Use subtle, pleasing background. This one is a bit too ominous – like the Hand of God is about to reach out and touch us.

Shell and Tube Heat Exchanger

October 7, 20XX
Cycle 2

Group 1X
Me
You
Her
Him

Outline

An outline slide is required.

Number your slides – this is required and helps the audience during Q&A session.

- Objectives
- Background
- Experimental Strategy
- Results
- Error Analysis
- Conclusions
- Recommendations
- References

Select a font size that is appropriate for the size of the room and size of the projection screen

You only have 10 minutes. Create transitions but know that separate transition slides can waste time. Each slide has to be visible long enough for the audience to absorb the information.

Objectives and Background

Objectives

Condense the objective into the primary objective(s). Do not list all tasks performed.

- Operate shell and tube heat exchanger varying steam flow
- Determine the outside overall heat transfer coefficient (U_o)
- Determine shellside heat transfer (Q_{SS})
- Determine tubeside heat transfer (Q_{TS})

Need to provide context (Background) for your work, but maintain focus on Objective(s) --> Results --> Conclusion(s) --> Recommendation(s)

Heat Exchanger Background

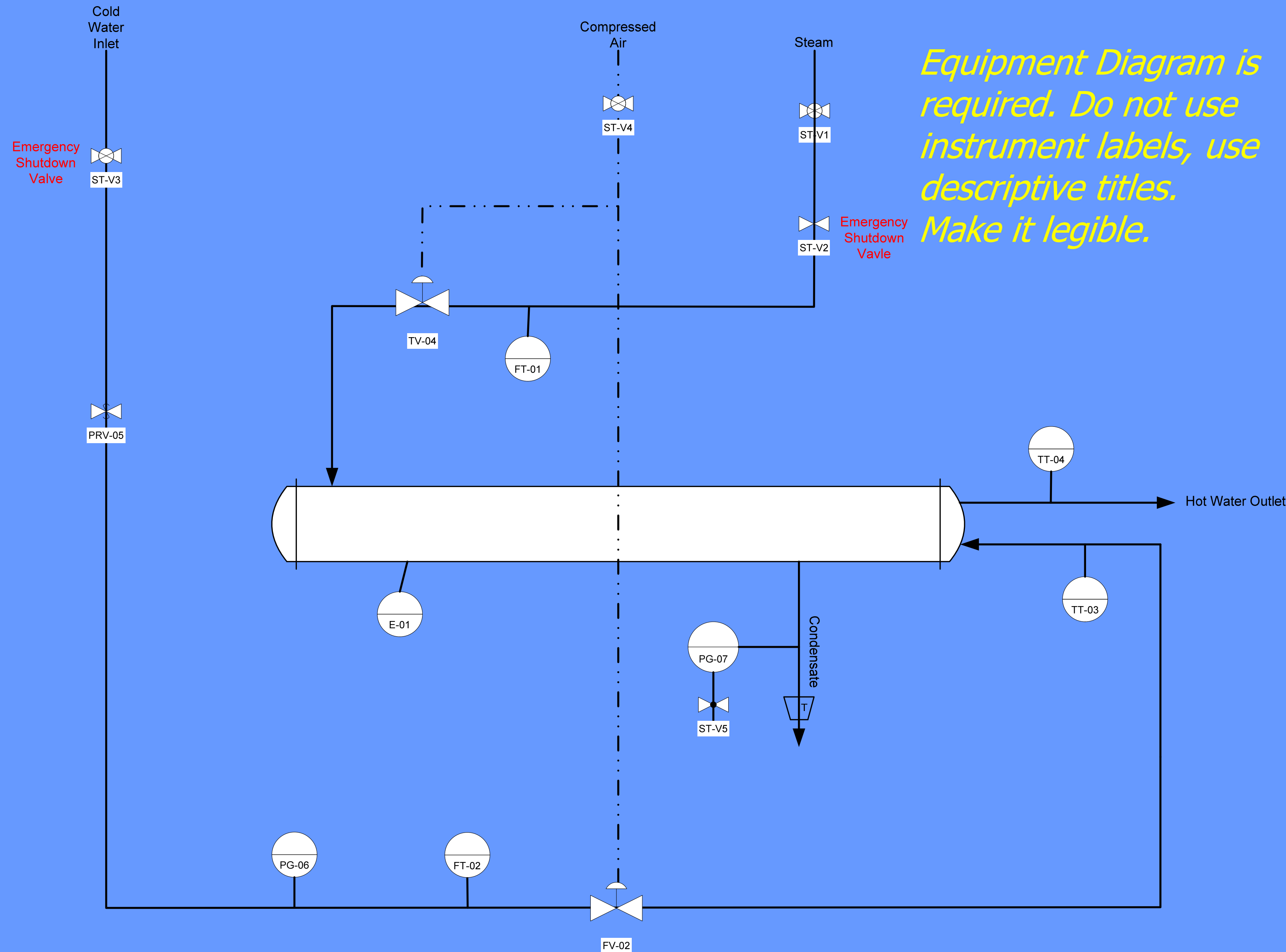
- Exchange heat between fluids
- Latent heat and sensible heat transfer
- Common to chemical process industry
- Types of heat exchangers
  - Air Cooled
  - Double Pipe
  - Spiral Plate and Tube
  - Shell and Tube

