic nature and less volatility[4].

Engine corrosion is a significant operational problem that is being faced at laboratory and industry scales. Gasoline is being replaced by biofuels in the transport industry. Different parts of the engine are made from different materials. Some of the most common parts of the engines include exhaust system, piston assembly, fuel pump, fuel filter, fuel fed-up, fuel tank, and fuel injection system. The most common materials which are used in the manufacture of these parts include steel, aluminum, copper, plastic, rubber and ceramics[5]. Biofuels have better lubricity at room temperature and with the increase in the concentration of biofuel, worn surface area decreases [6].

The biofuels which have been used in engines include palm oil, soybean oil, rapeseed oil, sunflower oil, olive oil, castor, jatropha curcas, pongamia glabra, linseed oil and milkweed seed oil etc. [7–10]. Corrosion studies have shown that biofuels are corrosive by nature. It has been observed that at elevated temperatures, the corrosion rate of copper increases with time. On the other hand, the use of palm oil biodiesel showed a little lower corrosion rate of aluminum. Stainless steel showed

* Corresponding author.
E-mail address: arslanahmad@ciitwah.edu.pk (A. Arslan).

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