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Iterative modelling of convergent divergent passage to embed over the renewable energy resources to augment the power generation

***Abstract**. Renewable energy resources (RERs) most required in day today life owing to its atmospheric friendly method of power generation. Power consumption is increasing day by day very drastically. So, power generation become essential without effecting the vicinity. This work emphases a work augmenting the solar PV module with additional embedment of convergent divergent system. This system comprises of see-saw module and convergent divergent module along with solar PV module. The methodology followed to design the convergent divergent module is physical iteration technique by varying the dimensions. Analysis reveals smaller convergent portion increases the fan RPM in this experiment is 1.4 cm length convergent portion. Power calculated in an average of 9V per day can be achieved. Overall system cost is very cheap and doesn't required much maintenance. This can be incorporated with the water tank in any house, industries or anywhere, with minor modification of placing objects to make the convergent divergent passage.*

Streszczenie.** Odnawialne zasoby energii (RER) są najbardziej potrzebne w dzisiejszym życiu ze względu na przyjazną dla atmosfery metodę wytwarzania energii. Zużycie energii rośnie z dnia na dzień bardzo drastycznie. Tak więc wytwarzanie energii staje się niezbędne bez wpływu na otoczenie. Praca ta kładzie nacisk na pracę rozszerzającą moduł fotowoltaiczny o dodatkowe osadzenie zbieżnego systemu rozbieżnego. System ten składa się z modułu huśtawki i modułu zbieżnego rozbieżnego wraz z modułem fotowoltaicznym. Metodologia zastosowana do zaprojektowania zbieżnego modułu rozbieżnego to fizyczna technika iteracji polegająca na zróżnicowaniu wymiarów. Analiza wykazała, że mniejsza zbieżna część zwiększa obroty wentylatora w tym eksperymencie o 1,4 cm długości zbieżnej części. Można osiągnąć moc obliczoną średnio na 9V dziennie. Całkowity koszt systemu jest bardzo tani i nie wymaga dużej konserwacji. Można go zintegrować ze zbiornikiem wody w dowolnym domu, przemyśle lub gdziekolwiek, z niewielką modyfikacją umieszczania obiektów, aby uzyskać zbieżne, rozbieżne przejście.* (Iteracyjne modelowanie zbieżnego, rozbieżnego przejścia do osadzenia nad odnawialnymi zasobami energii w celu zwiększenia wytwarzania energii***)

Keywords: Renewable Energy Resources (RERs), Iterative method, Convergent divergent passage, Solar PV, Hybrid RERs.
Słowa kluczowe: odnawialne źródła energii,hybrydowy RERs.

Introduction

Energy is an essential resource that is intricately connected to the growth of humanity, as well as economic and social advancement, and the liberation of people. It is frequently divided into traditional and non-traditional forms, the latter of which can also include renewable ones [1]. Although the implementation of renewable energy sources is speeding up, but still biosphere's energy demand mostly fulfilled by non-renewable sources including fossil fuels, nuclear energy and so on [2–5], this is the case even though the fact that the implementation of renewables is increasing. The fact that non-renewable resources must be used up is one of their defining characteristics. Their ongoing utilization at substantial rates of usage poses a considerable threat to both the continued availability of energy and the quality of the environment. This has resulted in comprehensive global efforts being made by a broad spectrum of diversified stakeholders (such as investigators, researchers, industries, organizations, policymakers, as well as governments) to upsurge the penetration of renewable energy sources in order to meet the increasing global demand for power generation in its diverse types [6–10]. It is arguable that, the renewable sources of energy, solar energy has been the most extensive, widespread, as well as encouraging in aspects of it'sprospective to gratify the energy requirements of the entire globe[11–13].

