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EFFECT OF USING WIND RESISTANCE AND WIRE MESH IN LPG COOKING STOVE

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ABSTRACT - *The liquefied petroleum gas (LPG) is one of the most commonly used fuelsin the cooking stove. The efficiency of the existingLPG cooking stove was 48 to 52%. Incomplete combustion, heat losses, flame stability, flame size and wind flow are main problems in the existing stove. In this present work, the reductions of the wind flow in LPG stove are controlled by using wind resistance. The wind resistance and wire mesh are studied and analysed by using the Simulation software (ANSYS). While using wind resistance and wire mesh the disruption of flame are reduced. From the temperature contours, it was observed that the temperature of the flame is increased in all directions by using the wind resistance and wire mesh. The work was concluded, that the better prospect for the use of wind resistance in domestic LPG stove are achieved the maximum thermal efficiency.*

Keywords: Wind resistance, Flame Temperature, LPG Stove, ANSYS.

1. INTRODUCTION

Liquefied petroleum gas (LPG) is one of the generally used conventional fuels for domestic applications. Its consumption in domestic cooking is increasing every year at the rate of approximately 10% [1,2,3]. The total domestic consumption of LPG in India is almost comparable with other petroleum products used in industrial applications [4,5]. With some improvements in the existing LPG cooking stoves, a small saving in its consumption per family will lead to an enormous saving nation-wide. Thus, there is a need for research in the LPG cooking stoves. In any combustion system, the burner plays a vital role. Improper design of the burner can result in inefficient combustion [6,7]. The thermal efficiency of normal conventional burner found to be 48-52% and the remaining dropped in the form of losses. The losses of thermal efficiency of the LPG stove happened due to the burner design, incomplete combustion, pot height and atmospheric wind [8].

The problems of affecting the performance of LPG stove is slightly reduced by some of those methods but Unfortunately, the effect of atmospheric wind on the flame temperature still present. In India, most of the families are middle class and they are lived-in home that consists of two or three rooms only [9]. The thermal efficiency of the LPG stove indirectly affected by the interior design of house. Here due to the presence of fans, the atmospheric velocity varied in the cooking place. This situation affects the thermal efficiency, because more wind velocity provides a high rate of heat transfer between atmospheric air and flame. Better alternative idea is required here to overcome this problem and increase the efficiency of the LPG stove [10,11]. The resistance of wind is a better alternative idea to increase the thermal efficiency of the LPG stove and the pan support was redesigned to act as a wind resistance.

In that manner, we proceed with this scenario as a project and check the results [12, 13].In view of huge consumption of LPG in India, thus there is a need to explore ways to further improve thermal efficiency of LPG cooking stoves. With the objective of improving the thermal efficiency of domestic LPG cooking stoves, in the present work, the analysis were carried out by wind resistance and wire mesh incorporating in conventional cooking stoves. Thermal efficiencies analyses were carried out with and without the usage of wind resistance and wire mesh.

2. EXPERIMENTAL METHODS

2.1. Numerical Modelling

The numerical analysis proceeds in two ways for the better understand about the effect of wind in LPG stove. Based on requirement, it's categorised in two ways. These are,

