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WASTE HEAT USED IN THERMAL POWER PLANT

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ABSTRACT

The supercritical CO2 Rankin Cycle uses waste carbon dioxide instead of water/steam in its driven cycle and converts the waste heat in electricity for various industries and scale power generation.

While thermoelectric system are solid state electricity converts combination of thermal, electrical and semiconducting properties which allow them to convert waste heat into electricity.

The electricity can be used in two phase air-conditioning compressor, heat pump or in any small industries.

Keywords: (Sco2), Thermal Electric System, Power Generation

I. INTRODUCTION

1.1 The Supercritical CO2-Based Power Cycle:

The supercritical carbon dioxide (sCO2) used in thermal efficient heat engineand patent-pending operating cycles to deliver a flexible, low-cost thermal engine for a wide variety of applications.

The five main components in sCO2 heat engines: exhaust and recuperator, condenser, heat exchangers, system pump, and power turbine.Heat energy is introduced to the sCO2 power cycle through an exhaust heat exchanger installed into the exhaust stack from a gas turbine or reciprocating engine or into a flue gas stream from a fuel-fired industrial process.

Echogen’s cost-effective, emission-free power will enable fuel intensive operations to address growing concerns regarding power cost and environmental stewardship.Echogen’s technology recycles the wasted thermal energy and provides integrated power and heating or cooling with flexible system architectures, configurable for power, co-generation or tri-generation.

Supercritical CO2 (sCO2) is an ideal working fluid for closed-loop power generation applications and It is a low-cost fluid that is non-toxic and non-flammable.The exhaust heat exchanger can be placed in direct contact with-high temperature heat sources, eliminating the cost and complexity of an intermediate heat transfer loop typically used in Organic Rankine Cycle (ORC) applications because of its high thermal stability and non-flamability**.**

1.2 Thermoelectrics as Heat Engines

TE devices are solid-state heat engines. Unliketoday’s air conditioners, which use two-phasefluids such as the standard refrigerant R-134A,TE devices use electrons as their working fluid.Figure 1 demonstrates the principal effects that govern their performance. In 1834, Peltier observed that if a current is

applied across a junction of dissimilar electrically conductive materials, either heating or cooling can occur at the junction. When the current is reversed, the opposite effect is observed. Figure 1A illustrates why this occurs.

Electric current is propagated by electrons in n-type materials and by holes (traveling in the opposite direction) in p-type materials, be they semiconductors,metals, or semimetals. If voltage is applied in the right direction across a p-n junction, electron/hole pairs are created in the vicinity of the junction. Electrons will flow away from the junction in the n-type material, and holes will flow away in the p-type material. The energy to form them comes from the junction region, cooling it. On the opposite end, electrons and holes stream toward junctions where pairs recombine. This process releases energy and heats the junctions. At the bottom of Fig. 1 is a typical TE module, configured so that all junctions on one side heat and those on the other side cool.

In 1821, Seebeck noticed that the needle of a magnet is deflected in the presence of dissimilar metals that are connected (electrically in series and thermally in parallel) and exposed to a temperature gradient. The effect he observed is the basis for TE power generation. As shown in Fig. 1B, if the junctions at the top are heated and those at the bottom are cooled (producing a temperature differential), electron/hole pairs will be created at the hot end and absorb heat in the process. The pairs recombine and reject heat at the cold ends. A voltage potential, the Seebeck voltage, which drives the hole/electron flow, is created by the temperature difference between the hot and cold ends of the TE elements. The net voltage appears across the bottom of the TE element legs. The Seebeck effect forms the basis of the operation of TE couples (thermocouples) used extensively in temperature-measurement systems. Electrical connections can be made from the TEs to an external load to extract power. In order for this process to be efficient, it is necessary to find materials that are good electric conductors, otherwise electron scattering generates heat on both sides of the barrier and throughout the materials. Also, the materials must be poor thermal conductors, otherwise the temperature difference that must be maintained between the hot and cold sides will produce large heat backflow. Similarly, the Seebeck effect should be maximized. Optimization of these three parameters is compromised because all three are affected by the electronic properties of the materials. Because

the working fluid (electrons) conducts unwanted heat as well as electric current, and the Seebeck effect decreases as the electrical conductivity increases, it is necessary to optimize these properties simultaneously (1). The highest performance is achievedwith heavily doped semiconductors, such as bismuth telluride or silicon germanium. Finally, for semiconductors, it is desirable to have a base material that can be both p- and n-type–doped, so that the same material system can be used on both sides of the junctions. It is useful to compare the electrical current as a working fluid with the gas/liquid two-phase fluids in conventional air conditioners. The key difference that allows a refrigeration system in a building to achieve up to 60% of the maximum theoretical efficiency (as compared with 12% for TEs to date) is that cooling and heat-rejection components can be physically well separated, and large temperature differences do not lead to the high heat backflow that penalizes efficiency in TE systems.

