Designing Cooling Water System for the Main Tank at Homes using renewable energy

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Abstract

Investigate the possibility of designing and fabricating a water cooling system for the main tank using renewable energy (solar panel). This research explores a different, varied and widely used first-class global practice for reducing the heat of water used in residences, hotels, and organizations. Understanding the applied metrics that are used to describe the performance of water-cooling using renewable energy, which in turn describes the components of water pipes and how the water flows within those pipes and is circulated in such a cooling system, which regulates the application on a regular basis and adheres to best practices. In addition, this project discusses the primary source of hot water as well as the advantages of using it for water-cooling. Some public water bodies spent large sums of money on facilities and numerous contracts to determine the causes of water heat, review the appropriate findings, and send them to the water sector for better monitoring and verification of the water-cooling system. The research addressed some studies and challenges that cause this temperature, and its forms vary depending on the circumstances that it follows, as all studies have shown that one of the real causes of hot water is due to sunshine and a hot climate in the summer, with a maximum temperature of about 50 degrees Celsius. This factor cannot be managed, but it can be assessed by adding a water-cooling system to the main tank, allowing the project's performance to be measured in terms of lowering water temperature while still accounting for secondary causes. This new design implements a new methodology for reducing water temperature by circulating water from the main tank through special renewable energy systems that absorb hot water in a short period.

Literature review

Cooling systems define the individual components of the cooling system, not the whole system. New cooling water systems must be designed and operated taking into account all the fundamentals and components of the cooling system due to interactions between the cooling water networks and the performance of the cooling radiator. In recycling cooling water systems, all cooling water is supplied from the cooling radiator to a network of chillers that usually have a parallel configuration. However, reuse of cooling water between different cooling tasks allows home cooling water systems to be designed in sequential arrangements. This allows for better radiator cooling performance and increased radiator capacity cooling, both in the context of a new design or a retrofit. A methodology for designing cooling networks has been developed to meet any cold tower supply conditions. The water-cooling system performance model for the main tank in homes allows the interactions between cooling tower performance and the design of cooling water networks to be systematically explored. (S.Palani, 2016)

1. Problems in Existing Cooling System

1.1 Pipe Defects

Hardened pipe will become brittle and will break and leak. Under the pressure during the circulation of cool-ant water through inflated pipes may losses its suppleness and causes crack and leakage of coolant water.

1.2 Head Loses in Pipe

Inlet pressure is 1 bar, inner diameter of pipe is 0.035m and length of the pipe is 0.850 m.

$$P = \varrho * g * h$$

1.3 Losses in Pipe Flow

- **Major Losses**

According to Darcy Weisbach‘s equation the head loss for a flow across a pipe is given to be

$$\Delta h = f*l*v^2 / 2 * g * d$$

Where, f is Darcy friction coefficient, l is length of the pipe, v is velocity, g is the gravity force and d is pipe diameter.

- **Minor Losses in Pipe**

The minor losses in this case is mainly due to bends in the pipe, let us discuss upon it. In the previous pipe arrange-ment we could see a four elbow 50 degree bends and hence the losses are given as,

$Hb = K * v^2 / 2*g$

Where, K is loss coefficient and the value depends upon the angle of bend, V is velocity across the flow. The value of K for the elbow plain 50 degree

1.4 Pipe Material: Aluminum

➢ *Pipe Weight Calculation*

1. Volume of pipe (v) = $\prod/4*(D_1^2 - D_2^2)*L$
2. Where, D_1 is 0.045m, D_2 is 0.035m, L is 0.06m, Mass of the pipe (m) =v*ρ,
3. Density of aluminum = 2860kg\m³ and weight of the pipe (w) = m*g.,
4. Weight of aluminum pipe (w) is 0.89kg ,
5. Cost of aluminum = 224/kg
6. Cost for making existing design = 0.89*224 = 200.

