# Review of Experiment on Spiral Heat Exchanger

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**Abstract:** Spiral tube heat exchangers are known as excellent heat exchanger because of far compact and high heat transfer efficiency. Spiral tube heat exchanger uses single channel technology, which means that both fluids occupy a single channel, which allows fully counter-current flow. The paper studies the experimental method for finding the performance of spiral tube heat exchanger over the shell and tube heat exchanger.

**Key Words:** Spiral heat exchanger, counter-current flow, performance.

## Introduction:

One of the important processes in engineering is the heat exchange. The means of heat exchanger that to transfer the heat between flowing fluids. A heat exchanger is the process to transfer heat from one fluid to another fluid. The heat exchanger is devise that used for transfer of internal thermal energy between two or more fluids at different temperatures. In most heat exchangers, the fluids are separated by a heat transfer surface, and ideally they do not mix. Heat exchangers are used in the process, power, petroleum, transportation, air conditioning, refrigeration, Cryogenic, heat recovery, alternate fuels, and other industries. Common examples of heat exchangers familiar to us in day-to-day use are automobile radiators, condensers, evaporators, and oil coolers. Helical and spiral coils are known types of curved tubes which have been used in a wide variety of applications for example, heat recovery processes, air conditioning and refrigeration systems, chemical reactors, food and dairy processes. Heat transfer and flow characteristics in curved tubes have been widely studied by researchers both experimentally and theoretically.[1]

## Spiral Tube Heat Exchanger:

Spiral tube heat exchanger has excellent heat exchanger because of far compact and high heat transfer efficiency. Spiral-tube heat exchangers consist of one or more spirally wound coils which are, in circular pattern, connected to header from which fluid is flowed. This spiral coil is installed in a shell another fluid is circulated around outside of the tube, leads to transfer the heat between the two fluids. Heat transfer rate associated with a spiral tube is higher than that for a straight tube. In addition, a considerable amount of surface can be accommodating in a given space by spiralling. In spiral tube heat exchanger, problem of thermal expansion is not probably occurring and self cleaning is also possible. A spiral tube heat exchanger is a coil assembly fitted in a compact shell that to optimizes heat transfer efficiency and space. Every spiral coil assembly has welded tube to manifold joints and uses stainless steel as a minimum material requirement for durability and strength. Spiral tube heat exchanger uses multiple parallel tubes connected to pipe or header to create a tube side flow. The spaces or gaps between the coils of the spiral tube bundle become the shell side flow path when the bundle is placed in the shell. Tube side and shell side connections on the bottom or top of the assembly allow for different flow path configurations. The spiral shape of the flow for the tube side and shell side fluids create centrifugal force and secondary circulating flow that enhances the heat transfer on both sides in a true counter flow arrangement. Since there are no baffles are provided in to the system, therefore to lower velocities and heat transfer-coefficients. Performance is optimized. Additionally, since there are a variety of multiple parallel tube configurations are not compromised by limited shell diameter sizes as it is in shell and tube designs. The profile of a spiral is very compact and fits in a smaller path than a shell and tube design. Since the tube bundle is coiled, space requirements for tube bundle removal are almost eliminated.[2]

## Experimental apparatus and method:

A schematic diagram of the experimental apparatus is shown in Fig. 1. The test loop consists of a test section, refrigerant loop, chilled water loop, hot air loop and data acquisition system. The water and air are used as working fluids. The test section is a spiral-coil heat exchanger which consists of a shell and spiral coil unit as shown in Fig. 2. The test section and the connections of the piping system are designed such that parts can be changed or repaired easily. In addition to the loop components, a full set of instruments for measuring and controlling the temperature and flow rate of all fluids is installed at all important points in the circuit.[1] Air is discharged by a centrifugal blower into the channel and is passed through a straightener, heater, guide vane, test section, and then discharged to the atmosphere. The purpose of straightener is to avoid the distortion of the air velocity profile. The speed of the centrifugal blower is controlled by the inverter. Air velocity is measured by a hot wire anemometer.[1] The inlet and outlet sections for hot air flowing through the test section unit are shown in Fig. 2. The hot air flows into the center core and then flows across the spiral coils, radially outwards the wall of the shell before leaving the heat exchanger at the air outlet section (Fig. 2). The inlet temperature of the air is raised to the desired level by using electric heaters controlled by a temperature controller. The entering and exiting air temperatures of the heat exchanger are measured by type T copper–constantan thermocouples extending inside the air channel in which the air flows.[1] The water temperature is measured in five positions with 1mm diameter probes extending inside the tube in which the water flows. Thermocouples are also mounted at five positions on the tube wall surface to measure the wall temperatures. Thermocouples are soldered into a small hole drilled 0.5mm deep into tube wall surface and fixed with special glue applied to the outside surface of the copper tubing. With this method, thermocouples are not biased by the fluid temperatures.[1]

New experimental data from the measurement of the heat transfer characteristics and the performance of a spiral coil heat exchanger under cooling and humidifying conditions are presented. The results obtained from the developed model are validated by comparing with the measured data. The effects of the inlet conditions of the working fluids flowing through the spirally coiled heat exchanger are discussed. The following conclusions can be given:

- There is reasonable agreement between the results obtained from the experiment and those from the developed model.
- Air mass flow rate and inlet-air temperature have significant effect on the increase of the outlet-air and water temperatures.
- The outlet-air and water temperatures decrease with increasing water mass flow rate.
- The enthalpy effectiveness and humidity effectiveness decrease as the air and water mass flow rates increase.
- The enthalpy effectiveness and humidity effectiveness increase as the inlet-air temperature increases.[1]

