

Numerical Study Of Airflow In A Conical Solar Chimney With Maroua Climate

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Abstract – This numerical investigation examines the airflow in a solar chimney with a conical geometry. The goal is to understand how the conical shape affects the flow characteristics and overall system performance. The findings indicate that conical design can enhance air velocity and minimize pressure losses, leading to improved energy production efficiency. We simulated a constant airflow in a chimney solar power plant using a mathematical fluid flow model. The influence of the wind speed at the entrance of the solar collector and the R/H radius-height ratio of the conical solar tower. We based ourselves on the Navier-Stokes equations, in cylindrical coordinates. The simulations were carried out with Maroua climate, the capital city of the Far North Region of Cameroon. We observe that the best speed is at the top of the cone and varies between 55.5m/s; 44.1m/s and 27.5m/s, for R/H ratios of 1.5; 1 and 0.4 respectively. Likewise, the best pressure recorded is 1.02.10⁵ Pa with an R/H ratio of 1.5. The temperature values are between 300K and 314K and increase from the base to the top of the conical tower. The phenomenon is favorable to the increase in speed in the same way as the conical geometry of the lathe. The speed values thus obtained are within the favorable operating ranges of mini turbines for electricity production. This research enhances our understanding of the flow physics in conical-shaped solar chimneys and offers guidelines for optimizing the design of such systems.

Keywords: Numerical study, airflow, conical solar chimney, Maroua

1. Introduction

Energy is at the heart of development and poverty reduction efforts around the world. According to [1], increasing sustainable energy services in underdeveloped countries could help combat poverty, create new jobs, guarantee education, reduce pollution, and improve human health. According to the 2020 report of the International Renewable Energy Agency Africa (IRENA), around 1.2 billion people worldwide do not have access to electricity, most of whom are in the rural areas. Nearly a billion more people only have access to an unreliable and insufficient electricity supply. The most recurring difficulties are on the African continent, where access to electricity in rural areas is barely between 10%-15% in certain cases AIE (2015). According to the 2016 Rural Electrification Master Plan in Cameroon and recent reports from the Rural Electrification Agency, the northern regions of geographical coordinates (latitude, longitude, altitude), in the Sudano-Sahelian climate, with a population of nearly 3.5 million inhabitants, remain the most isolated areas in terms of power supply in the country. However, the region is full of enormous potential in solar radiation which can make it possible to produce energy from the sun. According to assessments by the Cameroon Electricity Sector Regulatory Agency (ARSEL) and data from the Rural Electrification Agency (AER), the average sunshine in the northern part of the country is 5.8 kWh/ m² /day. Solar chimney technology presents a suitable way to harness the heat of the sun. It constitutes a more elaborate and more efficient concept than anything that has been designed to date in the field of electricity production [2]. Since 1997, several solar chimney power demonstration models have been built in Florida [3], with two improvements including the extension of the collector base and the introduction of an intermediate absorber [19], on the roof of a building in China, with a power of 5 W; in Botswana; in Brazil as well as. Overall, particular attention is paid to measuring airspeed, temperature, and solar radiation [4, 5, 6]. These results allow discussion of the relationship between average sunshine, temperature difference and speed for selected clear days. A recirculation zone of airflow at the bottom of the chimney has been observed after sunrise, whether on a hot or cold day, then the flow becomes regular inside the chimney with a maximum speed of 3m/s.[7,8,9] Have studied the mathematical model was used to predict the performance of a solar chimney power plant with a height of 20m, a diameter of 1m with a square collector of 28.5m side in the city of Aswan. The model shows that the plant can produce a maximum theoretical power of 2kw. Additionally, a CFD code was used to analyze the distribution of static pressure, and temperature inside the collector and the solar chimney under different operating conditions. [10] Conducted studies of the energy efficiency of a solar chimney power plant in the town of Tissemsilt. The results show that electricity production increases with increasing stack height and collector area. Furthermore,

the study highlighted that solar irradiation has a great influence on the production of the tower intensity and 302K ambient temperature would increase the airflow rate and the system's power output. However, they claimed that the collector radius size of 395m was the maximum power output point of the collector; increasing the collector radius length would not improve the system's performance[11]. Although significant progress has been made in renewable energy technologies, the optimal design of solar chimney power plants still poses a challenge. Yet, limited research has been done on conical geometries. The tower's shape is critical in optimizing airflow, affecting air velocity, pressure, and pressure loss, which in turn significantly impacts the system's overall performance. This study investigates the airflow in a solar chimney in conical shape. They aim is to examine the flow characteristics and assess the effect of the geometry on the overall system performance. The conical shape is modeled after traditional architecture of home in the far north region of Cameroon. This will involve starting from a mathematical formulation of the equations used in fluid mechanics with the different simplifying hypotheses to simulate the thermal and dynamic behavior of the airflow in the solar tower, conical collector.

2. Mathematical modeling

2.1. Description

Our system is a tower-collector assembly with conical geometry. Thanks to the climatic conditions of the city of Maroua (10°35'50"N, 14°18'57"E) with an average altitude of 423m [12]. At the peak periods, temperatures can reach 35°C, an average solar irradiance of 5.8 kWh/day/m² [13]. The conical chimneys can find their applications in the local architecture of houses.

2.2. Model equations

All The study of fluid dynamics is based on three fundamental principles of conservation of quantities: mass, momentum, and energy. These three fundamental principles govern the movement of air in the chimney and are described by the Navier-Stokes equations, then the equations governing the movement of air in the solar tower will be in cylindrical coordinates in a turbulent regime under the effect of natural convection. Figure 1 shows our solar collector tower device with conical geometry. The simplifying calculation assumptions will consist of considering that the flow regime will be permanent, incompressible, and asymmetric. Viscous dissipation and the work of pressure forces are negligible in the heat equation. The density of the fluid in the volume forces term varies linearly with the temperature T according to the approximation of J. Boussinesq. The physical properties of the fluid in the other terms of the equations are constant.

