Temperature and Conduction Heat Transfer Equations Development using Three Dimensional Techniques

Ahmed Nafi Aziz

*Abstract— **In this paper, new equations of temperature and the quantity of conduction heat transfer without and with heat generation for plan wall is presents. Temperature and Conduction heat transfer Equations are essential in application in all material, bodies or structure that has the same shape like the plan wall. For the plan wall without heat generation use wood material like plane wall shape where assumed that it has width, temperature value on the first side and on the second side, value of cross sectional area, value of thermal Conductivity. Therefore, one can determine the temperature at any point with different distance to study and analysis any parameter along the width of the wood material and the quantity of heat transfer from the first side to the second side in the wood material. For the plan wall with heat generation, the limestone material in plane wall shape assuming the width is present with the temperature value on the first and second side. Additionally, the value of cross sectional area, thermal conductivity and value of heat generation is considering. Results shows that the heat transfer Equations in the wood and limestone give better performance and accurate calculations compared with conventional equations.***

*Index Terms— **Conduction heat transfer, thermal Conductivity, heat generation, heat transfer Equations.***

I. INTRODUCTION

Conduction may be viewed as the transfer of energy from the more energetic to the less energetic particles of a substance due to interactions between the particles. Conduction can take place in solids, liquids, or gases [1]. In liquids and gases, conduction is due to the collisions and diffusion of the molecules during their random motion. In solids, it is due to combination of vibration the molecules in a lattice and the energy transport by free electrons [2]. The rate of heat conduction through a medium depends on the geometry of the medium, its thickness, and the material of the medium, as well as the temperature difference across the medium [3]. The sign convention used is based on the second law of thermodynamics with the flux being positive when it flows in the direction of decreasing temperature [6]. Mathematically it may be more appropriate to state that the heat flux is positive when the temperature gradient negative [4].

The rate of heat conduction through a solid is directly proportional to its thermal conductivity. In heat conduction analysis, a represents the area normal to the direction of heat transfer. The mechanism of heat conduction in different phases of a substance [5]. The ideal representation of temperature changing via distance could be shown in Fig. 1. The sample of wood used in this research is illustrated in Fig. 2.

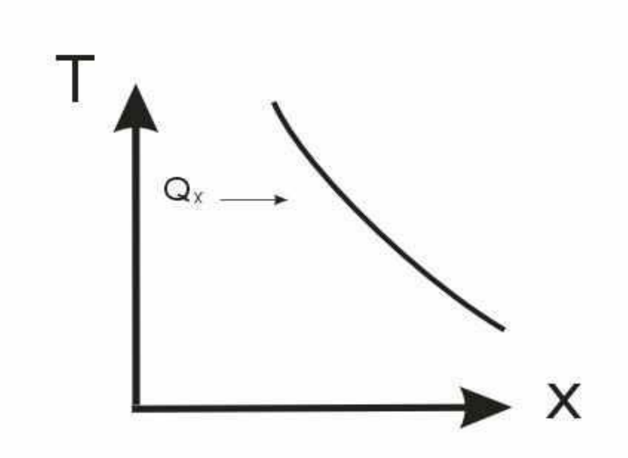

Fig. 1: Sketch Showing Direction Of Heat Flow

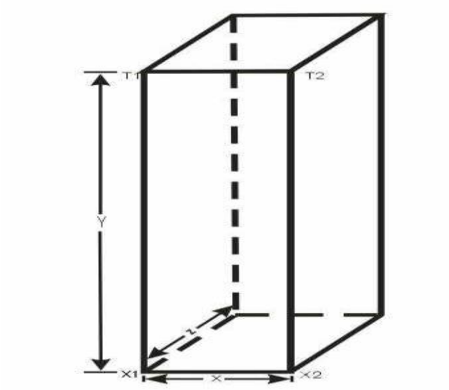

Fig. 2: Elemental Volume For One Dimensional Heat-Conduction.

Revised Manuscript Received on 30 May 2015.
***** Correspondence Author

Mr. Ahmed Nafi Aziz*, Department of Power Engineering, Middle Technical University, College of Electrical and Electronic Technical Engineering, Baghdad, Iraq.

