ch 3120 Lec 3 22 Jan 2020

Section A

1a

What CM Unit Ops have unsteady heat xfer

1. start up (shut down)
   - rxr
   - dist column
   - evap
   - boiler
2. furnaces – hot spots
3. unsteady
   - step change
   - programmed, time-dependent operation

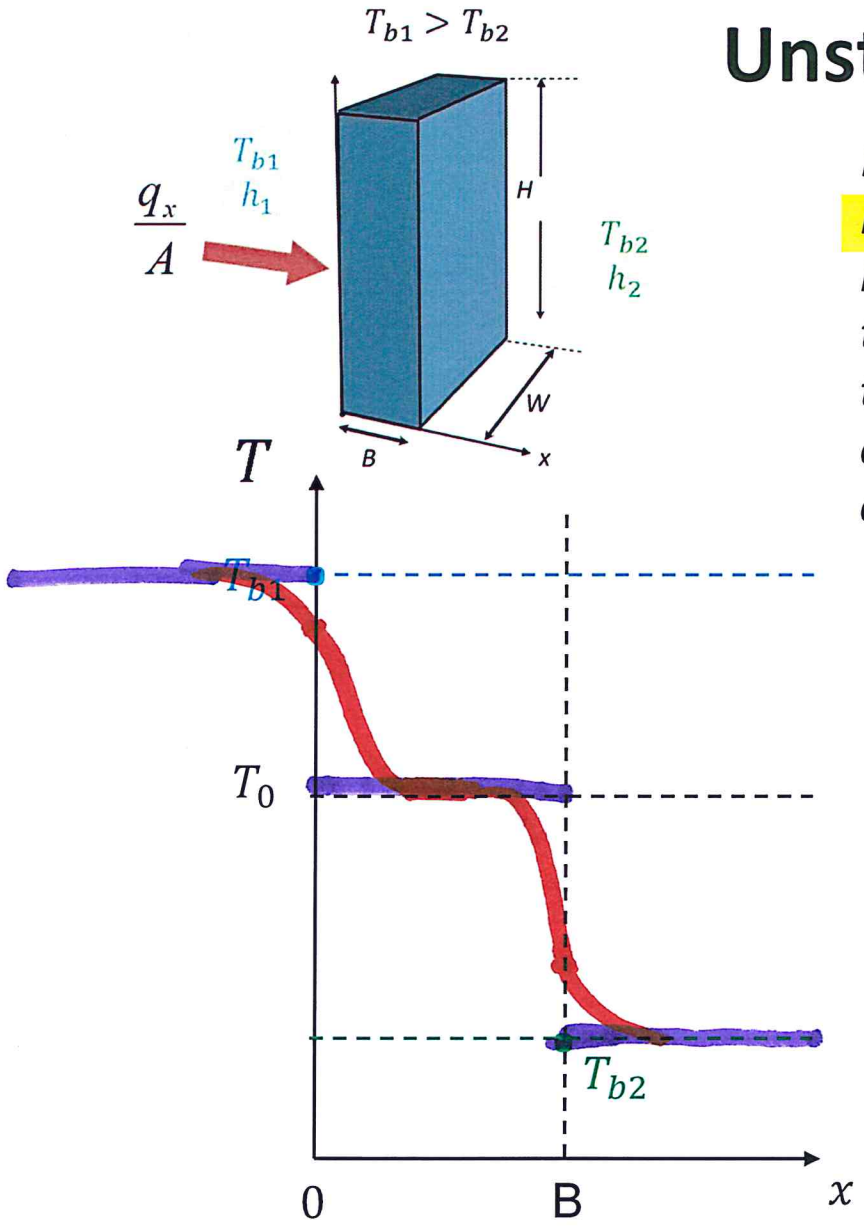
Unsteady Heat Xfr

- mixing Materials w/ different temp
- reaction (exothermic)
- distillation
  - start up
  - shut down

$$\frac{q_x}{A} = -k\frac{dT}{dx}$$

- digester (rxr)
- evaporator - (boiler)

Unsteady Heat Transfer



Example: A wide, tall slab initially uniformly at T_0 is suddenly subjected to flowing fluid on its two broad faces. The left fluid is at T_{b1} and its heat transfer to the wall is characterized by heat transfer coefficient h_1, while the right side is at T_{b2} and characterized by h_2. What is the temperature distribution across the slab as a function of time?

What do we think will happen?