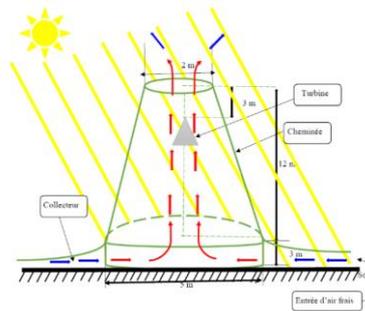


Figure 1. Device of the solar tower with conical geometry

Considering the simplifying hypotheses, mentioned above, in the equation of motion in cylindrical coordinates, we obtain the following system:

$$\begin{cases} \frac{V_r}{r} + \frac{\partial V_r}{\partial r} + \frac{\partial V_z}{\partial z} = 0 \\ V_r \frac{\partial V_r}{\partial r} + V_z \frac{\partial V_r}{\partial z} = -\frac{1}{\rho} \frac{\partial P}{\partial r} + \frac{\mu}{\rho} \left(\frac{\partial^2 V_r}{\partial r^2} + \frac{1}{r} \frac{\partial V_r}{\partial r} - \frac{V_r}{r^2} + \frac{\partial^2 V_r}{\partial z^2} \right) \\ V_r \frac{\partial V_z}{\partial r} + V_z \frac{\partial V_z}{\partial z} = -\frac{1}{\rho} \frac{\partial P}{\partial z} + \frac{\rho g(z)}{\rho} + \frac{\mu}{\rho} \left(\frac{\partial^2 V_z}{\partial r^2} + \frac{1}{r} \frac{\partial V_z}{\partial r} + \frac{\partial^2 V_z}{\partial z^2} \right) \\ V_r \frac{\partial T}{\partial r} + V_z \frac{\partial T}{\partial z} = \frac{\lambda}{\rho c_p} \left(r \frac{\partial^2 T}{\partial r^2} + \frac{\partial T}{\partial r} + \frac{\partial^2 V_z}{\partial z^2} \right) \end{cases} \quad (1)$$

We will make the equations dimensionless by using their reference quantities in the ratios of the terms of the equations. For turbulence modeling, we will use the standard ϵ -k-model of [14] with wall functions. In this model, the turbulent viscosity is evaluated from the turbulent kinetic energy k and the dissipation of turbulent kinetic energy ϵ :

$$\frac{\partial(\rho k)}{\partial t} + \frac{\partial(\rho k v_i)}{\partial x_i} = \frac{\partial}{\partial x_i} \left[\left(\mu + \frac{\mu_t}{\sigma_k} \right) \frac{\partial k}{\partial x_j} \right] + G_k + G_b - \rho \epsilon - Y_M + S_k \quad (2)$$

$$\frac{\partial(\rho \epsilon)}{\partial t} + \frac{\partial(\rho \epsilon v_i)}{\partial x_i} = \frac{\partial}{\partial x_i} \left[\left(\mu + \frac{\mu_t}{\sigma_\epsilon} \right) \frac{\partial \epsilon}{\partial x_j} \right] + C_{1\epsilon} \frac{\epsilon}{k} (G_k + C_{3\epsilon} G_b) - C_{2\epsilon} \rho \frac{\epsilon^2}{k} + S_\epsilon \quad (3)$$

The final equation system will therefore be:

$$\frac{\partial(\rho k)}{\partial t} + \frac{1}{r} \frac{\partial(r \rho k U)}{\partial r} + \frac{\partial(\rho k V)}{\partial z} = \frac{1}{r} \frac{\partial}{\partial r} \left[r \left(\mu + \frac{\mu_t}{\sigma_k} \right) \frac{\partial k}{\partial r} \right] + \frac{\partial}{\partial z} \left[\left(\mu + \frac{\mu_t}{\sigma_k} \right) \frac{\partial k}{\partial z} \right] + G_k + \beta g \frac{\mu_t}{Pr_t} \frac{\partial T}{\partial z} - \rho \epsilon \quad (4)$$

$$\frac{\partial(\rho \epsilon)}{\partial t} + \frac{1}{r} \frac{\partial(r \rho \epsilon U)}{\partial r} + \frac{\partial(\rho \epsilon V)}{\partial z} = \frac{1}{r} \frac{\partial}{\partial r} \left[r \left(\mu + \frac{\mu_t}{\sigma_\epsilon} \right) \frac{\partial \epsilon}{\partial r} \right] + \frac{\partial}{\partial z} \left[\left(\mu + \frac{\mu_t}{\sigma_\epsilon} \right) \frac{\partial \epsilon}{\partial z} \right] + C_{1\epsilon} G_k \frac{\epsilon}{k} - C_{2\epsilon} \rho \frac{\epsilon^2}{k} \quad (5)$$

The model constancies are grouped in Table 1 [14].

Table 1. Constancy of the k-epsilon model

Constancies	$C_{1\epsilon}$	$C_{2\epsilon}$	σ_k	σ_ϵ	C_μ	Pr_t
Values	1.44	1.92	1.00	1.3	0.09	0.85

Table 2 summarizes the variables, diffusion coefficients and source terms in used in this work:

Table 2. Expression of the diffusion coefficient and the source

Equation	ϕ	Γ_ϕ	S_ϕ
Continuity	1	0	0
Next Movement (Or)	u	μ	
Next Movement (Oz)	v	μ	$-\left[\frac{1}{r} \frac{\partial(r\rho u'u')}{\partial r} + \frac{\partial(\rho v'u')}{\partial z}\right] - \frac{\partial P}{\partial r}$
k	k	$\mu + \frac{\mu_t}{\sigma_k}$	$G_k + \beta g \frac{\mu_t}{Pr_t} \frac{\partial T}{\partial z} - \rho \epsilon$
ϵ	ϵ	$\mu + \frac{\mu_t}{\sigma_\epsilon}$	$C_{1\epsilon} G_k \frac{\epsilon}{k} - C_{2\epsilon} \rho \frac{\epsilon^2}{k}$
Energy	T	$\frac{\lambda}{c_v}$	0

2.3. Characteristic quantities

2.3.1. Thermal behavior of the solar tower [19]

The chimney converts the heat flux Q produced by the chimney collector into kinetic energy and potential energy. Thus, the difference in air density caused by the rise in temperature in the base-collector functions as a driving force. The pressure difference produced between the base (manifold outlet = chimney inlet) and the top of the chimney (chimney outlet) is given by equation (6). This pressure difference is called the driving pressure. Friction losses (friction of the air with the internal walls of the chimney) are neglected. ΔP_{tot} Can be subdivided into a turbine extraction component or ΔP_s represents the pressure extracted at the turbine, and a dynamic component ΔP_{dy} describing the kinetic energy of the airflow:

$$\Delta P_{tot} = \Delta P_s + \Delta P_{dy} \tag{6}$$

Using the standard definition of dynamic pressure, we obtain:

$$\Delta P_{dyn} = \frac{1}{2} \rho_2 V_2^2 \tag{7}$$

and

$$\Delta p_{tot} = \frac{1}{2} \rho_2 V_{max}^2 \tag{8}$$

We can calculate the pressure difference:

$$\Delta p_{tot} = 0,00353 gh \left(\Delta T_{1-2} + \frac{\delta_a + \delta}{2} \right) \tag{9}$$