II. Mathematics Background

A. The Conduction Equation

In undergraduate heat transfer were presenting with such an analysis – which typically involved applying the first law to small. Differential control volume within the system presented here is an alternative and more mathematically elegant method for obtaining the differential Equation for energy conservation. [6] It starts with arbitrary system, assuming that the volume of the system is fixed (so that no work is transferred) and its mass is constant, Energy conservation is simply described by. [7]

$$(DE/dt)= Ó \quad (1)$$

In which (Ó) is the rate of heat transfer into the system and (E) is the energy of the system. If the system is not in equilibrium then (E) cannot be related to a single temperature of the system. It is possible, however, [8] to represent (E) as a sum of energies of small volume elements within the system with each element to be in thermodynamic equilibrium at any instant. As the volumes of the elements go to zero the sum can be expressed as an integral,
This gives. [9]

$$(DE/dt) \int (\rho)\,(\partial e/\partial t)\,(dV) = \int (\rho c)\,(\partial T/\partial t)\,(dV) \quad (2)$$

Where (e) is the specific energy, (ρ) is the density, (c) is the specific heat and the integral is over the volume of the system. The heat transfer can also be written in integral form as. [9]

$$Ó= -\int Ő.ndA + \int Ơ dV \quad (3)$$

In the first integral (Ő) is the heat flux vector, n is the normal outward vector at the surface element (dA) which is why the minus sign is present) and the integral is taken over the area of the system. [10] The second integral the generation of heat within the system (through chemical or nuclear reactions, radiation absorption/emission, viscous dissipation etc.) which is described by a volumetric heat source function (Ơ)(W/m^3).[11] The area integral can be transformed into a volume integral by use of the divergence theorem of vector calculus:

$$\int Ő.\ ndA= \int \Delta.\ Ő dV \quad (4)$$

The terms in the energy are now all in the form of volume integrals. Energy conservation therefore appears as. [12]

$$\int [\{(\rho c)\,(\partial T/\partial t)\} + (\Delta.Ő) – Ơ]\ dV = 0 \quad (5)$$

Realize that this Equation should hold for integrals over any arbitrary volume within the system. That is, the system could be split into two volumes, [13] and we would expect the integral to hold individually for each of the volumes. The only way that this condition can be met is for the integrand to be identically zero at all points within the system, i.e., [14]

$$\rho c\,(\partial T/\partial t) + \Delta.Ő – Ơ = 0 \quad (6)$$

B. Conduction Equation Formula

Returning to Equation (6) Fourier's law is to eliminate the heat flux, which results in

$$\rho c\,(\partial T/\partial t) = \Delta.k\Delta T + Ơ \quad (7)$$

The assumption of constant thermal conductivity simplifies the above to. [15]

$$(1/\alpha)(\partial T/\partial t)= (\Delta^2 T) + (Ơ/k) \quad (8) \quad (8)$$

Where (α) = ($k/\rho c$), (precisely, ($k/\rho cp$)) is the thermal diffusivity of the material – which has units of square length by time (m^2/s) [16]. As the name implies, the thermal diffusivity can be viewed as a measure of the rate at which heat diffuses through the material. [17] When a thermal perturbation is applied at some point in a medium (say, for example, an instantaneous change in a surface temperature), it generally takes on the order of ($t=r^2/\alpha$) for the perturbation to appear at a distance (r) from the point.[18]Heat conduction is analogous in many respects to mass diffusion. Similar to heat flux, the diffusion mass fluxĴA ($kg/m^2.s$) of a dilute component (or species), denoted species A, through a medium of species B is given by ficks law of diffusion as. [19]

$$ĴA= - \rho DAB\Delta wA \quad (9)$$

Where WA is the mass fraction of (A) in (B) and (DAB) is the binary diffusion coefficient (m^2/s). [20] Similar to the derivation of the energy Equation, the species conservation Equation for A can be obtained by applying mass conservation laws to the system. [21] The resulting differential Equation would be in the same form as Eq. (10), with T replaced by WA, α by DAB, and (Ơ/k) by ($sA/\rho DAB$), where SA is the volumetric creation rate (through Chemical reactions) of species A. [22]The quantity ($\Delta^2 T$) is commonly referred to as the laplacian operator. The particular form of this operator will depend on Te coordinate system that best represents the system. It turns out that there are (11) orthogonal coordinate systems in the laplacian can be cast differential operator [23]. The samples of wood and limston are illustrated in Fig. 1, Fig. 2 and Fig. 3. We will deal with the most common geometries of Cartesian, the laplacian is. [24]

$$\Delta^2 T = (\partial^2 T/\partial X^2) + (\partial^2 T/\partial Y^2) + (\partial^2 T/\partial Z^2) \quad (10)$$

III. Proposed Algorithms

From the theory mentioned above one could be determined the temperature and conduction heat transfer Equations without and with heat generation for plane wall. The proposed Equations derivation steps are discussed in details as showing below. The Conduction heat transfer Equation is given by [24] as:

$$q=-KA\,(\partial T/\partial X) \quad (11)$$

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

For One dimension heat transfer Equation:

