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The Effect of Surface Hardening on The HQ 705 Steel Camshaft Using Static Induction Hardening and Tempering Method

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Abstract

Induction hardening (IH) is a popular choice for automotive components such as camshafts for its ability to harden portions of a component selectively. The camshaft will contact the tappet, connected to the rocker arm, to open and close the valve whenever the engine is running. This contact between the camshaft and the tappet causes wear on the camshaft surface . IH of the camshaft is required to improve wear resistance and service life, as well as core elasticity to absorb high torsional stresses. It is known that studies about IH on camshafts are still very limited. This study aims to determine the effect of the induction hardening and tempering treatment on the mechanical properties of the camshaft made of HQ 705 steel . The induction hardening carried out in this study uses different

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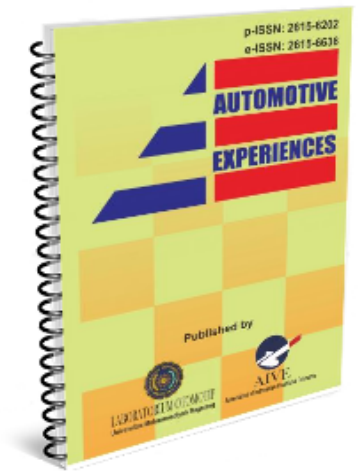

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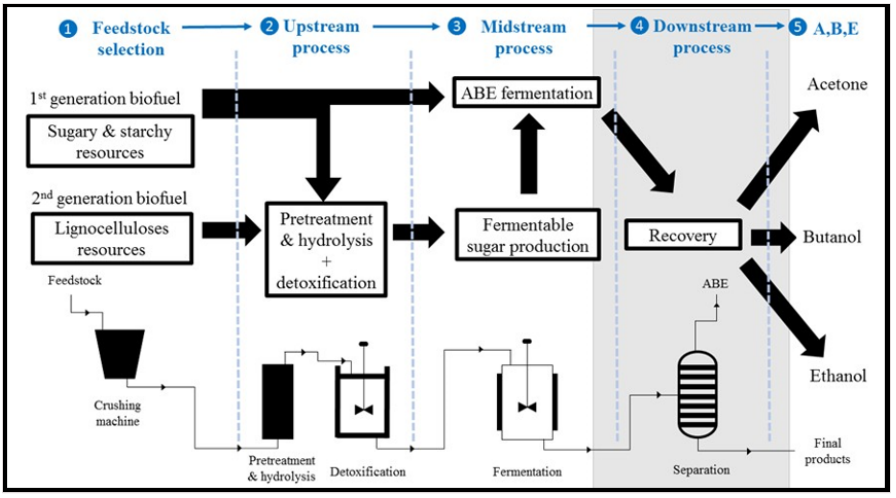

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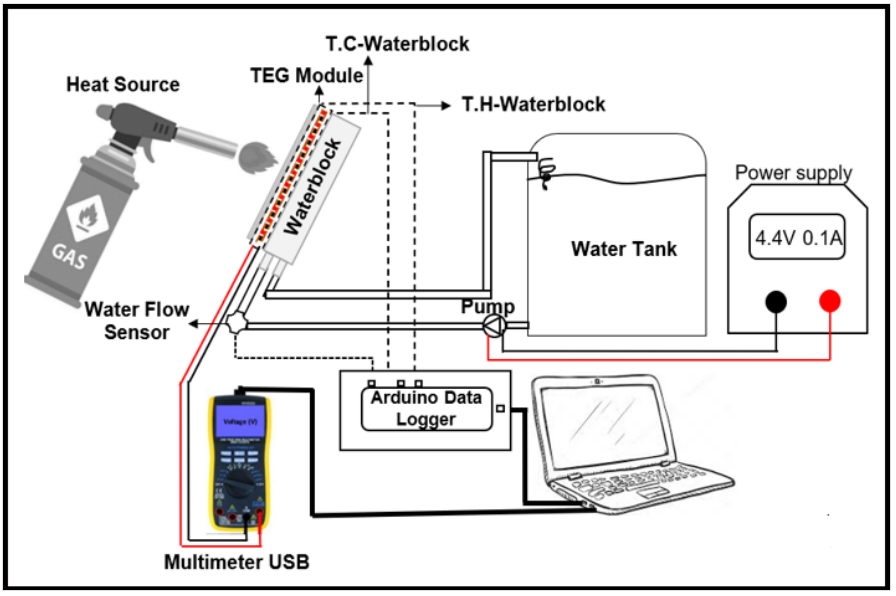

