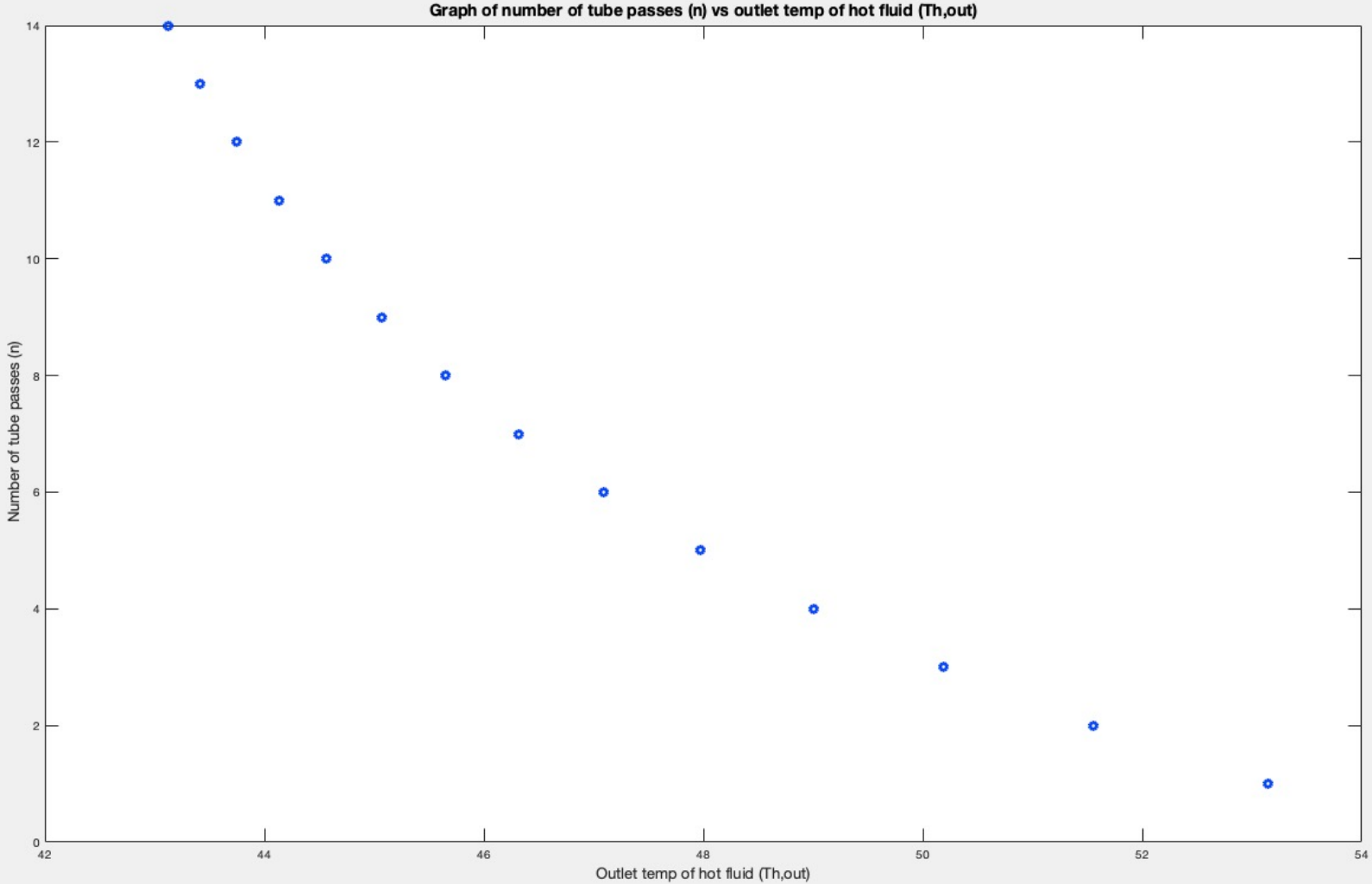
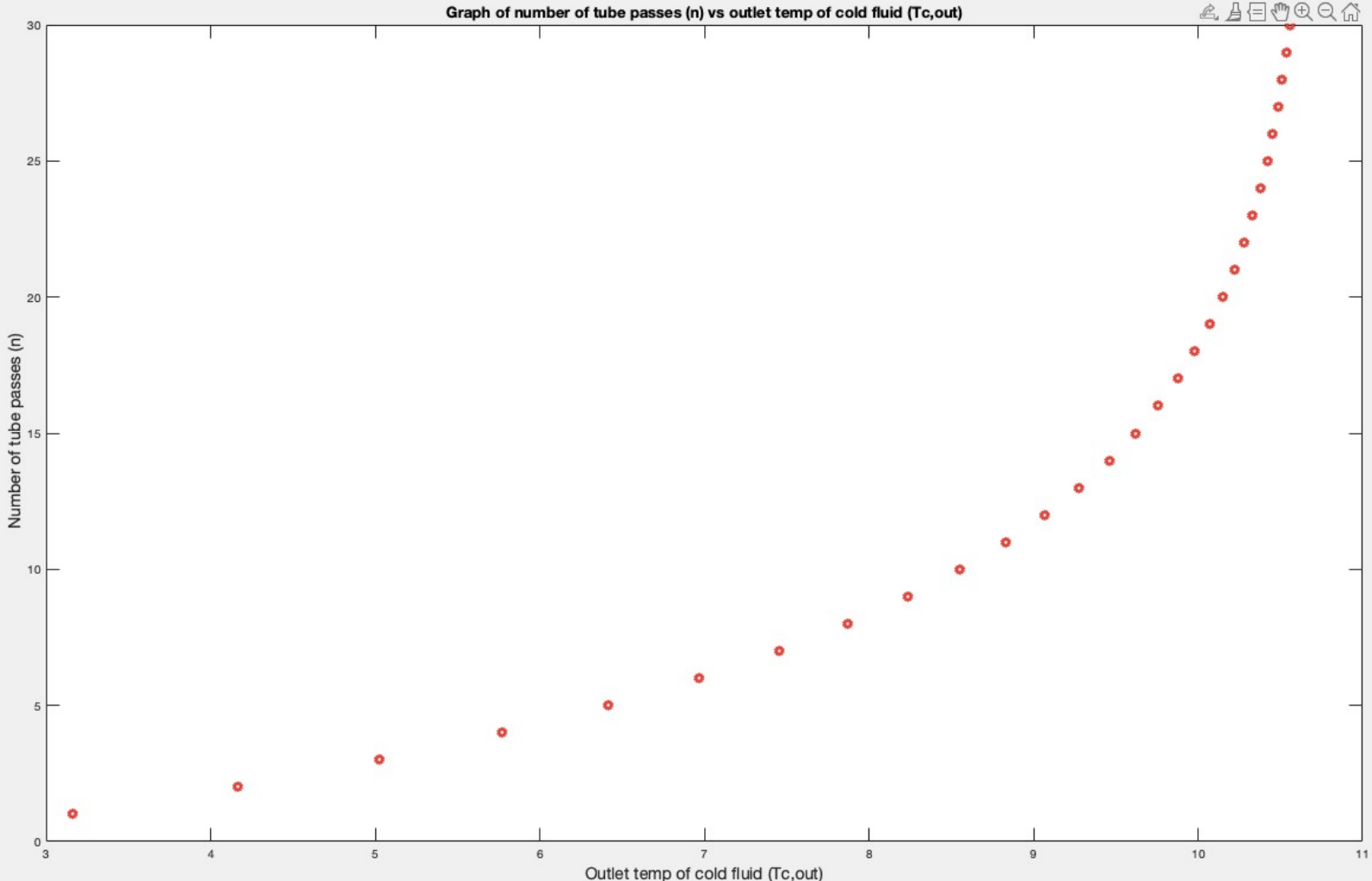
Part-A

