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CFD Simulation of Velocity and Temperature Distribution inside Refrigerator Compartment

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***ABSTRACT:** The utility of a household fridge is to preserve the food eminence. Eminence of food unswervingly be reliant on temperature and air velocity distribution esoteric the stowing compartments. Disapproving temperature for food preservation will cause food to worsen or dwindling. Proper temperature distribution as well air flow keep the food fresh in the food chambers. This work presents the air flow and temperature distribution through natural convection warmness switch in severally modeled freezer is studied. The freezer and refrigerant compartments is studied for three configurations. The freezer and refrigerant compartments is studied for three configurations. In initial configuration using Plate-evaporator with rectangular finned surface and In second configuration Plate-evaporator while not finned surface and In third configuration Plate-evaporator with perforated finned surface. The simulations are carried out using ANSYS 16 work bench computational fluid dynamics software program package. The heat transfer between the freezer and refrigerating compartment is neglected and laminar air flow conditions were assumed. Simulation consequences demonstrate temperature stratification inside the refrigerating section cold and warm region were top and bottom respectively, in freezer compartment warm and cold region were top and bottom for each configurations. Comparison of temperature variation for numerous configurations of refrigerating compartment. The freezer and cold compartments is studied for three configurations. The perforated finned surface provides best result.*

***Keywords:** Domestic-refrigerator, Airflow-distribution, Laminar-airflow, Temperature- distribution, Heat-transfer, CFD simulation, Plate-evaporator, Diffusion-absorption*

I. INTRODUCTION

In present time Refrigeration system is become part of our daily life. In present time it has various use in our daily life, just like for storing quality of fresh food, preserving medicine, for comfort . The quality of food inside refrigerator depend up on temperature distribution and air flow distribution inside compartment. Air flow distribution highly linked with temperature distribution i.e. if temperature distribution increase then air flow distribution also increase and if it decrease then air flow distribution also decrease due to temperature difference between air molecules. so temperature distribution takes important part in Refrigeration system. There are many work conducted related to temperature distribution on vapour compression cycle but there are only some work conducted related to temperature distribution on diffusion- absorption .In literature we find work related to **J.M. Belman-Flores et al. [1]** have presented the assessment of the velocity distribution and the thermodynamic performance of the test section in a household fridge, for this, its chilling influence is essentially centered on diffusion-absorption system. Computational Fluid Dynamics simulation is realistic to conclude the flow velocity & temperature distribution esoteric the test section. The primary goal is to equate the thermodynamic demeanor of a plate-evaporator design with a finned floor (allusion fridge) and a plate-evaporator with a smooth surface (projected proposal). Finally, the progress of the proposed work acmes the significance of the numerical simulation in the appearance for upgrades inside the layout of this fridge archetypal, which might be advantageous to producers of diffusion-absorption type refrigerators. **Mustafa Ali Ersoz et al. [2]** have investigated the properties of three types of specific heat input provided to generator on the overall performance of the diffusion absorption type preservation device and calibrated these experimentally. They have also analyzed the performance of the device on the basis of different criterion. **Souha Mazouz et al. [3]** have used industrial absorption diffusion system to access the significances of experimental and thermodynamic examinations. Steady state and dynamic technique are applied as investigational techniques to estimate the characteristics and the cooling potential of the system. **J.M.Belman et al. [4]** have conducted a series of experiments to scrutinize an investigative archetypal of the bubble pump in an industrial diffusion-absorption type refrigeration system. Furthermore, a vigorous investigation flawless is included with a heat relocation version and combined to a thermodynamic archetypal to appraise the chilling capability & the coefficient of overall performance for the refrigeration system. They have founded that the overall performance is totally dependent on shape, size and operating parameters like as hotness enter, diameter ratio and bubble tube period in addition to the ammonia fraction on the inlet of the bubble pump. **Adnan Sozen et al. [5]** premeditated the consequence of the unreceptive heat transmission enhancement procedure of ammonia or water coupled with alumina (Al_2O_3) debris in Nano-size were tested in diffusion absorption coolers with reference to the balminess overall performance of the machine. Accumulation of Nano-particles into fluid indicates to vast development in heat switch since the floor region and heat ability of the fluid flourishing because of nano-particles. Therefore, on this observe cooling/absorption fluid mixtures with Al_2O_3 nano-particles and its effects on device enactment were also evaluated.