Solar thermal collectors as well as photovoltaic (PV) panels are indeed the two primary technologies that are used to collect solar energy. The transformation of solar radiation into beneficial thermal energy is accomplished by a solar thermal collector, which typically makes use of a heat transfer fluid and those whose temperature (as well as, as a result, its enthalpy) enhances as it moves through the collector. The other way round, a photovoltaic panel utilizes the photovoltaic effect to directly transform the solar radiation that strikes its surface further into electricity. In general, the efficiency of solar photovoltaic panels used in commercial applications varies from around 10 percent to 23 percent [14, 15, 16]. The PV panels that are utilized the most frequently are those that are premised on silicon (Si) cells. These panels can be broken down into three different categories: mono-crystalline, poly- or multi-crystalline, as well as amorphous. In more recent times, silicon heterojunction cells and thin-film techniques (such as CdTe and CIGS) have both made their way into the market [17, 18]. In other words, any solution that is responsible of cooling a Pv module besides trying to remove some of the undesirable or acquired heat energy is of interest.

Over the course of the past several years, a number of different strategies for thermal management that are aimed specifically at the cooling of PV panels have been suggested, developed, as well as tested. There are also a number of commercial products on the market that implement such solutions. When looking through the research that is pertinent to this field that has been published, there are a number of reviews that are exhaustive and informative that can be found. For instance, Sieckerand their co-researchers provided a wide-ranging overview of a diversity of hybrid cooling methods, which included the following techniques: PV structures cooled by a heat sink,Floating tracked highly focused cooling systems, PV panels with clear coatings,Photovoltaic panels wherein, incorporated by Phase Change Materials (PCMs), photovoltaic systems cooled through the use of immersion cooling, hybrid PV-thermal structures cooled This review went as far as to provide a perspective into these cooling methods; nevertheless, it did not cover all of the techniques that are currently available, such as the prospective employment of nano - fluids, heat pipe temperature control, or radiative methods, including a demonstration of their own electrical as well as thermal efficiency [19].

Malekiand their co-researchers [20] along with Hasanuzzaman and their co-researchers [21] provided a summary of passive as well as active cooling methods are available. Muhammad Ali [23] elaborated on the latest progress in PV cooling, particularly with PCM systems who listic, whereas Velmurug anand his co-researchers [22] provided a literature review on PCM types as well as passive cooling using PCMs. Additionally, Sargunanathanand his co-researchers [24] discussed an exhaustive study on a range of cooling concepts including liquid soaking cooling, heat pipe cooling, along with active cooling by water flowing around the front exterior of PV modules or by incorporating water/air/fin An investigation into the impact that these techniques have on the temperatures that PV panels experience while they are in operation was detailed in the presentation.

Kandealand his co-researchers [25] presented a detailed survey on methods for improving the effectiveness of photovoltaic cells, wherein the authors focused specifically on methods of cooling premised on convection, conduction, as well as radiation.Bahaidarahand his co-researchers [26] as well asHamzatand his co-researchers [27] furthermore introduced was a summary of the various approaches to thermal control, which relied on the use of the following: liquid immersion, heat sinks, microchannels, impingement jets, heat pipes, as well as PCMs.The incident radiation as well as the power efficiency of a solar photovoltaic panel are the two primary factors that determine how much usable electricity can be produced by the panel. The temperature of a photovoltaic panel has a significant impact on the amount of electricity it generates. Particularly, the effectiveness of a PV panel declines by between 0.2 percent and 0.5 percent for silicon cells for every degree that the temperature rises. This is something that has been affirmed by a number of researchers [28–31]. In addition, the amount of power that is produced by the panel is dependent not only on the material composition but also on factors includingthe speed of the wind, amount of solar irradiance, the amount of cloud cover, as well as the relative humidity [32]. The operating temperatures of PV cells in concentrated photovoltaic (CPV) collectors are significantly higher than those in flat Pv module systems. This, in turn, substantially decreases the amount of time that CPV panels can generate electricity for their owners. Within those systems, cooling is essential for lowering the temperature of the cells and improving the overall performance, despite the different types of cells that are used. A photovoltaic (PV) cell's temperature will increase because heat will be produced as a by-product of the process by which solar energy is transformed into electricity. This results in a narrowing of the gap between the PV cell's valance and conduction bands, which in turn reduces the open-circuit voltage (Voc) by approximately 2 mV per degree C along with the fill factor, while simultaneously having caused a modest improvement inside the short circuit current (Isc)[33–35]. The whole output power of a PV panel, which really is dependent on the numerous of both Isc and Voc, decreases as a direct result of the pose a significant threat in Voc in comparison to the rise in Isc. In addition to a decrease in overall effectiveness, higher working temperatures contribute to the deterioration of photovoltaic (PV) cells, which in turn has an effect on the effective lifespan of those cells.

