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## Optimization of Heat Exchanger Network in Crude Distillation Unit for an Existing Refinery using Pinch Technology.

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### ABSTRACT

Pinch technology is a set of techniques used to determine the heat transfer characteristics in any process unit. Integration of heat between the heat exchangers reduces the heat utility requirement as well as cold utility requirement. In chemical industries, during operation of heat exchangers, the major aim is to focus on the best performance of the network. This would greatly reduce the external energy costs by utilizing the most energy within the system from the turbine exhausts and waste from other components. It is not only used for energy savings but also enhanced operation flexibility and reduced environmental impact. This project designs an optimum Heat Exchanger Networking using HINT software which uses pinch technology for the existing plant and total heat load required for hot and cold streams has been carried out which results in reduction of capital cost. Hot utility load of 95928.3 KW/hr is reduced to 86201.53 KW/hr which decreases the overall running cost of plant. Cold utility load of 3560.21 KW/hr is reduced to 0 KW/h. Several heat exchanger networks can be designed at different approaches and finally threshold limit can be obtained at approach 7°C. At this approach optimum heat exchanger network design can be obtained.

**Keywords:** Pinch technology; Composite curve method; Problem Table method; Maximum Energy Recovery.

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## INTRODUCTION

Every process industry requires heat to reach the desired target temperature. Heat exchangers are used for this purpose to get heat transfer from hot to cold fluid. In some cases industries are using utilities to fulfill their targets. Therefore industries require sufficient management of energy which results in reduction of cost of the plant [1]. The possibilities for energy savings results in environmental and economic saving for various industrial applications. All process plants mostly used hot utilities includes steam, hot oil and flue gas. Similarly, a widely used cold utility is cooling water.

In the petrochemical industry energy saving is the most important issue associated with cost. The petrochemical industry is a consuming much energy and it is more expensive to produce and its major portion lost in environment due to not proper integration of heat [2]. Energy cost is effect on the total production cost of the product. So the Oil prices increases recently. And it is also harmful for environment to discharging of CO<sub>2</sub> in to the environment during the production of Energy, so the regulation requires reduction of energy use.

To face these challenges in the industry pinch technology was introduced. The main principles of the pinch method are the calculation of energy and cost targets for the process, which inform the minimum energy consumption and the minimum cost of the HEN required to reach this minimum, and a systematic methodology for the design of a HEN that actually meets those targets is based on the use of simplified graphical representations of the thermodynamic analysis [3]. The pinch design method offers no guarantee of finding the optimal solution. However, it allows a HEN to be developed that operates with the minimum energy consumption and at the same time is a good approximation of the optimal network. Furthermore, it gives full control of the design to the engineer, and helps to identify the parameters of the process that are limiting the energy savings. For these reasons, the pinch design method is a popular and well-established tool for HEN design. The calculations required by pinch methodology are conceptually simple and can be done by hand. However, in real-scale problems they can become tedious and time consuming. Thus, the availability of computer software that performs those repetitive tasks is of interest for the learning [4] and application of the pinch method.

The pinch separates the problem into two thermodynamic regions, namely, hot end and cold end. The hot end is the region comprising all streams or parts of streams above the pinch temperature. Only hot utility is required in this region but not cold utility. The cold end is the region comprising all streams or parts of streams below the pinch temperature. Cold utility is required in this region but not for hot utility. There is no heat transferring across the pinch, therefore, the utility requirement is the minimum. As described previously, the hot end requires only hot utility so it acts as a heat sink while the cold end requires only cold utility so it acts as a heat source. To achieve this minimum requirement, the design has to obey the pinch principle. Several commercial flow sheet simulators are available include pinch analysis tools [5]. The main disadvantages of using this software to learn the pinch technology a previous knowledge of the use of the simulator is required and that sometimes the implementation of pinch design concepts in this software are not clear and it makes learning difficult. This work presents non-commercial software like HINT and THEN for the design of heat exchanger networks with the pinch method.

In olden days, pinch techniques are used for particular process but in recent days this technology is used for entire plant to integrate among all processes. Heat integration reduces the requirement of saturated steam and cooling water. In heat exchanger networking via pinch technology, the following facts are considered: Heat transferred from a hot stream must be equal to heat transferred from cold stream and heat can only be transferred from a hotter fluid to colder fluid (from second law of thermodynamics) [6]. Pinch technology uses thermodynamic principles to design networks. This technology gives a step by step procedure to find the energy savings in the plant. The entire process design is represented by onion diagram [7]. Firstly, the design starts with reactor which represents the core of onion. The separators can be designed by knowing the feed, product and recycle concentrations which represents the second layer of onion. The designing of heat exchanger network represents third layer and the determination of hot and cold utility requirements represents the fourth layer. It provides a proper methodology for energy saving, from the basic heat and material balance to total site utility system. It is a known fact that at all points in a heat exchanger the temperature of hot stream is always greater than the temperature of cold stream [7]. The acceptable minimum temperature difference is called pinch temperature. Pinch divides the entire temperature interval into two regions. Above the pinch there is hot utility region and below the pinch there is cold utility region.

