CHEMPHORIA

MAGAZINE - 2023 EDITION

IIChE Student Chapter
Department of Chemical Engineering
TKM College of Engineering

RENEWABLE ENERGY

Future with Floating Turbines

Microbial Fuel Cells

Point Absorbers

Food Waste Solar Panel

Pyroelectricity

GATE Corner

CHEMPHORIA 2023 EDITION

HOD’S MESSAGE

Dear Readers,

I am happy to note that IIChE (Indian Institute of Chemical Engineers) TKMCE, Student Chapter is bringing out the latest edition of the Magazine, ‘Chemphoria’, a platform that represents our department's commitment to excellence, innovation, and knowledge dissemination.

This edition of the IIChE Magazine encapsulates the spirit of our department as the academic activity is continuously geared up and monitored to cope-up with emerging trends of technological development and innovations. It serves as a testament to the dedication and hard work of the students who will get exposure to academic and professional fields which will leave a mark on their services, wherever they go, by exhibiting their sound professional knowledge, unimpeachable character, sense of discipline, and commitment.

Moreover, we are immensely proud to present the achievements and success stories of our students, who continue to make significant contributions to academia, industry, and society.

I would like to express my heartfelt gratitude to the editorial team, contributors, and all those involved in the production of this magazine. Their hard work and dedication have ensured the publication of this edition of the magazine.

Thank you all for your continued support, and I hope you find this edition of the IIChE Magazine insightful and inspiring. Together, let us continue to push the boundaries of knowledge and make significant contributions to the ever-evolving field of Chemical Engineering.

Warm regards,

Dr. Saibi R

Head of the Department

Department of Chemical Engineering

STAFF EDITOR'S EPISTLE

Dear Readers,

It is with great pleasure that I welcome you to the latest edition of our magazine. As the Staff Editor, I am happy to present to you a collection of captivating articles, and thought-provoking features that encompass the essence of our publication.

At the heart of our magazine is a dedicated team of talented writers, and editors who have worked tirelessly to curate content that informs, entertains, and inspires. Our goal is to bring you the latest trends, advancements, and ideas in our field.

We understand the importance of nurturing talent and fostering growth within the student community. This edition delves into a wide range of topics, from groundbreaking scientific discoveries to innovative technologies that are transforming industries.

As a team, we are committed to maintaining the highest accuracy, integrity, and quality standards. Every article undergoes a meticulous editing process, ensuring that the information presented is reliable and up-to-date. We take pride in our role as a trusted source of knowledge, and we strive to provide you with content that is both informative and engaging.

I would like to take this opportunity to express my gratitude to the incredible team of writers, editors, designers, and support staff who have contributed to the creation of this magazine. Their passion, creativity, and dedication are truly inspiring, and I am privileged to work alongside such talented individuals.

Lastly, I want to extend my deepest appreciation to our readers. Your continued support and feedback are invaluable to us. We are constantly striving to improve and evolve, and your engagement drives us to push boundaries and deliver a magazine that resonates with your interests and needs.

I invite you to dive into the pages of this edition and explore the captivating world of *'Chemphoria'*. We hope that you find inspiration, knowledge, and enjoyment in these contents.

Thank you for your ongoing support, and we look forward to bringing you more engaging content in the future.

Warmest regards,
Manikandan P M
Staff Editor - 'Chemphoria' (IICHE Magazine)

STUDENT EDITOR’S NOTE

Dear Readers,

I am excited to present to you our latest edition of Chemphoria , dedicated to the topic of renewable energy. In an era where the effects of climate change are becoming increasingly evident, it is crucial that we explore sustainable solutions for our energy needs. Renewable energy is not just a trend; it is a necessity for the future of our planet.

This edition aims to shed light on the incredible potential of renewable energy sources and the strides being made in this field. I have gathered a collection of articles, and features that will provide you with valuable insights into the advancements, challenges, and opportunities associated with renewable energy.

By exploring the realms of renewable energy in this edition, I hope to inspire our readers to become actively involved in the transition to a sustainable future. Whether you are a student, a professional, or simply interested in making a positive impact on the environment, renewable energy is a topic that concerns us all.

Also ,I would like to extend my warmest thanks to Manu M Johnson for his contribution to making the cover page for this magazine.

And hereby , I encourage you to dive into the articles and engage with the content. Together, let us explore the possibilities of renewable energy and strive for a greener, cleaner, and more sustainable world.

Happy reading!

Heloise Jose (2022-2026)
Student Editor - CHEMPHORIA

The department in a nutshell…….

Vision

Attainment of recognition by all stakeholders as well as peers as a department of choice for higher learning in the discipline and allied areas, that strives for excellence in teaching, outstanding research, scholarly activities and apply engineering expertise in meeting societal needs.

Mission

- Prepare the students for graduate study through an effective curriculum and produce chemical engineering professional who can serve the industry and the society at large by imparting the best of scientific and technological knowledge.
- Provide competitive and stimulating academic environment to nurture creativity, self-learning and inter-personal skills.
- Foster the pursuit of new knowledge and innovative ideas in chemical engineering through industry-institute interaction and facilitate progressive research.
- Practice ethical approach, pursue sustainable development and instill a passion for lifelong learning.

Program Educational Objectives (PEOs)

- Succeed in their chosen career path, as practitioners in process industries and organizations or pursue advanced technical and professional degrees.
- Exhibit the required mathematical and problem solving skills and competencies, necessary to adapt to the changing technologies and become lifelong learners.
- Possess integrity and ethical values both as individuals and in team environments and address global and societal issues including health, safety and protection of environment.

Programme Specific Outcomes (PSOs)

- Analyse and apply the knowledge of Unit Operations and Unit Processes to function as process engineer.
- Design process equipment and develop processes considering safety, economic, environmental and ethical aspects.
- Communicating effectively with peers and society and function as a member or a leader for managing projects, adapting to technological changes.

Program Outcomes (POs)

Engineering graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigation of complex problem**: Use research- based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage project and in multidisciplinary environment.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

About IIChE….

Indian Institute of Chemical Engineers is a confluence of streams of professionals from academia, research institutes and industry. It provides an appropriate forum for joint endeavours to work for human beings through application of chemical engineering and allied sciences. Programmes of IIChE are immensely beneficial, opening up doors of new and existing possibilities.

The student chapters guide its members in career choice and arrange lectures, seminars, short courses, plant visits, etc., at regular intervals to better equip and empower the students when they are out of their academic precincts

Vision

Over the years the Institute has developed a distinct profile of its own. Even though the IIChE is always moulding itself and playing a proactive role to keep up with the ever changing needs of the society and the economy, its basic objectives largely remain unchanged since its inception. One may shortlist them as:

- To promote advancement of chemical engineering and draw up a code of ethics in the profession
- To maintain and widen contacts with chemical engineering professionals in India and abroad
- To ensure regular exchange of ideas with other national and international professional institutes in this field
- To act as an authoritative body on matters pertaining to the teaching and the profession of chemical engineering
- To conduct examinations and assist persons engaged in the industry to qualify as chemical engineer
- To confer awards, diplomas and certificates to such persons as may be deemed fit.
- To undertake publication work i.e., journal, monographs, proceedings of seminars/symposia/workshops
- To conduct meeting and transact business in administrative, academic and technical matters relating to the profession

Mission

The primary objective of a student's chapter is to promote among chemical engineering undergraduates a feeling of fraternity, brotherhood and to complement the objectives and activities of the institute. It shall also render all possible assistance to the regional centres in matters relating to student members.

Objectives

The activities of the student's chapter specifically include the following:

- To arrange lectures, film shows and video shows related to the chemical engineering education and profession
- To arrange seminars, workshops, group discussions and debates and to promote interaction of the institute with industry
- To establish and operate book banks for the use of its members
- To arrange excursions and plant visits of interest to chemical engineers undergraduates
- To assist and guide student chemical engineers in their career planning and placement
- To assist any other activities of social, technical and educational interest to chemical engineering undergraduates.

CHEMPHORIA'23 MAGAZINE COMMITTEE

Alfiya S

Anugrah James

Anagha K

Akash A N

Athira Chandran G

Bismi S

Devi Chandana S

Heloise Jose

Jeevandersh S

Jugnu S

Sharon Mathew Sam

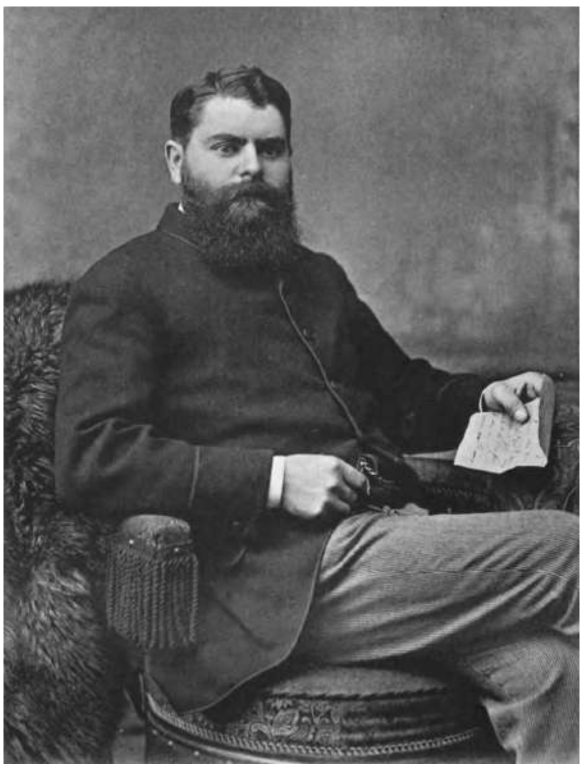
Manu M Johnson (cover page design)

IIChE TORCH BEARERS FOR THE ACADEMIC YEAR 2022-2023

FACULTY IN CHARGE	:	Mr.Manikandan P M
PRESIDENT	:	Ajith P Mangottil
VICE PRESIDENT	:	Ankith George Mathew
		Athira Chandran G
TREASURER	:	Anjana K Mohan
TECHNICAL HEAD	:	Gokul Padmanabhan
DOCUMENTATION HEAD	:	Jeevandersh S
DESIGN HEAD	:	Abhijith M
PUBLICITY HEAD	:	Akshara Rajesh
2nd YEAR REPRESENTATIVES	:	Anugrah James
		Bismi S
1st YEAR REPRESENTATIVES	:	Heloise Jose
		Jayshankar J

1850 - 1907

GEORGE EDWARD DAVIS



Source: wikidata

FOUNDING FATHER OF CHEMICAL ENGINEERING

British chemist and Engineer

ABOUT

Founding father of chemical engineering.

George E. Davis (1850-1907) was a British chemist and engineer who made significant contributions to the field of industrial chemistry. He is known for his work on the application of chemistry to various industrial processes, particularly in the fields of alkali manufacture, gas purification, and metallurgy.

Davis was born in London and received his education at the Royal School of Mines. He began his career as an analytical chemist, but soon became interested in the industrial applications of chemistry. He worked for several companies, including the Alkali Inspectorate and the Gas Light and Coke Company, where he made important contributions to the development of gas purification methods.

In 1887, Davis published a book called "The Manufacture of Alkali," which became a standard reference in the field. He also published numerous articles in scientific journals and was a Fellow of the Royal Society. Davis was instrumental in establishing the discipline of chemical engineering and was a founding member of the Society of Chemical Industry.

Davis is remembered as one of the pioneers of industrial chemistry and his contributions to the field have had a lasting impact on modern industrial processes.

Source: redbubble

CHEMICAL ENGINEERING IS THE PROFESSION IN WHICH A KNOWLEDGE OF MATHEMATICS , CHEMISTRY, AND OTHER NATURAL SCIENCES GAINED BY STUDY , EXPERIENCE , AND PRACTICE IS APPLIED WITH JUDGMENT TO DEVELOP ECONOMIC WAYS OF USING MATERIALS AND ENERGY FOR THE BENEFIT OF MANKIND .

-AICHE

CONTENTS

TOPICS

ALL YOU NEED TO KNOW ABOUT CHEMICAL ENGINEERING

1. Chemical engineers play a crucial role in developing and designing the processes and products that we use everyday , from the food we eat to the fuel we put in our cars.
2. The first chemical engineering curriculum was established at the University of Manchester in the United Kingdom in 1887.
3. Chemical engineers are involved in a wide range of industries, including pharmaceuticals, biotechnology, energy, materials science, and food and beverage production.
4. Chemical engineering has been listed as one of the highest paying professions in the world, with many chemical engineers earning six-figure salaries.
5. Chemical engineers have been involved in many groundbreaking projects, such as the development of synthetic insulin for diabetes treatment and the design of sustainable energy systems
6. Chemical engineers are also involved in environmental protection and sustainability, working to develop processes and products that minimize waste and reduce the impact on the environment.
7. Chemical engineering is a rapidly growing field, with demand for skilled professionals expected to continue to increase in the coming years.

RENEWABLE ENERGY

Harnessing the power of renewable energy sources for a sustainable future!

(HELOISE JOSE , 2022-2026)

Source: istock

The use of renewable energy sources has emerged as a crucial answer for a sustainable future in the face of rising global energy demand, diminishing fossil fuel supplies, and increased environmental concerns. Renewable energy is a clean and limitless substitute for conventional energy sources since it is produced from naturally replenishing resources including biomass, wind, sunlight, and water. This essay examines the relevance of renewable energy and focuses on its ability to slow global warming, improve energy security, and stimulate the economy.

1. Combating Climate Change: By lowering greenhouse gas emissions, renewable energy is essential in the fight against climate change. Renewable energy sources like solar and wind power emit very little greenhouse gas during operation, in contrast to fossil fuels, which release dangerous carbon dioxide and other pollutants. We may reduce the quantity of carbon dioxide released into the atmosphere by switching to renewable

energy sources, thereby reducing the negative effects of climate change, such as rising temperatures, sea level rise, and extreme weather events.

2. Energy Security and Independence: The potential of renewable energy to increase energy security and independence is one of its main benefits. Traditional energy sources frequently depend on imports from politically unstable areas, making countries susceptible to price changes and supply disruptions. In contrast, because renewable energy sources are plentiful and widely available, nations can use their own domestic resources and lessen their reliance on imported energy. This change encourages energy independence, boosts national security, and eases geopolitical tensions brought on by the extraction of fossil fuels.

3. Economic Development and Job Creation: The move to renewable energy presents enormous economic prospects. Investments in sustainable energy technology promote economic expansion, launch new businesses, and create jobs. Jobs are being created in a variety of industries, including engineering, manufacturing, construction, research and development, and maintenance, as the renewable energy sector grows. Decentralized renewable energy technologies, like rooftop solar panels, also give people and communities the ability to produce their own energy, giving them economic autonomy and stimulating local entrepreneurship.

4. Sustainable Development and Improved Public Health: By addressing present needs without sacrificing the capacity of future generations to address their own, renewable energy is in line with the ideals of sustainable development. It provides a mechanism to accomplish several SDGs, such as achieving inexpensive and clean energy, tackling climate change, and promoting responsible consumption and production. Furthermore, the enhanced public health results brought about by the use of renewable energy sources reduce air pollution. We may lessen the load on healthcare systems, lessen hospitalisations, and minimize respiratory ailments by substituting renewable energy options for fossil fuel burning.

5. Technical Innovation and Advancements: The widespread use of renewable energy promotes technical innovation and advances. Improved efficiency, lower costs, and

advancements in energy storage technologies are all results of increased research and development expenditures. The ability to overcome the intermittent nature of some renewable energy sources and provide a more dependable and stable power supply depends on advancements in these fields. in addition, the combination of digital technology like smart grids and energy management systems with renewable energy improves efficiency and optimizes energy consumption patterns.

