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Thermal performance of building prototype with different cool roof structures in composite climate

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ABSTRACT

In the domestic sector, buildings contribute to about 55% of the total energy consumption for space heating and cooling. In this study, an experiment was carried out using a square shape building prototype made up of laminated plywood with Reinforced Cement Concrete (RCC) roof. Surface treatment of four types of reflective paints was applied on the RCC roof slab. Their performance was monitored in the summer season (April and May). Based on the peak temperature of interior and exterior roof layers, several important parameters, such as temperature, indoor thermal amplitude, time lag, decrement factor, thermal damping, thermal performance index, peak degree hours and thermal performance of each roof slab, were analysed. The application of cool roofs (CR-1, CR-2, CR-3, and CR-4) shows a significant reduction in indoor temperature (2.1°C–3.2°C), and indoor thermal amplitude (16.10%–27.94%) compared to a standard RCC roof. The drops in peak temperature of exterior and interior roof layers were 4.8°C–6.8°C and 3.9°C–6.3°C, respectively. A significant improvement was achieved in time lag and decrement factor (3–4 h more than the reinforced concrete roof), with energy savings varying from 10.58% to 13.73%.

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KEYWORDS
Albedo; building envelope; cool roof; decrement factor; heat gain; time lag

1. Introduction

Global warming and climate change are the most critical challenges caused by greenhouse gas (GHGs) emissions, with the energy sector being a major contributor. In the domestic sector, buildings consume about 55% of the total energy for space heating and cooling (Lamrhari and Benhamou 2018). For recent trends, renewable energy utilisation for energy efficiency measures is necessary for net-zero energy buildings with cleaner power production (Zhou, Zheng, and Zhang 2020a, 2020b). Globally, the rate of urbanisation has rapidly increased due to the increase in population. The urban temperature profiles significantly affect the energy consumption in buildings (Santamouris and Yun 2020; Singh et al. 2021a). A higher ambient temperature leads to increased cooling demand and reduced working efficiency of air-conditioning systems in buildings. An increase in air temperature by 1°C would require additional 500 Megawatts (MW) electricity for air-conditioning in buildings (Singh and Bhat 2018). Due to climate change, the global average temperature has enhanced. The increase is about 0.83°C for 1951–1981 and 1.31°C during the twentieth century (Staszczuk and Kuczyński 2021). Over the past few decades, high-density concrete building clusters have been raised due to the rapid economic growth and urbanisation worldwide. Most of the building materials have a relatively low thermal capacity and albedo, which absorb solar radiation and raise the indoor temperature, thereby creating discomfort for human beings (He et al.

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REVIEW ARTICLE

Review on the progress of building-applied/integrated photovoltaic system

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Abstract

Integration of photovoltaic (PV) technologies with building envelopes started in the early 1990 to meet the building energy demand and shave the peak electrical load. The PV technologies can be either attached or integrated with the envelopes termed as building-attached (BA)/building-integrated (BI) PV system. The BAPV/BIPV system applications are categorized under the building envelope roof and facades as PV-roof, PV-skin facade, PV-Trombe wall, PV claddings, and louvers. This review covers various factors that affect the design and performance of the BAPV/BIPV system applications. The factors identified are air gap, ventilation rate, a tilt angle of PV shading devices, adjacent shading, semitransparent PV (STPV) glazing design, cell coverage ratio (CCR), transmittance, window to wall ratio (WWR), and glazing orientation. Furthermore, the results of the possible factors are compared to building locations. This review article will be beneficial for researchers in designing the BAPV/BIPV system and provides future research possibilities.