The maximum speed is deduced from equations (2) and (3)

$$V_{max} = \sqrt{\frac{2\Delta p_{tot}}{\rho_2}} = \sqrt{\frac{0,00353 gh \left(\Delta T_{1-2} + \frac{\delta_a + \delta}{2} \right)}{\rho_2}} \tag{10}$$

The maximum power is drawn when the speed V2 is one-third of the maximum speed when the turbine is under load. The speed V2 in the chimney is expressed as follows:

$$V_2 = \frac{1}{3} V_{max} = \frac{1}{3} \sqrt{\frac{0,00353 gh \left(\Delta T_{1-2} + \left(\frac{\gamma_a - \gamma}{2} \right) H \right)}{\rho_2}} \tag{11}$$

The total power of the solar tower can be calculated from the following equation from[8]:

$$P_{tot} = \Delta P_{tot} \cdot V_2 \cdot A_{ch} \quad (12)$$

2.3.2. At the wind turbine

The turbine converts the kinetic energy of airflow into mechanical energy, and the generator driven by the turbine converts the mechanical energy into electrical energy. The pressure drop across the turbine is two-thirds the total pressure difference.

$$\Delta P_s = \Delta P_{tot} - \frac{1}{2} \rho_2 \cdot V_2^2 \quad (13)$$

The theoretical useful power at the turbine (kinetic energy of the airflow converted into mechanical energy at the turbine shaft) is given by the following relationship:

$$P_{wt} = \Delta P_s \cdot V_2 \cdot A_{ch} \quad (14)$$

The power is at its maximum value when 2/3 of the total pressure difference is used by the turbine and given by

$$P_{wt \max} = \frac{2}{3} V_2 \cdot A_{ch} \cdot \Delta P_{tot} \quad (15)$$

2.4. Numerical resolution

The Navier-Stokes equations are nonlinear equations, for which an analytical solution is not known. Also, there is a great interdependence between the thermal and dynamic fields, modeled by the energy conservation equation. To establish a numerical scheme for solving these equations, many aspects other than physical ones must be considered: This concerns the discretization of the equations. Among the most frequently used discretization methods are finite difference, finite element, and finite volume methods. This study, the finite volume method was used. Its principle is represented in Fig. 2.

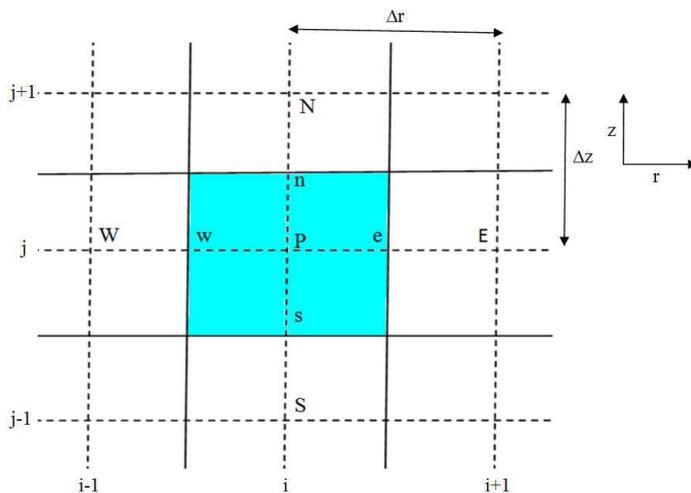


Figure 2. Finite volume method [16]

The geometry used is that of 12m, a radius of 5m and a collector height of 2.5m. At the outlet of the chimney tower, the flow is assumed to be in and established steady state. At the level of the walls, the condition of non-slip and impermeable walls is imposed. In the axial direction, the component, v of the speed is zero. As buoyancy forces induce the flow Since the flow, the component, u , of the velocity in the radial direction is unknown. The latter is determined using a mass balance at

each iteration, until the results converge. The air is at ambient temperature at the collector inlet. The ground temperature is fixed.

3. Results and discussion

The validation of the numerical results of our work was done by comparing the results of the numerical study of [17]. We observe similarities in the air velocity profile in the solar chimney. The calculation domain as well as the boundary conditions used are depicted Table 3.

Table 3. Calculation domain and boundary conditions.

Position	Kind	Value
Base	Ground temperature	T=300K
Entrance	Air speed	V= 3m/s; 3.5m/s; 4m/s
Aluminum walls (adiabatic)	Heat flux	W= 1003W/m ²
Entrance	Pressure	P=10 ⁵ Pa
Exit	Temperature	Outflow

3.1. Study of mesh sensitivity

Fig. 3 represents the physical domain after meshing. The mesh topology is hexahedral. As we can see, the mesh used is a set of cells (see Table 4). It is densified to consider the effects of temperature gradient, pressure, and wind speed.

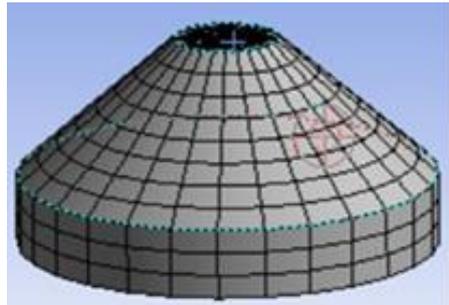


Figure 3. Mesh of conical-shaped solar chimney

Table 4. Testing the sensitivity of the solar cone mesh.

	Number of cells	Number of faces	Number of Nodes	speed (m/s)
Test 1	2673	8416	3096	55.5
Test 2	30096	110928	80832	44.12
Test 3	128521	439632	182626	44.1
Test 4	515145	1765200	734948	44.1

We see that, the more we increase the mesh, the more its impact on the maximum speed is negligible. Of some of faces close to 400,000, the sensitivity of the result on the mesh is no longer observed. The choice of mesh is a good compromise, and the results that will be presented later are those of this mesh. This is very important for our numerical simulation and constitutes a logical orientation in the choice of the mesh within the framework of our study. We therefore opt for the characteristics of mesh 3.

