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Study on Generation of Electricity using Sound

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Abstract — Life is intricately woven with many necessities. Electrical energy is no less than the life source itself, hence, tops the list source of priorities. Acute shortage of this energy in every field-from the domestic to the dynamic frontiers of growth and development- is hampering the functioning of progressive modules. "SOUND" a source which engulfs every phase of life and environment always goes waste once produced. This inspired the thought of looking at possibilities of generating electrical energy from sound energy. This source is 'easily available and renewable'. Tapping this source and converting it into a productive one will directly contribute to a sound pollution free environment too .The main idea is to produce the electrical energy from sound energy to overcome the acute shortages of power supply in various fields of life. The basic reason to take sound as the input source is that a lot of sound energy is being wasted around us which is a "RENEWABLE" source of energy that is produced ample in nature.

Keyword — Mass Flow Rate, Resonance, Power, Power Coefficient

1. INTRODUCTION

According to the law of energy "Energy can neither be created nor destroyed, it can be converted from one form of energy into any other form of energy". Production of electricity is done in a number of ways. Electricity can be produced from various sources such as wind energy, tidal energy, solar energy etc. The 'Wind Wheel' of the Greek engineer HERON of ALEXANDRIA in the 1st century AD is the earliest known instance of using a wind driven wheel to power a machine. The history of solar energy begins with Leonardo da Vinci whose sketches dating back to the 15th century show that he had been designing ways to harness solar energy. Scientists over the ages have been working to find established renewable sources to produce electricity that would be cost effective tool in the long run.

2. IMPLEMENTATION

Firstly the sound energy which is produced as input is passed through 'n' directions to enter into the 'n' different hollow cones of the closed vessel. Here for example we take n=4. So the sound energy enters into the closed vessel from 4 different directions. A closed vessel is one which is airtight, but enables the sound to enter, as sound can propagate through solids, liquids and gases respectively.

The sound that is generated as input is made to pass through the hollow cones in such a way that the sound propagated through the vibration of the molecules is 'pin-pointed' over to the wings of the turbine.

The vessel is filled with a very stable gas like helium gas in order to have a very low pressure inside the vessel. We choose this as the speed of sound is higher in the helium gas. Sound energy flows into the vessel as the pressure inside the vessel is much lower than the outside pressure. Due to this pressure difference the sound energy flows from outside to inside the vessel. The sound energy in the form of vibration of molecules is pin-pointed on to the wings of the turbine as shown in the diagram below.

This sound energy on rotating the first wing of turbine moves towards second wing.

Similarly, the sound energy in the form of vibration of molecules entering through the successive hollow cone gets pin pointed on to the second wing of the turbine. This sound energy moves towards the third successive wing of the turbine and the process continues, thereby leading to the continuous process of rotation of the turbine. Here, the frequency of the sound which is produced from one opening of the hollow cone with the sound being produced from the successive hollow cone is equated, thereby, creating 'resonance'.

Resonance is produced when the natural frequency is matched with the frequency of the sound that is produced. This resonance which is produced leads to increase in the amount of the energy produced to propel the wings of the turbine. This thrust enables the wings of the turbine to rotate. Therefore, the wings of the turbine start rotating and continue to rotate as the pressure inside the vessel is quite less due to the presence of the stable helium gas that is present in the closed vessel.

The rotation of the wings of the turbine produces mechanical energy which can be converted into the electrical energy using a 'dynamo' thereby satisfying the function of the "transducer". This leads to perfect alignment of the process-continuous movement of the wings of the turbine lead to the continuous production of the electricity.

Finally, electricity produced can be put to use in various fields as and when required. This kind of electricity can be produced mainly from the source of energy that is emitted out as useless form of energy in various places. So this is a boon to the production of electricity and to overcome the acute shortages.