Keywords Photovoltaic · Double-skin facades · Trombe wall · Glazings

Introduction

The energy demand in residential and commercial buildings was 2.25 Btoe in 2016 and is expected to be more than 3 Btoe by 2040 worldwide. This demand increases daily due to the overburdened population and extensive energy gadgets, such as heating, ventilation, and air conditioning (HVAC) (Global and Outlook 2018), which increases the rising price trends of conventional energy generation and may create price affordability problems, especially in developing countries (Timmons et al. 2020). Further, emissions from these primary energy sources will degrade the environment, causing natural climate change, which is also a severe issue. Photovoltaic integrated building envelopes technology can play a significant role in mitigating these energy and environmental issues.

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The integration of PV with the building envelopes has started in the early 1990s to fulfill the building electrical demand and shortage inland availability (Hagemann 1996; Clarke et al. 1996). The potential of PV-integrated technologies for European countries is about 840 TWh, fulfilling 22% of energy demand alone (Defaix et al. 2012). However, the market growth rate of these technologies in the Asia/Pacific region is 10% higher than in European countries for the year 2014–2020, playing an essential role in developing countries (Tabakovic et al. 2017). The technologies performed well in higher solar irradiance areas (Singh et al. 2020). Further, with the predicted increase in efficiency of about 22% for PV wafer–based and 17% for thin-film technologies by 2030 (Defaix et al. 2012), the BIPV/BAPV technologies will be gaining more attention in upcoming years. In recent years, the review on the topic by the authors is discussed. In a review, Jelle et al. (2012) initially categorize BIPV products in PV foils, tiles, and modules and identified the PV foil as the first commercial BIPV product.

Further, they discussed the electrical parameters of different BIPV products. The authors also hint at the evolution of organic and dye-synthesized solar cell (DSSC) technologies in BIPV applications. Shukla et al. (2018) discussed the BIPV-based buildings in Asian countries, concluding that factors like ambient temperature, direction, and the slope of the PV

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Statistical Analysis and Geochemical Modeling of Leachate and Chemical Speciation In Developed Concrete

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Abstract— **Paper discussed about the immobilization capacity of developed concrete with pHs. It was considered one of the most important acid and base properties of the waste material. The product "developed concrete" has prepared by fly ash and hazardous waste in different ratio. The developed concrete has examined through geochemical modeling and statistical analysis. Modeling and statistics provides a way to the immobilizing capacity for this complex system. In addition, it also provides information of all possible solubility and controlling phases. The computed results showed that increasing the alkaline binder is more effective for the stability of heavy metals in the concrete matrix. The results showed that acidic pH have correlation up to 0.988. Pure samples, S1, S2, F1 and F2 find most suitable for further analysis. High positive loading was observed for Fe, Na and Cu for 7, 28, 90 days of curing respectively. The screen plot, score plot and biplot show the highest correlation for 7 days cured samples. pH range from 6 – 10 is more acceptable to developed concrete.**
Keywords— **Geochemical Modeling, Statistics, developed concrete, fly ash, hazardous waste**

I. Introduction

The acid and base properties of hazardous waste and byproduct have considerable influence on their leaching behavior of developed concrete. Leaching observed when it exposed in rainwater. Reactions of waste were control the leaching processes at different pH in many conditions. The pH of environment was affected by the release of many toxic elements from the matrix [1].

The acid and base chemistry of developed concrete was determined by acidic or alkaline solution on different pHs. The neutralizing capacity at different pH levels was considered to be one of the most important acid/base properties of the waste. The hazardous waste was complicated and heterogeneous composition and structure. Modeling provides a way to an insight into a part of the neutralizing processes for this complex system. In addition, geochemical speciation modeling is provide useful insights into leaching behavior, as it provides information on possible solubility controlling mineral phases [1,2,3], although the above framework provides the specific basis for evaluation of inorganic constituents. Reduced leaching of heavy metals as a result of cement binder has been reported in papers worldwide [4-9].

Statistical analysis helps in the prediction of results and correlation between parameters. All parameters and method were determined and the variance of the whole data was distributed among the complete variation. The systematic differences between all parameters and variety of samples were identified for the Statistical analysis [10-12].