Heat Exchanger Background

Shell and Tube Heat Exchangers

- Account for 60% of heat exchangers in use today
- Can handle large flows, low temperatures and pressures, high temperatures and pressures
- Our shell and tube heat exchanger
  - Basco Type 500 U-tube Water Heater
  - 1 Shell Pass
  - 16 Tubes

Experimental Strategy



Equipment Diagram is required. Do not use instrument labels, use descriptive titles. Make it legible.

Figure 1. Unit Operations Lab: Shell and Tube Heat Exchanger (Group 1A)

These two experimental strategy slides say what was done, but not why this method was chosen.

Experimental Strategy

- 5 Runs Total
- Varied Steam Valve (TV-04) Position
  - 105% open
  - 75% open
  - 65% open
  - 60% open
  - 52% open
- Cooling water flow rate constant

"5 Runs" ??
One test at each of 5 conditions, or 5 replicates at each of these 5 test conditions?

What does 105% open mean to the audience?

Experimental Strategy

Can this be condensed?
Can a picture help to eliminate most of this text?

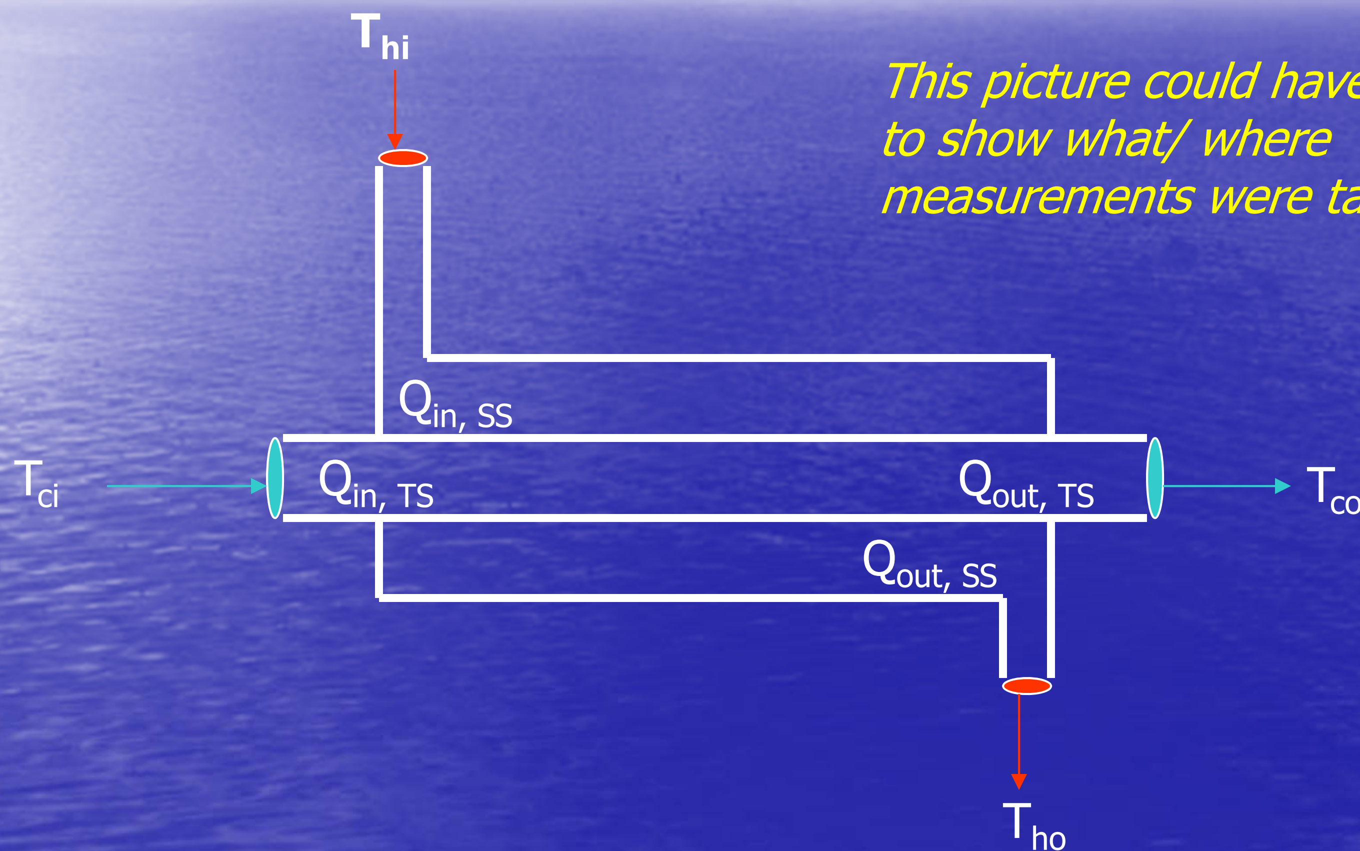
- Measured Variables
  - Condensate flow
  - Condensate temperature
  - Cooling water flow
  - Cooling water inlet temperature
  - Cooling water outlet temperature