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Nomenclature	
X,Y,Z	Space Coordinates
CAD	Computer Aided Designing
CFD	Computational Fluid Dynamics
COP	Coeff. Of Performance
DAR	Diffusion Absorption Refrigerator
HPG	High Pressure Generator
VAS	Vapor Absorption System
VCS	Vapour Compression System
C_P	Specific heat at Constant Pressure (J/Kg-K)
g	Gravity (m/s^2)
K	Thermal Conductivity
P	Pressure (Bar)
T	Temperature (K)
u	Velocity (m/s)
β	Thermal Expansion Coefficient (1/K)
μ	Dynamic Viscosity (Kg/m-s)
ρ	Density (Kg/m^3)

J.L. Rodriguez-Munoz et al. [6], have studied the diffusion–absorption refrigeration technology so individual can sell their primary mannerisms in expressions of the refrigeration method, their solicitations, work fluids, modern-day tendencies & hindrances, among others. **J.M. Belman-Flores et al. [7]** have presented the assessment of the temperatures variation in the garden- fresh meals and icebox compartment from a pressured-convection domestic type refrigerator established in a bottommost mount arrangement. Originally the assessment is carried out via investigational tests assessing constraints like: temperature, cold air velocity and electricity ingestion. Subsequently, CFD simulation is carried out to simulate the fridge. **Abdullah Yildiz et al. [8]** have designated diffusion absorption refrigeration cycle to investigate the thermodynamic properties. The investigational equipment is installed to an ammonia - water Diffusion Absorption Refrigeration system with Helium as auxiliary inert fuel. A thermodynamic archetypal inclusive of mass, strength and exergy stability equivalences are provided for every issue of the Diffusion Absorption Refrigerator cycle and this archetypal is then demonstrated through assessment with investigational facts. **Ozgur Bayer et al. [9]** have used predefined temperature standards and requisite constant wall temperature boundary conditions to experimentally investigate & simulate the flow velocity pattern and temperature dissemination in a free viable refrigerator system. The free convection in refrigerator presentations is estimated as a three dimensional (3D), tempestuous, transitory and matched non-linear drift hassle. Contamination heat switch approach is likewise covered inside the examination. **Adnan Sozena et al. [10]** have selected Diffusion Absorption type refrigeration system to accomplish an investigational exploration on performance enhancement expansion. They have scrutinized and installed three DARS cycles to carry out this investigation. In the primary cycle (DARS-1), demonstrating the maximum normally engaged version inside the enterprise, the condensate is allowed for sub cooling preceding to the evaporator façade through the attached evaporator / fuel warmness exchanger in a analogous way with the preservation arrangements artificial done by Electrolux Sweden. In another cycle (DARS-2), the condensate is not always allowed for sub-cooling prior to the evaporator entering and the gas heat exchanger is alienated from the evaporator. In the 3rd cycle (DARS-1WE), the radical gadget is being anticipated in this examine, differing from DARS-1 in sure factors is used, wherein an ejector become mounted to the absorber inlet of DARS-1. **Dilek Kumlutas et al. [11]** offered a solicitation of synthetic neural networks (ANNs) to expect the layout parameter's values of the static kind home fridge. The internal air quantity of fridge become demonstrated using computational fluid dynamics and Heat Transfer (CFDHT) approach and investigations were completed. The numerical outcomes have been tested by way of associating with the experimental outcomes after which internal layout constraints had been determined. **Q. Wang et al. [12]** examined a Diffusion Absorption Refrigerator (DAR) in succession in addition with dualistic refrigerant R23/R134a, the penetrable DMF and ancillary indolent gasoline helium. The effects exhibit that the coefficient of overall performance (COP) is in specific resolute by the arrangement straining, configuration of the amusing solution, remedying consequence of the rectifier and ratio of helium to the combined refrigerant at the specified producing temperature, ambient temperature and warmth supply temperature. **N. Ben Ezzine et al. [13]** have completed an experimental investigations of an air-cooled Diffusion Absorption Refrigerator type arrangement operational with a dualistic mild hydrocarbon mixture (C_4H_{10} / C_9H_{20}) as functional fluids and helium as pressure harmonizing indolent gasoline is presented. The gadget, made from copper an obtainable and good heat accomplishing metallic, is supposed to be sun power-driven warmness from flat plate or commonplace expatriate tube creditors.

Kai-Shing Yang et al. [14] have proposed a mathematical simulation of the enactment of domestic fridge having a top-mount arrangement is completed and a examination is accomplished with a actual refrigerator for substantiation. The outcomes suggest the temperature distributions from the mathematical simulation are qualitatively in keeping with the investigational measurements. The simulations display that the proposal of air duct and its places may also enforce an adverse function at the temperature consistency inside the fridge, but the airflow is strappingly prompted via gravity. **Xiangzhao Meng et al. [15]** have investigated the study of airflow presentation on the deliver-air openings in a BCD-190W type family frost-unfastened fridge. A translucent model developed primarily created on identicalness concept. The dimension device the usage of 2-D Digital Particle Image Velocimetry (DPIV) era and the proper tracer particles had been implemented to complete the study. **Zohar et al. [16]** have modified the erstwhile thermodynamic version and verified with the aid of an investigational system. Exhaustive thermodynamic approaches for 3 generator and bubble pump arrangements had been established. They have determined that for the equal warmness idea, the second one arrangement desorbed the best quantity of refrigerant and the primary configuration desorbed the bottom. The last one arrangement evidenced to be fewer green compared to the second configuration in terms of COP. **S. Ben Amara et al. [17]** performed numerical simulations using CFD software (ANSYS). In the numerical analysis, they presumed that the temperature of the evaporator is unvarying while an unvarying worldwide heat switch coefficient has been used to designate the warmth change with the external air at consistent temperature. Author considered laminar 3-D flows and took into account the heat switch with the aid of radiation among the exceptional partitions of the hollow space. **O. Laguerre et al. [18]** premeditated heat transfer with the encouragement of natural convection in domestic refrigerators without ventilation. Only the refrigerating test section was scrutinized for three arrangements: empty fridge, refrigerator ready with glass shelves and fridge loaded by product. Both investigational and numerical processes were applied. The simulations were accomplished the usage of CFD software by means of enchanting into consideration or through abandoning emission warmth switch. **Guo-Liang et al. [19]** have studied two types of refrigerators in direction to enhance the temperature consistency in the compartment via the CFD software and investigational techniques. For the completely natural convective fridge, the premeditated outcomes display that the allowance among shelves and the backwall and the allowance between the shelves and door play a crucial role in temperature distributions. Assessment of the two varieties of refrigerators demonstrate that temperature consistency within the new type of fridge is higher than that of the primary kind of fridge.

