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Heatline Visualization of Natural Convection in Cavity Subjected by Different Heat Flux Profiles and Filled with two Immiscible Fluids of Sulfuric Acid and Air

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Mahmoud Salari [α], Abbas Kasaeipoor [σ] & Emad Hasani Malekshah [ρ]

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Keywords: *natural convection; heatline visualization; tall cavity; variable heat flux; sulfuric acid-water (25-75%).*

Nomenclature:

AR	aspect ratio$(\frac{H}{L})$		
H	high of enclosure (m)		
			Greek symbols
L	width of enclosure (m)	α	Thermal diffusivity$(\frac{k}{\rho c_p})$
b	Height of air phase (m)	β	Thermal expansion coefficient
g	gravity $(\frac{m}{s^2})$	θ	dimensionless of temperature
k	thermal conductivity $(\frac{W}{mk})$	μ	dynamic viscosity
Nu	local Nusselt number	ν	kinematic viscosity
Nu_{avg}	average Nusselt number	ρ	density
q"	heat generation per area $(\frac{W}{m^2})$		
P_r	Prandtl number		
R_a	Rayleigh number		
T	temperature (c°)		Subscribes
T_c	cold temperature (c°)	c	cold
$\vec{U}$ and $\vec{V}$	dimensionless velocity components$(U = uH/\alpha\ ,V = vH/\alpha)$	h	heat
x, y, z	Cartesian coordinates (m)		
X, Y	dimensionless of Cartesian coordinates $(\frac{x}{L},\frac{y}{H})$		

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I. Introduction

The natural convection heat transfer and fluid flow attracts many interests due to many applications in the engineering applications and industrial projects. Some these applications can be mentioned as solar collectors, passive cooling, double pane windows, ventilation systems, lead-acid batteries, furnaces, etc. (***).

The natural convection phenomenon is investigated my many researchers who analyzed the influence of different governing parameters on the fluid flow and heat transfer. In this context, Alshuraiaan and Khanafer[1] examined the effects of the heated thin porous fin position on the laminar natural convection in a square cavity. It was found that the average Nusselt number enhances with the presence of fin compared with heated cavity without fin.Kefayati and CheSidik[2] simulated the natural convection and entropy generation in inclined square cavity filled by non-Newtonian nanofluid using Buongiorno's mathematical model. It was observed that the augmentation of the power-law increases various entropy generations in different inclined angles and Rayleigh number. Khatamifar et al. [3] studied the conjugate natural convection in a square cavity which is divided into two parts and heated partially for different Rayleigh number in range of 10^5 to 10^9. The results indicate that the average Nusselt number reduces with increasing of partition thickness and enhances with Rayleigh number. Sathe and sammakia[4] obtain a review on developments in practical studied of air-cooled electronic packages. They studied various cases of cavities of single heat source, two heat sources with same dissipation rate and two heat sources with different dissipation rates. In all cases, the heat sources were located at vertical wall. They analyzed different parameters which are important in the natural convection such as Rayleigh number, the ratio between heat sources dissipation rates, the distance between heat sources and the aspect ratio of the cavities. Ye [5] investigated the thermal and hydraulic performance of natural convection in a rectangular storage cavity. The fluid flow and temperature field were analyzed to identify the type of heat transfer mechanism during different stages of melting process. It was shown that the conduction mechanism was dominant heat transfer mode at the first levels of melting process. Subsequently, by transition from conduction mechanism to convection mechanism, the convection heat transfer became dominant mode of heat transfer. Mahdavi et al. [6] carried out an experimental and numerical investigation on the hydrodynamic and thermal characteristics of laminar free convection in a rectangular cavity filled by different fluids such as water, ethylene glycol-water and air. They presented the three-dimensional distribution of local Nusselt number on the surfaces of active walls. It was found that the impact of adiabatic walls on the Nusselt number is significant when the studied fluid is air compared with other type of fluids, in addition; the convective terms were dominant compared with thermal diffusion.Teamah and Shehata[7] carried out a numerical investigation to analyze the natural convection with considering magnetohydrodynamic double diffusion in a trapezoidal cavity. It was shown that the heat and mass transfer reduces with increasing of inclined wall inclination. Da Silva et al. [8] numerically investigated the natural convection within a trapezoidal enclosure with different physical and geometric parameters. They proposed a correlation for the average Nusselt number based on Ra and Pr numbers and the inclination angle of upper surface for each baffle height.

The main aim of this article is to consider the natural convection in a rectangular enclosure filled with two immiscible fluids (air and sulfuric acid) heated from side walls with different profile of heat flux and investigate the effect of different governing parameters such as heat flux profiles and Rayleigh number on heat transfer characteristics and flow pattern.

II. Physical Model

In this study, the side walls are exposed to four special profile of heat flux, while, the part of walls that located the air phases are exposed to constant heat flux. The equation profiles of these heat fluxes are:

(a): $q'' = Ay$, (b): $q'' = By^2$, (c): $q'' = Cy^{0.5}$ and (d): $q'' = Constant$

Where: $A = 416.67$, $B = 6696.35$ and $C = 96.4236$. For all profile of heat flux, the total heat flux (q') entire to side walls is identical. The top and bottom walls are cold and kept at the constant temperature. The ratio of height of air phase to height of enclosure is constant and equal $\frac{b}{H} = \frac{1}{5}$. Also, the ratio of height of enclosure to weight of enclosure is defined by $AR = \frac{H}{L}$ and equal 5, 10, 15 and 20.

