

ChE 306 HEAT TRANSFER
FALL 2009
Exam 3 Review Sheet

Ch 9 Free Convection

Ch 10 Free Convection with Phase Change (Boiling and Condensation)

Ch 11 Heat Exchangers

(also: concept of thermal resistances- Ch 3, internal and external forced convection Ch 7&8)

Concepts:

Ch9 Free Convection: density change- driven flow (gravity vector is a new factor!)

New dimensionless numbers (Ra, Gr)

The orientation & geometry of objects affects flow pattern & heat transfer rates

$Nu = f(Re, Pr)$ or $f(Gr, Pr)$ or BOTH. (how to select the proper correlation)

Newton's Law of Cooling.

T_s - T infinity driving force if there is a large stagnant pool

What T's to use to determine fluid properties

Ch10 Phase change-induced convection- REALLY HIGH h coefficients

surface tension is a new factor in estimating h,q. (why?)

POOL BOILING- 4 main regimes (depends on dT_e)

Rohsenow Eqn

q_{max}

Leidenfrost point

Film boiling (REQUIRES radiation as well as convection)

effect of geometry and orientation of surface

superheated and subcooled fluids

FORCED CONVECTION BOILING (complex, fluid changes from liq to vapor as it moves)

CONDENSATION

- dropwise vs. film condensation

- effect of geometry and surface

Ch 11 Types of Heat Exchangers (ways to characterize)

The five parts of UA (thermal resistances), fouling

Internal energy change of fluid 1 = Internal energy change of fluid 2 = $q = UA \Delta T_{lm}$

Temperature vs. x diagrams

Special cases for ΔT_{lm}

LMTD method: parallel vs. counter flow; double pipe vs. shell & tube exchangers

F (from figures) to correct ΔT_{lm} for shell & tube

DESIGN vs. RETROFIT problem

number of tubes, number of passes (shell and tube side),

E-NTU method: heat capacity rates (q/q_{max} ; C_{min})

Evaporators

WHICH PROCESS HAS THE HIGHER HEAT TRANSFER RATE (q)?

A		B
FILM BOILING		FILM CONDENSATION
FREE CONVECTION ON EARTH		FREE CONVECTION ON THE MOON
USING SATURATED STEAM at 150 °C TO HEAT A LIQUID		USING SUPERHEATED STEAM AT 175 °C TO HEAT A LIQUID
A DOUBLE PIPE EXCHANGER WITH PARALLEL FLOW		A DOUBLE PIPE EXCHANGER WITH COUNTER FLOW
POOL BOILING OF WATER AT 1 atm and 175 °C		POOL BOILING OF WATER AT 1 atm and 125 °C
FORCED CONVECTION BOILING IN THE BUBBLY REGIME		FORCED CONVECTION BOILING IN THE FREE CONVECTION REGIME
WATER BOILING ON EARTH AT 1 atm		WATER BOILING ON SATURN at 1 atm ($g_{SATURN} \sim 1.08 * g_{EARTH}$)
FILM CONDENSATION		DROPWISE CONDENSATION
CONDENSATION ON A VERTICAL PIPE		CONDENSATION ON A HORIZONTAL PIPE
A SHELL & TUBE HEAT EXCHANGER WITH 50 TUBES PER PASS & TWO PASSES		A SHELL & TUBE HEAT EXCHANGER WITH 100 TUBES PER PASS (but only one pass)
A SHELL & TUBE HEAT EXCHANGER WITH 2 BAFFLES		A SHELL & TUBE HEAT EXCHANGER WITH 20 BAFFLES
A S&T HEAT EXCHANGER WITH COPPER TUBES		A S&T HEAT EXCHANGER WITH STEEL TUBES
OPERATING A S&T HEAT EXCHANGER USING LAKE WATER AS THE COOL FLUID		THE SAME EXCHANGER, ONE YEAR LATER
Operating a double pipe heat exchanger with boiling on one side (saturated in/out) and co-current flow		Operating a double pipe heat exchanger with boiling on one side (saturated in/out) and counter-current flow
WHICH COLUMN HAS THE LARGER VALUE?		
Heat transfer rate in the 1st effect of a Double Effect Evaporator		Heat transfer rate in the 2nd effect of a Double Effect Evaporator
U_o (overall HX coeff for outside fluid)		U_i (overall HX coeff for inside fluid)
Boiling point of 10 % NaOH solution		Boiling point of 20% NaOH Solution
U for free convection boiling		U for forced convection boiling