Table 1-1 Material properties of mild

% of carbon in steel	Density In $10^3 Kgm^{-3}$	Thermal Conductivity in $Jm^{-1}k^{-1}s^{-1}$	Thermal Expansion in $10\text{-}6k^{-1}$	Young's Modulus in GNm^{-2}	Tensile strength in MNm^{-2}	% of Elongation
0.20%	7.8600	50	11.7000	210	350	30
0.40%	7.8500	48	11.3000	210	600	20
0.80%	7.8400	46	10.8000	210	800	8

1.5 Solar Panel

The GP-PV-80M Solar Module is by Go Power! he is the solar module and monocrystalline module are of high efficiency it provides a very distinguished, powerful and cost-effective performance. Solar energy, as we show in the table 2, all the characteristics required in this project it, with required domination, also features a limited warranty for all outlets for more than 25 years.

Table 1-2 Solar panel properties

Solar cell type	Monocrystalline
Output power	80W
Maximum Power Voltage (Vmp)	18.4 V
Maximum Power Current (Imp)	4.35 A
Open Circuit Voltage (Voc)	22.8 V
Module efficiency	17.30%
Connectivity	MC4 connectors
Frame type	Clear anodized aluminum frame
Maximum System Voltage	600VDC
Dimensions	13.58 x 18.50 x 0.98 in / 345 x 470 x 25 mm
Weight	3.97 lb (1.8 kg)
Warranty	25 years power output (module)

Methodology

This type of cooling system is employing in recent home. Coolant water presents in the system circulated by pipes through water passage in the head .The heat generated by direct sun shine is absorbing by coolant water method of heat conduction. The hot coolant water allows into the radiator for cooling The radiator is connected by the pipe for flexible operation. the hoses are tightly fitted by using pipe clip. The radiator pipe should able to withstand and carrying hot water in the system. As Figure0-1 show.

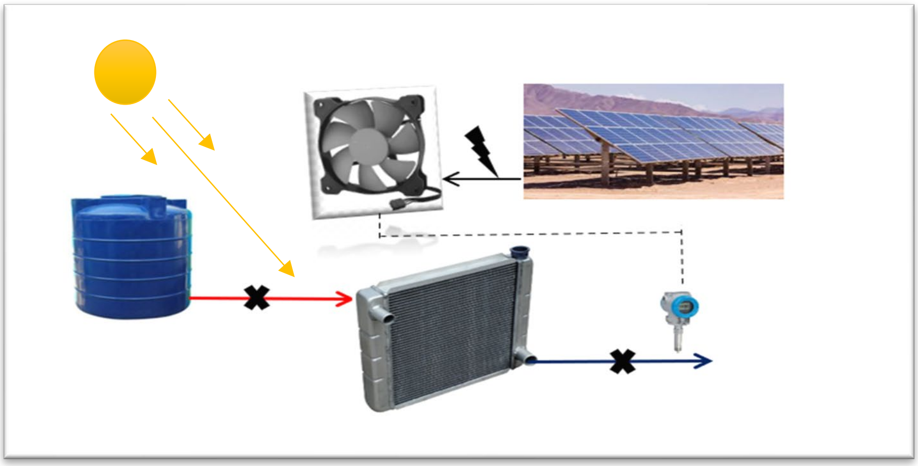

Figure 0-1 cooling system

2. Materials

2.1 Radiator in Cooling System

The schematic of radiator in cooling system is shown in Figure 2-1.