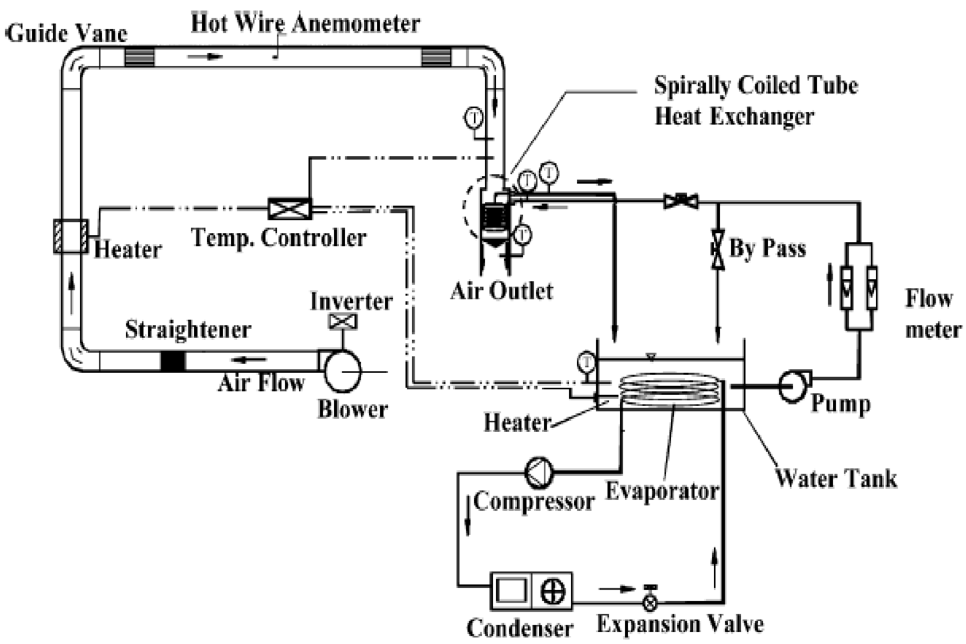


Fig. 1. Schematic diagram of experimental apparatus.

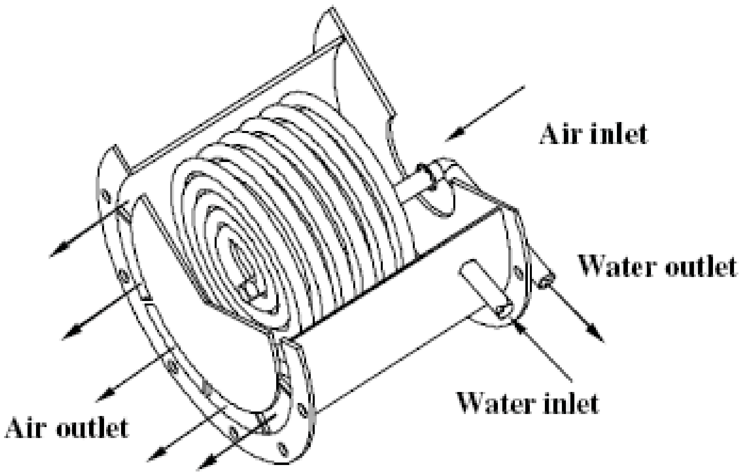


Fig. 2. Schematic diagram of the section of the spirally coiled tube heat exchanger.

## Performance Analysis of Spiral Tube Heat Exchanger:

1. The design of spiral tube heat exchanger has carried out from the theoretical and empirical correlation and spiral tube heat exchanger is developed from designed data. The designed spiral tube heat exchanger is tested experimentally.
2. The measurement of exit temperature of hot fluid (oil) and cold fluid (water) were carried out from the experimental setup developed during the course of this work. The results are consistent with published literature.
3. Exit temperature of hot fluid (oil) decreases with increase in mass flow rate of cold fluid (water). 4. Exit temperature of hot fluid (oil) increases with increase in mass f low rate of hot fluid (oil).
5. Increase in exit temperature of hot fluid is more initially, and it becomes small as mass flow rate of hot fluid (oil).
6. As the mass flow rate of cold fluid increase, effectiveness of heat exchanger decreases.
7. Exit temperature of cold fluid is decrease with increase the mass flow rate of cold fluid. [7]

Many researchers worked on spiral plate heat exchanger particular based on design, geometrical shape, changed different parameters like various temperature, mass flow rate, pressure for obtaining better heat transfer rate. They have concluded that all above things by experimental and theoretical point of view but few researchers worked on CFD analysis and compared with experimental data. Present days CFD analysis is too much well known for the optimum heat transfer rate in heat exchanger but nobody aware about that analysis and this is reduced the cost of research.[8]

The research was carried out by various scientists on spiral plate heat exchangers and the results obtained were found valid and satisfactory Study on the various effects of feed flow rate and the coil diameter was done and concluded that on increasing the feed flow rate the pressure drop increases and vice versa. A relation between the pressure drop and the feed flow rate for the steady state Newtonian fluid into the Archimedean spiral tubes was developed. [9]

Compact Heat Exchangers (CHEs) are increasingly being used on small and medium scale industries. Due to their compact size and efficient design, they facilitate more efficient heat transfer. Better heat transfer would imply lesser fuel consumption for the operations of the plant, giving improvement to overall efficiency. This reduction in consumption of fuel is a step towards sustainable development.[10]

## Conclusion:

The spiral tube heat exchanger is compact in size and more heat transfer can be carried out. The designed spiral tube heat exchanger is required to be developed and experiments will be performed on it to analyses pressure drop and temperature change in hot and cold fluid on shell side and tube side.

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