II. Methodology

A. *Sample Preparation*

The developed concrete were prepared through mixing sludge with ordinary Portland cement, sand, fly ash, hazardous waste, aggregate and water. The mix was molded, compacted and vibrated in a mold of dimensions $10\times10\times10$ inch^3. M15 grade of concrete was selected for molding the mix. The cubes were unmolded after 24h and samples were cured for 7, 28, 90 days. Sample's mixing and cube preparation have done according standard method IS 9013:1978. Samples were cured by dipping in water (20-30 minutes) twice in a day. Mix proportion of developed concrete is given in table 1.

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Impact of roof attached photovoltaic modules on building material performance

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ABSTRACT

One of the applications of PV technology is to either integrate or attach it with the building envelopes. In this paper, a simulation has been performed for Economic Weaker Section (EWS) housing schemes to see the impact of roof attached PV modules on room operative temperature (T_{opt}) and compare it with the base case roof without PV modules. A Non-conditioned building is simulated for the composite climate of Indore in the DesignBuilder software. For thermal comfort analysis, a simulation for the summer months has been performed (April-September). It has been observed that compared to No PV Roof 1 (RCC) as a base case, the maximum reduction in room operative temperature of PV Roof 1 (RCC) case is 3 °C and 3.7 °C for PV Roof 2 (stone). Due to the reduction in T_{opt}, the simple payback period (SPP) calculated for PV Roof 1 (RCC) is 5.77 yrs and for PV Roof 2 (Stone) it is 4.32 yrs. The Net CO_2 emission gets reduced by 30% and 50%, respectively, for BAPV Roof 1 and Roof 2 compared to the base case. The BAPV cases achieve the Net CO_2 mitigation of 109 tonnes and 113 tonnes. This study shows that PV modules' passive behavior reduces the T_{opt} and provides credibility to the low-cost materials in the building construction.

Selection and peer-review under responsibility of the scientific committee of the 2nd International Conference on Manufacturing Material Science and Engineering.

1. Introduction

The buildings rely on electrical units for maintaining thermal comfort depending on the heating and cooling degree-day of the location. These degree days units are either provided by conventional sources or by renewable ones like PV technologies. In India, housing schemes like Economically Weaker Section (EWS), Lower Income Group (LIG) lack in providing the necessary amenities, including electrical units [1]. The PV technologies, when installed on the building rooftop in a stand-alone manner, are termed as Building Applied Photovoltaics (BAPV) [2]. In Standalone manner, these technologies become a part of building material. They can also be used as passive cooling technology, reducing room temperature, and providing additional benefits in reducing electrical units consumption. In this paper, we have investigated the effect of BAPV on the building performance in terms of operative temperature (T_{opt}) of the building using the Design-Builder simulation software. The EWS houses with a floor area of 30 m^2 have been selected for simulation purpose. Also, from simulation, the feasibility analysis of high U value roof material (Stone) in terms of construction cost, Net CO_2 emission, and the operative temperature is compared with low U value roof material (RCC) when used along with the BAPV system. This study becomes still more important as the building sector consumes more than 30% of world energy [3]. Further dependence on conventional sources leads to CO_2 emission. Therefore, it is the need of the hour to generate energy from renewable sources, thereby reducing the CO_2 emission and achieving the goal of zero energy building.

2. Methodology

The study evaluate the impact of roof attached PV modules on material performance in terms of room operative temperature (T_{opt}) of Economic weaker Section houses. The comparison of operative temperature will assess the feasibility of low cost roof material having high U value compared to high cost, low U value materials. It will beneficial for EWS houses in terms of reduction in construction cost.