(ƏT/əτ)= (K/ρC) (ə²T/əX²) (12)

The general three dimension heat transfer conduction Equation is:

(ƏT/əτ)= [K/ρc] [(ə²T/ə²X) + (ə²T/ə²Y) + (ə²T/ə²Z)] (13)

Consequently, the general three dimension heat transfer conduction Equation with heat Generation is:

(ƏT/əτ)= [K/ρc] [(ə²T/ə²X) + (ə²T/ə²Y) + (ə²T/ə²Z)] + [ó/ρc] (14)

IV. DERIVATION RESULTS

For the case of the generation without heating, the obtained results is

ƏT/əτ= [K/ρc] [(ə²T/əX²) + (ə²T/əY²) + (ə²T/əZ²)] (15)

Assume For steady state ƏT/əτ=0, therefore, in One dimensional the change of temperature is:

Ə²T/əY²=0, ə²T/əZ²=0 (16)

Then the First and second integration could be formulated as in Equation 17 and 18 respectively as:

ƏT/əX= [ρc/k] A (17)

T= [ρc/k] [A] X+B (18)

Substations the Boundary condition of X=X1, T=T1, X=X2 and T=T2 in Equation 18 given

T1= [ρc/k] [A] X1+B (19)

T2= [ρc/k] [A] X2+B (20)

T1-T2= [ρc/k] [A] [X1-X2] (21)

A= [T1-T2]/ [ρc/k] [X1-X2] (22)

Once, subsisting the variable A in Equation 19 resulting:

T1= [ρc/k] [{(T1-T2)/ (ρc/k)}] [X1-X2] [X1] +B (23)

B=T1- [ρc/k] [{(T1-T2)/(ρc/k)}][X1-X2] [X1] (24)

The temperature (T) in Equation 18 could be represented by mean of Equation 21 and 23 as:

T= [ρc/k] [(T1-T2)/ (ρc/k)] [(X1-X2)] [X] + T1- [ρc/k] [{(T1-T2)/ (ρc/k)}] [X1-X2] [X1] (25)

T= (T1-T2) (X1-X2) (X) + T1- (T1-T2) (X1-X2) (X) (26)

q=-KA (əT/əX) (27)

Where, K is thermal conductivity constant, A is a cross sectional area Which is equal to dxdy and xy respectively. As a result, the quantity of heat transfer is:

q=-KA [ρc/k] [T1-T2]/[ρc/k] [X1-X2]=-KXY [T1-T2]/ [X1-X2] (28)

Once, for the case of the generation with heating, the obtained partial temperature with partial time is become

ƏT/əτ = [K/ρc] [(ə²T/əX²) + (ə²T/əY²) + (ə²T/əZ²)] + [ó/ρc]

Assume For steady state ƏT/əτ=0, therefore, in One dimensional the change of temperature

Ə²T/əY²=0, ə²T/əZ²=0

Then the First and second integration could be formulated as in Equation 23 and 24 respectively as:

[K/ρc] [Ə²T/ə²X] + [ó/ρc] = 0

Ə²T/ə²X= - [ó/K]

ƏT/əX= - [ó/K] [X] + A (29)

T= - [ó/K] [X²/2] + AX + B (30)

Substations the Boundary condition of X=X1, T=T1, X=X2 and T=T2 in Equation (26) given:

T1= - [ó/K] [X1/2] + AX1 + B (31)

T2= - [ó/K] [X2/2] + AX2 + B (32)

T1-T2=-[ó/K] [X1-X2] + AX1- AX2

A= [T1-T2 + (ó/k) (X1/2 – X2/2)]/[X1-X2] (33)

By subsisted A in equation 27 resulting

T1= - [ó/K] [X1/2] + [T1-T2 + (ó/k) (X1/2 – X2/2)] / [X1-X2][X1] +B (34)

Where B is given by

B= T1+ [ó/K] [X1/2] - [T1-T2 + (ó/k) (X1/2 – X2/2)] / [X1-X2] [X1] (35)

Then, by substituting Equation 29&22 in Equation 26 given

T= - [ó/K] [X²/2] + [{T1-T2 + (ó/k) (X1/2 – X2/2)}]/{X1-X2}] [X] + T1+ [ó/K] [X1/2] - [T1-T2 + (ó/k) (X1/2 – X2/2)] / [X1-X2] [X1] (36)

