Available online at www.sciencedirect.com
SCIENCE DIRECT®
Applied Energy 81 (2005) 1–18
APPLIED ENERGY
www.elsevier.com/locate/apenergy

Energy-saving hybrid vehicle using a pneumatic-power system

K. David Huang [a], Sheng-Chung Tzeng [b,*], Wei-Chuan Chang [a]

[a] *Graduate School of the Vehicular Engineering, Dayeh University, Changhua, Taiwan 500, ROC*
[b] *Department of Mechanical Engineering, ChienKuo Technology University, Changhua, Taiwan 500, ROC*

Accepted 15 June 2004
Available online 21 December 2004

Abstract

The power system enables the internal-combustion engine to function at its optimal operating point without a complicated controller. The waste heat from the internal-combustion engine can be recycled and stored, then converted into mechanical energy, thereby raising the overall thermal efficiency of this system. A computer-aided simulation program is used to simulate the overall dynamic features of this hybrid pneumatic-power system, so as to demonstrate its desirable features.The overall efficiency of this system is expected to increase by about 20%.

Keywords: Hybrid vehicle; Pneumatic-power system; Flow work

1. Introduction

Today, the R&D activities focus on Zero-Pollution Vehicles and green engines, of which the electronic vehicle (EV) serves as a representative of Zero-Pollution Vehicles and the hybrid electronic-vehicle (HEV) or fuel cell as a representative using a

* Corresponding author. Tel.: +886-4-7111-111x3132; fax: +886-4-7357-193.
E-mail address: tsc@ckit.edu.tw (S.-C. Tzeng).

0306-2619/$ - see front matter
doi:10.1016/j.apenergy.2004.06.005

Nomenclature

h_1 inlet enthalpy
h_2 outlet enthalpy
h_a inlet enthalpy at compressor
h_c outlet enthalpy at compressor
h_e outlet enthalpy at internal-combustion engine
h_m enthalpy at inlet of pneumatic motor
h_o outlet enthalpy at one-way pressure valve
h_t outlet enthalpy at throttle
h'_a enthalpy at outlet of pneumatic motor
h'_e enthalpy at pressure release for mixer chamber
$\dot{m}$ air-mass flow rate
$\dot{m}_a$ air-mass flow rate at compressor inlet
$\dot{m}_c$ air-mass flow rate at compressor outlet
$\dot{m}_e$ air-mass flow rate at internal-combustion engine's outlet
$\dot{m}_m$ air-mass flow rate at pneumatic-motor's inlet
$\dot{m}_o$ air-mass flow rate through one-way pressure valve
$\dot{m}_t$ air-mass flow rate through throttle's outlet
$\dot{m}'_a$ air-mass flow rate through pneumatic-motor's outlet
$\dot{m}'_e$ air-mass flow rate at pressure release for mixer chamber
P_0 ambient pressure
q_{out} energy loss
s_0 ambient entropy
s_1 inlet entropy
s_2 entropy of storage tank
T_0 ambient temperature
u_0 ambient internal-energy
u_2 internal energy of storage tank
v_0 ambient specific-volume
v_2 specific volume of storage tank
W_{Torque} output work of internal-combustion engine
$\dot{W}_{comp,in}$ input power of compressor
$\dot{W}_{comp,in,real}$ power loss of compressor
W_{in} input work
$\dot{W}_{motor,out,real}$ real output-power of pneumatic motor
$\dot{W}_{motor,out}$ output power of pneumatic motor
W_{net} output work
ΔKe kinetic energy
ΔPe potential energy
$\eta_{airmotor}$ thermal efficiency of pneumatic motor
η_{comp} mechanical efficiency of compressor
$\eta_{compressor}$ thermal efficiency of compressor
η_{mixer} recycling thermal efficiency of the exhaust heat