Role of Different Types of Nano-fluids to Enhance the Performance of Heat Transfer Heater Exchangers – A Review

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Abstract: *Particle immigration, electronic cooling, heat exchangers, solar collectors, and heat storage systems have all been investigated using nanofluids. Furthermore, many researchers looked into the impact of nanofluids on heat transfer. Flow separation as well as sequential reattachment occur when an abrupt pressure or geometry expansion, such as a backward-facing step (BFS), occurs. We have reviewed the use of various types of nano fluids in heat transfer analysis in this paper. We've talked about heat exchangers and their classification, as well as baffles as well as baffle architecture.*

Keywords: Heat Exchanger, baffles, nanofluids, flow mechanism

I. Introduction

In many real world applications for cooling or heating systems, the unexpected compression as well as expansion of the channels flow is critical. As shown in Fig. 1, the forward-facing and backward-facing steps are useful in many applications in these types of flows. Energy systems equipment, electronic cooling systems, chemical processes, combustion chambers, turbine blade cooling, environmental control systems, and high performance heat exchangers are all examples of heat transfer commercial processes using facing step channels.

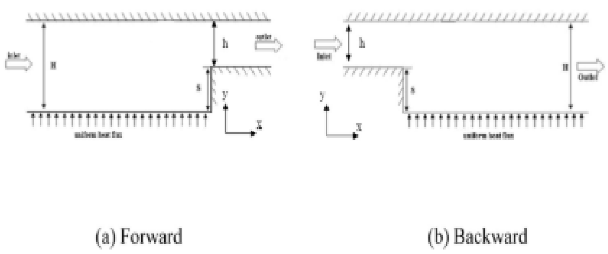

Figure 1 Facing Step Channel [1]

The pressure drop and heat transfer improvement in the reattaching flow area but inside the reverse flow area were particularly impressive. For instance –, near the wall channel area, low pressure drop and high heat transfer augmentation are procured, while the low rate of heat transfer gain at the corner where the sudden shift appears begins in the flow region. The corrugated channels shown in Fig. 2 have, on the other hand, been used plethora of different initiatives to increase heat transfer [1]. Bulk fluid mixing and re-initiation of the thermal boundary layer are required to improve heat transfer in these channels.

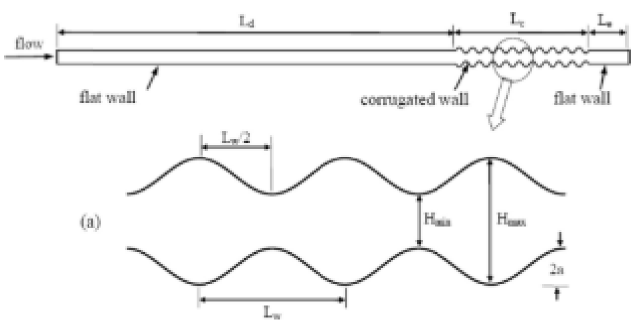

Figure 2 Corrugated Channels [1]

"Nanofluids" are dilute suspensions of ultrafine particles in common liquids, in which the nanoparticles can be metals, metal-oxides, polymers, silica, or even carbon nanotubes with a length scale of less than 100 nm. Water, oil, or ethylene glycol are frequently used as the base fluid. Once compared to their base fluids, such nanofluids have higher thermal conductivities, resulting in rapid heat transfer rates. Through use of nanofluids in thermal engineering systems to improve thermal efficiency and, as a result, improve effectiveness and decrease thermal device size is currently under investigation. Microchannels, thermosyphons, and heat pipes, car radiators, chillers, cooling of electronics, heating and air - conditioning in building structures, therapeutic applications, and solar collectors are just a few examples [2].

Backward-facing step (BFS) and forward-facing step (FFS) flow segregation and subsequent reattachment as a consequence of abrupt compression or expansion in a flow transit are critical in the design of general engineering applications that require heating or cooling systems [3]. Combustion chambers, electronic equipment, environmental inspection systems, turbine blade cooling passes, power components, and valve flow are all examples of thermal management applications. The findings acquired using a variety of conditions, parameters, instrumentation, and simple geometric aspects provide such a frame of reference in order to find a more precise research methods for fixing complex issues.

Particulate immigration, electronic cooling, exchangers, solar collectors, and heat storage solutions have all been investigated using nanofluids. Furthermore, numerous researchers looked into the impact of nanofluids on heat transfer. Fluid flow and sequences reattachment occur when an abrupt pressure or geometry expansion, such as a backward-facing step (BFS), occurs. The part where these processes operate is as essential as combustion chambers, cooling systems for electronic devices, environmental control systems, turbine blade cooling passages, high-performance heat exchangers, power system, and chemical system components in the configuration of many engineering disciplines. As a result, the reattachment region contains a large amount of higher and lower energy. Theoretical and analytical explorations have affirmed the flow problem on BFS in made by mixing, natural, as well as forced geometry.

