EFFICIENCY OF MINI TYPE SHELL HEAT EXCHANGER FOR CAR AIR CONDITIONING SYSTEM

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A project report submitted in partial fulfillment of the requirements for the award of Degree of Bachelor Mechanical Engineering (Thermal-Fluid)

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SUPERVISOR DECLARATION

"I hereby declare that I have read this thesis and my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Thermal-Fluids)"

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Date	:………………………………..

"I hereby, declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged"

Signature :…………………

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Special dedication to my family, supervisor, my friends and all that helped me to finish my thesis

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ABSTRACT

This research is about the efficiency of mini type shell heat exchanger in a car air conditioning system. Mini type Shell heat exchanger was used in this experiment by implying heat exchanger in car air conditioning system. Compressor will need less power in order to compress the air. Material used in this experiment was aluminum alloys after consideration of selection material. In this research, Proton Wira's air conditioning system is used for the experiment. During the experiment with heat exchanger installed, the temperature reading has been for 10 minutes were taken and been repeated with different engine rotational speed. Data from the experiment has been calculated and analyzed. From the experiments, the highest value of Coefficient of Performance (COP) was 3.40 without heat exchanger installed and at 1000 RPM engine rotational speed. Meanwhile, the highest value of Coefficient of Performance improvement by using shell tube heat exchanger was 33.96%.In addition, the value of fuel consumption also taken during conducting the experiment. The data shows that, the fuel consumption increased when engine rotational speed increasing.

ABSTRAK

Kajian ini dilakukan untuk mengkaji kesan penukar haba berjenis cengkerang dalam sistem penyaman udara kereta. Dengan mengunakan penukar haba ini, pemampat akan mengunakan tenaga yang lebih rendah untuk memapat udara. Alluminium telah digunakan sebagai bahan penukar haba ini Di dalam kajian ini, sistem penyaman udara Proton Wira digunakan untuk menjalani eksperimen. Selama melakukan percubaan dengan penukar panas dipasang, pembacaan suhu telah berlangsung selama 10 minit dan telah diulang dengan kelajuan putaran mesin yang berbeza. Data daripada percubaan telah dihitung dan dianalisa. Dari hasil percubaan, nilai tertinggi pekali prestasi (COP) adalah 3.40 tanpa dipasang penukar haba pada kelajuan putaran enjin sebanyak 1000 RPM. Sementara itu, nilai tertinggi peningkatan pekali prestasi dengan menggunakan penukar haba ialah 33,96%. Selain itu, nilai penggunaan bahan bakar juga diambil selama melakukan percubaan. Dari data yang diambil, penggunaan bahan bakar meningkat apabila kelajuan putaran enjin meningkat.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Air conditioning unit was designed to stabilize the air temperature and humidity within an area for cooling as well as for heating. It is typically used a refrigeration cycle but sometimes using evaporation concept. Air conditioning concept was adapted in automotive world, where an air conditioner unit was installed to provide comfort for driver and passengers.

A standard car air conditioning unit consists of compressor, condenser, expansion valve, evaporator, drier, and blower. The efficiency of the air conditioning system can be found by plotting the data in a P-h diagram. From there, the Coefficient of Performance (COP) can be calculated by using a specific equation.

The main difference between HVAC (Heating, Ventilating, and Air Conditioning) and a Standard Air Conditioning system is the scale of usage of the system. HVAC usually used in a large scale industry such as large office building (skyscrapers). Meanwhile, a standard air conditioning unit commonly use in a small scale factor such as a household usage. In addition, the working systems for both system also different.

1.2 OBJECTIVES

- To fabricate mini type shell heat exchanger.
- To install and test the product in Proton Wira air conditioning system.
- To find the efficiency in term of Coefficient of Performance (COP).

1.3 SCOPE

This propose of this project is to study the effect of mini type shell heat exchanger for car air conditioning system. The project is carry out until testing phase. The scope of research is limited to shell type heat exchanger and automotive industry only. In the testing phase, the effect on the fuel consumption and the efficiency of the heat exchanger need to be determined. All the testing will be conducted in a Proton Wira's air conditioning system.

1.4 PROBLEM STATEMENT

The current problem in a car air conditioning system is that the compressor needs a high volume of power, in order to compress the air. As an improvement, we apply a mini type shell heat exchanger so that the power to run the compressor would be reduced. Significantly, the performance of the car would be increase and improve fuel consumption efficiency.

