RESEARCH ON TRANSIENT RESPONSE CHARACTER ANALYSIS OF ORC WASTE HEAT RECOVERY SYSTEM FOR MARINE DIESEL ENGINE

Jiangnan Liu*, Zijian Zhang, Jingfen Li, Zhichao Gu, Jinyong Feng

中国船舶重工集团公司第七一一研究所
SHANGHAI MARINE DIESEL ENGINE RESEARCH INSTITUTE

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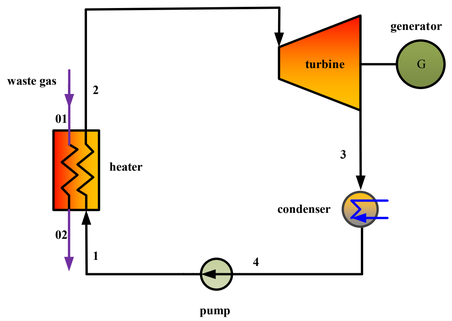
ABSTRACT

The ORC waste heat recovery system for marine diesel engine influenced by internal and external disturb. The transient response character effected by factors such as thermal inertia, evaporating pressure and evaporating temperature at multi time scale were analyzed. Results show: the higher the load of the diesel engine, the more stable of the energy generated; the larger the thermal inertia, the dully system response.

SYSTEM DESCRIPTION



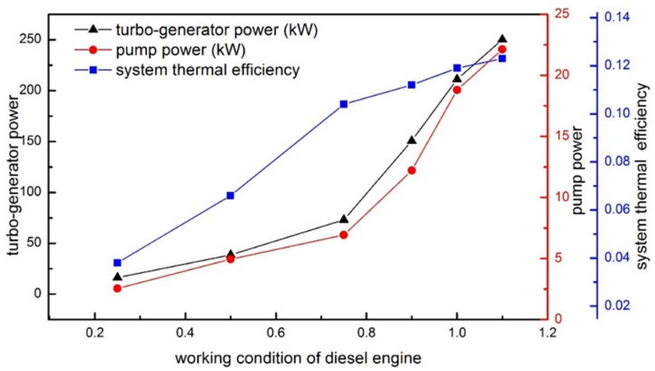
Diesel engine working condition	25%	50%	75%	90%	100%	110%
Temperature(℃)	200	208	215	248	268	295
Mass flow(kg/s)	6.55	10.39	14.67	15.64	17.15	18.04

parameters	unit	number
Turbine Isentropic efficiency	-	0.75
Turbine mechanical efficiency	-	0.95
Generator efficiency	-	0.98
Cooling water temperature	℃	28
Pump Isentropic efficiency	-	0.6
Pump mechanical efficiency	-	0.95
Heat exchanger node temperature difference	℃	5
Heat exchanger pressure loss	-	3%

WORKING FLUID CHARACTERISTICS

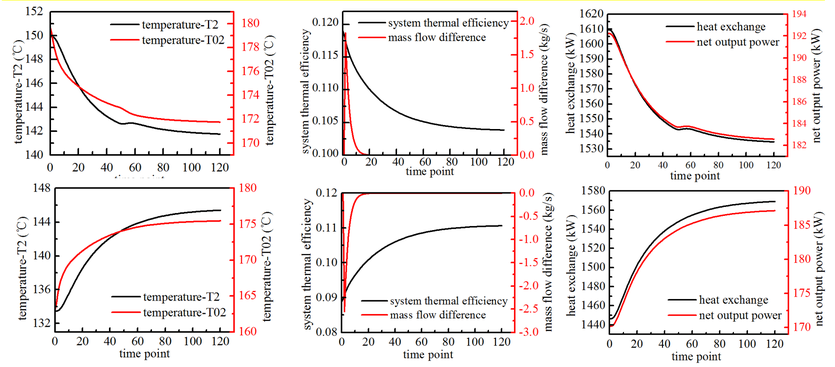
Parameter name/unit	value
Chemical formula	$CHF_2CH_2CF_3$
Critical temperature/℃	154.01
Critical pressure/MPa	3.651
Molecular weight/kg·kmol^{-1}	134.05
Critical density/kg·m^{-3}	516.08
Normal boiling point/℃	15.14
Maximum temperature/℃	166.85
Maximum pressure /MPa	200
ODP	0
GWP/100years	950

Energy recycle of diesel engine in variable load operation

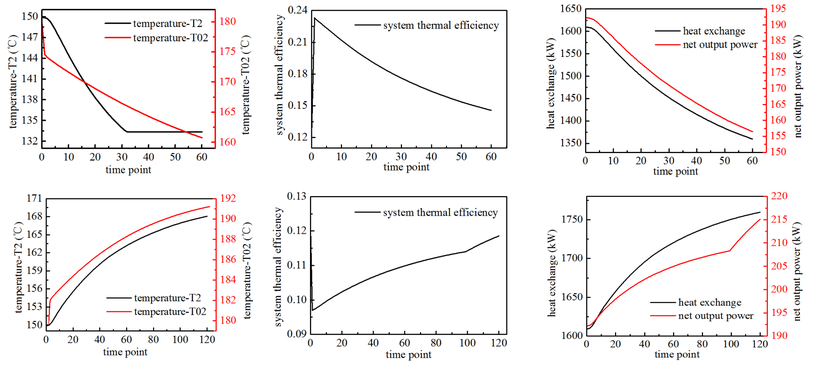


The working condition differs causing different system which are shown in Figure 2.

EFFECT OF THERMAL INERTIA



The heat flux decreases from 17.15kg/s to 15kg/s, and increases from 13kg/s to 16kg/s, as shown in Figure above, which shows the changing trend of system performance with the increase of heat source flow. The flue gas side changes directly, while the working fluid side has a certain delay.



When the temperature of heat source decreases from 268℃ to220 ℃, or increases from 268℃ to 290℃, the system behave is simulated: the working fluid side has been reduced to boiling point, resulting in the existence of gas-liquid two-phase at the outlet of the evaporator, which is disadvantage to the turbine equipment.

CONCLUSION

Under the condition of low load, the waste heat recovery system should be cut out. While when the load used under 75% or more the system can maintain an accepteable thermal efficiency and power output.

When the parameters of the exhausted gas are changed, due to the existence of thermal inertia, the working fluid side has a certain delay, we should pay attention to adjusting other relevant parameters in time during the system response, so as to prevent working fluid deterioration or equipment damage.