Review of the Baffle Effects on Natural Convection Heat Transfer in an Enclosure Filled with Nanofluid

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Abstract

A comprehensive review on wide range of studies on natural convection was published relevant to enclosures especially for the nanofluid enclosures which were exposed to different conditions on its boundary wall. The papers related to the ways that used to enhancement the natural convection heat transfer of a nanofluid within an enclosure region had been discussed in full details. Also contains the experimental and numerical studies related to natural convection heat transfer of a nanofluid. It is of practical and scientific importance to several engineering applications, such as industrial cold-storage installations and insulation for buildings. There are researchers attracted their attention and interested in studying the thermophysical characteristics of the nanoparticle more than anything else of the studies and did not focus on the characteristics of heat transfer by this new fluid. There was a series of investigations and several experimental and numerical studies were investigating within a square shape cavity using nanofluids as working fluid and with the effect of the conductive baffle has a variable-length attached to the bottom horizontal wall. It was found that there is a lot of things need to be investigated for studying the nanoparticle size and shape influence on the natural convection heat transfer inside an enclosure.

Keywords: Nanofluid, Natural Convection, Conjugate heat convection, Cavity, Baffle.

1. Introduction

There are several important engineering applications of natural convection heat transfer within a vertical enclosure with a various geometry and filled with working fluid. The wide number of thermal applications related to convection heat transfer using a fluid medium drawn the researchers to improve the properties of those conventional fluids. Therefore, more investigations and conducts should be experimented as attempts to improve the efficiency of heat transfer through natural convection with close volume (enclosure) constraints. Figure (1) displays the schematic diagram of the vertical enclosure.

The natural convection heat transfer inside an enclosure will be classified to four parts according to the working fluid, type of study and the embedding obstructions or fins as in Figure (2).

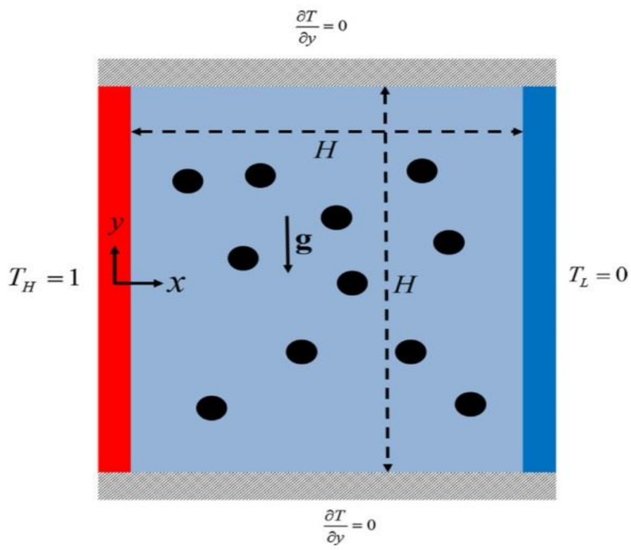

Figure (1): Schematic of natural convection heat transfer in water-based nanofluids within a square enclosure.

