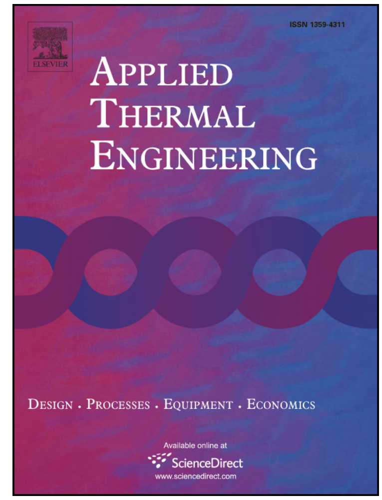

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Study on the steam-assisted Brayton air cycle for exhaust heat recovery of internal combustion engine

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Abstract: A steam-assisted Brayton air cycle (SBAC) is proposed for exhaust heat recovery (EHR) of internal combustion (IC) engine, which consists of a regenerated Brayton air cycle and an open Rankine steam cycle. The regenerated Brayton air cycle is coupled to IC engine exhaust pipe and used to directly recover IC engine exhaust heat. A steam generating plant is coupled to IC engine exhaust pipe behind the Brayton air cycle which uses IC engine exhaust heat to generate steam, and then the steam is injected into the power turbine of Brayton air cycle. In this way, the exhaust heat of IC engine can be recovered twice. The simulation model was built by using GT-Power and then the working processes of SBAC were investigated under IC engine full load. On this basis, the recovery potential of exhaust heat through this SBAC was revealed and the influence factors were analyzed. Results show that, EHR efficiency of this SBAC is determined by both the cycle parameters (such as pressure, temperature and flow rate of working medium air) and engine operating conditions. Under the fixed engine operating conditions, the maximum EHR efficiency first increases and then decreases with working pressure increasing. Since the effective working pressure, temperature as well as air flow rate of EHR system are influenced by IC engine speed, the maximum EHR efficiency increases with IC engine speed and comes up to 7.0% at 6000 r/min, which is obvious higher than the previous studies due to the complementary steam. The research results indicate that the proposed SBAC is an effective way for IC engine EHR.

Key words: IC engine; exhaust heat recovery; recovery efficiency; Brayton air cycle; Rankine cycle

1. Introduction

IC engine is the most widely used source of primary power for machinery critical to the transportation, construction and agriculture sectors. In China, the crude oil consumed by IC engine is approximate 66% of total consumption [1]. In terms of energy balance, shaft power output is only 30% to 45% of the heating value of diesel engine fuel and 20% to 30% for gasoline engine fuel [2-4]. It means that a large portion of thermal energy is lost to the environment through exhaust gas enthalpy and heat dissipation, outside of the 10% loss due to friction. Therefore, increasing total energy conversion efficiency by recovering part of waste heat energy is a very effective way to reduce IC engine fuel consumption. On the environmental front, the amount of CO_2 gas released from IC engines, just for transportation applications, makes up 25% of all human activity related CO_2 emissions [5]. For this reason, to reduce the

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