The critical global concerns of climate change, energy security, and economic development present enormous promise for renewable energy sources. We can reduce greenhouse gas emissions, improve energy security, boost economic growth, and advance sustainable development by switching from fossil fuels to renewable energy sources. Governments, corporations, and individuals must work together to speed up the adoption of renewable energy technology, make research and development investments, and construct supportive legislative and regulatory frameworks.

FOOD WASTE SOLAR PANEL

(Athira Chandran G , 2020-2024)

ABSTRACT:

The environmental balance has recently been endangered by the rise in energy consumption brought on by swift industrial expansion. Food waste is a major environmental problem, as it contributes to greenhouse gas emissions, wastes resources such as water and energy, and contributes to food insecurity. According to the Food and Agriculture Organization of the United Nations, approximately one-third of all food produced in the world is lost or wasted each year, which has a significant impact on the environment and the economy. Food that is wasted and put into garbage can be easily converted and used to generate electricity.

INTRODUCTION

According to the International Energy Agency, fossil fuels still make up more than 81% of the world's energy production. The world's oil and gas reserves will run out by 2060 if we keep using these resources at the same rate.The pursuit of renewable energy relies heavily on the utilization of solar panels. However, when the sun is obscured by clouds, their effectiveness is significantly reduced. Traditional photovoltaic panels have the drawback of only being able to absorb direct sunlight and missing out on the UV radiation emitted on cloudy days. In 2017, the journey for creating better materials with such capability has been started. In 2018, Quantum dot technology was researched but proved to be costly. Luckily, in a dark pub inspiration was drawn from glowing neon plates when exposed to blacklight. In 2019, Academic thesis and several prototypes testing the feasibility of the concept. Carvey Ehren Maigue, a Mapa University engineering student from the Philippines, earned the first James Dyson Sustainability Award in 2020 for his work on creating solar panels that can capture UV light from leftover fruit and vegetable food. Building walls and windows could soon serve as a plentiful new source of electricity.

The thing with traditional photovoltaic panels is that they can only absorb direct sunlight and miss out on the ultraviolet light that is emitted on cloudy days. The recently created idea is known as AuREUS, or Aurora Renewable Energy and UV Sequestration. Utilizing luminous particles made from fruit and vegetable waste, a Filipino engineering student created the ground-breaking substance. It combines solar film, which transforms visible light into DC electricity, with organic luminescent particles derived from vegetable and fruit waste that collect UV light and convert it to visible light. The voltage output is then processed by the regulating circuits to enable direct electrical use, storage, or battery charging. The new panels will collect the sun's ultraviolet rays, even in areas with heavy cloud cover, UV rays can still be seen. The light is reflected off the sheets' edges and is then transformed into power by solar PV cells that are fastened to the panels' outer borders. Either the electricity can be used right away or it can be stored. As well as food waste, AuREUS uses crops damaged by tropical storms.

Source: The James Dyson Award,

Source: The James Dyson Award,

"We upcycle the crops of the farmers that were hit by natural disasters, such as typhoons, which also happen to be an effect of climate change".

9 crops out of 78 have high potential to be used as key particles. The materials are initially squeezed to extract the luminescent particles which are steeped, distilled, and then the extracted juice is filtered. Finally, these particles are laid on a resin and further molded into

panels that can be used as screens on windows or as individual panels, or as walls of buildings. AuREUS polymer sheet is flexible and may be bent, molded, and clamped onto almost any shape. AuREUS panels may produce electricity from up to 50% of the light (sunlight and UV light) that strikes them since they can absorb UV light in addition to direct sunlight. Only 15 – 22% of the sunlight that hits standard PV solar panels can be used to produce power. The technology may also make it possible to turn entire structures into vertical solar farms.

"We need to utilize our resources more and create systems that don't deplete our current resources,*"*

Maigue told Dyson after winning.

"AuREUS has the chance to bring solar energy capture closer to people," he continued. *"I want to create threads and fabric so that even your clothes would be able to harvest ultraviolet light and convert it into electricity. We are also looking to create curved plates, for use on electric cars, airplanes and even boats."*

These panels will not only lower expenses and lessen the effects of climate change, but they will also benefit nearby agricultural areas and lessen the risk of radiation-related ailments for individuals.

"*In the conception of AuReus, I aimed to create a future-facing solution in the form of renewable energy and at the same time integrate a present-day value-creating solution for our farmers, who are being affected negatively by the present-day effects of climate change,*"

The project's three primary sources of inspiration are as follows:

- Urban environments with excessive UV exposure are induced by glass structures. The process used to create Auroras served as inspiration for the solution. High energy (gamma, UV) states are converted by luminescent particles in the environment to low energy states (visible light).
- AuREUS can generate electricity even when it is not facing the sun since it catches UV. Vertical solar farms are created when buildings are covered in AuREUS on all sides.

- With the expansion of this technology, crops that spoil quickly, causing losses to farmers can now be recycled.

Pros of using solar panels to manage food waste:

- Renewable energy source: Solar panels provide a reliable and renewable source of energy to power the equipment needed for anaerobic digestion, which can help reduce the environmental impact of food waste management.
- Cost savings: Solar power can help food processing companies save money on their electricity bills, particularly in areas with high electricity costs.
- Reduced carbon footprint: By using solar power to manage food waste, companies can reduce their carbon footprint and contribute to a more sustainable future.

Source: World Economic Forum

- Increased energy independence: Solar power provides a degree of energy independence for food processing facilities, reducing their reliance on grid electricity and fossil fuels.

Cons of using solar panels to manage food waste:

- Upfront costs: Installing solar panels can be expensive, particularly for smaller food processing companies. However, there may be government incentives or financing options available to help offset these costs.
- Weather-dependent: Solar power generation is dependent on weather conditions, which can be unpredictable. This may make it difficult to rely solely on solar power for food waste management.

- Maintenance: Solar panels require regular maintenance to ensure they are operating at peak efficiency, which can be time-consuming and costly.
- Limited applicability: The use of solar power to manage food waste may only be practical for larger food processing facilities that generate significant amounts of waste. Smaller facilities may not be able to justify the expense of installing solar panels.

SUMMARY:

In summary, Solar power is a key climate solution and is already the lowest cost option for increasing electricity generating capacity. Increased access to solar energy is the goal of AuREUS. It will lessen climate change, aid the regional agriculture industry, and reduce food waste.The use of food waste solar panels to convert food waste has several advantages, including cost savings, reduced carbon footprint, and increased energy independence. However, it also has some limitations, such as upfront costs and weather-dependency, which should be carefully considered before implementation.The innovator himself has plans to develop clothing fibers enabling designers to integrate the panels into a variety of innovative designs with this ideology. This feature could help people better understand and accept renewable energy solutions.

BIBLIOGRAPHY:

1.https://www.solarreviews.com/blog/new-invention-turns-food-waste-into-solar-energy

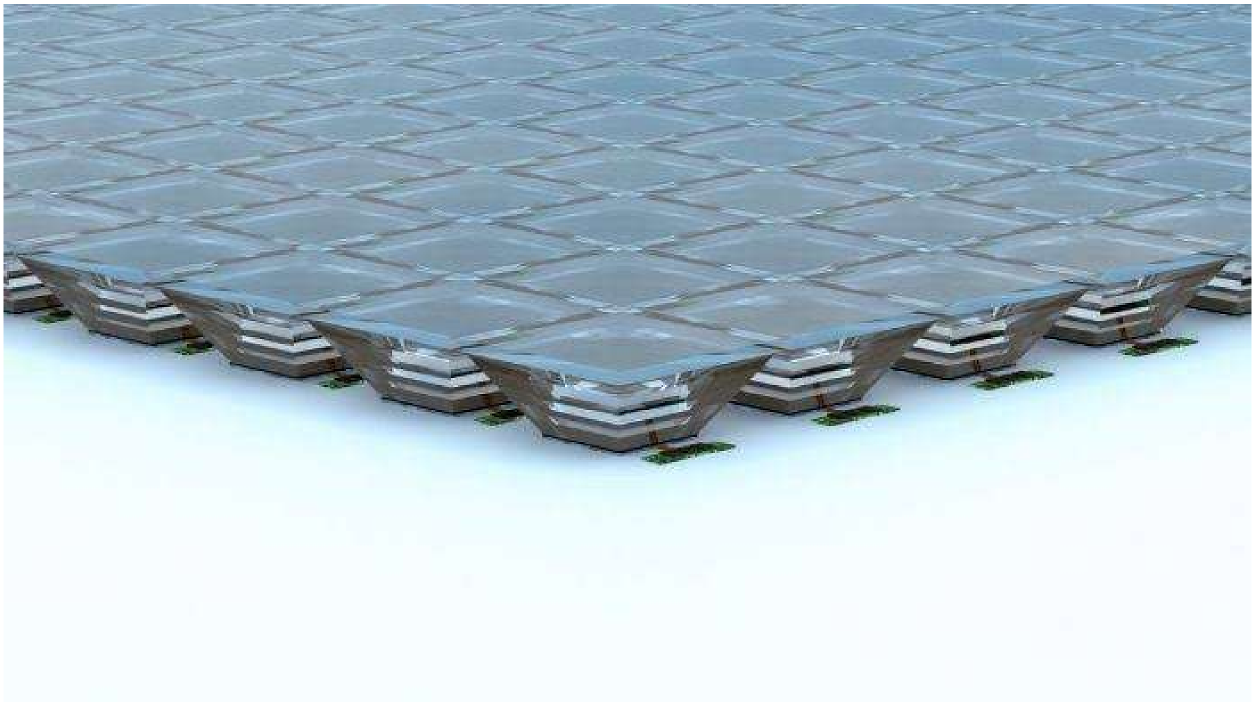
2.https://statensolar.com/2020/12/04/2463/

3.https://www.thebrighterside.news/post/green-solar-panels-made-from-food-waste-generate-energy-without-sunlight

4.https://www.dezeen.com/2020/11/27/aureus-carvey-ehren-maigue-james-dyson-awards sustainability/

3D PRINTED SOLAR CELLS

(JAYASHANKAR J , 2022-2026)

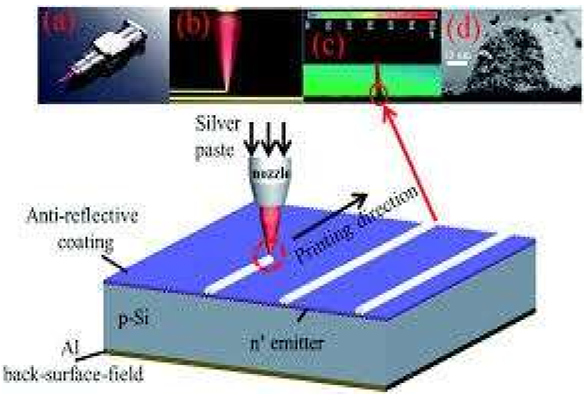


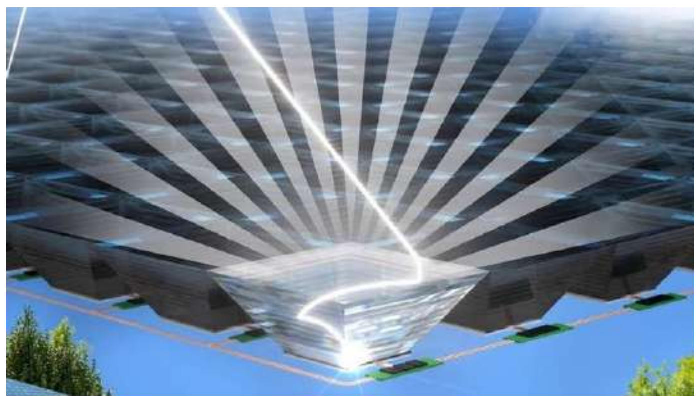
Source: Wiley Online Library,

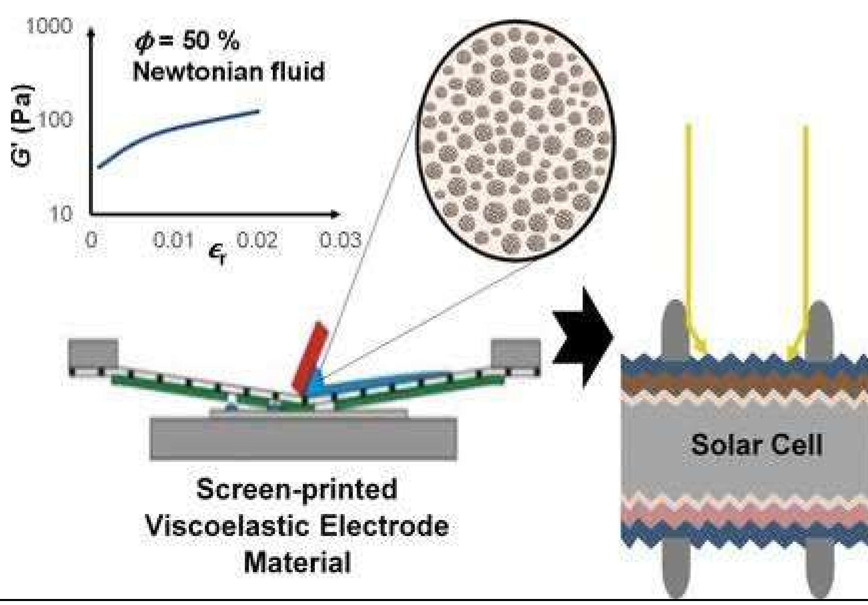
In the solar cell assiduity, three- dimensional printing technology is presently being tested and used in a trouble to address the colorful problems related to the fabrication of solar cells. 3D printing has the capability to achieve coating uniformity across large areas, excellent use of the material with little quantum of waste and the inflexibility to incorporate roll- to- roll and distance- to- distance systems. The major end of this note is to punctuate the crucial gaps in current solar cell manufacturing processes and to make the compendiums to understand the use of 3D printing technology as an volition in solar cell fabrication.The technology of creating solar cells in hunt of effective, featherlight, low- cost, and long- lasting solar cells has evolved dramatically. Likewise, One of the implicit solar cell manufacturing campaigners is 3D printing technology. The way panels are made is by placing alternately different glass layers and polymers helping light to bend at different angles which thereby eventually concentrate light in a single spot.

HOW DOES THE DEVICE WORK?

Conventional solar panels only work stylishly under specific circumstances. The sun is this technology's source of energy, and has to be set in the exact specific direction where the light can hit the panel's flat face directly. Due to the changing of the direction of light during the day, numerous solar arrays rotate towards the sun in order to catch as important light as possible. With the recently introduced advanced device, still, this lengthy and particular procedure may soon be spared. The new panel is suitable to capture and concentrate sun coming from any angle due to its tipless inverted aggregate structure. The material, combination of glass and polymers, enables the lens to concentrate the solar power from different angles in one spot, like a burning lawn with magnifying glass.







Source: Wiley Online Library,

ADVANTAGES OF 3D PUBLISHED SOLAR CELLS

With marketable- scale ministry able of manufacturing kilometers of material each day, published solar cells were quick and affordable to induce, with a low product cost of lower than$ 10 per square cadence.

No other renewable energy technology can be manufactured as snappily as this. The low cost and speed at which this technology can be stationed are instigative. With over 99 percent of the panels made of PET, polyethylene terephthalate, the material was recyclable, giving it a distinct advantage over traditional normal silicon solarcells.Compare that to a silicon cell that's 20 percent effective and lasts over just 20 years. This means that over a continuance, a 3D- published organic solar panel will only produce 1.5 percent of the power of a silicon cell.