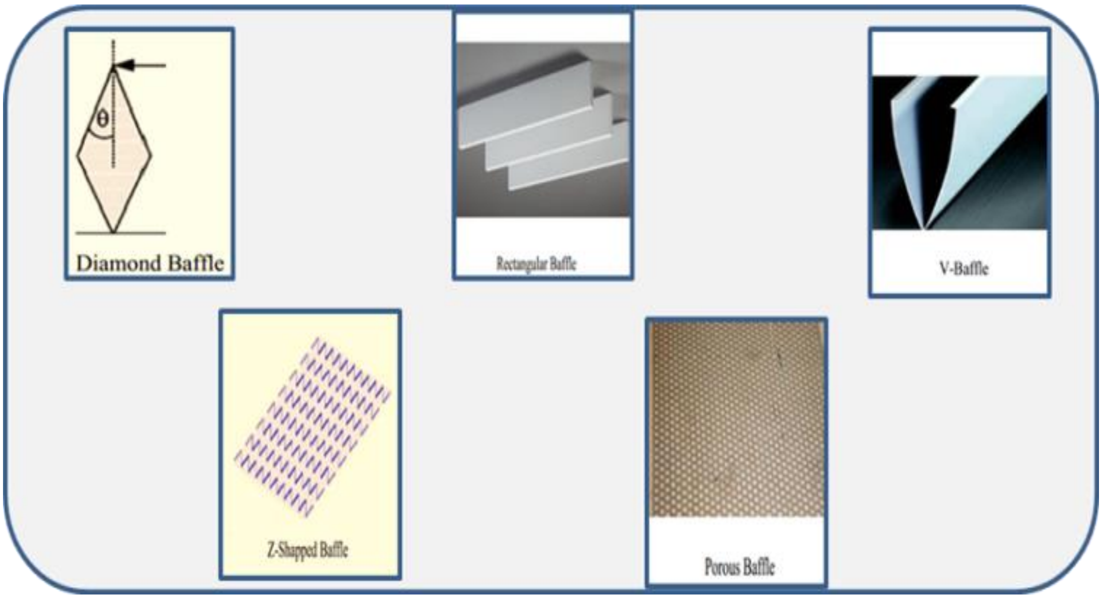

Figure (2): Types of Baffles

2. Numerical studies of the natural convection inside an enclosure filled with nanofluid.

Santra et al. [1] demonstrate a numerical simulation of the differentially heated square enclosure to study (Cu-water) nanofluid natural convection. The enclosure vertical walls considered differentially heated and the remainder walls were considered adiabatic. The nanofluid was presupposed to be incompressible and non-Newtonian. The effects of (ϕ) and (Ra) were considered. The result shows that the heat transfer increased as (Ra) value increase, whereas it decreased when the value of (ϕ) increases. A numerical investigation of laminar heat convection in a vertical cavity has square shape and use the (Al2O3-water) nanofluid as a working fluid was done by Ho et al. [2]. The horizontal walls assumed to be adiabatic, and the two vertical sidewalls were considered differentially heated. The thermal conductivity as well as viscosity of nanofluid has been examined using four different models and the comparisons between the results obtained from the models were presented. The volume fraction (ϕ) effects and the Rayleigh number (Ra) were investigated. The results showed that the properties of natural heat transfer in the space were clearly and strongly influenced by the uncertainties associated with the different models adopted in the published studies. In addition, it was concluded that the nanofluid improved the heat transfer inside the enclosure much better than the pure fluid (water). As well as Abu-Nada and Oztop [3] performed a numerical study on an inclined cavity filled with (Cu-water) nanofluid and their effect on the natural heat transfer was presented. The horizontal walls of the enclosure considered thermal insulated, while the vertical walls had different uniform temperature. The parameter that controls the behavior of the flow and heat transfer within the cavity is the tilt angle. The different parameters like inclination angle, Rayleigh numbers and solid volume fractions were investigated numerically. The results presented as streamlines, isotherms together with the Nusselt number. They briefed that, by raising the value of (Ra) and (ϕ), the Nusselt number go up. A Numerical and experimental studies was conducted by Ho, Liu et al. [4] heat convection of nanofluid in a square enclosure have various dimensions. The two vertical-cavity boundary walls were considered at mismatched temperature; while the others remaining walls were kept adiabatic The (Al2O3) nanoparticles and water were used to formulate the nanofluid by diluted different volumetric fractions of it and mixing together. It was concluding based on manipulation in the nanofluid thermal-characteristic. The results of the heat transfer rate towards the three different cavities were tested. It was generally similar to the estimate formulation, indicating a systematic drop in the heat transfer of nanoparticles with a fraction of 0.2%, and for nanoparticles containing a fraction of the particles much less than 0.1%, heat transfer promotion was found by about 18% compared with base water found at sufficiently high Rayleigh number. Lin and Violi [5] studied numerically natural convection within the nanofluid cavity of (Al2O3-water) with boundary walls temperatures. The vertical walls differentially heated while the other cavity's walls were kept adiabatic. The heat transfer rates were examined for parameters of non-uniform nanoparticle size, mean nanoparticle diameter, nanoparticle volume fraction and Grashof number. It was concluded that the range where the heat transfer uncertainties could be affected by the size of the nanoparticles. A numerical and experimental study of the natural convection within square shape nanofluid enclosure filled with (water/SiO2) were conducted by Jahanshahi, Hosseinizadeh et al. [6]. The enclosures vertical walls were kept in a different uniform temperature and the anthers walls were adiabatic. The nanofluid was treated as an incompressible and Newtonian fluid. The thermal conductivity of nanofluid using two models to test their impact on the heat transfer activity has been analyzed at various parameters of like: nanoparticles concentrations (ϕ), modify Rayleigh number (Ra). It shows that when (ϕ) increases, the heat transfer increases for the first model (experimental thermal conductivity) at all value of Rayleigh number, while the second model of (theoretical thermal-conductivity model) shows that the rate of heat transfer decreases. Sheikhzadeh et al. [7]studied numerically the (Cu-water) nanofluid of natural convection inside a partially heated