Heat Exchanger Calculations

The equations used must be shown in a slide.
Nomenclature needs to be defined.

- Heat transfer rate
  - $Q_{TS} = mCp\Delta T$
  - $Q_{SS} = m\Delta H + mCp\Delta T$
- Overall heat transfer coefficient
  - $U_o = Q_{SS}/(A_o*\Delta T_{LM})$
- Log mean temperature
  - $\Delta T_{LM} = ((T_{hi}-T_{co}) - (T_{ho} - T_{ci})) / \ln[(T_{hi} - T_{co}) - (T_{ho} - T_{ci})]$

Simplified Process Flow Diagram



This picture could have been used to show what/ where measurements were taken.

Results

Compare these tabulated results to the graphs in the next slides.
Which is easier for the audience to absorb?

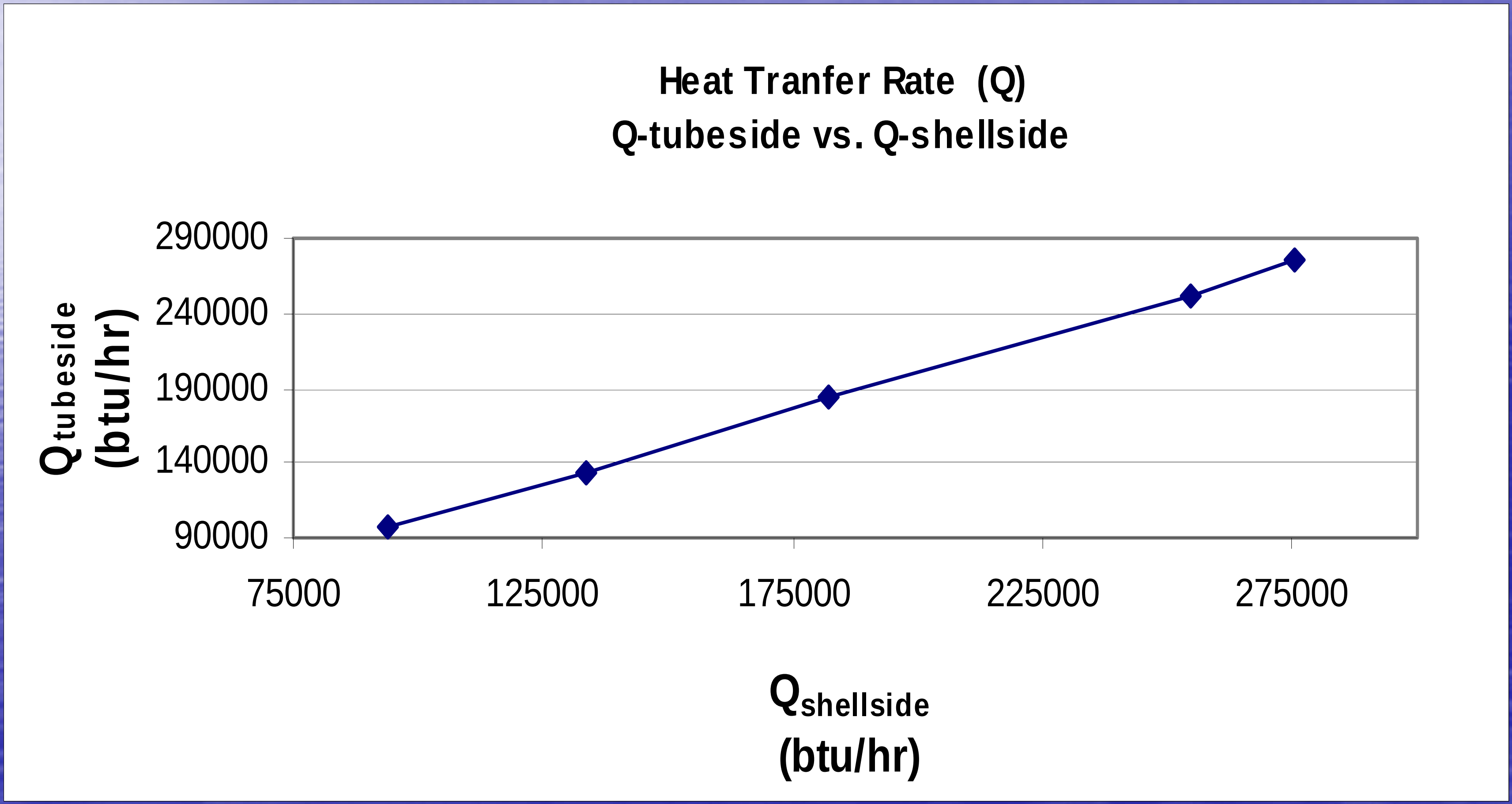
Experimental Results

Pay attention to ***significant figures!***

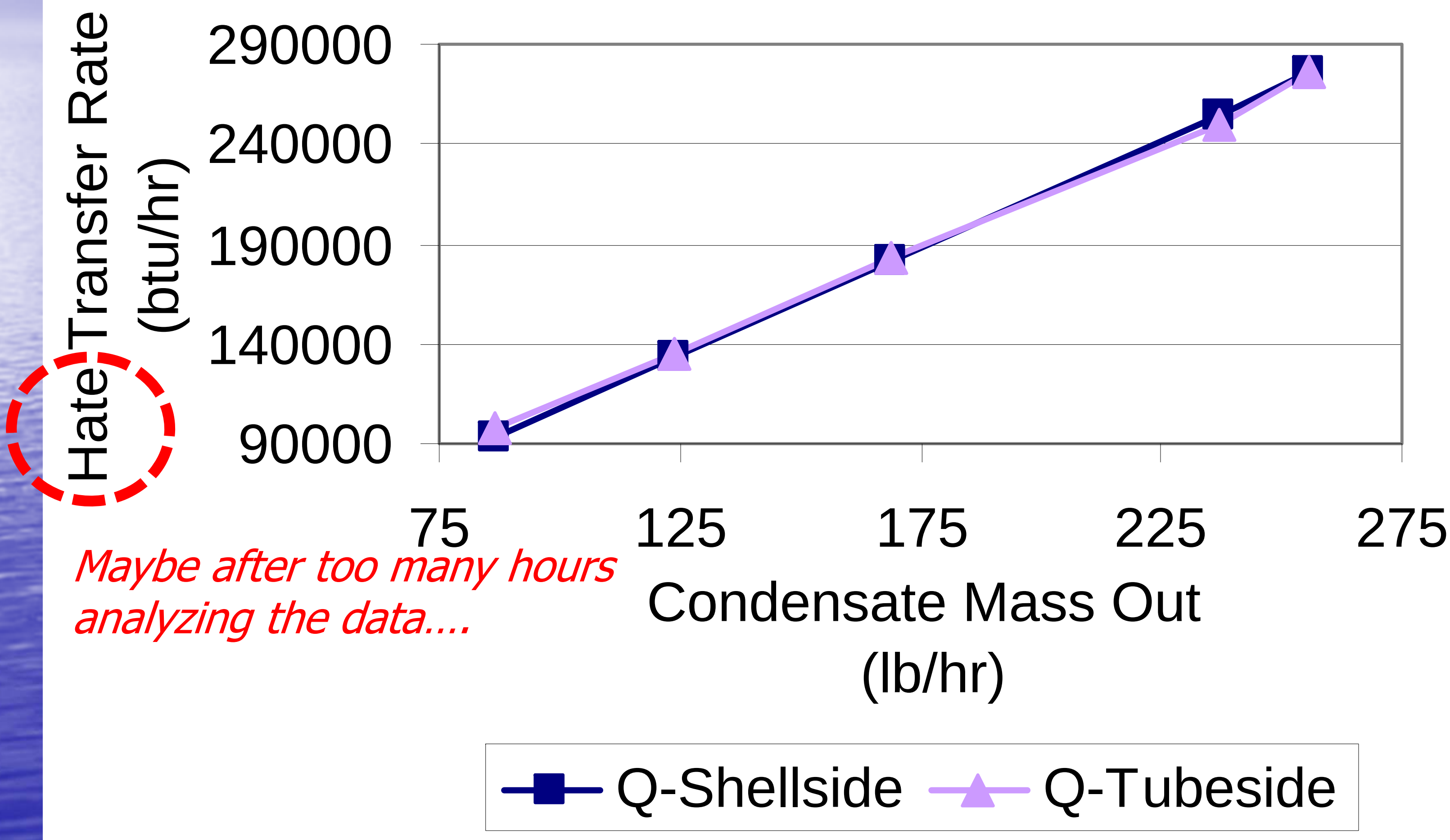
Steam Valve % Open	Heat Transfer Rate (Q_{TS}) (btu/hr)	Heat Transfer Rate (Q_{SS}) (btu/hr)	Overall Heat Transfer Coefficient (U_o) (btu/lb*F*hr)
105%	276489	275350	211
75%	250275	254588	201
65%	183357	181872	148
60%	134200	133777	112
52%	98289	93757	78