Above survey reveals the following

- Hybrid system is effective way to harvest higher quantity of power
- Need of cost effective method is required to harvest from existing renewable energy resources.
- Less sophisticated system has higher demand.
- System that is being incorporated should also be environmental friendly.
- It can be incorporated with existing system with less cost.

So, this work is derived accordingly, wherein the entire system is simple, cost effective and vicinity friendly

Methodology

The overview of the methodology for generating power using hybrid energy system with modified convergent divergent structure. The process starts with the development of convergent divergent passage using PVC pipe with physical iteration technique. Next the process continues with the making of functional model by hybridization with solar PV, in addition to this the designed convergent divergent structureis placed over the see-saw base arrangement, therein it consist of pizeo unit. Then the testing of functional model takes place. Optimization of functional model which helps in improving the efficiency of the model by physical iteration. The last step of this process is the working functional model is embed with the renewable energy system.

Fabrication and Iteration

Convergent divergent system is modelled using 3D modelling solid work software. Physical models are developed using the plastic pipes. The following figures shows the 3D model and physical model for various dimensions.

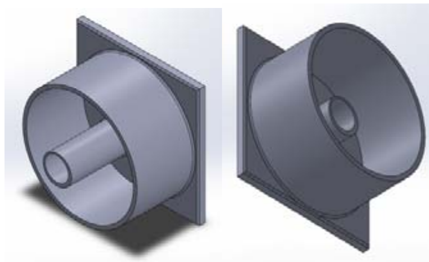

Fig. 1. TFig 1: Two different dimensions of 3D modelled convergent-divergent nozzle

Iteration process is carried out with developed physical models by varying the length of the convergent and divergent portion.

Fig. 2. Convergent Length (CL) = 2.0cm, Divergent Length (DL) = 6.0cm

Model fabrication extended to developing the base of structure for convergent divergent portion to accelerate the fluid flow inside the passage along with the additional power generation. Convergent divergent portionis completely sealed which a rotor is attached near the convergent part, wherein it provides higher velocity therein rotor rotates faster in turn it is attached to the generator to produce more power. Addition to this, a sensor is attached to measure the pressure flow rate of the fluid inside convergent divergent portion. In case, it senses that the flow has less pressure it triggers the hammer. Base structure comprises of a see-saw arrangement wherein, it has a spring unit is placed and at the end a pizeo unit is positioned. The pizeo units output is connected to the generator. In addition, solar PV is connected with 6V capacity. The role of the hammer is in case the see-saw stops it is activated by the generated power and by the external power source.