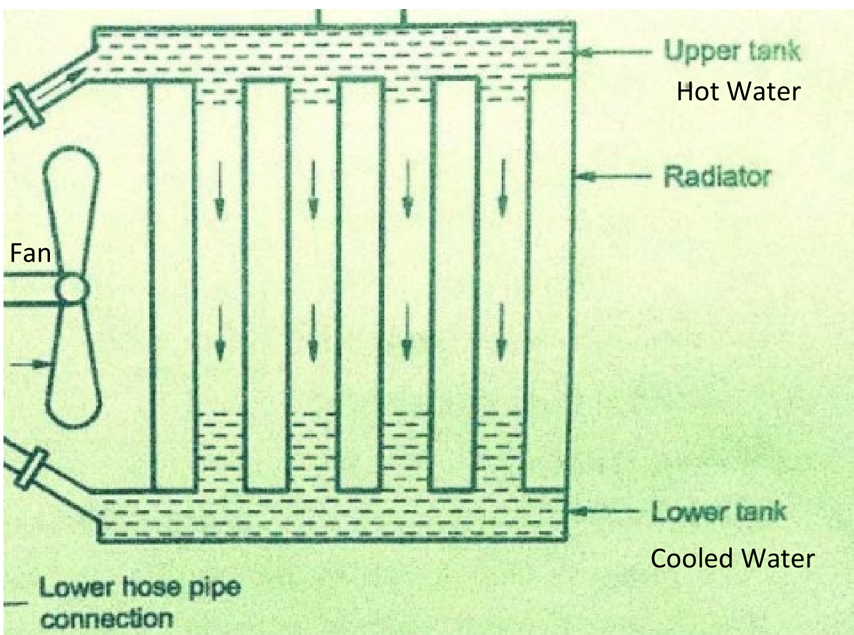

Figure 2-1Radiator in cooling system (EnggStaff, 2019)

The radiator is located in front of the tank It has a top and bottom tanks to accommodate coolant water. The cooling fins in the form of tube are arranged vertically in between showing Figure 1 . When the sun attains above normal temperature allows the coolant water into the radiator top tank. Then coolant water flows to the bottom tank of the radiator via cooling fins. The heat presents in the coolant water transfer to the atmosphere by conduction and convection methods by the fin materials and cooling fan air respectively. Thus the radiator is acts as a heat exchanger of the cooling system in tank

2.2 Piping in Existing Cooling System

Because in these types of design fin hardware there will be coolant leakages occurred. It uses too many parts to connect the pipes and hoses in the cooling system. In this design there is more number of bends which leads to losses in pipe that will affect the cooling efficiency. Then the pipe material is aluminium which is more cost and it have blowholes while moulding that also leads to coolant leakage. It is not feasible to manufactures while in assembly section and not easy for customers while replacing it. This design is doesn’t withstand for the long period of life as showing at. Figure 2-2

