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An overview of methanol as an internal combustion engine fuel

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ABSTRACT

Methanol is an alternative, renewable, environmentally and economically attractive fuel; it is considered to be one of the most favorable fuels for conventional fossil-based fuels. Methanol has been recently used as an alternative to conventional fuels for internal combustion (IC) engines in order to satisfy some environmental and economical concerns. Because of a number of relatively large research projects that have been ongoing recently, much progress has been made that is worth reporting. This paper systematically describes the methanol productions, including the productions from coal, natural gas, coke-oven gas, hydrogen, biomass etc. It introduces the potentials of methanol as a renewable resource taking into account the world supply and demand, economic benefits and the effects on human health and the environment. Thirteen methods of application such as methanol/gasoline, methanol/diesel blends which can be used on the IC engines are summarized. Finally, this paper puts forward some new suggestions on the weakness in the researches of methanol engine.

Contents

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1. Introduction

Nowadays, with reserves of these petroleum-based fuels being rapidly depleted, various alternative resources such as methanol, ethanol, or hydrogen are needed in order to replace the non-renewable resources [1]. With rising petroleum prices and global warming being a dominant environmental issue, it seems that the use of alternative fuels in the future is inevitable. Our present energy supply is based on the fossil fuels, which are non-renewable energy. Given the growing world population and atmospheric environment, increasing energy demand per capita and global warming, the need for a long-term alternative energy supply is clear. Methanol is one of the best candidates for long-term, widespread replacement of petroleum-based fuels [2]. Among renewable alternative energy sources, there are a lot of benefits to the development of alternative fuels such as alcohol fuels instead of the traditional nonrenewable oil resources, for instance, (1) it can mitigate national security and economic concerns over fuel supplies; (2) it can improve the atmospheric emissions; and (3) it can maintain the sustainable development of the resources [3]. Among gasoline and diesel replacement fuels, methanol (CH_3OH) fuel has been considered to be one of the most favorable fuels for IC engines [4,5].

Methanol is considered to be one of the most favorable fuels for engines, for instance, (1) it can be used in a high compression ratio spark ignition (SI) engine that could replace diesels in certain vocational applications; (2) it can be used in an inlet port injection SI engine; (3) it can be used in a high compression direct-injection stratified charge SI engine; (4) it can be used in a direct-injection SI engine; and (5) it can be used in a turbocharged, port-fuel-injected, high compression ratio medium duty engine [6–10].

The aim of this paper is to systematically review the methanol productions, including the productions from coal, natural gas, coke-oven gas, hydrogen and biomass etc., and to review the use of methanol as a fuel for IC engines. Finally, this paper puts forward some new suggestions in the researches of methanol engine.

2. Methanol production

Methanol synthesis has undergone continuous improvements for over nearly a century [11]. Nowadays, methanol as an alternative fuel can be produced from many ways, for instance, it can be produced from natural gas, biomass [12], or it can be produced based on coke oven gas [13], or it can be recovered through flashing vaporation in continuous production of biodiesel via supercritical methanol [14].

Among others, there are a lot of synthesis technologies, for instance, the advent of low-pressure synthesis, once-through designs, and advanced reforming technologies [11]. Nowadays, methanol is almost exclusively produced from synthesis gas [15,16], a raw material, consisting mainly of carbon monoxide (CO) and hydrogen, that is used in the large scale production of hydrogen and a wide variety of organic products in industry [17,18]. Methanol synthesis through syngas, which is a mixture of CO and hydrogen, involves the following chemical reactions [19,20]:

$$CO + 2H_2 \leftrightarrow CH_3OH \quad (1)$$

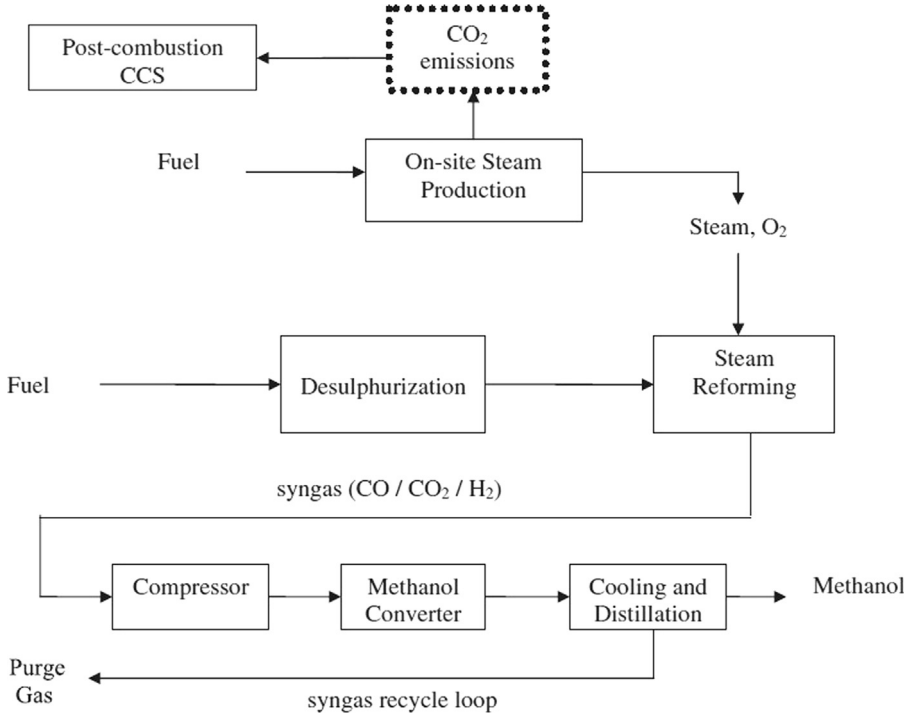

Fig. 1. The flowchart of the methanol synthesis process [19].