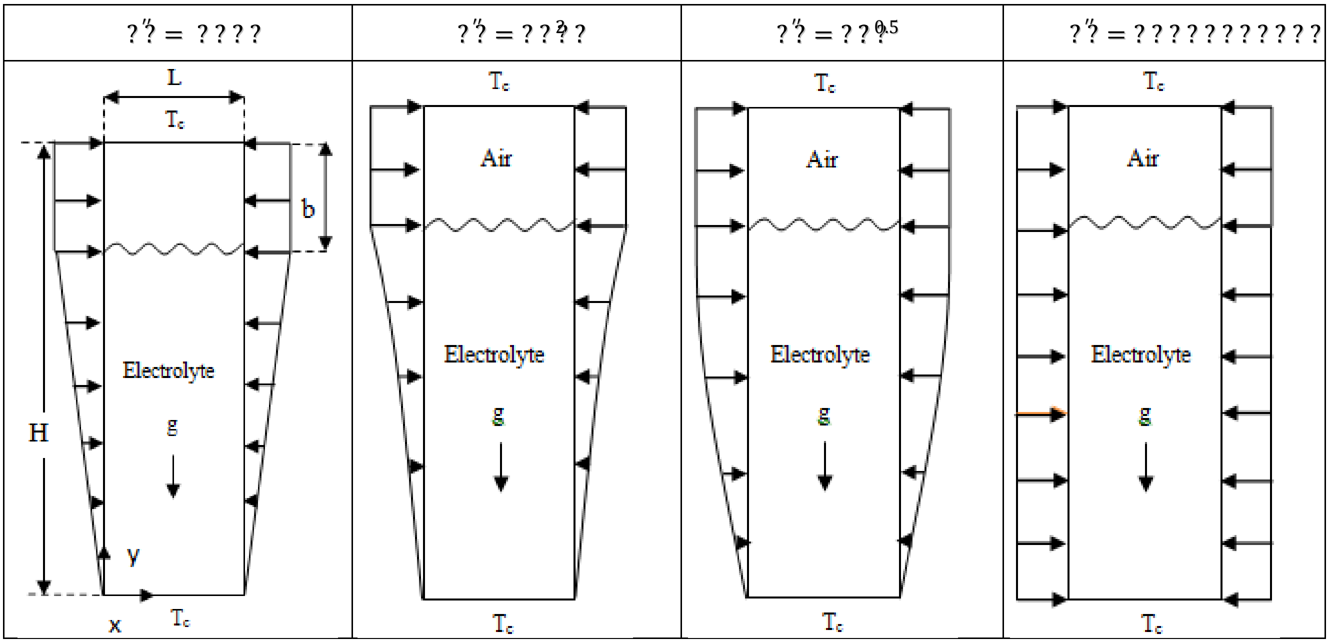

Fig. 1: Schematics of considered geometries with different heat flux distributions

III. Mathematical Formulation

In this study the governing equations are solved in two dimensional forms. The two dimensional form of continuity, momentum and energy equations for laminar and steady natural convection can be written as follows:

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}=0 \tag{1}$$

$$u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}=\frac{1}{\rho}\left[-\frac{\partial p}{\partial x}+\mu\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right)\right] \tag{2}$$

$$u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}=\frac{1}{\rho}\left[-\frac{\partial p}{\partial y}+\mu\left(\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}\right)+\rho\beta g(T-T_c)\right] \tag{3}$$

$$u\frac{\partial T}{\partial x}+v\frac{\partial T}{\partial y}=\alpha\left(\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}\right) \tag{4}$$

By introduction of the following dimensionless parameters:

$$X=\frac{x}{L},Y=\frac{y}{H},U=\frac{uH}{\alpha},V=\frac{vH}{\alpha},\theta=\frac{T-T_c}{\Delta T},P=\frac{pH^2}{\rho\alpha^2},pr=\frac{\nu}{\alpha},Ra=\frac{g\beta H^3\Delta T}{\nu\alpha},\Delta T=\frac{q''H}{k},$$

$$C_f=\frac{\tau_w}{\frac{1}{2}\rho\bar{u}^2},$$

Where $q''=\frac{q}{H}$ and $\bar{u}=5e^{-6}$.

The dimensionless form of the governing equations can be obtained as follows:

$$\frac{\partial U}{\partial X}+\frac{\partial V}{\partial Y}=0 \tag{5}$$

$$U\frac{\partial U}{\partial X}+V\frac{\partial U}{\partial Y}=-\frac{\partial P}{\partial X}+\frac{\nu}{\alpha}\left(\frac{\partial^2 U}{\partial X^2}+\frac{\partial^2 U}{\partial Y^2}\right) \tag{6}$$

$$U\frac{\partial V}{\partial X}+V\frac{\partial V}{\partial Y}=-\frac{\partial P}{\partial Y}+\frac{\nu}{\alpha}\left(\frac{\partial^2 V}{\partial X^2}+\frac{\partial^2 V}{\partial Y^2}\right)+Ra.Pr.\theta \tag{7}$$

$$U\frac{\partial \theta}{\partial X}+V\frac{\partial \theta}{\partial Y}=\left(\frac{\partial^2 \theta}{\partial X^2}+\frac{\partial^2 \theta}{\partial Y^2}\right) \tag{8}$$

The local Nusselt number of fluid on the side walls can be obtained from following equation:

$$Nu_s=\frac{hH}{k_{el}} \tag{9}$$

Whereas, the convection heat transfer coefficient can be determined by following:

$$h=\frac{q''}{T_s-T_c} \tag{10}$$

The total heat flux entry to side walls (q') is same for all heat flux profiles and q'' at the equation (10) is equal $q''=\frac{q'}{L}$.