walls cavity. Different parameters had been used like Rayleigh number, hot section locations at the walls, and the nanoparticles volume fraction. The parameters influence on fluid behavior and heat convection had been presented. It was shown that the Nu rise by boost both value of (Ra) and (ϕ). In addition, the optimum value of average Nusselt number for both value of Rayleigh numbers high and the low, found in case of position as (middle-middle) and (bottom-middle) of the active sections of the walls, respectively. Ternik and Rudolf [8] investigated the natural convection within a square shape enclosure exposed to different temperatures at boundary walls and contain the (Au-water, Al2O3-water, Cu-water, and TiO2-water) nanofluid. The nanoparticles volume fraction (ϕ) and Rayleigh numbers (Ra) influence were considered. It was presented that the increasing of (Ra) and (ϕ) enhanced the average Nusselt number. Oztop, Mobedi et al. [9] studied the heat transfer mode by nanofluid natural convection of (CuO-water) within an inclined enclosure with non-uniformly temperature distribution at boundary walls. It was heated non-uniformly at the wall and the opposite wall was cooled, and the remaining walls were kept thermally insulated. The computation was carried out for different parameters like Rayleigh numbers (Ra), tilt angle (Φ) and nanoparticle fraction (ϕ). It was concluded that when the volume fraction increases the heat transfer increases with low Rayleigh number. From Basak and Chamkha [10] numerical study done on the heat transfer by natural convection within the square-shaped cavity and contain (Cu-water, TiO2-water, and Al2O3-water) nanofluids. The horizontal walls of the cavity were considered either adiabatic considered as (case one) or adiabatic on the top wall and heated on the bottom wall considered as (case two) and the vertical walls boundary condition were considered either differentially heated (case one) or uniform cold temperature (case two). The impact of the different boundary conditions and parameters; volume fraction (ϕ) and Rayleigh, number (Ra) examined. It concluded that the (Cu-water and Al2O3-water) nanofluids show larger enhancement of the heat transfer. Moreover, it was concluded that for all values of (Ra), the Nusselt number for nanofluids was more than water. The effects of nanoparticles volume fractions and different Rayleigh numbers on nanofluid heat transfer in the transference region were investigated experimentally and numerically by He et al. [11] on the natural convection in a square enclosure filled with (Al2O3-water) nanofluid. The left wall of the cavity was at uniform hot temperature, while the opposite wall was at a low uniform temperature. The other wall thermal boundary conditions were maintained insulated. The results showed that the sensitivity of nanofluid heat transfer was remarkable to the change in thermal conductivity than viscosity at low volume fractions of nanoparticles, while it has a higher sensitivity to the effective viscosity in comparison with the thermal conductivity when the nanoparticle volume fractions become high. Another numerical study of laminar heat convection inside an enclosure filled with (CuO-water, Al2O3-water, and TiO2-water) nanofluids by Cianfrini, Corcione et al. [12]. The vertical right wall considered at a cold temperature and the opposite wall considered at hot temperature. Moreover, the horizontal walls of the cavity considered either adiabatic or differentially heated. The width (W) and (dp) of the enclosure effects were examined. It was observed that the nanoparticle was enhanced the heat transfer characteristic more than when using pure water. Furthermore, it was found that when (W) and the nanofluid average temperature were increased, this followed by an increase in heat transfer. A experimental as well as numerical investigation for steady free convection of (CuO-water) nanofluid within a two-dimensional rectangular shape enclosure with an inclined angle was presented by Bouhalleb and Abbassi [13]. The enclosure consists of two adiabatic walls at the horizontal direction and two left vertical sidewalls have spatial temperature distribution. The inclination angle effects (Ø), the volumetric fraction of nanoparticles (ϕ), aspect ratio (Ar), and constant Rayleigh number (Ra) were examined. It was observed that corresponding to unity aspect ratio (Ar = 1) as the slope angle of the enclosure increases, the heat transfer increases, then decreases. When (A<1), the heat transfer increased with increasing of the inclination angle. Moreover, as the volume fraction of nanoparticles increases the rate of heat transfer enhances.