REFERENCES

1. https://interestingengineering.com
2. https://www.dnatives.com

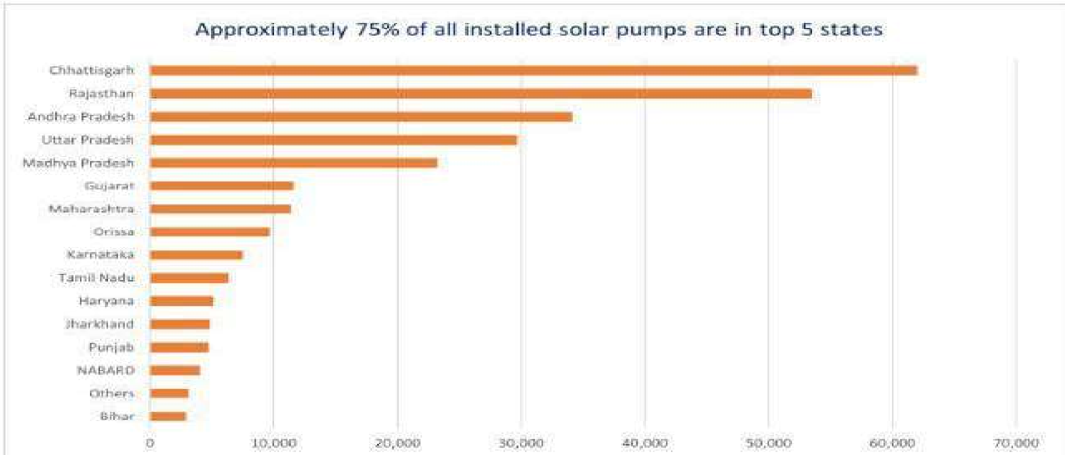
A SHIFT IN THINKING IN FAVOR OF SOLAR POWER PUMPS :AN INNOVATION IN TRANSFORMING THE AGRO SECTOR

(ANAGHA , NAWAL ZAKIR)

Farmers today face numerous difficulties, including unpredictable weather patterns, shifting monsoon patterns, climate change, and desertification. Farmers in many nations now lack access to adequate irrigation systems. The rising cost of electricity or limited access to the electricity grid only makes their problems worse. Solar pumps are becoming a crucial tool for farmers to meet their irrigation needs as a result of these issues. We are at a turning point. The importance of solar electricity is recognised by developed EU countries as well as emerging nations in Asia and Africa. In addition to being utilised to generate electricity for homes, solar energy is now being employed more and more in agriculture. Solar-powered centrifugal pumps are essential for advancing agriculture in countries like India, Asia, and Africa and other emergent markets.

In comparison to fuel-driven and electric pump sets, solar pumps provide a simple, energy-efficient, and clean alternative. They are environmentally benign and can considerably increase agricultural production. By streamlining irrigation in India's hinterlands, solar water pumps can increase agricultural productivity and the standard of living for millions of farmers. India is a pioneer in the widespread use of solar pumps. As part of the KUSUM plan, the government has set a goal of installing 1.75 million solar agriculture pumps by 2022, along with solar systems for another 1 million pumps that are connected to the grid. With only 272,700 pumps built by December 2020, progress is, however, lacking. Although the programme suffered many early difficulties, substantial advancements have been made in recent years. Unfortunately, a lot of momentum was lost as a result of COVID's difficulties with local marketing and installation efforts. But now that the administration is completely behind the plan, the 2022 deadline will soon be extended. By 2025–2026, he anticipates a market expansion of roughly 10 times, reaching 500,000 pump installations annually.

Figure: Solar Pump installation by state up till December, 2020



Source: Technology in Agriculture

Rajasthan, Chhattisgarh, and Andhra Pradesh have become the solar pump leaders in 2019–20.

Today, solar-powered pumps are widely employed both in rich and developing countries, having once been a novel option. However, the one obstacle preventing the mass adoption of solar-powered pumps is their high initial cost. Due to this, efficient and affordable second-generation solar-powered pumps have been created. The price of solar cells is continually falling, which helps solar-powered pumps become more popular**.** It is essential to improve key factors, such as general implementation and documentation standardisation, in order to realise the market's growth potential.

One of the first industries to use solar-powered centrifugal pumps is the agricultural sector. However, the use of solar pumps has now expanded to a number of different sectors, including wastewater treatment facilities, chemical businesses, the food and beverage industry, and the pharmaceutical industry. The adoption of solar-powered pumps is expanding in India for three primary reasons: energy efficiency, sustainability, and environmental concerns. The narrative is yet to engage us.

REFERENCES

1. https://www.un-igrac.org/sites
2. https://www.worldbank.org/en/topic/water/brief/solar-pumping
3. https://www.greenmatch.co.uk/blog/2014/07/7-reasons-why-you-should-use-solar-power

BIOFUEL:BIOETHANOL SYSTEM

(ALFIYA S , 2020-2024)

INTRODUCTION

Ethyl alcohol, or bioethanol, is produced by fermenting sugars or hydrolyzing bioresources (biomass). It serves as a primary fuel for cars used for road transportation in place of petrol. Although ethanol or ethyl alcohol can also be created chemically by reacting ethylene with steam, this approach cannot be referred to as bioethanol due to the lack of a renewable source of raw materials and the nature of the production process. Fermentation of sugar is the method most frequently used. The majority of the sugar needed to make ethanol comes from crops used to make fuel or electricity. Among these crops are corn, maize, and wheat as well as sawdust, willow and common trees, waste straw, Jerusalem artichoke, miscanthus, and sorghum plants. Additionally, efforts are being made to create ethanol fuel from municipal solid wastes. The chemical compound ethanol, also known as ethyl alcohol (C_2H_5OH), is a clear, colorless liquid that is biodegradable, not harmful and does not harm the environment when spilled. When ethanol burns, carbon dioxide and water are produced. Lead has been replaced by the high-octane fuel ethanol in petrol as an octane enhancer. By mixing ethanol with petrol, we can also oxygenate the fuel mixture, resulting in a fuel mixture that burns more thoroughly and emits fewer pollutants. In the US, ethanol fuel mixes are frequently utilized. The most popular mixture, known as E10, contains 10% ethanol and 90% petrol. Vehicle engines can run on E10 without seeking any changes, and this has no impact on vehicle warranties. E85 is an ethanol and petrol blend that may be used by only flexible-fuel cars.

CLASSIFICATION OF BIOETHANOL

Bioethanol can be divided into three categories based on the source of its basic materials. There are three generations of bioethanol:

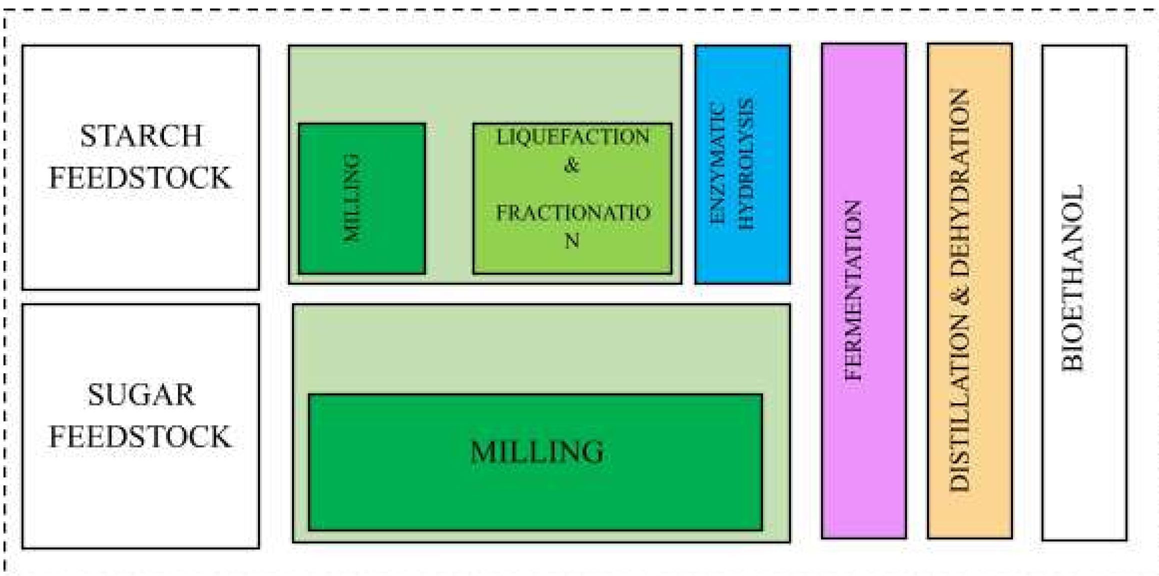
1. First Generation (1G)
2. Second Generation (2G)
3. Third Generation (3G)

1. <u>First Generation (1G) Bioethanol</u>

The term "first-generation bioethanol" refers to ethanols made from food-based feedstocks like starch, sugar, etc. These alcohols are made using enzymes and microorganisms during the fermentation of starches and sugar. These alcohols are the most prevalent kind.

Glucose, fructose, and sucrose are employed as the main components of sugar crops such as sugar cane, sugar beetroot, and sweet sorghum. By crushing or grinding these fermentable sugars, they can then be fermented into ethanol.

Additionally, distillation and subsequent dehydration are used to remove the ethanol from the product stream. Starch, a polysaccharide comprising glucose units connected by (1,4) and (1,6) glycosidic linkages, is a component of grains like maize and wheat. Yeast does not directly ferment starch. Using -amylase and glucoamylase, starch is hydrolyzed into glucose after being extracted from the grains and milled. Later, glucose is fermented to produce ethanol. Critics have criticized the cost-effectiveness of producing ethanol from feedstocks based on food and the effects on how land is used. Due to the shortcomings of first-generation bioethanol, biomass has become a necessary feedstock for ethanol production.



Source: European Biomass Industry Association

Bioethanol production from first-generation biomass.

2. Second Generation (2G) Bioethanol

Those bio ethanol produced from non-food feedstocks are considered to be of the second generation. Since the second generation bioethanol is made from different feedstock, they frequently need different technology. Cellulosic biomass such as specialized energy crops (such as switchgrass and miscanthus) and agricultural and wood residues (such as wood chips, corn stover, sugarcane bagasse, and sawdust) make up the nonfood-based feedstocks used to produce second-generation ethanol. The major components of cellulosic biomass are cellulose, hemicellulose, and lignin polymers that are bonded together in a heterogeneous matrix. A linear polysaccharide, cellulose is made up of many (1,4) connected D-glucose units. A heteropolymer containing xylose, mannose, galactose, rhamnose, and arabinose is hemicellulose. Lignin is a complex polymer of cross-linked aromatic compounds. It functions as a barrier of protection and prevents the breakdown of cellulose and hemicellulose into fermentable sugars. Contrary to first-generation ethanol production, cellulosic feedstock conversion to ethanol is a complicated procedure. To break down the polymeric units and improve the accessibility of C5-C6 sugars for microbial fermentation to create ethanol, cellulosic biomass is first processed chemically or enzymatically. Commercial-scale ethanol plants with a 25-million-gallon annual capacity

were launched in 2014 by POET-DSM and Abengoa Bioenergy. Even if the implementation of second-generation ethanol facilities appears promising, their long-term viability will largely depend on the market's capacity to supply feedstocks at competitive costs. Chemical and biological techniques can be used to convert nonfood-based feedstocks into bioethanol and other products. Furthermore, direct or indirect fermentation can be used to convert biomass biologically. Both direct fermentation of the biomass using hydrolysis-fermentation and indirect fermentation using syngas fermentation can create bioethanol.

3. Third Generation (3G) Bioethanols

Algal biomass is used to create third-generation bioethanol, which can be made from ethanol, hydrogen, diesel, and isobutene. Microalgae are unicellular, heterotrophic, or autotrophic organisms that convert atmospheric CO2 into carbohydrates like starch and cellulose. Macroalgae are huge, multicellular marine algae that can be found in both natural and farmed sources. The primary function of harvested macroalgae is to make hydrocolloids, which account for 10-40% of their biomass. The generation of bioethanol from both micro- and macro-algal biomass has been documented in several studies.

Using mechanical shear or enzyme hydrolysis, starch and cellulose are separated from algal biomass and then used to produce bioethanol. Enzymatic hydrolysis of cellulose from algae is simpler than from plant biomass. Algal biomass can be converted to ethanol using similar processes as plant-based cellulosic biomass. Algae can flourish on non-arable land and do not alter the use of the land. Algal biomass can also be grown using CO2 that is created in industrial flue gasses.

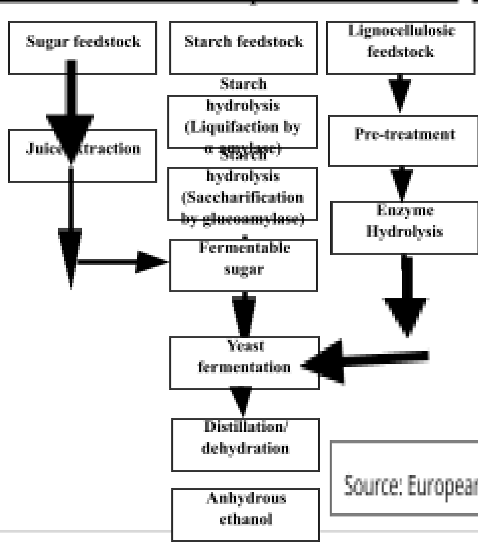
Process economics is the main barrier to the commercialization of algae biofuels, with the cost of harvesting making around 20-30% of the entire cost of agriculture. Closed photobioreactors have been created, but have issues with hydrodynamic stress, high scale-up costs, wall growth, fouling, CO2, O2, and pH gradients. Despite the recent resurgence of interest in macroalgae as a bioethanol feedstock, its economics in the production process remain unaddressed. A recent quantitative examination of macroalgae's sustainability found that it might be used as a sustainable bioethanol feedstock.

COMMERCIAL PRODUCTION OF BIOETHANOL

Bioethanol production is the process of fermentation of simple sugars by microbes to produce ethanol from renewable sugar-containing biomass. The first-generation feedstocks are sugarcane, molasses, sugar beet, and sweet sorghum, while the second-generation feedstock is lignocellulosic materials made from agricultural waste. Yeast can directly eat simple sugars and turn them into ethanol, but starch and cellulose must be converted or depolymerized to glucose. Starch is a polysaccharide composed of glucose monomers that are bonded together by glycosidic linkages. Most starches have an amylose content of 20-30% with amylopectin making up the remainder.

Starch granules are less sensitive to enzyme hydrolysis due to their semi-crystalline structure and water-insoluble granules. Gelatinization is the process involved, and different starches have different gelatinization temperatures. Liquefaction and saccharification are two steps in the two-stage process of enzyme-mediated starch hydrolysis. In the process of liquefaction, an endo-acting enzyme called -amylase hydrolyzes just -1,4 percent cooked starch, substantially reducing its viscosity. The dextrins, or by-products of the liquefaction process, are further hydrolyzed to glucose by the glucoamylase enzyme, which can break down both 1,4 and 1,6 glycosidic linkages. By the end of fermentation, the produced beer with roughly 10%v/v ethanol is treated to distillation & dehydration to eliminate water and other impurities.

Common flow diagram for bioethanol production for 1st and 2nd generation



Source: European Biomass Industry Association

BIOETHANOL PROPERTIES

Compared with fossil fuels, bioethanol fuel has the following special qualities:

1) It has a high-octane level
2) It can reduce the level of particle emission that endangers health (CO)
3) It is similar to gasoline, so its use does not require engine modification
4) It is also regarded as a renewable fuel that does not have CO2 emissions
5) It has low-cost production
6) It is an alternative solution in facing globalization since it is eco-friendly
7) It can be made at home and is low-cost production than fossil fuel
8) The physical characteristic of bioethanol in its pure form is soluble in all proportions with water and also with ether, acetone, benzene, and some other organic solvents
9) Its characteristic chemical function is dominated by the OH group, which can readily help reactions in chemical industries such as dehydration, halogenation, ester formation, and oxidation.