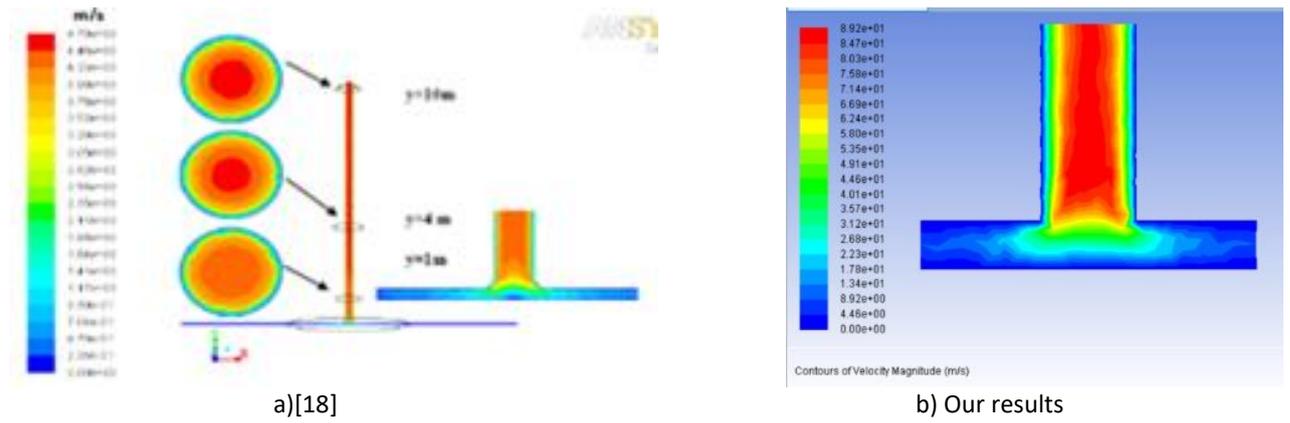


Figure 4. a) the results of [18] and b) our results

3.2. Study of the dynamic field

We present here the results of the dynamic fields for different values of the wind speed at the entrance to the collector of the conical solar tower.

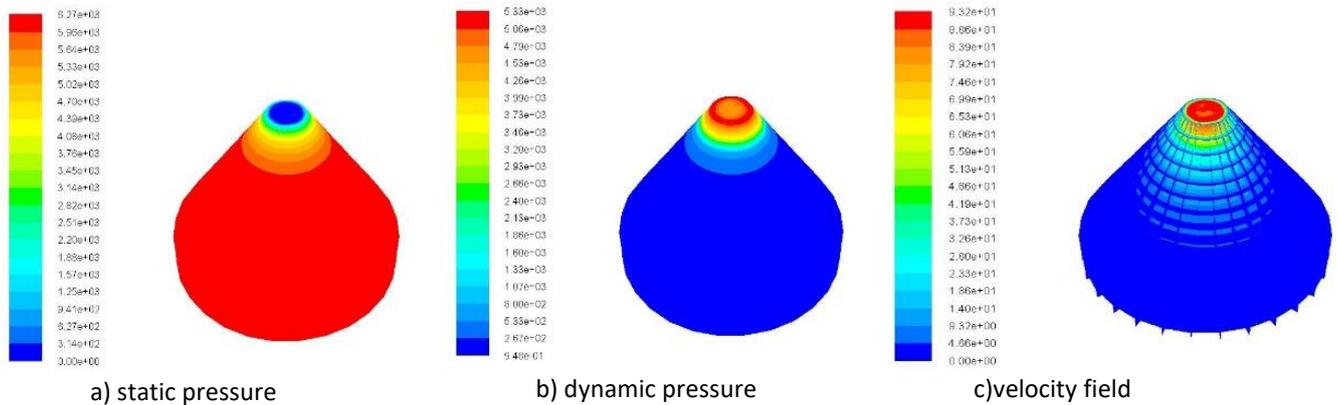


Figure 5. Dynamic fields for different speed values in the solar tower at $V=3$ m/s.

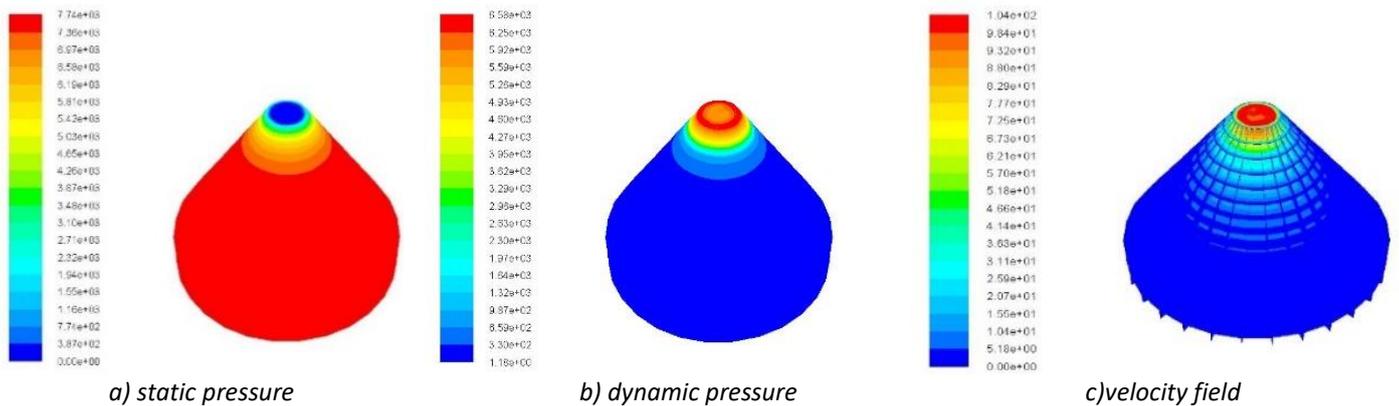


Figure 6. Dynamic fields for different speed values in the solar tower at $V=4$ m/s