There is no heat transfer across the pinch which is a golden rule for pinch technology. In general, minimum temperature difference is always lies in the range of 10°C to 20°C [8]. But in some cases, the difference is less than 10°C based upon the process. The use of pinch technology allows us to find the optimum utility requirements for the process. Maximizing the use of lower temperature utilities reduces the cost of hot utilities. The stages in a process of pinch analysis of a real process plant or site are collection of data from plant which includes temperature and flow heat capacity, selection of initial  $\Delta T$  value, Construction of composite curves and grand composite curves, estimation of optimum hot and cold utility requirements, design of heat exchanger network [9]. The procedure first predicts the minimum hot and cold requirements and number of units at pinch point. Finally the optimized heat exchanger network is determined by doing calculations at different minimum temperature differences.

### HEAT INTEGRATION METHODS (HEN)

#### Collection of data from existing refinery

From the consistent energy balance, the data is taken from Tatipaka refinery. The characteristics of leaving streams are listed in following table. From the table it is observed that the heat load on hot streams is 132901 KW/hr and similarly the heat load on cold streams is 219102 KW/hr. This implies that the current hot and cold utility demands, reducing the hot and cold utility targeting procedure is applied. As already mentioned there are two methods to reduce the hot and cold utility requirements namely composite curve method and Problem table method. Pinch technology is used for the construction of composite curve. This curve is obtained by using HINT software.

**Table.1: Kerosene – Crude Heat Exchanger (20-E-101) data extraction from existing refinery**

Fluid properties	Kerosene		Crude	
Liquid Flow(Kg/hr)	1200		9000	
	Shell inlet	Shell outlet	Tube inlet	Tube outlet
Specific Heat (KW/Kg °C)	0.539	0.639	0.492	0.532
Temperature( °C)	181.8	76.7	37.9	72.8

**Table.2: Heavy Naphtha – Cooling water (20-E-110) data extraction from existing refinery**

Fluid properties	Heavy Naphtha		Cooling Water	
Liquid Flow(Kg/hr)	1417.12		4163.12	
	Shell inlet	Shell outlet	Tube inlet	Tube outlet
Specific Heat (KW/Kg °C)	0.591	0.515	1	1
Temperature( °C)	114.8	40	33	47

#### Procedure

In this work data required for the design of heat exchanger network was taken from existing Refinery at Rajahmundry. In general the specific heat is found to be dependent on temperature. But in this data as the specified components are taken in large quantities the specific heat is significantly dependent on temperature.

#### Process description

The products from crude distillation unit consist of Kerosene, heavy naphtha and heavy end products. This product comes out of the distillation column at higher temperatures which is to be cooled for its beneficial use. To decrease its temperature heat exchangers are used outside the distillation column. Similarly, the crude oil which is a feed to the distillation column enters at colder temperatures which are required to be heated to separate it into different fractions. Therefore integrating the heat between these streams reduces the capital cost and the usage of utility requirements. To integrate between these streams we require some software which uses pinch technology. Kerosene – Crude Heat Exchanger (20-E-101) is the first heat exchanger

at the outside of distillation column, in which the hotter fluid is kerosene where its temperature is to be reduced. The temperature of kerosene is reduced by using crude which is a colder fluid increases its temperature by gaining the heat from the naphtha. Kerosene– Cooling Water Heat Exchanger (20-E-110) is the second heat exchanger used to decrease the temperature of kerosene by using cooling water.

### ***Pinch Analysis***

Pinch analysis is also called as heat integration. Utilities optimization can be done by integrating the heat with in the streams rather than using the utilities outside the plant. Estimation of Pinch point temperature is carried out in two different ways, namely composite curve method and problem table method. Composite curve method is a graphical procedure used to determine the minimum utility usage. Problem table method is an algorithm used to find the required targets.

### ***Composite Curve Method***

In this method the data from all streams is plotted enthalpy against temperature to find the minimum utility requirements. It is obtained by lumping all the heat from different streams that are at the same interval of temperature [21]. Mainly, the process requires three pieces of data to plot the composite curve. They are enthalpy in KW, Source and targets temperature in °C, and specific heat. After obtaining stream data the enthalpy of streams at each interval (on X-axis) is plotted against temperature (on y-axis). First of all enter all the hot streams data in a single plot. Select a temperature interval in which all the hot streams exist. In that interval join the head of one hot stream to the tail of another hot stream. In that interval the required specific heat can be obtained by summing up all the specific heats of hot streams. Finally, hot composite curve is obtained. Similarly, take all the cold stream data in single plot and by joining the streams in the same interval of temperature we can obtain cold composite curve. Making plot how far from y-axis is not important in determination of composite curves. Then plot both the hot composite curve and cold composite curve in the same interval of temperature. Then move both the hot and cold composite curves together where temperature difference is minimum. Grand composite curve is obtained by plotting the horizontal distances between the shifted composite curves against energy. Grand composite curve shows the net heating or cooling requirement at each temperature interval after process to process heat recovery has been made. This curve is also used to predict the type, level and load of each utility required [22]. We can also obtain the additional information about what are the modifications required for particular process by seeing this grand composite curve. The non-overlap on the right is the minimum heating Utility and the non-overlap on the left is the minimum Cooling Utility. In the total overlap region the utility cost is constant over entire range. In the partial overlap region the utility cost increases as move further. The temperature at which  $\Delta T_{\min}$  is the PINCH. Pinch point provides an important constraint to design the heat exchanger network. By changing the approach the total surface area required for our heat exchanger network varies. As  $\Delta T_{\min}$  decreases the utility requirements may decrease but the area required to get heat transfer will increase which results in increase of capital cost [23]. Therefore  $\Delta T_{\min}$  is the heart for pinch technology. As the entire temperature range is divided into different temperature intervals each interval is either consuming heat (sink) or producing heat (source). Interval which acts as a heat sink, represented by a line segment that moves down and to the left in grand composite curve. Interval which acts as a heat source, represented by a line segment that moves down and to the right. Whenever there is a heat source segment just above a heat sink segment right facing zone appears in grand composite curve [24]. Such right zones can be self-integrated.

