

CRYOGENIC ENGINEERING

Tutorial - 1

- Determine the y , y_{max} , the work/unit mass compressed, work/unit mass liquefied and FOM for the Simple and Precooled Linde - Hampson systems with Nitrogen as working fluid. The R134A is the refrigerant for the precooling system with ratio r as 0.08. The liquefaction system is operated between 1.013 bar (1 atm) and 101.3 bar (100 atm) at 300 K. The following is the data for R134a. Comment on the results.

	a	b	c
p (bar)	1.013	101.3	101.3
T (K)	300	373	300
h (J/g)	390	482	260

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Given

Cycle : Simple and Precooled L - H System
 Working Fluid : Nitrogen
 Pressure : 1 atm \rightarrow 100 atm
 Temperature : 300 K
 Refrigerant : R134a, 1 atm \rightarrow 10 atm
 Mass ratio(r) : 0.08

For above cycles, Calculate and comment

- Liquid Yield y , y_{max}
- Work/unit mass of gas compressed
- Work/unit mass of gas liquefied
- FOM

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	1	2	f
p (bar)	1.013	101.3	1.013
T (K)	300	300	77
h (J/g)	462	445	29
s (J/gK)	4.42	3.1	0.42

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p (bar)	1.013	101.3	101.3
T (K)	300	373	300
h (J/g)	390	482	260
s (J/gK)	R134a		

- $h_d = h_c$, since the expansion is isenthalpic.

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- Work/unit mass of gas liquefied

$-\frac{W_c}{\dot{m}} = 379$

$y = 0.04$

$-\frac{W_c}{\dot{m}_f} = -\frac{W_c}{y\dot{m}} = \frac{379}{0.04} = 9475 \text{ J/g}$

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• **Figure of Merit (FOM)**

$$-\frac{W_c}{\dot{m}_f} = 9475$$

$$-\frac{W_l}{\dot{m}_f} = 767$$

$$FOM = \frac{\frac{W_l}{\dot{m}_f}}{\frac{W_c}{\dot{m}_f}} = \frac{767}{9475} = 0.081$$

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• The T - s diagram for a Precooled Linde - Hampson system is as shown.

• The state properties are as tabulated below.

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T (K)	300	300	77
h (J/g)	462	445	29
s (J/gK)	4.42	3.1	0.42

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