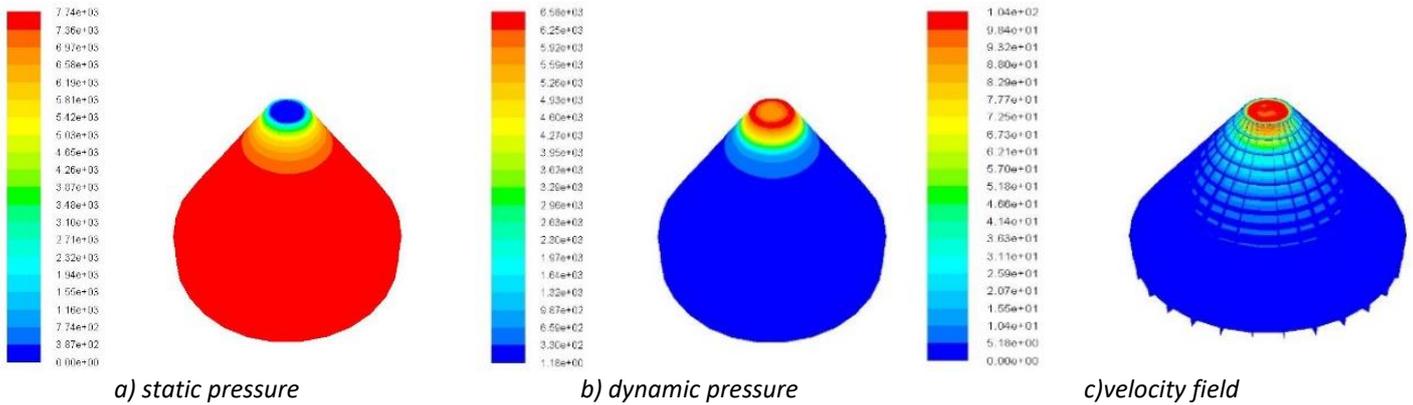


Figure 7. Dynamic fields for different speed values in the solar tower at $V= 4.5$ m/s

For a wind speed at the collector inlet of 3m/s, the static pressure field is very dense (for a maximum value of $5.27 \cdot 10^3$ Pa) from the collector up to 10.2m height of the chimney, and afterward it begins to drop drastically until reaching a pressure $3.14 \cdot 10^2$ Pa. On the other hand, we observe the opposite phenomenon for the profile of the dynamic pressure field where it is very dense at a certain height of the chimney until at the top of the conical solar tower with a maximum value of $5.3 \cdot 10^3$ Pa. But this dynamic pressure begins to decrease up to the solar collector where the pressure is 94.8 Pa. This creates a pressure difference between the static and dynamic pressure thus increasing the speed of rise of the air in the chimney thanks to the chimney effect. This pressure difference is the driving force behind the solar chimney.

For the velocity field of the conical solar tower, the air being sufficiently heated in the solar collector by solar radiation, reaches a speed of 4.66 m/s towards the center of the collector which will trigger natural convection. A temperature gradient thus created between the top of the conical solar tower and the collector causes an upward movement of the air, thereby creating the thermosyphon phenomenon.

In the case where the wind speed at the entrance of the solar collector is 4 m/s, we observe the same profiles for the static pressure field, dynamic, and airspeed in the solar chimney. But for static pressure, the maximum value is $7.74 \cdot 10^3$ Pa from the base of the collector to a certain height of the chimney. This pressure drops towards a certain height of the chimney until it reaches a value of $3.3 \cdot 10^2$ Pa at the top of the chimney. For the dynamic pressure, it is $6.5 \cdot 10^3$ Pa. At the top of the conical solar tower and begins to drop to 1.18 Pa. At the top of the chimney, this pressure difference will increase the chimney effect, accelerating the movement of air in the solar chimney. For the velocity field, the air mass in the solar collector is heated by solar rays which triggers the phenomenon of natural convection. The phenomenon remains the same for a wind speed of 4.5 m/s at the entrance to the solar collector. We observe almost the same profiles in the work of [9] but he instead uses the model of the prototype of Manzanares. Likewise, the work of [17] also used the model of the Manzanares prototype to illustrate the distribution of speed, pressure and temperature inside the collector and the solar chimney.

3.3. Study of the thermal field

Figures 8 and 9 below are the different profiles of the thermal field at the external and internal walls of the conical solar tower for different values of wind speed (3 m/s; 4 m/s; 4.5 m/s). At the entrance to the solar collector. The gives us the profile of the different thermal fields in the collector and the chimney for different values of the speed at the entrance to the collector. We notice here that, for the external wall of the solar cone, the air is heated by absorption of the solar flux in the collector and with the phenomenon of natural convection, it begins to rise towards the chimney where this air is naturally absorbed by the chimney, it will continue its ascent and becomes increasingly hotter, hence the temperature of the external wall begins to densify to reach values of approximately 314 K. The temperature profiles are identical for all dynamic fields. As the speed of the air does not influence the temperature, but on the other hand, the speed increases with the increase in solar irradiation.