### ***Problem Table Method***

Composite curves are inconvenient due to we lose information on the vertical arrangement of heat transfer between streams. Thus Problem table method was introduced to find the minimum hot and cold utility requirements. The steps in this method are as follows: divide the temperature range into intervals and shift the cold temperature scale, make a heat balance in each interval, cascade the heat surplus/deficit through the intervals and add heat so that no deficit is cascaded.

Streams are shown in a scheme representation with a vertical temperature scale. Temperature interval boundaries are superimposed. The interval boundary temperatures are set as  $\frac{1}{2} \Delta T_{\min}$  below hot stream temperature and  $\frac{1}{2} \Delta T_{\min}$  above cold stream temperature. Hence, each interval will have either a net surplus or net deficit of heat but never both [25]. The first step in this method is to fix the minimum

temperature difference. Choose the highest temperature in both the streams, and then divide the temperature intervals according to the minimum temperature difference. In each interval calculate the heat available in hot streams and similarly calculate the heat requirement in cold streams. Cascade all the intervals in both hot and cold streams. Now calculate the available heat in each interval. Again cascade the available heat intervals. The highest negative heat availability is the minimum hot utility required to reach the target temperature. Finally, the pinch temperature is obtained by using this method. The enthalpy in each interval can be calculated by using the formula

$$\Delta H_i = (T_i - T_{i+1})(\sum C_{pc} - \sum C_{ph})_i \quad \text{for any interval } i.$$

So to design the heat exchanger network one should follow the fundamental rules: Don't transfer heat across the Pinch, don't use cold utilities above and don't use hot utilities below [26].

### **HINT software**

Following commercial software are available HEN designs: Aspen Energy Analyzer, Supertarget, Ws.pinch and WS.HEN-Explorer. Some non-commercial software is also available free of cost: HINT (Heat Integration), THEN (Heat Exchanger Network).

In some of the cases the design of HEN is too complicated and computationally intensive. Thus, to tackle bigger and complicated problems for the design of HEN, one needs software. Hint is used for design of small heat exchanger networks. The GUI (Graphical user interface) of HINT software can be divided into three parts: Bottom Section, Central Section, Left portion. Bottom Section is a table that can be used to introduce the thermal properties of streams. They can be called as stream table which contains definition type, initial and target temperatures,  $mc_p$  are available. Central section is used to display different diagrams such as HEN and grid diagram. Left portion which is this displays auxiliary diagrams on a smaller scale.  $\Delta T_{min}$  is the crucial parameter in design of heat exchanger network. Entering the stream data is of two types: Linear type (heat capacity is independent of temperature) and Non-Linear type (heat capacity is function of temperature).

For Non-linear problems go to streams click add and again click nonlinear streams type. For linear type directly go to stream data table. Give the definition type as hot1, hot2, cold1, cold2 and give specifications like inlet and outlet temperatures of all streams. A grid diagram is generated. Press the diagram menu to see different diagrams. Use Format statement to change the width and height of plot. In Composite curve and Grand composite curve the relative positions of two curves depends upon  $\Delta T_{min}$ . As  $\Delta T_{min}$  decreases utilities required may be less but area required for heat transfer will increase. Energy utilities at different  $\Delta T$ 's can be obtained by using more plot menu. Here we have to give  $\Delta T$  range and number of points. Similarly pinch points at different  $\Delta T_{min}$  can be obtained by clicking more plot menu. In streams tab we have Cascade and feasibility options to find the minimum hot utility and cold utility requirements. Feasibility options are required for the design of heat exchangers. In Heat Exchanger menu, we can add a heat exchanger; delete a heat exchanger in the streams. Loops and Paths dropdown menu is used to break the loops and to detect temperature paths. Additional information like heat transfer coefficients are required for area targeting. HINT software takes the default of heat transfer coefficient value as 2 KW/m<sup>2</sup>K. For cost calculations we have to click stream option [27].

## **RESULTS AND DISCUSSIONS**

### **Hand calculations for different $\Delta T_{min}$ to estimate minimum utilities**

We have calculated the minimum utility requirements at different temperature approaches and finally concluded that threshold limit reaches at approach 7°C. Optimum can never occur below the threshold value. It can be at or above the threshold value. Threshold problems are turned into pinched problem when additional utilities are added [30].