Above study shows that only J.M. Belman-Flores et al. [1] worked on thermal behavior and air flow distribution of refrigerator compartment with diffusion absorption technology, they have worked on both experimental and numerical simulation (CFD simulation) within refrigerator compartment and compared their results. In experiment, they have taken refrigerator compartment with rectangular finned plate evaporator and located temperature distribution of air within compartment using thermocouple and equated these end in CFD simulation with refrigerator compartment while not finned plate evaporator by temperature distribution and rate distribution and located compartment that using rectangular finned plate provide best result as a compare with compartment without finned plate and based on their experiments they have provided few suggestions for future in extension of design of plate evaporator of compartment. Therefore, this work benevolences an extension of design of plate evaporator and scrutinizes the thermal conduct within the test section of a trivial fridge that is predicated on diffusion-absorption technology. The most assistances of this paper into this arena are:

1. The aim of this research work is to form some effective changes within the design of a conventional refrigerant system in order that performance of the evaporator may be optimized.
2. An investigation of air flow and temperature distribution arenas wherever stagnation sockets are known, and of smallest and most temperatures within the fridge test section.
3. The freezer and refrigerant compartments is studied for 3 configurations. To check the consequences of traditional and perforated fin on the rate and temperature distribution at different level.
4. Comparison of temperature profiles for various configurations of refrigerating compartment. to form comparative analysis between various cases of with and while not fin refrigerating system.

2. Diffusion-Absorption Refrigeration System

Based on the experimental evidences to achieve the desired cooling result and preserve the compartment temperature under the atmosphere, an evaporator tube is used with aluminum plate with rectangular fins within the refrigerator, and this is done to transfer heat only within the food test section. The plate comprised of 19 fins and was 0.3 m x 0.3 m. and currently found most average temperature is 286 K and minimum average temperature is 273 K within compartment with the assistance of 16 kind K (±0.3 K) thermocouples. This **result** is used in CFD simulation as a boundary condition for compare different finned plate model. To achieve desired freezing effect ammonia, water and gas are used as operating fluids. Ammonia is used as refrigerant, water is used as absorbent, while gas is used as supporting gas. The test equipment is shown in figure 1.

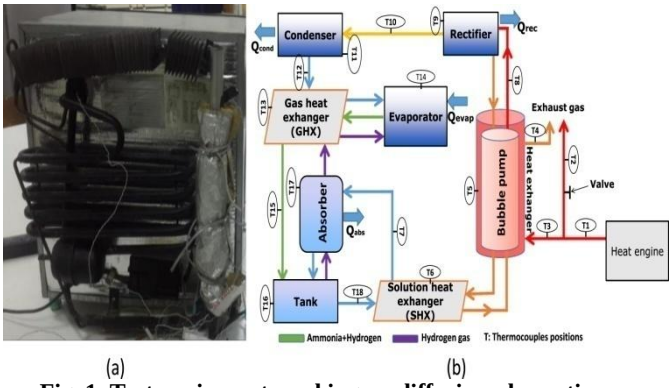


Fig. 1. Test equipment working on diffusion-absorption system.

3. Formulation of Problem

Above explained test equipment is mathematically formulated to analyze the fluid flow behavior of air inside the compartment of refrigerator. The foremost aim is to scrutinize its thermodynamic performance and dissemination rate engendered by the gradient, and to equate the **thermodynamic** performance of the mention fridge (plate with rectangular surface) with the plate with perforated surface and plate-evaporator while not prolonged exteriors projected now. The subsequent concerns were finished for the mathematical model.

1. Incompressible flow
2. Steady state flow
3. Boussinesq archetypal
4. Refrigerator without any thermal load (no load condition)
5. Laminar flow system

Boussinesq approximation is used to calculate density which is to be used in momentum equation in Y direction. The conservation equalities are amended to the model, keeping in mind persistent properties and together with the Boussinesq's equation in the y-component of the Navier-Stokes equation.

