

# Enhancement of Film Boiling Characteristics Using Computational Fluid Dynamics Analysis for Moving Steel Plate

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**Abstract-** Present study provides guidelines and recommendations for solving film boiling problems in steel plate production, where the surface temperature of steel plate is much higher than the saturation temperature of the liquid in contact with the plate surface and the entire steel plate surface is immersed in water. Due to the boiling mass exchange occurring at the vapor liquid interface bubbles of steam are periodically produced and emitted upward such a regime is known as film boiling. A computational fluid dynamics analysis of steel plate using VOF multiphase model moving at different velocity i.e. 0.1 to 0.5 m/sec. the volume of fraction for vapor phase have been obtained for different time interval, the generation of bubbles starts moving upwards after 0.05 sec, as time goes the formation of vapor bubbles generate and collapse more rapidly because the thermal boundary is very thin and the fluid temperature around the bubbles almost equal to the saturation temperature. The thermal properties of the steel plate are implicit to be constant with temperature for convenience because the present study is focused on the boiling heat transfer on the steel plate. The size of element is set as 0.1 mm to generate mesh and quad-4 rectangular elements used are which is a rectangular in shape with four nodes on each element are applied for the analysis. Results show that that the 37.98% of Convective heat transfer coefficient of mixture is increased and 13.1% of temperature drop has been observed with 40.67% of heat flux increased for the steel plate moving at 0.1 m/sec.

## I. INTRODUCTION

Plate cooling is one of the most important processes in steel production because it is the last process controlling

the mechanical properties of products. There are different types of cooling methods such as circular impinging water jet, slit impinging water jet, mist cooling; air cooling and so on is available with specific purposes. In the present work circular impinging water jet has been analyzed. Although this cooling process contains the multiphase flow problem having the freely changing interface between the liquid water and air. Moreover in the thermal aspect, the phase-changing heat transfer (i.e. boiling) occurs between the cooling water and the hot steel plate. In the aspect of hydrodynamics, the plate moves with high speed, thus the movement of the water remaining on the plate are closely related with the plate motion.[4-6] This means the present problem includes one more moving interface except the water-air interface. Moreover this additional moving interface is not a system boundary but an important threshold thermally coupling the plate and the cooling water.

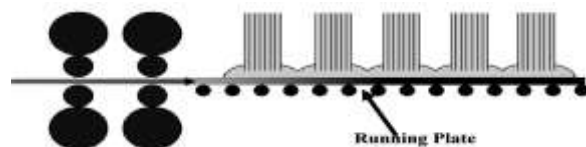


Figure 1: water jet cooling system in hot rolling mill.

## II. LITERATURE REVIEW

**Sanskar singh et al.** [1] A computational fluid dynamics analysis of steel plate using volume of fluid multiphase model moving at different velocity i.e. 0.1 to 1 m/sec with

0.1 m/sec interval. From the above concluding points it has been observed that heat flux increased for the steel plate moving at 0.2 m/sec. During quenching process the surface heat transfer coefficient increases at first. And when plate surface temperature is nearly 550 oC, surface heat transfer varied from 2000 to 4500 W/(m<sup>2</sup>K).

**Avadhesh Kumar Sharma et al. [2]** The present paper reports thermal and rewetting behaviour of moving surfaces with upward circular water jet impingement. A stainless-steel foil (SS-304) with 0.15 mm thickness, used as a test specimen and temperature is measured by infrared thermal imaging camera, for transient cooling conditions. The initial surface temperature of the test foil is kept at 500 ± 10 °C, and the distance between nozzle to plate is maintained at 6. During tests, Reynolds number was varied between 2500 and 10000, while the plate test specimen speed was varied within 0 and 40 mm/s. Except for the stagnation zone (x = 0), the local heat flux values are found to be higher for moving surfaces compared to stationary surfaces.

**Vishal TALARI et. al. [3]** In the Leidenfrost state, the liquid drop is levitated above a hot solid surface by a vapor layer generated via evaporation from the drop. Ans in this paper presents a comprehensive review of recent literature concerning the Leiden frost drops on micro/nanostructured surfaces with an emphasis on the enhancement of the Leiden frost temperature. The basic physical processes of the Leiden frost effect and the key characteristics of the Leiden frost drops were first introduced. Then, the major findings of the influence of various micro/nanoscale surface structures on the Leidenfrost temperature were presented in detail, and the underlying enhancement mechanism for each specific surface topology was also discussed.

**Mehrdad Shahmohammadi Beni et. al. [4]** The droplet dynamics and heat removal is one of the popular research streams in spray cooling applications. The increase in the water droplet temperature as a result of its impact on the hot solid surface would determine the efficiency of the heat removal that is crucial in some sensitive applications such as spray cooling in depressurization systems in commercial nuclear power plants. Computer modelling of the underlying mechanism of the liquid droplet interaction with the hot solid surface would be necessary.