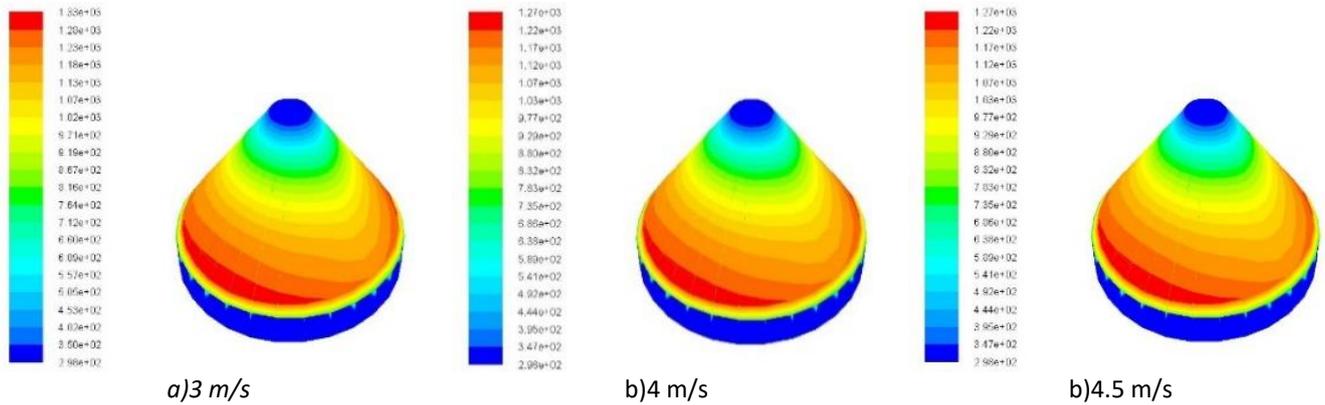


Figure 8. Thermal fields on the external wall of the tower

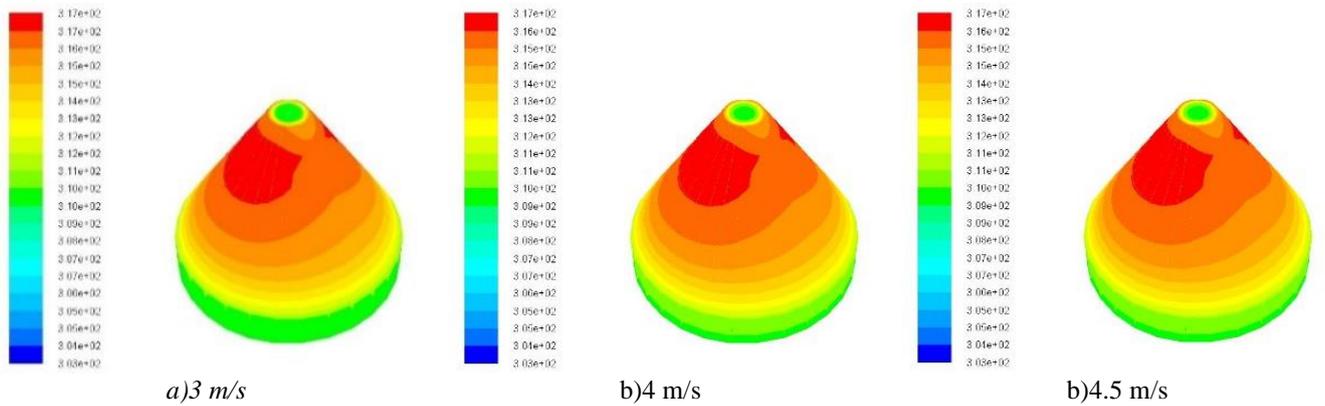


Figure 9. Thermal fields on the internal wall of the tower

3.4. Influence of the R/H ratio on the flow in the solar tower

In this part, it is a question of varying the R/H ratio, and of showing its influence on the dynamic and thermal fields. This ratio is particularly important, as the study could be applied in the architecture of conical roofs encountered regularly in the study area. Thus, additional energy recovery would be possible.

3.4.1. Study of speed fields.

The graphs in Figures 10, 11 and 12 illustrates the speed profile in the solar chimney for different values of wind speed at the entrance to the collector, namely: 3m/s; 4 m/s; 4.5 m/s representing the wind averages in the North Cameroon region. On these 3D profiles of the velocity field of the evolution of the air in the conical solar collector tower, the air enters the collector with a speed of 3 m/s where it is sufficiently heated by the solar rays; then it begins to rise towards the chimney thanks to the phenomenon of natural convection and arrives at the center of the chimney with a speed of 20.4 m/s because the air is absorbed naturally towards the chimney then it evolves thanks to Archimedes' thrust until it reaches 37 m/s where it is at its maximum at the top of the cone.

We observe an evolution from the center of the collector towards the top of the chimney, going from 1.85 m/s to 37 m/s towards the top of the conical solar tower. However, for a speed of 4 m/s at the entrance to the collector, we can also notice that the speed of the air as a function of the height of the solar tower is 2.47m/s toward the center of the conical solar tower at 49.4 m/s at the top of the solar tower. Also, we see that the wind speed becomes more and more important with the initial speed at the entrance to the collector. Finally, for a wind entry speed at the entrance to the collector of the conical solar tower

of 4.5 m/s, we also notice an increase in airspeed as a function of the height of the solar tower. Passing from 2.78 m/s towards the center of the base of the collector to 55.5 m/s at the top of the tower where the speed is at maximum.

