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Research Paper | Engineering

Performance Enhancement of Air Cooled Heat Exchanger in Winter Conditions

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ABSTRACT

In this present work, attention is focused on studying and analyzing"-Performance Enhancement of Air Cooled Heat Exchangers (ACHEs) under Winter conditions ".It is found that ambient conditions in winter is limiting the operation of air cooler due to temperature drop and low sweet gas flow. To solve this problem several iterations are done using HTRI software. Further for minimum fan selection software of Hudson TUFLITE V5-7 has been used to achieve optimized air flow rate as per the conditions. Finally validation has been done using empirical formulas.

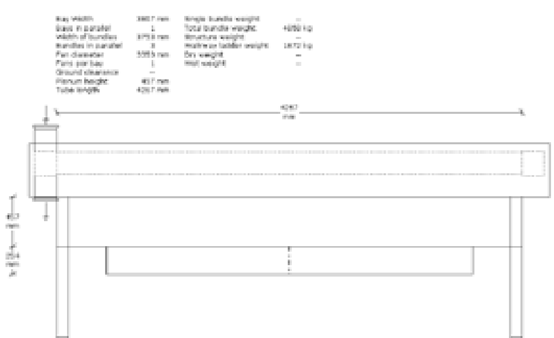
KEYWORDS : *Air cooled heat exchangers (ACHE), Auto variable pitch fans (AVP)*

Introduction

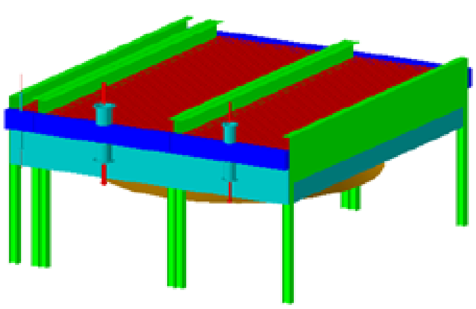
An Air Cooled Heat Exchanger (ACHE) is a device for rejecting heat from a fluid directly to ambient air. This is in contrast to rejecting heat to water and then rejecting it to air, as with a shell and tube heat exchanger and a wet cooling tower system. The main advantage of an ACHE is that it does not require water, which means that plants requiring large cooling capacities need not be located near a supply of cooling water. An ACHE may be as small as an automobile radiator or large enough to reject the heat of turbine exhaust steam condensation from a 1,200 MW power plant - which would require 42 modules, each 90 feet wide by 10 feet long and served by two 60- foot diameter fans driven by 500-horsepower motors.

Objective:

The objective is to control the overcooling in after cooler during winter condition by controlling the air flow using Auto variable pitch and its mechanism supplied by Hudson fans.



2-D view od Air cooled heat exchanger[6]



3-D view of heat exchanger[6]

Detailed Analysis;

The existing compressor cooler's are used for cooling of Lube oil , Compressed sweet gas through Inter and After cooler. These coolers are used for HP gas reciprocating compressors.

The after coolers in existing compressor coolers were originally designed to cool the compressed sweet gas to 58 ˚C. However stable temperature could not be maintained on the after cooler due to low ambient temperature particularly during winter and low sweet gas flow. The sweet gas temperature at the outlet of the after cooler drops near to 35 ˚C during winter condition.

Various options were studied, discussed and was recommended that the existing manual adjustable fan to be modified to auto variable pitch fan in order to maintain the outlet temperature of the after cooler at 58 ˚C. The compressor inter and after coolers to be rerated with a new gas composition data with existing geometry.

- **Design considerations-Existing Geometry:**

  Existing air cooler is forced draft type with a common fan arrangement for process tube bundles of lube oil , inter and after cooler.

  Fin type is 'Extruded' and tube thickness is 2.159 mm.
  Number of Fin / length is 393.7/meter.

  There are total two numbers of the manual adjustable 11 feet diameter Moore make fans common for above coolers.

  Existing compressor coolers are with 18.5 KW rating motor.

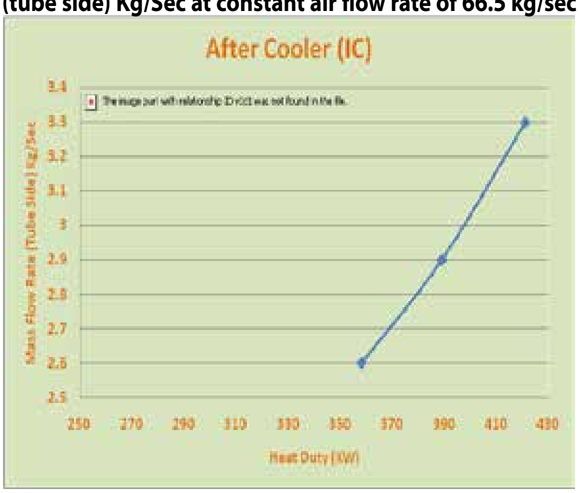
cooler	Inlet/outlet temperature Deg C	Inlet pressure/ allowable pressure drop kg/cm^2	Number of rows of tubes	Number of tubes	Number of phases
Lube oil cooler	72.34/70	3,474/0.492	4	22	2
Inter cooler	105/58	12.35/0.205	4	122	2
After cooler	116/58	21.35/0.51	4	102	4