Continuity Equation

$$\rho\left(\frac{\partial u_x}{\partial x}+\frac{\partial u_y}{\partial y}+\frac{\partial u_z}{\partial z}\right)=0$$

……..(1)

Energy Equation

$$\rho c\ \left(u_x\frac{\partial u_x}{\partial x}+u_y\frac{\partial u_y}{\partial y}+u_z\frac{\partial u_z}{\partial z}\right)=k\left(\frac{\partial^2 u_x}{\partial x^2}+\frac{\partial^2 u_y}{\partial y^2}+\frac{\partial^2 u_z}{\partial z^2}\right)$$

……..(2)

Density difference calculated form

$(\rho_\infty-\rho)=\rho\beta(T-T_\infty)$ **……..(3)**

Momentum equations

Component X

$$u_x\frac{\partial u_x}{\partial x}+u_y\frac{\partial u_y}{\partial y}+u_z\frac{\partial u_z}{\partial z}=-\frac{1}{\rho}\frac{\partial p}{\partial x}+\frac{\mu}{\rho}\left(\frac{\partial^2 u_x}{\partial x^2}+\frac{\partial^2 u_y}{\partial y^2}+\frac{\partial^2 u_z}{\partial z^2}\right)$$

……(4)

Component Y

$$u_x\frac{\partial u_x}{\partial x}+u_y\frac{\partial u_y}{\partial y}+u_z\frac{\partial u_z}{\partial z}=g_y\,\beta\,(T-T_\infty)+\frac{\mu}{\rho}\left(\frac{\partial^2 u_x}{\partial x^2}+\right.$$

∂2uy∂y2 + ∂2uz∂z2

……..(5)

Component Z

$$u_x\frac{\partial u_x}{\partial x}+u_y\frac{\partial u_y}{\partial y}+u_z\frac{\partial u_z}{\partial z}=-\frac{1}{\rho}\frac{\partial p}{\partial x}+\frac{\mu}{\rho}\left(\frac{\partial^2 u_x}{\partial x^2}+\frac{\partial^2 u_y}{\partial y^2}+\right.$$

∂2uz∂z2

……(6)

3.1 Geometrical Model

For the geometrical modeling of proposed model, CATIA V5 R20 is used for modeling the three designs of fridge. In these three design special models are used namely Plate-evaporator without finned, Plate-evaporator with rectangular finned floor and Plate-evaporator with perforated finned floor. CATIA software provides the approaches for model generation like creating a solid model within the 3D work space. For the requirement of CFD evaluation ANSYS-Fluent software program is used. ANSYS-Fluent software is a software designed for solving computational fluid dynamics based issues. CFD simulation of fridge compartment is carried out with the help of ANSYS FLUENT software. The mesh size for the compartment with **finned** plate-evaporator is 47,8747 hexahedral rudiments, for the non-finned plate-evaporator is 15,6198 rudiments and for perforated-finned plate evaporator is 1848509 rudiments. The geometry constructions for door of the plate-evaporator refrigerator, walls with channels to put the shelves, and finally the bottom and the top of the compartment is also taken into the consideration.

3.2 Numerical Simulation

As CFD simulation of the compartment has been carried out by ANSYS-FLUENT 16 software. In general we give solver as a pressure based and velocity formulation is absolute and time is taken as steady and also we count gravity. In model we take two type of model energy model and viscous as a laminar model. **Now** in material test section we take fluid as a air and solid as a aluminium, properties of air and aluminium as shown in table 1. Simple algorithm is used to solve the conservation equations to steady state along with connection of the velocity and pressure. Meanwhile a subsequent order upwind arrangement is used for momentum and energy equations and a conventional scheme for the pressure. The Boussinesq's equation in the y- component of the momentum equation is smeared for the laminar regime.

3.3 Boundary Condition

The boundary circumstances smeared in the territory of test section takes a condition of median temperature for experimental tests which was carried out by research work of J.M. Belman-Flores et al.

[1], wherein the plate-evaporator has the minimum **temperature**, with respect to location of the thermostat of the fridge for the given temperature changes as well as without slip situation to velocity across all walls was also measured. Table 1 shows the property of the dry air that was considered as fluid inside the compartment. Aluminum is the material of fin plate that is taken into consideration and its properties are given in table 1.

- Fin Material- Aluminium
- Temperature of Cold wall - 273 K
- Temperature of Hot wall -286 K

Table 1: Properties Air and Aluminium

	Density	Specific Heat	Thermal Conductivity	Viscosity
Air	1.22	1006.43	0.24	1.78×10^{-5}
Al	2719	871	202.4	-

After applying the proper boundary condition the simulation is set to run and the results were recorded.