CHAPTER 2

LITERATURE REVIEW

This chapter briefly explains about the theory and working principle of car air conditioning system. Furthermore, this chapter will also explain about the theory of mini type shell heat exchanger and how to apply it into a car air conditioning system. By referring to previous research and data, knowledge about the research can be increased.

2.1 LITERATURE REVIEW

Literature review present about the information and the research which was published on a research area. The information for literature review was taken from various sources such as journal, books and technical paper and some online information.

2.2 HEAT EXCHANGER

Heat exchanger is a device built for efficient heat transfer from one medium to another, whether the media are separated by solid wall so that they never mix, or the media are in contact. Heat exchanger widely used in refrigeration, air conditioning, power plants, space heating, and natural gas processing. One common example of a heat exchanger is the radiator in car, which the heat source, being a hot engine-cooling fluid, water transfers heat to air flowing through the radiator [1].

2.3 TUBULAR HEAT EXCHANGER

This exchanger is generally built of circular tubes, although elliptical, rectangular, or round/flat twisted tubes have also been used in some applications. There is considerable flexibility in the design because the core geometry can be varied easily by changing the tube diameter, length, and arrangement. Tubular exchangers can be designed for high pressure relative to the environment and high pressure differences between the fluids. Tubular exchangers are used primarily for liquid to liquid and liquid to phase change (condensing or evaporating) heat transfer applications. These exchangers may be classified as shell and tube, double-pipe, and spiral tube exchangers [2].

2.4 SHELL AND TUBE HEAT EXCHANGER

Shell and tube heat exchangers generally built of a bundle of round tubes mounted in a cylindrical shell with the tube axis parallel to that of the shell [3]. One fluid flows inside the tubes, the other flows across and along the tubes. The major component of this exchanger are tubes (or tube bundle), shell, front-end head, rear-end head, baffles, and tube sheets. A variety of different internal constructions are used in shell and tube exchangers depending on the desired heat transfer and pressure drop performance and the methods employed to reduce thermal stresses, to prevent leakage, to provide for ease cleaning, to contain operating pressures and temperatures, to control corrosion, to accommodate highly asymmetric flows and so on[2].

More than 90 % of heat exchanger used in industry are of the shell and tube type [4]. The shell and tube heat exchangers are the “work horses” of industrial process heat transfer [5]. They are first choice because of well established procedures for design and manufacture from a variety of materials, many years of satisfactory service and availability of codes and standards for design and fabrication. There is virtually no limit on the operating temperature and pressure [6].