II. Nanofluids

A nanofluid is a new type of heat transfer fluid created by solubilizing metallic or non-metallic nanoparticles having a regular size of less than 100 nanometers in a base fluid (e.g., water, ethylene glycol and oil). For several years, suspensions of millimeter or micrometer-sized solid particles have been studied to improve the thermal conductivity of conventional fluids, but sedimentation issues resulted in a higher pressure drop in the flow channel [4]. In a binary mixture of water and ethylene glycol, hybrid nanofluids made of iron (Fe) and copper oxide (Cuo) were also demonstrated. At low concentrations, Newtonian behavior was observed, whereas at high concentrations, non-Newtonian type of behaviour was observed.

Later developments in nanotechnology led to the idea of using suspended nanoparticles in heat transfer fluids to boost the base fluid's heat transfer coefficient. In many pragmatic heat as well as fluid flow regime (e.g., heat exchanger, solar energy collector, chemical vapour deposition instrument, etc.) [4,] the research of nanoparticles is among the innovative methods. Nanofluids, on the other hand, offer better flow mixing and a faster heat transfer rate than real fluids. Since the first introduction of nanofluids, many researchers have focused their efforts on determining the suitability of this future group of heat transfer fluid in specific engineering disciplines.

The primary design necessity of any lifting devices with desired functionalities is the consistency of a mechanism over time. The rise in temperature is a major factor in the deterioration of electric machinery. Due to space constraints, noise regulations, inordinate maintenance, and other energy requirements, thermal cooling methods such as tiny centrifugal fans have proven to be ineffective. In this case, a passive thermal management approach utilizing heat sinks can assist in bouncing the apparatus' operational period and functional operation.

The substitution of conventional fluids with an innovative sort of fluid wherein conductive nanoparticles are distributed is one of the methods used for optimizing solar collectors, i.e. equipment that collect solar energy for usage. Nanofluids are the name given to such fluids. Nanofluids are colloidal nanoparticle suspensions (Fig. 3). Nanoparticles range in size from 10 to 100 nanometers, relying on the procedure. Various materials are used to make these nanoparticles. Metals (copper, silver), metal oxides (aluminum oxide, copper oxide, titanium oxide), and non-metallic materials are all used in the production of nanomaterials (carbides and carbon nano tubes). Because of their thermo - physical properties, nanofluids have a great deal of potential in commercial implementations like heat transfer, microelectronics, fuel cells, pharmaceutical processes, hybrid motors, and heat removal strategic planning in automotive engine cooling.

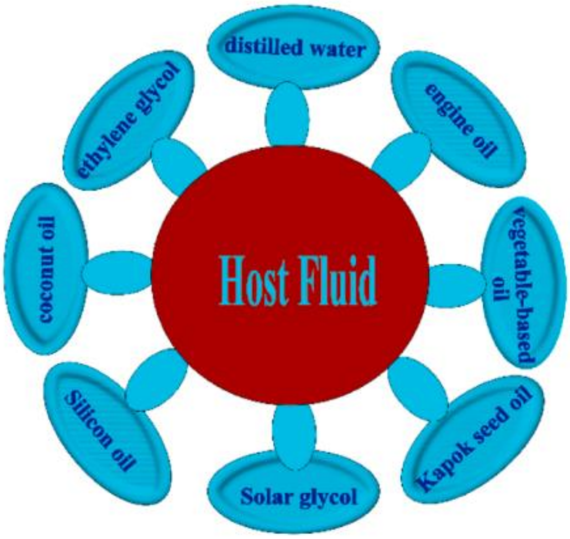

Figure 3 Some base fluids used as host medium of dispersed nanoparticles [5]

The flow as well as thermal conditions of nanofluids are directly influenced by numerous different metallic nanoparticles used throughout their synthesis, as well as the characteristics of the nanoparticles used during their synthesis. Multiple researches on the use of nanofluids with various nanoparticles, including metallic, metal oxides, and non-metallic nanoparticles, have been conducted.

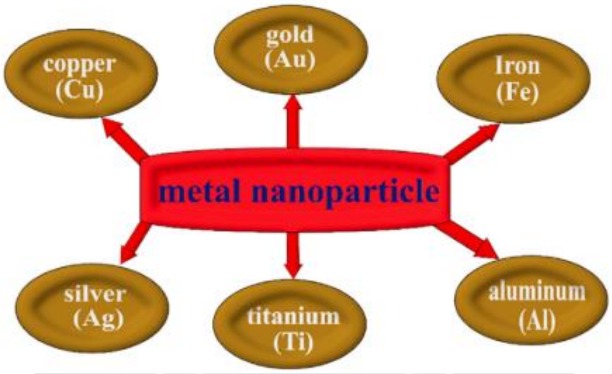

Figure 4 Various types of metal nanoparticles used in synthesis of nanofluids [5]

Figure 4 depicts the various types of metals used as nanoparticles. Metal nanoparticle-containing nanofluids have excellent thermal properties. They do, even so, depict a lack of stability, which is a significant factor. In fact, the thermophysical properties of the used nanofluids are impacted by their low stability, resulting in heat transfer fluids that are unsuitable for potential implementation. Agglomeration, sedimentation, and oxidation are some of the physical and/or chemical conditions that cause this low stability. Techniques such as vibration, surfactant addition, as well as dry ball milling can decrease this instability, which is still a barrier to the use of metal-based nanofluids in heat transfer implementations.