### III. OBJECTIVE

In this paper, for the simulation of film boiling problem for the steel plate, volume of fluid (VOF) multiphase model has been used, in multiphase interface mechanism an insufficient study has been seen in worldwide so that it has been decide to study in film boiling mechanism. Current study is extended by taking various saturation temperatures at different velocity of moving steel plate.

### IV. METHODOLOGY

The cooling mechanism of moving plate from the finishing rolling mill is water jets is usually used for cooling process because of its high cooling capacity.

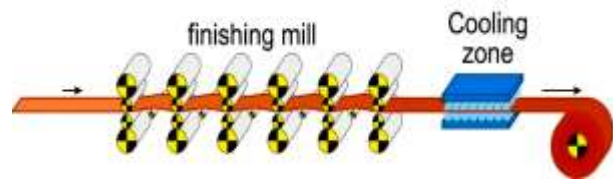


Figure 2: Cooling Mechanism of moving plates

Due to cooling water supplied on moving plate a thick water layer on the moving plate. Causing high flow rate conditions, the thermal interaction between the running plate and the cooling water can be classified according to the plate surface temperature ( $T_{wall}$ ).

When the surface temperature is below the vaporizing temperature, 100°C at the ambient pressure, of 1 bar, the thermal interaction between the plate and the cooling water occurs without phase change, i.e. no vaporizing. [7-9]

If the surface temperature is higher than 100°C and below the Leiden frost temperature, the nucleate boiling appears on the plate surface. If the surface temperature is over the Leiden frost temperature the plate surface is covered with a thin steam layer and the plate water thermal interaction alters the film boiling mode. [10]

#### 1) Heat Transfer Correlations for Film Boiling:

Bromley relation for heat flux of film boiling on a horizontal cylinder is given by

$$\dot{q}_{film} = C_{film} \left[ \frac{g k_v^3 \rho_v (\rho_l - \rho_v) [h_{fg} + 0.4 C_{pv} (T_s - T_{sat})]}{\mu_v D (T_s - T_{sat})} \right]^{1/4} (T_s - T_{sat})$$

Where

$\dot{q}_{film}$  = heat flux for film boiling W/m<sup>2</sup>

$$C_{film} = \begin{cases} 0.62 & \text{for horizontal cylinders} \\ 0.67 & \text{for spheres} \end{cases}$$

- $g$  = gravitational acceleration,  $m/s^2$
- $k_v$  = thermal conductivity of the vapor in  $W/m \cdot ^\circ C$
- $\rho_v$  = density of the vapor,  $kg/m^3$
- $\rho_l$  = density of the liquid,  $kg/m^3$
- $h_{fg}$  = enthalpy of vaporization,  $J/kg$
- $C_{pv}$  = specific heat of vapor
- $T_s$  = surface temperature of the heater,  $^\circ C$
- $T_{sat}$  = saturation temperature of the fluid,  $^\circ C$
- $\mu_v$  = viscosity of the vapor,  $kg/m \cdot s$

The vapor properties are to be evaluated at the film temperature, given as

$$T_f = \frac{(T_s + T_{sat})}{2}$$

Which is the average temperature of the vapor film  
 At high surface temperatures (typically above  $300^\circ C$ ), heat transfer across the vapor film by radiation becomes significant and needs to be considered.

**2) Radiation heat transfer can be determined from**

$$q_{rad} = \epsilon \sigma (T_s^4 - T_{sat}^4)$$

Where

$\epsilon$  = emissivity of the heating surface

$\sigma = 5.67 \times 10^{-8} W/m^2 \cdot k^4$  is the Stefan Boltzman constant

For  $q_{rad} < q_{film}$  film, Bromley determined that the relation

$$q_{total} = q_{film} + \frac{3}{4} q_{rad}$$

**3) Relation for maximum heat flux:**

The maximum (or critical) heat flux in nucleate pool boiling was determined theoretically by S. S. Kutateladze in Russia in 1948 and N. Zuber in the United States in 1958 using quite different approaches, and is expressed as

$$q_{max} = C_{cr} h_{fg} [\sigma g \rho_v^2 (\rho_l - \rho_v)]^{1/4}$$

Where  $C_{cr}$  is a constant whose value depends on the heater geometry. Exhaustive experimental studies by Lienhard and his coworkers indicated that the value of  $C_{cr}$  is about 0.15.

**4) Computational fluid dynamics analysis of steel plate:**

In the present work computational fluid dynamics analysis is carried out using Ansys fluent for steel plate moving at different velocity. The governing equations such as multiphase volume of fluid (VOF) model

continuity equation, momentum equation, energy equations, K equation and  $\epsilon$  equations are used to perform this computational analysis.

Three main elements are used to solve the Computational fluid dynamics problems.

- 1) Pre-processor,
  - 2) Solver and
  - 3) Post-processor.
- 5) **Algorithm used for Computational fluid dynamics analysis:**



Figure 3: Algorithm used for Computational fluid dynamics analysis

**6) Governing Equations:**

The main objective is to analyze the thermal behavior and velocity distribution generated by the temperature gradient, and to compare the thermal behavior of the reference steel plate.