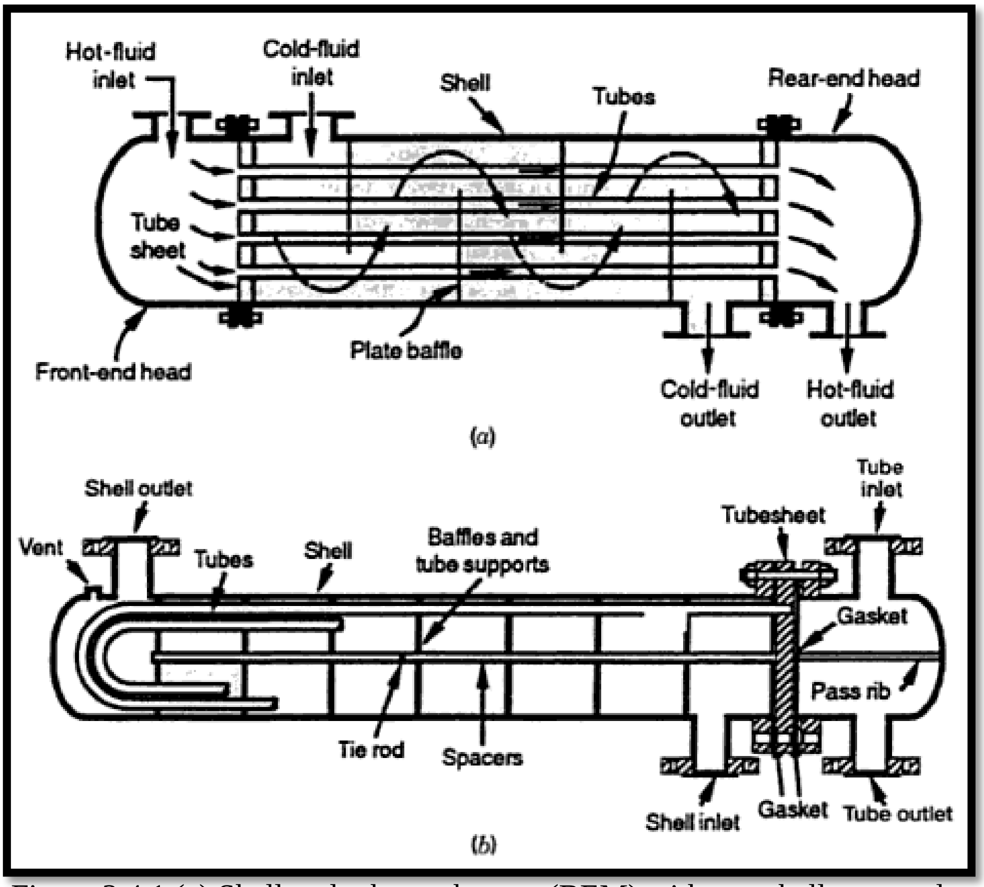

Figure 2.4.1 (a) Shell and tube exchanger (BEM) with one shell pass and one tube pass. (b) Shell and tube exchanger (BEU) with one shell pass and two tubes passes [2].

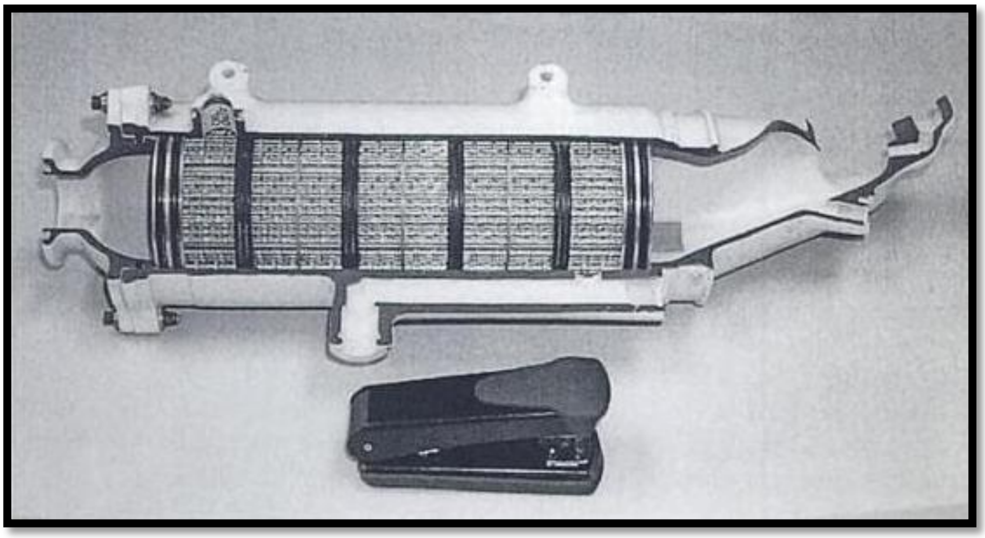

Figure 2.4.2 A compact, small shell and tube exchanger for oil/fuel heat exchange [7].