3.4. Experimentation Algorithm

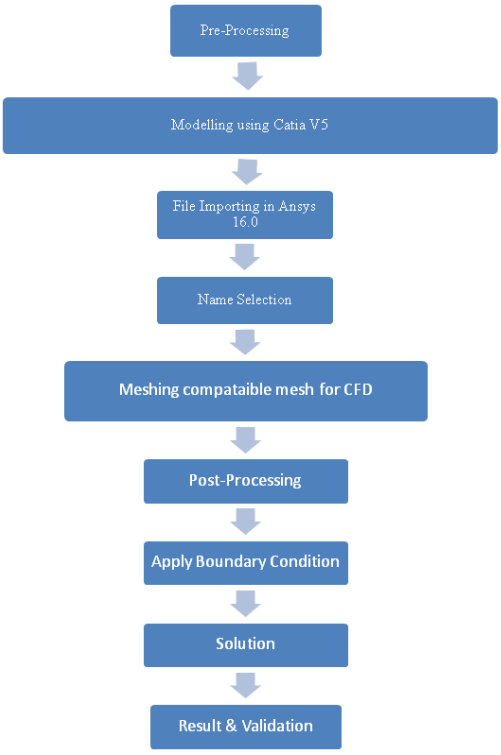


Fig. 2. Experimentation algorithm

4 Simulation & Result Analysis

Case 1-Without Finned Surface

CFD Simulation of Plate-evaporator without finned surface are as:

a. Contour of without fin refrigeration system for temperature distribution

Below images shows the result of CFD analysis on without fin refrigerator. The contour of temperature distribution behaviour for plate evaporator without finned surface inside the refrigerator is shown in fig 3. The bottom of the refrigerator low **temperature** and the upper part of the refrigerator is higher temperature in section. It can be interpreted from the result of CFD analysis that the temperature distribution behaviour in refrigerator compartment is slightly increased with Plate-evaporator without finned surface. However, this can also be seen that the temperature distribution behaviour does not vary significantly by showing in upright direction a colder sector in the bottom of 280.634 K and an upper region with a higher temperature of 281.928 K. It can also be seen that most of the performance is comparatively low temperature (Blue zone). Hence, the temperature acquired by CFD analysis with all three thermocouples positioned over this plane (upper, middle, lower) shows an average of 281.243 K.

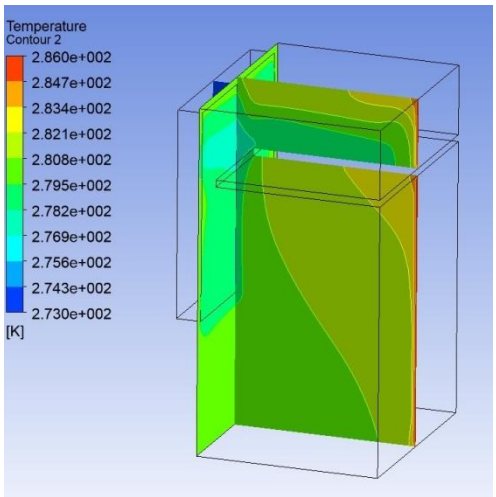


Fig.3. Temperature Contour for plate evaporator without finned surface

b. Contour of without fin refrigeration system for velocity distribution

One more portion of the investigation within the test section is that the speed dissemination generated by the temperature gradient. Fig. 4 shows the rate **contour** for similar cases as stated in above case. The upper density of air is appreciated on the lateral walls and also the bottommost of the test section that comprise areas of the prolonged surface. The position of the projection effects the flow arena, mainly as a result of the shelf within the lower position causes an upstream holding (for instance, the red and yellow ones close to door), supportive the consistency of temperature in this region of the test section. For this case, the typical speed at the center plane is 0.00747102 m/s and 0.015645 m/s for the lower and also the upper shelves, and also the average speed at the center plane is 0.0077 m/s.

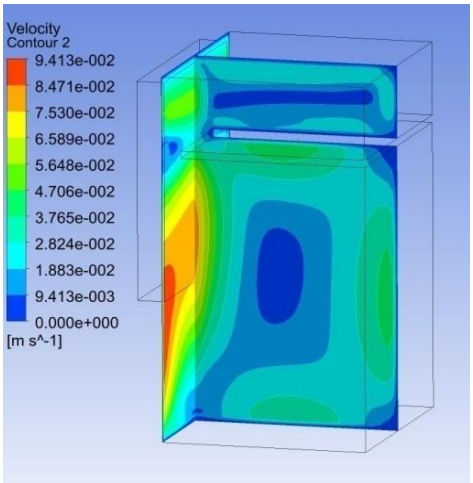


Fig.4.Velocity Contour for plate evaporator without finned surface

Case 2- With Rectangular Finned Surface

CFD Simulation of Plate-evaporator with rectangular finned surface are as:

a. Contour of Plate-evaporator with finned surface for temperature distribution

The contour shown in figure 5 is the temperature distribution behaviour within the refrigerator obtained by the CFD analysis on rectangular finned refrigerator. It can be interpreted from figure that upper part of the refrigerator temperature is higher inside test section. In this case Plate-evaporator with rectangular finned surface is used. However, it is also seen that the temperature distribution doesn't vary considerably. Temperature ranges from Upright direction, which is a colder zone, within the bottom of 275.235 K and an upper test section with a greater temperature of 284.417 K. It is seen that almost all of the performance is reasonably low temperature (Blue zone). Hence, the temperature acquired by CFD analysis with all three thermocouples positioned over these plane (upper, middle, lower) shows an average of 278.77 K.