i. Without wire mesh and wind resistance

ii. With wire mesh and wind resistance

Case 1 - Without wire mesh and wind resistance

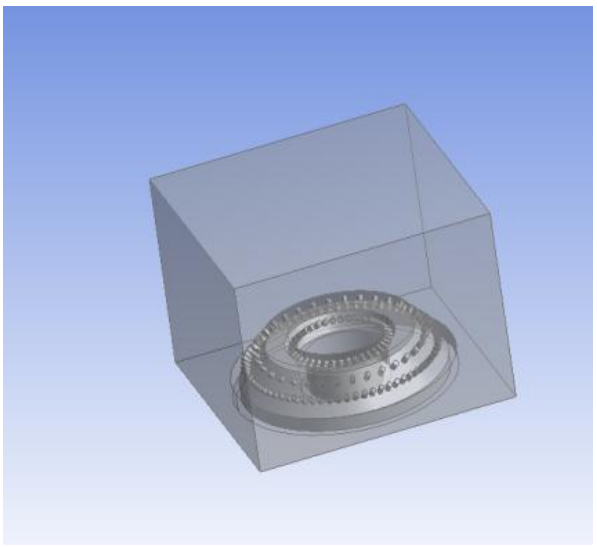

Fig -1: Computational Domain

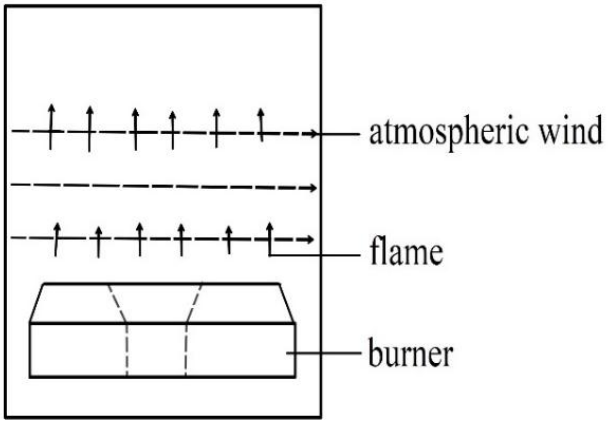

Fig -2: Boundary Conditions

Figure 1 shows the 3D domain of burner for the fluent or numerical analysis. In meshing operation, wherever possible, the Structural meshes were used and in complicated places, the tetrahedral mesh was used. The purpose of this study to figure out the effect of wind on the LPG flame. We directly take an excited LPG stove without any modifications for case 1 analysis. Atmospheric wind and flame are given as an input for the computation analysis. The suitable property was given to these to fluids [14,15]. Gravitational forces were included to simulate the buoyancy-driven flow around the burner head.

Case 2 - With wind resistance

Figure 4 shows the boundary condition of fluent to evaluate the temperature of flame. In this case, a similar process was carried out like case 1, but additional wind resistance added to reduce the heat transfer. To figure out the advantage of using wind resistance in the conversational LPG stove, these two numerical results were compared.

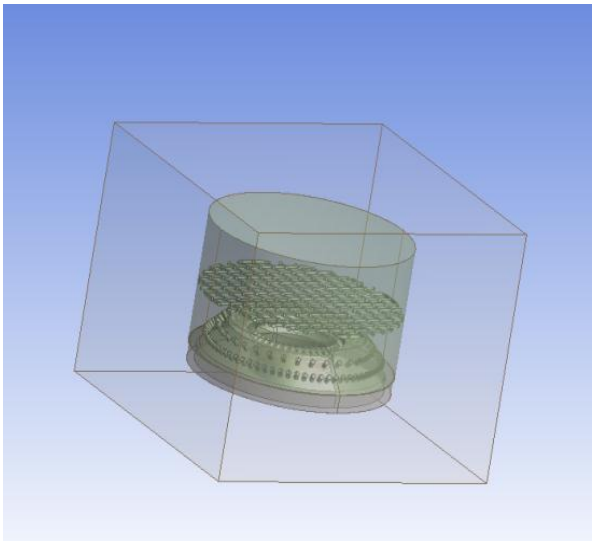

Fig -3: Computational Domain

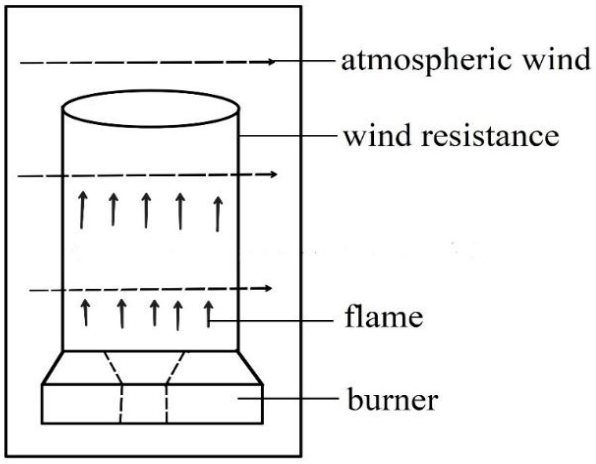

Fig -4: Boundary Conditions

The inlet value of mass flow rate of the LPG–air mixture and its mass fraction of propane, butane, nitrogen and oxygen were taken from the Mana wichangaram simulation study of LPG cooking burner[16, 17]. shown in table 1 and table 2 shows the design details of Burner and Wind resistance.

