File: hw11.py, methods: baseFunctions.py

	Units	F	B	D
Description				
From			B1	B1
To		B1		
Stream Class		CONVEN	CONVEN	CONVEN
Maximum Relative Error				
Cost Flow	$/hr			
− MIXED Substream				
Phase		Liquid Phase	Liquid Phase	Liquid Phase
Temperature	C	126.074	135.694	110.869
Pressure	bar	1.01325	1.01325	1.01325
Molar Vapor Fraction		0	0	0
Molar Liquid Fraction		1	1	1
Molar Solid Fraction		0	0	0
Mass Vapor Fraction		0	0	0
Mass Liquid Fraction		1	1	1
Mass Solid Fraction		0	0	0
Molar Enthalpy	kcal/mol	3.58532	2.68673	6.45679
Mass Enthalpy	kcal/kg	35.1642	25.3401	69.9689
Molar Entropy	cal/mol-K	-83.8367	-89.9029	-71.2701
Mass Entropy	cal/gm-K	-0.822256	-0.847925	-0.772317
Molar Density	mol/cc	0.00753546	0.00717265	0.00845793
Mass Density	kg/cum	768.311	760.495	780.505
Enthalpy Flow	Gcal/hr	0.896329	0.472923	0.477662
Average MW		101.959	106.027	92.2809
+ Mole Flows	**kmol/hr**	**250**	**176.022**	**73.9783**
− Mole Fractions				
TOLUE-01		0.3	0.0100099	0.989994
ETHYL-01		0.7	0.98999	0.0100061
+ Mass Flows	**kg/hr**	**25489.8**	**18663.1**	**6826.78**
+ Mass Fractions				
Volume Flow	cum/hr	33.1765	24.5407	8.74662
+ Liquid Phase				

Problem 1ab

Condenser / Top stage performance

Name	Value	Units
Temperature	110.869	C
Subcooled temperature		
Heat duty	-13.387	GJ/hr
Subcooled duty		
Distillate rate	73.9783	kmol/hr
Reflux rate	327.483	kmol/hr
Reflux ratio	4.42675	
Free water distillate rate		
Free water reflux ratio		
Distillate to feed ratio		

Reboiler / Bottom stage performance

Name	Value	Units
Temperature	135.694	C
Heat duty	13.6141	GJ/hr
Bottoms rate	176.022	kmol/hr
Boilup rate	381.248	kmol/hr
Boilup ratio	2.16591	
Bottoms to feed ratio		

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Summary

	Value	Units
Number of Trayed/Packed stages	23	
Total height		ft
Total head loss (Hot liquid height)		ft
Total pressure drop		bar
Number of sections	1	
Number of diameters	1	
Pressure drop across sump		bar
Total residence time		hr

Sections

	Start Stage	End Stage	Diameter		Section Height		Internals Type	Tray Type or Packing Type	Section Pressure Drop		% Approach to Flood	Limiting Stage	
CS-1	2	13	1.99955	ft	24	ft	TRAY	SIEVE	18.654	bar	1092.53	13	View