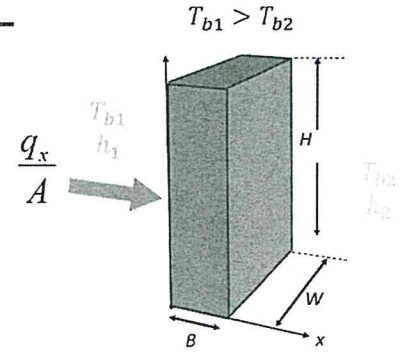
- Will there be heat transfer resistance at the boundaries?
- Will there be a linear temperature profile in the slab?
- Femtoseconds after the change, what does the profile look like?
- What will the solution trend towards as time goes on ($\to \infty$)?

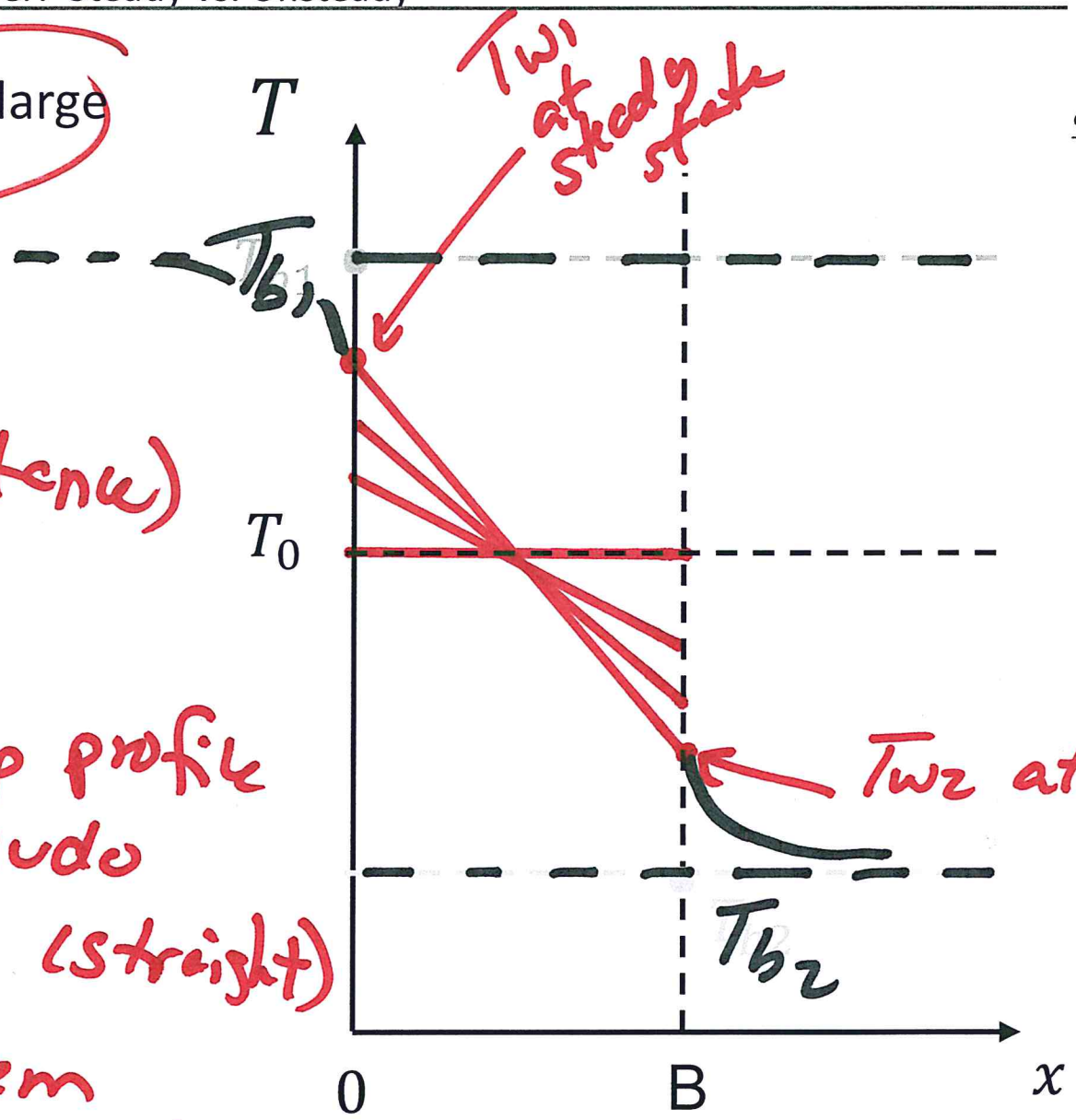
$\Rightarrow$ $\frac{1}{h}$ (resistance) is small

