Helium reverse brayton cycle

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Unit system: C5

Thermodynamic Package: NRTL is chosen to describe vapor-liquid equilibrium

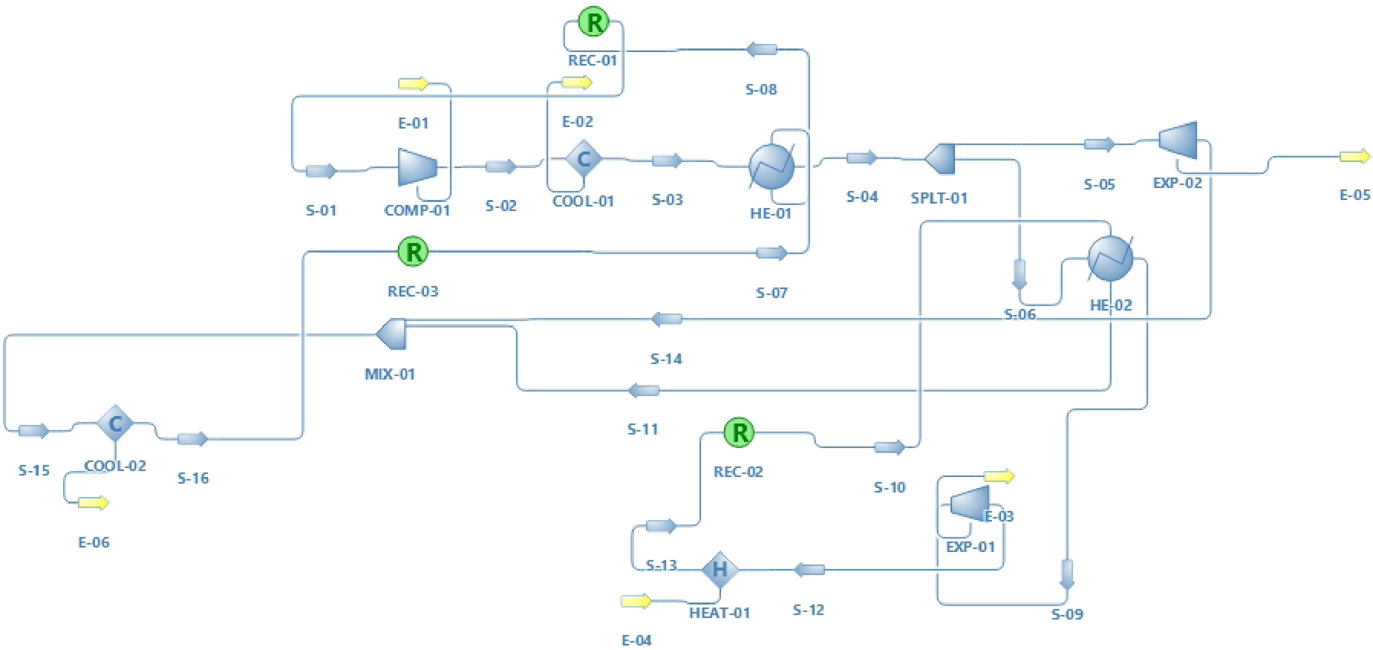
Background:

A Brayton cycle that operates in the reverse direction is known as the reverse Brayton cycle. The sole purpose is to move heat from the colder to the hotter body rather than produce work. Heat can flow from insensitive to the more desirable body, but only when forced by superficial work. This is precisely what refrigerators and heat pumps accomplish. It is also known as the gas refrigeration cycle, the Bell Coleman cycle, and the Brayton refrigeration cycle. This cycle is widely used in jet aircraft for air conditioning systems using air from the engine compressors. It is also commonly used in the LNG industry. The reverse Brayton cycle can also be used for cryogenic applications.
The ideal reverse Brayton cycle consists of four processes:
1. Isentropic compression in a compressor
2. Reversible, isobaric heat rejection in a heat exchanger
3. Isentropic expansion in a turbine
4. Reversible, isobaric heat absorption in a heat exchanger

An actual reverse Brayton cycle undergoes non-isentropic expansion and compression due to irreversibilities and pressure drop in the heat exchanger.

Description:

Here, in the below flowsheet, Helium is used as the working fluid. 1 Kmol/hr of Helium enters the compressor in S-01 at 20°C and 5 bar. It is then compressed to a pressure of 20 bar, and the temperature rises to 309.937°C. Then, this stream S-02 passed through a cooler to reduce its temperature to 30°C. S-03 passes through a heat exchanger 1 to reduce its temperature to -160°C. Then, the stream gets split to S-05 and S-06. S-05 passes through the turbine to reduce its pressure from 20bar to 5 bar. At the same time, S-06 passes through a heat exchanger 2 to reduce its temperature from -160°C to -248.49°C. At the same time, the temperature of S-10 increases from -253.15°C to -164.075°C. S-06, whose temperature reduces after passing through a heat exchanger-02, passes through a turbine to undergo expansion to a pressure of 5 bar. S-11 and S-14 passes through the mixer, and mixed stream (S-15) gets cooled to -170°C in S-16 and enters heat exchanger 1 to reduce the temperature of S-03; during this process, the temperature of S-16 increases from -170 to 20°C, which enters the compressor in S-01



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Results:

Master Property Table									
Object	**S-08**	**S-07**	**S-06**	**S-05**	**S-04**	**S-03**	**S-02**	**S-01**	
Temperature	20.0593	-170	-160	-160	-160	30	309.937	20.0593	**C**
Pressure	5	5	20	20	20	20	20	5	**bar**
Molar Flow	1	1	0.88	0.12	1	1	1	1	**kmol/h**
Molar Fraction (Mixture) / Helium-4	1	1	1	1	1	1	1	1	
Molar Flow (Mixture) / Helium-4	1	1	0.88	0.12	1	1	1	1	**kmol/h**

Master Property Table									
Object	**S-16**	**S-15**	**S-14**	**S-13**	**S-12**	**S-11**	**S-10**	**S-09**	
Temperature	-170	-167.913	-196.047	-253.15	-256.551	-164.075	-253.15	-248.49	**C**
Pressure	5	5	5	5	5	5	5	20	**bar**
Molar Flow	1	1	0.12	0.88	0.88	0.88	0.88	0.88	**kmol/h**
Molar Fraction (Mixture) / Helium-4	1	1	1	1	1	1	1	1	
Molar Flow (Mixture) / Helium-4	1	1	0.12	0.88	0.88	0.88	0.88	0.88	**kmol/h**