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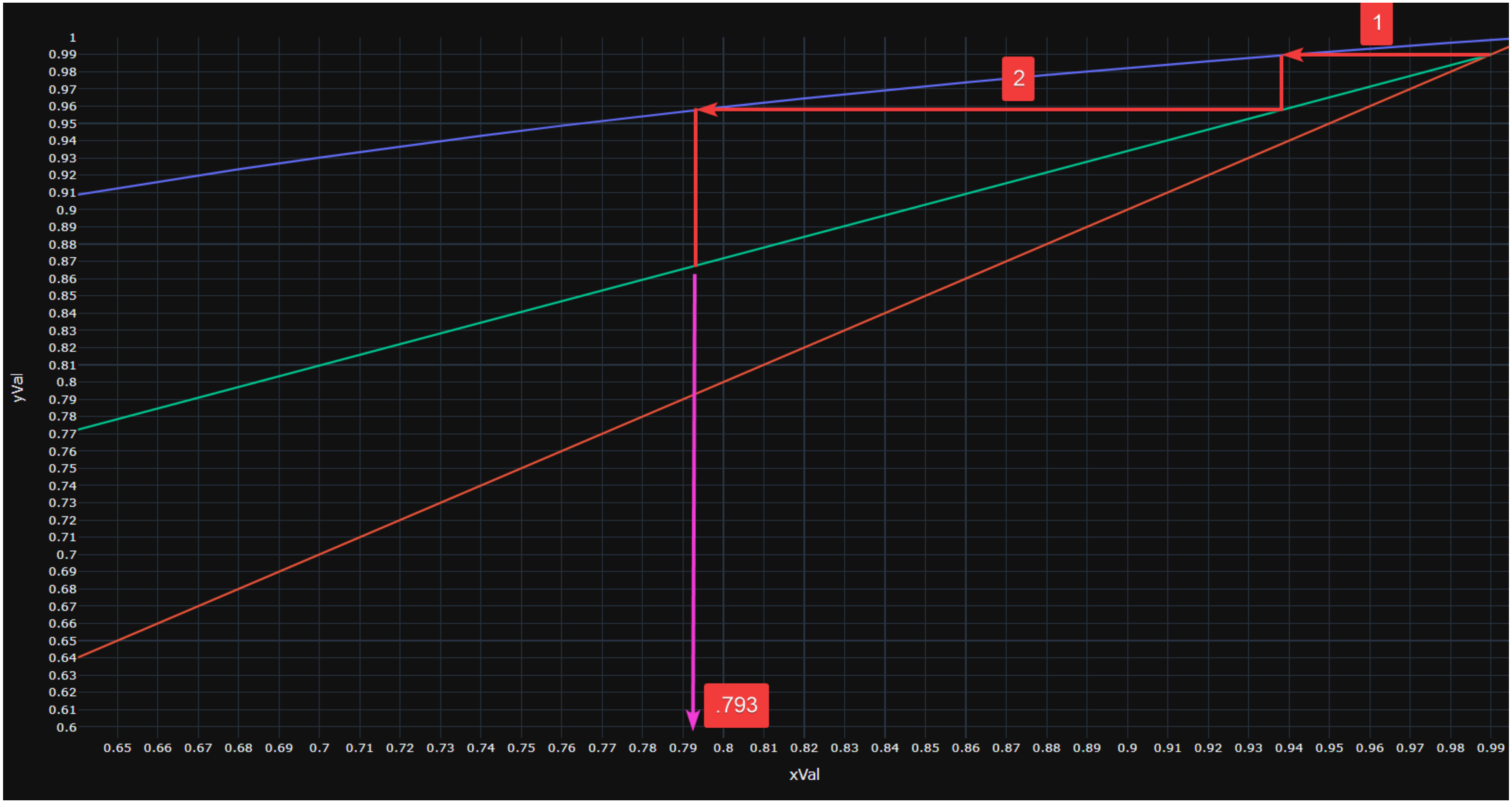
McCabe-Thiele diagram: 14 stages, feed at 6



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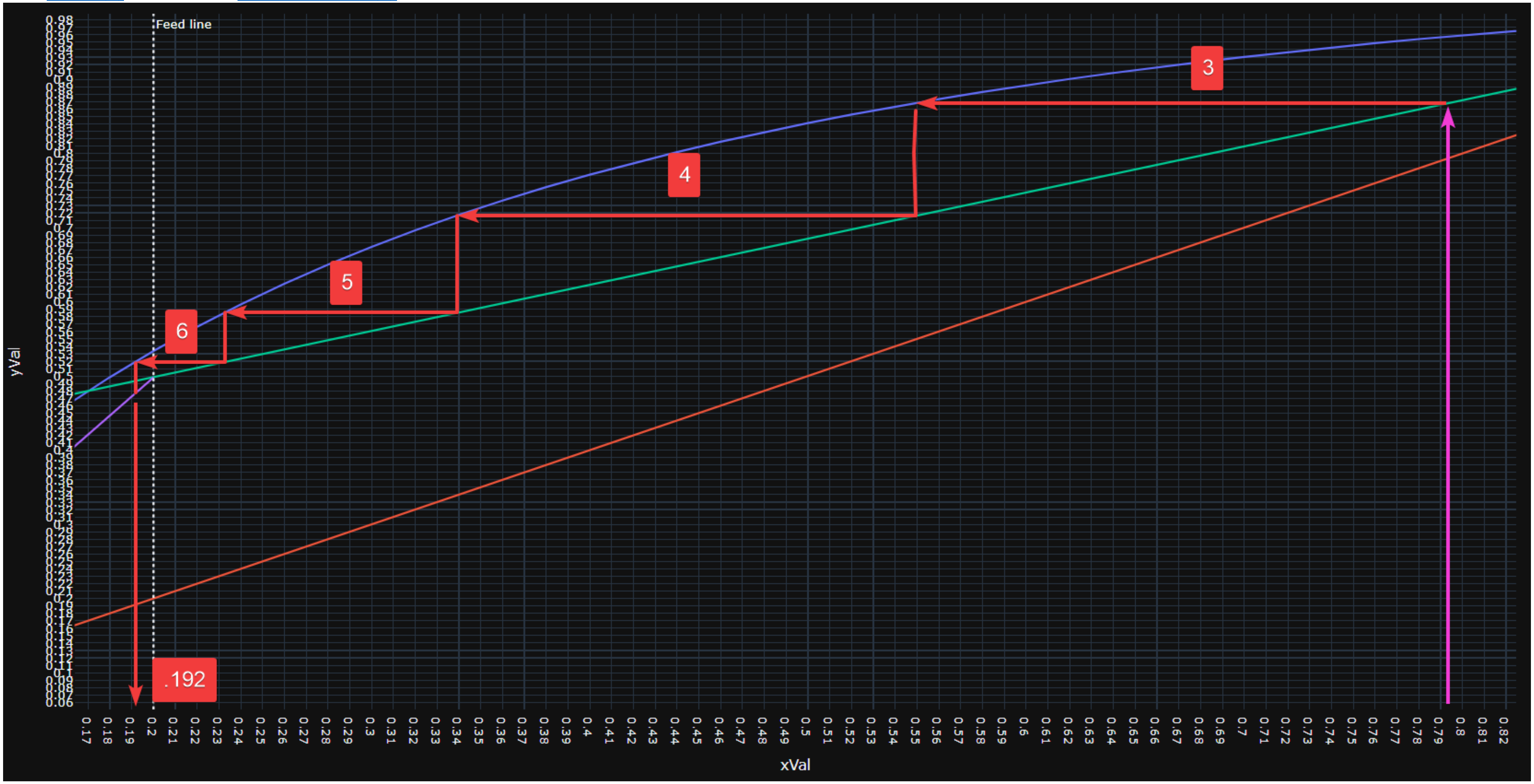