Table.3: Hand calculations for  $\Delta T_{\min}=10^{\circ}\text{C}$

Hotstream temperature( $^{\circ}\text{C}$ )	cold stream temperature( $^{\circ}\text{C}$ )	Available heat(MW)	Cascaded heat(MW)	Required heat(MW)	cascaded heat(MW)	Net heat (MW)	cascaded heat(MW)	Adjusted cascaded heat(MW)
								<b>88.5</b>
181.8	171.8	47.3	47.3	0	0	47.3	47.3	135.9
114.8	104.8	47.6	95.0	0	0	47.6	95.0	183.6
82.8	72.8	9.0	104.1	28.1	28.1	-19.0	76.0	164.5
76.7	66.7	15.4	119.5	90.7	118.8	-75.3	0.6	89.2
57	47	7.1	126.7	79.8	198.7	-72.6	-71.9	16.4
47.9	37.9	3.8	130.5	20.3	219.1	-16.5	-88.5	0
43	33	2.3	132.8	0	219.1	2.3	-86.2	<b>2.35</b>
40	30							

Table.4: Hand calculations for  $\Delta T_{\min}=7^{\circ}\text{C}$

Hot stream temperature( $^{\circ}\text{C}$ )	coldstream temperature( $^{\circ}\text{C}$ )	Available heat(MW)	Cascaded heat(MW)	Required heat(MW)	cascaded heat(MW)	Net heat (MW)	cascaded heat(MW)	Adjusted cascaded heat(MW)
								<b>86.201</b>
181.8	174.8	47.3	47.3	0	0	47.3	47.3	133.5
114.8	107.8	52.	99.5	0	0	52.1	99.5	185.7
79.8	72.8	4.62	104.1	14.2	14.2	-9.6	89.8	176.0
76.7	69.7	17.7	121.9	104.6	118.8	-86.8	3.0	89.2
54	47	7.1	129.0	79.8	198.7	-72.6	-69.6	16.5
44.9	37.9	3.8	132.9	20.3	219.1	-16.5	-86.2	<b>0</b>
40	33							
40	33							

Table .5: Hand Calculations for  $\Delta T_{\min}=8^{\circ}\text{C}$

Hot stream temperature ( $^{\circ}\text{C}$ )	cold stream temperature ( $^{\circ}\text{C}$ )	Available heat (MW)	Cascaded heat(MW)	Required heat(MW)	cascaded heat(MW)	Net heat (MW)	cascaded heat (MW)	Adjusted cascaded heat(MW)
								<b>87.436</b>
181.8	173.8	47.355	47.355	0	0	47.355	47.355	134.791
114.8	106.8	50.675	98.03	0	0	50.675	98.03	185.466
80.8	72.8	6.11	104.14	18.892	18.892	-12.782	85.248	172.684
76.7	68.7	17.005	121.145	99.993	118.885	-82.988	2.26	89.696
55	47	7.131	128.276	79.817	198.702	-72.686	-70.426	17.01
45.9	37.9	3.839	131.665	20.399	219.101	-17.01	-87.436	0
41	33	0.7836	132.448	0	219.101	0.7836	-86.42	<b>0.7836</b>
40	32							

Table .6: Hand Calculations for  $\Delta T_{\min}=9^{\circ}\text{C}$

Hot stream temperature ( $^{\circ}\text{C}$ )	cold stream temperature ( $^{\circ}\text{C}$ )	Available heat(MW)	Cascaded heat (MW)	Required heat(MW)	cascaded heat(MW)	Net heat (MW)	cascaded heat(MW)	Adjusted cascaded heat(MW)
								<b>87.869</b>
181.8	172.8	47.355	47.355	0	0	47.355	47.355	135.224
114.8	105.8	49.185	96.54	0	0	49.185	96.54	184.409
81.2	72.8	7.601	104.141	23.5	23.5	-15.899	80.641	168.5
76.7	67.7	16.221	120.362	95.385	118.885	-79.164	1.477	89.346
56	47	7.131	127.493	79.817	198.702	-72.786	-71.309	17.06
46.9	37.9	3.839	131.332	20.399	219.101	-16.56	-87.869	0
42	33	1.567	132.899	0	219.101	1.564	-86.302	1.567
40	31							

Table.7: Hand Calculations for  $\Delta T_{\min}=11^{\circ}\text{C}$

Hot stream temperature (°C)	cold stream temperature (°C)	Available heat (MW)	Cascaded heat (MW)	Required heat (MW)	cascaded heat (MW)	Net heat (MW)	cascaded heat (MW)	Adjusted cascaded heat(MW)
								<b>89.336</b>
181.8	170.8	47.355	47.355	0	0	47.355	47.355	136.691
144.8	133.8	46.204	93.559	0	0	46.204	93.559	182.895
83.8	72.8	10.582	104.141	32.716	32.716	-22.134	-11.425	160.761
76.7	65.7	14.654	118.795	86.169	118.885	-71.515	-0.09	89.246
58	47	7.131	125.926	79.817	198.702	-72.686	-72.776	16.56
48.9	37.9	3.839	129.765	20.399	219.101	-16.56	-89.336	0
44	33	3.134	132.899	0	219.101	3.134	-86.202	<b>3.134</b>
40	29							

