Document No : UniKL MFI_SD_AC41
Revision No: 02
Effective Date: 01 December 2008

CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR

MALAYSIA FRANCE INSTITUTE

FINAL EXAMINATION

JANUARY 2010 SESSION

SUBJECT CODE	:	FRB 30403
SUBJECT TITLE	:	HEAT EXCHANGER
LEVEL	:	BACHELOR
TIME/DURATION	:	9.00 AM – 1.00 PM 4 HOURS
DATE	:	6 May 2010

INSTRUCTIONS TO CANDIDATES

1. All documents authorized (Open Book Examination)
2. This question paper is printed on both sides of the paper.
3. Answer should be written in blue or black ink except for sketching, graphic and illustration.
4. This question paper consists only one section. Answer all questions.
5. Answer all questions in English.

THERE ARE 5 PRINTED PAGES OF QUESTIONS.

INSTRUCTION: Answer ALL questions.

Please use the answer booklet provided.

Question 1

Evaporator with plates –Calculation of the load in fluid

We wish to calculate the charge in refrigerant R134a of an exchanger with brazed plates. For that, we will note the geometrical configuration of the exchanger with plates:

- number of channels receiving R134a: 7
- active width 100 mm/ active length: 700 mm
- height of the corrugations: 2 mm (it is pointed out that the bypass section of a channel is the product of the width of the plate by the height of corrugation)
- type of corrugation: rafters at an angle of 45° with the axis of the plate

The temperature of saturation of R134a is 5° C and the physical properties are:

Temp [C]	Quality [mol/mol]	Pressure [MPa]	Density [kg/m^3]	Enthalpy [kJ/kg]	Viscosity [μ Pa-s]	Therm Cond [W/m-K]
5.000	0.0	0.3497	1278	206.8	254.4	0.08980
5.000	1.0000	0.3497	17.13	401.5	10.94	0.01195

(a). The superheated vapor zone accounts for 10% of the active heat-transferring surface of the exchanger. Calculate the vapor mass superheated in the exchanger

(b). The "diphasic " zone of the evaporator accounts for 90% of the active surface of the exchanger. By considering an average vapor quality of 60% representative of the flow, we will evaluate starting from the traditional methods of calculation

  a. The void fraction in the diphasic zone (starting from the average value of quality)

  b. Average density of the liquid mixture and vapor.

c. Mass of R134a fluid in the "diphasic " zone and the total mass in the two zones (volumes of distribution and the collectors will be regarded as negligible)

(3 marks)

Question 2

Calculation of a fin for a copper tube with circular fin

We wishes to develop a copper tube with external circular fins known as "integral " (i.e. constituted of same material that the tube) These fins have an average thickness of 0.5 mm. The fluid which runs out side near these fins authorizes a coefficient of exchange of 2000 W/m2.K.

Knowing the necessary effectiveness of fin as 0.95, evaluate the height of fin to be recommended?

(the thermal conductivity of copper is 388 W/m.K).

(3 marks)

Question 3

Calculation of a flooded evaporator in R404A with a secondary fluid of the type "potassium acetate"

We wish to check the performances of an apparatus "flooded evaporator" of shell and tube type whose design and operation features are as follows:

<u>Tube side (secondary fluid)</u> :

Operation: potassium acetate at 39% of concentration

Inlet temperature: -27 ° C/Temperature of exit: - 32° C

Mass flow rate: 200 kg/s

Technique: 2 000 tubes with a diameter 15.9/14.9 mm

2 pass

<u>Shell side (refrigerant)</u>: R404A at -40° C

quality at inlet:0%/ outlet: 100%

(a). Calculate Reynolds number and Prandtl number of the secondary fluid at the average temperature of -30° C

(b). To identify the friction and heat transfer laws adapted to the convective transfer in the tube

(c). to evaluate the coefficient of convective transfer at the secondary fluid side

(d). to evaluate the factor of friction and the pressure loss by friction of the secondary fluid (by neglecting the losses associated with the entry and exit in the tubes)

(e). the coefficient of transfer at the shell side will be evaluated starting from a simple expression which is expressed by
h_{evap} = 24 X phi ^0,65
with phi density flux (W/m2) exchanged on the external wall of the tubes. To calculate this coefficient of transfer

(f). To deduce from it the coefficient from total exchange of the evaporator and the exchanged power

(g). What conclusion will you draw on initial dimensioning from the apparatus

(5 marks)

Properties of Potassium Acetate at -30° C (point freezing to -40° C)

- Mass concentration for -40°C freezing point : 39 %
- Density: 1350 kg/m^3
- Specific Heat: 2592 J/kg K
- Thermal conductivity : 0.42 W/mK
- Kinematic Viscosity: 25.0 mm^2/s

Question 4

Cross flow Air-to-Air economizer

We wishes to calculate the exchanged power of an exchanger air-to-air economizer in which the two flows of air are running cross. Taking into account the structure of the fins we will consider that flows of air are not mixed (both unmixed)

The technical data are as follows:

- Heat-transferring primary surface, that is the surface of the plane plates which separate the two fluids: 40 m^2 –Thickness of primary surface: 0.5 mm
- Secondary heat-transferring surface at the hot air side i.e. surface of the fins in contact with the hot fluid: 70 m^2
- Secondary heat-transferring surface at the cold air side i.e. surface of the fins in contact with the cold fluid: 70 m^2
- Effectiveness of fin at hot air and cold air sides: 0.85
- Material of primary and secondary surfaces: aluminium of conductivity 280 W/m/K
- No resistance of clogging and no resistance of contact.

Data of operation:

- Hot air: inlet temperature: 23° C
  - flow: 5000 kg/h
  - coefficient of wall-air exchange: 30 W/m2/K
- Cold air: inlet temperature: 5° C
  - flow: 4000 kg/h
  - coefficient of wall-air exchange: 27 W/m2/K

Recall: we gives the value of the specific heat of the air Cp=1000 J/kg/K

(a) Write an expression connecting the coefficient of exchange and the coefficients of wall-air exchange

(b) Determine the value of this coefficient of total exchange

(c) From this coefficient of total exchange, evaluate the effectiveness of the exchanger

(d) Determine the thermal power from It

(5 marks)

Question 5

Calculation of a glazed solar collector

We wish to evaluate the utilized thermal power of a glazed solar collector. This collector consists of a copper absorber. On this collector, a tube is, also out of copper, contact with the lower face of the absorber.

A glass pane is positioned at the top of the upper face of the absorber. It thus limits the thermal losses between the ambient air and the absorber.

Technical data of the collector:

- Surface absorber: 2 m^2
- Coefficient of transmission of the glass wall: 0.8
- Absorption coefficient of the absorber: 0.9
- Thermal loss ratio (including loss by convection/conduction/radiation): 5 W/m2/K. The variation in temperature (Δt) taken into account for the calculation of the losses is the difference between the average temperature of water in the tube of the absorber and the ambient temperature.

Data of operation:

- Solar flux: direct incidental flux is 670 W/m2 –the radiation is at an angle of 30° to the normal to the plane of the collector
- Ambient temperature: 15° C
- Average temperature of water circulating in the tube equipping the rear face of absorber: 43° C

(a). Write an expression of the effectiveness of the collector according to the variation in temperature between water and environment, incidental flow and the parameters characteristic of the pane and the absorber.

(b). Evaluate the effectiveness of the solar collector

(c). Deduce the useful thermal power from the collector under the operating conditions indicated

(4 marks)

END OF QUESTION