3. The numerical studies of the natural convection in an enclosure with baffle and filled with base fluid.

A wide number of studies has received some consideration in recent years for the heat transfer modulation in cavities owing to the introduction of obstacles and baffles fixed to the cavity wall which filled with fluid and theseswalls have different boundary conditionas shown in Xundan Shi [14]. It presented a numerical analysis of natural convection within a square shape enclosure filled with air as a base fluid. The effect of the horizontal thin baffle, which attached to the left hot wall, was studied. The right wall cavity considered to be at constant cold temperature, while the other walls were kept thermal insulated. The effect of the fin length (Lb) and it's located at the hot left wall was examined for different rang of (Ra). The results shows that, the heat transfer enhanced in any case (location or the length) of the fin the for high Ra. Humaira Tasnim and Collins [15] intended a numerically of the natural convection inside a square shape cavity filled with air cavity. A solid thin baffle attached to the left wall of the enclosure. The horizontal walls were assumed to be adiabatic, while the other walls considered differentially heated. The effect of baffle length, high and Rayleigh numbers (Ra) on characteristic natural convection had been examined. The results shows that the adding baffle at the surface of hot wall can improve the heat transfer inside the cavity much better than the absence of baffle and the best position of the baffle corresponding to the good feature of heat transfer was close to the isolated wall. As well as increasing the heat transfer with increasing Rayleigh numbers. A natural convection heat transfer inside a cavity was numerically investigation by Bilgen [16]. The cavity left wall was hot, while the right wall was cold and the remainder walls of the cavity were considered insulated. A solid horizontal baffle set on the hot wall. The impact of different non-dimensional parameters including modifying Rayleigh number (Ra), fin length (Lb) and its position (Db), and conductivity ratio of the fin (kr) were considered. It was concluded that the position (Db) of the fin plays a vital character in the heat transfer of the cavity. It was also concluded that when the fin reaches to the center/near the center of the wall, the heat transfer rate reduced. Furthermore, heat transfer decreased with increasing (Lb) and (kr). Oztop and Bilgen [17] preformed numerically natural convection heat transfer in a differentially heated square cavity filled with air. The vertical walls were isothermal different temperature and the horizontal walls kept adiabatically. The bottom wall of the cavity has a vertically adiabatic partition. The effect of partition thickness, the length (Lb), and the modify Rayleigh number (Ra) were considered. The results shows that the rate of heat transfer increases when there is a change in thickness and partition length. Ambarita, Kishinami et al. [18] investigated numerically steady laminar natural convection inside a square enclosure filled with air. The vertical walls formed the cavity were uniformly differently heated. Whilst, the two horizontal walls of the cavity have two isolated thin fins at an asymmetric location inside the cavity. The effects of (Lb), (Db) and (Ra) were studied. It was found that the (Nu) enhance when the value of (Ra) increase, while it was decreased with increasing of (Lb). Furthermore, the flow and thermal fields in comparison with no baffle case become better with the existence of the two baffles with more than 0.5. Numerical study made by Ben-Nakhi and Chamkha [19] on laminar heat convection inside an enclosure filled with air and a solid fin with an inclined angle fixed to the hot wall. The two horizontal walls of the enclosure were thermal insulated and, the other walls were considered in different but constant temperature. The fin length (Lb), inclination angle (ε), and Rayleigh numbers (Ra) effects on characteristic of natural convection were investigated. It is observed that, the length and the angle of the fin had a significant impact on the average Nusselt number of the hot wall, furthermore, the heat transfer increase with the increase (Ra), while it decreased with the increase (Lb).Natural convection within a differentially heated enclosure(square) filled with air have been studied numerically by Sheikhzadeh, Pirmohammadi et al [20]. The cavity has adiabatic horizontal walls, while, the other vertical walls were assumed to be at uniform different temperature. High conductivity thin baffles were attached to the isothermal walls in a symmetrical position. The effect of baffle position (Db) and the length of the baffle (Lb), as well as the (Ra), were investigated. It was concluding that Nusselt number reaches the maximum value when (Lf) is greater than 0.5 and the position of the baffles near the middle of the cavity. Also, conclude that the position and length of the baffle, as well as the Rayleigh number, effected significantly on Nusselt number. Mobedi [21] performed a numerical simulation of the conjugate heat convection in an inclined square shape enclosure filled with air. The vertical walls of the cavity were at different constant temperatures while the outer surfaces of horizontal walls are insulated. The cavity consists of a two solid walls with uniform heat flux. The effects of different parameters like (Ra), the conductivity ratio (kr), the wall thickness (w) and the angle of inclination were investigated. It was found that, for high thermal conductivity ratio and Rayleigh number, the rate of heat transfer decreased. Basak, Anandalakshmi et al. [22] investigated numerically the conjugate natural convection in a square cavity filled with air. The enclosure consists of two vertical differentially heated solid walls of specified width (t1 and t2) and adiabatic horizontal walls.Three cases studied by manipulating the wall thickness location as the first case of(left wall), the second (right wall), and the third (both side walls) and conductivity ratio (K). The effects of conductivity ratio (Kr), the wall thickness (b), the modify Rayleigh number (Ra) were considered. It was concluded that as (Ra) increases, the temperature gradient within inner fluid were reduced in the second case for lower and higher wall width. Saleh and Hashim [23] studied numerically conjugate natural convection conduction heat transfer in a square enclosure filled with air. The vertical walls of the enclosure considered adiabatic while the top wall was at constant cold temperature and the hot lower wall have a finite thickness. The effects of thermal conductivity ratio (Kr), thickness of the solid wall (d), Rayleigh number (Ra) were investigated. It shows that the average Nusselt number increaseing by increasing thermal conductivity ratio as well as increasing the Rayleigh number, while it decreases by increasing the thickness of the solid wall.