Design results from HTRI

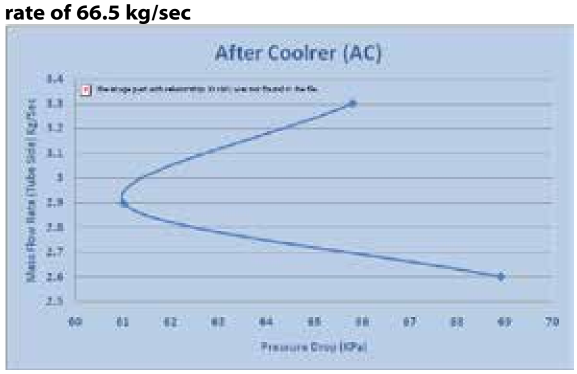
2.7. Comparative Design results from HTRI;
Table 3.3 Design results from HTRI [18]

Process parameters	Original Design case(summer) Air DBT 48.89 ˚C	New Design case (summer).Air DBT 48.89 ˚C	New Design case (winter). Air DBT 10 ˚C
Combined services			
Air flow rate m^3/sec	62.769	62.769	19
Fan absorbed power as per HTRI kW.	16.56	16.58	0.84
Heat duty MW.	0.6235	0.7338	0.8095
After cooler			
Process flow rate kg/sec.	2.612	3.317	3.317
Static pressure mm H_2O.	15.597	16.33	2.773
Operating temperature in/ out ˚C	116.01/59.16	116.01/63.42	116.01/58
Operating pressure kg/cm^2.	24.589	24.589	24.589
Calculated/allowable pressure drop kg/cm^2	0.68/0.51	0.658/0.51	0.672/0.51
Air side flow rate kg/sec.	28.167	28.123	9.330
Velocity on air side m/sec.	8.28	8.29	2.61
Actual U/Required U. w/m^2 K.	22.753/22.698	23.928/23.759	18.282/18.152
Heat duty MW.	0.3579	0.4212	0.4977
Overdesign %	0.24	0.71	0.71

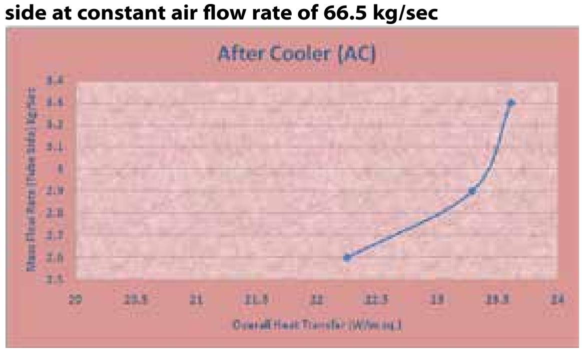
Graphical results for Heat Duty (KW) V/s Mass Flow Rate (tube side) Kg/Sec at constant air flow rate of 66.5 kg/sec



Graphical results for Pressure Drop (KPa) (tube side) V/s Mass Flow Rate (tube Side) (Kg/Sec) at constant air flow rate of 66.5 kg/sec



Graphical results for Overall Heat Transfer (W/m^2) V/s ass Flow Rate (tube Side) (Kg/Sec) at air flow rate of tube side at constant air flow rate of 66.5 kg/sec



Fan Data comparison
Table.4 Results from TUF-LITTE V5-7 HUDSON software[6]

Parameters	Existing fan	New fan (summer case)	New fan (winter case)
Fan model detail	40 series class 5000	Tuf-LiteII	Tuf-LiteII
Fan make	Moore	Hudson	Hudson
Fan diameter-feet Number of blades-number	11x6	11x4	11x4
Fan type	Manual adajustable	Auto variable pitch adjustable	Auto variable pitch adjustable
Fan blade material	Aluminium	FRP	FRP
Air dry bulb temparature ˚C	48.89	48.89	10
Air flow m^3/sec	62.95	62.77	26
Fan total pressure, mm H_2O	Not available	19.474	13.717
RPM	302	302	302
Fan blade angle , Deg	13	13.7	2
Fan absorbed power ,kW	14.914	15.3	5
Motor rating, kW	18.5	15.6	5.1
Fan noise, dba	87	<85	<85

Results from validations using formulas:
For after cooler,
Results from analytical calculations for after coolers

Mass flow rate tube side , kg/sec	Heat duty, MW	Pressure drop, Kg/cm^2	Overall heat transfer coefficient, W/m®K
2.6	0.335	0.587	20
2.8	0.361	0.641	20.2
3.0	0.387	0.736	20.6
3.2	0.413	0.837	21.4
3.4	0.439	0.945	21.83

Results and discussions:

The client's main problem is the achievement of outlet temperature of after cooler as 58 ° C , which is not attained due to ambient conditions and technical limitations of manually adjustable fan without provision of louvers. Means if there is some problem in pressure drop, the client can be informed to make changes in the pumping device. Results are displayed graphically as well as in tabular form to facilitate in changing the flow of chemical or the fluid flowing through the tubes at various flow rate. It is seen that from several iterations on HTRI we are able to get the required air flow rate. The aim of using simulations and validating it with analytical calculations is to facilitate the client in case if any problem arises.

Conclusion

From several iterations done on HTRI it was found that the required temperature of 58 Deg C can be achieved at air flow rate of 19 m^3/sec, but from minimum fan selection software it was clear that for the fan selected the minimum air flow rate that is manually adjustable Louvers on each cooler is to be attached.

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