The density is calculated using the Boussinesq approximation in the momentum equation in y direction. The conservation equations are adapted to the model, considering constant properties and including the Boussinesq's equation in the y-component of the Navier-Stokes equation.

**7) Energy Equation**

The VOF formulation in FLUENT is generally used to compute a time-dependent solution. The VOF formulation relies on the fact that two or more fluids (or phases) are not interpenetrating. For each additional phase that you add to your model, a variable is introduced: the volume fraction of the phase in the computational cell. In each control volume, the volume fractions of all phases sum to unity.

### 8) Computational fluid dynamics analysis for steel plate moving at 0.1 m/sec:

In the present work a two dimensional CAD model of steel plate having sampling length of 20 mm x 80 mm is created with the help of design modular of ANSYS workbench. A two dimensional view of steel plate is shown in figure No 4.



Figure 4: CAD model of steel plate with sampling length 20 mm x 80 mm

### 9) Meshing:

After completing the CAD geometry of steel plate is imported in ANSYS workbench for further computational fluid dynamics analysis and the next step is meshing. Meshing is a critical operation in computational fluid dynamic analysis, in this process CAD geometry is divided into large numbers of small pieces called mesh. The size of element is set as 0.1 mm to generate mesh and the total no of nodes generated in the present work is 33830 and total No. of Elements is 33462. Types of elements used are quad-4 which is a rectangular in shape with four nodes on each element.

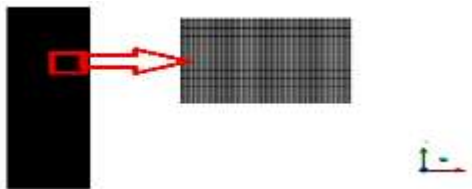


Figure 5: Meshing of steel plate

### 10) Quality of meshing:

The quality of the mesh plays an important role in the accuracy and stability of the calculation. In the present work the Quadrilateral elements have been generated during discretization. The quality of the cell including its orthogonal quality, aspect ratio, and skewers has an important effect on the accuracy of the solution.

### 11) Factor that affect the mesh quality:

- **Rate of convergence:** if the mesh quality is good the rate of convergence will be grater which means the correct solution can be achieved faster.
- **Solution precision:** A better mesh quality provides a more precise solution.

- **Computational processing time required:** for the highly refined mesh the computational time will be relatively large.
- **Grid Independence result:** Once the computations are done and the desired property of fluid does not vary with respect to different mesh elements then it represents that further change in elements doesn't vary the results this term known as Independent Grid.

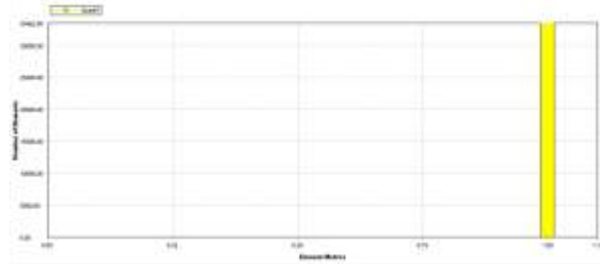


Figure 6: Orthogonal mesh quality for steel plate

Orthogonal quality is computed for cells using the vector from the cell centroid to each of its faces, corresponding face area vector, and the vector from the cell centroid to centroids of each of the adjacent cells. The worst cells will have an orthogonal quality closer to 0, with the best cells closer to 1. In the present case the minimum value is 1 and maximum value is 1 and average value is 1, which means the mesh quality is acceptable and very good.



Figure 7: different boundaries of steel plate for film boiling analysis

### 12) Boundary condition:

1. Define the solver settings as pressure based transient and enable gravity option in y direction with the value of  $-9.81 \text{ m/s}^2$ .
2. In multiphase model select the Volume of Fluid multiphase model and Enable the Implicit Body Force formulation.
3. Define the primary phase as vapor and secondary phase as liquid.
4. To determine the temperature distribution need to on energy equation.

5. Defining of material property, the working fluid is taken as mixture of water liquid & water vapor.
6. For the outlet boundary condition the gauge pressure needs to be set as zero.
7. Under Thermal Conditions, select hot surface temperature as 850 °C. This indicates superheat with respect to the saturation temperature.
8. Under Discretization, select PRESTO! For Pressure, and QUICK for Momentum and Energy.
9. The Fluent solver is used for CFD analysis.

**V. RESULTS**

In the present work computational fluid dynamics analysis have been performed for steel plate moving at different velocity to check performance of heat transfer. The running speed of steel plate varies from 0.1 m/sec to 0.5 m/sec, and the surface temperature of hot steel plate is taken as 850 °C and it is assume that the incoming temperature uniformly distributed over the heated steel plate. The thermal properties of the steel plate are implicit to be constant with temperature for convenience because the present study is focused on the for the boiling heat transfer on the steel plate. The size of element is set as 0.1 mm to generate mesh and quad-4 rectangular elements used are which is a rectangular in shape with four nodes on each element.

