TEST 3

First discussion session (in my office) no later than March 12. This discussion session should be over ALL difficulties noticed. Test due on March 25 (right after spring break, although I'd prefer you are done before spring break).

Consider the retrofit design of a crude unit.

Hot Streams

	TCR	MCR	LCR	KERO	LGO	HGO	OVHD	HVGO	LVGO	SR1	SR2	SRQ
Fcp [kW/C]	106.20	117.81	233.98	33.79	31.98	25.05	122.69	130.94	47.40	66.32	28.23	24.20
Tin [C]	140.18	210.00	303.56	170.11	248.82	276.98	117.71	250.55	178.55	359.97	290.00	359.55
Tout [C]	39.53	162.98	270.23	60.00	110.00	121.91	50.00	90.00	108.87	290.00	115.00	280.00

Cold Streams

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
Fcp [kW/C]	200.04	223.73	228.00	230.91	236.67	246.35	255.25	265.83	328.06	371.49	373.8	413.6
Tin [C]	30.00	130.00	145.00	153.74	161.90	185.00	216.66	234.84	270	290	310	330
Tout [C]	130.00	145.00	153.74	161.90	185.00	216.66	234.84	270.00	290	310	330	350

The system has two cold streams. The second cold stream is represented by piece wise sections (C2-C12) because the FCP varies with temperature (the stream vaporizes). The existing network is shown next.

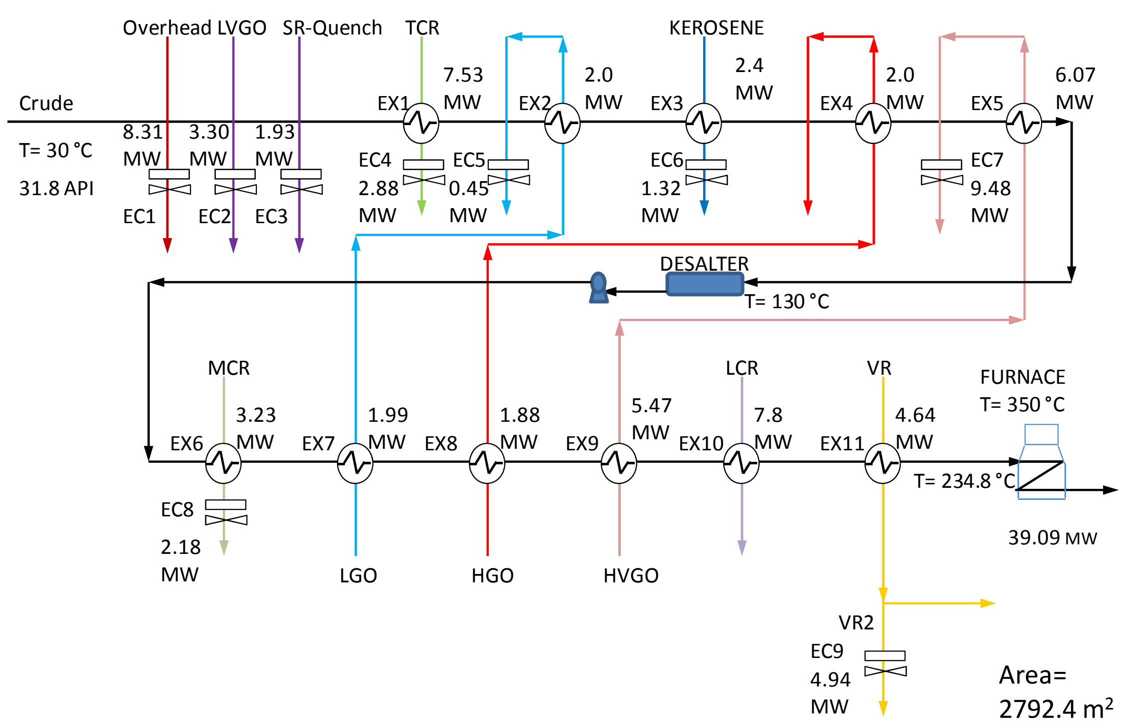

Figure 1. Existing heat exchanger network

Economic Data

Furnace Utility Costs ($/Kw-yr)	$100.00	Maximum area per shell (m^2)	500
Area addition costs ($/$m^2$)	$271.20	Installation cost as % of equipment cost	50%
Fixed exchanger cost ($)	$17,129	Furnace Efficiency	80%