The heat line can be used to visualize the path-line and intensity of heat flow which is similar to streamlines. The heatlines are applicable to visualize and identify the heat flow from heat sources to heat sinks in the cavities. The heat filed within a two-dimensional cavity for convective transport process was mathematically studied by Kimura and Bejan [9]. The heatlines are represented by heat functions ($\bar{h}$) which can be applied to plot the heatlines in the cavity and also obtained from the conductive heat fluxes $(-\frac{\partial T}{\partial x}, -\frac{\partial T}{\partial y})$ and convective heat fluxes (uT, vT). The heatfunctions parameter ($\bar{h}$) satisfies the energy conservation equation for fluid media:

$$u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial y} = \alpha\left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2}\right) \qquad (11)$$

So:

$$\frac{\partial \bar{h}}{\partial y} = \rho c_p u(T - T_0) - k\frac{\partial T}{\partial x} \qquad (12a)$$

$$-\frac{\partial \bar{\bar{h}}}{\partial x} = \rho v(T - T_0) - k\frac{\partial T}{\partial y} \qquad (12b)$$

To make dimensionless form of heatfunctionsΠ, the above-mentioned dimensionless variables are used:

$$\frac{\partial \Pi}{\partial Y} = U\theta - \frac{\partial \theta}{\partial X}, \qquad (13a)$$

$$-\frac{\partial \Pi}{\partial X} = V\theta - \frac{\partial \theta}{\partial Y}, \qquad (13b)$$

This can be written in a single equation as follows:

$$\frac{\partial^2 \Pi}{\partial X^2} + \frac{\partial^2 \Pi}{\partial Y^2} = \frac{\partial}{\partial Y}(U\theta) - \frac{\partial}{\partial X}(V\theta) \qquad (14)$$

It should be noted that the counter clockwise circulation is represented by positive sign ofΠ, and the clockwise circulation is represented by negative sign ofΠ.

IV. Numerical Methodology

The above-mentioned equations have been solved based on the finite volume approach and the SIMPLE algorithm has been employed. To discrete the convection terms, the second-order upwind approach is employed. Also, the central differencing scheme is used to discrete the diffusive terms. In order to perform the grid independency analysis, 5 different structured grids are used. The value of average Nusselt number for left wall with constant heat flux in $Ra = 10^5$ is evaluated and shown in Table.1. The grid distribution of 80×40 is selected for further simulations. Moreover, the numerical result obtained by Oztop and Abunada[10] is selected in order to verify the obtained results in the present investigation. It can be observed that there are close consistencies between obtained mean Nusselt number of present code and the previous one in a range of Rayleigh number $(10^3 < Ra < 10^5)$.

AR=5, Ra= 〖10〗 ^5

Table 1: Grid independency for ? ? ?= 5, ? ? ?= 10^5 and all heat flux distributions.

Mesh size		**10 × 50**	**20 × 60**	**30 × 70**	**40 × 80**	**50 × 90**
Average Nusselt number	$q'' = By^2$	2.632	2.691	2.704	2.710	2.712
	$q'' = Ay$	2.476	2.498	2.500	2.501	2.503
	$q'' = Cy^{0.5}$	2.184	2.200	2.279	2.286	2.281
	$q'' = Constant$	1.101	1.117	1.121	1.123	1.123

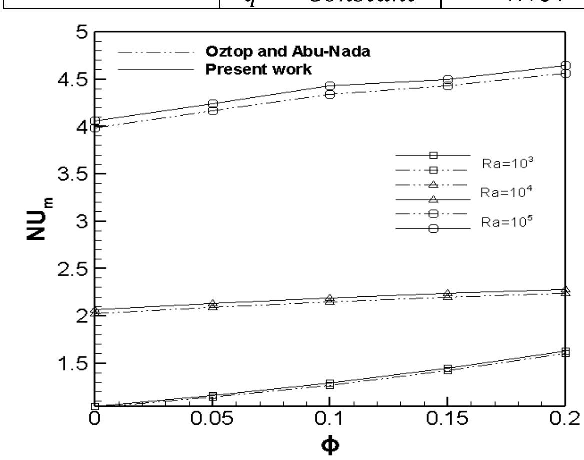

Fig. 2: Validation of the present work for Al2O3–water nanofluid compared with Oztop and Abu-Nada [10]

V. Results and Discussion

a) Convective flow analysis

In the natural convection phenomenon, the fluid flow depends on many different parameters which have influences on the flow structure in confined environments.