FUEL PROPERTIES OF BIOGAS AND ETHANOL

FUEL PROPERTIES	BIOGAS	ETHANOL
Molecular Weight[kg/kmol]	111	46
Density [kg/l] at 15°C	0.75	0.80-0.82
Oxygen content[wt%]		34.8
Lower Calorific Value [MJ/kg]	41.3	26.4
Lower Calorific Value [MJ/l]	31	21.2
Octane Number (RON)	97	109
Octane Number (MON)	86	92
Cetane Number	8	11
Stoichiometric air/fuel ratio [kg air/kg fuel]	14.7	9

Boiling Temperature[°C]	30-190	78
Reid Vapour Pressure[kPa]	75	16.5

APPLICATIONS OF BIOETHANOL

1.Transport fuel to replace gasoline, as it reduces CO_2 emissions.
2.Fuel for power generation by thermal combustion.
3.Fuel for fuel cells by the thermochemical reaction.
4.Fuel in cogeneration systems.
5.Feedstocks in the chemical industry.
6.Blending ethanol with a small proportion of volatile fuel such as gasoline is cost-effective.
7.Various mixtures of bioethanol with gasoline or diesel fuels.

- E5G to E26G (5% - 26% ethanol, 95% - 74% gasoline)
- E85G (85% ethanol, 15% gasoline)
- E15D (15% ethanol, 85% diesel)
- E95D (95% ethanol, 5% water, with ignition improver)

REFERENCES

1. https://www.energy.gov/eere/bioenergy/biofuel-basics
2. https://www.esru.strath.ac.uk/EandE/Web_sites/02-03/biofuels/what_bioethanol.htm
3. https://www.sciencedirect.com/topics/engineering/bioethanol

BIOGAS : A RENEWABLE ENERGY REVOLUTION

(AFSAL AHAMMED A , 2020-2024)

INTRODUCTION

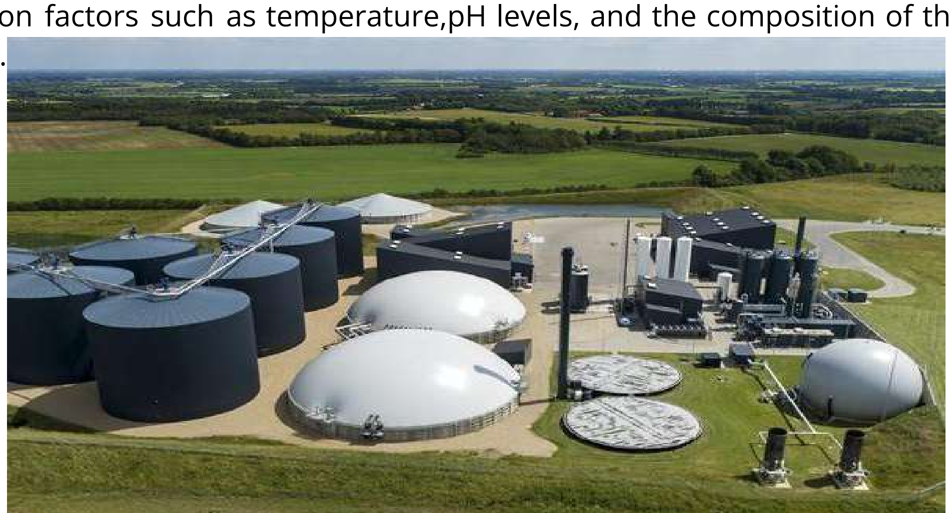
In the search for a renewable and sustainable energy resources, the answer was found as biogas energy.Derived from organic materials, biogas not only provide clean and renewable energy but also helps in waste management thus leading to a sustainable environment.

Understanding Biogas:

Biogas is a versatile fuel produced through anaerobic digestion, a natural process in which organic matter undergoes decomposition in absence of oxygen.The general constituents of biogas are methane(CH_4) and carbon dioxide(CO_2),with traces of other gases.The primary source for biogas production includes agricultural wastes,food residues,sewage sludge etc .

The Anaerobic digestion process:

Biogas production involves 4 main stages:feedstock preparation,anaerobic digestion,biogas collection, and residue management.During the anaerobic digestion process microorganisms break down organic matter in the absence of oxygen, producing biogas as the byproduct.The efficiency of the process depends on factors such as temperature,pH levels, and the composition of the feedstock.



Source: World Wildlife Fund

The Energy Potential of Biogas:

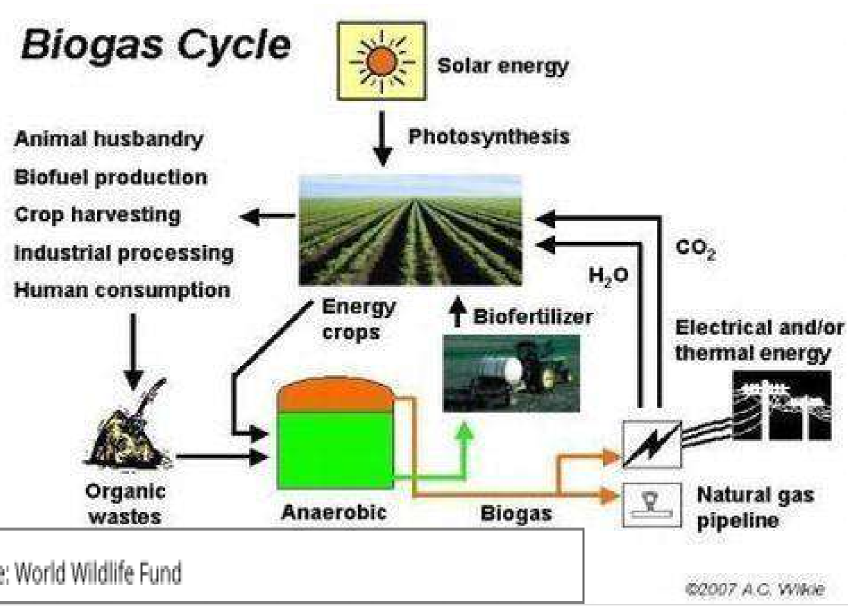
The energy potential of biogas is massive.Methane, the primary component of biogas, is a major source for global warming. By capturing and utilizing methane through biogas production, we not only reduce its harmful emissions but also harness its energy for various applications. Methane provides a great environmental benefit, producing more heat and light energy by mass than other hydrocarbon, or fossil fuel, including coal and gasoline refined from oil, while producing significantly less carbon dioxide and other pollutants that contribute to smog and unhealthy air.

Biogas in Electricity Generation:

Biogas power plants employ combined heat and power systems for the conversion of biogas into electricity. These systems ensure efficient energy utilization by capturing the heat generated during the conversion process, thus maximizing overall energy output.Biogas powered electricity generation offers decentralized and reliable energy solutions, particularly in rural areas where access to the grid is limited.

Biogas as transportation fuel:

Transportation is a significant contributor to carbon emissions and air pollution.Biogas, in the form of compressed natural gas(CNG), or liquified biogas(LBG) presents a viable alternative for the conventional sources like petrol and diesel.Furthermore, the harmful emissions from biogas is minimal when compared to the other sources of fuel.



Source: World Wildlife Fund

Environmental benefits:

One of the most significant advantages of biogas lies in its positive impact on the environment.As organic waste decomposes naturally, it releases methane-a potent greenhouse gas-into the atmosphere.By capturing and utilizing this methane as biogas, we not only prevent its release but also mitigate its harmful effects.

CONCLUSION:

Biogas represents a compelling solution for sustainable energy generation,offering both environmental anEconomic benefits.By harnessing the power of organic waste, we can simultaneously address waste management challenges,reduce greenhouse gas emissions and meet our energy needs.As we move forward greener and more sustainable future, biogas stands as shining example of innovation and resourcefulness in the pursuit of a cleaner planet.

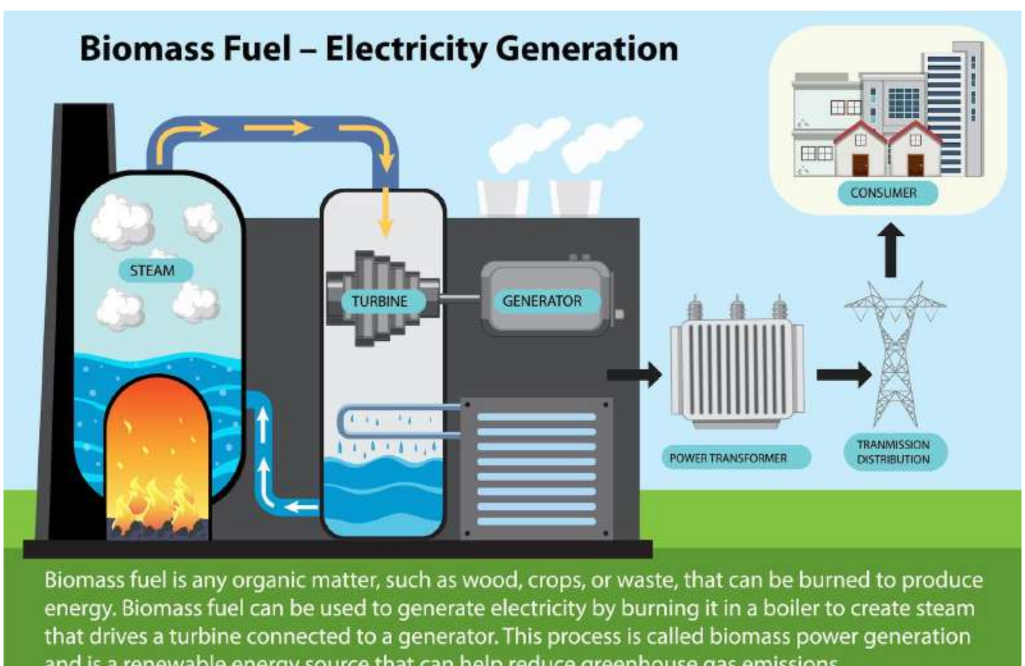
REFERENCES

1. https://www.thehindu.com/opinion/op-ed/a-renewable-energy-revolution-rooted-in-agriculture/article66054028.ece
2. https://vajiramias.com/article/a-renewable-energy-revolution-rooted-in-agriculture/63591195132ea705c5b57e92/
3. https://www.insightsonindia.com/2022/10/26/a-renewable-energy-revolution-rooted-in-agriculture/

BIOGAS ENERGY: A CLEAN AND RENEWABLE SOURCE OF POWER

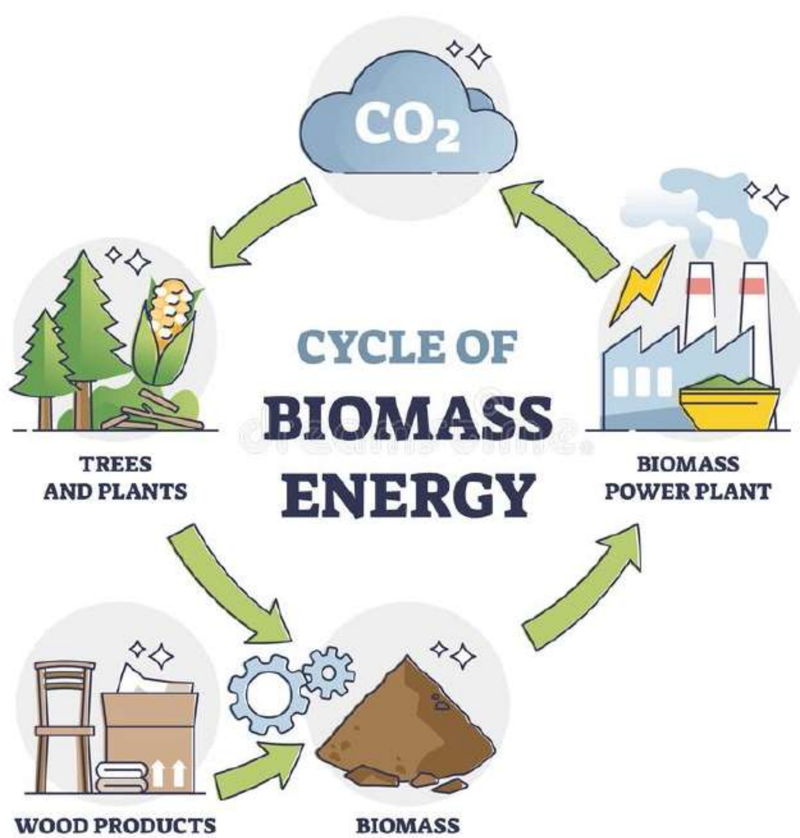
(JUSTIN REJI)

Biogas energy is a clean, promising, and sustainable renewable energy alternative which has recently gained popularity due to its capacity to provide a sustainable alternative to traditional sources of energy. Biogas energy is an increasingly popular renewable energy source that is generated by the decomposition of organic waste in the absence of oxygen. It is a clean-burning fuel that can be used for heating, electricity generation, and transportation. Biogas offers numerous environmental and economic benefits, including reducing greenhouse gas emissions, improving waste management, and providing a reliable source of energy. In this article, we will provide an overview of biogas energy, including its production process, properties, and applications, and discuss its potential as a



Source: World Wildlife Fund

sustainable energy solution . The production of biogas energy begins with the collection and processing of organic waste materials such as agricultural waste, food scraps, and animal manure. These materials are then placed in an anaerobic digester, which breaks down the waste into methane and carbon dioxide through a process called anaerobic digestion. The resulting biogas can be purified and used for various energy applications such as power generation, heating, and transportation. Biogas energy has several advantages over fossil fuels, including its renewable nature, reduced emissions, and positive impact on waste management. Additionally, biogas energy offers economic benefits such as the creation of job opportunities and the potential for revenue generation through the sale of energy and by-products.



Source: National Geographic Society

In conclusion, biogas energy offers a promising solution to the energy and waste management challenges facing many communities worldwide. The production of biogas energy not only provides a reliable source of renewable energy but also promotes sustainable waste management practices. The benefits of biogas energy are numerous, including reduced greenhouse gas emissions, improved waste management, and potential economic opportunities. However, despite its advantages, the adoption and scaling up of biogas energy face several challenges such as high initial costs, lack of infrastructure, and technological limitations. Addressing these challenges will require collaboration between policymakers, investors, and communities. Overall, biogas energy represents a crucial step towards a sustainable and clean energy future.

REFERENCES

1. https://www.nationalgrid.com/stories/
2. https://www.worldwildlife.org/
3. https://www.eesi.org/

BIOMASS ENERGY

(CELIA JOHNSON , 2021-2025)

Biomass energy is the energy obtained from biomass ie., living or once-living organisms. It is a renewable as well as non-conventional energy source. Plants, wood, and waste are the most typical biomass materials used as energy sources. This energy can be used to generate electricity or be burned to produce heat.

WHAT IS BIOMASS?

Many rural communities rely heavily on forestry and agriculture for their livelihoods. Landowners grow trees and agricultural crops, and mills produce lumber from all of these materials. Consider forestry, where the high-value fibre is utilised to make paper or lumber. Biomass is the term for leftovers or residual materials such tops and limbs, bark, woodchips, and sawdust. It is defined as the fuel made from organic matter or wastes of living organisms that can be used as a renewable source of energy.

CONVERTING BIOMASS INTO ENERGY

Biomass can be converted into energy by various methods, which are:

- Direct combustion (burning) to produce heat
- Thermochemical conversion (pyrolysis and gasification) to produce solid, liquid and gaseous fuels.
- Chemical conversion (transesterification) to produce liquid fuels
- Biological conversion (fermentation) to produce liquid and gaseous fuels.