Metal oxide nanoparticle nanofluids are steady, but have a low thermal conductivity when tried to compare to metal-based nanofluids. As a result, metal oxide nanoparticles and hybrid (metal and non-metal composites) composites may be viable options for improving thermal and hydrodynamic properties. As a result, they will progressively make sense in practical implementations in the coming years. Figure 5 depicts the numerous metal oxide nanoparticles used throughout the synthesis of nanofluids.

Figure 5 Metal oxide nanoparticles used in synthesis of nanofluids [5].

Due to its superior thermo - physical properties, nanofluids (NFs) have become a popular way to improve the performance of heat exchangers. This makes them suitable for a variety of industrial implementations. A steady suspension of nanoparticles (NPs) in a conventional heat transfer fluid (HTF), i.e. base fluid, is all that NF is (BF). Metallic NPs in NF, unlike other conventional fluids, start reducing thermal resistance, making them perfect for Heat Transfer devices. TiO2/water NF coupled with rib channels has been explored, improving HT. The solar collector performance is better by 10%, with an increase in the volume fraction of the NPs rising the collector's effectiveness [6].

Two choices for expanding heat transfer rates such as the innovative ideas of new pulsating flow technologies and improved fluids with higher potential for thermal property improvement. Because of the unique properties of nanofluids, such as rising temperatures transfer, enhanced thermal conductivity [7], enhanced surface-to-volume ratio, Brownian motion, and thermophoresis, numerous experimental and numerical studies on free and forced convection in this novel breed of suspension have been conducted.

III. Flow Mechanism

Along with its wide range of implementations, studying forced, free, and mixed convective heat transfer in closed conduits is a major research topic [8]. Heat exchangers, solar collectors, thermal storage systems, oil recovery, and electrical appliance cooling can all find this study useful. The majority of implementations rely on free or mixed convection as the primary heat transfer mechanism. With the addition of nanofluids to the flow, it is possible to improve forced convective heat transfer across both laminar and turbulent flow regimes, particularly in laminar flow.

The biggest distinction among free and forced convection is that in free convection, fluid molecules move as a result of temperature and density differences, whereas in forced convection, fluid molecules move as a result of an external entity. Free convection, also recognized as Natural convection, is a form of convection heat transfer wherein the fluid particles start moving to raise the temperature due to density as well as temperature gradients.

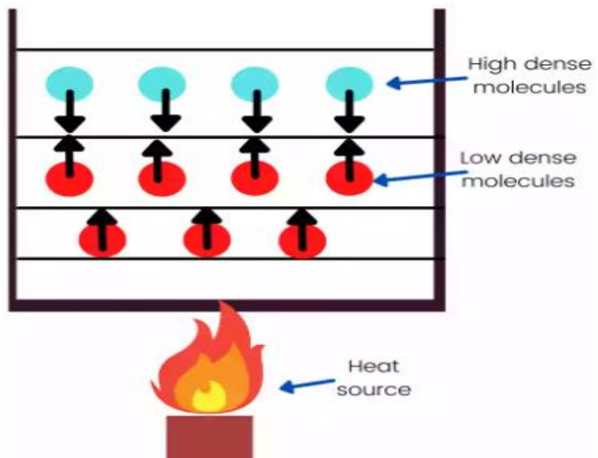

Figure 6 Free Convective Heat Transfer

As a result, a buoyant force is exerted on molecules in the lower layer, causing these molecules to pass upward. The less dense upper molecules, on the other hand, move down the slope due to their lower density. As a result, no exterior device is necessary to start generating motion in the molecule for natural convection.
Forced convection is a form of convective heat transfer wherein the motion of molecules is caused by the application of heat from an external entity. For example, an exhaust fan or a ceiling fan. By causing motion in the air molecules, the exhaust fan aids in the ejection of heat from the room. Forced convection has a faster rate of heat transfer that can be governed by additional equipment. As a result, the forced convection system has a greater overarching heat transfer coefficient than the free convection system. Due to rapid advances in electronic and electrical devices and systems that are becoming progressively small and compact, lightweight and easy, but high in heat transfer dissipation demands, the impact of heat transfer and flow flow has become more intriguing and highly challenging [9].
Free convection occurs in a variety of industries, including solar cells, air and space, food, solar and nuclear collectors, and so on. As a result, it has been investigated in various geometries. The most important host for these heat transfer process is cavities. Heat is transferred in a narrow area in these cavities. Due to the lack of an external monitor to speed up fluid flow, the heat transfer method in shuttered cavities is natural. Conduction, convection, and radiation heat transfer are the three primary methods involved in heat transfer. Every one of those processes has the potential becoming a sub-branch. Free or natural convection is among the branches of convection. Different kinds of heat transfer process are depicted in Figure 7 along with their sub-branches.