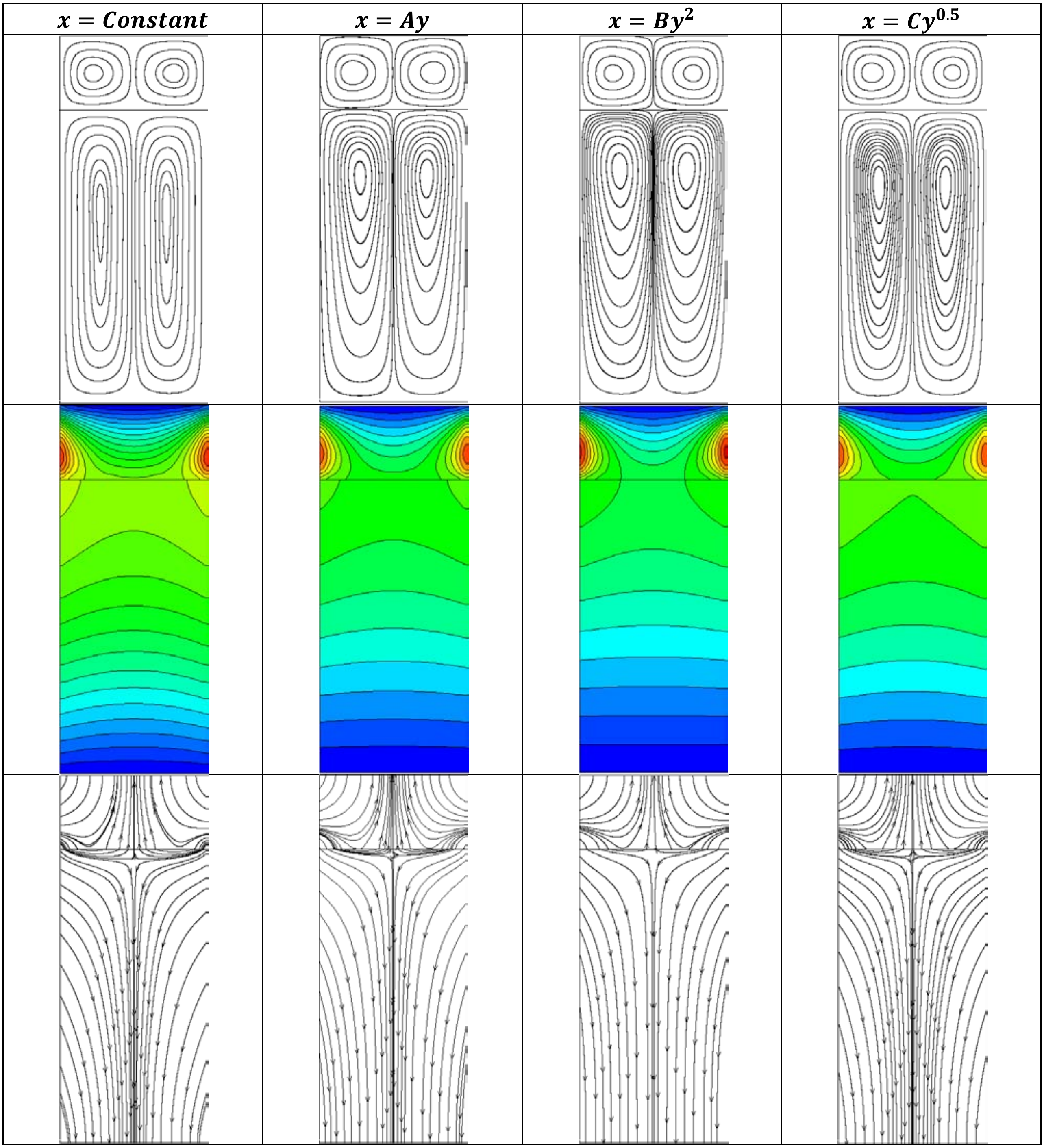

Fig. 3: Flow structure, temperature filed and heatlines for different heat flux distributions in $\boldsymbol{Ra} = \mathbf{10^3}$.

Some these effective parameters are gravity acceleration, thermo-physical properties of operating fluid, thermal boundary condition, physical boundary condition, geometry of considered enclosure, external forces like magnetic force, etc. As a result, it can be concluded that to analyze the natural convection heat transfer, the influences of these parameters must be identified and considered in the investigation. In this study, the cavity is filled with two immiscible fluids, liquid and gas, and heated from side walls with different kind of temperature distribution. The temperature of the electrolyte stream at the adjacent of side walls enhances. As a result of this matter, the density of the electrolyte stream at these regions, sides of the cavity, reduces causing ascending the electrolyte stream forced by buoyancy force in presence of gravity acceleration. So, the electrolyte stream goes up along the side walls to reach the interface of liquid and gas. At this part, the electrolyte stream transfers its heat energy to the gas phase causing decreasing the temperature of the electrolyte stream. The density of electrolyte stream enhances again resulted by lower temperature, and the electrolyte stream descending from the collision point of two ascending electrolyte stream from sides at the surface of interface. This process occurs again and again which creating two main clockwise and counter-clockwise circulations at the left and right sides of the cavity, respectively. The similar process occurs at the gas phase creating two main circulations.

b) Temperature field analysis

In the engineering applications, it is necessary to find the different parameters to control the temperature distributions in the confined environment such as cavity. For example, in some industrial applications, it is desirable to hold the temperature distribution uniform throughout the enclosure which prevents creating very high temperature stream in some regions and using special strong alloys which is not cost effective. The temperature fields within the cavity for different linear and non-linear heat flux profiles of heated side walls and different aspect ratio of cavities are depicted in Fig.5. It is obvious that the heat flux profiles at the side walls have considerable influence on the temperature field. The cold regions in case with heat flux profile of $q'' = By^2$ is wider with respect to other cases since the amount of heat flux offloaded at the above regions of the cavity is more than other cases, although the total amount of heat flux is constant for all cases.