Numerical and experimental study of natural convection in square enclosure presented by Nardini, Paroncini et al. [24]. Horizontal and vertical Plexiglas walls with for discrete sources formed the cavity. Two insulated Plexiglas baffles were attached in symmetrically position between the sources at the vertical walls. The effects of (Lb) and (Ra) were studied. It observed that the (Nu) increased when the value of (Ra) increased and it decreased when the baffle length increased, for the lower sources and increased for the higher sources. A numerical investigation was preform by Elatar et al. [25] in order to study the natural convection inside an enclosure (square) filled with air. It was consist of two horizontal adiabatic walls, and the other sidewalls were considered differentially heated. Inside the cavity, on the right side of the left wall, a horizontal solid fin has been added. The effects of fin length (Lb), width (w), positions (Db), conductivity ratio (Kr), modify Rayleigh number (Ra) were considered. It was concluded that the fin influence was increased with increasing (Lb). Also, it was found that the fin efficiency was decreased with increasing (Lb). Torabi, Keyhani et al. [26] numerically examined the natural convection within the square air-filled enclosure. The vertical walls heated partially and kept at steady temperatures. The other parts, as well as the two horizontal walls, were kept adiabatic. A solid thin horizontal fin was close fitting to the hot wall. The effect of the active sections (hf), (hc), the position of the fin (hf), fin length (lf) and different rang of Rayleigh numbers (Ra) were investigated. It was observed that the temperature distribution and fluid flow behavior within the cavity was enhanced. Consequently, the average (Nu) can control by moving the position of the active part of the vertical walls, and changing the fin location on the hot wall and using three different Rayleigh numbers.

