Optimum Design of a High Performance Intermediary Heat Exchanging System

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Abstract: *In the design of efficient thermal systems, the regulation of steam or hot air through the cylindrically designed tubes find out efficient only if the heat exchanging system is in par with other heat transfer systems. The primary aim of a thermal system is the formation of thermal energy and its transformation into work Energy. This process involves lots of passages over the entire heat transfer area. Simultaneously across the flow of motive steam over the tubes, there are obviously Energy and Power losses. This affects the overall effectiveness of the thermal system. Therefore if optimum size parameters are defined for the heat transfer system, it will be highly helpful. This will definitely improve the performances in the thermal system. In this paper, there is an attempt to design optimally a high efficient intermediary heat exchanging system.*

1. INTRODUCTION

Thermal systems often find applications in Energy conversion and Power producing plants and utilities. The primary motive of this system is the generation and transmission of heat energy and its secondary and main aim is the doing of work Energy to produce Mechanical Power. This system as whole is highly sophisticated but there are different intermediary elements which will function and assist the main system to fulfill primary and secondary objective of the entire system.Heat exchanging systems or heat exchangers find enough places in the entire operation of thermal systems and functions effectively during transferring of steam or hot fluids.

A Heat Exchanger may be defined as equipment which transfers energy from a hot fluid to a cold fluid with maximum efficiency andeffectiveness. Here the temperature of passing fluids changes considerably.The examples of heat exchangers are:

1. Pre heaters
2. Condensers and boilers
3. Intercoolers
4. Condensers and Evaporators
5. Regenerators
6. Automobile radiators
7. Coolers of heat engines

Heat Exchangers are classified into many types. They are

1. Parallel flow heat exchangers
2. Counter flow heat exchangers
3. Cross flow heat exchangers

In a parallel flow arrangement, hot and cold fluids travel in the same direction.

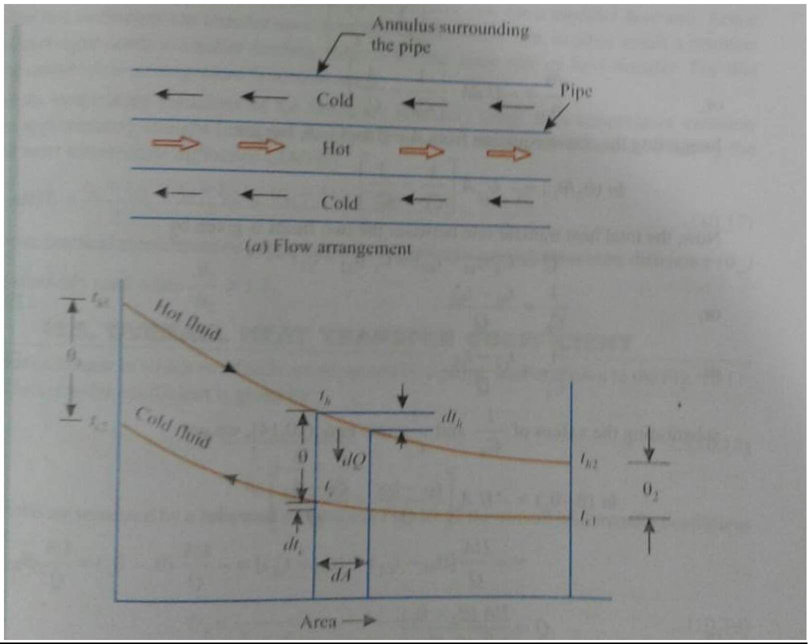
In counter flow, the two fluids flow in opposite direction.

In cross flow arrangements, the two fluids cross one another in space, usually at right angles.

Here in this design, shell and tube is selected. Here the fluid flows through a bundle of tubes enclosed by a shell.The other fluid is forced through the shelland it flows over the outside surface of the tubes.Here this arrangement is selected because it is highly reliable and can obtain better heat transfer effectiveness.Multiple tubes are also considered to increase heat transfer area.