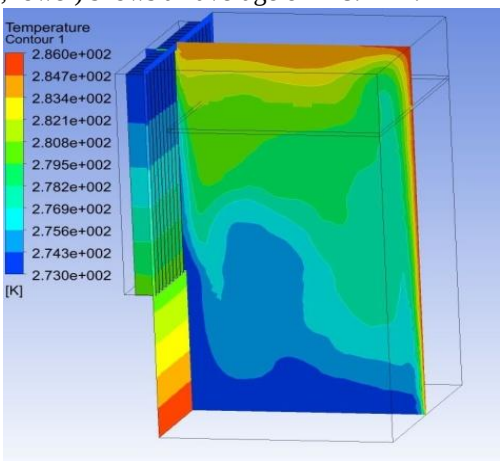


Fig.5. Temperature Contour for Plate-Evaporator with Rectangular Finned Surface

b. Contour of Plate-evaporator with finned surface for velocity distribution

The next segment of the investigation within the test section is the velocity distribution produced by the temperature gradient. Fig. 6 show the velocity delineation for the same cases as revealed in above mentioned analysis. For this case the result obtained from CFD analysis are, the mediocre velocity at the intermediate plane is 0.008432 m/s and 0.01523 m/s for the lower and the upper shelves, correspondingly and mediocre velocity at middle plane is 0.00728m/s .

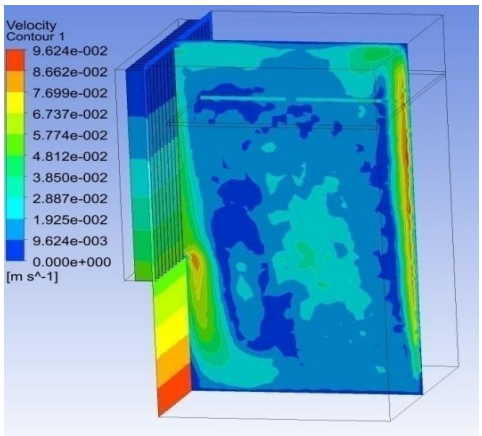


Fig.6. Velocity Contour for Plate-Evaporator with rectagular Finned Surface

Case3-With Perforated Finned Surface

CFD Simulation of Plate-evaporator with perforated finned surface are as:

a. Contour of Plate-evaporator with perforated finned surface for temperature distribution

The contour of temperature distribution in the refrigerator shown in Fig. 7 is obtained from the CFD analysis on with perforated fin refrigerator. The bottom of the refrigerator is at low temperature and the upper part of the refrigerator is at higher temperature in compartment. In this case Plate-evaporator with perforated finned surface is used. However, it can be interpreted that the temperature distribution behaviour does not change significantly by screening in upright direction a colder region in the bottommost of 274.476 K and an upper region with a greater temperature of 283.273 K. It can also be interpreted that most of the performance is comparatively low temperature (Blue zone). Hence, the temperature acquired all three thermocouples positioned over this plane (upper, middle, lower) show a mediocre of 277.99 K.

b. Contours of Plate-evaporator with perforated finned surface for velocity distribution

The next segment of the analysis within the test section is the velocity distribution engendered by the temperature gradient. The advanced speed is located on the lateral walls and the bottommost of the test section, which include regions of the prolonged surface. The location of the projection encouragements the flow arena, predominantly because the shelf in the lower position roots an upstream retention, associating the uniformity of temperature in this terrestrial of the test section. For this circumstance the result conquered from CFD analysis are the mediocre velocity at the intermediate plane is 0.008905 m/s and 0.0151833m/s for the lower and the upper shelves, correspondingly and mediocre velocity at intermediate plane is 0.00803m/s.