4. The numerical studies of the natural convection in an enclosure with baffle and filled with nanofluid.

Conjugate heat transfer by natural convection within the cavity which exposes to different boundary conditions and finite wall thickness has been received a notably large in size by many studies because they have important engineering applications in our modern area. A numerical analysis of heat transfermode by natural convection inside a square shape enclosure filled with (Cu-water) nanofluid have been done by Mahmoudi et al. [27] .The left wall of the cavity has a horizontal partition work as heat source generate a uniform flux of heat. The right wall of the enclosure was considered at uniform cold temperature, while the other parts of walls kept adiabatically. The effects of the position (Db), the heat source geometry, the volume fraction (ϕ) and Rayleigh number (Ra) were considered. It was concluded that the average (Nu) was increased by increasing (ϕ) while it decreased by increasing (Lb). Also, concluded that when (Ra) was value risen, the temperature of the heater source was reduced. Habibzadeh et al.[28]performed a numerically analysis on convection inside a square shape enclosure. The cavity filled with (Al2O3-water) nanofluid. The vertical left and right walls were considered as the high and low tempreature walls, respectively while the horizontal walls of the enclosure were kept adiabatic. An adiabatic partition joint at the left hot wall bottom of the enclosure. The influence of Rayleigh number (Ra), the hot wall distance (d) and height of partition (h) and nanoparticles solid volume fractions (φ) were investigated. It was found that when the Rayleigh number (Ra) increases the average Nusselt number increase, while, it was not sensitive to (ϕ). It was also concluded that when the partition height was growth, the heat transfer was decreased. A numerical investigations made by Sayehvand et al. [29] to study the natural convection in a square enclosure with (Al2O3-water) nanofluid. The lower and upper walls of the cavity were considered adiabatic, whilst the right and left walls were considered differentially heated. Two adiabatic partitions were attached symmetrically at the horizontal two walls of its. The effects of (Lb) and (Ra) were studied. It was found that the Nusselt number increased when the value of (Ra) increase, while it decreased by increasing (Lb). Also, they found that by increasing (Lb), the vortices moved towards the vertical walls. The heat transfer by natural convection of nanofluid consist of (Cu-water) inside an enclosure was studied numerically by Naoufal, Zaydan et al. [30] The horizontal walls were considered insulated, whilst the two vertical walls were considered at cold temperature. A hot partition was linked vertically to the bottom wall. The effects of the partition length (Lb), location (Db), the volume fraction (ϕ), and (Ra) were considered. It was concluded that for all (ϕ) the increase in the value of (Ra) resulting in an increase of Nusselt number. In addition, they found that, the maximum value of the average Nusselt number occurred as the partition was located at the center of the cavity. Selimefendigil and Oztop [31] investigated numerically the conjugate heat transfer within a square enclosure with an inclined angle and contain (Al2O3-water and CuO-water. nanofluids). The enclosure horizontal walls were kept adiabatic, while the two vertical walls were maintain at uniform different temperatures. A high conductive partition was divided equally the space of the cavity. The (Al2O3-water) type filled the enclosure on the left side while the (CuO-water) nanofluid filled the right one .The effects of (Φ), (Db), (ϕ), conductivity ratio (kr), and the Grashof number (Gr) studied. It was found that the Nusselt number increases as the (Gr) and (ϕ) increases.while, it decreased by increasing (Db). Also, found that the rate of heat transfer was improved by about when the left or right side of a cavity was filled with nanofluids while the other part of it was filled with water only. Alsabery, Chamkha et al. [32] investigated numerically the conjugate natural convection in a square enclosure filled with (Al2O3-water, Cu-water, Ag-water, and TiO2-water) nanofluids. The cavity consists of two horizontal walls which have sin wave temperature distributions, while the two vertical walls were kept adiabatic. As the solid wall thickness enlarge, the heat convection rate was significantly improved. Also found the increment in Phase deviation have effects on the temperature distribution, fluid flow behavior across the cavity and Nusselt number were significantly enhanced. Chamkha and Ismael [33] observed the conjugate heat transfer inside a porous cavity using nanofluids as a working fluid. The cavity triangular thick wall, where the heat was supplied. The results show that for low Rayleigh number, the heat convection was significantly consolidated with increasing the volume fraction of the solid particles. At a recent time, Rusul and Ahmed Kadim.[34]studied numerically the effect of the baffle length and location on the natural convection heat transfer within an inclined enclosure filled with two types of nanofluids. The horizontal walls of the enclosure were assumed to be adiabatic. While, the vertical walls were at differentially heated. Two cases have been investigated by manipulate the baffle location: on left sidewall as a (case one) and on the right sidewall as a (case two). The influences of various parameters were studied. It was concluding that, when the parameters like Rayleigh number, solid volume fraction, baffle length and aspect ratio increase, the fluid flow intensity in the enclosure increases also. While, it decreases when the inclination angle increases for the two cases. Al-Farhany and Abdulkadhim [35] analyzed the influence of conjugate natural convective heat transfer in a square a porous enclosure with a partially heated vertical wall, while the horizontal wall kept adiabatic. They demonstrate that by increasing Rayleigh number (Ra) and the thermal conductivity ratio of the solid wall the heat transfer rate also increased. Mustafa and Salam Hadi.[36], studied numerically the natural convection in a square enclosure filled with nanofluid superposed porous layers. Four cases have been investigated deepens on two layers locations, the temperature walls, presence or absence of the circular cylinder and the straight or corrugated left sidewall. The left-side wall is heated at a constant hot temperature, while the right side wall was at a constant cold temperature; the other walls were isolated thermally for case one and two while, for case three and four the surface cylinder was heated at a constant hot temperature, and the enclosure walls kept at a cold temperature. The influences of various parameters were studied. It was concluding that, when the Rayleigh number, Darcy number, thermal conductivity ratio, cylinder diameter and volume fraction increase, the fluid flow intensity in the enclosure also increases. While, it decreases when the thickness of porous layer increases for all the cases. Ishrat and Alim [37] preformed a numerical analysis of conjugate effects on heat convection inside a vertical cavity with heat conducting vertical wall, the cavity filled with (Cu-water) nanofluid. The vertical thick wall of cavity subject to a steady distribution of heat flowing and a solid divider at various location at the bottom horizontal wall. It is found that the solid divider location contributes to enhancing the natural convection within an enclosure.