Shellside vs. Tubeside Heat Transfer

Both values are equal. So, both axes should be scaled equally.

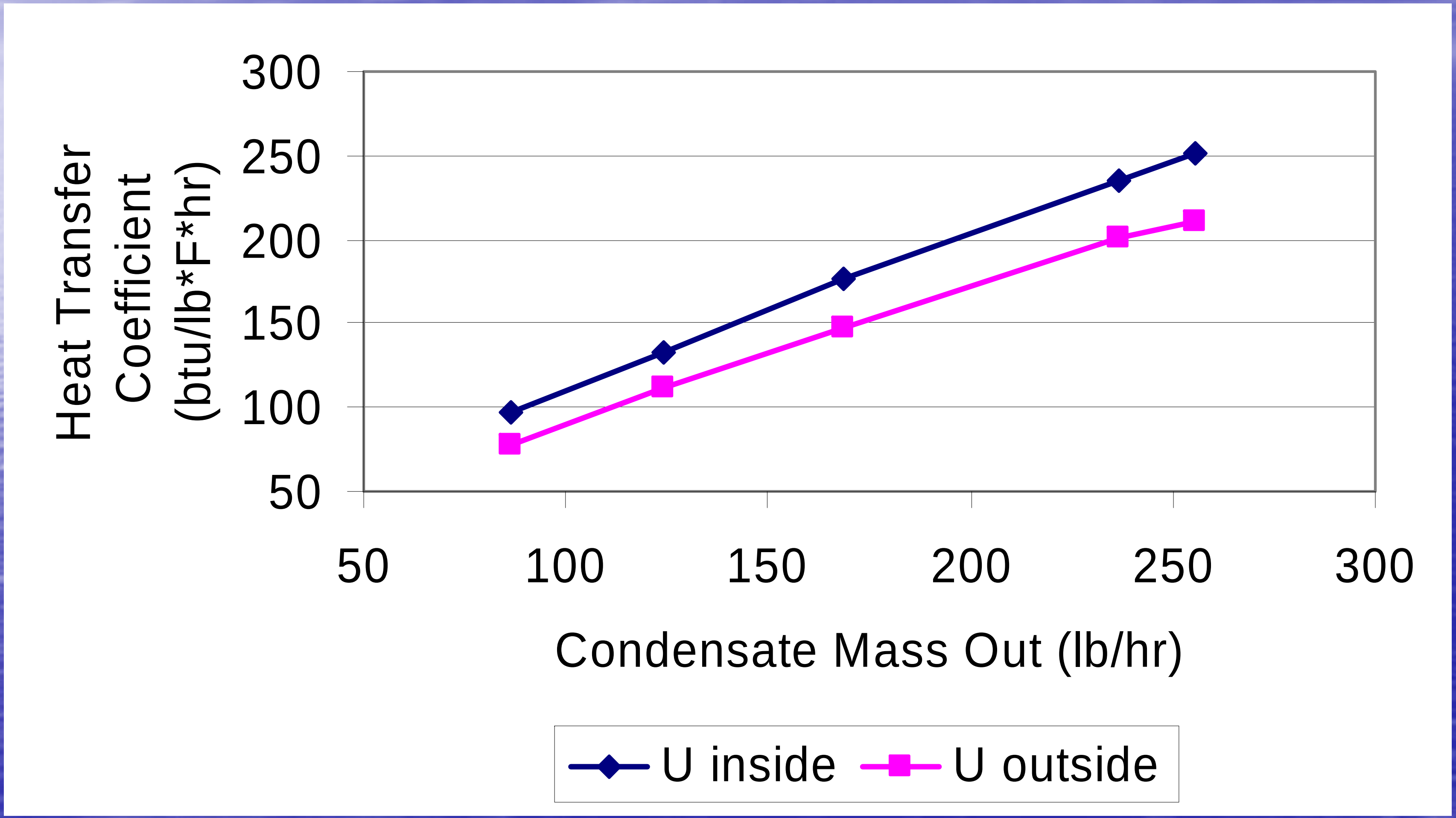


Steam vs. Heat Transfer Rate (Q_{TS}, Q_{SS})



Maybe after too many hours analyzing the data....

Steam vs. Overall Heat Transfer Coefficient



Error Analysis

Propagation of Error

The only thing important here is that RMS error propagation method was used.

- Determine the accuracy of measured variables
- Apply the propagation of error equation to each function

$$\Delta y = \left[\sum_{i=1}^{k} \left(\frac{\partial y}{\partial x_i} \Delta x_i \right)^2 \right]^{1/2}$$

Variable Measurement Accuracy

- Flow rate of the steam +/- 5 lb/hr
- Flow rate of the cooling water +/- 50 lb/hr
- Temperature readings +/- 2 °F
- Largest sources of error
  - Mass flow rate of the steam
  - Mass flow rate of the cooling water

These values can be reported with the results.
Either tabulate key results with uncertainty, or show graphically with error bars.