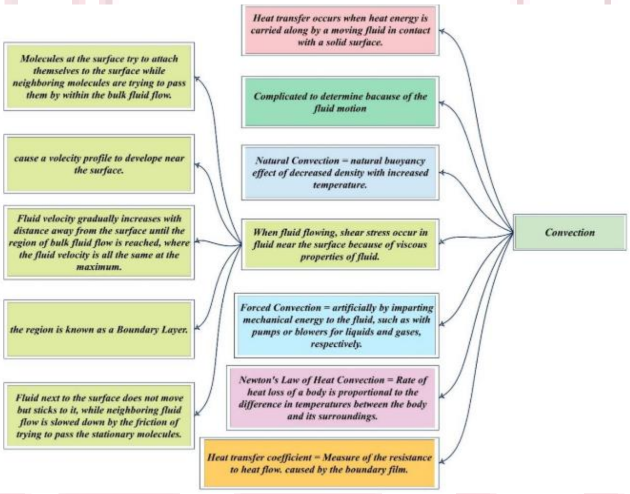

Figure 7 Types of heat transfer mechanisms and their subdivisions [10]

Free convection has numerous uses in sector and even in everyday life. Due to the obvious difference in temperature in a closed system, free convection occurs in the family environment and when water is heated by a heat source. Free convection reinforces as the temperature difference rises, and its value goes up as well.

IV. Literature Review

(Javed et al., 2019)introduces a systematic review of the literature on nanofluid heat transfer rate in various flow regimes for various heat transfer equipment such as tubes, heat sinks, and heat exchangers. The friction factor and convective heat transfer for laminar and turbulent regimes are thoroughly discussed, and research for the transition flow regime are also gathered. This report will also discuss Nusselt number and friction factor correlations in various flow regimes, as well as their constraints. The based on the flow regime, form of nanofluidutilised, and nanoparticle size has been spotlighted by the publishers.

(Menni et al., 2019)Oil, water, and ethylene glycol mixtures, which are convectional heat transfer fluids, are poor heat transfer fluids because their thermal conductivity affects the heat transfer coefficient between the heat transfer medium and the heat transfer surface. As a result, many methods for improving the thermal conductivity of these fluids by delaying nano/micro-sized particle materials in liquids have been suggested. Numerous numerical simulations of convection heat transfer in nanofluids have previously been reported. Different successful studies in three basic complex geometries, namely microchannels, heat exchangers, and solar energy collectors, are presented in this paper. The authors have contributed in a number of different ways by describing the theoretical and analytical techniques used and then trying to discuss them.

(Awais et al., 2021)The effect of nanofluids on the thermo-hydraulic performance of thermal devices is discussed in detail in order to ensure that nanofluids are properly selected and implemented in a variety of designing and building thermal devices. Integration of nanofluid as heat transfer fluid in multiple systems going to require high heat transfer rate e.g. solar thermal conversion systems, HVAC structures, electronic devices, heat exchangers, nuclear reactors have conveyed larger part in decreasing adverse impacts of climate change. The impact of size, concentration, category and shape of nanoparticles, operating temperature, compound passive methods and magnetic field impact on heat transfer as well as pressure drop performance of nanofluids are discussed extensively including the detriments of nanofluids such as creation of fouling on heating surface.

(Giwa et al., 2020)The use of a magnetic field to manipulate the convective flow and heat transfer behavior of nanofluids in non-square enclosures has been thoroughly examined. The impact among several variables including such controlling variables, heat distribution channels, heat as well as concentration boundary conditions, magnetic field different kinds, numerical methods, correlation types, nanofluid types, heaters types, numbers as well as length, and slip conditions, among others, on the magnetohydrodynamic (MHD) natural convection flow as well as heat transfer behavior of nanofluid in non-square cavities has gotten a lot of attention and conversation. In relation to natural convection, the notions of bioconvection, micro-polar nanofluid, bio-nanofluid (green nanofluid), ionic nanofluid, as well as hybrid nanofluid have all been mentioned for the very first moment.This paper also discusses special cases of MHD natural convection in non-square cavities encompassing hybrid nanofluids as well as micro-polar nanofluids.

(Kumar, n.d.)This review compiled the most recent research on nanofluid planning and preparation, characteristics, and numerically and experimentally heat transfer behavior. The simulations were classified into two parts: single-phase inference, wherein the nanoparticle and base fluid are treated as a single-phase mixture with steady characteristics, as well as two-phase modeling, in which the nanoparticle characteristics and behavioural patterns are considered differently from the base fluid characteristics and behaviors.