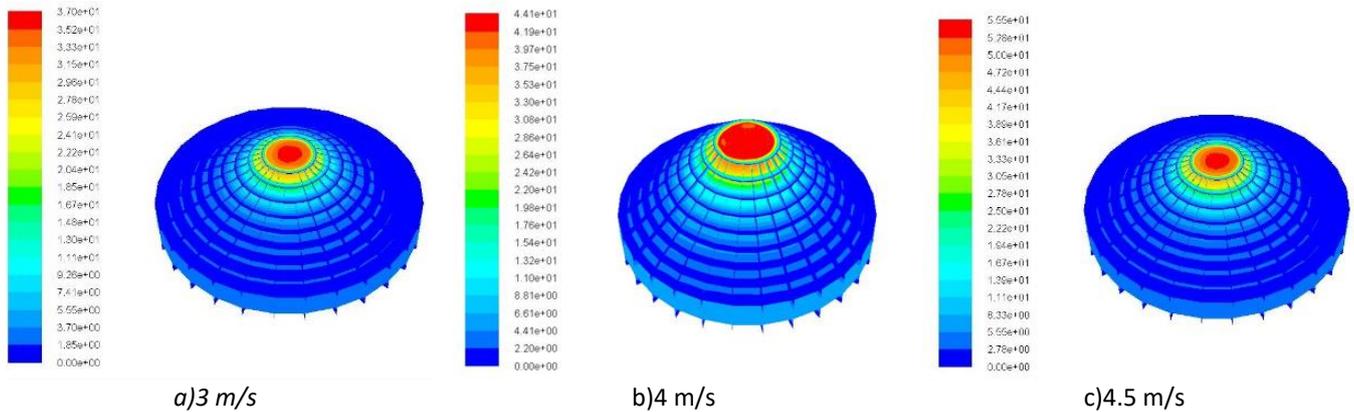


Figure 10. Speed profile, for different values of input speed for R/H =1.5

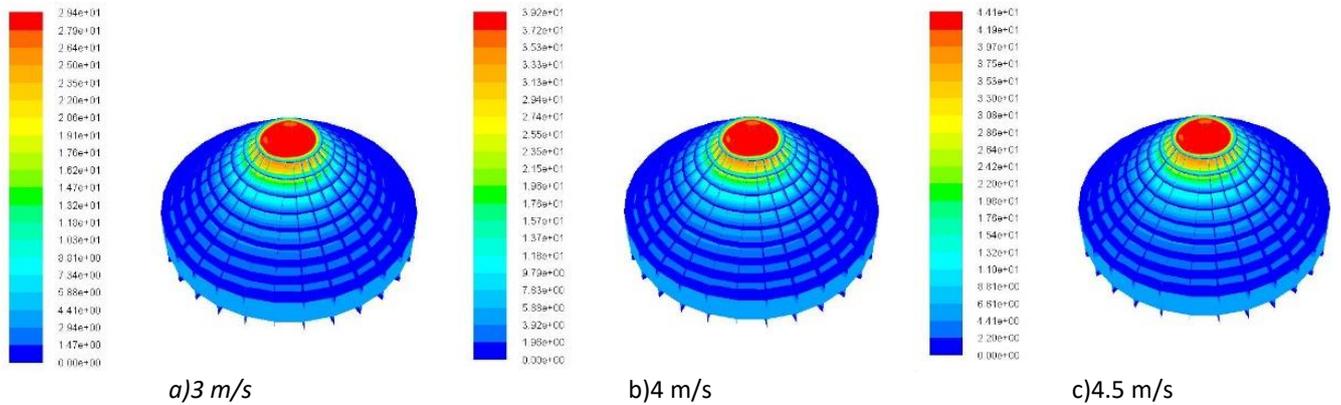


Figure 11. Speed profile, for different values of input speed for R/H =1

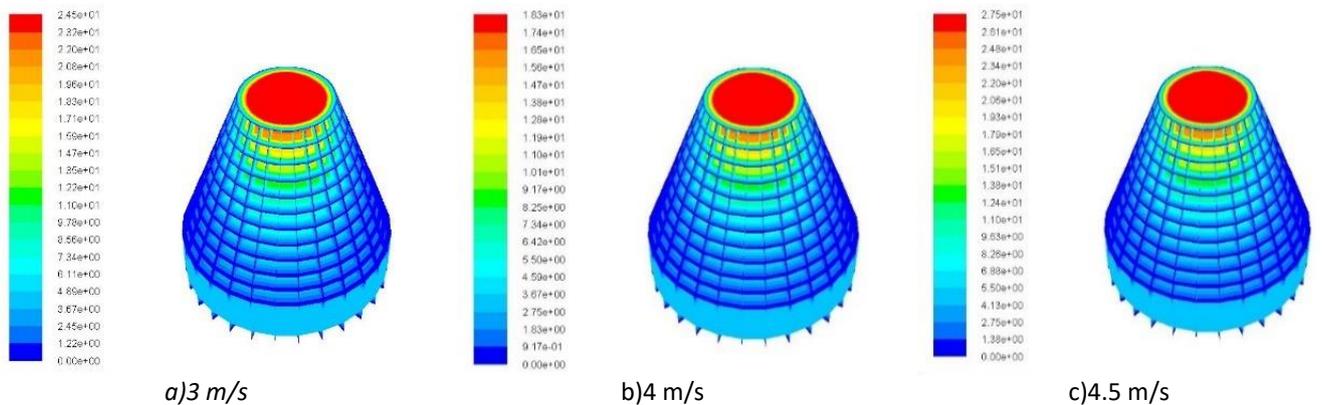


Figure 12. Speed profile, for different values of input speed for R/H =0.4

We also note that the speed at the entrance to the collector drops towards the center of the tower before increasing as a function of height up to the top of the tower where it becomes more significant. From all these remarks, we can observe that the air speed in the conical solar tower is greater at the top of the cone, which is very conducive to the installation of our turbine, because at this point, the values of the airspeed is significant namely: 37 m/s; 49.4 m/s and 55.5 m/s. The air particles

heated at the base in the solar collector become less dense due to their thermal expansion and rise under the action of Archimedes' thrust. This is the phenomenon of natural convection.

3.4.2. Study of static temperature fields

Figure 13 and 14 below gives the contours of the static temperature field in the conical solar tower for different values of the wind speed at the entrance to the solar collector.

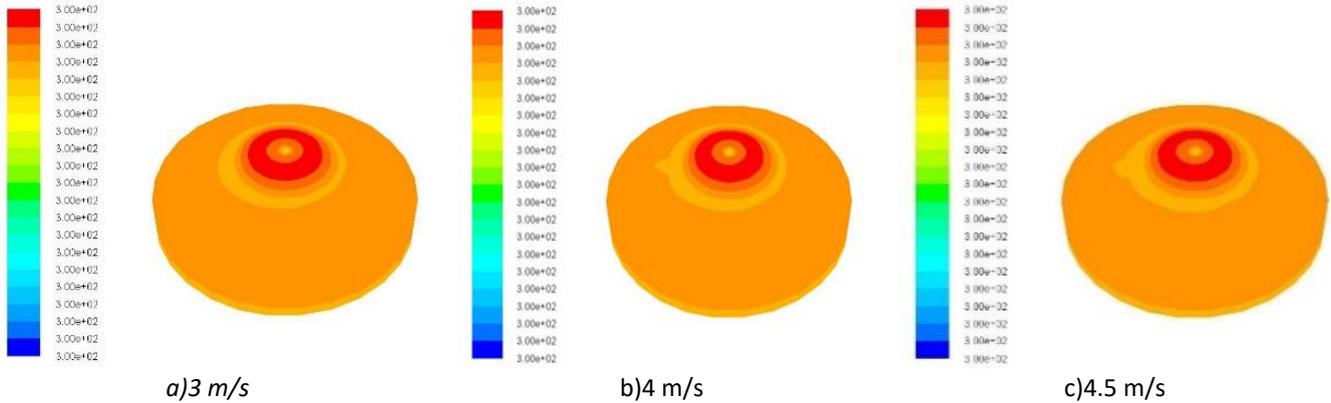


Figure 13. Static temperature contours for different speed values for R/H =1

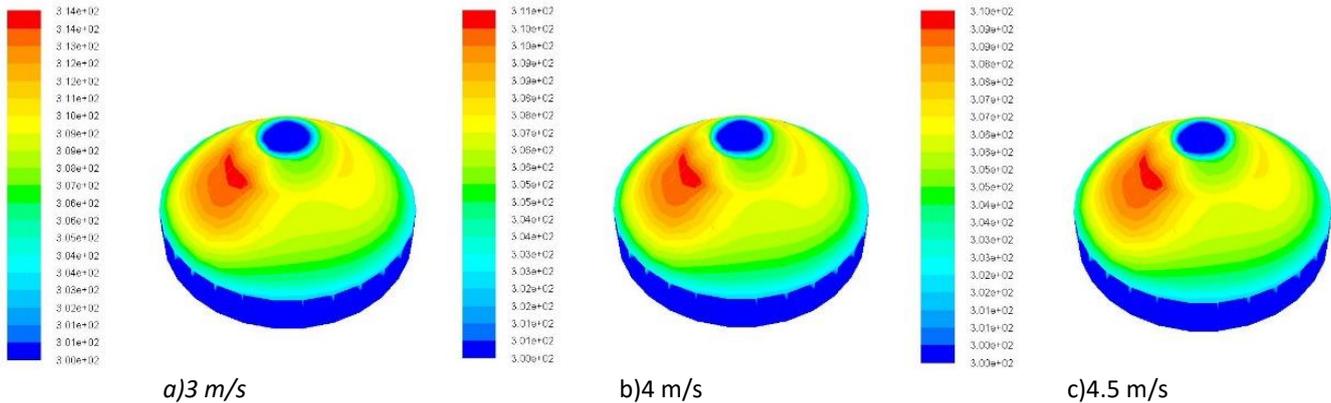


Figure 14. Static temperature contours for different speed values for R/H =1.5

It was noticed that or it could be seen that the temperature remains very constant from the collector to the top of our conical solar tower for the three contours of the temperature fields whatever the wind speed at the entrance to the collector. The maximum temperature reached is around 300K. We notice that the profiles of the different temperature contours are similar. Thus, it can be noted that the air inlet speed does not greatly influence the temperature in the conical solar tower. Whatever the value of this at the collector inlet, we can obtain significant temperatures in the conical solar tower necessary for its operation.