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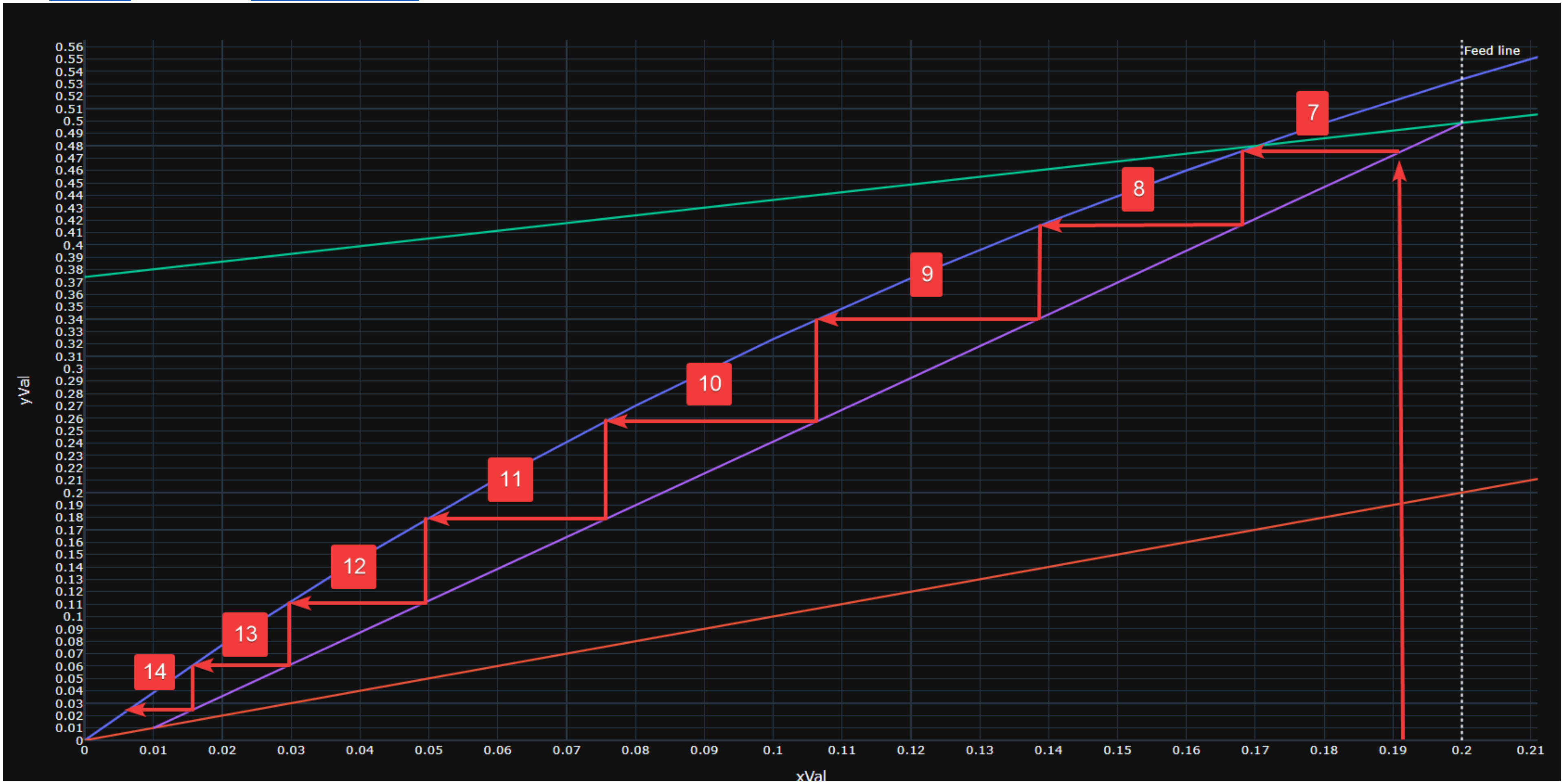