(Azwadi et al., 2016)Convectional heat transfer fluids (oil, water, and ethylene glycol) and single nanoparticle nanofluids are prospective fluids that offer higher heat transfer performance and thermophysical properties than hybrid nanofluids. Hybrid nanofluid is an innovative nanotechnology fluid made by dispersing two different nanoparticles in a heat transfer fluid. Scientists recently reported that hybrid nanofluids can completely replace convectional coolants, particularly for those operating at extremely high temperatures. The publications on the synthesis of nanocomposites, hybrid nanofluids, and hybrid nanofluid thermodynamic properties has been accumulated and evaluated in this paper. Eventually, the problems and potential trends in hybrid nanofluid implementations in heat transfer are mentioned.

(Rashidi et al., 2019)Heat exchangers are well-known thermal devices that have a wide spectrum of uses in manufacturing energy systems. To maintain the energy in these devices, a range of methodologies were used. Porous properties of composites potential for energy development and improving thermal performance in heat exchangers were widespread used among all these methodologies. This paper examines recent advancements in the use of various types of porous materials in heat exchangers. Both models and experimental collaborate were described briefly. Current gaps in literature and design were explored, and solutions were mentioned.

(*Review of Heat Transfer Enhancement Methods : Focus on Passive Methods Using Swirl Flow Devices*, n.d.)Throughout this paper, a thorough literature overview of different turbulators (coiled tubes, extended surfaces (fin, louvered strip, winglet), rough surfaces (Corrugated tube, Rib), and swirl flow devices (twisted tape, conical ring, snail entry turbulator, vortex rings, coiled wire) for improving heat transfer in heat exchangers has really been carried out. When the pressure drop penalty is taken into account, it can be indicated that wire coil provides better overall performance. When compared to a smooth wall tube, the use of coiled square wire turbulators results in a significant rise in heat transfer and friction loss.

(Yong, 2020)The studies reviewed are able to focus and clustered into conduction, convection, radiation, phase-change material and energy storage, and high-performance heat exchange gadgets due to the huge amount of published articles. The methodologies for improving convective heat transfer are divided into three categories: passive, active, and compound. The micro/nanoscale facets, interactions, as well as high-conductivity carbon - based materials are the focus of the heat conduction evaluation. Near-field radiation, solar energy, and metamaterial are the focal points of thermal radiation. It's also discussed how machine learning is being used to improve heat transfer investigations in nano fluids, solar energy, and heat exchangers.

(Chamkha et al., 2018)Nanofluids have gotten a lot of press over the last two decades. Researchers from all over the world are looking into the feasibility of using nanofluids in various phenomena and hardware. The growing importance of nanofluids highlights the urgent need for a comprehensive review of nanofluids' applications in various fields. This paper provides a thorough examination of nanofluid applications in a variety of microchannel geometries. All of the studies were divided into three categories: investigational, analytical, and numerical studies. In each section, critical information is presented in a comprehensive table. Statistical aspects, including conducting the literature review, have also been taken into account. The findings show that nanofluid implementations in microchannels are becoming increasingly important. The bibliographic analysis reveals a shift in scientific research over the last decade. Almost all studies have demonstrated the preferred nanofluids thermal behavior in microchannels, compared to the base fluids.

(Maradiya et al., 2018)In broad sense, heat transfer improvement techniques are used to reduce thermal resistance by continuing to increase the high heat transfer surface area or by creating turbulence. These modification are sometimes accompanied by a rise in the necessary pumping power, resulting in increased costs. The Thermal Performance Factor, which really is a ratio of the change in heat transfer rate to the change in friction factor, is used to examine the performance of a heat transfer enhancement technique. Many better heat transfer devices use multiple kinds of inserts. The heat transfer is affected by the insert's geometry parameters, such as width, length, twist ratio, twist direction, and so on.When tried to compare to twisted tape as well as wire coil by itself, a counter double twisted tape insert has a TPF of more than 2, and a merged twisted tape insert with wire coil can provide better performance in both laminar and turbulent flow. Roughness, in many cases, outperforms twisted tape, as seen in the case of flow with a high Prandtl Number. A corrugated surface can be used to create artificial roughness, which enhances heat transfer characteristics by splitting and destabilisation the thermal boundary layer. This paper presents a thorough investigation of passive heat transfer devices and their various advantages in a variety of industrial applications.

V. Heat Exchanger

Heat exchangers, or heat transferring gadgets, are devices that enable thermal energy to flow among two or more fluids at varying temperatures. Heat exchangers have been used in a variety of implementations including power generation, process, chemical, and food processing, electronics, industrial production, air conditioning, cooling systems, and space implementations. Figure 8 depicts some of the applications of heat exchangers in multiple industries.