II. TABLE

2.1 Reciprocating Genset Operating Characteristics:

Genset Unit No.	Nameplate Rating (kWe)	Capacity Factor (%)	Capacity Factor Profile				Exhaust Gas Temperature (ºF)	Exhaust Gas Mass Flow Rate (lb/h)
			1Q	**2Q**	**3Q**	**4Q**		
1	1,050	75	off	on	on	on	763	14,500
2	1,050	75	off	on	on	on	763	14,500
3	1,050	75	on	on	on	off	763	14,500
4	1,050	75	on	on	on	off	763	14,500
5	1,135	75	off	on	on	on	794	18,000
6	1,135	75	on	on	on	off	794	18,000

Notes:

1) Units 1, 2 and 5 operate on the same capacity factor schedule to provide 3.2 MWebaseload.

2) Units 3, 4 and 6 operate on the same capacity factor schedule to provide 3.2 MWebaseload.

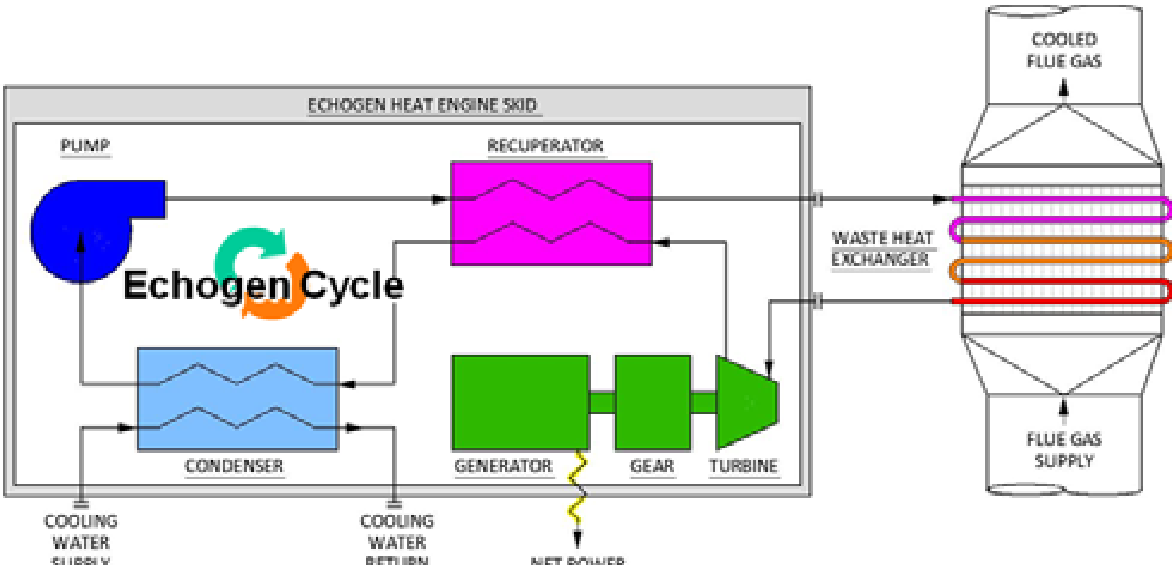
3) Quarters 2 and 3 (Apr - Sep) is peak power season to support local fishing and canning industry. All units operating provide 6.5 MWe seasonal baseload.

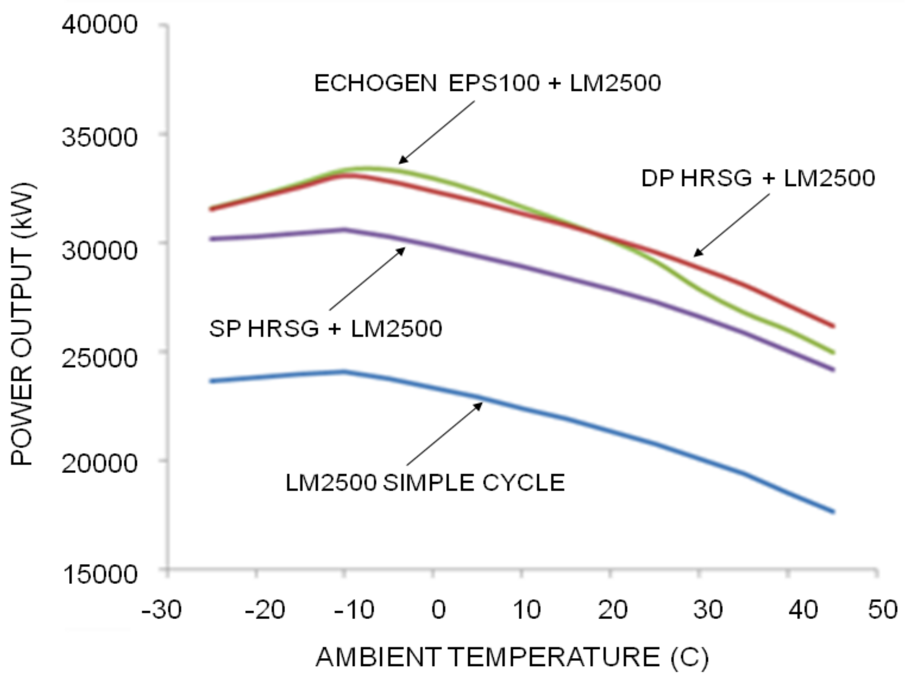
2.2 Waste Heat to Power Analysis for Each Reciprocating Genset:

Genset Unit No.	Nameplate Rating (kWe)	Generated Power by Operating Quarter (kWe)				Net Power Recovered Per Unit (kWe)	Total Recovered Power by Operating Quarter (kWe)			
		1Q	**2Q**	**3Q**	**4Q**		**1Q**	**2Q**	**3Q**	**4Q**
1	1,050	**--**	1,050	1,050	1,050	93	--	93	93	93
2	1,050	--	1,050	1,050	1,050	93	--	93	93	93
3	1,050	1,050	1,050	1,050	--	93	93	93	93	--
4	1,050	1,050	1,050	1,050	--	93	93	93	93	--
5	1,135	--	1,135	1,135	1,135	124	--	124	124	124
6	1,135	1,135	1,135	1,135	--	124	124	124	124	--
Total Generated Power by Operating Quarter (kWe):		**3,235**	**6,470**	**6,470**	**3,235**					
Total Recovered Power by Operating Quarter (kWe):							**310**	**620**	**620**	**310**

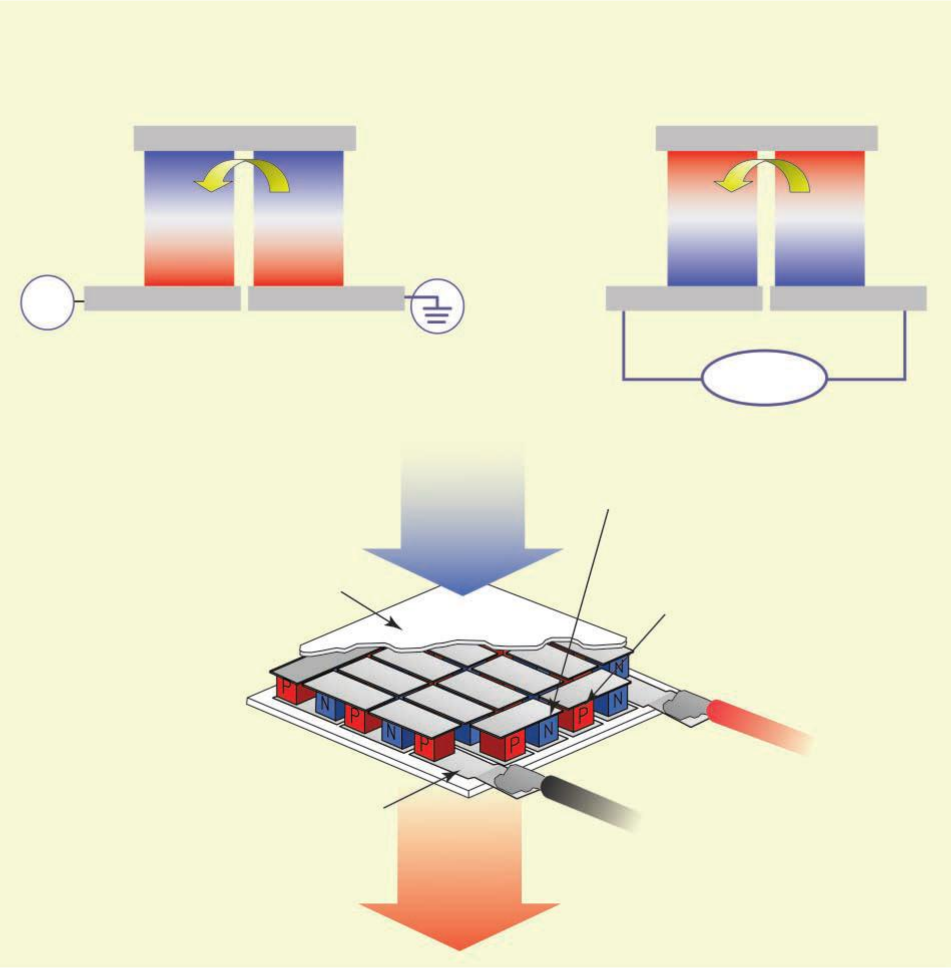
III. FIGURE

3.1 The supercritical CO2 power cycle:





3.2 Te Heat Engines



IV. CONCLUSION

We conclude that heat energy is reused by thermalelectric system and supercritical CO2 rankine cycle. If we used the thermal electric system power generation is increases. Supercritical CO2 system are used for scale power generation.

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