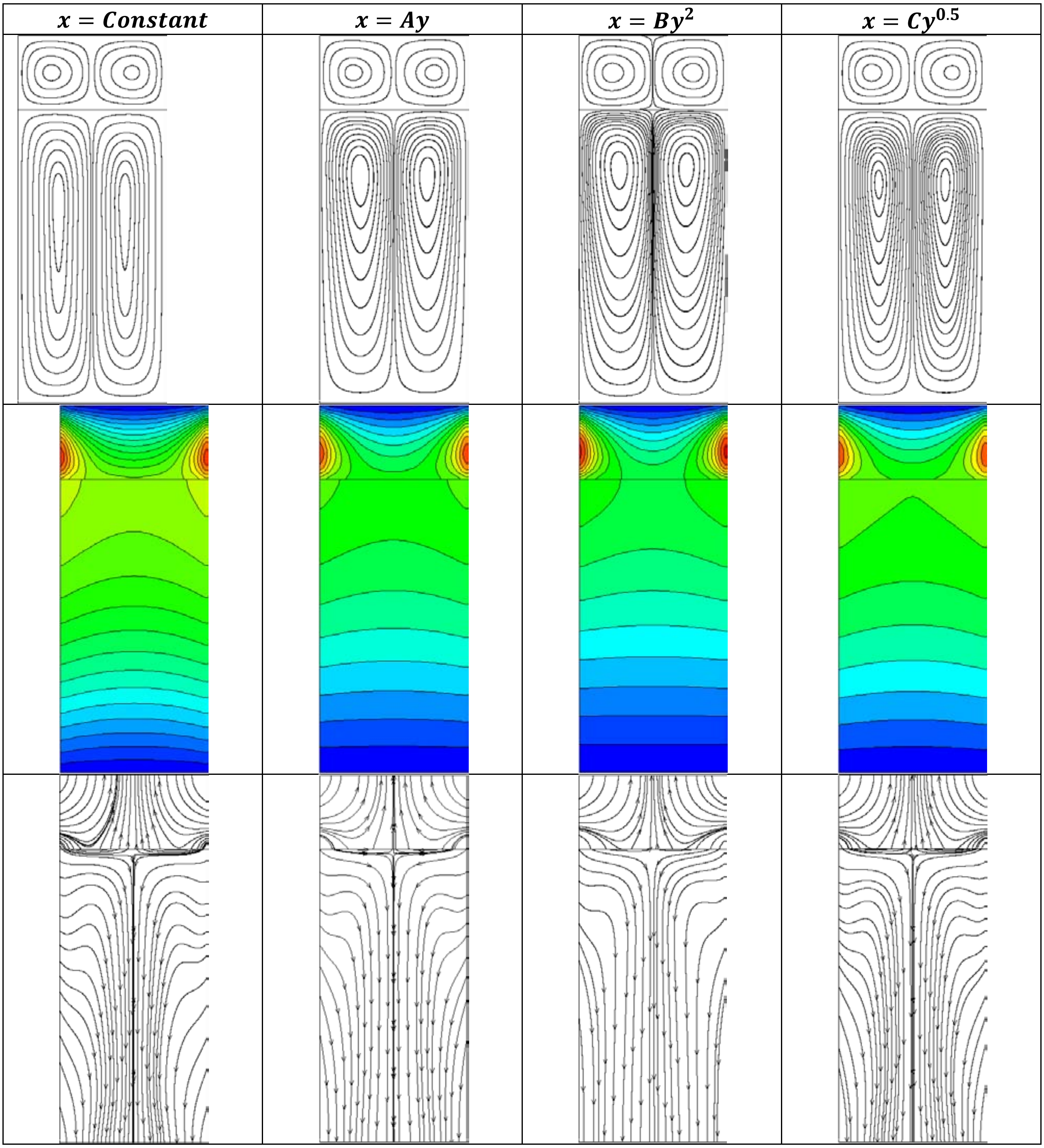

Fig. 4: Flow structure, temperature filed and heatlines for different heat flux distributions in $\boldsymbol{Ra} = \mathbf{10^4}$.