HOW DOES BIOMASS ENERGY WORK

Firstly, the plant waste, wood scraps, sawdust and crop waste can be collected from farms or manufacturers. The waste is burned to heat water. Steam is created by the hot water. The steam pressure drives the turbine. The generator is powered by the turbine, producing electricity.

For the animal waste, a large tank called a ‘digester’ filled with bacteria is used. These bacteria eat the waste and convert it to methane gas. The methane is captured and burned to heat water and steam and thereby produce electricity.

WHY BIOMASS ENERGY?

Biomass is a widely available energy source that can considerably boost societal prosperity and economic growth. It is a renewable as well as environmentally friendly energy source. It does not eject or produce pollutant gases like nitrogen dioxide, sulphur dioxide, carbon dioxide etc. It is a cheap energy source and needs a low initial investment. Moreover, if properly managed, biomass is a sustainable fuel that can make a remarkable reduction in the net carbon emissions.

HOW MUCH BIOMASS IS USED FOR ENERGY?

As per the study of 2021, approximately 4,835 trillion British thermal units (TBtu) or roughly 5% of the US's total primary energy consumption were produced by biomass. About 2,316 TBtu of that quantity came from biofuels, 2,087 TBtu from wood and wood-derived biomass, and 431 TBtu from biomass made from solid waste and sewage, animal manure, and agricultural by-products. The studies also show that the industrial and transportation sectors use the largest amounts of biomass energy, followed by residential, electric power and commercial sectors.

REFERENCES

1. https://www.nationalgeographic.org/
2. https://www.eia.gov/
3. https://www.nrel.gov/research/

BIOMASS POWER PLANTS

(DIYA SAJI , 2021-2025)

The matter from recently living (but now dead) organisms as well as wood, wood residues, energy crops, agricultural residues, and organic waste from industries and households which is used for bioenergy production is collectively known as biomass. Wood and wood residues are the largest biomass energy source today. Biomass can be used as a power generation source. The type of power generation facility that produces electricity by burning biomass is referred to as biomass power plants. Combustion of biomass generates steam which in turn drives a turbine to generate electricity.

The world's biggest biomass power plant is the Ironbridge power plant, located in the Severn Gorge, UK, with a capacity of 740MW. Ironbridge was previously a coal-fired power station and in 2013, two units of the plant were converted for biomass-based power generation. The Alholmens Kraft power plant, located in Finland, the Polaniec biomass power plant located at Polaniec in south-east Poland, the Kymijärvi II power plant located in the Lahti city of Finland, Vaasa Bio-gasification plant, and the Wisapower plant located in Finland are some of the biomass power plants located across the world.

The Ministry of New and Renewable Energy has been implementing biomass power generation programmes since the mid-nineties. Over 800 biomass power plants aggregating to 10205.61 MW capacity have been installed in the country. States which have taken a leadership position in the implementation of this project are Maharashtra, Karnataka, Uttar Pradesh, Tamil Nadu and Andhra Pradesh. The leading States for biomass power projects are Chhattisgarh, Madhya Pradesh, Gujarat, Rajasthan, and Tamil Nadu.

Based on the type of fuel used biomass power plants are classified into four. Some plants burn wood and agricultural products, solid waste, landfill gas and biogas, and alcohol fuels (like ethanol or biodiesel).

THE OPERATION OF A BIOMASS PLANT

As mentioned earlier, a biomass power plant generates electricity from the steam that is released during the combustion of biomass in a combustion chamber. This process is done in several steps:

1. Combustion: The plant and animal matter (biomass) is burned in a combustion chamber.

2. Steam production: The biomass releases heat that heats water in a boiler and produces steam, which is sent under pressure to turbines.

3. Electricity production: The steam turns a turbine which in turn drives an alternator. The alternator produces an alternating electric current. A transformer raises the voltage of the electric current produced by the alternator so that it can be more easily transported in medium and high voltage lines.

4. Recycling: At the exit of the turbine, part of the steam is recovered and used for heating.

ADVANTAGES AND DISADVANTAGES

The main advantage of biomass power plants is that they allow to create energy without using fossil fuels. As it uses biomass, the recovery of waste and reusing it to produce energy is also possible. As it produces relatively a low quantity of carbon dioxide and other greenhouse gases, this mode of electricity production has a neutral carbon balance.

One of the other advantages is that since biomass power plants use renewable fuel sources, there is a reduced dependence on fossil fuels.

However, biomass plants contribute to some environmental concerns. The combustion of biomass release pollutants such as nitrogen oxides and sulphur dioxides which can contribute to air pollution. There can also be chances of soil erosion and deforestation.

Overall, biomass power plants can be one of the best alternative methods to generate electricity from renewable resources. However, it is important to carefully plan and manage such that the environmental impacts are reduced.

REFERENCES

1. https://www.siemens-energy.com/
2. https://mnre.gov.in/bio-energy/
3. https://www.energy.gov/eere/

CLEAN ENERGY REVOLUTION: POWERING A SUSTAINABLE FUTURE

(MOHAMMED YASIN [1] , AKASH AN [2] , RONY RAJU [3])

[1]

Clean energy is energy that comes from renewable sources with zero emissions that does not pollute the atmosphere when used, and energy that is saved through energy optimization measures. While there is some overlap between clean energy and green or renewable energy sources, they are not exactly the same. To understand the difference, it is worth understanding what it really means. It is possible that one may misconstrue between the idea of clean energy , green energy and renewable energy. Clean energy is energy from sources that emit air pollutants, and green energy is energy from natural sources. Although these two types of energy are often said to be the same, there are subtle differences between the two. Renewable energy is electricity produced from sources that are constantly replenished. Unlike fossil fuels and gas, these renewable energy sources never run out and include wind and solar energy. However, while most green energy sources are renewable, not all renewable energy sources are green. For example, hydroelectricity is a renewable resource, but some argue that hydropower is not green because deforestation and industrialization associated with the construction of hydroelectric dams can destroy the environment. Where green and renewable energy (such as solar and wind energy) intersect, a complete mix of clean energy is achieved. Here's an easy way to remember the difference between these different types of energy.

Clean energy = clean air

Green energy = natural resources

Renewable energy = renewable resources

Now, the most important aspect of clean energy is its environmental benefits as part of the global energy future. Clean and renewable resources protect the world's natural resources while reducing the risk of environmental hazards such as problems related to fuel and natural gas leaks. Fuel diversity makes it possible to create reliable power sources that increase energy security and ensure that there is enough power to meet demand through a variety of power plants using different energy sources.

INDIA’S CLEAN ENERGY REVOLUTION IS A GLOBAL WIN CONTROL

[2]

The scale of change in India is staggering. India is adding cities the size of London to its urban population every year, including the construction of new buildings, factories and transportation networks. India's size and huge potential for growth means that energy demand will grow more than any other country in the coming decades. On track for net zero emissions by 2070, we estimate that most of the growth in energy demand this decade will need to be met by low-carbon energy sources. The good news is that India's clean energy transition is well under way. It met the COP 21- Paris summit commitment of 40 percent non-fossil fuel capacity - almost 9 years ago and the share of solar and wind power in India's energy mix has grown tremendously. Renewable electricity in India is growing at a faster rate than any other major economy, with new capacity additions set to double by 2026. The country is one of the leading producers of modern bioenergy and its economy has huge ambitions to expand its use worldwide . However, with a zero target, India faces several major challenges in the near term. Rising commodity prices are making energy cheaper, and tighter markets are increasing energy security risks for the world's third-largest energy importer. There is still a lack of reliable electricity supply for many consumers. Relying on conventional fuels for cooking causes unnecessary harm to the health of many people. Financially troubled electricity distribution companies are hindering the industry's urgent transformation. High levels of pollution have resulted in Indian cities having the lowest air quality in the world. India already has a number of policy measures that, if fully implemented, can address some of these challenges by accelerating the transition to cleaner and more efficient technologies. India's robust energy efficiency programs have successfully reduced energy consumption and emissions from buildings, vehicles and key industries. The government's efforts to provide millions of homes with gas fuel for cooking and heating allowed a steady shift away from traditional biomass use such as wood burning. India is also laying the groundwork for scaling up emerging technologies such as hydrogen, battery storage and low-carbon steel, cement and fertilisers. The transition to clean energy is a huge economic opportunity. India is uniquely positioned to lead the world in renewable batteries and green hydrogen. This and other low-carbon technologies could create a market of up to $80 billion in India by 2030. Achieving net zero is not limited to reducing greenhouse gas emissions. India's energy transition must benefit its citizens and well-designed policies can limit potential trade-offs between affordability, security and sustainability. Green hydrogen will play an important role in achieving net zero and decarbonizing the sector which is very difficult. India aims to become a global hub for the production and export of green hydrogen. India can easily produce 5 million tonnes of green hydrogen demand by replacing gray hydrogen in refineries and fertilizer industries. These 5 million tons will reduce 28 million tons of CO2. As we increase green hydrogen savings, this share will increase and lead to 400 million tons of CO2 reduction by 2050. As a large growing economy with a population of over 1.3 billion, India's climate adaptation and mitigation needs are transformative not only for India, but for our entire planet.

POWERING TOMORROW WITH A PRISTINE PROMISE: THE BRIGHT FUTURE OF CLEAN ENERGY!

[3]

Humans have been using fossil fuels for over 150 years, and as their use has increased, so have the greenhouse gas emissions produced when these fuels are burned. These greenhouse gases absorb heat in the atmosphere, causing the Earth's temperature to rise. These are symptoms of climate change, which has seen global warming, an increase in extreme weather events, changes in wildlife habitats and populations, rising sea levels, and other impacts. Because renewable energy sources do not emit greenhouse gases such as carbon dioxide, they do not contribute to global warming. These renewable resources mean that climate change is not a priority, while measures such as afforestation can be combined to reduce global warming and help reduce the damage caused by climate change.

In a global picture, clean energy seems to be the future for humanity's energy needs around the world as dependence on fossil fuels decreases. As the movement towards clean, green, and renewable energy advances, costs will be reduced and jobs will be created to develop and build these new power solutions. More and more people are recognizing the environmental, social, and economic benefits of clean energy, and it will continue to do so as more cities, states and countries sign up for green power plans.

REFERENCES

1. https://cleanenergyrevolution.org/
2. https://www.energy.gov/clean-energy
3. https://www.un.org/en/climatechange/raising-ambition/renewable-energy

Exploring the present and future of solar desalination collectors in India - a sustainable solution to meet the country's water needs

(LAKSHMI GAYATRI , ASLIHA SHERIN)

A major water problem has been affecting India for a number of years as a result of issues like population expansion, climate change, and rapidly diminishing groundwater resources. More than half of India's population is currently impacted by water scarcity, according to reports from the World Bank and the National Institute for Transforming India. Due to this situation, there is an urgent need for sustainable and creative solutions to fulfil the nation's escalating water demands. Solar desalination collectors are one such promising alternative that has drawn a lot of interest. These devices are made to use the sun's energy to convert salt water into fresh water, making them the perfect answer for coastal areas with a shortage of fresh water supplies. Let us investigate solar desalination collectors' present and future, as well as how they may be crucial in India's efforts to address its water shortfall.

India's Infrastructure and Solar Desalination Technology at the Present Time

In India, infrastructure and technology for solar desalination have advanced steadily in recent years.

In reality, both public and commercial organisations have started a number of projects to utilise solar energy for desalination. Additionally, India has a wealth of renewable energy resources, particularly solar energy, which makes the technology viable and affordable. The adoption of solar desalination technology has come a long way, but there is still much to be done.

The development of this industry has been severely constrained by elements including high initial investment costs, technological limitations, and a lack of appropriate infrastructure. However, with ongoing funding for research and development and coordinated efforts from the government and other stakeholders, India may become a leader in solar desalination technology and infrastructure and assist in easing the severe water shortages that are now occurring in several parts of the country.

Comparing Solar Desalination Collectors to Traditional Methods: Pros and Cons

Solar desalination collectors have a number of important advantages over conventional technologies, including sustainability and minimal environmental effect. Because there are no greenhouse gas emissions during the desalination process thanks to the utilisation of solar energy, less non-renewable energy is needed. Solar desalination collectors also require less maintenance, which means lower operating expenses. The expensive initial cost of solar desalination collectors, however, is one of the major issues that prevents their widespread use in developing nations.

Additionally, meteorological factors like cloud cover or low solar radiation may reduce their performance, which makes it difficult to use them during the monsoon season. Despite these difficulties, scientific advances targeted at enhancing the efficiency of solar desalination collectors indicate their constant cost-cutting efforts and effectiveness.

Examining the climate and market demands in India, future prospects and areas for improvement in solar desalination collectors

Given India's extensive coastal area and plenty of sun radiation, the country's prospects for solar desalination collectors are favorable. To be economically viable and effective given the environment and market demands of India, the current technology must be improved. improved selectivity and rejection rates in the materials utilized, such as selective absorbers, could result in improved efficiency and lower operating costs. Furthermore, the combination of intelligent control algorithms and energy storage devices may provide dependable and constant performance under a variety of environmental situations. In-depth study and development in these fields could pave the way for a long-term solution to India's fresh water supply problems.

REFERENCES

1. https://www.un.org/en/climatechange/raising-ambition/renewable-energy
2. https://www.nationalgrid.com/podcasts/clean-energy-revolution

FUTURE WITH FLOATING TURBINES

(SHARON MATHEW SAM , 2021-2025)

A helium-filled floating wind turbine is a type of wind turbine that is designed to float on the surface of the water, held in place by a mooring system. The turbine is filled with helium to make it lighter than air, which allows it to float at a high altitude where wind speeds are stronger and more consistent.

The main advantage of a helium-filled floating wind turbine is that it can harness stronger winds at higher altitudes than traditional offshore wind turbines, which are typically fixed to the seafloor in shallower waters. By using the stronger, more consistent winds at higher altitudes, the turbine can generate more electricity than a traditional offshore turbine, making it more efficient.

Another advantage is that a floating wind turbine can be located farther offshore, away from the coastline and potential visual and environmental impacts. This can help to address concerns about the aesthetics of wind farms and the potential impacts on marine life.

However, there are also some challenges associated with helium-filled floating wind turbines. One challenge is the cost of the helium, which is a relatively expensive gas. Additionally, the mooring system required to keep the turbine in place can be complex and expensive to install and maintain.

Overall, while helium-filled floating wind turbines show promise for increasing the efficiency and capacity of offshore wind energy, further research and development is needed to address the technical and economic challenges associated with this technology.

REFERENCES

1. https://www.equinor.com/
2. https://www.cnn.com/
3. https://www.stormgeo.com/

GEOTHERMAL POWER PLANT

(JEEVANDERSH S, 2020-2024)

INTRODUCTION

Geothermal energy is a renewable and sustainable form of energy derived from the heat generated within the Earth's core. It harnesses the natural heat energy produced by the Earth's geological processes and converts it into usable power.The Earth's interior is extremely hot, with temperatures reaching several 1000^0 C at the core. This heat is a result of the radioactive decay of minerals and the residual heat from the planet's formation.

Geothermal energy utilizes this immense heat by extracting it from the Earth's crust and converting it into electricity or for direct use in heating and cooling systems. It is one of the most profitable sources of energy. The Earth's warmth is a real pearl, which has several advantages over the energy of gas, coal and other sources.