ƏT/əX= - [ó/K] [X] + [T1-T2 + (ó/k) (X1/2 – 2/2)]/[X1-X2]

q=-KA (əT/əX) (37)

q=-KA [{ó/K} {X} + {T1-T2 + (ó/k) (X1/2 – X2/2)} / {X1-X2}]

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

q=-KXY [{ó/K} {X} + {T1-T2 + (ó/k) (X1/2 – X2/2)} / {X1-X2}] (38)

V. APPLICATION

A. *Wood without Heat Generation*

For plan wall of wood with out heat generation assuming, K= 0.115 w.m/m².ċ, T1= 20 ċ, T2= 30 ċ, X=0.5 m, X1= 0 m, X2= 1 m and Y= 4 m

Then, the temperature is equal to:

T= (T1-T2) (X1-X2) (X) + T1- (T1-T2) (X1-X2) (X)
= (20-30) (0-1) (0.5) +20-(20-30 (0-1) (0.5) = 20ċ

Subsequently, the variation of temperature compared with the plane wall width is:

(ƏT/əX)= (T1-T2)/(X2-X1) = (20-30)/ (1-0) = -10 ċ/m

And the amount of heat transfer value is

q= -KA (əT/əX) = (-0.115) (1) (4) (-10) = 4.6 w

B. *Limestone with Heat Generation*

For plan wall of wood with heat generation assuming, Q=400 w/s, K=1.3 w.m/m².ċ, T1=30ċ, T2=50ċ, X=1 m, X1=0 m, X2=2m, AND Y=3 m, then, the temperature could be calculated as below,

T= - [ó/K] [X²/2] + [{T1-T2 + (ó/k) (X1/2 – X2/2)}]/{X1-X2}] [X] + T1+ [ó/K] [X1/2] - [T1-T2 + (ó/k) (X1/2 – X2/2)] / [X1-X2][X1]

= - [400/1.3] [1/2] + [{30-50 + (400/1.3) (0/2 – 2/2)}]/{0-2}][1] + 30 + [400/1.3] [1/2] – [30-50 + (400/1.3) (0/2 – 2/2)] / [0-2]
= 30ċ

Consequently, the variation of temperature compared with the plane wall width is:

ƏT/əX=-[Q/K] [X] + [T1-T2+ (Ó/K) (X1/2 –X2/2)]/[X1-X2]
=-[400/1.3] [1] + [30-50+ (400/1.3) (0/2-2/2)]/ [0-2]
= - 471.53 ċ/m

And the amount of heat transfer value is

q= -KA [{Q/K} {X} + {T1-T2+ (Q/K) (X1/2-X2/2)}/{X1-X2}]

= -1.3*2*3[{400/1.3}{1} + {50-30+ (400/1.3) (1/2-2/2)}/ {0-2}]
= 2921.9993w

VI. RESULTS AND DISCUSSION

The conduction heat transfer Equation depends on the value of thermal conductivity, Cross sectional area, the temperature, on the distance in the first side and on the temperature, on the distance in the second side as illustrated in Fig. 3. The shape of the mathematically Equation, where it is the relation between the width of the plane wall and temperature, where done selecting differences distances along the width of the plane wall, where it is, x=o.2m, x=o.4m, x=o.6m, x=o.8m, x=1m and then obtained a values of temperature according to the (x) distance and it is, T=27.3c, T=25.5c, T=23.7c, T=21.9c, T=20.1c, by subsisting in the Equation that mentioned before, assuming that the temperature of the first and the second side for the plane wall it is equal to T2=20c, T1=30c and it's a constant and assuming that the width for the plane wall is equal to (0.9m) and the distance of the first and second side of the plane wall its equal to x1=0.1m, x2=1m, respectively. One could noting that the relation between the differences distances of the width and the temperature that obtained as a result to the differences of the distances for the plane wall it's a straight line relation. The relation between distance and temperature were plotted as illustrated in Fig. 3. The increasing in values of the distance (x) leads to decreasing in temperature, the heat transfer is from the left direction to the right direction, and this is the better direction because the temperature of the first side is bigger than the second side of the plan wall. The relation between the temperature of the first side and the quantity of heat transfer for the plane wall, where done a selecting a differences of temperature for the first side for the plane wall, where it is, T1=25c, T1=30c, T1=35c, T1=40c, T1=45c, and then obtained values of quantity of heat transfer according to the differences values of temperature of the first side for the plane wall and respectively and it is, q=2.3w, q=4.6w, q=6.9w, q=9.2w, q=11.5w, by subsisting in the Equation that mentioned before, where done assuming that the thermal conductivity factor is equal to k=0.115w/mc and it is a constant value, and done assuming that the cross sectional area of the plan wall is equal to A=(4m²) and done assuming that the value of the width of the plane wall is equal to (1m)and the distance of the first and the second side for the plane wall is equal to X1=(0m),