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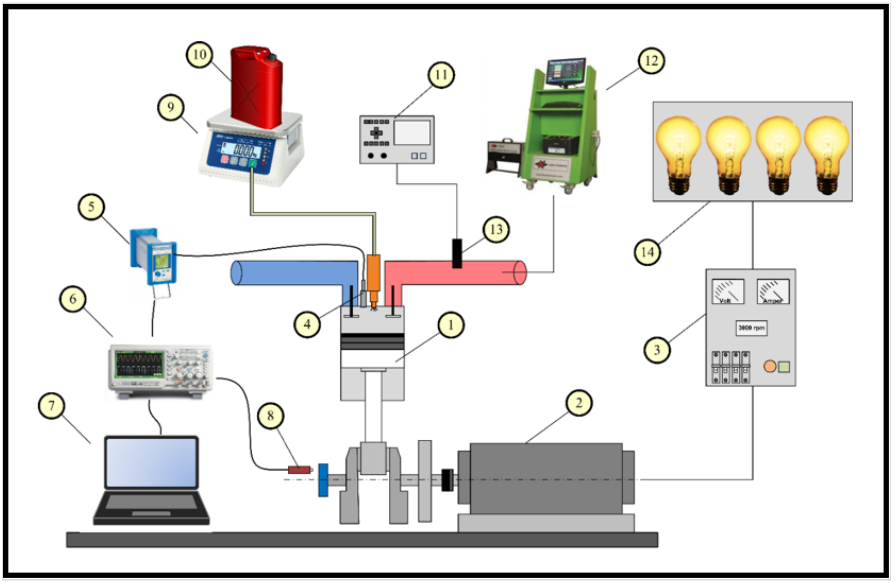

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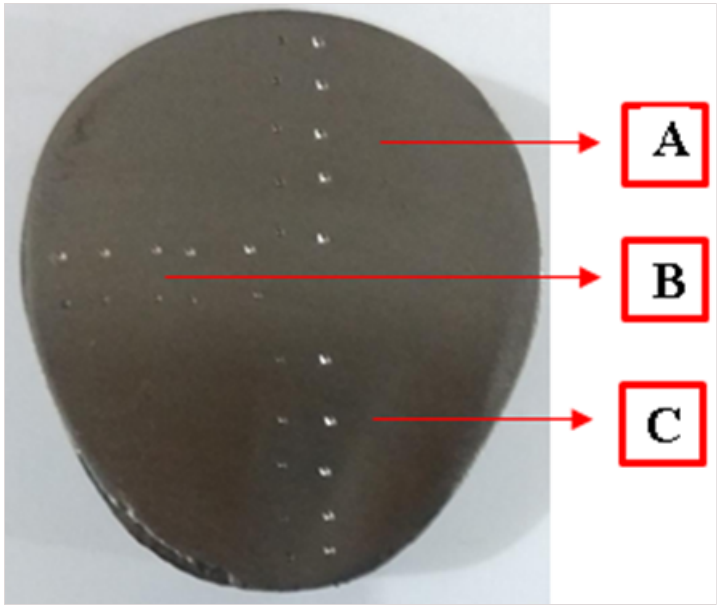

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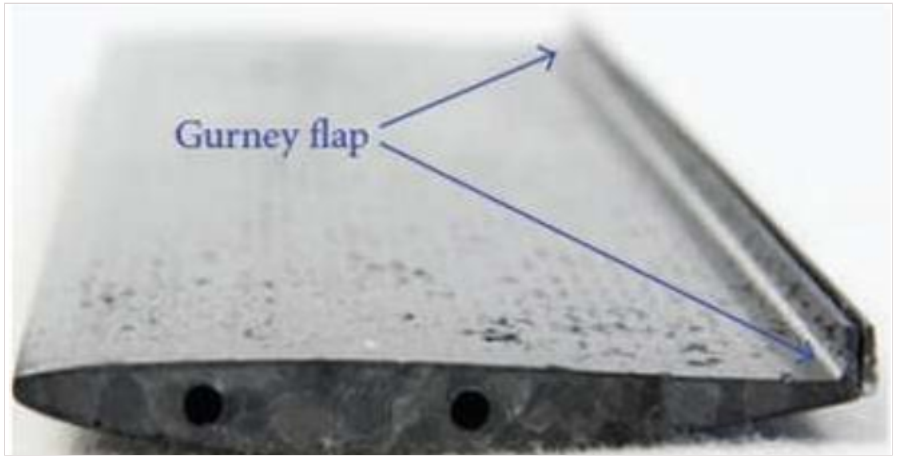

