Prof. Hicken • JEC 5020 • email: *hickej2@rpi.edu*

Project #1

Analysis-model write-up: due Sep 10, 2024
Report: due Sep 24, 2024

Background

You are tasked with designing the shape of a heat exchanger. Specifically, you must design a two-dimensional section that is repeated horizontally to get heat exchangers of desired widths, where each section has a width of $L = 5$ cm; see Figure 1 for reference.

The exchanger is designed to heat air using hot water. You can assume that the temperature of the water is uniformly 90°C and that the air is 20°C. Assume that the exchanger is made of a steel alloy with a thermal conductivity of 20 W/(mK).

The objective is to maximize the heat flux per unit length from the water to the air. You have direct control of the shape of the exchanger that touches the air. The side of the exchanger that touches the water is flat and will not be altered. The air-side shape can take on any shape, provided

- the shape is a function of horizontal distance (i.e. no implicit functions);
- the thickness of the heat exchanger is at least $h_{\min} = 1$ cm and no more than $h_{\max} = 5$ cm at any point along the horizontal, and;
- the shape is accurately captured by the heat-flux analysis method.

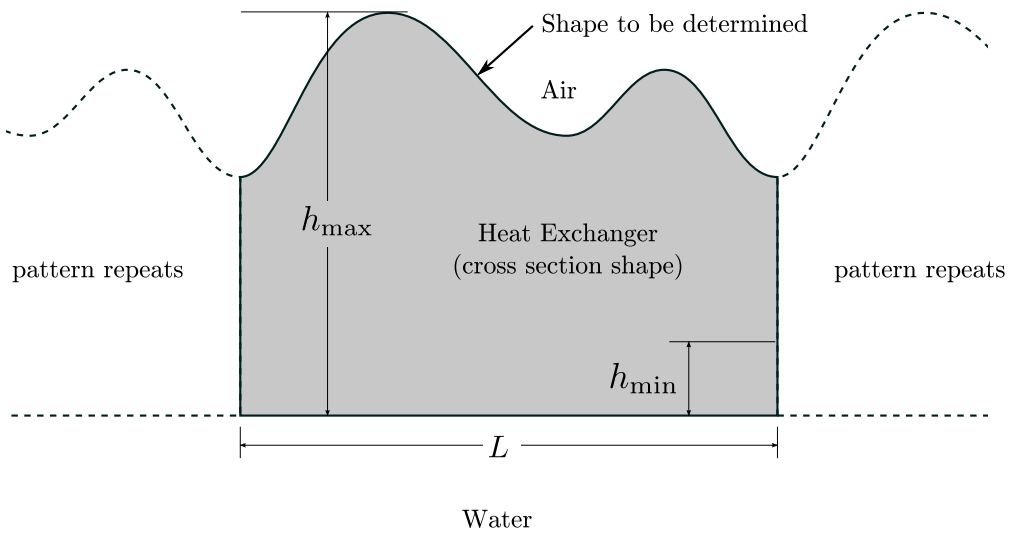

Figure 1: Illustration of the heat-exchanger design problem.

Analysis Model

Write a concise (less than one page) description of how you might analyze the heat exchanger. Specifically, you need to

- address how you might estimate the heat-flux per unit length, and;
- describe how you might go about representing the geometry so that it is amenable to optimization (i.e. what are the design variables?).

Project Report

Write a report that **concisely** describes your approach and results. At a minimum, the report should contain

- an executive summary;
- a description of the analysis method, including any assumptions and limitations inherent in the method;
- a description of the geometry parameterization;
- the optimization problem statement and optimization method(s), including the objective and any constraints;
- results, including the final geometry(ies) and convergence history(ies);
- conclusions and/or discussion of the results, and;
- an appendix with the source code.

The length of the report is not to exceed 10 pages (excluding the code appendix). Please refer to the corresponding rubric for how the report will be assessed.

Collaboration

You are permitted and encouraged to discuss the project with each other, provided each of you writes your own code and report. A good policy to follow in order to avoid academic misconduct is to not take project notes or exchange project files with one another; i.e. exchange information verbally and you should be fine.