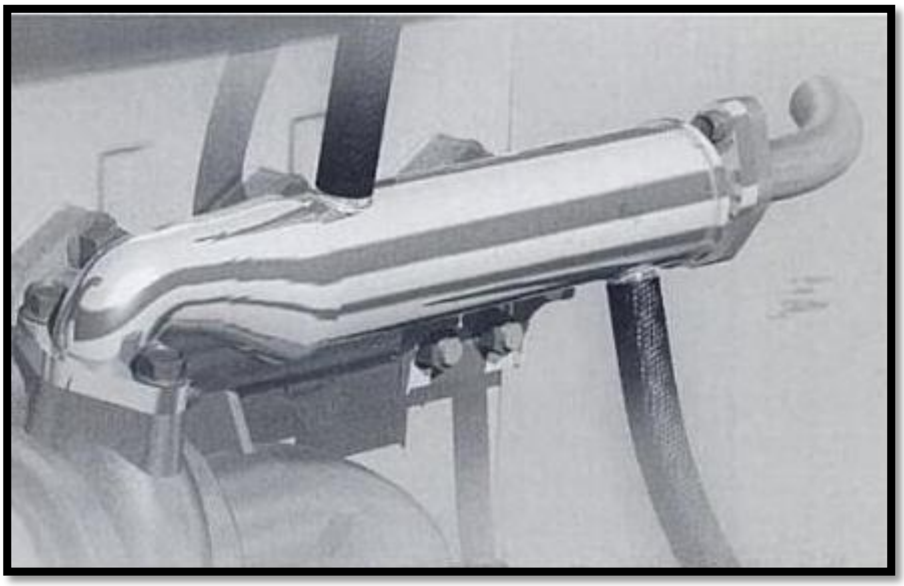

Figure 2.4.3 A non-compact, small shell and tube exchanger for exhaust gas recirculation [7].

2.5 CONSTRUCTION DETAILS FOR SHELL AND TUBE HEAT EXCHANGER

The major components of a shell and tube heat exchanger are tubes, baffles, shell, front head, rear head, tube sheet(s), and nozzles. Expansion joint is an important component in the case of fixed tube sheet exchanger for certain design conditions. The selection criteria for a proper combination of these components are dependent upon the operating pressures, temperatures, thermal stresses, corrosion characteristics of fluids, fouling, clean ability and cost [6].

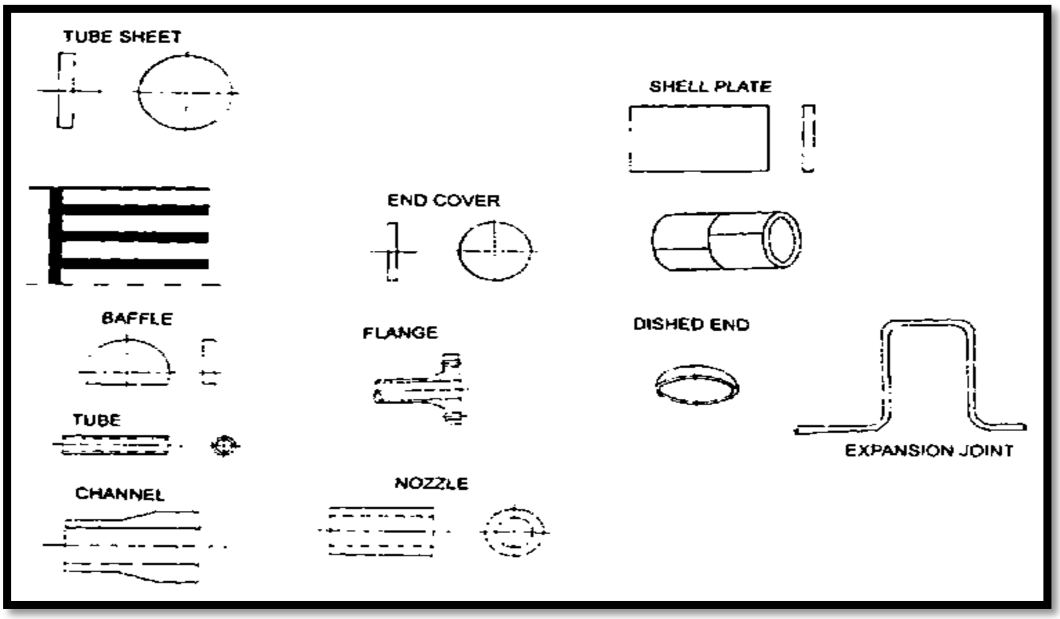

Figure 2.5.1: Major component of a shell and tube heat exchanger [6].

