

AIR COOLED HEAT EXCHANGERS**JGS 210-120-1-25E**

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CONTENTS

	<u>PAGE</u>
1. SCOPE.....	2
2. WORK PROCEDURE.....	2
2.1 Input to the Design	2
2.1.1 Process Conditions	2
2.1.2 Input Data	2
2.2 Work Steps	3
3. DESIGN.....	3
3.1 General	3
3.2 Process Side Design	3
3.2.1 Design Conditions	3
3.2.2 Maximum Tube Inside Velocity	4
3.2.3 Tube Specification.....	4
3.3 Air Side Design.....	4
3.3.1 General	4
3.3.2 Air Intake Temperature for Thermal Design.....	4
3.3.3 Air Outlet Temperature.....	4
3.4 Header Manifold Design.....	4
3.4.1 Type of Manifold Pattern.....	5
3.4.2 Optional Pattern	6
3.4.3 Header Details.....	6
3.4.4 Header Arrangement.....	7
3.4.4.1 Inlet Header.....	7
3.4.4.2 Outlet Header	8
3.7 Plugging.....	10
3.7.1 Protection Against Plugging.....	10
3.8 Process Fluid Control Method.....	11
3.8.1 Outlet Temperature Control.....	11
3.8.2 Inlet Pressure Control	13
3.9 Consideration on P&ID Preparation.....	15
4. DEFINITION	16

1. SCOPE

This standard practice covers the information and guidances for the basic design of Air-cooled Heat Exchangers, alias Air Fin Cooler (hereinafter called as AFC).

2. WORK PROCEDURE

2.1 Input to the Design

2.1.1 Process Conditions

The data to be used for the design of AFC will be obtained from, but not limited to, the following documents ;

- Process Flow Diagram (PFD), including material and heat balances
- Basic Engineering Design Data (BEDD)
- Piping & Instrument Diagram (P&ID)
- Plot plan
- Piping material specification
- Material Selection Basis

2.1.2 Input Data

The following is a summary of input data to be prepared for data sheet of AFC.

- (1) Service for identification
 - Item number, Service name
- (2) Process side operation data

		Required data	Notes
Fluid name		Yes	
Flow rate	(W : kg/h)	Yes	
Operating pressure	(P : kg/cm ² G)	Yes	
Terminal temperature	(T : °C)	Yes	
Vapor	Thermal conductivity (Kv : Kcal/m-h °C)	Yes	At inlet and outlet
	Viscosity (μv : c.p)	Yes	
	Enthalpy (H : Kcal/kg)	Yes	
	Specific heat (Cpv : Kcal/kg °C)	Yes	
	Dew point (Td : °C)	(If necessary)	
	Density (ζv : kg/m ³)	Yes	
Liquid	Thermal conductivity (Kl : Kcal/m-h °C)	Yes	At inlet and outlet
	Viscosity (μl : c.p)	Yes	
	Enthalpy (Hl : Kcal/kg)	Yes	
	Specific heat (Cpl : Kcal/kg °C)	Yes	
	Bubble point (TB : °C)	(If necessary)	
	Density (ρl : kg/m ³)	Yes	
		Pour point	
Condensing curve : Temperature vs Heat content (or Enthalpy) and Temperature vs V/F (wt)			
Heat duty	(Q : Kcal/h)	Yes	
Fouling factor	(r : m ² ·h°C/Kcal)	Yes	

- (3) Air side operation data
 - Ambient temperature (Max./Min.)
 - Fouling factor (ra : m²·h·°C/Kcal)
- (4) Construction data
 - Design pressure
 - Design temperature
 - Short term design conditions, if specified.
 - Materials including Special Requirement such as NACE, PWHT etc.

- Steam Coil (Yes / No)
 - Corrosion allowance
 - Code requirement
 - Nozzle size
 - Nozzle rating and facing
 - Tube/Tube Sheet Connection if specified
- (5) Design requirements
- Allowable pressure drop
 - Allowable velocity, if specified.
 - Max. noise level
 - Outlet temperature control method

2.2 Work Steps

The AFC design will be conducted according to the following work steps, as a guideline.

- (1) Decide the use of AFC based on project specification and/or comparison result with water-coolant cooler
- (2) Prepare input data as listed in section 2.1.2.
- (3) Issue data sheet to vendor.
- (4) Check vendor's design. (Request vendor to submit thermal rating calculation output for critical service.)
- (5) Revise P&ID based on the above results.

3. DESIGN

3.1 General

The feature of AFC is originated from the fact that AFC treats air as coolant, therefore it has advantages and disadvantages compared with water-coolant cooler.

The following should be clarified in the selection.