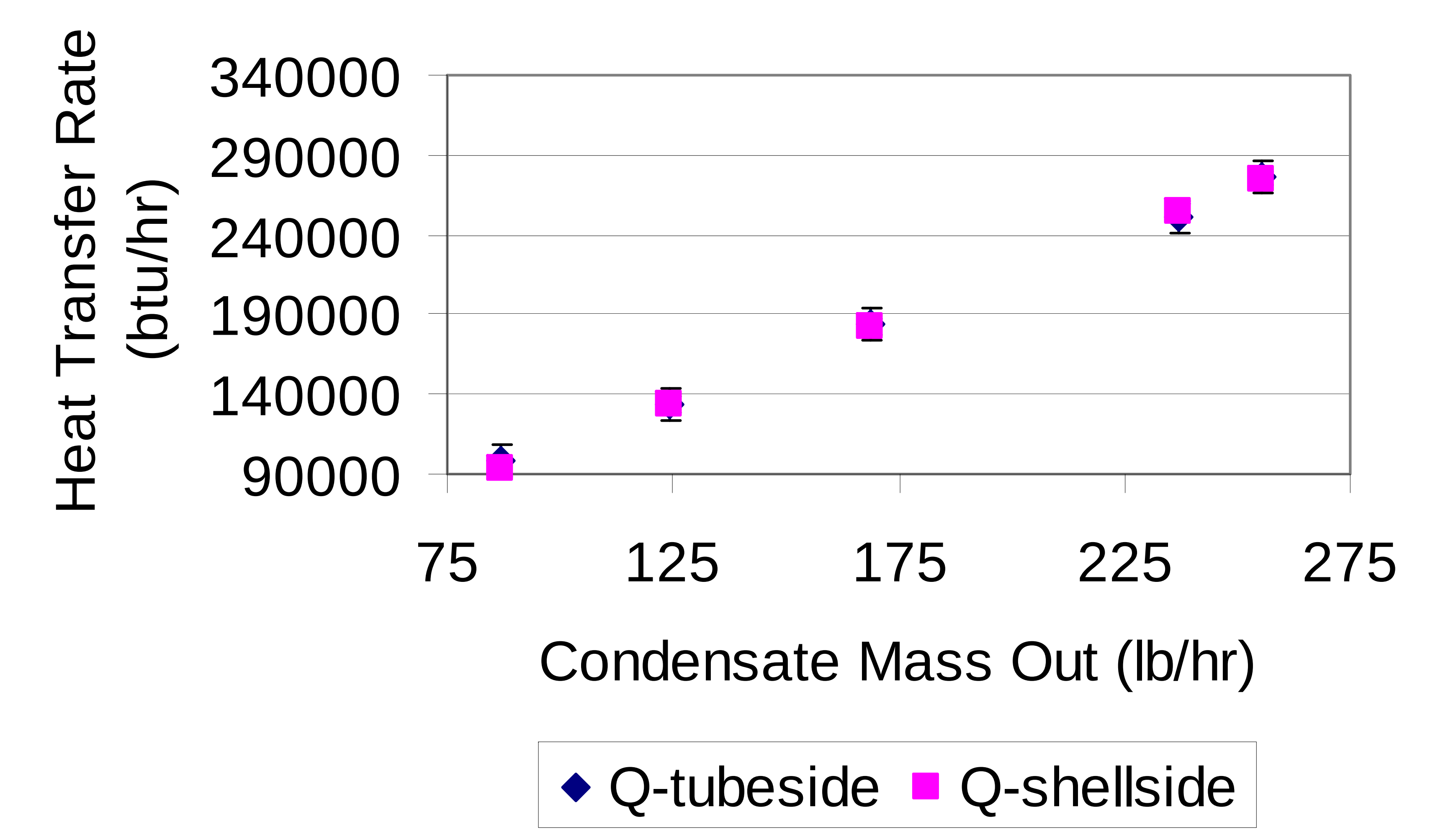
Calculated Error Values

- $\Delta Q_{TS} \approx$ +/- 1,000 btu/hr
- $\Delta Q_{SS} \approx$ +/- 50,000 btu/hr
- $\Delta U_o \approx$ +/- 4 btu/lb °F hr
- $\Delta U_i \approx$ +/- 4 to +/- 1.6 btu/lb °F hr

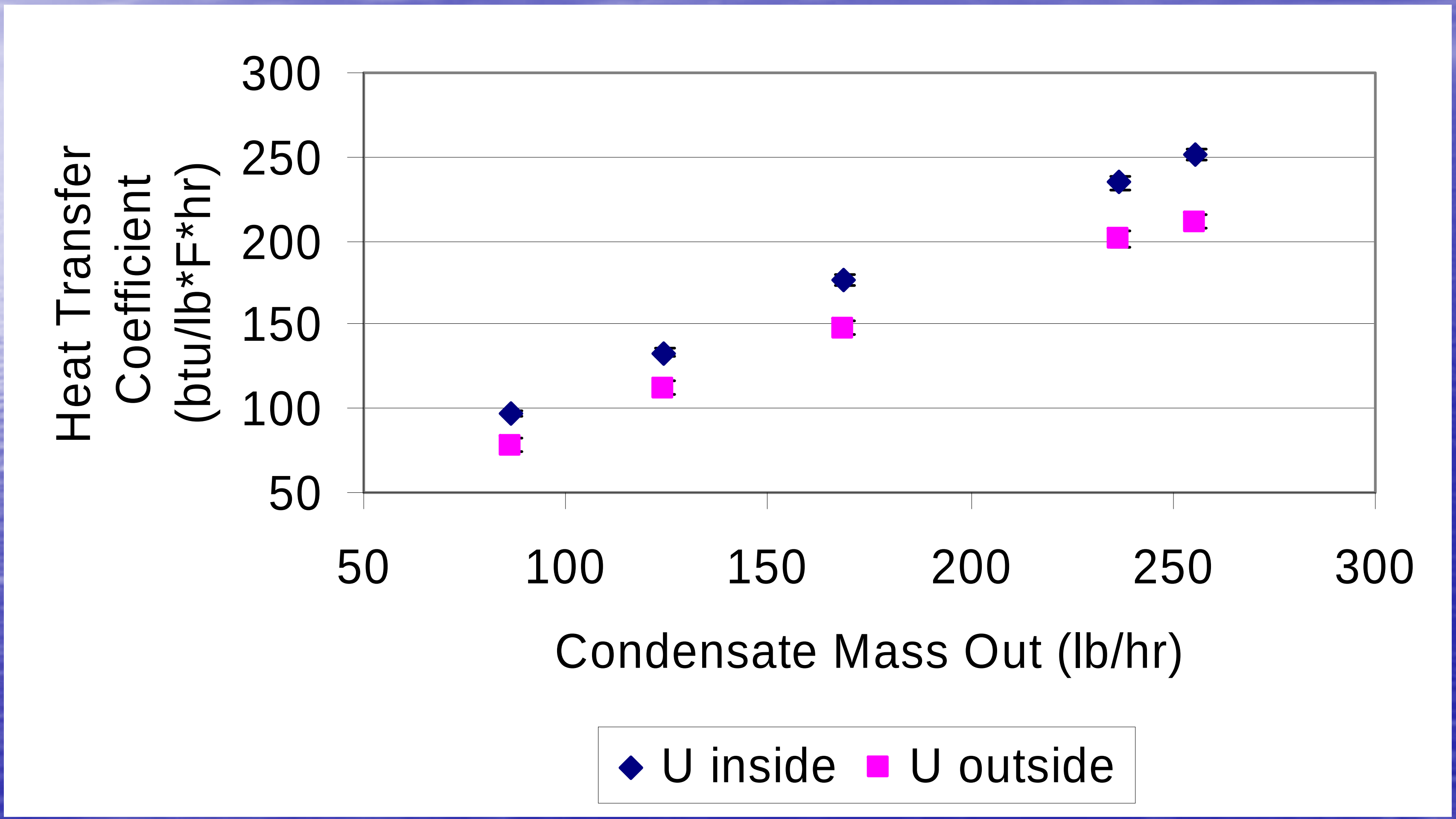
The problem with Error Analysis is that it is a lot of work, and you want everyone to know how hard you worked on it. Move all these slides (and any other supporting slides) after the Q&A slide at the end.
If anyone has follow up questions on this, you can take them to the extra slides. This is an excellent technique that can really impress your audience.

