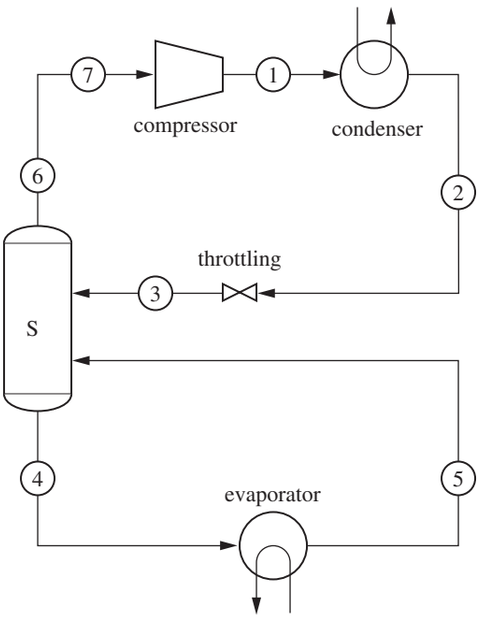

Figure 6-21: Process flow diagram for problem 6.38.

Problem 6.39: Natural gas, which you may take to be pure methane, is liquefied in the Claude process shown in Figure 6-22. The process operates between a high pressure of 30 bar and a low pressure of 1 bar. The inlet stream is at 1 bar, 20 °C, compression is to 30 bar, ~~stream 14 is at 10 °C~~, the precooler uses water to cool the stream 13 is at 3 °C

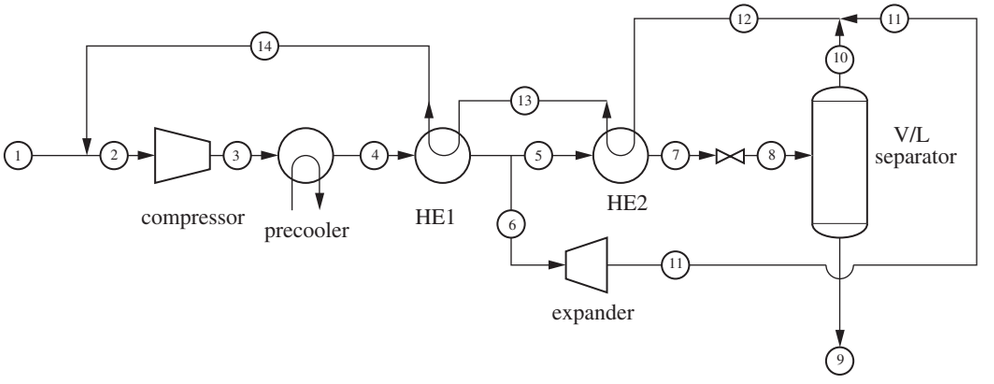

Figure 6-22: Process flow diagram for problem 6.39.

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compressed gas to 30 °C, streams 5 and 6 are at 8 °C, and the mass flow rate in stream 2 is ~~10~~ times larger than $\dot{m}_1$. The efficiency of the compressor and the turbine is 85%. Determine the mass, energy, and entropy balances on the basis of 1 kg of liquified natural gas, and report the actual and ideal work. Discuss the features of this process compared to the Linde process.

Problem 6.40: Design a Linde process to liquefy oxygen. Pure oxygen is supplied at 1 bar, 25 °C and liquid oxygen is received at 1 bar. The fluid is compressed to 150 bar in a series of compressors whose efficiency is 80%. Precooling is done by water at 20 °C. Compression in done in stages with intercooling, to maximum temperature of 200 °C. Perform the energy balance and a second-law analysis of the process.

Problem 6.41: Oxygen is compressed from 1 bar, 25 °C, to 150 bar. To avoid overheating, compression is done in stages followed by intercooling with water at 30 °C so that the temperature exiting each stage of the compressor does not exceed 200 °C. Using data from the NIST WebBook, determine the number of stages, the work in each stage, and the amount of cooling, if the efficiency of all stages is 80%.

Problem 6.42: A 3 m^3 insulated tank contains steam at 1 bar, 150 °C. The tank is connected to a steam line that is maintained at 10 bar, 300 °C until the pressure in the tank is 5 bar. How much steam (kg) was transferred into the tank and what is the final temperature in the tank?

Problem 6.43: A 5 m^3 insulated tank contains steam at 10 bar, 200 °C. Three kilograms of steam is removed by venting to the atmosphere (1 bar, 20 °C). What is the pressure and temperature in the tank after venting?