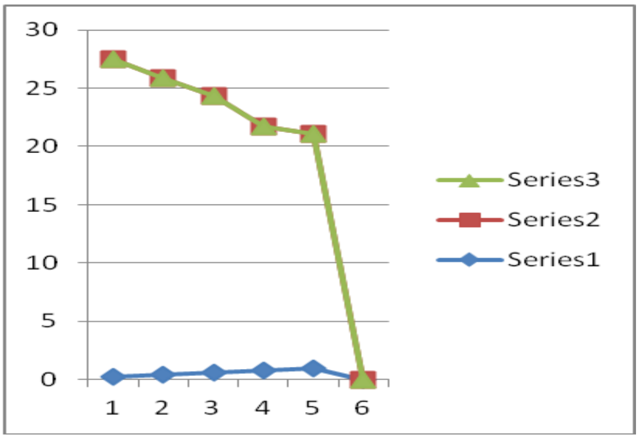

Fig. 3: the relation between the width and the temperature

X2=(1m) and respectively and done an assuming that the temperature of the second side of the plane wall it is T2=20c and it is a constant and from the Fig. 4 note that the relation between the differences of the temperature for the first side of the plane wall and the quantity of heat transfer it is a straight line relation.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

To show the effect of increasing the values of temperature of the first side of the plan wall leads to increasing in quantity of heat transfer, this relation is plotted as shown in Fig. 4. The heat transfer is from the left to the right direction and this direction it is the better direction because the temperature of the first side is larger than the second side of the plan wall.

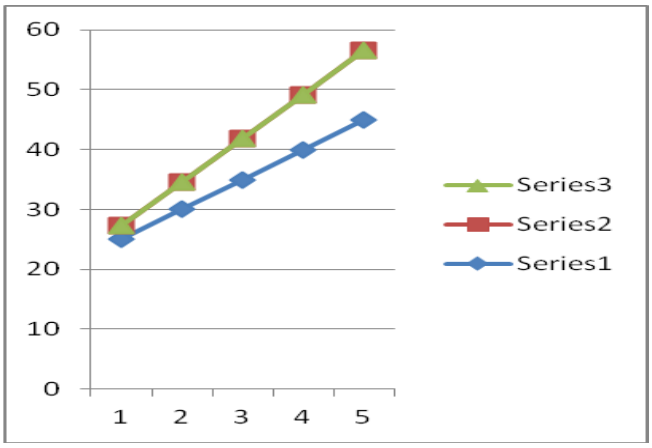

Fig. 4: the relation between the first side temperature and the quantity of heat transfer

Consequently, the increasing in values of temperature of the second side of the plan wall, that leads to increasing in quantity of heat transfer, the direction of heat transfer being from the left to the right direction and that it's the better direction, because of the first side in larger than the temperature of the second side of the plan wall as show in Fig. 5. According to Fig. 5 that explain above, represent the shape of the mathematically Equation, where it is the relation between the temperature of the second side and the quantity of heat transfer for the plane wall, where done a selecting a differences of temperature for the second side for the plane wall, where it is, T2=60c, T2=70c, T2=80c, T2=90c, T2=100c, and then obtained values of quantity of heat transfer according to the differences values of temperature of the second side 0f the plane wall and respectively and it is, q=13.8w, q=18.4w, q=23w, q=27.6w, q=32.2w, by subsisting in the Equation that mentioned before, where done assuming that the thermal conductivity factor is equal to k=0.115w/mc and it is a constant value, and done assuming that the cross sectional area of the plan wall is equal to A=(4m²) and done assuming that the value of the width of the plane wall is equal to (1m)and the distance of the first and the second side for the plane wall is equal to X1=(0m), X2=(1m) and respectively and done an assuming that the temperature of the first side of the plane wall it is T1=30c and it is a constant and from the Fig. 5 note that the relation between the differences of the temperature for the second side of the plane wall and the quantity of heat transfer it is a straight line relation.