This is just a repeat of an earlier slide with error bars included. Why put the audience through it twice?

Propagation of Error Heat Transfer



Propagation of Error Heat Transfer Coefficient



Finally….

Conclusions and Recommendations

Conclusions

- Q_{TS}, Q_{SS}, U_o all increase as the steam flow rate increases
- Q_{TS}, Q_{SS}, U_o all have a linear relationship with the mass flow rate of the steam
- Heat transfer rate of the tube side is equal to the heat transfer rate of the shell side

Recommendations

The first one is good.
Second one has nothing to do with anything else presented up to this point.

- Operation Recommendation
  - Operate the shell and tube heat exchanger at approximately 75% for sufficient heat transfer and economic efficiency
- Experiment Recommendations
  - Monitor pressure gauge (PG-07) at low steam rates to prevent a vacuum

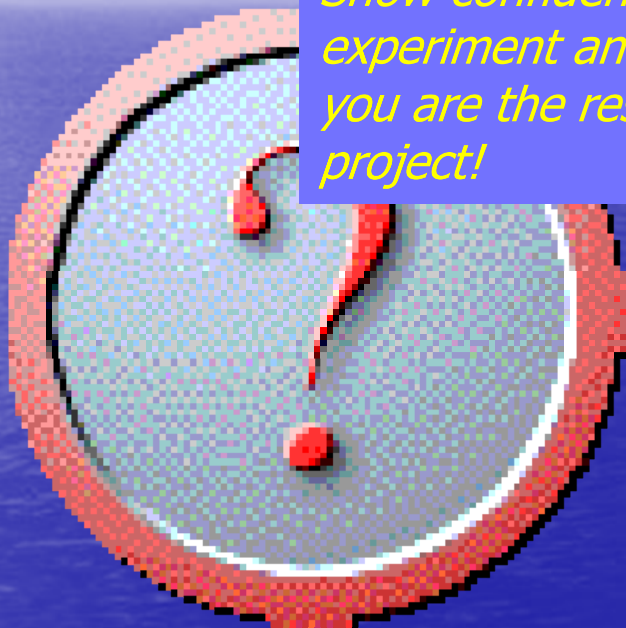
References

Another required slide.

- API Heat Transfer. Shell and Tube Heat Exchanger Picture www.apiheattransfer.com/en/Products/HeatExchangers/ShellAndTube/
- Georgia Tech. *Propagation of Error*. www.swiki.che.gatech.edu/CHE4200. August 2002.
- Geankoplis, Christie J. *Transport Processes and Unit Operations*, 3rd ed. Englewood Cliffs, NJ. Prentice-Hall Publishing, Inc. 1993.
- Heald, C. C. *Cameron Hydraulic Data*. Liberty Corner, NJ. Ingersoll-Dresser Pump Co. 1998.
- Peters, Timmerhaus, West. *Plant Design and Economics for Chemical Engineers*, 5th ed. New York, NY. McGaw-Hill Co. Inc., 2003.

Proofread.
Any spelin errors?
Appropriate grammar?
Format consistency?
Punctuation consistency?

Practice.
Use a stopwatch.
Don't rush it.
Work on voice rate, volume, clarity.
Avoid casual language!
Show confidence – you just ran the experiment and calculated the results – you are the resident expert on this project!



This presentation was 28 slides. That's enough for most 50 minute lectures! You only have 10.