2.1. Building modelling

A EWS scheme house is modeled in DesignBuilder software (see Fig. 1) with no PV as a base case and other as BAPV cases. The

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Design, Development and performance Evaluation of Photo Bioreactor for Algae Production

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Abstract— **Photosynthetic algae are significant resources for producing required and environmental friendly yields. Photo bioreactors (PBRs) play vital roles in these methods. Design of photo bioreactors for the growth of *Spirogyra* species is still challenging. No appropriate types of photo bioreactors are available for mass cultivation of algae due to its high capital cost,high operating costs and short lifespan. Relative study of the growth of algae in lab scale photo-bioreactor, Horizontal type photo-bioreactor (HT-PBR) and Vertical type Photo-bioreactor were observed in tap water and BBM medium, tap water and BG11 medium, BBM medium and BG11 medium. These research papers provide a critical indication of the key parameters and influence the performance of the different types of photo bioreactors**

Keywords— ***Algae; Photo Bio Reactor; Spirogyra species; BG 11 medium; Specific growth rate.***

I. INTRODUCTION

The design of energy efficient photo-bioreactor for the growth of photosynthetic microorganisms is important due to the immense potential for algae-based products in numerous applications**[1- 4]**.Algae could be grown in open culture systems or closed systems (photo bioreactors). The photo-bioreactor (PBR) process could be designed to convert solar energy into required products. It is a highly strikingmethod compared with open-air culture methods**[5]**. Photo-bioreactor uses photosynthetic organisms. It may be due to its favorable advantages such as higher photosynthetic efficiency, higher concentrations, areal productivities, low contamination, the prevention of water loss caused by evaporation, and a precisely controlled environment **[6, 7]**. A typical PBR is a three-phase system that includes the culture medium as the liquid phase, the cells as the solid phase, and CO_2enriched air as the gas phase in auto phototrophic cultivation. It is well known that light availability is the limiting factor for cell growth in a PBR **[8, 9]**.

The efficiency of PBRs is determined by the mixing of light capturing, light transportation, light distribution and light consumption by microalgae through photosynthesis.Light accessibility is the regulating factor for cell growth in a photo bioreactor **[8]**.Microalgae consume carbon dioxide (CO_2) as a carbon source. High concentration of dissolved carbon dioxide can lead to a low culture p^H; it would be inhibit certain species of microalgae **[6]**.

Therefore, biodiesel production from microalgae will not contribute to global warming by excessive release of carbon dioxide (CO_2).Numerous types of photo bioreactors have been developed till date, however limitedphoto bioreactors can be used for mass cultivation of algae **[10-18]**.

A photo bioreactor is one of the most effective methods of microalgae cultivation because of the high solar receiver area and better biomass productivity. An optimal design is necessary to maximize biomass productivity. This paper covers the detailed design, development and performance evaluation of Photo Bioreactor for Algae Production.

Energy saving aspects of green and shaded roofs: A review

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Abstract— **For the present world scenario, global warming, air and water pollution, diminution of natural resources, acid rains, and ozone depletion are significant environmental consequences that are considered due to human activities on Earth. Sustainable strategies have been therefore developed as main remedies to tackles these problems. The green roof is one solution that provides thermal comfort for dwellers and reduces energy consumption in buildings. The most appropriate sustainable solution to resolve the problem of the Urban Heat Island (UHI) effect is green roofs, and it is a sustainable practice to mitigate the adverse effects of urbanization. In this review paper includes energy-saving aspects of green roof and shaded roof in different climatic zones. However, the construction and maintenance cost of green roofs is high with roof leakage problems, but these problems can be overcome using new effective green roof design strategies. The energy-saving achieved using the green, and shaded roofs vary from 10.2% to 36.0% and this paper mainly highlights the energy-saving challenges using green and shaded roofs with advanced modifications for future recommendations.**

Keywords— **Building envelope, Green Roof, Heat Gain, Energy Saving, Shaded roof, Thermal Comfort;**

