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Corrosion failure analysis in a biodiesel plant using electrical resistance probes

Carlos Eduardo de Almeida Souza Torres [a], Cíntia Gonçalves Fonseca Costa [b], Amanda Petronilha Pereira [c], Maria das Mercês Reis de Castro [b], Vanessa de Freitas Cunha Lins [b,*]

[a] Petrobras, Avenida das Indústrias 531, Zip Code 39404000 Montes Claros, Brazil
[b] Corrosion and Surface Engineering Laboratory, Chemical Engineering Department, Federal University of Minas Gerais, Antonio Carlos Avenue 6627, Zip Code 31270901, Brazil
[c] Fiat Automoveis, Rodovia Fernão Dias km 429, Zip Code 32530000, Brazil

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ABSTRACT

The search for alternative forms of energy that generate a lower emission of carbon dioxide and pollutants leads to an increase in biodiesel fuel production in Brazil. The corrosion of steel equipment is a major problem in biodiesel fuel plants. The methodology applied in the research includes a survey of operating conditions and failure history as well as collection and analysis of corrosion data obtained in installing AISI 316L electrical resistance probes at strategic points in the process.

1. Introduction

The use of fuels derived from biomass has been pointed as a technical alternative to minimize the fossil fuel consumption and environmental damage caused by burns. Furthermore biofuels are a potential option in socioeconomic benefits [1]. Biofuels are products derived from renewable biomass that can partially or totally replace fuels derived from petroleum or natural gas in combustion engines or other types of energy generation [1,2].

The biofuel can be obtained by transesterification [3] through a methyl route with homogeneous basic catalysis. A reaction between the triglyceride (vegetal oil or adipose) and alcohol (methanol) with an alkaline catalyst occurs at 64 °C, at atmospheric pressure, and is accompanied by sedimentation, neutralization, washing, distillation and filtration resulting in biodiesel (product) and glycerin (co product) specified [4]. Alkali-catalyzed transesterification is a most commonly used process for oils with low free fatty acids and low moisture content [4] but acid-catalyzed transesterification using *p*-toluenesulfonic acid (PTSA), benzenesulfonic acid and sulfuric acid is also reported [5]. Other catalysts such as Ca and Zr mixed oxides as heterogeneous base catalysts [6], sulfated zirconia catalyst [7], and hydrated lime [8] were used in transesterification reactions to produce biodiesels.

The neutralization is an important step because the biofuel and glycerin need to be neutralized with hydrochloric acid and the pH can be very low (pH 3).

Biodiesel has been widely used as an additive to traditional fuel supplies, but the corrosion of metals used in biodiesel infrastructure is becoming an increasing concern [9]. In a Brazilian biodiesel plant the material used in the major part of equipment

* Corresponding author.
E-mail addresses: carloseduardotorres@petrobras.com.br (C.E. de Almeida Souza Torres), cintiagf@gmail.com (C.G.F. Costa), amanda.pereira@fiat.com.br (A.P. Pereira), deia@deq.ufmg.br (M.M.R. de Castro), vlins@deq.ufmg.br (V. de Freitas Cunha Lins).

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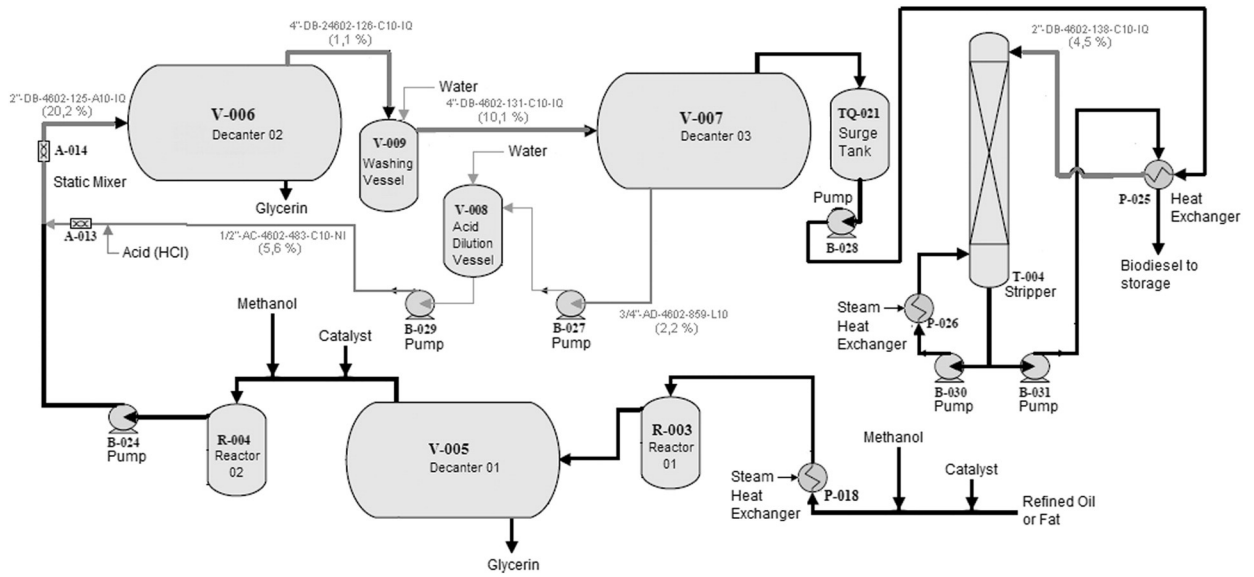