Table 2.5.1: Design feature of shell heat exchanger [10]

Design Feature	Fixed Tubesheet	Return Bend (U-Tube)	Outside-packed Stuffing box	Outside-Packed Latern Ring	Pull-Through Bundle	Inside Split Backing Ring
TEMA Rear-Head Type:	L, M, N	U	P	W	T	S
Tube bundle removable	No	Yes	Yes	Yes	Yes	Yes
Spare bundles used	No	Yes	Yes	Yes	Yes	Yes
Provides for differential movement between shell and tubes	Yes, with bellows in shell	Tes	Yes	Yes	Yes	Yes
Individual tubes can be replaced	Yes	Yes[a]	Yes	Yes	Yes	Yes
Tubes can be chemically cleaned, both inside and outside	Yes	Yes	Yes	Yes	Yes	Yes
Tubes can be mechanicall cleaned on inside	Yes	With special tools	Yes	Yes	Yes	Yes
Tubes can be mechanically cleaned on outside	Yes	Yes[b]	Yes[b]	Yes[b]	Yes[b]	Yes[b]
Internal gaskets and bolting are required	No	No	No	No	Yes	Yes
Double tubesheets are practical	Yes	Yes	Yes	No	No	No
Number of tubesheet passes available	Any	Any even number	Any[c]	One or two[d]	Any[e]	Any[e]
Approximate diametral clearance (mm) (Shell ID, D_{otl})	11–18	11–18	25–50	15–35	95–160	35–50
Relative costs in ascending order, (least expensive = 1)	2	1	4	3	5	6

2.5.1 Shell Type

The basic shell type is TEMA (The Tubular Exchanger Manufactures Association) E [9], with entry and outlet nozzles at the opposite ends in single shell pass [8].

