Design of Supercritical CO2 Waste Heat Recovery System for Shipboard Application

Yoonhan Ahn (KAERI), Han Seo (KAERI), Jae Eun Cha (KAERI), Heung June Chung (KAERI)

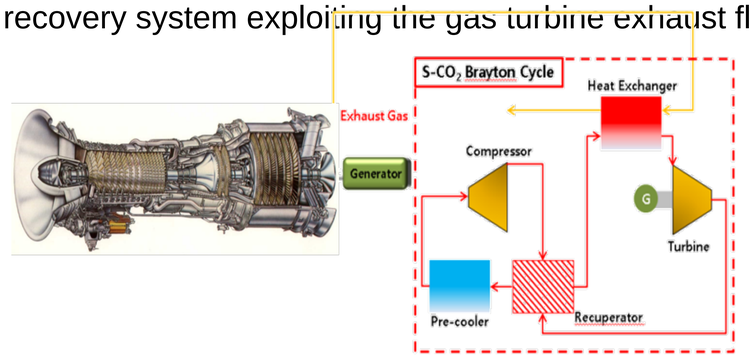
Supercritical CO_2 Power Cycles Symposium

SwRI

▣ Supercritical CO_2 cycle is gaining interests for the promising power conversion system for the various heat source applications.

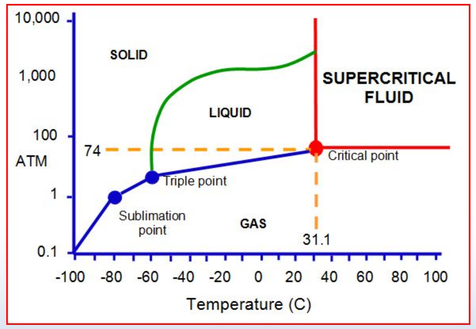
▣ The benefits of supercritical CO_2 cycle are theoretical high efficiency in the mild turbine inlet temperature range (450 – 650 ℃), simple configuration and small footprint incorporated with compact components.

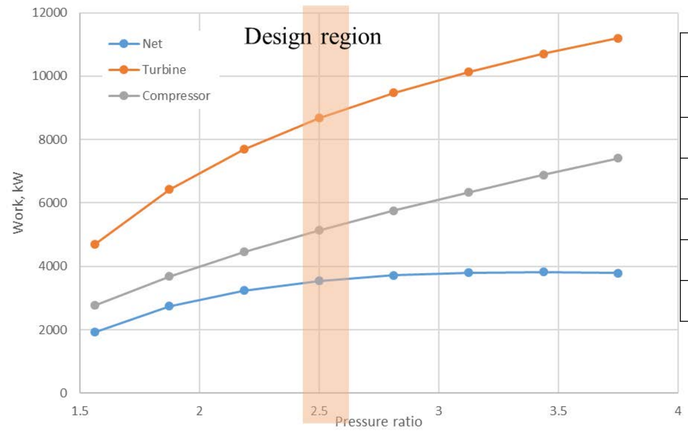
▣ Korea Atomic Energy Research Institute (KAERI) designs supercritical CO_2 heat recovery system exploiting the gas turbine exhaust flow.



Gas turbine system			Supercritical CO_2 system		
Gas Turbine (GT) power	MW	25	Turbine efficiency	%	80
GT exhaust temperature	℃	566	Compressor efficiency	%	70
GT exhaust flow rate	kg/s	70.5	Waste heat exchanger pinch point	℃	50
N_2, 74.9, O_2, 13.7, Ar, 0.8, CO_2, 3.3, H_2O, 7.3 (in % GT exhaust composition)			Recuperator effectiveness	%	80
			Heat exchanger pressure drop	%	1

Fluid	Critical Temperature, ℃	Critical Pressure, MPa
NH_3	132.9	11.28
CO_2	31.0	7.38
R134a	101.1	4.06
SO_2	157.5	7.88
SF_6	45.6	3.76
H_2O	373.9	22.10
Xe	16.6	5.88
He	-268.0	0.23
Air	-140.6	3.79





Heat from GT exhaust	MW	21.0
Recuperated heat	MW	27.5
Turbine (TB) work	MW	7.4
Compressor work	MW	2.6
Thermal efficiency	%	16.7
CO_2 flow rate	kg/s	89.0
TB inlet temperature	℃	34

Fig. Thermal work from the GT exhaust depending on the pressure ratio

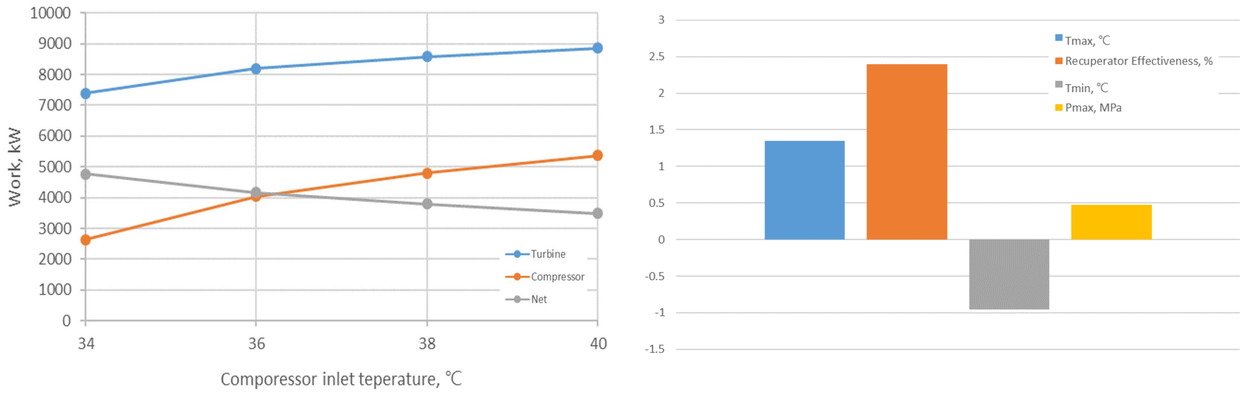


Fig. Thermal work from the GT exhaust depending on the pressure ratio

Summary and Future work

▣ Preliminary design of supercritical CO_2 system for exhaust heat application was studied. The simple recuperated layout was considered and 16.7% marginal power can be expected through heat recovery system.

▣ Several design parameters of the system are compared for 1% power increase. Compressor inlet temperature is the most sensitive. The compressor demonstration under the criticial condition is essential for the supercritical CO_2 technology.