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Renewable Energy and Computational Fluid Dynamics

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ABSTRACT-

In the present article I would like to stress on the potential research agenda for lasting reforms in the area of computational fluid dynamics. On the theoretical frameworks, I have tried to propose that a scope for lots of research is required in this area of fluid dynamics. On the basis of varied problem domains carried out in this research area in the past, we can find out varied extensive applications like in transportation, microelectronics and renewable energy resources. I would like to specially adhere to its potential applications and findings in the area of energy renewable sources. Whenever an energy scientist or engineer undertake some project for installation, then his prime focus is on maximizing the output and minimizing the cost, so computational fluid dynamics helps him to achieve his goal fruitfully thus saving time, money and conserving the efficiency. In the present communication I have tried to enlist the impact of computational fluid dynamics on renewable energy sources.

KEYWORDS: Fluids, Wind, Hydro energy, Biofuel, Turbulent flow, Computational Fluid Dynamics

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INTRODUCTION-

Today's reform rhetoric has revived the area of stretching sheet as represented the essence of computational fluid dynamics. The study of laminar flow of a thin liquid film over a stretching sheet is currently attracting the attention of a growing number of researchers because of its immense potential to be used as a technological tool in many engineering applications, with applications in industries such as extrusion, melt-spinning, the hot rolling, wire drawing, glass– fiber production, manufacture of plastic and rubber sheets, cooling of a large metallic plate in a bath, which may be an electrolyte, etc. In industry, polymer sheets and filaments are manufactured by continuous extrusion of the polymer from a die to a windup roller, which is located at a finite distance away. Other applications can be found in food processing, transpiration cooling, reactor fluidization, the aerodynamic extrusion of plastic sheets, the boundary layer along a liquid film in condensation process, the cooling of metallic plate in a cooling bath and last but not the least in present context is use of Computational Fluid Dynamics[1] (CFD) flow modeling in such a manner that that it will provide visible benefits to the wide range of renewable energy applications like wind, wave, tidal and hydro projects.

Renewable sources are those sources which exist for a long time without replenishing and if they would be exhausted that would be only due to the Mother Nature. There are lots of sources which come under the tag of renewable sources like solar, wind, hydropower, tides, geothermal etc. and all these aforesaid sources provide energy to us and that energy is called as renewable energy. So we all are getting the renewable energy[2] at the cost of these natural resources. Renewable energy is the cleanest form of energy which will not cause any harm to our forthcoming generation and by proper utilization of the energy resources we can get rid of the danger that the world could face in the forthcoming future.

THEORY-

The conventional energy sources like petroleum, coal etc. are going to be extinguished in the coming future, so we require some alternate sources of energy which will without harming our generation develop within ours a competence to prosper in our life. Apart from the extinguishing criterion of conventional energy sources, they cause a lot of pollution which not only affect our present population but it will have the lasting impact on the coming generations.[3] The various types of emissions produced by the burning of these conventional sources like carbon di oxide cause a lot

of pollution in the environment. These emitted gases contribute towards the overall heating of the atmosphere by the phenomenon of green house effect. Due to this very phenomenon this planet would be a heated blanket for the forthcoming generations. So the need of the hour is that it would be an appropriate choice that we switch over to some other alternate source of energy. The best alternative that comes to fore in this scenario is the renewable sources and their energy called renewable energy[4].

Every part of this world understand the need of the hour that we must propel in the direction of renewable energy sources but we are putting extremely small steps in the forward direction. It can be estimated from the fact that the whole of world just uses sixteen percent of the energy from the renewable sources and if we make a dissection of even this meager energy, then we find that the biomass is the major contributor in it accounting for around sixty percent of it, hydro energy comes at the second with twenty percent and the rest wind, geothermal, biofuel and solar contributing the rest twenty. In 2011-12, the United States, China, and Russia were the only three countries which were consuming the Crude Oil and Natural Gas greater than that of India. One can easily see that energy demand from India has not diminished either, despite a slowdown in the global economy but on the contrary it always had a upward trend and even continues to rise. If we make a statistical calculation then we find that India produces over half of the electricity from coal based power plants which is a cause for the worry for every one of us. If we talk about the share of the renewable sources then we have to look downward because it is a shame for such a large country that possess enormous resources but still producing a 2 percent share of the Indian fuel mix from all the combined renewable resources and further one percent share is contributed by the nuclear energy. If we go by the 2013 energy statistics provided by the Indian government through central statistics office then approximate 70% of Indian energy comes from two conventional sources coal and petroleum[5].