CLASSIFICATION

According to the typology of the International Energy Agency (IEA), sources of Geothermal energy has been classified into five :

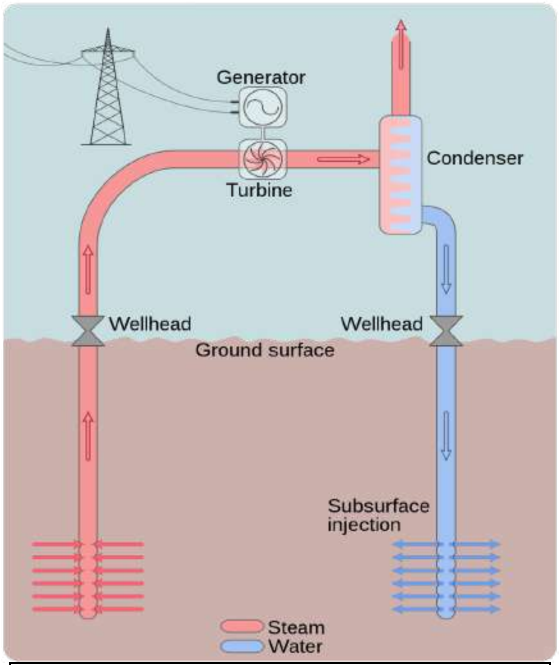
1. Dry Steam
2. Wet Steam (Hot water + Steam)
3. Geothermal Water
4. Dry Hot Rocks
5. Magma

There are three methods for converting steam to electricity.

1. Dry Steam Cycle
2. Flash Steam Cycle
3. Binary Cycle (Organic Rankine Cycle - ORC)

DRY STEAM CYCLE

In this cycle, wells are dug at a depth of about 10,000 feet from the earth's surface. Dry Steam obtained from the well is transported to a turbine using pipes to generate electricity. The condensed water from the turbine can be used to cool the power plant.



Source: WIKIMEDIA COMMONS

Process explanation

Resource Identification: Hot dry steam exists deep beneath the Earth's surface.

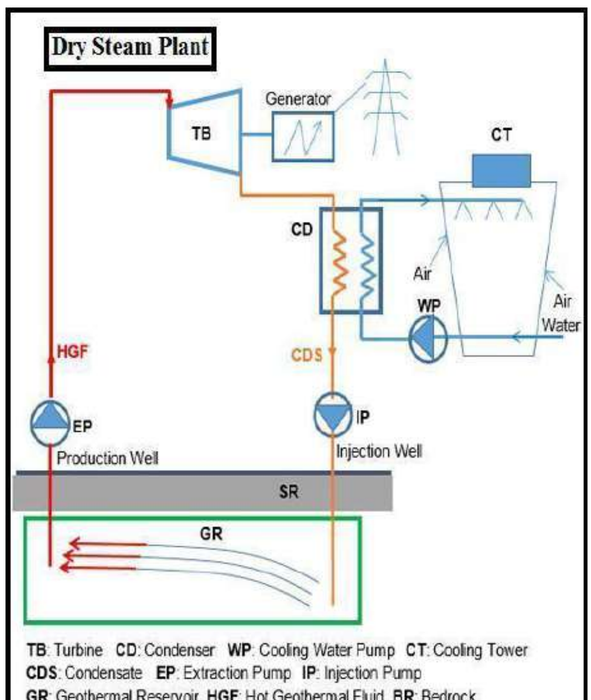
Well Drilling: Production wells are drilled into the geothermal reservoir to tap into the high-pressure dry steam.

Steam Extraction: The high-pressure dry steam is then extracted from the reservoir through the production wells. The steam flows up the wellbore due to the natural pressure gradient within the reservoir.

Separation and Purification: The extracted steam contains impurities such as entrained water droplets and non-condensable gasses. These impurities are separated from the steam using separators and scrubbers, ensuring that only clean dry steam remains.

Steam Turbine: The purified dry steam is directed towards a steam turbine. The steam's high pressure and temperature allow it to drive the turbine blades, causing the turbine rotor to rotate.

Electricity Generation: As the turbine rotor rotates, it spins a generator, which converts mechanical energy into electrical energy. The generated electricity is then transmitted to the power grid for distribution.



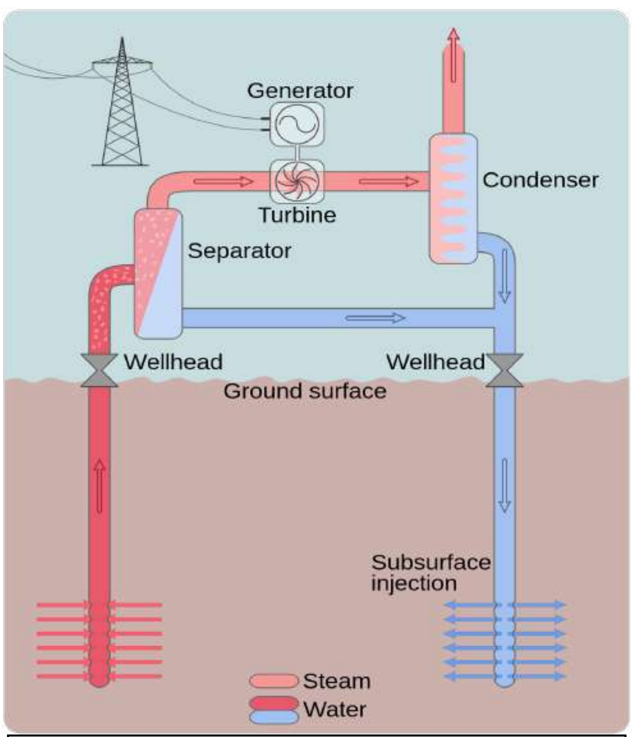
Source: SUBSTANCE

Condensation and Re-injection: After passing through the turbine, the steam loses its energy and needs to be condensed back into water. In the case of the dry steam cycle, the condensed water is usually re-injected back into the geothermal reservoir through reinjection wells. This helps to sustain the reservoir pressure and maintain the long-term viability of the geothermal resource.

Cooling: To cool down the steam that has passed through the turbine, a cooling system, such as a cooling tower, is employed. The cooling system removes heat from the exhaust steam, condensing it into water for reinjection or disposal.

The dry steam cycle is an effective method of harnessing geothermal energy when a high-pressure dry steam resource is available. It has been successfully employed in several geothermal power plants worldwide, contributing to the generation of renewable and sustainable electricity.

FLASH STEAM CYCLE



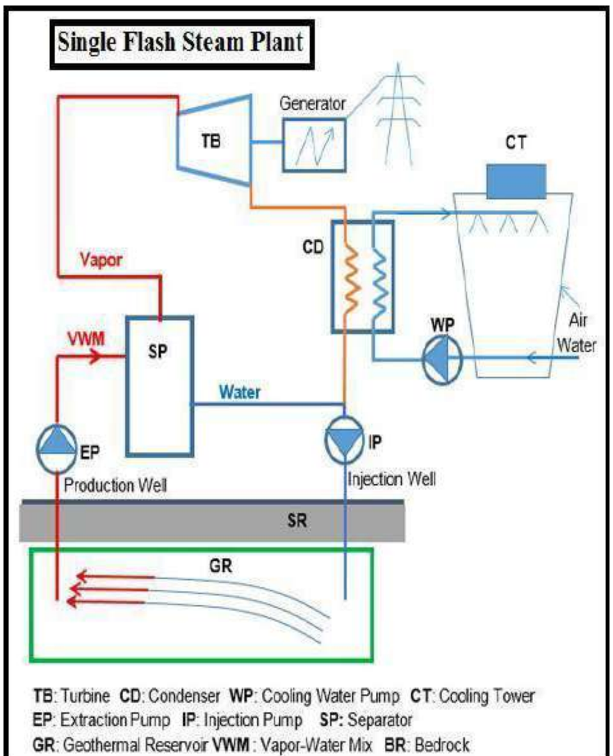
Source: WIKIMEDIA COMMONS

In a single flash steam power plant, the geothermal fluid is in liquid state which is expanded through an expansion valve resulting in two-phase flow. This mixture of liquid and vapour is directed to a separator kept at a constant temperature and pressure, so that the liquid and the vapour are separated from each other. The produced vapour is directed to the steam turbine to generate electricity while the remaining liquid is re-injected to a reinjection well.

With the exception of the use of two separators in the former, which results in both high- and low-pressure steam flows that drive the steam turbine, the double flash steam power plant operates on the same principles as the single flash power plant. Although they are more expensive than single flash geothermal power plants, double flash geothermal power plants have a higher power

output. Because more piping, a second separator, and low- and high-pressure steam turbines are required for the dual flash than for the single flash, the cost of the dual flash is higher.
It is specifically designed to utilize high-pressure, high-temperature geothermal water that contains a mixture of steam and liquid water.

Process explanation :
Resource Identification: Hot geothermal water exists deep beneath the Earth's surface.
Well Drilling: Production wells are drilled into the geothermal reservoir to tap into the hot water source. The geothermal water is under high pressure and temperature due to its proximity to the heat source.
Steam Separation: Once the hot geothermal water is extracted from the reservoir through production wells, it is directed to a flash tank or separator. The pressure of the water is reduced rapidly as it enters the flash tank, causing a portion of the water to "flash" into steam. The steam separates from the remaining liquid water.



Source: SUBSTANCE

Steam Turbine: The separated steam from the flash tank is directed towards a steam turbine. The steam's high pressure and temperature allow it to drive the turbine blades, causing the turbine rotor to rotate.

Electricity Generation: As the turbine rotor rotates, it spins a generator, which converts mechanical energy into electrical energy. The generated electricity is then transmitted to the power grid for distribution.

Condensation and Re-injection: After passing through the turbine, the steam loses its energy and needs to be condensed back into water. The condensed steam, known as condensate, is usually re-injected back into the geothermal reservoir through reinjection wells. This helps maintain the pressure of the reservoir and sustain the long-term viability of the geothermal resource.

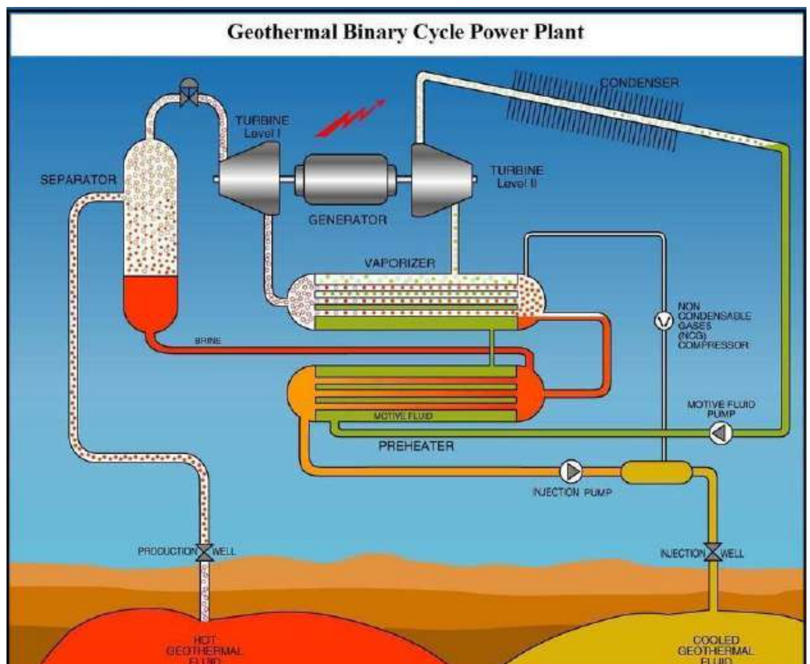
Cooling: To cool down the steam that has passed through the turbine, a cooling system, such as a cooling tower or air condenser, is employed. The cooling system removes heat from the exhaust steam, condensing it into water for reinjection or disposal.

Separation and Utilization of Remaining Hot Water: The remaining liquid water from the flash tank, which did not flash into steam, still contains a significant amount of heat. This hot water is separated from any entrained steam or gases and can be used for various purposes, such as direct heating applications, agricultural uses, or further power generation through a secondary binary cycle.

The flash steam cycle is an efficient method of harnessing geothermal energy when high-pressure, high-temperature geothermal water is available. It allows for the extraction of both steam and liquid water, maximizing the utilization of the geothermal resource. Flash steam power plants have been

successfully implemented in various geothermal regions worldwide, contributing to the generation of renewable and sustainable electricity.

BINARY POWER PLANT(ORGANIC RANKINE CYCLE)



Source: ORMAT TECHNOLOGIES

In this type of power plant, a secondary fluid is used instead of water to run the ORC turbine. In ORC, the geothermal fluid is circulated in a vaporizer and sent back to the reinjection well. The secondary fluid is heated and vaporized in the vaporizer by the heat exchange between the geothermal fluid and the secondary fluid. The generated vapor from the secondary fluid is directed to the turbine for electricity production. The condensed fluid exiting the condenser is heated by superheated steam in the regenerator before it enters the vaporizer as the vapor leaves the turbine. By utilizing various secondary working fluids like hydrocarbon or fluorocarbon, it is possible to operate an ORC geothermal power plant with a geothermal fluid that has a temperature of 200 °C. These working fluids can function in temperatures as high as 200 °C. Additionally, numerical calculations to determine the output power of an ORC geothermal power plant were made using isopentane as the secondary working fluid to run the turbine at a geothermal fluid temperature of 200 °C. A binary power plant has a number of benefits, including environmentally friendly practises, high operational reliability, and reservoir sustainability. It is particularly suitable when the geothermal fluid temperature is not high enough to directly produce steam for a traditional steam turbine.

Process explanation :

Resource Identification: Low-temperature geothermal resources such as geothermal water or brine.

Well Drilling: Production wells are drilled into the geothermal reservoir to extract the hot geothermal fluid. The fluid is typically at a lower temperature than what is required for direct steam production.
Heat Exchanger : The hot geothermal fluid is directed to a heat exchanger, where it transfers heat to a separate working fluid with a lower boiling point. The working fluid used in the binary ORC is usually an organic compound with favorable thermodynamic properties.

Working Fluid Vaporization: As the hot geothermal fluid transfers heat to the working fluid in the heat exchanger, the working fluid vaporizes, turning into a high-pressure vapor. The geothermal fluid, after heat transfer, usually undergoes a cooling process before being reinjected into the geothermal reservoir.

Expansion and Power Generation: The high-pressure vapor from the working fluid is directed to a turbine, specifically designed for the lower boiling point of the working fluid. The vapor expands in the turbine, driving the turbine blades and generating mechanical energy.

Electricity Generation: As the turbine rotor rotates, it spins a generator, which converts the mechanical energy into electrical energy. The generated electricity is then transmitted to the power grid for distribution.

Condensation and Recirculation : After passing through the turbine, the low-pressure vapor exits and is condensed back into a liquid form by a condenser. The condensed working fluid is then recirculated back to the heat exchanger to repeat the cycle. The heat released during condensation can be rejected to the environment or used for other purposes, such as heating applications.

The main advantages of ORC are that it operates at a low temperature which results in low-mechanical stresses on the turbine, along with the fact that there is no erosion of the turbine blades due to the absence of moisture during the vapor expansion in the turbine. Moreover, the turbine in ORC has a smaller size so it is consequently less expensive, and there are no air in-leakage problems nor problems due to operating in a vacuum, since a vacuum is not needed.

REFERENCES

1. *https://geothermal-energy-journal.springeropen.com/articles/10.1186/s40517-017-0074-z*
2. *https://www.twi-global.com/technical-knowledge/faqs/geothermal-energy*
3. *https://www.academia.edu/57059761/Development_of_a_Direct_Evaporator_for_the_Organic_Rankine_Cycle*

HYDROELECTRIC POWER STATIONS

(JUGNU S , 2020-2024)

Hydropower generation system is a sophisticated, nonlinear power system that includes electrical, mechanical, and hydraulic components. In hydropower plants (HPPs), the intricacy of waterway systems and the size of the generator have both increased. A hydroelectric power plant is made up of turbines that use the dam's water flow in gravity to turn the turbines and produce energy. The water can either be pumped back into the reservoir and utilized there or released into the river below the dam. In general, hydroelectric dams are constructed primarily to generate electricity; they do not supply water for cultivation or drinking. Over 150 nations use hydropower to generate 19% of the world's electricity, with 24 of those nations relying on it for 90% of their needs. China, Canada, Brazil, the United States, and Russia are the top five hydroelectric energy producers.