- To reduce the ethanol temperature from 55°C to 15°C, the 1-shell pass heat exchanger requires at least 12-tube-passes of 1.5-cm-diameter and 3-m-long tubes. At 15°C, the temperature is below the flash point of ethanol, and the risk of fire hazard is alleviated. The heat exchanger can accommodate up to 14-tube-passes, therefore it is suitable for this application.


Graph of number of tube passes (n) vs outlet temp of hot fluid (Th,out)
Number of tube passes (n)
Outlet temp of hot fluid (Th,out)
0
2
4
6
8
10
12
14
42
44
46
48
50
52
54


Graph of number of tube passes (n) vs outlet temp of cold fluid (Tc,out)
Number of tube passes (n)
Outlet temp of cold fluid (Tc,out)
0
5
10
15
20
25
30
3
4
5
6
7
8
9
10
11

Part-B

- **Point of infeasibility** is comes out to be around 20, that means we cannot increase the coolant temperature beyond 20 tubes.

Part-C

- Shell and tube heat exchanger gives highest effectiveness.
- Shell and tube heat exchangers **make it possible to pump materials as soon as possible**, and they transfer temperatures efficiently so we can ensure the materials are at the necessary temperature without expending extra energy to do so.

Part-D

Application of double-pipe heat exchanger

The application range of double tube heat exchangers is very broad and difficult to cover due to its practical, beautiful, and concise design. Some of them are:

- The double pipe exchanger is used in the compressors and boiler because they have very high pressure and temperature
- Cooling and heating systems of the process plant.
- Wastewater treatment
- Refrigeration
- Oil refining

Part-D

Application of Shell and tube heat exchanger

Shell and tube heat exchangers are considered one among the most effective type of heat exchangers. These heat exchanges have a cylindrical shell with a bundle of tubes. The tubes are made from thermally conductive materials, which allow heat exchange between the hot fluids flowing outside the tubes and the coolant flowing through the tubes. These heat exchangers offer an optimal cooling solution to different applications including:

- Hydraulic
- Leisure
- Marine
- Rail
- Industrial

Part-D

Application of Cross flow heat exchanger

- A cross-flow heat exchanger exchanges thermal energy from one airstream to another in an air handling unit (AHU). Unlike a rotary heat exchanger, a cross-flow heat exchanger does not exchange humidity and there is no risk of short-circuiting the airstreams.
- A cross-flow heat exchanger is used in a cooling and ventilation system that requires heat to be transferred from one airstream to another. A cross-flow heat exchanger is made of thin metal panels, normally aluminium. The thermal energy is exchanged via the panels. A traditional cross-flow heat exchanger has a square cross-section. It has a thermal efficiency of 40-65 %. A counter-flow or dual cross-flow heat exchanger can be used if greater thermal efficiencies are required – typically up to 75-85 %.

Part-D

- The most common type of heat exchangers, **shell and tube heat exchangers** are constructed of a single tube or series of parallel tubes (i.e., tube bundle) enclosed within a sealed, cylindrical pressure vessel (i.e., shell).
- The selection of the baffle plays a vital role to regulate and increase the thermohydraulic performance and also to decrease fluid-induced vibrations due to shell side flow.