



Supercritical carbon dioxide cycles for power generation: A review



Francesco Crespi^a, Giacomo Gavagnin^a, David Sánchez^{a,*}, Gonzalo S. Martínez^b

^aDepartment of Energy Engineering, University of Seville, Camino de los descubrimientos s/n, 41092 Seville, Spain

^bAICIA, Camino de los descubrimientos s/n, 41092 Seville, Spain

HIGHLIGHTS

- Over one hundred and fifty references, one third of which from the last three years.
- Cycles are classified into categories according to common features.
- Forty-two categories for stand-alone cycles and thirty-eight for combined layouts.
- Stand-alone (simple) cycles in literature show dispersion of up to 30%.
- Stand-alone (simple) cycles in literature show dispersion of up to 50%.

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ABSTRACT

Power cycles running on carbon dioxide at supercritical pressure and temperature were introduced in the late ninety-sixties but, after a warm welcome to the theoretical performance announced, they were later abandoned in favour of standard combustion gas turbines. Nevertheless, the technology was brought forward about a decade ago and has since captured significant attention from the scientific and industrial community. The number of publications has risen exponentially and there are several experimental projects under development today. The performances of these cycles have been deeply analysed in literature, proving to be theoretically competitive.

This paper reviews all the works published in the topic to date. Different cycle concepts (stand-alone and in combination with other cycles using the same or different technologies), layouts, fuels, applications (power only or combined heat and power) and operating conditions are reviewed and categorised according to the configuration of the cycle. This latter feature is thought to be an interesting added value of this paper since, rather than just listing the past work in the area of sCO₂ power cycles, it also organises the numerous cycles in different categories and provides a comparison of the claimed performance of each one of them.

This comparison between the performances of the various configurations is based on the values declared in the original papers and thus applies to very different boundary conditions. Obviously, this great heterogeneity of the available data (in particular the temperatures and pressures considered) makes it impossible to establish a fair comparison between the configurations reviewed. Therefore, a future study seems to be mandatory where the performances of all cycles should be compared for the same set of operating conditions.

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* Corresponding author.

E-mail addresses: crespi@us.es (F. Crespi), gavagnin@us.es (G. Gavagnin), ds@us.es (D. Sánchez), gsm@us.es (G.S. Martínez).

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Nomenclature

η_{th}	thermal efficiency	Recompr.	Recompression
ASME	American Society of Mechanical Engineers	RH	Reheated Expansion process
Bott.	Bottoming	sCO ₂	Supercritical Carbon Dioxide
CSP	Concentrated Solar Power	SFC	Split-flow before Compression process
GT	Gas Turbine	SFE	Split-flow before Expansion process
IC	Intercooled Compression process	SFH	Split-flow before Heating process
KAERI	Korea Atomic Energy Research Institute	SFHE	Split-flow before Heating and Expansion process
KAIST	Korea Advanced Institute of Science and Technology	ST	Steam Turbine
LNG	Liquified natural gas	SwRI	Southwest Research Institute
MCFC	Molten Carbonate Fuel Cell	TEES	Thermo-Electric Energy Storage
n.d.	not declared	TES	Thermal Energy Storage
Nes.	Nested	TIT	Turbine Inlet Temperature
ORC	Organic Rankine Cycle	Topp.	Topping
Preh.	Preheating	w/	with
R	Regeneration process	WHR	Waste Heat Recovery
R134-a	Haloalkane Refrigerant, Norflurane		

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