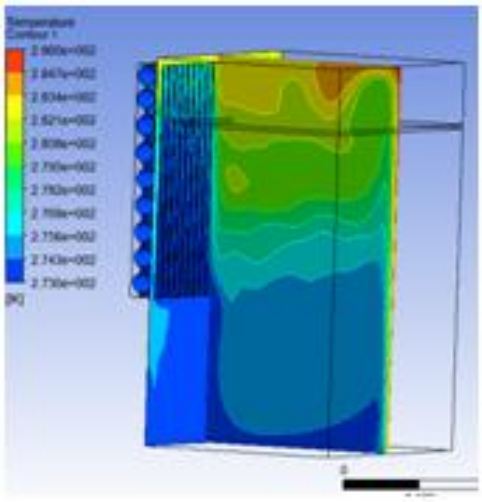


Fig.7. Temperature Contour for Plate-Evaporator with Perforated Finned Surface

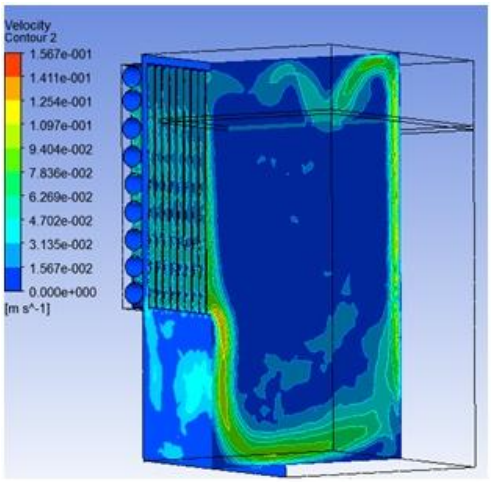


Fig.8.Velocity Contour for Plate-Evaporator with perforated Finned Surface

5 Contours for Horizontal plane in different cases

The consistency of temperature on the lower part of the test section is connected to normal movement triggered by the density alteration owing to temperature gradient. This consistency for a without finned plate can be comprehended in fig 9, for a rectangular finned plate is shown in Fig 10 and for perforated finned plate on a horizontal plane at the centre of the test section. The mediocre temperature in the horizontal plane is 281.915 K for a without finned plate, 278.114 K for a rectangular finned plate and 277.734 for perforated finned plate. The result shows that perforated fin plate model have lowest temperature compare to other two models.

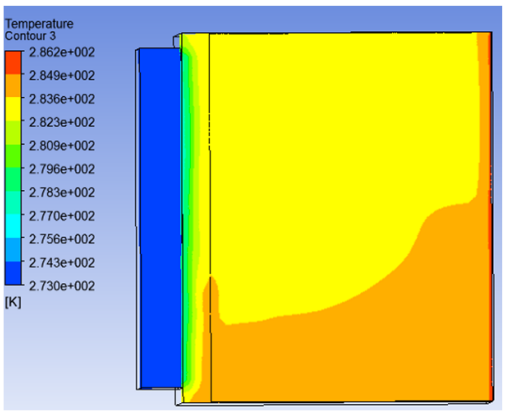


Fig. 9. Without Finned Plate

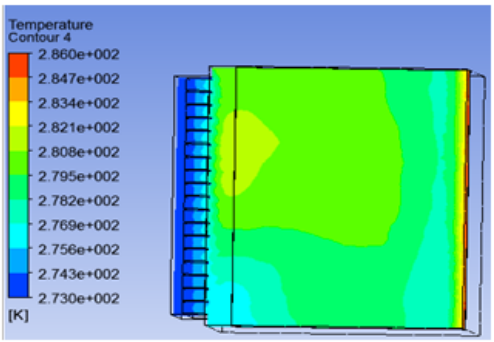


Fig. 10. With Rectangular Finned Plate

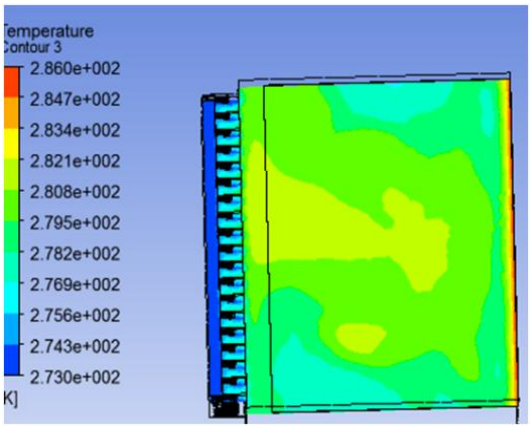


Fig. 11. With Perforated Finned Plate

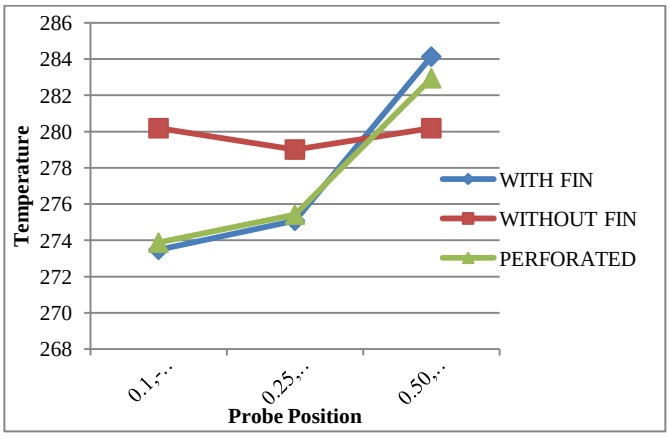
6 Performance Analysis

CFD results are acquired in directive to study the temperature variation and change in velocity fields esoteric the domestic frost-free refrigerator. Table II shows the temperature range in test section for three conditions (without finned / with finned / perforated finned).