I. Introduction

In the worldwide rate of urbanization increased due to the population level and comfort demand of people. When the urban air temperature is higher than the cooler surrounding rural areas, this effect is called an urban heat island (UHI) effect. The modification of urban land areas where trees and vegetation were replaced by built surfaces (like building surfaces and paved roads) occurred. This urban temperature profiles significantly affect the energy consumption in buildings [1]. A higher temperature leads to an increase in cooling demand and reduced working efficiency of air-conditioning systems for buildings. An increase 10C air temperature required the addition of 500 megawatts (MW) electricity for air-conditioning for buildings [2]. The Asian countries near the equator received maximum solar radiation with an intensity of 800-100 W/m2, causing thermal discomfort associated with the built environment. It leads to a higher energy demand for thermal comfort in building sectors due to air conditioning systems [3]. The requirement of thermal comfort is an essential concern in urban areas for human health quality. About 45 % of the world's population lived in urban areas, and 60 % will shift until 2025. So the requirement of thermal comfort is an essential concern in urban areas for human health quality [4]. Green places are replaced by roads, roofs, and facades in cities due to the rapid urbanization, and all of these components absorb heat from the Sun and cause the warming of these spaces to produce urban heat island (UHI) effect [5]. The roof is one of the primary building envelopes, and many investigations proved that about 50% heat gain achieved through it from the environment causes radiant heat load on the occupants [6]. Roof contributes about 50-60% thermal load towards environment in peak summer season so proper energy-efficient roof design considered to achieve thermal comfort [7-8].Buildings are responsible for about 33% of global green gas emissions. Therefore, it is essential to design more environment-friendly buildings that lead to more energy savings and less diminution of natural resources. Generally, a green roof is defined as a roof covered with a green plant or green technology incorporated in it [9]. Green and shaded roofs are both sustainable rooftop technologies, and these roofs reduced the environmental impact of buildings. When a green roof is integrated with shading like a photovoltaic (PV) system, the indoor temperature decreased due to the evaporative cooling effects [10].

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Green roofs are most popular in urban areas because it promotes biodiversity by the higher presence and plenty of inherent plant species compared to conventional roofs and provides other benefits like cooling of

3.4.5

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CONVERTING BIOMASS INTO BIOENERGY FUELS BY SOLAR PYROLYSIS: A REVIEW

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Abstract- *Concentrated solar energy provides heat to drive biomass pyrolysis reactions, which improves feedstock energy by storing solar energy in chemical types like biogas, biooil, and biochar. Direct solar pyrolysis will produce more pyrolytic gas with a lower heating value due to the high temperature and rapid heating rate.Pyrolysis is one of the methods for extracting energy and useful biomass chemicals. The primary goal of biomass pyrolysis is to produce a liquid fuel that is easier to transport and store and can be used as a substitute for* energy. Pyrolysis oil yield and composition are determined by biomass feedstock and *operating parameters. It's also crucial to investigate the impact of variables on response performance and the desire to maximize them. The latest biomass pyrolysis literature is used to investigate operating variables.Final pyrolysis temperature, inert gas sweeping, residence times, biomass heating intensity, mineral matter, biomass particle size, and biomass moisture content are the most important operational variables. The aim of this paper is to look into the details of biomass solar pyrolys is using various methods.*

INTRODUCTION

Total global final energy consumption was almost 10000 million tones of oil equivalent (Mtoe) in 2018,an increase of 2.2% compared with 2017. In the Stated Policies Scenario, It rises to almost 12700 Mtoe by 2040, an increase of around 1.1% per year on average, while global energy intensity improves by 2.3% per year. Implementation of the specified policy scenario results in changes in energy intensity and renewable energy growth, but the pace of change is not adequate to fulfil the Sustainable Development Goals related to energy. There's a similar storey with renewables.

While investment in the Defined Policies Scenario is projected to rise from around \$390 billion in 2018 to nearly \$440 billion annually on average by 2030, it falls short of the \$650 billion annually expected on average to achieve the Sustain7ble Development Goals by 2030. Worldwide, energy transitions mean improvements in how we supply and consume energy.