Fig. 1. Flowchart of biodiesel circuit with the percentage of failures occurred in each section.

and piping in transesterification region is the stainless steel AISI 316L. The AISI 316L steel must be used with caution at room temperature and with a low concentration of hydrochloric acid.

The corrosion of steel equipment is a major problem in biofuel plants. The failures which occur due to corrosion impair the operational reliability which causes production and economic losses.

Corrosion of stainless steels in media containing chlorides is extensively studied in literature [10], but this study has a novelty aspect of monitoring corrosion rates in a very specific media consisting of an acidified glycerin and process biodiesel at a temperature of 64 °C, in situ in a biodiesel industrial plant.

The corrosion rate in industrial processes can be measured by installing online electronic devices. Electrical resistance probes are devices which determine the corrosion rate of the sensor element by the variation of the electrical resistance [11]. The corrosion process tends to reduce the cross-sectional area of the sensing element causing an increase of its resistance to the passage of current. To compensate the effect of temperature on conductivity, two sensing elements are used: one inside the probe body and the other exposed to the media. Based on the measured initial resistance of the sensor, variations in electrical resistance are measured cumulatively over time and then converted to corrosion rates.

In this work, AISI 316L steel corrosion failure analysis in a biodiesel plant was performed using electrical resistance probes.

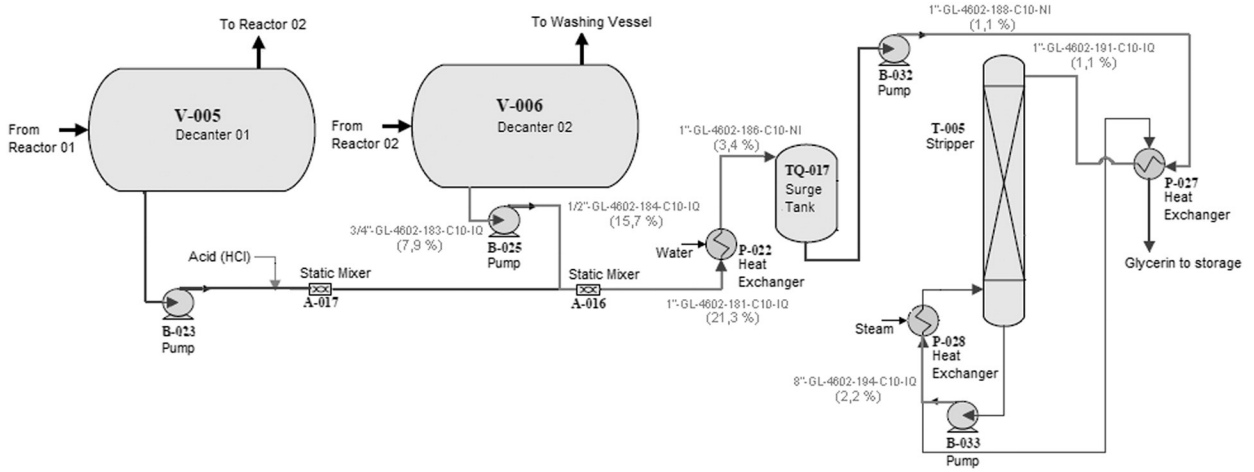

Fig. 2. Flowchart of glycerin circuit with the percentage of failures occurred in each section.