To: Heat Transfer Design Group

From: Morris Argyle

Date: April 26, 2022

Subject: Sizing of New Shell-and-Tube Heat Exchanger

A shell-and-tube heat exchanger is to be installed in our new plant that must heat 200 gpm of water from 25 °C to 75 °C. Saturated steam up to 300 psig is available to use in the process. Please determine which unit to purchase from Standard Xchange to accomplish the required heat transfer.

To aid in your selection, the R&D team has set up a pilot-scale heat transfer system with a shell-and-tube heat exchanger from Standard Xchange. The system uses Model 03014 SSCF set up in a one shell pass and one tube pass configuration. Assuming that the fouling factor, f, is only a function of heat exchanger condition, use this apparatus to find a unique fouling factor value that can be expected for heat exchangers from Standard Xchange. Then use this fouling factor to select an appropriate heat exchanger for the application explained above.

I look forward to your report.

Unit Operations Laboratory

**Shell & Tube Heat Exchanger Lab**

Ch En 479

# Introduction

Shell and tube heat exchangers are one of the most common pieces of equipment encountered by chemical and other engineers. They are used in many industries including oil and gas, pharmaceuticals, chemicals, and food processing. BYU chemical engineering students learn the *theoretical* basics of heat exchangers in lecture courses and have preliminary experience with these apparatus in Ch En 385; however, many things must be considered when designing real heat exchangers. The purpose of this lab is to help students understand these subtleties and give them experience selecting a shell and tube heat exchanger for a specific application. A second purpose is to provide experience solving a complex problem presented with little direction on how to proceed—a core skill expected of all engineers.

The memo above is written to help simulate the work environment. The main deliverable for this lab will be a report written in response to this memo. In addition to the report, you will also complete a few other assignments as explained in the next section.

In this experiment, saturated steam enters the shell side of the heat exchanger and water enters the tube side. You can control the flowrate of the water and the steam pressure. The water to the exchanger is supplied from a 30-gallon tank. When running, cold water is added to the tank to prevent the system from overheating from constant recirculation through the heat exchanger. The exact details of the system are found on the UO lab website and the walkaround video available at

<http://uolab.groups.et.byu.net/files/shelltube/videos.htm>.

The UO Lab website for this experiment contains many documents and videos. Make sure to examine *all* the items provided. They contain *all* the information needed to analyze the system. Also, if you want to examine the control panel for the lab, make sure you are using Pale Moon. Do not click “View and/or Control Experiment” for the Shell and Tube lab, or any other lab, unless you are using the Pale Moon web browser on a UO Lab computer. Using Chrome, Firefox, Safari, or other browsers will require a manual restart of the system.

# Deliverables

1. **Proposal (*Team*, email to the instructor)**

In industry, before devoting time or resources to a project, the team must demonstrate understanding of the problem and a logical plan of attack. To this end, craft a proposal, based on the proposal information made during the presentation or found on the UO Lab Website. All the information for this task, including the details of the exchanger, are found above in this document, in your textbooks, in the explanatory video, or on the UO Lab Website.

***(Due by the end of class on the day indicated in the schedule.)***

1. **Safety and Ethics (Individual, give to instructor)**

All labs in this class require safety and ethics training. Complete the document entitled “Shell and Tube Safety and Ethics Training” to prepare to take data safely for this lab.

***(Due by the end of class on the day indicated in the schedule.)***

1. **Progress Report (*Team*, email to Instructor and TA)**

This short memo highlights the current progress on the project, obstacles encountered, and projected finish date. The outline is described in a presentation made before the due date.

***(Due at the end of class on the day indicated on the schedule.)***

1. **Formal Written Memo Report** **(*Individual*, Microsoft Word Document as attachment in email to instructor)**

Deliver an *individual* memo report to your instructor in response to the problem statement memo. This report should explain how you used the apparatus and theory to determine a fouling factor, how you used the fouling factor to scale up to the larger installation, and your recommendation for the heat exchanger needed for the new plant. Make sure to explain how what you measured and calculated led to your conclusions. This is an important part of technical writing that students often neglect. The communication should explain what you did, the outcomes, and how you interpreted the data. It should have several tables, charts, and/or graphs describing the data you took, the quantities you calculated, and the scale up to the larger heat exchanger. Make sure the reader knows why you are placing these in the report (can follow your logic). Include enough description that the reader can know how you interpreted the data and why this interpretation is important. Don’t forget to take uncertainties into account when recommending a unit. Also, “doing more tests” or waffling on your answer is not acceptable. Your boss wants to know which unit to purchase for the application described in the memo. The format will follow the outline in the presentation given in class.

***(Due at the beginning of class on the day indicated on the schedule.)***

1. **Report Appendix** **(*Team*, Microsoft Word Document emailed to instructor and TA)**

Following the outline in the presentation made in class, each *TEAM* will prepare one Appendix which describes in detail information that could not be included in the formal report due to length. This must be a stand-alone document.

***(Due at the beginning of class on the day indicated on the schedule.)***

1. **Leadership and Teamwork Report** **(Individual, email to instructor)**

Follow the instructions in the document “Leadership and Teamwork Report” to reflect on your relationship with your teammates and your ability to be a leader.

***(Due by the end of class on the day indicated on the schedule.)***

1. **Shell and Tube Quiz** **(Individual, In class)**

Each team member will take a quiz to determine basic understanding of this heat exchange project.

***(Due during class [20 minutes] on the day indicated on the schedule.)***

1. **Lab Notebook (*Team*, email to TA)**

Email your final lab notebook to the TA. See the document “LabNotebook – Guidelines” for more information.

***(Due by the end of class on the day indicated on the schedule.)***