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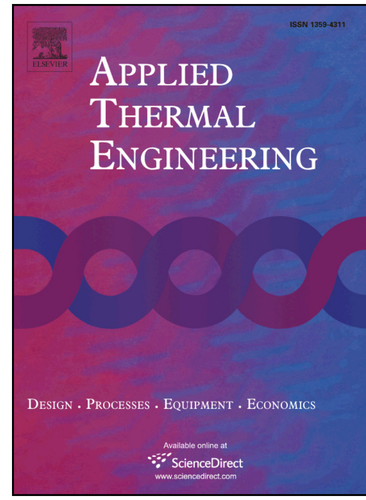

Research Paper

Effect of Geometry and Speed on the Temperatures Estimated by CFD for an Isothermal Model of a Gamma Configuration Low Temperature Differential Stirling Engine with Flat-shaped Heat Exchangers

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Title

Effect of Geometry and Speed on the Temperatures Estimated by CFD for an Isothermal Model of a Gamma Configuration Low Temperature Differential Stirling Engine with Flat-shaped Heat Exchangers

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ABSTRACT

In the temperature distribution in a hot-side displacer chamber of a low temperature differential Stirling engine, a relation between the inlet temperature, average temperature and heat exchanger temperature is calculated by CFD and is expressed by the ratio of temperatures. The parameters of the CFD are the inlet velocity; the sizes of the inlet, heat exchanger and displacer; the positions of the inlet, heat exchanger and displacer chamber wall; and the temperatures of the inlet and heat exchanger. The calculation result and the estimated regenerator efficiency produce the temperature difference in the working fluid, which can be utilized for isothermal model analysis. In the Schmidt cycle, only a phase angle and the dimensionless value introduced here dominate the shape of the *P*-*V* diagram. The maximum fluctuation of the ensemble averaged working fluid temperatures (MFEAWFTs) is utilized to evaluate a *P*-*V* diagram. When the analyses are compared with experimental results, estimated MFEAWFTs are approximately 80 % of the experimental results. In comparing the calculation results, a higher engine speed causes a lower average temperature on the hot side of a displacer chamber and the larger indicated power. A wider inlet reduces the difference between inlet temperature and average temperature. The longer stroke of displacer motion makes the indicated work larger to some extent.

Keywords:
Low temperature differential Stirling engine; Temperature distribution; Indicated work; Isothermal model; Schmidt cycle; Regenerator

Nomenclature

a:	Number used when an indicated work is calculated in the Schmidt analysis
b:	Number used when an indicated work is calculated in the Schmidt analysis
A_D:	Cross-sectional area of the displacer chamber [m^2]
A_p:	Cross-sectional area of the piston [m^2]
A_{pp}:	Cross-sectional area of the piston in regenerator evaluation equipment [m^2]
A_r:	Surface area of the regenerator [m^2]
C:	Specific heat [J/(kg·K)]
C_i:	Coefficient, where i is 1, 2, 3, μ, a, b or c
d:	Gap between displacer and displacer chamber wall [m]
d_i:	Exponent, where i is an integer [-]
E_{tu}:	Number of heat transfer units [-]
f:	Estimated engine speed [Hz]
F_i:	Force, where i is B, F, p [N]
g:	Acceleration of gravity [m/s^2]
h:	Ratio of temperature differences
	Thickness of displacer [m]
h_C, h_H :	Ratio of temperature differences
k:	Turbulent kinetic energy
L:	Circumference of displacer [m]
	Length of connecting rod [m]
L_{ij}:	Length of link, where i and j are alphabet [m]
m:	Mass of working fluid [kg]
p_i:	Pressure, where i is 1, 2 or 3 [Pa]
P:	Pressure [Pa]
Q:	Volumetric flow rate of working fluid [m^3/s]