$x = Constant$	$x = Ay$	$x = By^2$	$x = Cy^{0.5}$

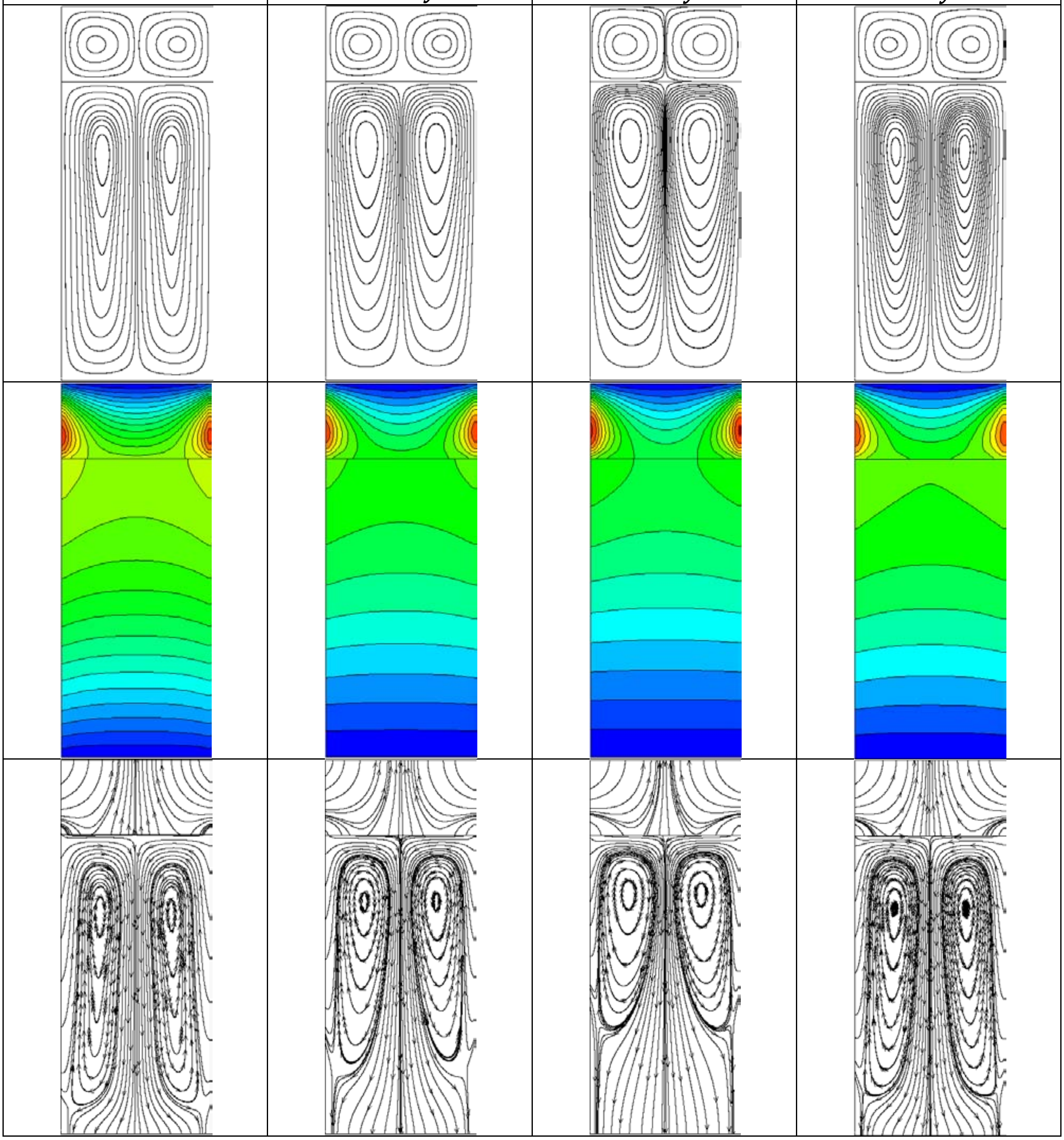

Fig. 5: Flow structure, temperature filed and heatlines for different heat flux distributions in $\boldsymbol{Ra} = \mathbf{10^5}$.

c) *Flow structure analysis*

The flow structures for different profiles of heat fluxes within the cavity are presented in Figs.***. The profiles of heat flux of side walls have influences on determining the configurations of the circulations. In constant heat flux of $q'' = constant$, the configuration of the circulations are completely similar at the top region and bottom region due to symmetric heat flux profile of side walls. On the contrary, it is clear that the streamlines are compacted at the top region. It is due to the fact that the amount of offloading heat flux at top region is more than bottom region causing stronger electrolyte flow at top region. On the other hand, the configurations of the circulations in the gas phase are completely similar to each other in all cases with different heat flux profiles.

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d) Heatline Visualization

The influences of heat flux profile of the cavities on the heatlines for both air phase and electrolyte phase at different Rayleigh numbers are presented graphically in Fig.9. It can be observed that the heat flux profiles at side walls have no pronounced effects on the heatlines as a result of limited space of air phase. On the contrary, the influences of Rayleigh numbers on the heatlines are significant. As Rayleigh number enhances, the fluid flow becomes stronger as a consequence of increases temperature difference. As a result of this matter, the fluid flow will be able to transfer the heat energy in the fluid media. As Rayleigh number enhances, the heatline maps at the air phase have no considerable differences. It is due to the fact that the volume of air phase is limited. On the other hand, in the electrolyte phase, the fluid flow becomes stronger as Rayleigh number increase and the main circulations will be able to transfer the heat energy. As a result of this matter, it can be observed that the heat energy is entrapped in the circulations at high Rayleigh number.