Table.8: Hand Calculations for  $\Delta T_{\min}=12^{\circ}\text{C}$

Hot stream temperature (°C)	cold stream temperature (°C)	Available heat (MW)	Cascaded heat(MW)	Required heat(MW)	cascaded heat(MW)	Net heat (MW)	cascaded heat(MW)	Adjusted cascaded heat (MW)
								<b>90.121</b>
181.8	169.8	47.355	47.355	0	0	47.35	47.355	137.476
114.8	102.8	44.713	92.068	0	0	44.71	92.068	182.189
84.8	72.8	12.072	104.14	37.324	37.324	-25.25	66.816	156.937
76.7	64.7	13.87	118.01	81.561	118.88	-67.69	-0.875	89.246
59	47	7.131	125.141	79.817	198.70	-72.68	-73.561	16.56
49.9	37.9	3.839	128.98	20.399	219.10	-16.56	-90.121	0
45	33	3.918	132.898	0	219.10	3.918	-86.203	<b>3.918</b>
40	28							

Table.9:Hand Calculations for  $\Delta T_{\min}=14^{\circ}\text{C}$

Hot stream temperature (°C)	cold stream temperature (°C)	Available heat(MW)	Cascaded heat (MW)	Required heat (MW)	cascaded heat(MW)	Net heat (MW)	cascaded heat (MW)	Adjusted cascaded heat (MW)
								<b>91.088</b>
181.8	167.8	47.355	47.355	0	0	47.355	47.355	139.043
114.8	100.8	41.732	59.087	0	0	41.732	89.087	180.775
86.8	72.8	15.053	101.14	46.54	46.54	-31.487	57.6	149.288
76.7	62.7	12.303	116.443	72.345	118.88	-60.042	-2.442	89.246
61	47	7.131	123.57	79.817	198.70	-72.686	-75.128	16.56
51.9	37.9	3.839	127.413	20.399	219.10	-16.56	-91.688	0
47	33	5.485	132.898	0	219.01	5.485	-86.203	<b>5.485</b>
40	26							

**Pinch Analysis using HINT Software**

HINT (Heat Integration) is designed for optimization of utility requirements and improving the performance of heat exchanger network. This software helps the designer to compare the current and thermodynamic optimum operations. To reach the desired target the software requires the information about process requirements and the designed heat exchanger network meets the process requirements. The designed heat exchanger network helps us to understand the gap between current scenario and optimum thermodynamic operations.

**Composite Curve**

Click on composite curve menu at right corner to view the composite curve. Composite curve tells us the minimum hot and cold utility requirements required to reach the desired target temperature.

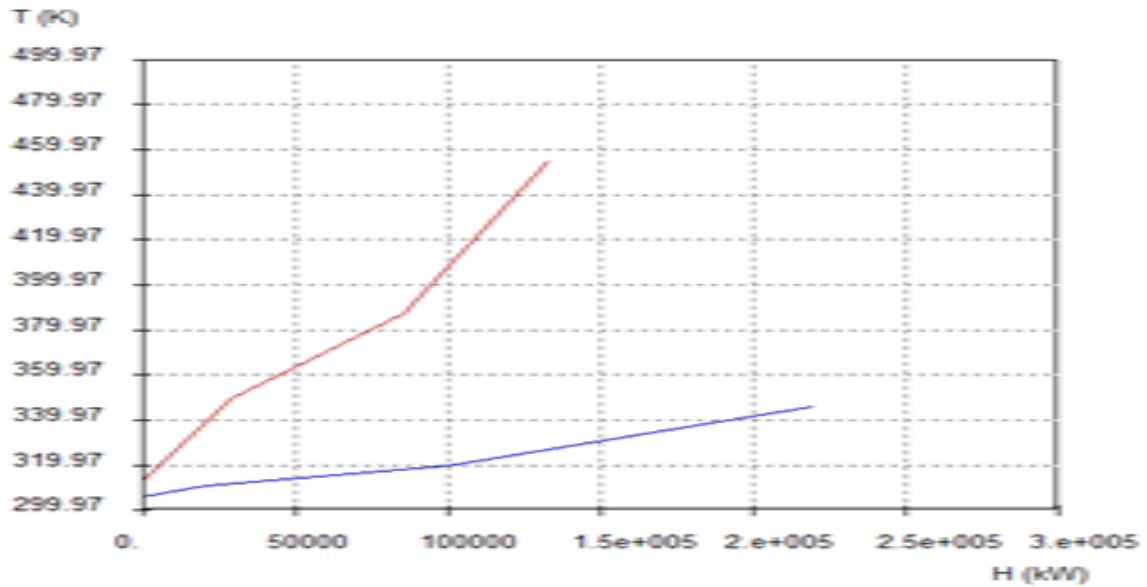


Fig. 1: Composite Curve in HINT Software

**Grand Composite curve**

Click on grand composite curve option at right corner to view the grand composite curve. GCC is also used to determine the minimum amount of hot and cold utilities needed by the process. To find amount of hot utility required, locate the topmost point of curve and read its x- coordinate. Similarly to find amount of cold utility required, locate the bottom most point of the curve and read its x-coordinate. If the curve touches the temperature axis at zero enthalpy indicates the pinch temperature.