**1) CFD result of volume of fraction for vapor phase on steel plate moving at 0.1 m/Sec:**

After performing computational fluid dynamics analysis of steel plate using VOF multiphase model moving at 0.1 m/Sec. the volume of fraction for vapor phase have been obtained for different time interval and the formation of vapor and liquid have been shown in below contours diagram.

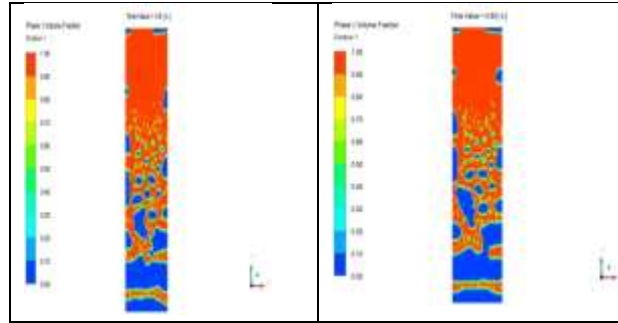
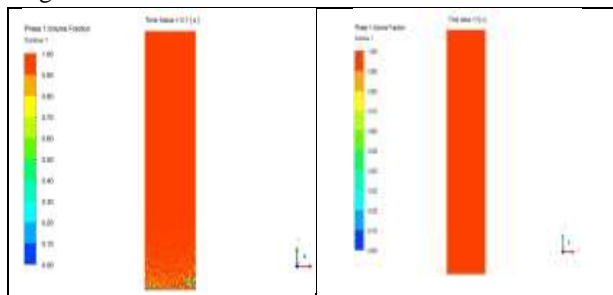


Figure 8: volume of fraction for vapor phase on steel plate moving at 0.1 m/Sec

**2) CFD result of temperature distribution over the heated surface of steel plate moving at 0.1 m/Sec:**

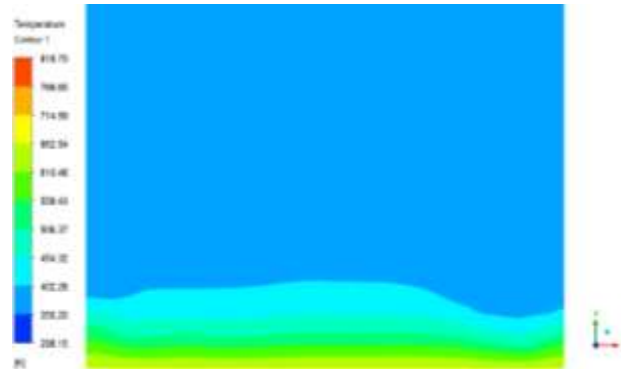


Figure 9: Temperature of the mixture of vapor and liquid on hot surface plate moving at 0.1 m/sec

In the formation of vapor and merging process the mixture (water & vapor) temperature increases from 298.15 k to 818.7 K.

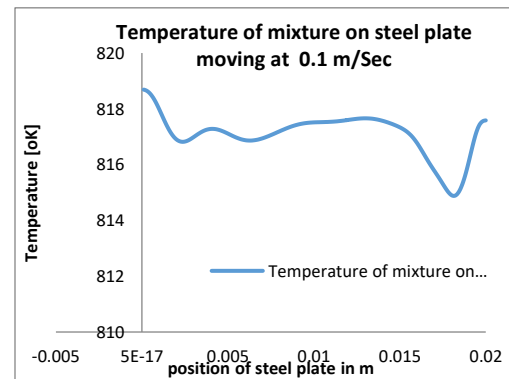


Figure 10: Temperature of mixture on steel plate moving at 0.1 m/Sec

**3) CFD result of volume of fraction for vapor phase on steel plate moving at 0.2 m/Sec:**

After performing computational fluid dynamics analysis of steel plate using VOF multiphase model moving at 0.2 m/Sec. the volume of fraction for vapor phase have been

obtained for different time interval and the formation of vapor and liquid have been shown in below contours diagram.