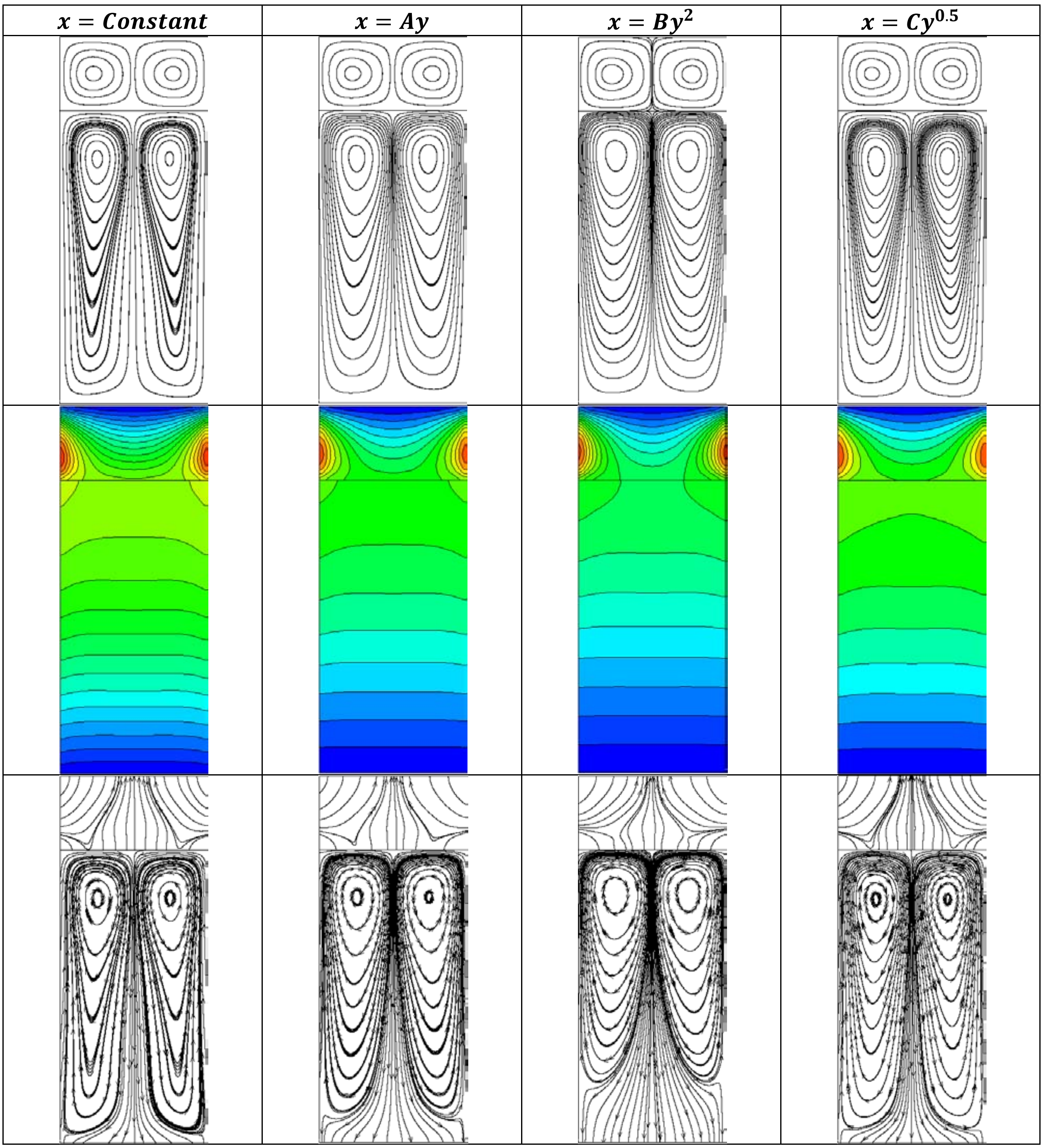

Fig. 6: Flow structure, temperature filed and heatlines for different heat flux distributions in $Ra = 10^6$.

e) Skin friction coefficient analysis

The values of skin friction coefficient with respect to dimensionless height of the cavity as a function of different profiles of heat flux on side heated walls are presented in Fig.7. It should be noted that the skin friction coefficient is calculated for the electrolyte phase. The value of skin friction coefficient or the similar quantities such as wall shear stress are important in some engineering applications. For an instance of an industrial application needing to enhance the skin friction coefficient, in the lead-acid batteries, it is important to design the gap distance of the cells to increase the skin friction coefficient in order to omit the created bubbles at the surface of the anodes and cathodes.Because, the effective area of electrodes is reduce when the bubbles located on the surface of them. Then, the performance of battery will be reduced.