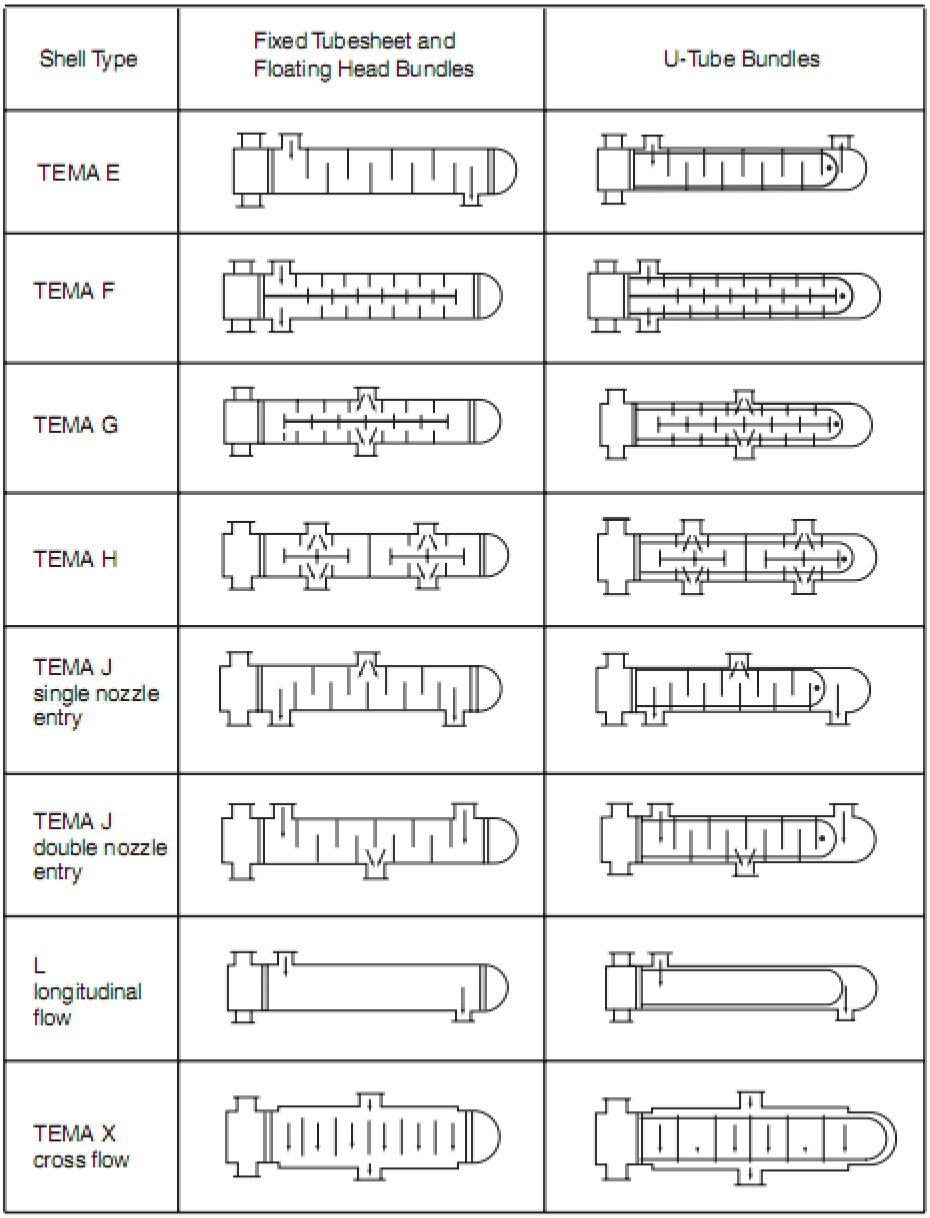

Figure 2.5.2 Shell side flow arrangement for various shell types [2].

2.5.2 Tube Bundle Type

Tube bundle type determines mainly as far as the thermo hydraulic calculation method is concerned the possible bundle to shell bypass. In mechanical design considerations, it is selected mainly on account of compatibility with thermal expansion considerations such as fixed tubesheet, various types of floating head, and U-tube bundle [8].

2.5.3 Tube Diameter

Thermal hydraulic considerations favor small tube diameter. Also, greater surface density within a given shell is possible with small diameter tubes. Tube cleaning practice limit tube diameters to a minimum of approximately 2 mm OD. For reboilers and condensers, other tube diameter selection considerations will apply [8].

2.5.4 Tube Length

In general, the longer the tubes, the lower the cost of the exchangers for a given surface. This is due to the resulting smaller shell diameter, thinner tubesheets and flanges, fewer pieces to handle and fewer holes to drill. The limitations are accommodating shell side flow areas with reasonable baffle spacing, and practical design considerations. Usual length to shell diameter ratios range from about 5 to 10 best performance [8].

2.5.5 Tube Layout Pattern and Pitch

Tube layout arrangements are designed so as to include as many tubes as possible within the shell to achieve maximum heat transfers area. The selection of the tube layout pattern depends on the following parameters, which influence the shell side performance and hence the overall performance which is compactness, heat transfer, pressure drop, accessibility for mechanical cleaning and phase change if any on the shell side [6].

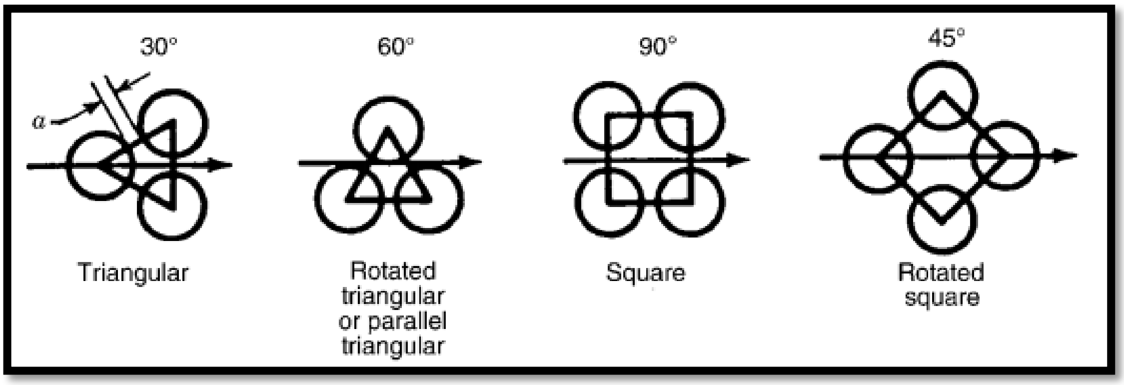

Figure 2.5.3: Tube layout arrangement [2].

2.5.6 Baffle Type

The function of the cross baffle is to direct the flow across the tubefield as well as to mechanically support the tubes against sagging and possible vibration. The most common type is the segmental baffle, with a baffle cut resulting in a baffle window. Baffle spacing is subject to minimum and maximum limitations for good hydraulic performance and tube support. The ratio of baffle spacing to baffle cut is a crucial design parameter for efficient conversion of pressure drop to heat transfer. If very low pressure drops have to be accommodated, so called double segmental pr i-disk and doughnut baffles will reduce the pressure drop by about 60% [8].