Table -1: Inlet Data

Detail	Value
Mass flow rate of mixture (kg/s)	0.003952742
Mass fraction of C3H8	0.0392758
Mass fraction of C4H10	0.0392758
Mass fraction of N2	0.7095291
Mass fraction of O2	0.2119193

Table -2: Design Details

S.no	Parameters	Dimensions(mm)
1	Burner Diameter (outer)	84

2	Number of inner holes	32
3	Number of outer holes	64
4	Diameter of inner hole	1.5
5	Diameter of outer hole	1.5
Wind Resistance		
6	Diameter of Wind resistance	88
7	Length	40
8	Thickness of plate	3

3. RESULTS AND DISCUSSION

Many researchers had pay attention to the higher thermal efficiency of domestic gas burner since the demand for energy savings. This paper consists of increasing the thermal efficiency of the LPG stove by using the wind resistance and wire mesh and it's evaluated numerically.

Case 1: Without wind proof and wire mesh

The figure.5 shows the temperature results of the LPG stove. From the temperature results, it's clear that the maximum temperature attained the centre portion of the burner and the enters portion of wind the temperature of flame is reduced. When the distance travels in the vertical direction, the temperature silently reduced because atmospheric wind collides with flame, and it reduces the temperature of flame through the convection operation. So the distance between the vessel and top layer of the burner is important for better thermal efficiency. Based on the previous result, we carried out all the experiments under the distance of 25 mm from the top portion of the burner [10,19].

Case -2: With Wind proof and Wire mesh

Figure.6 shows the temperature result of case -2, using wind resistance and wire mess in LPG stove. The temperature of flame slightly increased in LPG stove, because the wind resistance reduces the reaction of atmospheric wind in the flame. The results show that the range of maximum temperature increased in center of the burner. We can able to increase the thermal efficiency of the LPG stove by addition to other approaches like using a porous medium, preheating method, porous radiant recirculated burner, Co and counter swirling domestic burners, etc.