Table II: Maximum and Minimum Temperature Obtained From Simulation

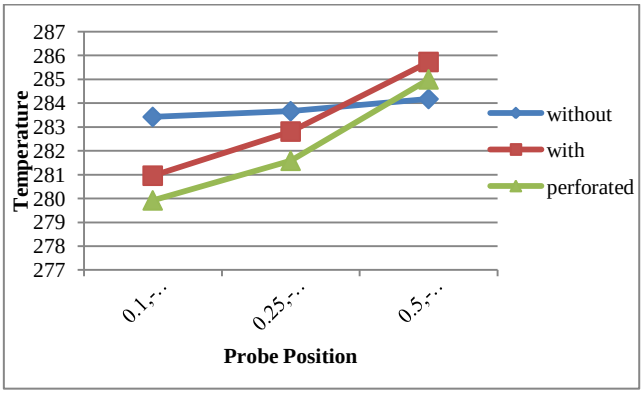
Refrigerator	With finned	Without finned	Perforated finned
Minimum Temperature	277.56 k	279.972k	277.41 k
Maximum Temperature	283.16 k	283.75 k	282.335 k

Temperature Distribution Comparison



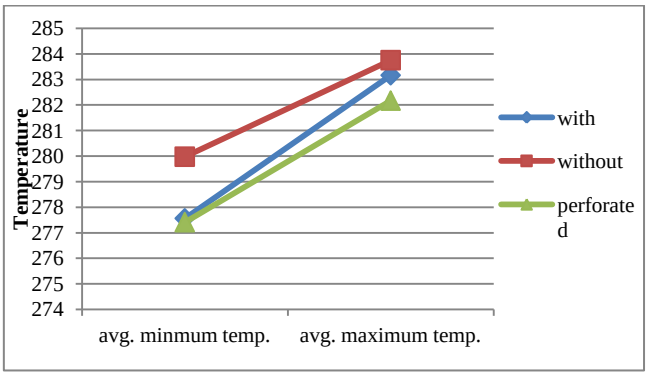
Graph 1: Minimum Temperature Graph

The above graph shows the minimum temperature in the refrigerator test section in three cases at three different points, which show that perforated fin has slightly minimum temperature 273.87 K than other two cases with fin and without fin.



Graph 2: Maximum Temperature Graph

The above graph shows the maximum temperature in the refrigerator test section in three cases at three different points, which show that perforated fin has lowest maximum temperature other than two cases rectangular fin and without fin.



Graph 3: Average Temperature Graph

The above graph shows the average maximum and minimum temperature in the refrigerator test section at different point which show that plate with perforated fin surface, has lowest avg. maximum and lowest avg. minimum temp compare with two models.

7 Conclusion and Future Scope

CFD simulation of air flow and heat transfer is approved out within the freezer and refrigerating test section of a domestic frost-free refrigerator. Three arrangements are premeditated in the test sections with rectangular finned and without finned and perforated finned. Temperature distributions in the freezer model endorse the philosophy that there is stratification, a warm region (higher temperature) at the top and a cold region at the bottom.

1. The mediocre temperature maintained in the freezer and refrigerating test section is about 273K and 286K respectively.
2. In Test section
   - Temperature in without finned system – 279.972K to 283.755K
   - Temperature in with rectangular finned system – 277.563K to 283.1667K
   - Temperature in with perforated finned system – 277.362K to 282.335K
3. The air temperature at the top is 5K higher than the average air temperature irrespective of the conditions (empty, with/without shelve, loaded with products). So it can be conclude that always avoid placing sensitive products at top of the refrigerator test section.
4. While perforated finned demonstrated maximum Temperature distributions and providing higher cooling effect.
5. Lastly, the investigation and demonstration through CFD for fridge sustained diffusion-absorption is specified by way of a possible apparatus for the aim of estimating applications within the interior architecture of the fridge. This arrangements contemplates that vivacious enhancements may be accomplished on the thermal contours, by investigating an optimum symmetrical plate-evaporator, in which the air flow is enclosed as a constraint of pronounced significance within the operability of the fridge and so, within the safeguarding of foodstuffs.

The present work concerned just the update of Fins of evaporator plate from the purpose of warm exchange rate. There are some conceivable proposals which might be feasible for reception in future.

1. In future we tend to work on associated with thermal performance of the test section of fridge with diffusion-absorption technology, on investigation of the design of parts apart from plate-evaporator.
2. The speed of air changes with change in thermal profile because of these changes providing serviceable cooling result within the refrigerator therefore in future it's going to be possible augmentations may be accomplished on the thermal contours, by investigating an optimum symmetrical plate evaporator.
3. The impact of different fin design providing good result for future purpose.
4. The CFD simulation accomplished in this research work can be further focussed in forthcoming as a tool in order to investigate the effect of functioning circumstances on the temperature and velocity arenas such as evaporator temperature, dimensions of the evaporator and the percentage of product-occupied volume in the refrigerating test section.

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