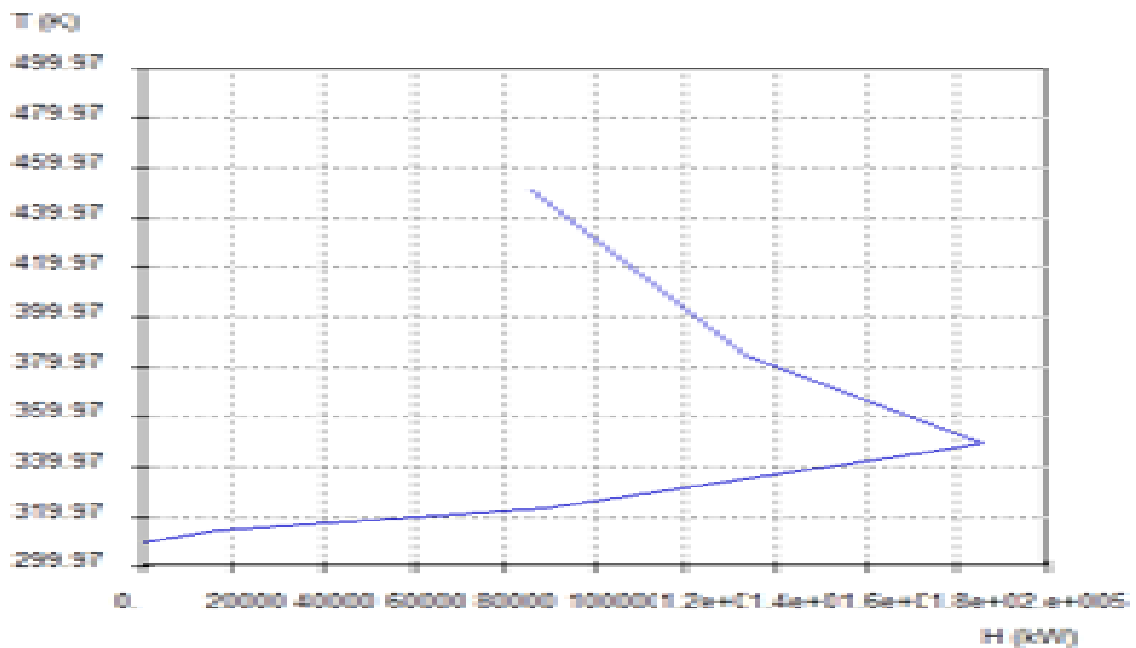


Fig. 2: Grand composite curve in HINT Software

**Energy Targets Vs  $\Delta T_{min}$**

Click on more streams menu to see how different parameters (minimum number of heat exchangers, area targeting...etc.) varies with  $\Delta T_{min}$ . This option tells us the minimum approach that we have to choose which gives the best performance (i.e., reduction of capital cost).



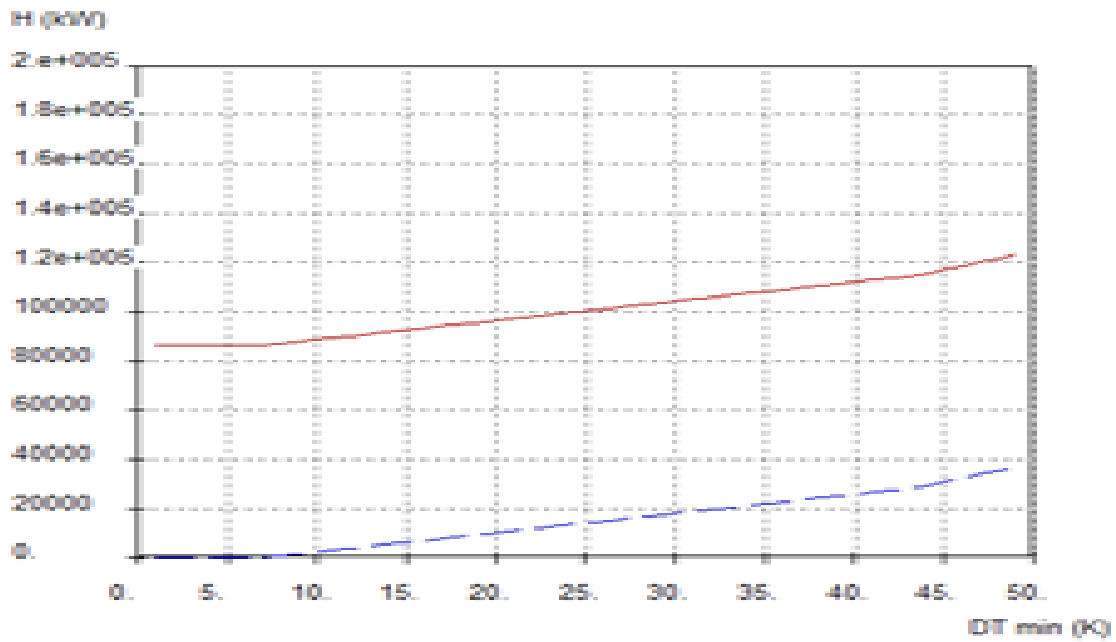


Fig. 3: Energy Targets Vs  $\Delta T_{min}$  in HINT Software

**Cascade Diagram**

Go to streams and click cascade diagram menu so that we can get the information about minimum utility requirements and the optimum number of heat exchangers required to reach the desired target specifications.