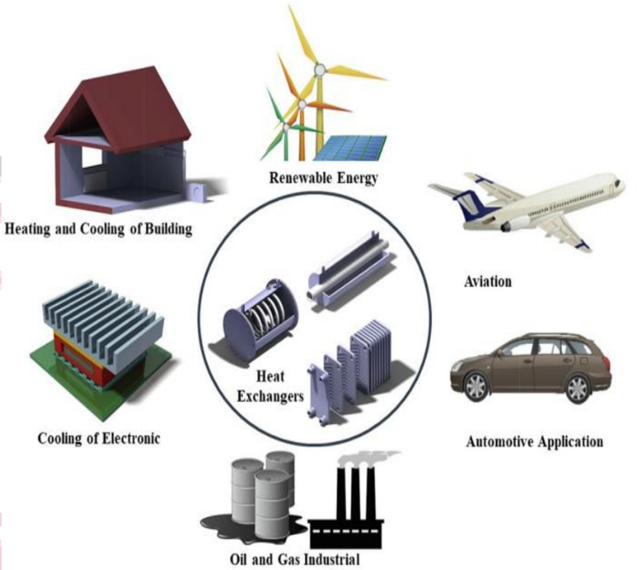

Figure 8 Various Applications of Heat Exchangers

As per Fig. 8, heat exchangers are most frequently used in the automotive sector, such as in car radiators, in household appliances such as coolers, radiators, and fridges, in the oil as well as gas industry for fluid cooling and preheating, and at power stations for cooling the exhaust turbine fluid or preheating the air intake boiler fluid to decrease heating costs. Solar collectors, electronics, aeronautics, and other applications of heating systems are of specific importance.

Energy, space, substance, and global economics savings considerations have prompted an increase in efforts to develop more cost-effective heat exchange equipment. These efforts have resulted in the body dimensions of heat exchange hardware being reduced for a provided heat capacity. As a result, the most important thermal-hydraulic goals inside a heat exchanger are to reduce the size of a heat exchanger needed for a specific heat duty (capacity), to upgrade the capacity and procedure of an existing heat exchanger, or to decrease pumping power.

The associated with heat transfer fluids are dependent on the structural thermal properties conductivity, viscosity, density, and heat capacity, which offer the circumstances for energy exchange in a system. Low thermal conductivity is a common limitation of heat transfer fluids, so nanofluids, with there own high thermal conductivity, are showing promise heat transfer fluids for use in heat exchangers rather than just heat fluids. A device known as a heat exchanger is used to transfer heat between two fluids. Petrochemicals, oil and gas, dairy industries, automobiles, and airplanes are just a few of the industry sectors that use heat exchangers.Systems are extensively used nowadays, and there are very few devices that work in the presence of thermal radiation transfer that do not use one. As per the flow pattern, heat exchangers are classified into four categories (see Fig. 9).

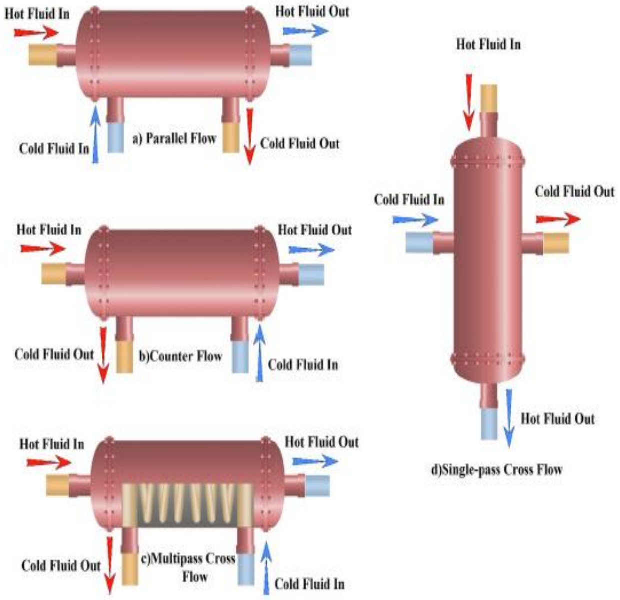

Figure 9 Type of flow in heat exchanger

In parallel flow heat exchangers, two very different fluids insert one side of the heat exchanger and flow in almost the same direction across the tube, as shown in Fig. 9a. The inlet is where the most heat is transferred. Their temperature gets closer as they get closer to the output. In counter flow heat exchangers, a fluid needs to enter from one side of the heat exchanger and exits from the contrary direction, as shown in Fig. 9b. In comparison to other heat exchangers, counter flow heat exchangers have had the highest efficiency since the average difference in temperature is the greatest.Multi pass cross-flow heat exchangers, as shown in Fig. 9c, can combine parallel as well as counter flow heat exchanger qualities, including the use of baffles in shell and tube heat exchangers. The flows can be vertical to each other, as shown in Fig. 9d, for instance in air-cooled heat exchangers.
Distinct types of heat exchangers depending on their shapes as well as physics. Figure 10 depicts the various types of heat exchangers. All of these heat exchangers has advantages and drawbacks, and their use is determined by the benefits they provide in different sectors.