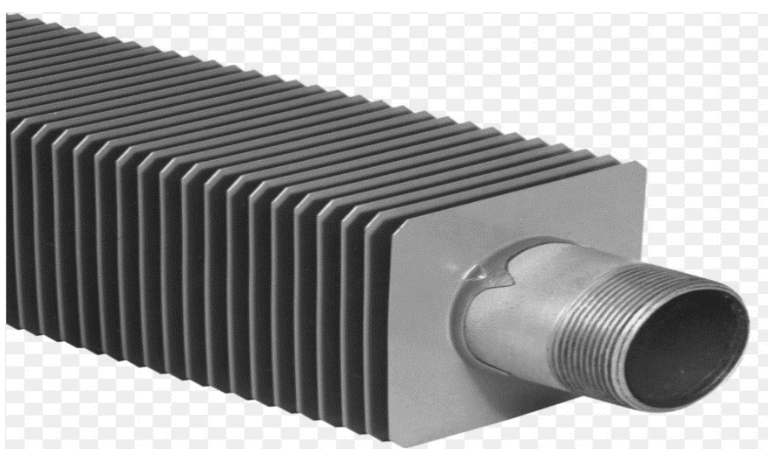

Figure 2-2 *Existing cooling system piping fin hardware (CleanPNG, 2021)*

3. FE analysis

3.1 Analysis of cooling radiator

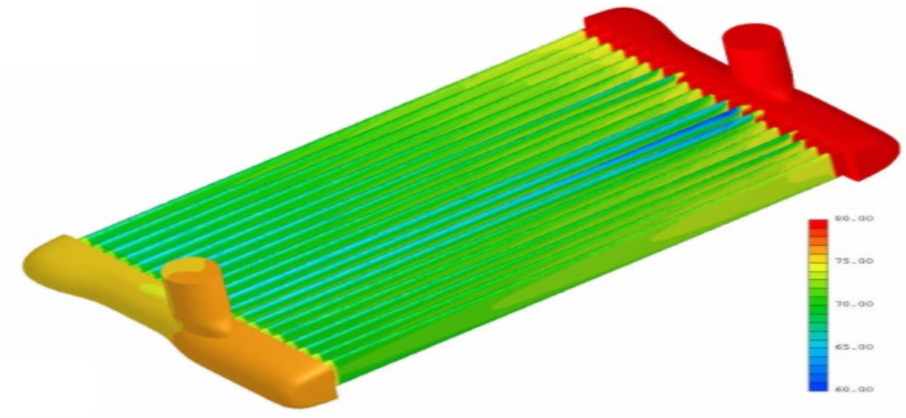

Figure 3-1 Temperatures on the walls on the radiator [°C]

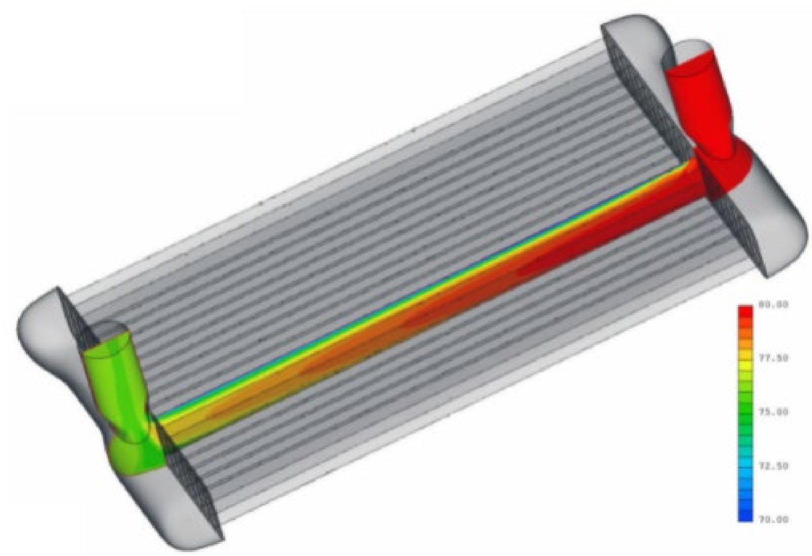

Figure 3-2 Temperatures [° C] in a plane intersecting a tube located in the middle of the row   of tubes on the radiator

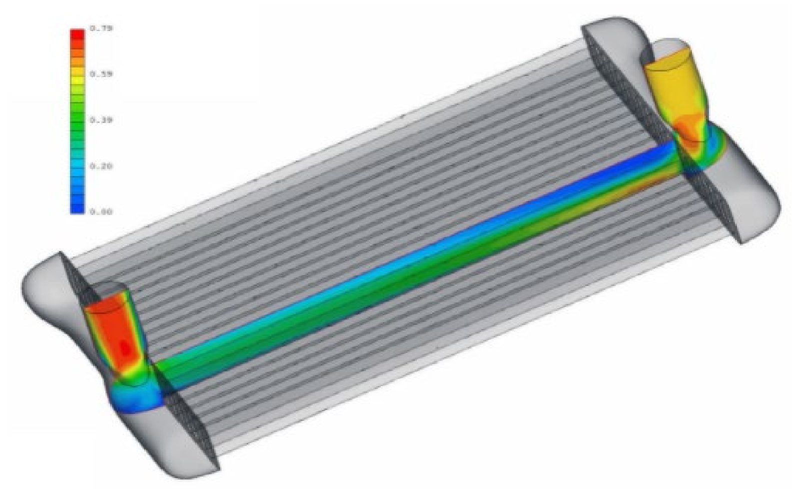

Figure 3-3 Temperatures [° C] in a plane intersecting a tube located in the middle of the row of tubes on the radiator

3.2 The Simulation results of cooling Radiator

The temperature profile on the radiator walls shows an identical decrease in temperature on all the tubes between the inlet and outlet manifolds. This suggests, on the whole, a homogeneous supply of the tubes. An area is observed on the tubes where the temperature is lower in the axis of the inlet / outlet pipes. Indeed, the circulation in the tubes in question has velocity separations, and an accelerated flow opposite the inlet pipe. The heat exchange rate on the hot side in this zone is therefore less efficient and the heat exchange on the outside (cold side) side has an increased relative importance compared to the rest of the tubes. As a result, the temperature decreases.