Table 1. Heat exchanger flow rates and temperatures for example network

Exchanger	EX1		EX2		EX3		EX4		EX5		Desalter Crude T=130°C	
Cold Stream	Crude BD		CRUDE BD		CRUDE BD		CRUDE BD		CRUDE BD			
Flow (tonm/day)	8330.3		8330.3		8330.3		8330.3		8330.3			
	In	Out	In	Out	In	Out	In	Out	In	Out		
Temperature (°C)	30.0	70.0	70.0	80.0	80.0	91.9	91.9	101.6	101.6	130.0		
Hot Stream	TCR		LGO		KEROSENE		HGO		HVGO			
Flow (tonm/day)	4000.0		1100.0		1273.6		850.0		4760.6			
	In	Out	In	Out	In	Out	In	Out	In	Out		
Temperature (°C)	140.2	69.3	190.0	125.4	170.1	101.5	206.0	121.9	212.6	167.6		
DUTY (MW)	7.53		2.00		2.40		2.00		6.07			
[redacted]												
Exchanger	EX6		EX7		EX8		EX9		EX10		EX11	
Cold Stream	CRUDE AD		CRUDE AD		CRUDE AD		CRUDE AD		CRUDE AD		CRUDE AD	
Flow (tonm/day)	8350.2		8350.2		8350.2		8350.2		8350.2		8350.2	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Temperature (°C)	130.0	145.0	145.0	153.7	153.7	161.9	161.9	185.0	185.0	216.7	216.7	234.8
Hot Stream	MCR		LGO		HGO		HVGO		LCR		VR	
Flow (tonm/day)	4000.0		1100.0		850.		4760.6		7000		2023.5	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Temperature (°C)	210.0	181.9	248.8	190.0	277.0	206.0	250.6	212.6	303.6	270.2	360.0	290.0
DUTY (MW)	3.36		1.99		1.88		5.47		7.80		4.64	

Table 2. Heater and cooler flow rates and temperatures for example network

Heater/Cooler	EC1		EC2		EC3		EC4		EC5		EC6	
Stream	Overhead		LVGO		SR-Quench		TCR		LGO		KEROSENE	
Flow (tonm/day)	994.3		1653.7		662.4		4000.0		1100.0		1273.6	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Temperature (°C)	117.7	50.0	178.6	108.9	359.6	280.0	140.2	69.3	125.4	110.0	101.5	60.0
DUTY (MW)	8.31		3.30		1.93		2.88		0.45		1.32	
[redacted]												
Heater/Cooler	EC7		EC8		EC9		FURNACE					

Stream	HVGO		MCR		VR2		CRUDE AD		
Flow (tonm/day)	4760.6		4000.0		2023.5		8350.2		
	In	Out	In	Out	In	Out	In	Out	
Temperature (°C)	167.6	90.0	181.9	163.0	290.0	115.0	234.8	350.0	
DUTY (MW)	9.48		2.18		4.94		39.09		

Table 3. Overall heat transfer coefficients and areas for example network

	EX1	EX2	EX3	EX4	EX5	EX6	EX7	EX8	EX9	EX10	EX11
U (MW/m^2-K)	0.2	0.4	0.3	0.35	0.2	0.2	0.4	0.35	0.2	0.28	0.31
Area (m^2)	707	63	182	96	411	240	74	68	473	324	154

PROVIDE A RETROFIT DESIGN USING PINCH TECHNOLOGY YOUR LOWEST POSSIBLE EMAT is 5 ^oC) : Your goal is to beat the following answer obtained using a linear model (HIT; discussed briefly in class): Hot utility: 25.96 MW, Area 6627 m^2, (new area=3882 m^2), 13 new shells, Investment: 4,060,000, Savings \$1,641,250 \$/yr, NPV=\$6,024,000, IRR=39%. **Use the following steps:**

1) **Perform Pinch Retrofit Targeting:** Use different values of α. As an economic objective, use NPV (10 years and a rate of 10%).
2) **Identify matches that cross the pinch.**
3) **Perform Pinch Design for the HRAT recommended in 1):** Carefully make your choices so that existing matches coincide with your matches. Use the transshipment model when appropriate to obtain alternatives. We will discuss an exclusion constraint in class.
4) **Obtain a first retrofit design by placing new exchangers as suggested by the design obtained in 3).** Can driving forces plot help here?
5) **Identify loops that can allow you to transfer area from exchangers with area larger than the existing one to new exchangers.** You can use this technique when designing step 3) and/or after the first answer in step 4 was obtained. Which is best? **Use paths only if needed.**
6) **Can you use criss-crossing to obtain a better network?** You can use this technique when designing step 3) and/or after the first answer in step 4 was obtained. Which is best?
7) **Consider now that the furnace is working NOW at its given efficiency.** Read the attached article and figure out how much the efficiency of a box-type furnace will change.