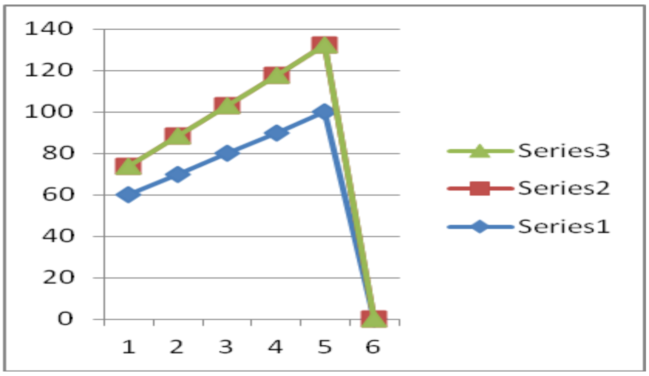

Fig. 5: the relation between the second side temperature and the quantity of heat transfer

In the same time, the increasing of values of the distance (x) leads to increasing in temperature, the heat transfer being from the right to the left direction for the first two distances and after that the direction of heat transfer be from the left to the right and that it is the better as highlight in Fig. 6. However, the increasing of values of (x) the distance leads to decreasing in quantity of heat transfer, the direction of heat transfer is from the left to the right and this is the better and after that the direction of heat transfer is from the left to the right and this is not better as clear in Fig. 5. According to Fig. 6, that explains as above, represent the shape of the mathematically equation, where it is the relation between the width of the plane wall and temperature, where done selecting differences distances along the width of the plane wall, where it is, x=o.3m, x=o.6m, x=o.9m, x=1.2m, x=1.5m and then obtained a values of temperature according to the (x) distance and it is, T=-279.51c, T=-39.78c, T=40.12c, T=80.08c, T=104.05.1c, by subsisting in the Equation that mentioned before, assuming that the temperature of the first and the second side for the plane wall it is equal to T1=50c, T2=30c and its a constant and assuming that the width for the plane wall is equal to (2m) and the distance of the first and second side of the plane wall its equal to x1=0m, x2=1m, respectively and assuming that the thermal conductivity factor and quantity of heat generation it is equal to k=1.3w/mc, q=400w/s and respectively, from Fig.3 noting that the relation between the differences distances of the width and the temperature that obtained as a result to the differences of the distances for the plane wall it's a straight line relation.

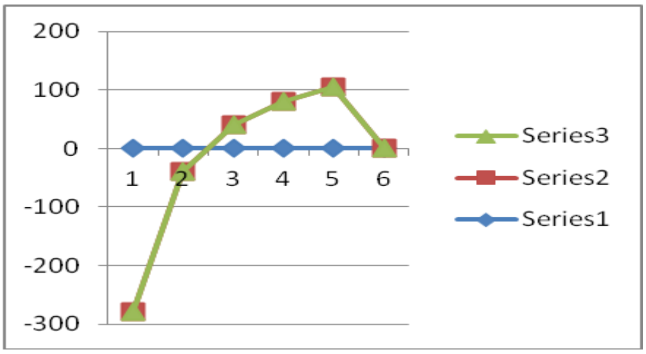

Fig. 6: the relation between the width and the temperature with heat generation

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

According to Fig. 7, that explains as below, represent the shape of the mathematically Equation, where it is the relation between the width of the plane wall and the quantity of heat transfer, where done selecting a differences distances along the width of the plan wall, where it is, x=o.3m, x=o.6m, x=o.9m, x=1.2m, x=1.5m, and then obtained a values of quantity of heat transfer according to the (x) distance and it is, q=1523.98w, q=803.99w, q=83.99w, q=-620.39w, q=-1340.39w, by subsisting in the Equation that mentioned before, assuming that the temperature of the first and the second side for the plane wall it is equal to T1=50c, T2=30c and its a constant and assuming that the width of the plane wall is equal to (2m) and the distance of the first and second side of the plane wall its equal to x1=0m, x2=2m, respectively, assuming that the height and thermal conductivity and the quantity of heat generation of the plan wall it is equal to, y=3m, k=1.3w/m.c, Q=400w and respectively, from Fig.7 noting that the relation between the differences distances of the width and the quantity of heat transfer that obtained as a result to the differences of the distances for the plane wall it’s a straight line relation.