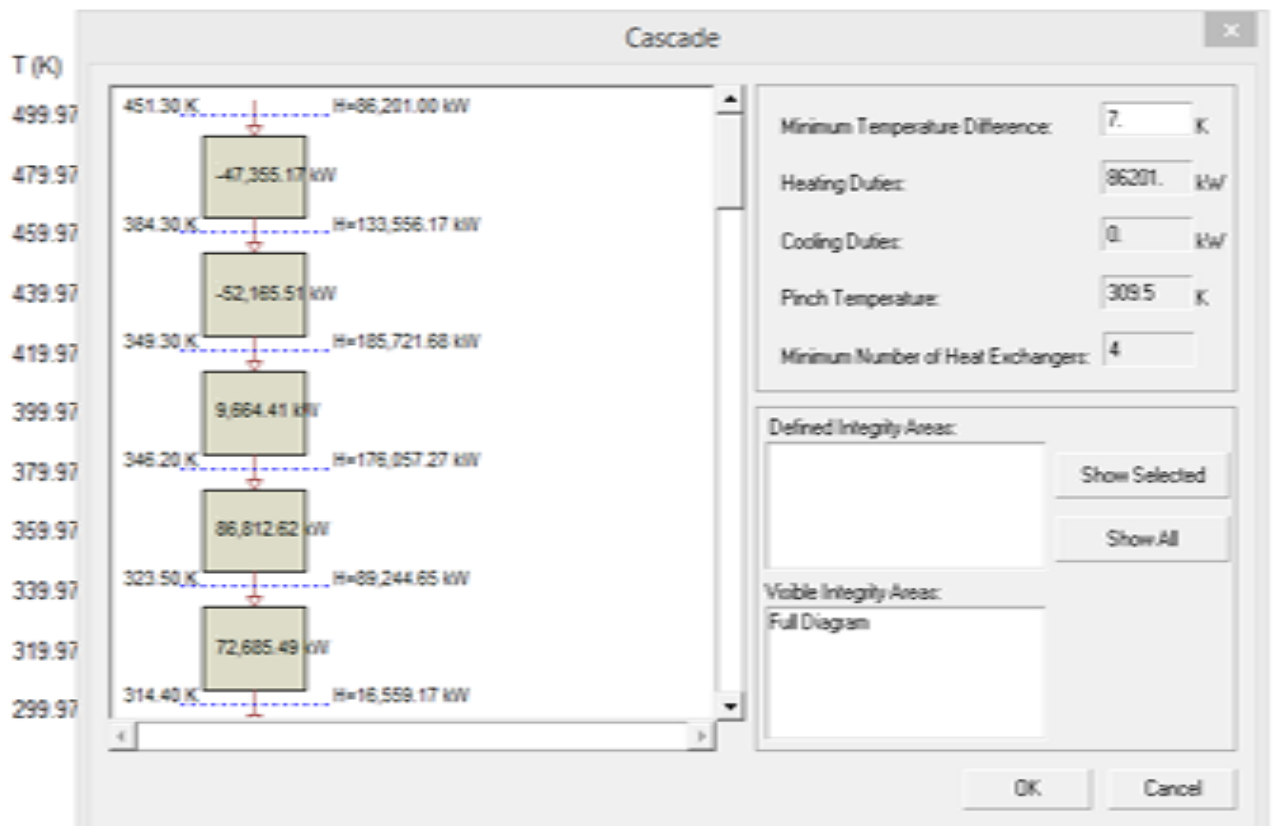


Fig. 4: Cascade Diagram in HINT Software

**Heat exchanger network**

Firstly, we have to choose streams menu and check the feasibility. Above Pinch, number of hot streams are less than or equal to the number of cold streams [31]. If matching is not possible, then the streams are splitted into two streams. Give the  $m \cdot c_p$  values of our own choice and then split. Placement of heat exchangers can be done by using heat exchangers menu at top section. Feasibility option tells us very clearly what the matches to be taken. Go to the feasibility feasible matches to keep the heat exchanger between the streams. In the remaining problem analysis we can see that this matches increases or decreases the area of HEN. Color changes indicate that the streams matches are possible in feasibility. We can place the Heat exchanger in anywhere within the loop.