For our country, hydroelectric power is essential. Modern technology and rising populations demand enormous amounts of electricity to create, construct, and grow. Up to 40% of the electricity generated in the 1920s was provided by hydroelectric plants. Although the amount of energy produced by these methods has continuously increased, other forms of powerplants have produced more energy at a faster rate. Because it can respond swiftly to rapidly changing loads or system disturbances, while base load facilities with steam systems driven by combustion or nuclear processes cannot, hydropower is a crucial component of the national power grid.

Impoundment, diversion, and pumped storage facilities are the three different types of hydroelectric facilities. Hydropower plants vary in their utilization of dams. Despite the fact that not all dams were constructed for hydropower, they have been successful in supplying vast amounts of renewable energy to the grid. Hydropower facilities come in a variety of sizes, from modest initiatives providing electricity for a single house or community to massive undertakings.

IMPOUNDMENT

An impoundment facility is the type of hydroelectric power plant that is most prevalent. A dam is used in an impoundment facility, which is usually a big hydroelectric system, to hold river water in a reservoir. Released water from the reservoir spins a turbine as it passes through, starting a generator that generates power. The water may be released to address shifting electrical needs as well as other requirements, including those for flood control, leisure, fish passage, and other environmental and water quality requirements.

DIVERSION

A diversion, often known as a "run-of-river" facility, directs a segment of a river through a canal and/or a penstock in order to harness the energy-producing potential of the river's natural elevation decline. Water flow is controlled by gates, valves, and turbines in a penstock, a closed pipe that directs water to turbines. It's possible that a diversion won't need a dam.

PUMPED STORAGE

Pumped storage hydropower, often known as PSH, is another type of hydropower that functions like a large battery. The electricity produced by alternative power sources, such as solar, wind, and nuclear, can be stored at a PSH facility for later use. Pumping water from a reservoir at a lower elevation to a reservoir at a higher elevation is how these systems store energy.

A PSH facility stores energy by pumping water from a lower reservoir to an upper reservoir when the need for electricity is low. When there is a significant demand for energy, the water is discharged back into the lower reservoir where it turns a turbine and produces electricity.

Transmitting Power

After being generated, energy needs to be transported to the locations where it is most nee ded, such as our homes, schools, workplaces, industries, etc.
The users of dams must get power over a certain distance because they are frequently loca ted in distant areas.

To get electricity to us in a form that we can use, extensive networks of transmission lines and facilities are used. Transformers enhance the voltage of all the electricity produced at a power plant so that it may be transmitted across great distances by power lines. The force that pushes an electric current across a wire is known as voltage. Transformers at nearby substations lower the voltage so that it can be divided and distributed throughout a region.

The electric power is further reduced to the appropriate voltage for appliances and use in the home by transformers mounted on poles (or buried underground, in some neighborhoods). When it reaches our houses, we purchase electricity by the kilowatt-hour, and a meter tracks how much we consume.

How Power is computed

Engineers determine how much power can be generated after a hydroelectric power station is built before beginning construction. The amount of water discharged (referred to as discharge) and the height of the waterfall (referred to as a head) at a dam define its actual energy production. Therefore, a particular quantity of energy will be produced by a given volume of water dropping at a given distance. The type of turbine to be utilized depends on the head and discharge at the power site as well as the required generator rotational speed.

Pressure is created by the head (water pressure), and the higher the head, the more pressure is produced to power turbines. PPI (pounds per square inch) is the unit of measurement for this pressure. More force or swifter water flow translates to more power.

Turbines

Turbines come in a wide variety despite having only two fundamental types (impulse and response). Before choosing a specific turbine for a power plant, operational studies and cost projections must be finished. The site characteristics have a significant impact on the turbine choice.

A horizontal or vertical wheel that functions with the entire wheel submerged lowers turbulence is called a response turbine. Theoretically, the response turbine operates similarly to a rotating lawn sprinkler, with water under pressure in the centre escaping out the blade tips to drive spinning. The most common kind of turbines are reaction turbines.

An impulse turbine is a vertical or horizontal wheel that rotates as a result of the kinetic energy of water striking its buckets or blades. The wheel is protected by a housing, and the buckets or blades are designed to turn the water flow inside the housing by around 170 degrees. The water pours out of the bottom of the wheel housing after turning the blades or buckets.

Modern Concepts and Future Role

Although hydropower does not release toxins into the environment, it can nonetheless have a negative impact on the ecosystem. In the past ten years, significant efforts have been undertaken at both Federal facilities and non-Federal facilities licensed by the Federal Energy Regulatory Commission to alleviate environmental problems connected with hydropower operations, such as providing safe fish passage and improving water quality.

Additional prospects for environmental improvement have been made possible by initiatives to strengthen the security of dams and the application of newly developed computer technologies to optimize operations. The best way to sustain hydropower's economic viability in the face of rising demands to conserve fish and other environmental resources, however, remains a mystery.

To increase operational effectiveness and the environmental performance of hydropower facilities, Reclamation aggressively conducts research and development (R&D) programs. Reclamation is still working to increase the hydropower industry's dependability and productivity. Engineers today strive to eeeeeeee both new and existing facilities to boost output and efficiency.

REFERENCES

1. https://www.energy.gov

Get ready to break the mold with glass batteries - the game-changer that's electrifying the future!

(Tony V Morris, Johan Joe Panjikkaran, Sarath Manikandan , 2021-2025)

From smartphones to electric cars, lithium-ion batteries have long been the preferred power source for a wide range of electronic gadgets. With their high energy density, low self-discharge rates, and long cycle lives, they have revolutionized the world. They do have their limitations, though. First, there are safety issues with lithium-ion batteries, such as overheating and fires, which have in the past resulted in significant damage. Secondly, the lithium-ion battery is not environmentally friendly; it contains toxic, flammable, and non-biodegradable components such as cobalt. Additionally, they have limited capacity, which means they can only store a small amount of energy at once, and they take a long time to charge fully. These limitations have led scientists to search for alternatives, and it seems that glass batteries are becoming increasingly popular because of their potential to address several of lithium-ion batteries' shortcomings.

The fact that glass batteries can store more energy than conventional lithium-ion batteries is one of their main advantages. This is because unlike liquid electrolytes, which are currently utilised in the majority of lithium-ion batteries, glass electrolytes have a higher ionic conductivity. Additionally, compared to their lithium-ion equivalents, glass batteries have the ability to charge significantly more quickly. This is why they can conduct energy with considerably less resistance and tolerate higher temperatures without the risk of combusting. Additionally, glass batteries have the potential to survive up to three times as long as lithium-ion batteries. Overall, glass batteries offer a promising substitute for conventional lithium-ion batteries for a variety of applications

Glass batteries may have a big impact on a variety of industries, including transportation, aviation, and renewable energy. Glass batteries' high energy density enables longer-lasting and quicker-charging electric vehicles, which might completely change the transportation industry. Glass batteries can also be produced utilising plentiful and inexpensive ingredients, doing away with the toxicity and flammability of conventional lithium-ion batteries. In addition to increasing energy storage capacity, the use of glass batteries in renewable energy systems can facilitate a more seamless transition to a more sustainable energy future. The creation of a more effective and environmentally friendly system in the energy sector may result from the development and commercialization of glass batteries.

Glass batteries have a bright future in energy storage because they have a number of benefits over conventional lithium-ion batteries. Glass batteries have a lower risk of starting a fire and are more environmentally friendly because they are made of sodium and can be recycled. Furthermore, they are a desirable option for a variety of applications, including electric vehicles and grid-scale energy storage, because to their high energy density and quicker charging and discharging times than conventional batteries. Glass batteries are still in the research and development stage, but recent developments at the University of Texas have yielded encouraging findings, indicating that they might soon establish themselves as a major force in the energy storage industry. Overall, they offer a competitive option to lithium-ion batteries due to their potential for sustainability, safety, and high performance.

REFERENCES

1. https://www.analyticssteps.com/
2. https://www.fuergy.com/
3. https://spectrum.ieee.org/

THERMIONIC ENERGY CONVERSION

(ANUGRAH JAMES, 2021-2025)

INTRODUCTION

In our current world energy is an undeniable necessity, and this has initiated many attempts to generate viable forms of power with hopefully lesser ill-effects and waste generation. Thermionic energy conversion is a developing concept that captures this essence. Thermionic energy conversion (TEC) or thermionics relates to the direct conversion of heat into electricity by utilizing the heated materials ability to emit electrons during the heating process, removing intermediary steps in the conversion of heat to electrical energy.

REASON BEHIND THE STUDY IN THERMIONICS

Engineers and scientists, at the end of the day, strive to make processes and machines more efficient than ever and this is the same thinking pushing research in the field of thermionics. A good percentage of heat energy conversion systems utilize an energy-storing medium like water, which then runs a mechanical turbine which generates electricity by electromagnetic induction. This process is still good considering its conceptual simplicity and construction feasibility. Still, no matter the pros, these intermediary steps decrease energy conversion rates and increase equipment maintenance costs. So, what if we were able to directly convert this heat energy into electrical energy. Such a converter would include several benefits as we will see now.

EXPLAINING THERMIONIC CONVERSION

The simplest form of a thermionic converter utilizes two pieces of metal at different temperatures, held at distinct electrostatic potentials. The anode is the cooler piece of metal where the electrons are collected, and the cathode is the hotter piece of metal where the electrons are generated. The cathode heated to a very high temperature allows electrons to gain enough thermal energy to escape from the cathode by overcoming the work function, or energy barrier, of the metal. The ejected electrons are directed to the anode, and because the anode is held at a higher potential, a portion of the energy that the electrons gained from being heated can now be used in an external electrical circuit. The higher the voltage the more energy can be extracted from the electron in the external circuit.

Thermionic energy conversion is in fact not a novel concept. In 1958, V. C. Wilson described a simple thermionic converter with an energy conversion efficiency of 9.2%, which means for every Joule of heat injected into the cathode, 0.092 Joules of energy can be extracted from the anode in the form of electricity. This converter was made with a cathode and anode of tungsten and molybdenum respectively, enclosed in a glass tube pumped with

caesium gas to facilitate the thermionic emission process. Since then, many techniques and processes have been improved and innovated to improve the feasibility of his technology.

ADVANTAGES AND CHALLENGES OF THERMIONIC CONVERSION

There are certain advantages to thermionic converters over other energy converters, such as a traditional Carnot heat engine, which converts heat into mechanical energy in the form of work. One benefit of the thermionic process is that there are no moving parts in the system, which allows for very long operational lifetimes. Furthermore, thermionic converters can be fabricated at a much smaller scale than the Carnot engine, which opens the door for possibilities of thermal energy conversion at the microscale.

The primary challenge of thermionic energy conversion is low efficiency when compared to Carnot engines. Large mechanical heat engines, such as steam turbines, have a practical efficiency of about 40%. Thermionic converters, however, have a practical efficiency limit of around 20%. A major contributor to the low efficiency problem is the work function of the electrodes. Work function is a product of the material surface and serves as a barrier to electron emission, and thus it is desirable to have low work functions to avoid large energy barriers. Furthermore, the available energy to be extracted is proportional to the difference in work functions of the two electrodes. Having two low work function electrodes while maintaining a large difference between the electrodes is an ongoing challenge.

RECENT ADVANCES IN THERMIONIC EMISSION TECHNOLOGY

Another advance is the use of nanofabrication of the cathode and anode surfaces to increase the efficiency of the conversion process. By patterning materials at the nanoscale, engineers can adjust the work function of the anode and cathode. Low work function materials are required to extract as much energy as possible from the emitted electrons. One example is Lanthanum Hexaboride, which can significantly lower the work function when compared to typical electrode materials. Furthermore, fabrication of the converter in thin layers or fabrication of nanowires on the emitter surface allow electrons to tunnel from the cathode to the anode without overcoming the work function, adding to the overall efficiency of the device.

APPLICATIONS OF THERMIONIC ENERGY CONVERTERS

The benefits of thermionic energy application make it desirable for a number of applications. One such application is increasing the efficiency of power plants that burn fossil fuels. These plants operate at temperatures over 2000°K, but the turbines generally need only 800-1300°K. The extra heat could then be used to power a thermionic converter, increasing the overall efficiency of the plant. In 1973, Rasor Associated estimated that the efficiency of a nuclear fusion plant could be increased from 41.3% to 47% by implementing

thermionic converters. Another application of thermionic energy is optimizing energy expenditure in a house. Excess heat from water boilers or natural gas burners could be used as electricity, simultaneously conserving energy while saving homeowners money on utilities. Several companies on the west coast are currently attempting to commercialize thermionic energy conversion for both utility and residential applications.

CONCLUSION

Thermionic energy conversion is a promising technology that allows for the extraction of usable energy from heat sources. Challenges including space charge and the difficulty of finding low work function materials have suppressed the usefulness of this technology in the past, but recent advances have made it a viable method of energy conversion in industrial and residential environments. Several companies are attempting to commercialize the technology to compete with traditional forms of heat energy conversion such as steam turbines.

REFERENCES

1. https://www.frontiersin.org/
2. https://www.britannica.com/
3. https://fti.neep.wisc.edu/

PYROELECTRICITY

(MANU JOHNSON , 2019-2023)

The phenomenon of pyroelectricity is characteristic of those crystals which are by default electrically polarized and contain large electric fields, and thus have the capacity to give rise to a transient potential difference when subjected to a heating or cooling effect. From the first record of the effect way back in 1707 by Johann George Schmidt when he noticed the ability of hot tourmaline, a crystalline silicate mineral group, to attract ashes from warm coal, only to repel them after coming into contact, the study of pyroelectricity has greatly advanced. Scientists such as Sir David Brewster, who gave the phenomenon its present name, William Thomson, Woldemar Voigt, Pierre Curie and Jacques Curie helped pave the way to understand the mechanisms of pyroelectricity.

A change in temperature can lead to a shift in the position of atoms within a crystal structure, resulting in a polarization change and the generation of voltage across the crystal. If the temperature remains constant, the voltage gradually disappears due to leakage current caused by electrons moving through the crystal, ions moving through the air, or current leaking through a voltmeter connected to the crystal. Asymmetric crystals produce pyroelectric charge on opposite faces, and this change is generally consistent throughout the sample but can be modified by applying an electric field. Pyroelectricity is measured by the change in net polarization, which is a vector, proportional to temperature fluctuations. The total pyroelectric coefficient is determined by adding the pyroelectric coefficients at constant strain (primary effect) and the piezoelectric contribution from thermal expansion (secondary effect) measured under constant stress.

It is quite natural to confuse pyroelectricity with thermoelectricity; after all, both effects are based on getting a voltage from a temperature change. The key difference between them can be summarized with the following statement: thermoelectricity depends on a temperature difference created based on position, while pyroelectricity depends on one based on time. What this means is that a thermoelectric material is able to produce a permanent voltage when subjected to a temperature gradient in which the hot side and the cold side temperatures need not change over time, i.e., it just needs a stagnant temperature gradient to exist. Pyroelectric materials on the other hand need a uniform temperature change to occur across the entire body over time, and the voltage which is generated exists only as long as the heating or cooling effect exists.