In shaping energy consumption and carbon dioxide (CO2) emissions in industry , demand for materials and industrial goods plays a central role. In the face of demand growth, the policies adopted or announced so far will not halt a potential rise in industry emissions: the Reported Policies Scenario will grow by 16 percent in 2040. The carbon footprint of the usage of energy fluctuates increasingly depending on the time of day or night as the electrification of economies progresses and the share of variable renewables in generation rises. In India, our study shows that average CO2 emissions from the use of electricity at noon or 23:00 vary by a factor of seven when the share of variable renewables exceeds 50 percent. In Europe, a factor of three is the difference. Although biogas-producing technologies are not new, interest in their potential has been resurgent in recent years. Analysis by the IEA shows that today, more than 570 Mtoe per year of biogas could be generated sustainably, equivalent to almost 20 percent of global demand for natural gas.Two thirds of the global demand for biogas is accounted for by emerging economies. Biogas, however, needs positive policies anywhere if it is to be completely used. There are several advantages to the use of biogas, and the economic situation improves dramatically if these non-economic advantages are completely taken into account. By 2040, close to 150 Mtoe of biogas is generated globally in the Specified Policies Scenario, over 40 percent of which is in China and India.There is a more pronounced rise in biogas production in the Sustainable Development Scenario: it will cross around 330 Mtoe by 2040, using around 40 percent of the total sustainable technological capacity. [1]

POET and Archer Daniels Midland, the world's two largest ethanol producers, are both based in the United States (ADM). POET is expanding its capacity by upgrading some of its 27 ethanol plants, and in 2018 the company began expanding a facility in Marion, Ohio, and also began construction on a new plant in Indiana. Meanwhile, 121 ADM decreased its ethanol ability marginally, focusing on other high-value chemicals. [2] There is a considerable potential for renewable sources, such as solar and biomass, but they

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Energy Saving Opportunities in Buildings Using Cool Roofs for India: A Review

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Abstract. India is a tropical country with vast climatic zones varying from region to region, and from a fast few years, the rate of urbanization also increased. The requirement of thermal comfort in buildings is one of the primary needs in residential buildings in the present scenario. The roof is one of the most critical parts of the building envelopes, and maximum heat gain entered through it. This paper presents the systematic review of cool roofs and its energy-saving opportunities in Indian residential buildings for different climatic zones, identifying the present scenario of cool roof technology in India. The majority of the research work performed in India's composite climate, so more research work based on the cool roofs strategies need to be performed in other climates. The energy-saving achieved using cool roofs vary from 8.4 to 30.4%, and indoor temperature varied from 2.0 to 7.0^{0}C for different climatic zones of India.

INTRODUCTION

In the present scenario, about 50 % of the populations live in urban areas, and it would be increased by up to 70 % by 2040. Energy consumption in buildings is growing worldwide at an average rate of 40% because of the growing population and faster development of nations [1]. India ranked third for energy consumption in the buildings and in which about 56-60% of the energy consumed by air conditioning. High-energy use will also lead to environmental degradation and put the impact on climate change. The buildings in tropical and semitropical regions have high-energy consumption, especially for thermal comfort. Special attention is needed to reduce the cooling loads of buildings, so energy-conscious designs and techniques may decrease buildings' construction and operational cost [2]. Due to the improvement of comfort level and the extension of human activities, the per capita energy consumptions increased by 11.18% in the last ten years [3]. The building envelope components (windows, doors, walls, roofs, etc.) define the energy interchange between the outdoor and indoor environment and manage the building's overall energy performance. The accurate design of building envelopes plays a crucial role in building and improving energy efficiencies [4]. The roof is a primary component of the buildings. The maximum heat gain entered through it, and roof surface treatment with high solar reflectance and high emissivity paints is one technique to accomplish comfort conditions in buildings [5]. Cool roofs could reduce peak temperatures up to 3 0C during day time, and direct energy saving achieved between 20-70% using a cool roof of albedo greater than 0.70 [6]. The application of a cool roof could reduce about 54% cooling energy demand. It was also reported that cool roof is one of the most efficient surface treatment techniques than other cooling technologies. It retained the building, close to comfort conditions during the summer seasons [7]. It also reduced the heat gain and indoor air temperature between 11-60% and 1-7 0C, respectively [8]. Literature indicates that proposing an optimum combination of surface reflectivity and insulation of the roof may give the best results in energy saving for buildings. Cool roofs with adequate insulation used by some countries to meet their requirements especially in hot-dry climates [9].