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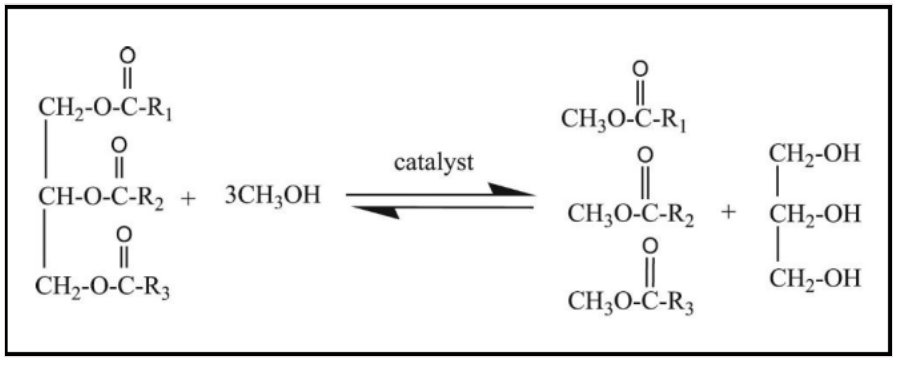

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Research Paper

The Effect of Surface Hardening on The HQ 705 Steel Camshaft Using Static Induction Hardening and Tempering Method

Sri Nugroho[1], **Deni Fajar Fitriyana**[2], **Rifky Ismail**[1], **Thesar Aditya Nurcholis**[1], **Tezara Cionita**[3], **Januar Parlaungan Siregar**[4]

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Abstract

Induction hardening (IH) is a popular choice for automotive components such as camshafts for its ability to harden portions of a component selectively. The camshaft will contact the tappet, connected to the rocker arm, to open and close the valve whenever the engine is running. This contact between the camshaft and the tappet causes wear on the camshaft surface. IH of the camshaft is required to improve wear resistance and service life, as well as core elasticity to absorb high torsional stresses. It is known that studies about IH on camshafts are still very limited. This study aims to determine the effect of the induction hardening and tempering treatment on the mechanical properties of the camshaft made of HQ 705 steel. The induction hardening carried out in this study uses different parameter settings such as heating time and output current. The camshaft specimen is hardened by static induction and then quenched in oil. The specimens are tempered after induction hardening with different temperatures and holding times to adjust the hardness level and reduce brittleness. Hardness, macro photographs, micrograph, and wear tests were conducted to determine the mechanical properties of the camshaft specimen after the induction hardening and tempering process. This study indicates that induction hardening with an output current of 747 A for 15 seconds followed by tempering at 150 °C for 15 seconds on specimen 1 produced the best mechanical properties. On the surface of these specimens found more martensite content while there was no microstructural change on the inside. The surface hardness of these specimens is 44 HRC (Rockwell C Hardness), while the inside is 26 HRC. Meanwhile, specific wear decreased by 45.45%.

Keywords: Surface hardening; Camshaft; Induction; Quenching; Tempering

1. Introduction

The overhead-valve train system in the diesel engine consists of a camshaft, tappet, pushrod, rocker arm, upper retainer, valve spring, fixed retainer, valve guide, valve, and valve seat [1]. The camshaft is used to open and close the intake and exhaust valves of the diesel engine at certain intervals. They work under high speed, variable load, and complex elastohydrodynamic lubrication conditions. The camshaft will be in direct contact with the tappet, connected to the pushrod and rocker arm to open and close the valve when the engine is running. This contact between the camshaft and the tappet causes

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Research Paper

The Effects of Canola Oil/Diesel Fuel/Ethanol/N-Butanol/Butyl Di Glycol Fuel Mixtures on Combustion, Exhaust Gas Emissions and Exergy Analysis

