CHAPTER I

INTRODUCTION

Nowadays, much large quantities of fuel oils are consumed in many countries throughout the world. Generally, fuel oils have to be taxed accordingly to the government rate, which is depended on the type of fuel oils as well as purposes (the same fuel, but used for different purposes, thus having different tax rate). This causes the government encountered many problems such as adulteration of the higher priced product with lower priced material; for examples; the addition of a regular grade gasoline to a premium grade gasoline; mixing of hydrocarbon solvents to fuel oils; and the addition of low-taxed light heating oil to high-taxed diesel fuel. For these reasons, it is essential to develop the methods of marking and identifying petroleum products so as to distinguish a variety of fuel oils available in the market.

Markers in fuel oils are used for identifying specific brands of fuel from particular refiner, monitoring the tax classification of petroleum products. Marker systems for fuel oils and petroleum products have been used for a long time but various drawbacks have existed. For example, quinizarin and diphenylamine were used as markers for heating oil in France since 1956, but both of them are fairly sensitive with simple detection procedures and have the disadvantages of poor solubility in fuel oils [1]. In Germany, furfural was used as a marker for fuel oils since 1976, but it is unstable in fuel oils, making its too difficult to detect after prolonged storage. Furthermore, some marking agents are partially dissolved in water, and this causes the markers to lose their effectiveness when storage occurs in tanks that contain some water. The fuel oils and other petroleum products are themselves substantially free of water. In 1994, the U.S. Environmental Protection Agency used phenolphthalein as a fuel marker, but it lacks adequate solubility in petroleum fuels at the concentration required as a marker. This caused phenolphthalein to crystallize from the fuels, resulting in contamination in refinery equipment, pipelines, etc [2]. In 1999, Thowongs K. [3] and Silapakampeerapab, S. [4] were synthesized marker dyes for petroleum fuels from the reaction of cashew nut shell liquid with chloroanilines and nitroanilines, respectively. Those marker dyes were used as markers in gasoline and high-speed diesel at high treat rate (15-30 ppm), because these marker dyes were synthesized from cashew nut shell liquid, which was a mixture of compounds. Thus, it is desirable to develop the marker dyes with low levels of use from the partially purified cashew nut shell liquid.

This research involved the synthesis of petroleum fuel markers from the naturally occurring substrate, cardanol, which was obtained from partially purification of decarboxylated cashew nut shell liquid. Various aniline derivatives were reacted with cardanol to form a variety of marker dyes. These synthetic marker dyes provide invisible color in liquid petroleum products at an effectively usable level, but they provide distinctive color when these marker dyes were extracted from the petroleum products into an appropriate basic reagent. In addition, this basic reagent using for extraction is easy to handle and readily applicable for rapid detection of marker dyes.

The objectives of this research

The objectives of this research are to synthesize marker dyes from cardanol and aniline derivatives for petroleum products, and to study properties as well as stability of marker dyes when added in fuel oils.

The scope of this research

The scope of this research covers the synthesis of marker dyes from cardanol and aniline derivatives, including *p*-nitroaniline, *m*-nitroaniline, *o*-nitroaniline, *p*-chloroaniline, *m*-chloroaniline, *o*-chloroaniline, 2-chloro-4-nitroaniline, 2-chloro-5-nitroaniline, 4-chloro-2-nitroaniline, 4-chloro-3-nitroaniline, *p*-toluidine, *m*-toluidine, *o*-toluidine, 2-methoxy-4-nitroaniline, Fast Blue B salt, Fast Blue BB salt, and Fast Red RC salt. Those marker dyes are characterized using spectroscopic techniques, including FT-IR, ^{1}H-NMR, and ^{13}C-NMR. Moreover, stability and properties of marker dyes in fuel oils are also studied.