5. Experimental studies of the natural convection in an enclosure filled with nanofluid.

The lack of the experimental study on natural convection within nanofluid enclosure leads to increase the experimental investigations. in fact, small numbers of experimental studies are obtainable in the literature because of the difficulties faced by researchers when measuring effective parameters, which can be summarized as the effect of nanoparticle concentration on heat transfer coefficient of the natural heat convection was investigated by Putra et al. [38]. The study was done within a horizontal heated cylinder from the side and the opposite was side cooled. The study used the (Al2O3) nanoparticles suspended in distilled water with (d = 131.3 nm) and CuO (d = 87.3 nm). It is found that as the volume fraction of nanoparticles increases (1-4%), we observe an increase in the systematic deterioration of natural convection. An experimental investigation was conducted by Wen and Ding [39] on the nanofluid natural convection heat transfer of (TiO2-water) with the size of rang (30-40nm) have a disc-shaped cavity for(0.19, 0.36 and 0.57%) nanoparticle concentration. It was found that when applying a high-shear homogenizer, the mean size of accumulation was reduced from so, a small amount of sedimentation was reported. Li and Peterson [40] carries out an experimental study of Al2O3 with (d = 47 nm) deionized water inside a cavity of cylindrical shape. The nanofluid concentration range (0.5, 2, 4 and 6%). The influence of increasing the solid volume fraction on the coefficient of heat the transfer with was reported. Azmi, Sharma et al. [41] investigated experimentally of turbulent forced convection heat transfer in a circular tube under constant heat flux boundary condition using (SiO2/water) nanofluid with particle volume concentration up to(4%). It was concluded that at any concentration the nanofluid factor of friction decreases as Reynolds number increases. Also the particle volume fraction up to 3.0% at which SiO2 nanofluid provide maximum heat transfer. In addition, when the enhancement ratio of the viscosity to thermal conductivity is greater than (5.0) the heat transfer coefficient decreases. Joshi and Pattamatta [42] experimental investigation of the convective inside a square shape enclosure using various types of nanofluids, The Rayleigh number over a range of (7 x105 to 1 x107). It was found that as Rayleigh, number increase the Nusselt number increases for both base fluid and nanofluid. Also found that the (graphene/water) nanofluid has a higher value of Nusselt number for all concentration compared to that of (alumina /Water) and base fluid but the value is lower than that of (MWCNT/water). The nanoparticles distribution in the nanofluid heat transfer by natural convection within squared shape cavity was conducted by Khalili, Saboonchi et al. [43] the experimental study preform using 20 nm-gamma type Al2O3 nanoparticles mixing with distilled water. The experiments were done for three Rayleigh number (0.992 x 107, 0.51 x 108 and 1.53 x 108). It was found that the average size of the nanoparticles at the cold side wall was(3.10%)higher than that along the hot wall at low (Ra) number anyway at a higher value of Rayleigh number.