3.3 Analysis of cooling Fan

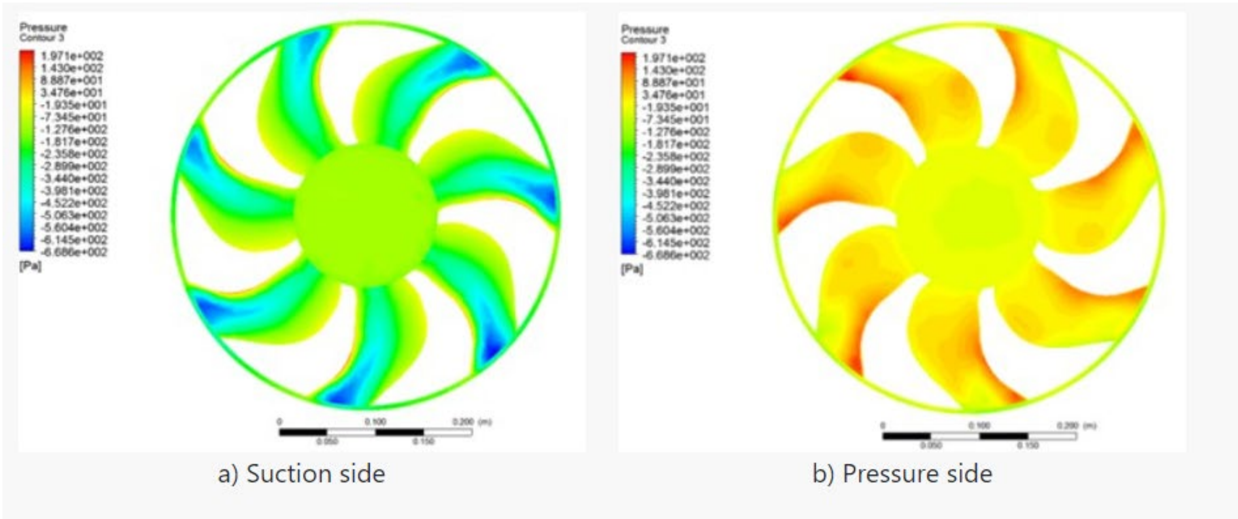

Figure 3-4 Pressure field on fan surface

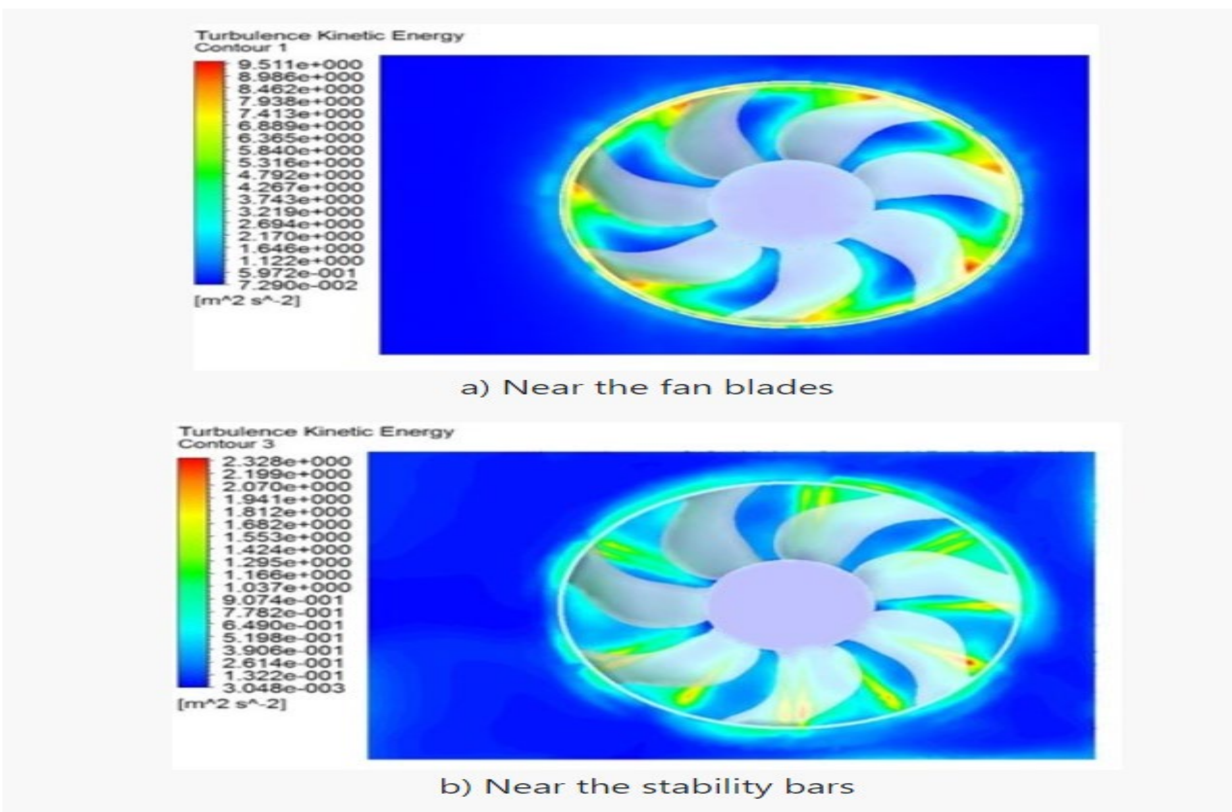

Figure 3-5 Turbulence kinetic energy

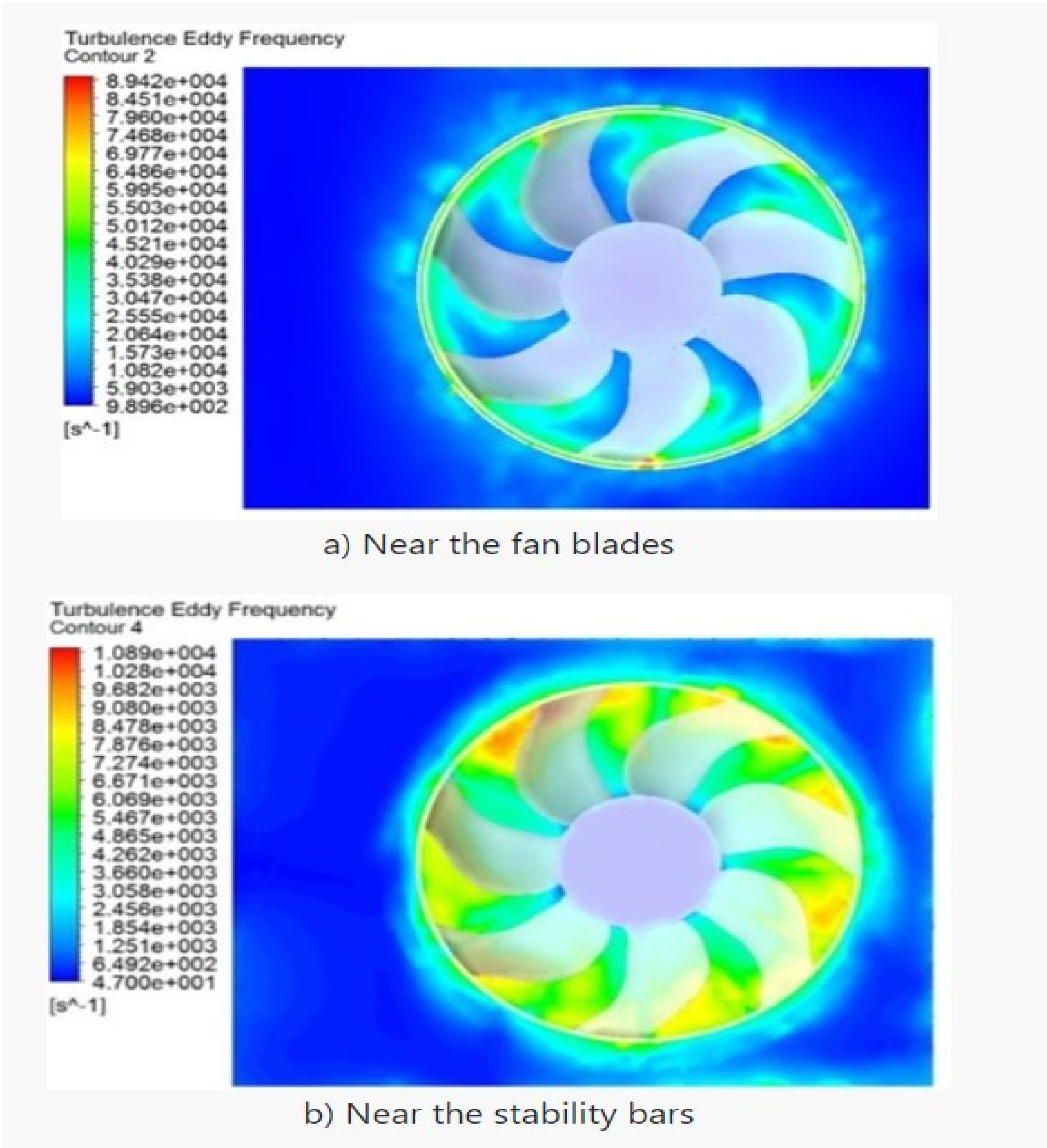

Figure 3-6 Turbulence eddy frequency

3.4 The Simulation results of Cooling Fan

A complete cooling fan module CFD model is established using Large Eddy Simulation (LES) to capture the fan sound source information in three cases. Considering the impact of fan shroud for sound propagation, a boundary element method (BEM) model is set up for cooling fan module aerodynamic noise prediction. Finally experimental verification is taken. Conclusions are as follows:

1) Fan shroud impediment to air flow makes the blade surface pressure fluctuations increasing so that the aerodynamic noise increases.
2) The sound field is with strong axial dipole characteristic at low frequencies while axial deflection occurs at high frequencies.
3) Tonal noise is major part of the aerodynamic noise at high rotation speed.
4) At the same receiving point, tonal noise and broadband noise increase with the rotation speed.
5) The aerodynamic noise prediction is accurate, which can provide a reference for low-noise design.