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Production of Bio-ethanol from Renewable Resources: A Review

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ABSTRACT
Bio-fuels such as bio-ethanol have been found a suitable replacement for fossil fuels in terms of energy and environmental safety. Bioethanol can be produced by sugars, starch, lignocelluloses, and algae. Biomasses containing sugar or starch are the traditional source for commercial biofuel production however, feedstock from lignocelluloses and algae groups still drive the attraction of researchers. It may be due to the variety of available options and their different processing techniques. For commercial production of bio-ethanol, several biomasses have been tried by researchers. This review paper concentrates on an overview of the different types of biomass used for bio-ethanol production.

Keywords-- Biomass, Bio-ethanol, Bio-fuels, Feedstock

INTRODUCTION

The escalating consumption of crude oil is not only harmful to energy security but also immensely affects the environment with the greenhouse effect. Therefore researchers are focusing to develop a promising alternative and renewable technology to replace fossil fuels [1].

Bioethanol is one of the alternatives to fossil fuels. Renewable sources which are rich in carbohydrates, starch, protein, sugar, or its components can be used to produce good quality bio-ethanol [2]. Worldwide various countries use a different type of biomass to achieve the satisfactory target of bio-ethanol production so that their reliance on fossil fuels could be decreased (Fig. 1). Globally, the United States is the leader and producing the highest amount of Bio-ethanol (13,926 Million Gallons 2020), which is approximately 53% of total Bio-ethanol produced.

On 4th June 2018 Indian Government has approved National Policy on Biofuel 2018. The policy has the major objective of reaching 20% ethanol-blending by the year 2030 [3]. Presently India is contributing only 2% in global Bio-ethanol production. In 2020, 515 Million Gallons of ethanol were produced in India [17]. To meet the challenges of National Policy on Bio-fuel 2018, a consistent and low-cost technology needs to be developed to increase the production of bio-ethanol. At the same time, it should not affect the food chain, farming land and avoid monoculture. This review is mainly confined to different biomass available for potential bio-ethanol production from the first and second generation of bio-fuel.