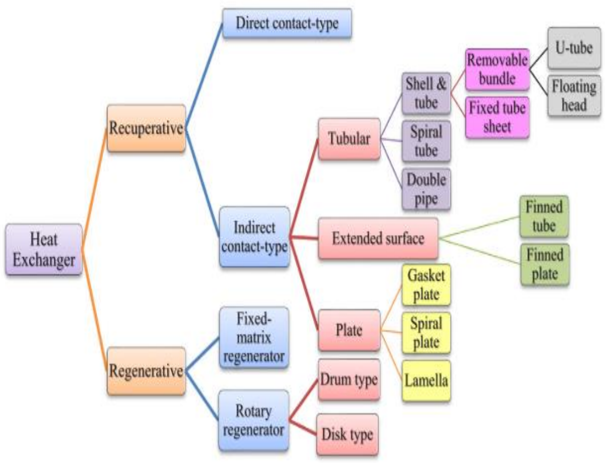

Figure 10 Classification of heat exchangers

For use in steam power plants, chemical processing plants, building heat and air conditioners systems, transportation power systems, and refrigeration units, a variety of heat exchangers have been developed. Heat exchanger design is a difficult problem to solve. It entails more than just variable thermal conductivity. From a total cost of ownership standpoint, fabrication and implementation costs, weight, and size all play a role in final design selection. And though cost is a factor in many cases, size and footprint are often the most important considerations when making a choice a design.

VI. Baffles in Heat Exchanger

In any shell and tube heat exchanger configuration, baffles are frequently used more as a central component. The flow-directing or obstructing vanes or panels used to direct a liquid or gas flow are known as baffles. Some residential stoves as well as industrial operations vessels (tanks), such as shell and tube heat exchangers, chemical reactors, as well as static mixers, use this material.

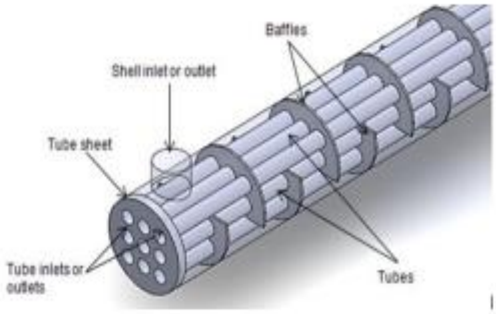

Figure 11 Baffles in Shell and Tube Heat Exchanger

Baffles also act as support systems for the tubes throughout operation, reducing vibration caused by eddies in the flow. Whereas the baffle agreement improves heat transfer, it also increases the pressure drop of the shell side fluid due to reduced flow area, leaking, and bypass effects, as shown in Fig. 11.

A. Types of Baffles

Baffles are managed to install on the shell side to increase heat transfer due to increased turbulence as well as to assistance the tubes, minimising the chances of vibration damage. There are several types of baffles that support the ducts and promote flow through them..

- ***Single Segmental and Double Segmental (this is the most common)***-A plate type baffle maybe single segmental, double segmental or triple segmental. With the single and double segmental baffles are most frequently used as they divert the flow most effectively across the tubes.

- Disc and Doughnut- Has alternating outer rings and inner disks which directs the flow radially across the tube field. They all very effective in pressure drop to heat transfer conversion.

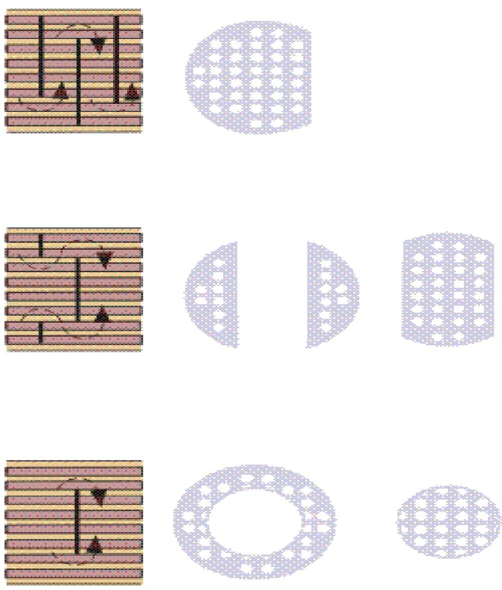

Figure 12 Baffles Arrangement

The baffle-pitch is the center-to-center distance among baffles that can be modified to change the counter flow velocity. In practise, the baffle pitch is not generally greater than the inside diameter of the shells or close than one-fifth the diameter or 50.8 mm (2 in), whichever is higher. A portion of the baffle is taken away to allowing fluid to flow backwards and forwards through the tubing The baffle-cut refers to the height of this section, which is measured as a percent of the shell diameter.