$\Rightarrow$ $T_b = T_w$ $\forall$ time "for all time"

3

- k is large

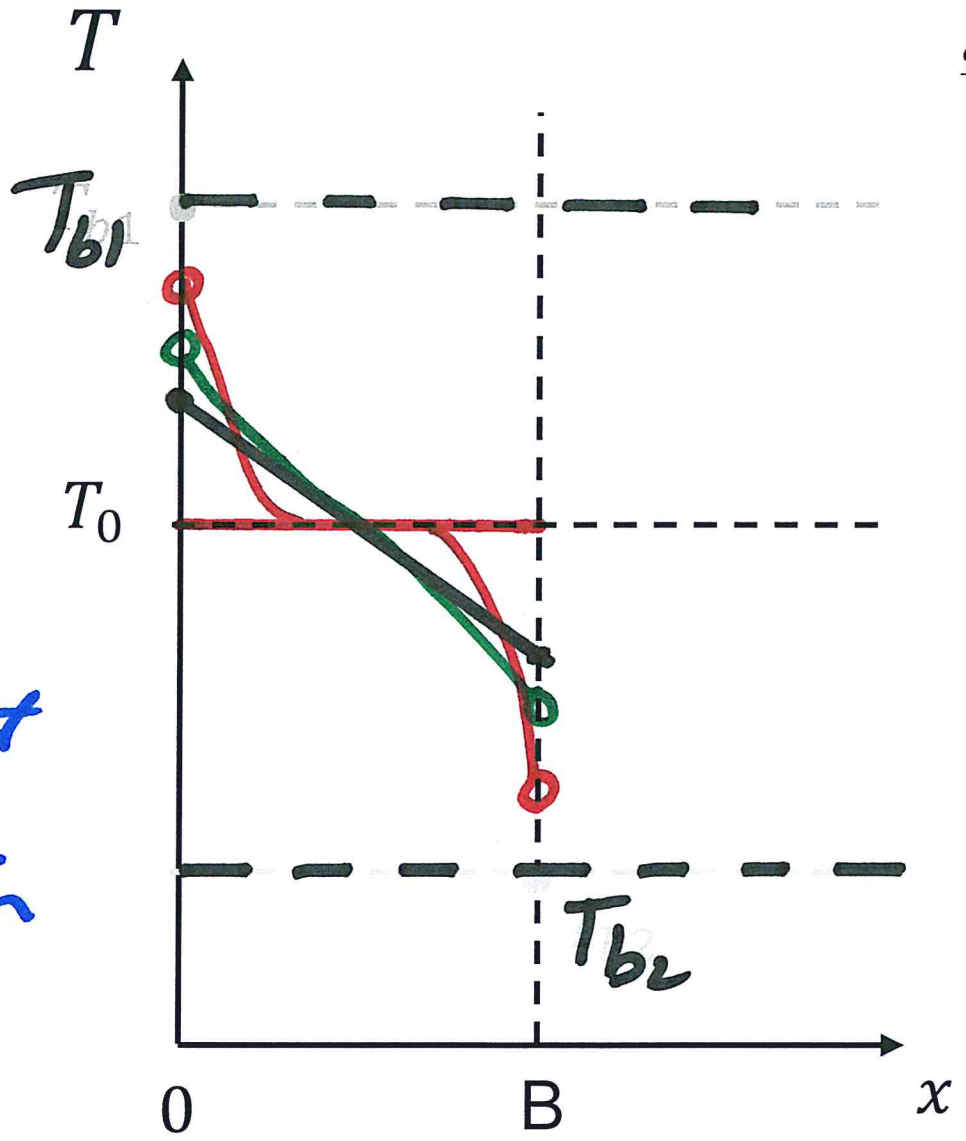


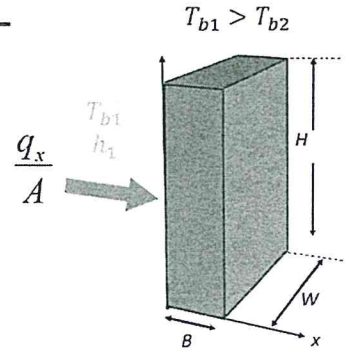


$\Rightarrow \frac{B}{k}$ (resistance) is small

$\Rightarrow$ temp profile is "pseudo steady" (straight) as system approaches steady state

- Neither slab conduction nor fluid convection dominates





both resistances $\frac{B}{k}$, $\frac{1}{h}$ affect time evolution of $T(x)$