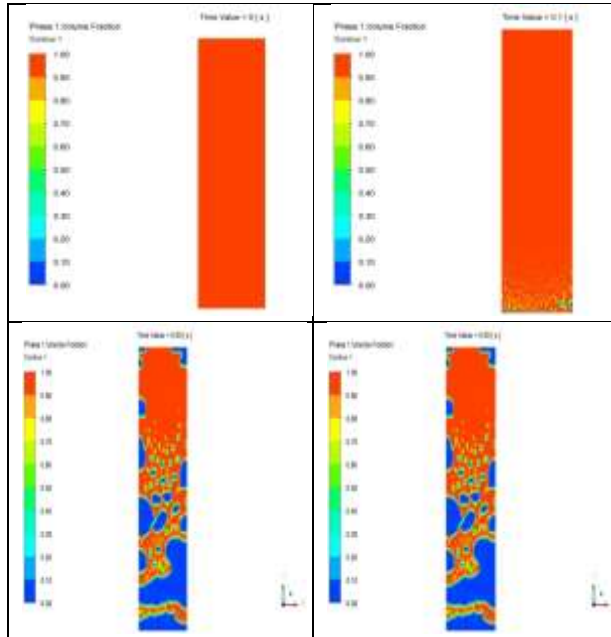


Figure 11: volume of fraction for vapor phase on steel plate moving at 0.2 m/Sec

**4) CFD result of temperature distribution over the heated surface of steel plate moving at 0.2 m/Sec:**

The contours of the temperature distribution over the heated surface of the moving steel plate is shown in above figure. The maximum temperature of 861.2 degree Kelvin has been observed near the lower surface. The contours diagrams of temperature distribution above the heated surface are plotted on XY plane. The growth of temperature profile show a linear pattern throughout plate surface and variation in temperature profile is captured for different time interval of 0 to 1.0 sec. it has been observed from 0.2 sec to 0.43 sec maximum changes occurs and after .45 sec the temperature profile have very little changes in its linear profile.

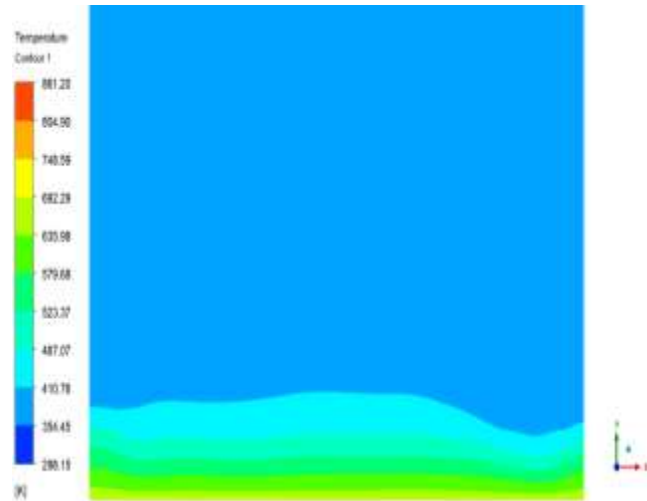


Figure 12: Temperature of the mixture of vapor and liquid on hot surface plate moving at 0.2 m/sec

In the formation of vapor and merging process the mixture (water & vapor) temperature increases from 298.15 k to 861.2K.

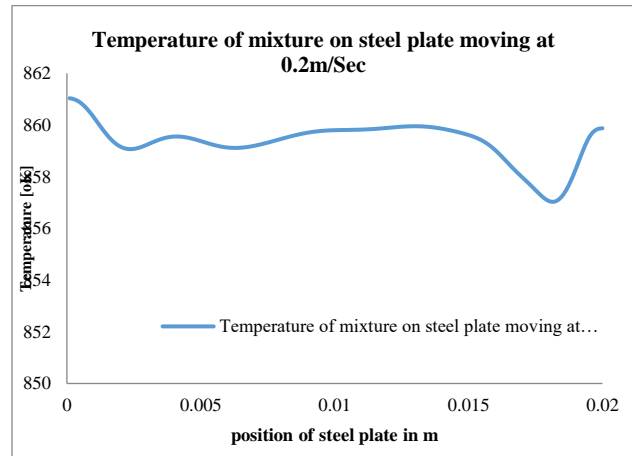


Figure 13: Temperature of mixture on steel plate moving at 0.2 m/Sec

**5) CFD result of volume of fraction for vapor phase on steel plate moving at 0.5 m/Sec:**

After performing computational fluid dynamics analysis of steel plate using VOF multiphase model moving at 0.5 m/Sec. the volume of fraction for vapor phase have been obtained for different time interval and the formation of vapor and liquid have been shown in below contours diagram.

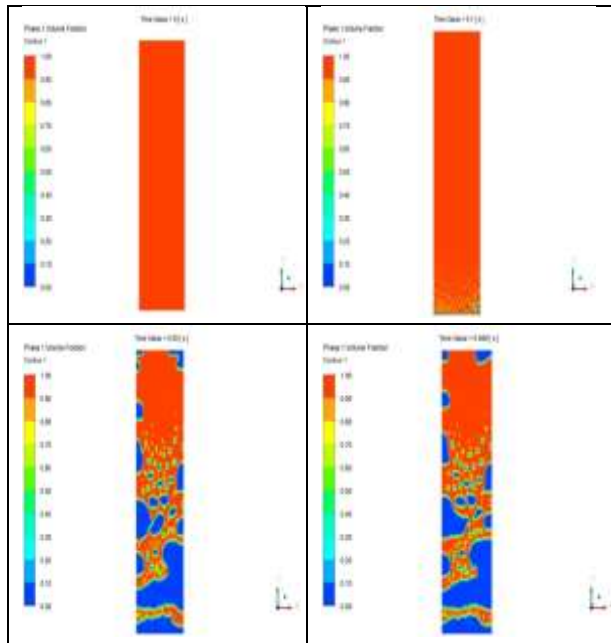


Figure 14: volume of fraction for vapor phase on steel plate moving at 0.5 m/Sec

6) **CFD result of temperature distribution over the heated surface of steel plate moving at 0.5 m/Sec:**