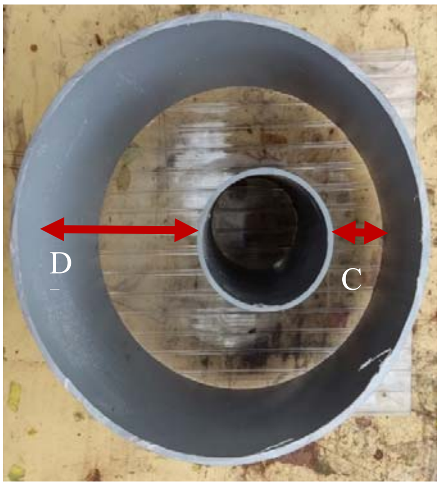

Fig. 3. Convergent Length (CL)= 1.5cm, Divergent Length (DL)= 5.0cm

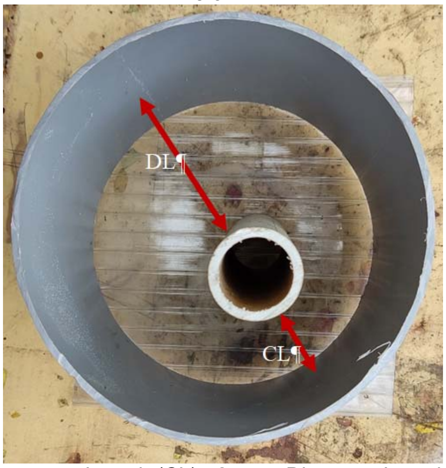

Fig. 4. Convergent Length (CL)= 2.5cm, Divergent Length (DL)= 5.5cm

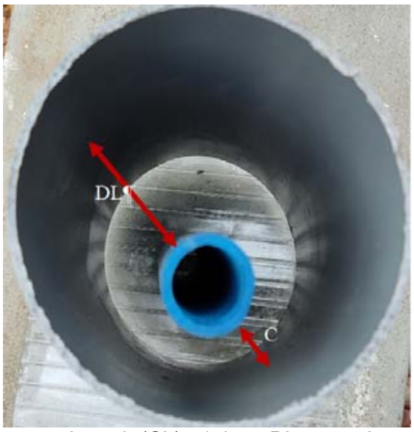

Fig. 5. Convergent Length (CL)= 1.4cm, Divergent Length (DL)= 4.0cm

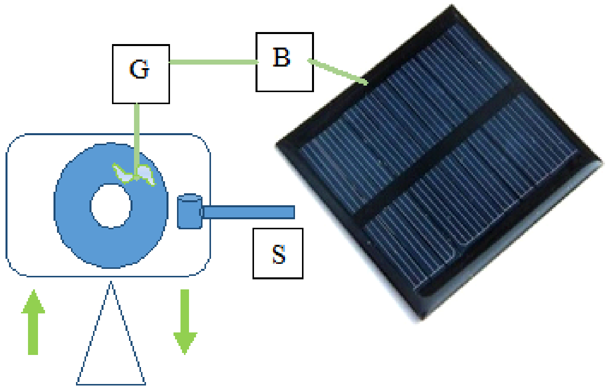

Fig. 6. Developed model

Results and discussion

Physical iteration reveals the following data with respect to the higher fan speed and it tabulated in table 1. High RPM is obtained for the smaller convergent portion that is 1.4 cm with 99 RPM. Further analysis this size is taken.

Table 1. Convergent divergent dimension's VS fan RPM

S. No	Convergent length in cm	Divergent length in cm	Fan RPM
1	2	6	90
2	1.5	5	95
3	2.5	5.5	87
4	1.4	4	99
5	1.8	4.5	89

Convergent divergent system is placed in the non-shaded area in the top floor of the building. The following table 2 reveals the power generation data for a day. In this case India's summer day is taken for consideration with average temperature of 25 degree Celsius.

Table 2. power generation data for a day

S. No	Duration	PV power in volt per sec	See-saw power in volt per sec	CD power in volt per sec
1	6am to 10am	5	1	2
2	10am to 2pm	6	1	2
3	2pm to 6pm	6	1	2
4	6pm to 10pm	1	1	2
5	10pm to 6am	0	1	2

The voltage generation revealed by the table is an average generation during that specific time in a second. In addition, so the total power generated by the system is augmented around 9V per sec as average can be achieved round the clock.

Conclusion

Convergent divergent system is a simple economic system which can be implemented in real time. The following points are summarised,

- Smaller convergent portion increases the fan RPM, in this experiment is 1.4 cm length convergent portion, with larger divergent portion herein 4 cm length.
- Hybrid system is optimum method which used to augment the power generation.
- Power calculated in an average of 9V per day can be achieved.
- Overall system cost is very cheap and doesn't required much maintenance.
- This can be incorporated with the water tank in any house, industries or anywhere, with minor modification of placing objects to make the convergent divergent passage.

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