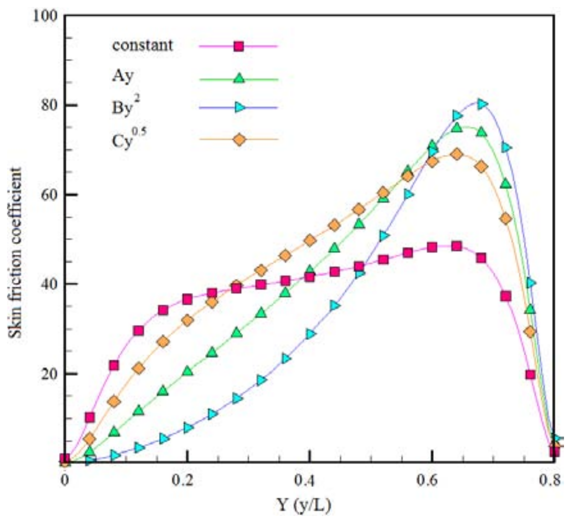

Fig. 10: Skin friction coefficient with respect to dimensionless height of cavity as a function of different heat flux distributions in $\boldsymbol{Ra} = \mathbf{10^5}$

The results show that the profiles of the heat fluxes at the side walls have pronounced influences of the distributions of the skin friction quantity. It should be noted that the distribution of the skin friction coefficient has direct relationship with the profile of the heat fluxes. It can be observed that the distribution of the skin friction coefficient for the case with linear heat flux profile $(q'' = constant)$ is almost linear except at the corners which are caused by the secondary eddies and weak electrolyte stream at these regions. For $q'' = Ay$, the distribution of the skin friction coefficient is linear with constant slope as same as the heat flux profile. For other case, $q'' = Cy^{0.5}$and $q'' = By^2$, the distribution of the skin friction coefficient and heat flux are similar as well. So, it can be concluded that the heat flux profile of the side walls is an effective approach to control the distribution of the skin friction coefficient.

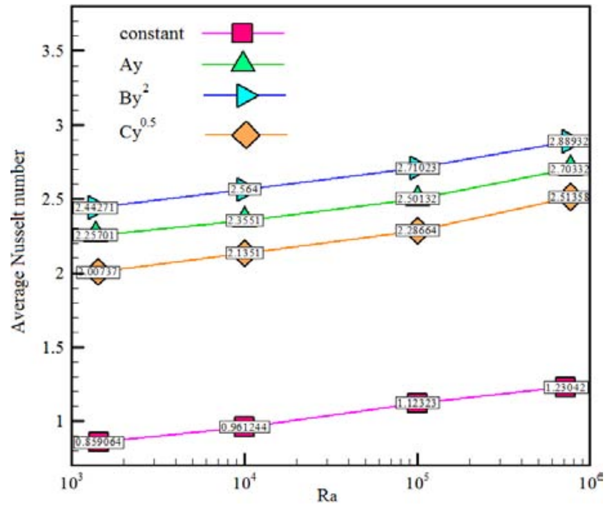

Fig. 11: Average nusselt number for different heat flux profile and Rayleigh number

f) Averaged Nusselt Number

The values of averaged Nusselt number with respect to Rayleigh number as a function of different heat flux profiles are presented in Fig.8. The Nusselt number is a dimensionless parameter which denotes the share of each mechanism of conduction and convection on the heat transfer within the enclosure. At high value of Nusselt number, the convection is the main heat transfer mechanism, and the conduction is the dominant heat transfer mechanism at low Nusselt numbers. It can be seen from Fig.8 that the profiles of heat flux have considerable effect on determining the value of average Nusselt number. The maximum values of average Nusselt number at all Rayleigh numbers occurs as the heat flux profile is $q'' = By^2$. Moreover, the heat flux profile of $q'' = constant$ has not considerable influence on creating convective flow as the average Nusselt number is close to unity in all Rayleigh number.

VI. Conclusion

The natural convection heat transfer in cavities with different profiles of heat flux and filled with two immiscible fluids of sulfuric acid-water (25-75%) and air has been studied. The heatline visualization approach has been utilized to detect the heat energy path within the cavity. The physical and thermal boundary conditions are as follows:

1. Side wall: heaters with variable heat flux with no-slip boundary condition
2. Bottom wall: cold wall, no-slip boundary condition
3. Top wall: cold wall, no-slip boundary condition
4. Interface: heat transfer and shear stress are applied

Different governing parameters such as aspect ratio$(5 < AR < 20)$, Rayleigh number $(10^3 < Ra < 10^5)$

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and different heat flux distributions on the flow structure, temperature filed, Nusselt number and heatlines have been analyzed systematically. The results can be summarized as follows:

- The heat flux distributions have pronounced effect on the flow structure at the liquid phase and negligible effect at air phase.
- The value of skin friction coefficient has close similarity with the heat flux profile.
- The value of average Nusselt number has direct relationship with the Rayleigh number.
- Two main circulations are created in heatline maps at high Rayleigh number.
- Maximum temperature value occurs when the heat flux distribution is constant.

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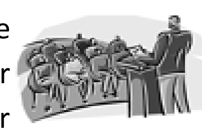

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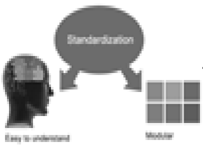

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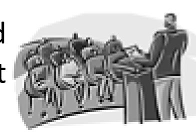
The author fees of such paper may be waived off up to 40%.



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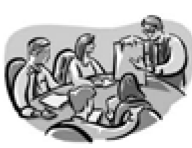

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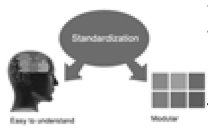

After nomination of your institution as “Institutional Fellow” and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:

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Note :

"

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"

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2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

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- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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