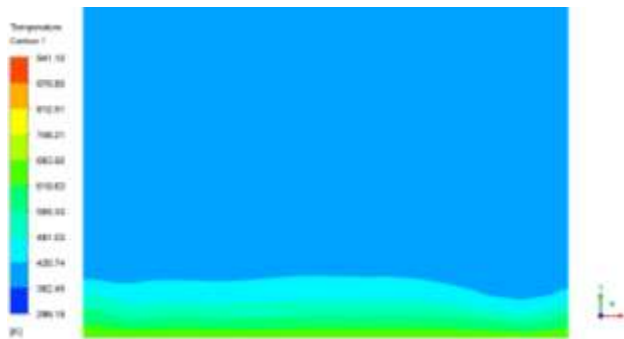


Figure 15: Temperature of the mixture of vapor and liquid on hot surface plate moving at velocity of 0.5 m/sec

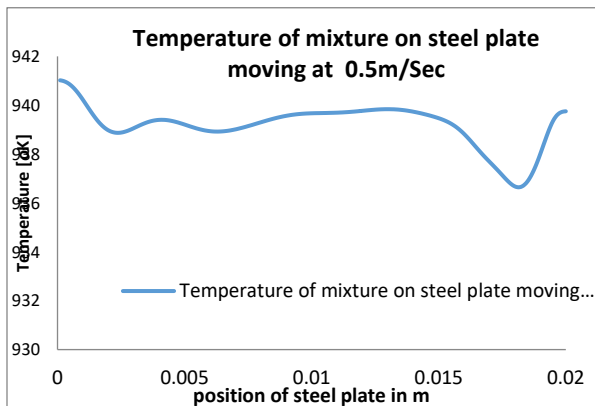


Figure 16: Temperature of mixture on steel plate moving at 0.5 m/Sec

7) **Results analysis of steel plate moving at velocity of 0.5 m/sec:**

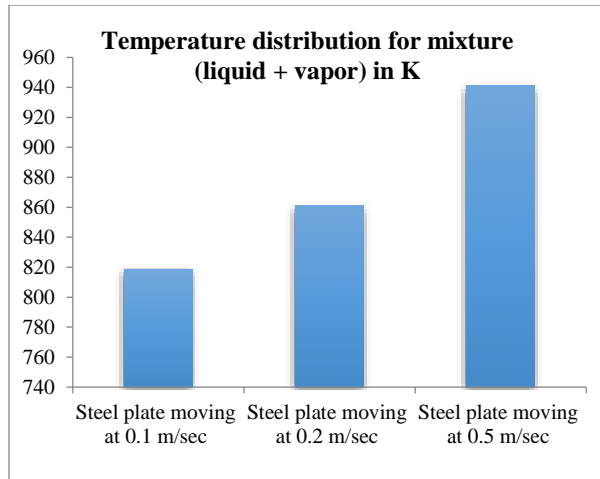


Figure 17: Temperature distribution for mixture (liquid + vapor) for steel plate moving at different velocity

From the above figure it has been observed that the maximum temperature drop occurs on plate moving at 0.1 m/sec. hence 13.1% of temperature drop has been observed at this condition.

8) **Calculation of heat flux:**

Heat flux is a flow of energy per unit area per unit time, its unit is  $W/m^2$ . It is a vector quantity having both direction and magnitude.

$$Q = h\Delta T$$

Where:

$Q$  = heat flux in  $W/m^2$

$h$  = Convective heat transfer coefficient of mixture

$\Delta T$  = temperature difference in degree kelvin

9) **Heat flux for steel plate moving at 0.1 m/sec**

$$Q = h\Delta T$$

Heat flux for mixture:

$$Q_{mixture} = h \cdot \Delta T_{0.1 m/sec}$$

$$Q_{mixture} = 56792.28 \times (818.7 - 303.15)$$

$$Q_{mixture} = 29279259.95 \text{ W/m}^2$$

10) **Heat flux for steel plate moving at 0.2 m/sec**

$$Q_{mixture} = h \cdot \Delta T_{0.2 m/sec}$$

$$Q_{mixture} = 44854 \times (861.2 - 303.15)$$

$$Q_{mixture} = 25030774.7 \text{ W/m}^2$$

**11) Heat flux for steel plate moving at 0.5 m/sec**

$$Q_{mixture} = h \cdot \Delta T_{0.5 \text{ m/sec}}$$

$$Q_{mixture} = 35218.75 \times (941 - 303.15)$$

$$Q_{mixture} = 22464279.69 \text{ W/m}^2$$

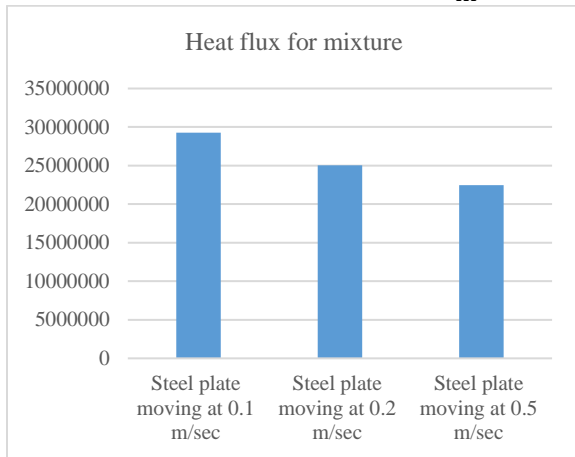


Figure 18: Heat flux of mixture for steel plate moving at different velocity

From the above figure it has been observed that the heat flux is increasing with increasing plate velocity at same boundary condition. The maximum heat flux occurs on plate moving at 0.1 m/sec. hence 30.7% of heat flux increased as compared with plate moving at 0.5 m/sec.

**12) Calculation of Mass flow rate:**

Mass flow rate:  $\rho \times A \times V$   $\text{Kg/m}^3$

Surface area 1600 mm<sup>2</sup>

Density of liquid= 998 Kg/m<sup>3</sup>

Density of vapour= 0.5542 Kg/m<sup>3</sup>

Density of mixture= 998.2 Kg/m<sup>3</sup>

**13) Mass flow rate for steel plate moving at 0.1 m/sec**

Mass flow rate for Liquid:  $\rho_{liquid} \times A \times V$

$$998 \text{ Kg/m}^3 \times 1600\text{mm}^2 \times 36.48 \text{ m/sec} = 58.25 \text{ kg/sec}$$

Mass flow rate for Vapour:  $\rho_{vapour} \times A \times V$

$$0.5542 \text{ Kg/m}^3 \times 1600\text{mm}^2 \times 36.48 \text{ m/sec} = 0.0323475456 \text{ kg/sec}$$

Mass flow rate for mixture:  $\rho_{mixture} \times A \times V$

$$998.2 \text{ Kg/m}^3 \times 1600\text{mm}^2 \times 36.48 \text{ m/sec} = 58.2629 \text{ kg/sec}$$

**14) Mass flow rate for steel plate moving at 0.2 m/sec**

Mass flow rate for Liquid:  $\rho_{liquid} \times A \times V$

$$998 \text{ Kg/m}^3 \times 1600\text{mm}^2 \times 41.45 \text{ m/sec} = 66.18736 \text{ kg/sec}$$

Mass flow rate for vapour:  $\rho_{vapour} \times A \times V$

$$0.5542 \text{ Kg/m}^3 \times 1600\text{mm}^2 \times 41.45 \text{ m/sec} = 0.036754544 \text{ kg/sec}$$

Mass flow rate for mixture:  $\rho_{mixture} \times A \times V$

$$998.2 \text{ Kg/m}^3 \times 1600\text{mm}^2 \times 41.45 \text{ m/sec} = 66.200624 \text{ kg/sec}$$

**15) Mass flow rate for steel plate moving at 0.5 m/sec**

Mass flow rate for Liquid:  $\rho_{liquid} \times A \times V$

$$998 \text{ Kg/m}^3 \times 1600\text{mm}^2 \times 49.7 \text{ m/sec} = 79.36096 \text{ kg/sec}$$

Mass flow rate for vapour:  $\rho_{vapour} \times A \times V$

$$0.5542 \text{ Kg/m}^3 \times 1600\text{mm}^2 \times 49.7 \text{ m/sec} = 0.044069984 \text{ kg/sec}$$

Mass flow rate for mixture:  $\rho_{mixture} \times A \times V$

$$998.2 \text{ Kg/m}^3 \times 1600\text{mm}^2 \times 49.7 \text{ m/sec} = 79.376864 \text{ kg/sec}$$