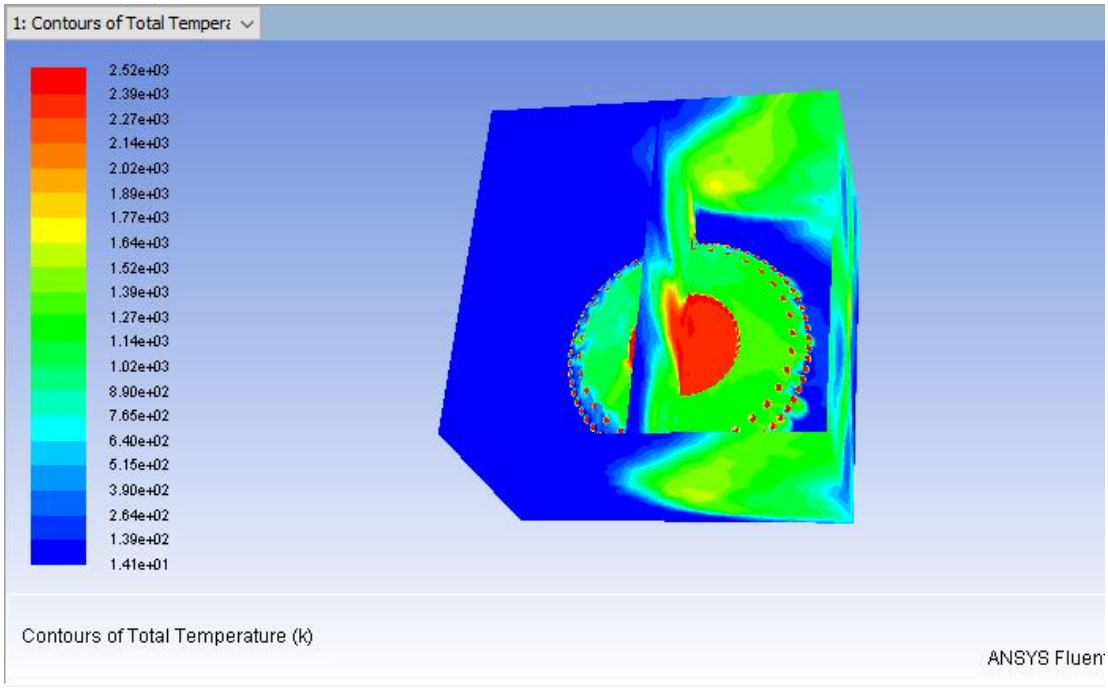

Fig -5: Contours of temperature without use of wind resistance

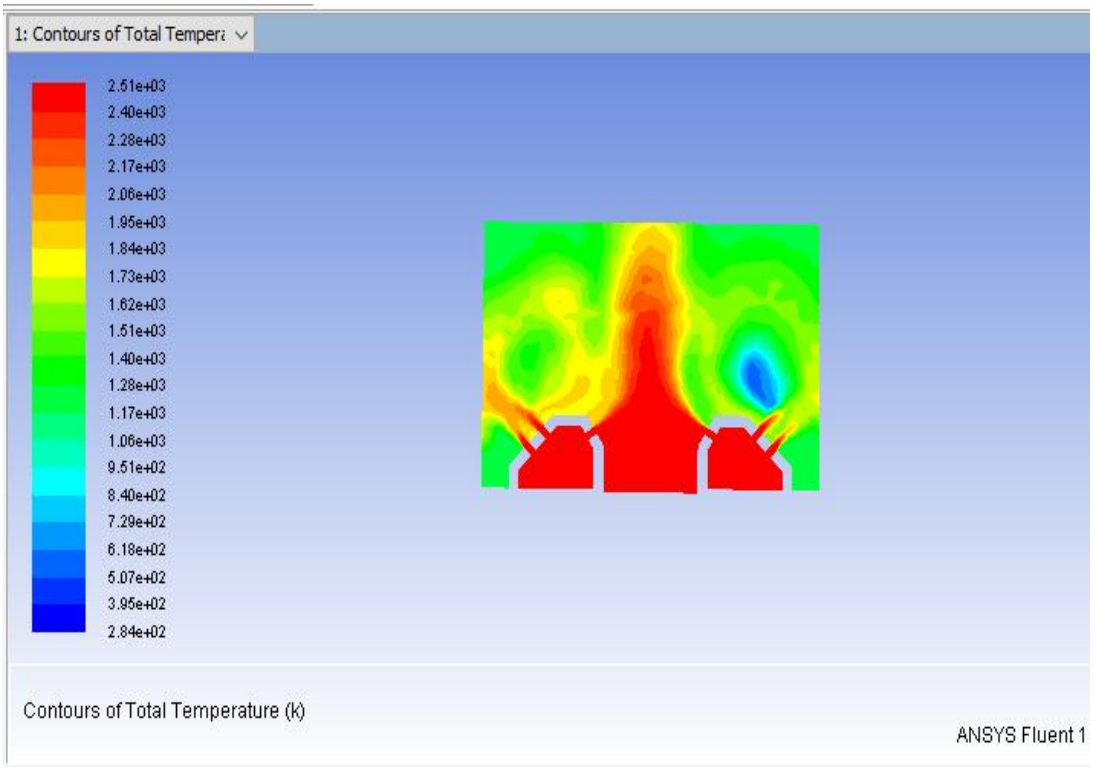

Fig -6: Contours of temperature with use of wind resistance

4. CONCLUSION

India is one of the fastest-growing countries and the economic status of people increasing day by day. So the reduction in the usage of fossil fuels is not possible. We need choices to manage this huge amount of requirement, increase the efficiency of the domestic LPG stove is the best option for that. The effect of using wind resistance and wire mesh on the LPG stove was studied. Based on the computational analysis the maximum temperature of 2345 k was observed for a burner having a wind resistance. From the results, it's clear that the atmospheric wind made an effect on the LPG stove. Similarly, from the experiment, the maximum efficiency was achieved by using wind resistance when compared to a traditional one. Also, this method can able to combine with other methods to achieve more thermal efficiency of the LPG stove.

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