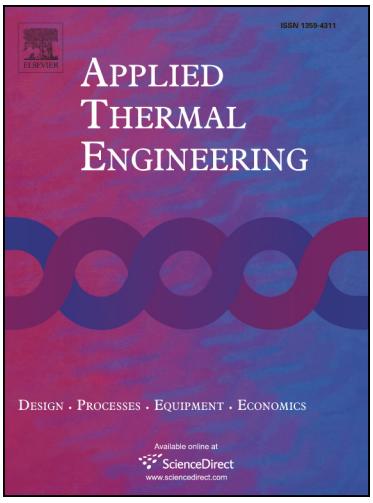

Research Paper

Investigation of Improvement of Desorption Efficiency Using Engine Cooling Water in Natural Gas Vehicle Tank

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Investigation of Improvement of Desorption Efficiency Using Engine Cooling Water in Natural Gas Vehicle Tank

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Abstract：In natural gas driven vehicles, the endothermic effect during the desorption process in the gas tank not only poses a great impact on the quantity and efficiency of desorption but also affects the vehicle speed and the maximal mileage seriously. To investigate the influence of the thermal effect, this paper firstly establishes a mathematical model for the desorption process based on the conservation equations of mass, momentum and energy, as well as the gas state equation and the adsorption isotherm equation. The solution results of the model show that the average adsorbents temperature in the tank reduces from 293.15K to 250.46K due to the endothermic effect. The desorption efficiency decreases by 24.29% compared with that of the isothermal desorption. To mitigate this effect, a heating jacket, which uses the engine cooling water to heat the gas storage tank, is proposed in this paper. The modeling result shows that when the tank is heated by engine cooling water, the average temperature of adsorbents is 273.44K, which is 26.88K higher than that in a natural process. When the vehicle speed is 100km/h, the natural gas mass released by the vehicle storage tank is 3.182kg, which is 1.163 times of that in the natural desorption.

Keywords: natural gas vehicle; desorption process; endothermic effect; numerical simulation

Nomenclature

B_w	—tank wall thickness (m)	C_{pa}	—specific heat of air (J/(kg·K))
C_{py}	—specific heat of water (J/(kg·K))	C_{pg}	—specific heat of gas (J/(kg·K))
C_{ps}	—specific heat of activated carbon (J/(kg·K))	C_{pw}	—specific heat of tank wall (J/(kg·K))
h_a	—convective heat transfer coefficient	k	—mass transfer coefficient (1/s)
$\dot{m}$	—outgassing rate per unit volume (g/(m^3·s))	L	—tank length (m)
$\dot{m}_o$	—mass flow of water (kg/s)	$m_{o,J}$	—fluid mass in the micro cylinder (kg)
M	—gas rate of car (g/s)	M_g	—molar mass of natural gas (g/mol)
n	—coefficient	P	—pressure inside the tank (Pa)
P_E	—gas source pressure (Pa)	P_I	—initial pressure inside the tank;
$Q_{o,J}$	—convective heat transfer power of liquid	q*	— immediate adsorption capacity (kg/kg)
q_{eq}	—equilibrium adsorption amounts (kg/kg)	q_m	—saturated adsorption capacity (kg/kg)