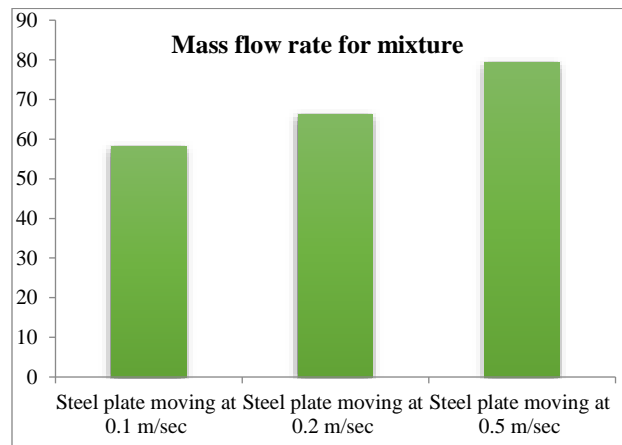


Figure 19: mass flow rate of mixture for plate moving at different velocity

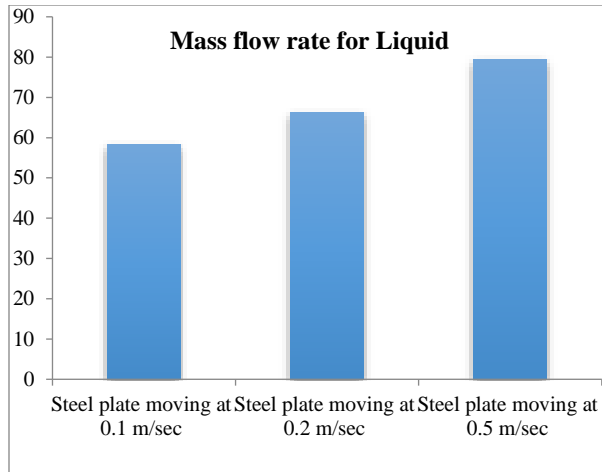


Figure 20: mass flow rate of liquid for plate moving at different velocity

## VI. CONCLUSION

In the present work computational fluid dynamics analysis have been performed for hot steel plate moving at different velocities to check heat transfer performance. Computational fluid dynamic analysis for the steel plate moving at different velocities such as 0.1 m/sec, 0.2 m/sec and 0.5 m/sec, and the hot surface temperature of 850 °C uniformly distributed over the steel plate. The thermal properties of the steel plate are assumed to be constant with temperature for convenience because the present study is focusing on the simulation model for the boiling heat transfer on the plate. The cold water temperature is taken as 30 °C, the thermal properties of the steel plate are implicit to be constant with temperature for convenience because the present study is focused on the for the boiling heat transfer on the steel plate. The size of element is set as 0.1 mm to generate mesh and quad-4 rectangular elements used are which is a rectangular in shape with four nodes on each element are applied for the analysis. Although the present work is limited only for the very high temperature, the various results of computational fluid dynamics for all variables have been concluded.

1. After performing computational fluid dynamics analysis of steel plate using VOF multiphase model moving at 0.1 m/Sec. the volume of fraction for vapor phase have been obtained for different time interval, the generation of bubbles starts moving upwards after 0.05 sec, as time goes (0.1 to 0.95 sec) the formation of vapor bubbles and collapse more rapidly because the thermal boundary is very thin and the fluid temperature around the bubbles almost equal to the saturation temperature. The mass flow rate of 58.25

kg/sec, Temperature of the mixture of vapor and liquid on hot surface increases from 298.15 k to 818.7 K, maximum velocity of the mixture of vapor and liquid on hot surface has been observed as 36.48 m/sec, heat flux is 29279259.95 w/m<sup>2</sup>.

2. After performing computational fluid dynamics analysis of steel plate using VOF multiphase model moving at 0.2 m/Sec. the volume of fraction for vapor phase have been obtained for different time interval, the generation of bubbles starts moving upwards after 0.05 sec, as time goes (0.1 to 0.95 sec) it has been observe that from 0.2 sec to 0.43 sec maximum changes occurs and after .45 sec the temperature profile have very little changes in its linear profile. The mass flow rate of 66.18736 kg/sec, Temperature of the mixture of vapor and liquid on hot surface increases from 298.15 k to 861.2 K, maximum velocity of the mixture of vapor and liquid on hot surface has been observed as 41.45 m/sec, heat flux is 25030774.7 w/m<sup>2</sup>.
3. After performing computational fluid dynamics analysis of steel plate using VOF multiphase model moving at 0.5 m/Sec. the volume of fraction for vapor phase have been obtained for different time interval, the generation of bubbles starts moving upwards after 0.05 sec, as time goes (0.1 to 0.95 sec) the formation of vapor bubbles and collapse more rapidly because the thermal boundary is very thin and the fluid temperature around the bubbles almost equal to the saturation temperature. The mass flow rate of 79.36096 kg/sec, Temperature of the mixture of vapor and liquid on hot surface increases from 298.15 k to 941 K, maximum velocity of the mixture of vapor and liquid on hot surface has been observed as 49.7 m/sec, heat flux is 22464279.69 w/m<sup>2</sup>.

From the above concluding points it has been observed that 13.1% of temperature drop has been observed with 30.7% of heat flux increased for the steel plate moving at 0.1 m/sec.

## VII. FUTURE SCOPE

The present work is concentrated to improve the thermal performance and reduce the effect of film boiling from the steel plate moving at different velocity. Though the study is performed with an utmost care then also there is scope for further improvement. Some of the suggestions for future study might be possible.

1. In the present work two dimensional geometry is used for CFD simulation, but in future three dimensional geometry may also be used.

2. In the present work for steel plate three different running velocity is used, but some other velocities may also used.
3. In the present work only effect of film boiling has been study, but in future some other effect like nucleate boiling and transition boiling may also done.

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