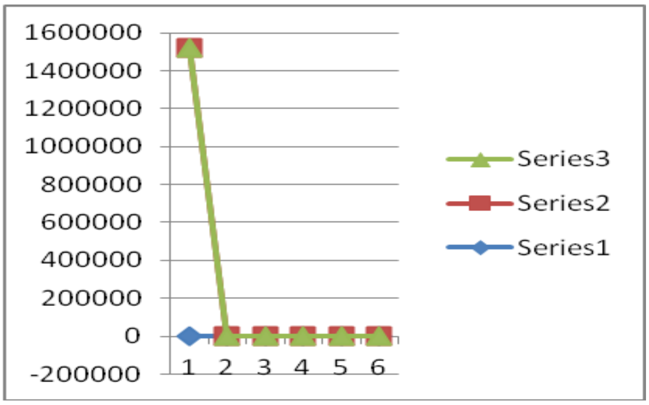

Fig. 7: the relation between the width and the quantity of heat transfer with heat generation

Fig. 8 and Fig. 9 shows the effect of changing the temperature o the heat transfer. Here one could explain the increasing in values of temperature for the first side of the plan wall, leads to increasing in the quantity of heat transfer, the heat transfer direction is from the right to the left and this is the not better direction and it must changing in values of temperature of the second side of the plan wall to be the direction from the left to the right direction and that is the better. According to Fig. 8 that explain above, represent the shape of the mathematically Equation, where it is the relation between the temperature of the first side and the quantity of heat transfer for the plane wall, where done a selecting a differences of temperature for the first side for the plane wall, where it is, T1=55c, T1=60c, T1=65c, T1=70c, T1=75c, and then obtained values of quantity of heat transfer according to the differences values of temperature of the first side for the plane wall and respectively and it is, q=-5158.49w, q=-5138.99w, q=-8309.9w, q=-5099.99w, q=-5080.49w, by subsisting in the Equation that mentioned before, where done assuming that the thermal conductivity factor is equal to k=1.3w/mc and it is a constant value, and done assuming that the height of the plan wall is equal to y=(2m) and done assuming that the value of the width of the plane wall is equal to (2m)and the distance of the first and the second side for the plane wall is equal to X1=(0m), X2=(2m) and respectively and done an assuming that the temperature of the second side of the plane wall it is T2=20c and it is a constant, assuming that the quantity of heat generation it is equal to q=400w and from the Fig. 8 one can notes that the relation between the differences of the temperature of the first side of the plane wall and the quantity of heat transfer it is a straight line relation. According to Fig. 9 that explain above, represent the shape of the mathematically Equation, where it is the relation between the temperature of the second side and the quantity of heat transfer for the plane wall, where done a selecting a differences of temperature for the second side for the plane wall, where it is, T2=25c, T1=20c, T1=15c, T1=10c, T1=5c, and then obtained values of quantity of heat transfer according to the differences values of temperature of the second side for the plane wall and respectively and it is, q=-3502.47w, q=-3480.9w, q=-3463.47w, q=-3443.97w, q=-3424.47w, by subsisting in the Equation that mentioned before, where done assuming that the thermal conductivity factor is equal to k=1.3w/mc and it is a constant value, and done assuming that the height of the plan wall is equal to y=(3m) and done assuming that the value of the width of the plane wall is equal to (2m)and the distance of the first and the second side for the plane wall is equal to X1=(0m), X2=(2m) and respectively and done an assuming that the temperature of the first side of the plane wall it is T1=20c and it is a constant, assuming that the quantity of heat generation it is equal to q=400w and from the Fig. 9 note that the relation between the differences of the temperature of the second side of the plan wall and the quantity of heat transfer it is a straight line relation.

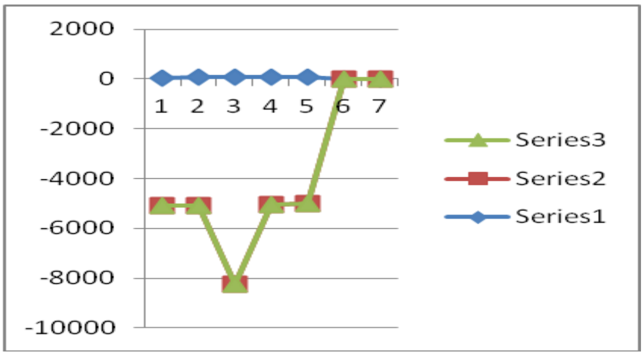

Fig. 8: the relation between the first side temperature and the quantity of heat transfer with heat generation

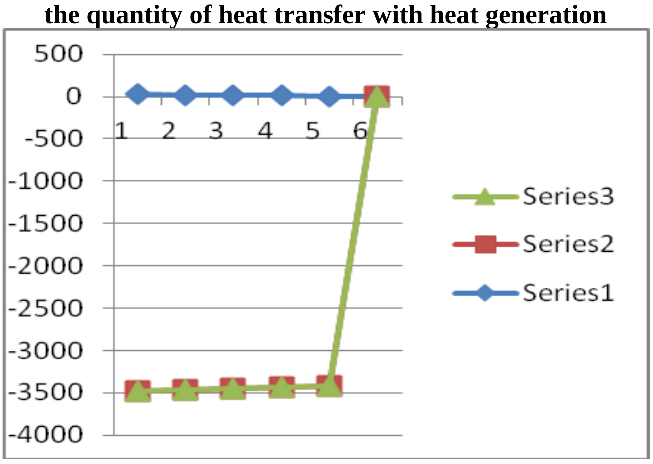

Fig. 9: the relation between the second side temperature and the quantity of heat transfer with heat generation