3.4.3. Study of Static pressure fields

Figures 16 and 17 present the contours of the static and dynamic pressure in the solar tower for speeds at the inlet of the collector of the conical solar tower chosen respectively at 3 m/s, 4 m/s, 4.5 m/s and at R/H ratio values of 1.5 and 1 as well. We can notice that the static pressure varies little with the increase in wind speed at the collector inlet. 1.01.10 5 Pa as the maximum pressure with 3 m/s at the inlet, and 1.02.10 5 Pa, as the maximum static pressure for the two other values of the

air inlet speed at the collector. However, we can also notice that the static pressure is very high from the collector up to a height of 7.5m of the conical solar tower, and then it begins to drop towards the top of the cone 105 Pa. Thus, we note that the airspeed at the entrance of the solar collector influences the efficiency of the conical solar tower.

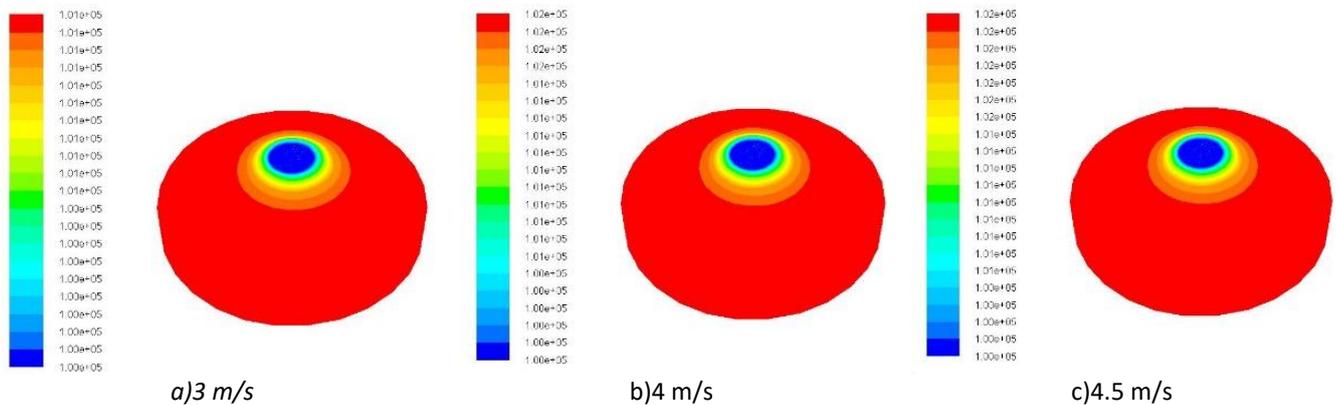


Figure 15. Static pressure contours for different speeds for $R/H = 1.5$

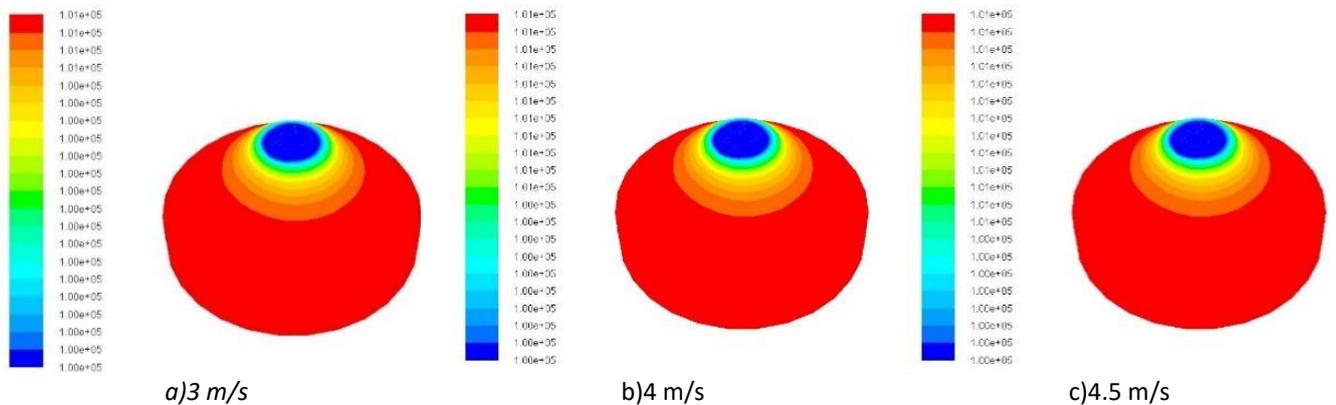


Figure 16. Static pressure contours for different speeds for $R/H = 1$

4. Conclusion

Renewable energies are considered the most attractive sources of energy for their renewable aspect and their ecological virtues. Solar energy therefore stands out for its universal free availability and its density in certain regions of the world, particularly in sub-Saharan Africa. The Far North Cameroon region with its strong solar potential and good wind speed values is an ideal area for the implementation of solar energy technologies, particularly solar tower power plants. After a brief review of our work, the objective was it was to carry out steady-state modeling and simulation of the airflow in a solar tower with a conical geometry collector and Aluminum absorber. To do this, we have carried out a state-of-the-art on solar chimney power plants. Due a steady-state mathematical modeling of the Navier-Stokes equations in cylindrical coordinates, we modeled the airflow in the solar tower. For our simulations, we used the Ansys Fluent numerical simulation software. Considering the ratio R/H radius of the base on the height of the collector tower, and for different values of the wind speed at the entrance to the collector, the speed fields, static and dynamic pressures, as well as the field of temperature are generated. From these simulations, it appears that the maximum speed is observed at the top of the lap with an R/H ratio of 1.5. A construction taking this parameter into account could allow easy operation of a turbine at the outlet of the tower and thus contribute to reducing the energy deficit. Thus, solar chimney power plants with the conical model could be exploited to produce electricity even on a small scale while respecting the R/H ratio. The electrical energy produced by a conical solar chimney that can be manufactured in the field can meet in the settlement where it is located 2.3MW compared to the Manzanares which was 50KV.