3.5 Analysis of Pipe

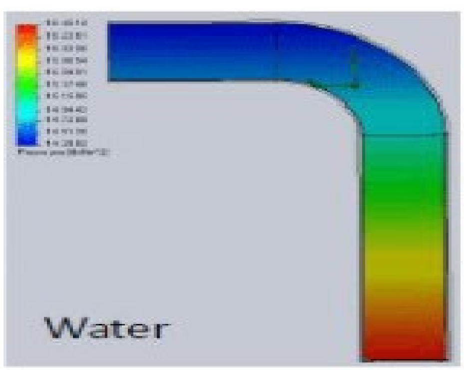

Figure 3-7Pressure Distribution

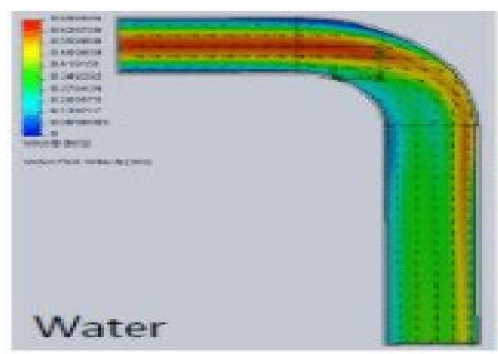

Figure 3-8 Velocity filed

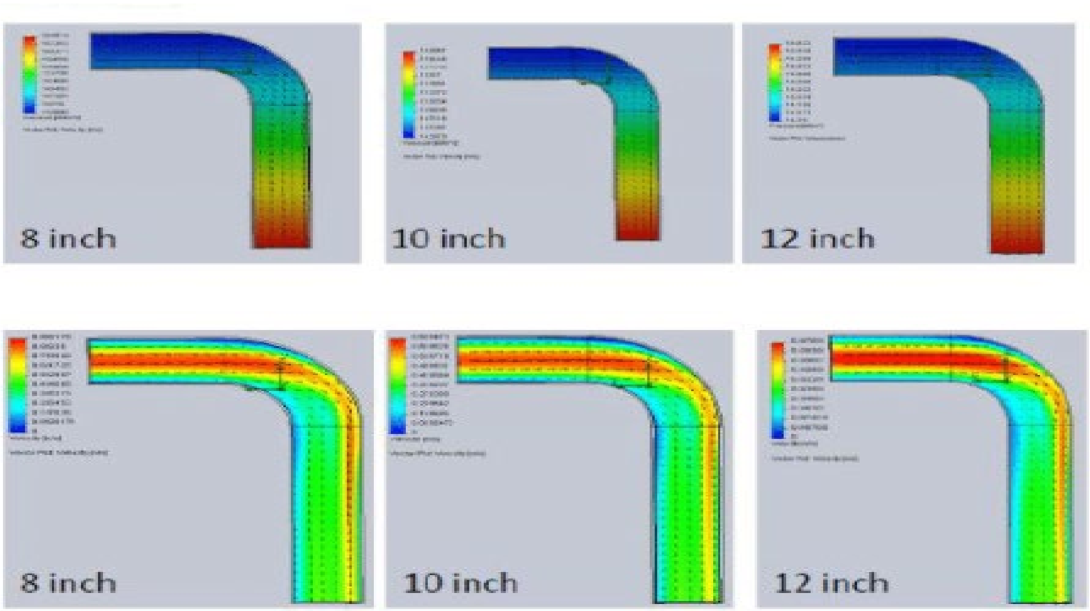

Figure 3-9 Model with diameter size variation:

Table 3-1 The sensitivity of Pressure difference to Elbow diameter size

Diameter (inch)	**Pressure Difference (CFD Model)**	**Pressure Difference (Analytical Solution)**	**Error %**
8	0.1863	0.1875	0.65%
10	0.2292	0.2343	2.22%
12	0.2652	0.2740	3.2%

Table 3-2The sensitivity of Pressure difference to flow property variations

Diameter (inch)	**Pressure Difference (CFD Model)**	**Pressure Difference (Analytical Solution)**	**Error %**
Water	0.22906	0.2343	2.23&

3.6 The Simulation results of Pipe

The paper was carried out of two stages. First one was to study and investigate the sensitivity of pressure difference and distribution to the change in Elbow geometry. The results show that pressure difference increased with increasing in pipe diameter. In this paper, the error between the analytical solution and CFD outputs ranged from 0.65% to 3.2%, the larger pipe size giving larger errors. The high accuracy in present model may due to using high level of refining CFD mesh.

The second stage of this paper was to study the sensitivity of pressure difference to changing of fluid type. The results show that the pressure difference increase as the fluid transmit from gas to liquid phase. The error between the analytical solution and CFD outputs ranged at 2.23% of the water. The results show that errors in Elbow meter was not depend on pipe geometric only but it also depend on the fluid which might be used. The results also recommend that in industries which used steam and liquid flow, elbow meter can give a good accuracy according to this study.

Conclusion

The existing piping in cooling system of the thank modified with reduced number of bends, number of connecting hoses and also the material is changed from aluminium alloy to mild steel. The proposed design would benefit with coolant leakage elimination by reduction in hose defects, reduced head loss, cost reduction and improved life of piping system. We have reached a goal that makes us hope that the problem will be solved and help to make hot water in use in our daily life, and if all the scientific studies and new applications necessary for this are applied and then the positive results will appear and be reflected in those homes and contribute to knowing the main causes of hot water and its cooling.

References

1. CleanPNG. (2021). *Fin Hardware pipe.*
2. EnggStaff. (2019). *Working of cooling system .*
3. S.Palani. (2016). *Cooling System .* Tamil ,India: Department of Mechanical Engineering