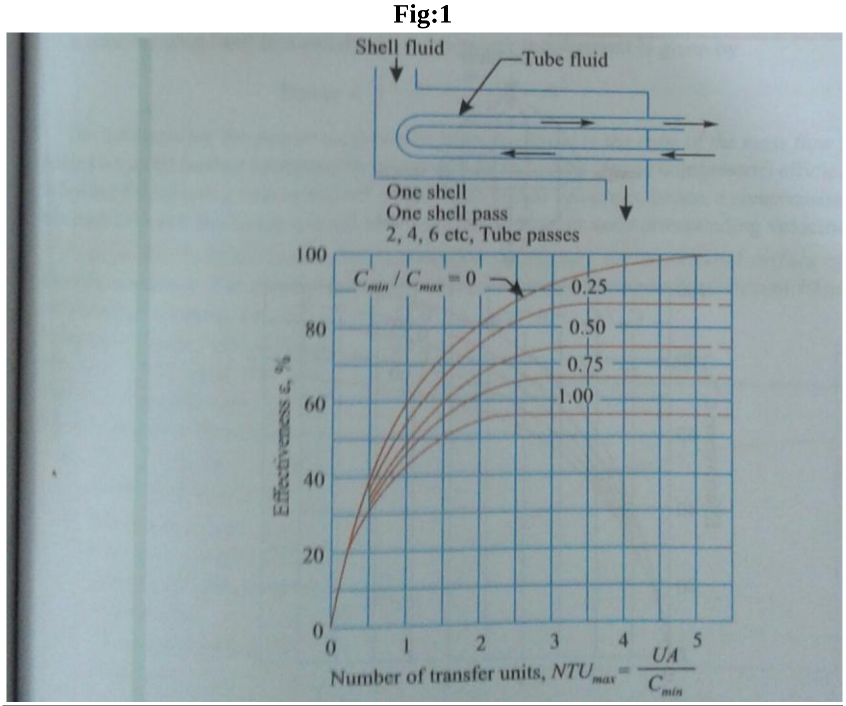
2. SYSTEM DESIGN

LMTD for counter flow unit is always greater than that for a parallel unit; hence counter-flow heat exchanger can transfer more heat than parallel-flow one.



Annulus surrounding the pipe
Cold
Pipe
Hot
Cold
(a) Flow arrangement
Hot fluid
Cold fluid
dQ
dA
Area

Fig:1



Shell fluid
Tube fluid
One shell
One shell pass
2, 4, 6 etc, Tube passes
Cmin / Cmax = 0
0.25
0.50
0.75
1.00
Effectiveness ε, %
Number of transfer units, NTUmax = UA / Cmin

Fig:2

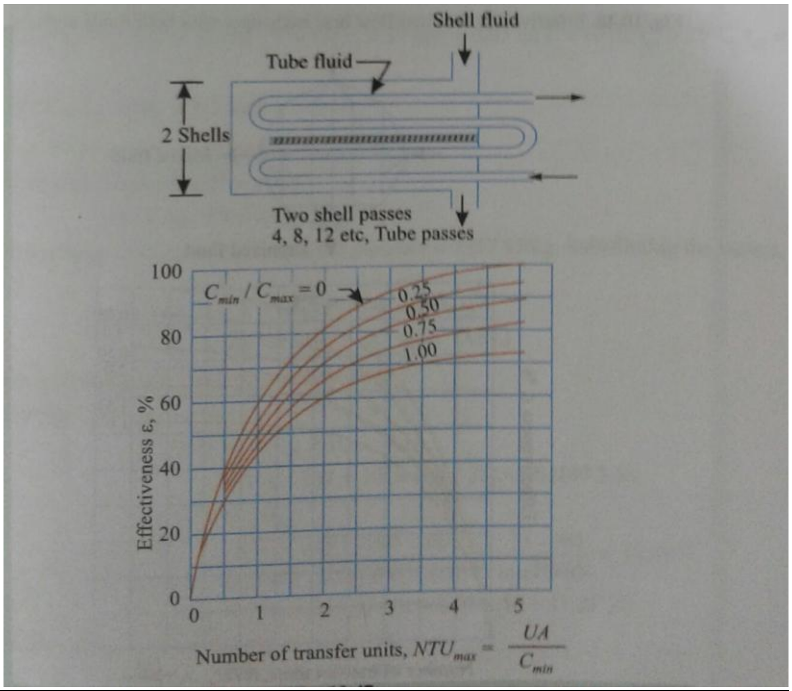


Fig:3

3. HIGH PERFORMANCE SYSTEM CALCULATION

Properties of hot air at 300K

k=0.03W/mK

ν=0.000022m²/s

Pr=0.697

Re=VD/ν

=4545

Nu=0.4(Re)$^{0.6}$ = hD/k

h=8.004W/m²K

ṁ for air=0.006kg/s

Cp at 300K=1050J/kgK

Q=1600W

LMTD=(ΔTmax-ΔTmin)/ln(ΔTmax/ΔTmin)=155K

Q=hA(LMTD)

A=3.14DL

L=0.55m

NTU=UA/C

=175×3.14DL/1050

ϵ=0.4

ϵ=Q/Qmax

Qmax=Q/ϵ=1600/0.4=4000W

Qmax=8×3.14×1×0.55×N

N=290 tubes

Qmax=FUA(LMTD)

A=Qmax/(FU(LMTD))=0.18m²/tube

Total Area=54m²

Number of shell passes=4

4. CONCLUSIONS

Thermal systems carry out best performances only when heat transferring system ratings are excellent.

Inorder to make this criterion, a well defined heat exchange system must be designed with optimum parameters. Here a heat exchanging system having counter flow arrangement of cold and hot fluid is being taken for consideration.The total area for these tubes was optimally fixed to 54m².

For this design, optimum number of tubes after selection by design calculations are 290 and number of shell passes restricted to 4.By all these considerations we can clearly predict high performance from this intermediary heat exchanging system.

5. REFERENCES

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