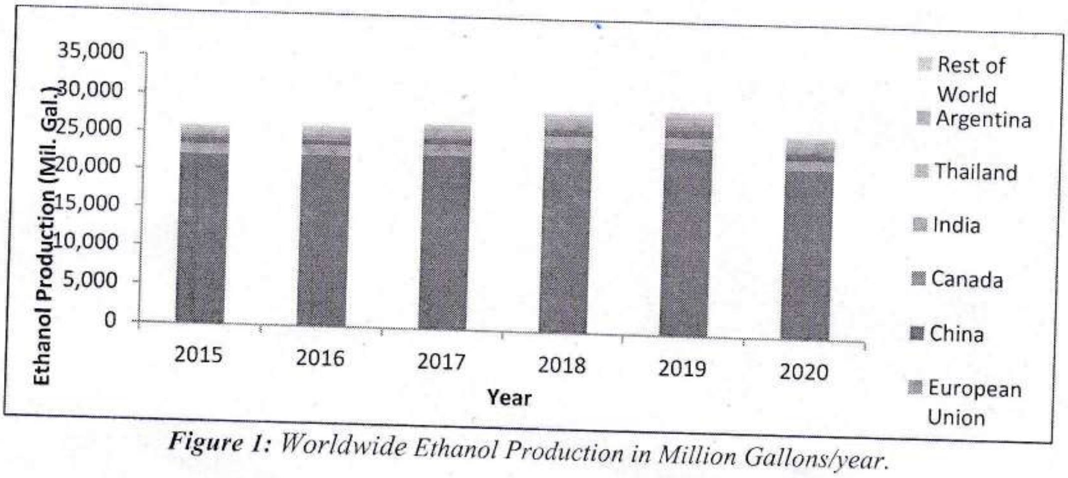

Figure 1: Worldwide Ethanol Production in Million Gallons/year.

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Performance evaluation of a cool roof model in composite climate

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Thermal Comfort

ABSTRACT

India is the seventh-largest country in the world and ranked second with more than a billion populations after China. The annual electricity consumption demand increased to 8% in the buildings for residential and commercial sectors. The requirement of thermal comfort is a primary need in residential buildings located in composite and hot-dry climates. The thermal performance of cool roof model was analyzed in terms of indoor temperature compared to Reinforced Cement Concrete (RCC) roof for composite climate, Indore, Madhya Pradesh, India. The study aims to assess the impact of the cool roof on the indoor temperature of buildings. The experimental study indicates that a cool roof performed better for indoor temperature profile and maintains a thermal comfort in buildings. The cool roof technology is more economical and easy to implement in all residential and commercial buildings. The study revealed that the roof's interior and exterior surface temperature reduced about 4.1 °C and 9.2 °C, respectively, while indoor room temperature reduced about 2.4 °C.

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1. Introduction

The rate of urbanization in the world enhanced in recent times, and about 80% of the world population will live in an urban area within 50 years. The most significant contributor to world energy consumption is the building sector due to the rapid growth and construction of new buildings and the dramatic increase of populations. International Energy Agency (IEA) predicted that global energy consumption enhanced up to 53% for the next ten years due to the rapid urbanization in developing countries of the world [1]. Building sector is considered a primary contributor in terms of world energy consumption and greenhouse gas emission. Due to the improvement of comfort level and the extension of human activities, the per capita energy consumptions increased by 11.18% in the last 10 years [2]. About 10% of the world delivered energy consumed by residential buildings and it will enhance at the rate of 1.5% per year as per the International Energy Agency (IEA). In India's present scenario, the per capita consumption is less compared to other developing countries and one of the biggest energy consumers are residential sectors of buildings [3]. The roof is an essential attribute of the building envelope and it contributes maximum load (50–60%) in a total cooling load of the building reaching inside from the environment. So the requirement of thermal comfort is needed, especially in summer seasons [4]. The most common construction materials for roofs have a low reflectance values ranging from 20 and 30%. The indoor temperature reduced to 3 °C if an increase in solar reflectance was 50% to 92% of roof paints [5]. India is a tropical country, and climatic zones vary from region to region, and significant amount of heat is absorbed by a roof to enhance discomfort in non-conditioning buildings. By selecting appropriate roofing materials eliminated the need for HVAC (Heating Ventilation and Air-conditioning) systems. Passive cooling methods with low R-value used in hot climates due to their higher energy performance reduced the cooling load up to 37%. Cooling load reduction achieved up to 80% if passive cooling techniques integrated with reflective material and cool roof. [6].

The main properties of cool roofs absorb less solar radiation and transmitting less heat into the building. Moreover, it reduced air-conditioning demand and carbon emission of electricity to operate air conditioners and provide more comfortable indoor conditions. Cooling Energy demand reduced up to 16% using the cool products in summer. Meanwhile, the annual requirement reduced by about 3% [7].For India most of the parts located in a composite climate where heat gains through the roof caused indoor discomfort. Mostly construction materials used in the buildings are reinforced concrete cement (RCC) followed by concrete, brick, tiles, and mud. So the requirement of thermal comfort is an essential need due to

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