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Problem 2

```
==== Problem 2 ====
dT Ln, condenser: 131.11700047464612 Δ°F
dT, reboiler: 50 Δ°F
Heat duty, condenser: 13.38695324118 GJ/h
Heat duty, reboiler: 13.614113476152 GJ/h
Heat transfer coefficient, condenser: 150 Btu/ft²/h/Δ°F
Heat transfer coefficient, reboilder: 200 Btu/ft²/h/Δ°F
Heat transfer area, condenser: 59.93574330274267 m²
Heat transfer area, reboiler: 119.87918450200634 m²
```

File: hw11.py, methods: baseFunctions.py

Problem 3

$trayspacing := 2\ ft \quad nTrays := 26 \quad F_P := 1 \quad F_M := 1 \quad GJ := 10^9\ J$

$H := 10\ ft + nTrays \cdot traySpacing = 62\ ft \quad D := 6.5\ ft \quad V := \left(\frac{D}{2}\right)^2 \cdot H = 18.544\ m^3$

$$cShell := 10^{3.4974 + 0.4485 \cdot \log\left(\frac{V}{m^3}\right) + 0.1074 \cdot \log\left(\frac{V}{m^3}\right)^2} \cdot (2.25 + 1.82 \cdot F_P \cdot F_M) = 7.055 \cdot 10^4$$

$A := \pi \cdot \left(\frac{D}{2}\right)^2 = 3.083\ m^2 \quad N_{trays} := 26$

$$Fq := \textbf{if}\left(N_{trays} < 20, 10^{\left(0.4771 + 0.08516 \cdot \log\left(N_{trays}\right) - 0.3473 \cdot \log\left(N_{trays}\right)^2\right)}, 1\right) = 1$$

$$cTrays := 10^{3.3322 + 0.4838 \cdot \log\left(\frac{A}{m^2}\right) + 0.3434 \cdot \log\left(\frac{A}{m^2}\right)^2} \cdot Fq \cdot nTrays = 1.164 \cdot 10^5$$

$A_C := 55.016\ m^2 \quad A_B := 110.164\ m^2$

$$cCond := 10^{4.3247 - 0.3030 \cdot \log\left(\frac{A_C}{m^2}\right) + 0.1634 \cdot \log\left(\frac{A_C}{m^2}\right)^2} \cdot (1.63 + 1.66 \cdot F_M \cdot F_P) = 64493$$

$$cBoiler := 10^{4.4646 - 0.5277 \cdot \log\left(\frac{A_B}{m^2}\right) + 0.3955 \cdot \log\left(\frac{A_B}{m^2}\right)^2} \cdot (1.63 + 1.66 \cdot F_M \cdot F_P) = 357616$$

$$cSteam := 4.399\ \frac{GJ}{hr} \cdot \frac{14.83}{GJ} \cdot 350\ day = 5.48 \cdot 10^5$$

$$cWater := 4.28\ \frac{GJ}{hr} \cdot \frac{0.354}{GJ} \cdot 350\ day = 1.273 \cdot 10^4$$

$CapCost := cShell + cTrays + cCond + cBoiler = 6.09 \cdot 10^5$

$OpCost := cSteam + cWater = 5.607 \cdot 10^5$

$$EAOC := OpCost + \frac{CapCost}{5} = 6.825 \cdot 10^5 \qquad \frac{cSteam}{EAOC} = 0.803$$