The renewable energy scenario in India is even worse which must not be. As India is a large country having abundance of renewable energy resources like biomass, water, sunlight etc. but still the scenario is not at all encouraging. In the past few decades we have made some tremendous improvement in this renewable energy area but still a scope of enormous improvement is there. To harness this potential area in the future the Indian Government has established a specialized department of non conventional energy in 1982 and afterwards in 1992, a full fledged ministry called ministry of non conventional energy was established. The Indian government in the past few years has established a large number of missions like Jawaharlal Nehru National solar mission for the

upliftment of the solar energy and Indian Renewable Energy Development Agency Limited to monitor the renewable energy development in the area. Various types of renewable energy technologies are being promoted throughout the country. Lots of organizations are directly or indirectly involved in promoting and providing the conducive environment for expanding these renewable energy technologies[6].

India is now considered among the countries that have tremendously improved their situation in the wind energy generation area and categorized as a "wind superpower". The total installed wind power capacity of India is found to be 1167 MW and which has contributed about 5 billion units of electricity to the national grid so far. If we think about the renewable energy utilization then India's electricity sector is the fastest growing sector amongst the world's most active countries and as on March 2012, the installed capacity of India is around 24.9 GW of renewable technologies based electricity. Here special concentration must be given to the wind energy sector. If we statistically interpret the Indian energy use then we conclude that the Combustible renewable and waste possess around 25% share which includes traditional biomass sources for example firewood and dung. Around 800 million Indian households use these firewood and dung for the cooking purpose. As per the 2011 Census, traditional biomass fuels are consumed by a major part of the Indian population, around 85% of rural households. These biomass fuels are the largest source for their cooking energy requirements[7].

Now we come to the second part of our concern that is the computational fluid dynamics. The term Fluids contains both liquids and gases. So fluid is a substance on which when we apply a little shearing stress then it deforms continuously. Two of the major renewable sources are wind means a gas and water means a liquid. Fluid mechanics is the study of the behavior of the fluids at rest and in motion where the latter one is termed as Fluid dynamics. Most important phenomena in our physical world like ocean currents and weather systems can be explained with the help of fluid dynamics. Computational Fluid Dynamics implies the extensive use of these computational methods for solving various types of fluid engineering systems. In Computational Fluid Dynamics different types of numerical methods like runge kutta fourth order etc. and algorithm are employed to solve and analyze various fluid flow problems. In most of the computational fluid problems we model the continuous fluids with Partial Differential Equations, these partial differential equations are then converted to ordinary differential equations which are further solved numerically to get the result[8].

As we know the cost of installing a wind or hydro power plant is very high so one cannot think about installing a plant at a place and latter on finds that the output of the whole process is very low. Before installing a plant one has to theoretically calculate the pros and cons of installing the plant. Here the computational fluid dynamics comes into picture. As the flow of wind, water or any fluid is of two types- one the streamline flow and the other is turbulent flow. The flow is streamline or turbulent is determined by the Reynolds number. If the Reynolds number is greater than 2000 then the flow is turbulent and for the electricity generation from the fluid the flow must be turbulent. So computational fluid dynamics tells that which are the necessary changes that must be made to enhance the performance of a plant or it can tell before installing whether it would be a fruitful exercise to install a plant at a particular location. The cost of installing the whole physical model is very high so computational fluid dynamics at a very low cost tells the feasibility of the project and hence saving a large amount of money. The modelling of the planned site has to be perfect otherwise it would create a chaos and prediction of energy yields and wind turbine loading would be very complex and leads to reduced accuracy and high uncertainty, which ultimately increases the revenues and maintenance costs. So the solution of such types of problem is computational fluid dynamics, which provides an explored understanding of the effect of complex site surroundings the wind regime[9].

Various numerical methods used in computational fluid dynamics are improving rapidly which makes it more and more reliable to tell the exact possibility of a happening. Environment is the most crucial aspect while deciding the policies of each and every government in the world, so every nation tries to have some stringent regulations for the well being of the environment and hence the individuals. So the demand of the century is the innovative design solutions which without harming our environment provide us the solution of all the problems. Computational fluid dynamics provides the most appropriate solution to tackle all the environment related flow problems efficiently and in a cost-effective manner. The major areas that are covered in Computational fluid dynamics are turbulence, heat and mass transfer and multiphase flows.

If one requires to increase the energy efficiency of a particular building so that it will consume optimum energy then at the planning stage itself, computational fluid dynamics is employed before the actual start of the construction of the building and one can get the complete information regarding the wind flow effects by making an air flow model and the feasibility of the solar radiation effects.

CONCLUSION-

One can easily see that day by day the technology is improving at a fast rate, so the advent of computer has made a great impact in all the areas including this one. After the advent of computer one can use software like ANSYS, other fast computational softwares to find out the solution of computational problems. We have to look beyond the current scenario and find out some innovative techniques to the fluid problems so that this renewable energy area will get a further boost. Whatever has been done is meagre, if we sincerely approach to find the solution of flow problems in an efficient and cost effective way. The computational fluid dynamics is especially important in the conceptual studies of new designs and redesign. Computational fluid dynamics complements testing and experimentation so if we make sincere effort in progressing in this area then renewable energy sector is going to be surely get benefitted.

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