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Abstract

In recent years, there have been many studies on the widespread use of liquid fuels derived from biomass. A common emphasis in such studies is on fewer exhaust gas emissions and the expansion of renewable fuel production. Biodiesel is considered to be an important type of biomass fuel that is already produced commercially. But the production of biodiesel is laborious and comprises combination of several chemical processes. This study examines the effects of using oil used in biodiesel production with oxygen-rich chemicals on combustion (in-cylinder pressure (Cp), heat release rate (HRR), rate of pressure rise (RoPR), and cumulative heat release (CHR)), exhaust emission values, energy and exergy analysis. In this study, the effects of butyl di glycol use were also investigated and compared with commercially used ethanol and n-butanol. A transesterification method produced from canola oil the biodiesel used in the experiments. The experimental fuels were mixed volumetrically. For this purpose, experiments were carried out with canola biodiesel produced at 20% (D80B20) in diesel fuel and the results of the experiments were recorded. Under the same conditions, experiments were carried out by adding ethanol (D60C20E20), n-butanol (D60C20B20), butyl di glycol (D60C20G20) at a rate of 20% by volume to the canola oil added to the diesel fuel. The lowest values in terms of thermal and exergy efficiency were obtained in D60C20G20 fuel at all engine loads. Also, the highest entropy generation was calculated at all engine loads for this fuel blend.

Keywords: Biofuels; Biodiesel; Canola oil; Oxygenated fuels; Butyl di glycol; Energy and exergy

1. Introduction

The conventional fossil fuels, such as diesel and gasoline, have been used in internal combustion (IC) engines for more than a century [1], and their use is expected to continue even in 2040 [2],[3]. However, in addition to having limited lifetimes of fossil fuel sources, it pollutes the atmosphere and leads to serious environmental problems [4]–[6]. This situation has led most researchers to seek renewable and environmentally friendly alternative fuels. Biofuels such as alcohols and biodiesel are recommended as alternative fuel to internal combustion engines. Biodiesel, seen as a renewable fuel with the potential to help reduce exhaust emissions and total carbon dioxide (CO_2) emissions, can reduce net CO_2 emissions by 78% on a life-cycle basis compared to conventional diesel fuel [7]–[9].

Biodiesel is a renewable biofuel that can be produced from vegetable oil, waste vegetable oil, and animal fats [10]. Due to its good solubility with

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Review Paper

A Review of the Emission, Performance, Combustion, and Optimization Parameters in the Production of Biodiesel from Waste Cooking Oil

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Abstract

With the rising consumption of energy comes the challenge of the depletion of fossil fuels. Fossil fuels are non-renewable and finite energy sources with increasing energy demand as a result of the rise in human population and industrialization. This concern has led researchers to seek alternative energy sources that are both economically, technically viable, and environmentally beneficial. Biodiesel is considered an alternative source of energy supply. It is non-toxic, biodegradable, carbon-neutral, and ecologically friendly. However, the high cost of producing biodiesel from feedstocks impedes its commercialization. Hence, WCO used in the production of biodiesel helps to reduce the overall cost of production. The characteristics of the performance, emission, and combustion of the biodiesel produced from the transesterification of WCO are reviewed in this study. The molar ratio of methanol to oil, the concentration of the catalyst, reaction temperature, and time were used to investigate the optimization parameter required in the synthesis of biodiesel from WCO. The number of times the catalyst can be reused while maintaining a good catalytic activity in biodiesel production was also studied. The optimization models and techniques for the prediction of biodiesel yield were also studied.

Keywords: Waste cooking oil; Catalyst; Optimization parameter; Emission; Performance; Combustion characteristics

1. Introduction

The rapid rise of the human population, urbanization, industrialization, and transportation requirements have increased global energy demand. These energy demands and the rise in the global economy raise the concern of fossil fuel depletion [1]. The use of fossil fuels poses environmental risks such as greenhouse gas and pollution emissions [2]–[4]. These fossil fuels are finite, non-renewable, and with an increased cost have led researchers to an alternate energy source that is technically feasible, economically viable, and ecologically friendly. Biodiesel is a clean, safe, biodegradable, renewable, non-hazardous, carbon-neutral, and can be used as an alternative source of energy [5]. Biodiesel can be produced from either edible or non-edible feedstock. Examples of feedstock used in the production of biodiesel include karanja, palm, soybean, canola, sunflower, jatropha, rapeseed, etc [6]–[9]. Biodiesel can be produced via the transesterification process in which triglycerides from feedstocks react with alcohol in the presence of a catalyst [10]–[16]. Among the different types of alcohol used in the production of biodiesel, methanol is the most frequently used and it's specially selected because of the physical and chemical advantage it possesses. The scheme showing the transesterification of the triglycerides with methanol for the production of methyl esters is shown in **Figure 1** [17]. Biodiesel may also be used as a partial or complete replacement for diesel fuel in compression ignition engines for automotive locomotion or energy generation. The