CHAPTER

3

ORGANIC INHIBITORS AND OXYGEN SCAVENGERS REDUCE STEEL CORROSION

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3.1 INTRODUCTION

The demand for carbon steel is increasing from year to year due to its widely uses as construction material, mostly in major industries particularly in water pipeline. Its excellent mechanical properties and cost effectiveness has become the key factors that captures people interest in using carbon steel. However, the critical issue is that carbon steels are highly susceptible to corrosion when in contact with corrosive medium such as acidic or chloride solution.

National Association of Corrosion Engineers (NACE) International, the worldwide corrosion authority has reported that global cost of corrosion has costs billions of dollars every year. This cost has reached about USD2.5 trillion or 3–5% of gross domestic product (GDP). The corrosion cost study by previous study revealed that the United States spent about USD1.372 billion per year for cost of corrosion in main production (Popoola et al., 2013). This equates to approximately 3% to 5% of the nation's Gross Domestic Product, which can be extrapolated to many other countries as well. While, Malaysia has spent about RM5 billion (USD1.205 billion) per year for cost of corrosion in main distribution network (Ahmad Saupi et al., 2016). This outcome shows that the problem of corrosion is a great challenge to the world and must be greatly tackled.

Several methods are used in controlling corrosion problems including; material selection, design concept, painting, corrosion inhibitors as well as cathodic and anodic protection. Among these methods, the most commonly used method for internal surface is application of corrosion inhibitor. The use of corrosion inhibitors is explained by the fact that at a low cost, can reach internal surface of metal application and it is possible to slow down corrosion destruction, even if constructions or equipment are in operation. Thus, it remains as the most practical method to control the internal surface of metallic material (Mikhail et al., 2022).

The global anticorrosion coating market was estimated to USD24.84 billion in 2017 which is having a cost growth rate over 5 years of approximately 5% year (Petrunin, 2022). The development of green corrosion inhibitors is a priority and desirable in order to find a cheap and environmentally safe corrosion inhibitor in inhibiting the internal corrosion of carbon steel in corrosive medium.

3.2 SYNTHESIS OF CORROSION INHIBITOR

This work used palm fatty acid distillate (PFAD) as a main material to produce organic corrosion inhibitor. PFAD is a main by-product in the production process of crude palm oil. A typical PFAD contains about 81.7% of free fatty acids (FFA) of various chain-lengths. FFA can be reacted with secondary amine to produce fatty amides compound which has been disclosed in previous work (Vuorte et al., 2021).

Fatty amides was synthesised by reflux reaction of PFAD with iso-propyl amine, and toluene used as the media for reaction. A catalyst is needed to speed up the reaction and the catalyst used was amberlite IR-120. The reaction was refluxed at temperature of 80 °C. After 24 hours, the collected product was characterised by fourier transform infrared spectroscopy (FTIR) and gas chromatography/mass spectroscopy (GCMS) to determine the presence of amide compounds in the product.

From the data, it was proven the collected product was mixture of fatty amide compounds. The fatty amide was characterised by FTIR and GCMS. The main purpose of FTIR analysis is to determine the chemical bond and functional groups formed while GCMS to identify the compounds existing in the products. Prior to the analysis of the products, the main raw material PFAD was analysed by both analysis also. Then, both results from raw material PFAD and product (fatty amide) was compared by overlapping the FTIR spectra and highlighting the differences between the two spectra of compounds. Figure 3.1 shows the FTIR spectra, the red line represents PFAD while the blue line represents fatty amides.

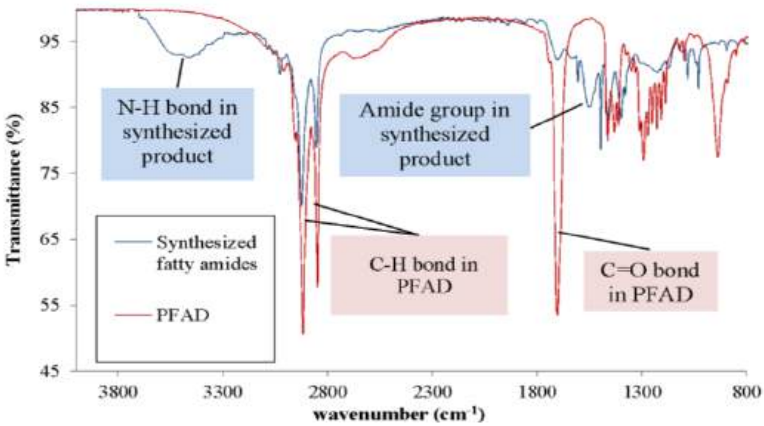

Figure 3.1 Fourier transform infrared spectroscopy spectra of palm fatty acid distillate and fatty amides

From PFAD spectrum shows the presence of carboxylic acid in PFAD. The presence of carboxylic acids in the raw materials is important due to high potential to be synthesised into amide compound. Since in general, fatty amides are formed when fatty acids are reacted with amine. Meanwhile, the fatty amide spectrum shows amide and N-H group. The difference in both spectrum, PFAD and fatty amides indicates that a reaction occurred and a product is produced.