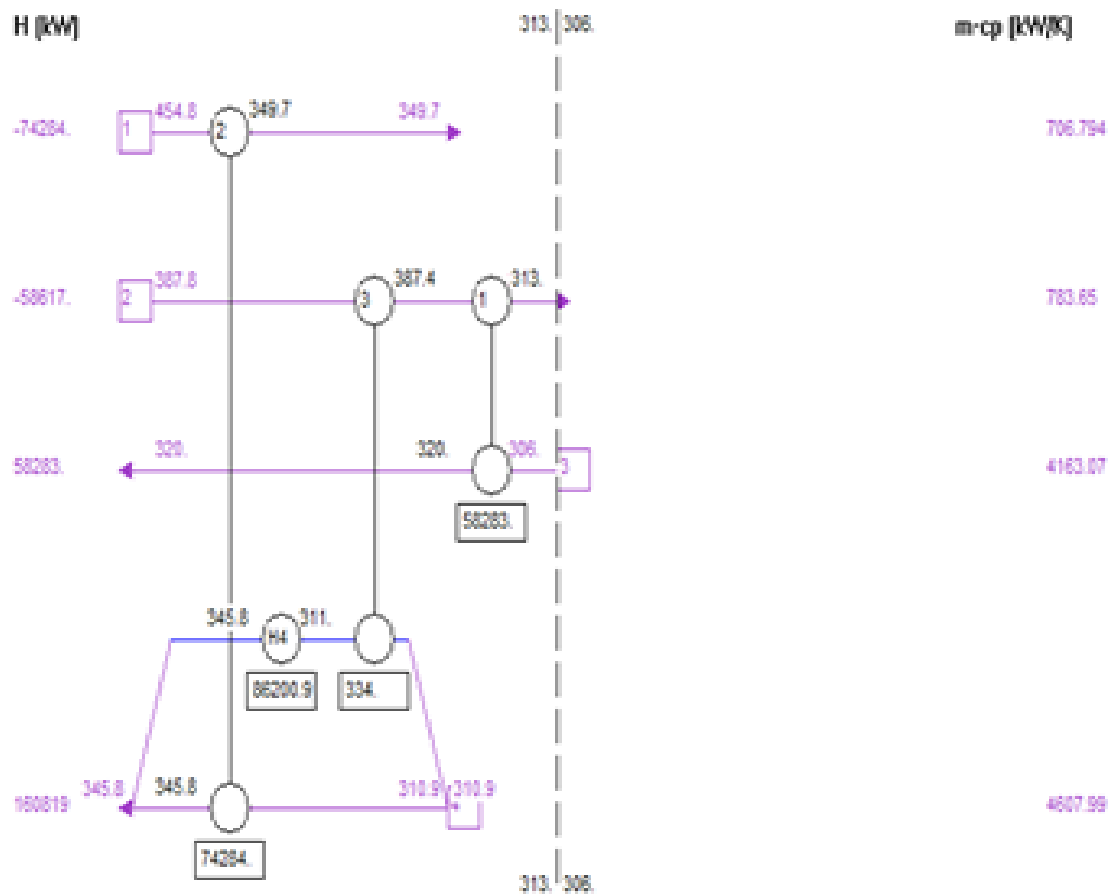


Fig. 5: Heat Exchanger Networking in HINT Software

**Specification of heat exchangers in final design**

Specification of heat exchangers appeared in final design is tabulated in following table. Here we added extra heat exchangers to recover heat and to save additional heating or cooling load on utilities. Minimum hot utility requirement is 86201 KW, Minimum cold utility requirement is 0 KW ,Pinch Temperature is 309.5 K and Minimum number of heat exchangers required were 4.

Table 9: Specifications of Heat Exchangers

Heat Exchanger	Heat load (KW/hr)	Area(m <sup>2</sup> )
1	58283.68	6.9951
2	74204.60	11.37199
3	334.6367	0.0403
<b>4</b>	<b>86199.91</b>	



## CONCLUSIONS

- Comparing the present plant data and final design the number of heat exchangers required to reach the specified target may increase the number, but at the same time the utility requirement decreases.
- Heat exchanger No.1 requires the area of 6.9951m<sup>2</sup> and heat load of 58283.68 KW to reach the target temperature. Heat exchanger No.2 requires the area of 11.37199m<sup>2</sup> and heat load of 74204.6 KW to reach the target temperature.
- Heat exchanger No.2 requires the area of 0.0403m<sup>2</sup> and heat load of 334.6367 KW to reach the target temperature. Similarly heat exchanger No.4 has a heat load of 86199.91m<sup>2</sup> which is a hot utility requirement to reach specified target.
- Comparing both existing and new designed network, Hot utility load of 95928.3 KW is reduced to 86201.53 KW which decreases the overall running cost of plant. Cold utility load of 3560.21 KW is reduced to 0 KW.
- In present study the heat exchanger network is designed by using HINT which uses pinch technology. Several heat exchanger networks can be designed at different approaches and finally threshold limit can be obtained at approach 7°C. At this approach optimum heat exchanger network design can be obtained.
- The largest saving of utilities was obtained with the appropriate use of utilities. This save could be achieved by installing the additional two heat exchangers in existing plant. The pinch design method can be employed to give accurate designs in rapid time with minimum data.
- The application of HINT software in designing the heat exchanger network is represented in present work. The software is able to assist all steps of design includes utilities design, feasibility approach, heat exchanger network.
- The use of the software improves the efficiency of the design since it solves the problem without spending too much time with repetitive calculations and without requiring previous knowledge of commercial flow sheet simulators. By observing the conclusions it is concluded that both the software results are same. In HINT software the heat exchanger network design can be designed by selecting possible matches. HINT program yields better results because it is possible to find out the cost calculations, utilities design at different approaches.

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