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

VII. CONCLUSION

In this research, the equations of temperature heat transfer with different distance from plan wall have been developed and a novel equation is presented. The new formula will support and help all researchers in this topic to get any temperature directly by using the proposed equation without more derivation. By using the proposed equation, the complexity and time will decrease with and without heat generation by approximately 80% compared with current procedures. Consequently, this novelty could be support the current and future research in the field of heat transfer.

REFERENCES

1. Y.C .Shih "*Heat Transfer*", NTUT, February 2013.
2. H. S Carslow; J.C Jaeger "*Conduction of Heat in Solids*", Oxford University press, 1946.
3. M. Abramowitz; I.S. Stegun "*Hand Book of Mathematical Function*", Washingon National Bureau, 1964.
4. U.S Apraci "*Conduction Heat Transfer*", Addison Wesley, 1966.
5. Y.A Cengel "*Heat and Mass Transfer*". McGraw Hill New York, A practical Apprach.3rd edition 2007.
6. C. Geank Oplis. "*Transport Processes and Separation Process Principles*", Englewood Cliffs prentice Hill, 2003.
7. H.P. Heisler "Temperature Charts for induction and Constant Temperature heating" *A.S. ME*, Vol. 69, No. 227, 1947.
8. F.B. Hildebrand "*Advanced Calculus for applications*", Cliffs Prentice hall, 2nd edition, 1976.
9. J.P. Holman "*Heat transfer*", McGraw,HillNewyork, 5th edition 1981.
10. P.E. liley; R. C. Reid. E. Buek. "*Physical and chemical data*", McGraw New York, 6th edition, 1984.
11. R.J. Rihando; G.w. Olerary "Ateaching Module for one-Dimensional Transient conduction" computer applications in Engineering education v.6, 1998, pp. 41-51.
12. P.J. Chenider. "*Conduction Heat Transfer*", Addison Wesley Incorporation, 1955.
13. B.H. Jennings, "*Environmental Analysis*", International Text Book co, 1970.
14. W.B. Harper; D.R. Brown, "Mathematical Equations for Heat conduction in the fins of Air- cooled engines" v.158. 1922.
15. K.A. Gardner, "*Efficiency of extended Surfaces*", ASME, Vol. 67, 1945, pp. 621-631.
16. C.J. M00re, "*Heat across Surfaces in Contact*", Thermal/Fluid Science Rep. Vol. 67, No. 2, 1967.
17. L.J: Ybarrondo; J.E. Sunderland "*Heat from extended Surfaces*", Ball.Mech.Eng. Vol.5, 1966, pp. 299-234.
18. C.J: Moore; H.A. Blam; H.Atkins "Classification Bibliography for thermal contact resistance studies", *WA/HT Company*, 1968.
19. A.M. clausing, "Transfer at interface of Dissimilar metals", *Int. J. Mass Transfer*, Vol. 9, 1966, PP. 791.
20. D.Q; A.D. Kranus, "*Extended surface Heat Transfer*", MC Graw Hill Book Company, 1972
21. R. Sigel; J.R. Howell, "*Thermal Radiation Heat Transfer*", 2nd Edition, MC Graw-Hill Company, 1980.
22. E. Fried, "Thermal Conductivity", *Academic Press Incorporation*, New York, Vol.2, 1969.
23. I.S. Fletcher, "Recent Developments in Contact Conductance Heat Transfer", *J.Heat Transfer*, Vol. 110, Nno.4 (B), 1988, pp. 1059.

AUTHORS PROFILE

Ahmed Nafi Aziz Received His Bsc. degree in the college of engineering from University of Baghdad in 1995 and his MSC degree in Aerodynamic from University of Technology Baghdad – Iraq-2002 which is belong to Iraqi Ministry of high education and scientific research. He is currently lecturer in college of Technical engineering since 2004 that Teaches thermodynamic, strength of material, engineering drawing, mathematics, theory of machine, fluid mechanics & aerodynamic. He is interesting in temperature and conduction heat transfer, fluid mechanics & thermodynamics fields and published several papers by local and international journals.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)