6. Conclusion

1. It can be noted that that at low value of Rayleigh number ($Ra \leq 10^3$) flow strength and the convective heat flow in case of pure water at effect the center of the cavity due to viscous force are dominance in this case. Also The core of circulation cells of nanofluid has smaller strength as compared to that of base fluid (water) but, at high Rayleigh number the flow strength increase and also the convective heat flow due to nanofluids Significantly enhance for ($Ra=10^6$) this because the buoyancy force of nanofluids dominance, where it is greater than that in pure fluid.
2. It can be noted that the increase in (Kr) mean rise the conductivity of the solid wall by use high conductivity material. As the thermal conductivity ratio increase, that mean more amount of heat transmitted through the solid wall and the temperature gradient appears clearly at the solid-fluid interface because the wall resistance reduce by increasing the conductivity ratio. Therefore, we can say that thermal conductivity ratio plays as control parameter that impact on the temperature profile as well as the heat transfer within enclosure had a lot of investigation.

3. Baffle has two effects if present within the enclosure, the first one effect on the fluid flow strength and shape of circulation cells .the second one on temperature field within the enclosure, first its act as an obstacle to the flow of natural convection and thus drop in the thermal performance of the enclosure, second related to the thermal effect of baffle due to its thermal conductivity. With respect to the flow field effect, the blockage effect of the baffle depends on its length. The larger blockage happened with the longest baffle.
4. The concentration of nanoparticles plays a major role that could manipulate the convection heat transfer of nanofluids within an enclosure. The flow strengths influenced by the presence of nanoparticle, when increasing the solid volume fraction (ϕ), the thermal conductivity of the nanofluid will be increased. For example suspending (Cu, Al_2O_3) nanoparticle (0.02 to 0.06) improved the natural convection heat transfer in comparison with base fluid (water). Also, the increase in the nanoparticles concentration is accompanied by higher effective thermal conductivity and the temperature of the nanofluid slightly decreases. Therefore, this is an indication of an improvement in the heat transfer rate.

CONFLICT OF INTERESTS.

- There are no conflicts of interest.

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مراجعة حول تأثير الحاجز على انتقال الحرارة بالحمل الطبيعي في حيز مغلق مملوء عادة نانوية

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الخلاصة:

تم عرض مراجعة شاملة حول مجموعة واسعة من الدراسات حول انتقال الحرارة بالحمل الطبيعي وخاصة على للدراسات التي اجريت على الحيز المغلق والذي يحتوي على مادة نانوية متناهية الصغر والتي درست تحت ومتغيرات ظروف حرارية مختلفة على جدران الحيز. تمت مناقشة التفاصيل المتعلقة بالطرق المستخدمة في تعزيز النقل الحراري باستخدام تلك المواد النانوية داخل منطقة حيز الدراسة. أيضًا تم عرض الدراسات التجريبية والعددية المتعلقة بالانتقال الحراري بالحمل الطبيعي لتلك السوائل النانوية .حيث ان دراسة هذه المواضيع لها أهمية عملية وعلمية للعديد من التطبيقات الهندسية، مثل المنشآت الصناعية للتخزين البارد والعزل للمباني. لقد جذب الباحثون اهتمامهم بدراسة الخصائص الفيزيائية الحرارية للجسيمات النانوية أكثر من أي شيء آخر من الدراسات ولم يركزوا على خصائص انتقال الحرارة بواسطة هذا السائل الجديد. كانت هناك سلسلة من التحقيقات والعديد من الدراسات التجريبية والعددية تم التحقيق داخل حيز مربع الشكل باستخدام السوائل النانوية استخدمت كوسيط نقل ومع تأثير حاجز ذات موصلية جيدة ودراسة تأثير تغيير طول الحاجز على الجدار الأفقي السفلي. لقد وجد أن هناك الكثير من الأشياء التي يجب دراستها لدراسة حجم الجسيمات النانوية وتأثيرها على انتقال الحرارة الحراري الطبيعي داخل الحيز المغلق.

الكلمات الدالة: – النانوفلويد، الحمل الحراري، الحمل الحراري المترافق، التجويف، الحيرة.