Heat exchangers come in a variety of shapes and sizes, each with its own set of needs. Double pipeline, shell and tube, plates fins, plates and shells, pillows plates, as well as other heat transfer are just a few examples of industrial heat exchangers. Double pipes heat exchangers are the simpler of these types, whereas shell and tube heat exchangers (STHEs) are the most commonly employed in the chemical process industries. STHEs account for more than 35 percent to 40 percent of all heat exchangers used in industry around the world. STHEs are widely utilized in a variety of industry due to their lower manufacturing costs, ease of cleaning, and perceived versatility when compared to conventional heat exchangers. STHEs are classified into three types based on the flow direction: longitudinally, transversal, and helical [31].

The type of baffle is one of the most critical factors to consider while designing a STHE. Baffles, which are an essential component of STHE, support tube bundles and maintain a desired velocity for shell side fluidflow; also, they create turbulent and resists vibration, which improve fluid velocity and heat transfer coefficient. STHEs make use of a variety of baffles. Segmental, floral, ring, trefoil hole, discs and doughnuts type, and helical are a few of them [31]. Traditional STHEs with segmented baffles, on the other hand, have a lower efficiency of heat transfer and a highly pressurized drop. One of the most important variables determining STHE effectiveness is baffles shape.

Heat exchangers are an integral part of the sectors such as: power stations, industrial plants, oil refineries and so on. Meanwhile, shell and tube heat exchangers (STHE) account for 40% of all heat exchangers in the industry. As a result, a concentrated effort on this gadget is required to increase its efficiency. The configuration and placement of baffling and tubes have a significant impact on the performance of this type of heat exchanger. The following are examples of common segmented baffling issues:Fouling in the dead zone, highly pressurized drop due to dead zones, notable flowing streamers among shells and baffles, tubes and baffle due to the construction tolerances, and a reduction in the heating exchanger's lifetime due to vibration induced by flowing fluid through the tube bundle

Inserting baffles is a frequent approach to increase thermal performance in the new-generation STHX. They produce mechanical resistance in the tube bundle by increasing fluid turbulence [32]. The most frequent type of segmental baffle is the conventional segmented baffles, which consists of a circular with a cut portion, referred to as baffle cut. On the shell-side fluids from across tubing, these baffles modify the flow direction and increasing the fluctuation velocity. One of the most common approaches for THE is to use porous medium in the implanted baffle.

As previously said, nanofluids have a better thermal conduction than ordinary working fluids such as water, oil, and others due to the employment of nanoparticles [33]. As a result, nanofluids are becoming a popular heat exchange fluid in a wide range of applications. For example, nano fluid's heat transfer study using a heating tube system (microchannel, heat exchanger, and PVT panel) has recently gotten a lot of attention from researchers..Different nanofluids were tested in a set of tests conducted by various researchers, and it was demonstrated that the temperature distribution of the framework could've been improved once nanomaterials were added, which was due to Brownian motion, convective heat transfer effect, and local agitation caused by movement of the particles.

Due to the need for high heat transference in heat exchangers, different strategies were developed to improve convective heat transfer by lowering thermal performance at the hot surface.Increased heat transfer rate is usually accompanied by an increase in pressure drop, which necessitates a large amount of pumping power. Researchers have been attempting to create ways that improve heat transfer rates while minimizing pressure loss. Forced flowing of fluids such as air, liquid, mineral oil, ethylene glycol, and other nano - fluid across a heated surface is one of these strategies.

Depending on the use, the heating surfaces might be smooth, rough, stationary, or movable. Heat transfer improvement methods are divided into two categories: passive and active. The active approach necessitates some external input power to boost the rate of heat transfer.

Depending on the system requirements, the external power can be directed to either the heated surface or the fluid. Since of the external effect, active approaches are difficult to utilize because flow structure analysis is not readily available. Passive approaches use changed surfaces and/or the introduction of elements (turbulence promoters) into the flow without requiring any extra energy. This approach alters the flow treatments, leading to an increase in the convective heat transfer coefficient. Turbulent promoters produce turbulence inside the flows, which aids in the elimination of the atmospheric boundary layer and promotes fluid mixing, resulting in a high rate of heat transfer.

VII. CONCLUSION

Heat transfer machines were used in a variety of household applications for heat converting and recovering. Over the last 5 decades, there has been a concerted demand to improve heat transfer designs that can reduce energy consumption as well as material as well as other costs. This paper provides a brief overview of nanofluids' application in heat transfer. The lack of reaction of heat machines in high capacity is one of the barriers to increasing capacity of multiple industries. Furthermore, increasing the capacity increases pressure drop, which is among the most significant constraints facing huge companies. We also talked about heat transfer and how to use various types of heat exchangers, as well as baffles and their various kinds.

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