- (1) Advantage
 - (a) Coolant pipings can be reduced
 - (b) Suitable for high temperature and pressure
 - (c) Low running cost
 - (d) Long life (water corrosion free)
 - (e) Min. 20% cooling capacity may be kept in electric failure case
- (2) Disadvantage
 - (a) Large body and installation area needed
 - (b) High installation cost,
 - (c) Noise problem
 - (d) High transportation cost
 - (e) High process side temperature

3.2 Process Side Design

Process side means tube bundle side.

Related items with process design are as follows;

3.2.1 Design Conditions

Refer to JGS 210-120-1-18E (Determination of Design Conditions).

Note : Full or half vacuum design is needed if steam purging is required.

3.2.2 Maximum Tube Inside Velocity

Limitation values are as listed below.

System	Limitation
(1) Wet H ₂ S service	max. 6 m/s
(2) H.C vapor (no liquid or solid particles)	max. 30 m/s
(3) H.C vapor (Particles are anticipated)	max. 20 m/s
(4) H.C vapor at vacuum or mixed phase	max. ρv^2 7000 kg/ms ²
(5) H.C liquid general	dependent on allowable ΔP

3.2.3 Tube Specification

It should be specified on BEDD.

In general standards are as listed below.

Standard Size & Material	
Tube O.D.	25.4mm, 31.8mm, 38.1mm
Tube material	Carbon steel, Stainless Steel, Alum. Brass, Titanium
Tube length	2m ~ 12m (40FT)
Bundle width	0.5m ~ 3.25m
Fin type	EMBEDDED, EXTRUDED, L-FOOTED

3.3 Air Side Design**3.3.1 General**

Air side design should be based on the following criteria.

- (1) Weather (maximum temperature in summer and minimum temperature in winter)
- (2) Height above sea level (for air velocity adjustment)
- (3) Adjacent unit or building (in/out and air direction)
- (4) Noise limitation (beside the equipment and/or at boundary)

3.3.2 Air Intake Temperature for Thermal Design

In general air intake temperature for design should be 110% of average of daily highest temperature in summer. When a big HFC bank is installed, the effect of air circulation shall be investigated taking into account the plot area.

3.3.3 Air Outlet Temperature

Max. air outlet temperature shall be specified to protect mechanical parts (fan etc.) if necessary.

Average of outlet temperatures at different points should be used for performance check of AFC.

3.4 Header Manifold Design

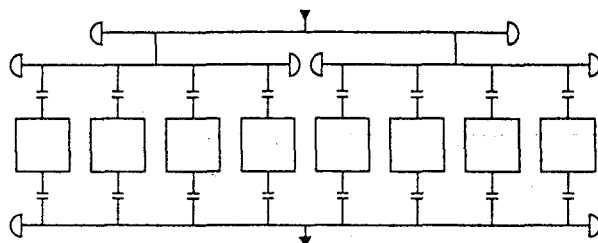
AFC usually has so several number of bundles that Header connects multi bundle's inlet/outlet to keep uniform flow distribution. Selected type of Header Manifold should be drawn on P&ID in the form of "NOTE".

3.4.1 Type of Manifold Pattern

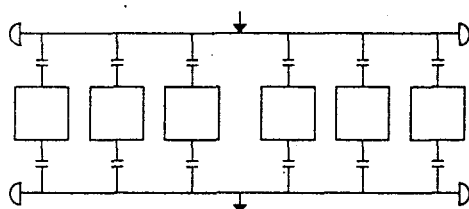
Standard types are as follows.

(1) T-type

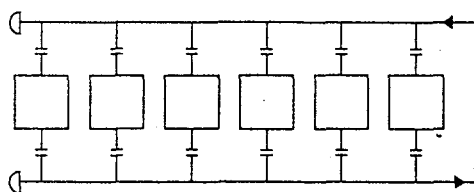
This pattern is so called "Tournament type" in which the piping arrangement is symmetrical.

**(2) MU-type**

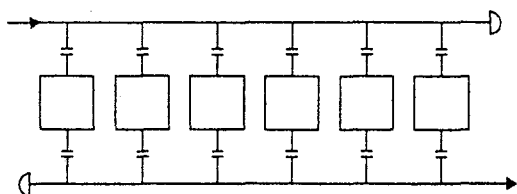
The MU-type pattern is a modification of "U-flow type".

**(3) U-type**

This pattern is so-called "U-flow type"

**(4) S-type**

This pattern is so-called S-flow type.



Goodness of flow distribution is in the following order.

$T > MU > U > S$

Practically MU type may be treated in the same grade as T type.

For overhead condenser MU or T type and for liquid cooler U type should be recommended.