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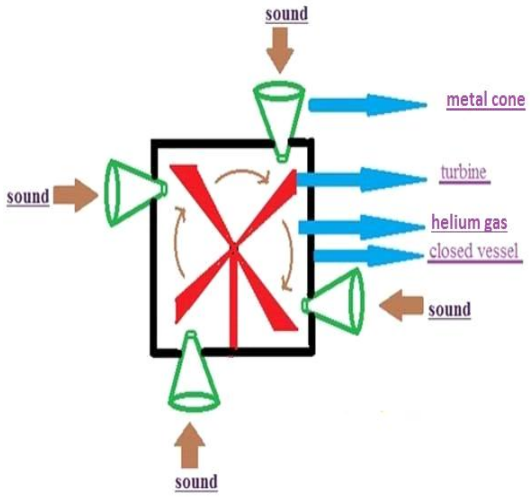
3. CIRCUIT DESIGN



4. MATHEMATICAL ANALYSIS

- E=kinetic energy(J)
- m=mass
- v=speed of sound
- P=power(w)
- $\frac{dm}{dt}$=mass flow rate($\frac{kg}{sec}$)
- $\frac{dE}{dt}$=energy flow rate($\frac{J}{sec}$)
- ρ=density($\frac{kg}{m^3}$)
- A=sweep area of the turbine
- C_p=power co-efficient
- r=radius of the turbine wing
- x=distance(m)
- t=time(sec)

We know under constant acceleration,the kinetic energy of an object of mass 'm' and velocity 'v' is equal to the work done 'W' in displacing that object from rest to a distance 's' under a force 'F' is,

E=work done= F.S=(m×a×s) ----------(1)

We also know,

$(v^2)-(u^2)=2as$

Since the initial velocity of the object =u=0, so we get

$a=\frac{v^2}{2s}$ ---------- (2)

Substituting (2) in (1) we get the kinetic energy as,

Kinetic energy= $(\frac{1}{2})$ (m) (v^2) ---------- (3)

The power due to sound is given by the rate of change of energy,

Power generated=rate of change in energy

Power generated=P=$\frac{dE}{dt}$= $(\frac{v2}{2})$ $(\frac{dm}{dt})$ ---------- ---- (4)

Mass flow rate=$\frac{dm}{dt}$= (ρA) $(\frac{dx}{dt})$ ---------- (5)

Rate of change in distance= $\frac{dx}{dt}$=v---------- (6)

Therefore, we can get:

Power generated= $(\frac{1}{2})$ (ρAv^3) ---------- (7) (from Eq. (4), (5), (6))

A is nothing but the area swept by the wings of the turbine.

$A=\pi r^2$---------- (8)

Where r = length of the blade

Therefore area swept by the turbine is $A=\pi r^2$

Expected Power Generated:

ρ=density of helium =0.164 $\frac{kg}{m^3}$

v=velocity of sound=340 $\frac{m}{sec}$

Area=πr^2

Let us assume the length of the wing of the turbine =0.5m

Power generated= $(\frac{1}{2})$ (ρA) (v^3) (from Eq. (7))

$(\frac{1}{2})$ x (0.164) x $[(340)^3]$ x $[(\frac{1}{2})^2]$ x 3.14

=2529998.48W

=2.53MW

This is the power generated when there are no losses.

But there are losses due to the ball bearings, gear box, power generator etc.

So we have to multiply the resulted power generated with the power coefficient 'C_p'.

Therefore power generated = $(\frac{1}{2})$ (ρA) (v^3) (C_p)

According to the law of Betz limit we can assume the value of C_p to be of 0.4

So the power generated= (2.53Mw) (0.4) =1.02MW

The above mathematical analysis has been done based on the assumption that wind and sound have same amount of force to generate a considerable amount of electricity.

5. ADVANTAGES

- Sound is a RENEWABLE source of energy.
- It leads to pollution free environment.
- There is no deficiency in the input as there is ample sound in everyday life and environment.
- It can be used in industries, where a lot of sound is produced from the machines and generate the electricity, may be to run the same machine.
- It can be used at heavy traffic junctions where a lot of sound is produced from the honking of vehicles and can be used in traffic lights.
- It can be used in stadiums where a lot of sound is produced from the cheering crowd.
- It can be used in water bodies also as sound can propagate through water.
- It can also be used in theatres where a lot of sound is produced.
- It is compatible in nature as its size can be varied according to the requirement.

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7. CONCLUSION

As sound is an abundant source of energy, we need to use it in an efficient manner. At this point of time, the production of sound may be an expensive process but the production of electricity from sound becomes a vital source of supply of input energy in the near future. The fuels being used to produce electricity today are 'Non-Renewable' in nature. Hence, the proposed idea is a ray of hope for the generations to come that alternate sources of energy are on the anvil. Yet another striking feature of the proposed idea is that it does not create any pollution or generates residual bi-products which would open up a Pandora's Box of related issue.

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