The determination of which materials are pyroelectric come down to the nature of their crystal structures; based on the number of rotational axes and reflection planes that leave the structure unchanged, all crystal structures belong to one of 32 crystal classes. 21 of these are centrosymmetric, i.e., do not possess a centre of symmetry, and 20 of these are said to exhibit piezoelectricity which is the ability to give rise to a potential difference on the application of mechanical stresses. The 10 crystal structures out of these 20 are known to have a natural charge separation even in the absence of an electric field are considered to be polar crystals; these are the crystal classes that exhibit pyroelectricity. It can thus be understood that pyroelectric and piezoelectric structures are closely related to one another.

As we have already come across, the first material in which pyroelectricity was discovered had been in the mineral tourmaline. The effect is also present in our bones and tendons due to the nature of the collagen present in them. This is said to happen due to the bending of the mucopolysaccharide molecules such as hyaluronic acid or by stresses at the collagen-hydroxyapatite interface. The most important example of a pyroelectric material is the semiconductor of Gallium Nitride; the large electric fields in them hamper the functioning of LEDs but are incredibly useful for the production of power transistors. The development of artificial pyroelectric materials in the form of thin films of materials such as Gallium Nitride, Caesium Nitrate, Polyvinyl Fluorides, derivatives of Phenylpyridine, and Cobalt Phtalocyanine is also underway at a tremendous pace.

The applications of this technology are plentiful. Passive infrared sensors, commonly used in security alarms and automatic lighting sensors, are often designed around pyroelectric materials since the heat of a living organism from several metres away is sufficient to generate a voltage. Pyroelectric materials can also be heated and cooled continuously similar to heat engines to generate useful electrical power, with studies showing that they can theoretically reach efficiencies of almost 90 percent of the Carnot efficiency. Some of the advantages of such generators include lower operating temperatures, less bulky equipment, and fewer moving parts. Unfortunately, this technology still has a long way to go before being commercially available and viable. An interesting application is the use of pyroelectric materials such as Lithium Tantalate to create small-scale nuclear fusion by generating large enough electric fields to steer deuterium atoms into the process; this is known as pyroelectric fusion. The idea is to accelerate these hydrogen species into a metal hydride with enough kinetic energy to force nuclear fusion. As of now, though it promises to be a green and sustainable way of power generation, the technology still needs to be made feasible.

Pyroelectricity is one of those intriguing phenomena found in nature that many may not be aware of but plays an important role in modern-day society in getting us collectively closer to a state in which we are best able to make use of the resources around us in the most sensible and sustainable manner possible.

REFERENCES

1. https://www.sciencedirect.com/
2. https://www.chemeurope.com/
3. https://www.elprocus.com/

OCEAN THERMAL ENERGY CONSERVATION

(AADITH A , 2022-2026)

Ocean thermal energy conversion(OTEC) is a process or technology for producing energy by employing the temperature differences between ocean surface waters and deep ocean waters. The OTEC generality was first proposed in the early 1880s by the French engineer JacquesArsène d'Arsonval. His idea called for a Closed- cycle system, a design that has been shaped for the utmost present- day OTEC pilot plant. Such a system employs a secondary working fluid(a refrigerant) analogous as ammonia. Heat transferred from the warm face ocean water causes the working fluid to ruin through a heat exchanger. The vapor also expands under moderate pressures, turning a turbine connected to a generator and thereby producing electricity. Cold seawater pumped up from the ocean depths to an alternate heat exchanger provides a face cool enough to beget the vapor to condense. The working fluid remains within the unrestricted system, vaporizing and reliquefying continuously. Energy from the sun heats the face water of the ocean. In tropical regions, face water can be important warmer than deep water. This temperature difference can be used to produce electricity and to desalinate ocean water. Ocean Thermal Energy Conversion(OTEC) systems use a temperature difference(of at least 20 ° Celsius or 36 ° Fahrenheit) to power a turbine to produce electricity. Warm face water is pumped through an evaporator containing a working fluid. The destroyed fluid drives a turbine/ creator. The destroyed fluid is turned back to a liquid in a condenser cooled with cold ocean water pumped from deeper in the ocean. OTEC systems using seawater as the working fluid can use the condensed water to produce desalinated water. OTEC is one of the various green energy options that are getting further current in certain of our nations. abysms are fully available, and there is principally no chance that they will ever run out. also, there will nearly always be a variation in temperature between the ocean bodies. As a result, ocean thermal energy generation is sustainable. As a result, we can continue to produce electricity without the source running out. Indeed while we can be inclined to get enthusiastic about the creation of renewable energy, some of the manufacturing ways might turn out to be unreliable. Weather variations can affect the delicacy of electrical generation methods like solar and wind power. We may have noticed that several nations are making green enterprises these days. This also applies to the creation of electrical power, not just the planting of trees. future pretensions for multitudinous nations include the generation of clean energy. One of several sustainable energy sources is ocean thermal energy. multitudinous of us would want to buy commodities that demanded little to no care and lasted for a long time. These characteristics live in ocean thermal energy installations. formerly installed, the outfit takes little conservation.also, these floating OTEC plants bear lower staff to run, which makes them cost-effective. We can learn that ocean thermal energy power shops are located in the water. Only the top portion seems to be floating in the water.Since these shops are celebrated to be each- downfall and hurricane-substantiation, the downfall has little impact on them. We can conclude that employing OTEC involves precious outfit that must be bought and installed. Considering that multitudinous of our countries presently have good living morals, only certain of them may be suitable to make ocean thermal energy installations. There might not be important of a temperature difference between the deep waters and the face swell. As a result, this can produce electricity with poor effectiveness.

The deepest sections of the ocean are reached by channels from the ocean thermal energy plant. As a result, it's clear that these channels could affect marine life. also, due to the power of the water's pumping, small submarine brutes may be drawn to the pipes. The ocean thermal plant has a lengthy, enormous construction under the face indeed though it appears to be floating on the ocean. Large vessels may have trouble navigating around the floating body circle. In general, one of the fairly new energy product styles that are arising presently is ocean thermal energy. In the future, the maturity of our countries might decide to outlaw reactionary powers permanently. So, the possibility of resource reduction or the negative consequences that these reactionary powers have on our atmosphere may be to condemn for the increase in this ban. Still, there is significant room for the growth and installation of ocean thermal energy in the future. People in moment's society are drinking green energy, and some of our nations have pretensions to reach for going green in the coming years. Investments in alternative energy sources will be made because we can't calculate just on solar and wind energy. In any case, disquisition indicates that ocean thermal energy can give enough electricity for marketable use, which can support a nation's profitable development.

REFERENCES

https://interestingengineering.com
https://www.dnatives.com

MICROBIAL FUEL CELLS

(BISMI S , 2021-2025)

Microbial fuel cell (MFC) is a type of bioelectrochemical fuel cell system that generates electric current by diverting electrons produced from the microbial oxidation of reduced compounds (also known as fuel or electron donor) on the anode to oxidize compounds such as oxygen (also known as oxidizing agent or electron acceptor) on the cathode through an external electrical circuit. MFCs produce electricity by using the electrons derived from biochemical reactions catalyzed by bacteria. MFCs can be grouped into two general categories: mediated and unmediated The first MFCs,demonstrated in the early 20th century, used a mediator: a chemical that transfers electrons from the bacteria in the cell to the anode. Unmediated MFCs emerged in the 1970s; in this type of MFC the bacteria typically have electrochemically active redox proteins such as cytochromes on their outer membrane that can transfer electrons directly to the anode. In the 21st century MFCs have started to find commercial use in wastewater treatment mainly sediment microbial fuel cells (SMFCs) have been applied for wastewater treatment. Simple SMFCs can generate energy while decontaminating wastewater. Most such SMFCs contain plants to mimic constructed wetlands. Components of the Microbial Fuel cell there are various components of the microbial fuel cell, which are majorly divided into 2 chambers. They are an anodic chamber and cathodic chamber. The anodic chamber contains the anode and the cathodic chamber contains the cathode.The several components of the mIcrobial fuel cell are:-

Anode chamber

Cathode chamber

Exchange membrane

Substrate

Electrical circuit

Microbes or Microorganisms

Electrodes and copper wires for connecting electrodes.

Anode chamber

It is a biocompatible and conductive component,which is stable chemically with the substrate.

The bacteria present in this chamber convert the substrate to H_2O (water) , CO_2(carbon dioxide), and energy These bacteria are stored in an environment with limited oxygen levels. It is made up of stainless steel mesh with graphite rods or plates.

Cathode Chamber

In this chamber protons and electrons are recombined. The level of oxygen (O_2) is reduced to water.

Exchange Membrane

It acts as either a cation exchange membrane or a proton exchange membrane. The exchange membrane in MFC technology uses Ultrex or Nafion. The protons are allowed to flow through this membrane. While on the other side, the electrons and protons are recombined.

Substrate

These are used to generate energy for the bacteria cell.The power density,Coulombic efficiency, performance , and economic viability of a microbial fuel cell are influenced by the type of substrates, which can be used in MFC are protein, volatile acids, carbohydrates, wastewater,and cellulose. The most commonly used substrate is Acetate.

Microbes

The microorganisms or microbes used in the MFC technology are based on the culture of bacteria.

1. Axenic bacteria
    - Metal that reduces bacteria
    - Geobacter sulfurreducens
    - Rhodoferax ferrireducens
    - Clostridium beijerinckii
    - Shewanella putrefaciens .

2. Mixed bacterial fuel
    - Alcaligenes faecalis
    - Pseudomonas aeruginosa
    - Enterococcus faecium
    - Proteobacteria
    - Desulfuromonas
    - Clostridium butricum
    - Bacteroides
    - Nitrogen-fixing bacteria like Azospirillum and Azoarus
    - Aeromonas species

Construction Of Microbial Fuel Cell

The microbial fuel cell technology is used to convert chemical energy into electrical energy by the oxidation process of organic wastes and several carbon sources. The various components involved in the construction of microbial fuel cell technology are anode and cathode chambers, microbes, exchange membrane, substrates,electrodes, and an electrical circuit to generate electricity.

- The anode and cathode chamber of MFC are made up of glass, plexiglass, and polycarbonate material. The materials like carbon paper,carbon cloth, graphite are used as anode electrodes. To maintain the electrode's aerobic nature, an air cathode is used and it is made up of pI-black catalyst material or platinum material.
- In the MFC technology, the majority of the microbial population belongs to the Shewanella and Geobacter species. To generate electricity, photosynthetic bacteria are used effectively. Mixed bacteria cultures are used in MFC, such as natural microbial communities, marine and lake sediments, domestic wastewater, and brewery wastewater.
- To generate power, the substrates such as acetate glucose, propionate, and butyrates are used in MFC. In bio-electricity generation, the various organic substrates are used, which are involved in anaerobic activity by the microbes.
- To produce continuous electricity, domestic wastewater is used effectively. For maximum power density production- swine wastewater; For bio-electricity and hydrogen production – waste sludge; For bio-electricity generation – oil wastewater.

The construction of microbial Fuel cell technology depends on its design. There are two designs of MFC, such as single Chambered MFC and dual or Two-Chambered MFC.

Single – Chambered MFC

This microbial fuel cell design contains only one anode chamber and it is coupled with an air cathode to transfer the protons and electrons. It can be operated in either continuous mode or batch mode.

Two – Chambered MFC

It is a classic type of technology that consists of two or dual chambers, which are separated by an exchange membrane. It runs in batch mode and works in continuous mode. This MFC design is widely used in laboratories. Acetate or glucose is used as a substrate for Dual – Chambered MFC . It is available in cylindrical, rectangular, upflow with cylindrical, miniature, and U-shaped cathodes.

Advantages

The advantages of Microbial Fuel cell technology are given below ;-

- This technology can generate electricity from biowastes and organic matter.
- It can convert the energy of the substrate to electrical energy/electricity.
- Aeration
- Omission of gas treatment
- Bioremediation of toxic compounds.

Disadvantages

The following are the disadvantages of Microbial Fuel Cell technology

- The generated power density is low.
- Very expensive
- Activation losses and ohmic are present
- Metabolic losses of bacteria.

Applications

A few Microbial Fuel Cell applications are listed below.

- Used in the generation of electricity or power and bio – electricity
- Used in biosensor
- Used in biogas
- USED in the treatment of wastewater
- Used in various bio – fuel applications such as gasses.
- Used in the desalination process
- Used in production of secondary fuel
- Used as an education tool.

REFERENCES

1. https://interestingengineering.com
2. https://www.dnatives.com

POINT ABSORBERS

(DEVI CHANDANA S , 2021-2025)

A point absorber is a floating object that moves at or near the water's surface and absorbs energy from all directions. It generates electricity from the motion of the bouncy top in relation to the base.As these equipments are of small size, the direction of wave is not a matter for this

Method of Working

The relative motion between a body that moves in response to wave pushing and fixed or immobile structures is how point absorbers extract energy. The 'fixed' body might be the seafloor or another structure less impacted by wave movement, whereas the moving body could be above the surface or below the water. In comparison to the length of the waves they are receiving energy from, their primary dimension is modest. A fluid can be pumped directly using mechanical force and motion, or electricity can be generated using a linear or rotational generator.

Advantages

- Efficiency:

Point absorbers have the capacity to generate considerable amounts of electricity from wave energy. Due to their capacity to collect wave energy from various angles, they can achieve great energy conversion efficiency.

- Adaptability:

Point absorbers can be deployed in a range of areas and are comparatively mobile in terms of their positioning. They enable the use of wave energy resources in various places because they are suited for both nearshore and offshore installations.

- Environmental Impact

Compared to other methods of energy production, point absorbers have a negligible influence on the environment. They contribute to lowering carbon dioxide emissions and tackling climate change by producing clean, renewable energy that emits no greenhouse gasses.

- Predictability:

The regularity of wave patterns makes it possible to predict the wave energy potential with accuracy because waves are a predictable source of energy. The stability and dependability of energy generation from point absorbers are improved by this predictability.

- Scalability:

Systems using point absorbers can be scaled up or down to satisfy various energy requirements. They can be set up alone or in groups, giving a modular strategy for energy production and scalability dependent on particular power requirements.

- Resource Availability:

Wave energy has a huge potential in the world's oceans. Point absorbers help diversify the energy mix and lessen reliance on fossil fuels by giving access to a sizable renewable energy resource that is now mostly untapped.

DISADVANTAGES

- Expensive:

It can cost a lot of money to create, build, and put in point absorber systems. Engineers need really strong materials to build things that can survive in the ocean, which makes it expensive at first. These expenses can make point absorbers less cost-effective in comparison to other types of renewable energy.

- Uncertain Performance

Maintenance and durability: The machines that absorb energy from waves can be damaged by the tough conditions in the ocean. This can happen as time goes on. Being constantly exposed to waves, saltwater, and corrosion means that things need to be taken care of often and might be expensive to fix. Making sure that point absorbers will last a long time and work well can be hard.

Wave energy can change a lot and this can affect how well machines that make energy from waves work. This change in wave energy is caused by how high the waves are, how many there are, and which way they are going. It is difficult to generate power consistently because waves come and go. When waves change a lot, it can be hard to get a lot of energy from them and make sure the energy is always there.

- Grid Integration Challenges

Wave energy production is sometimes unpredictable and not always consistent, making it difficult to integrate into the electrical grid. Wave energy systems have to be connected correctly to the electrical grid so that they work well together and don't cause problems for the existing power system. Fixing problems with connecting to the power grid and dealing with the fact that tidal energy is not always consistent can be hard and may need more money spent on building new things.

- Environmental Impact

The use of point absorbers for energy has less harm on the environment than fossil fuels. However, it can still affect nature. The setup and use of point absorbers might disturb sea creatures and plants, change their migration ways, and the movement of sand and mud. We need to evaluate and take action to reduce harm to the environment.

- Limited deployment Areas

Point absorbers only work well in certain places with specific types of waves. The waves need to be regular and high enough for them to work properly. This means that the devices that generate energy from waves need to be placed in areas where there are good waves. This can limit how many places they can be used. It can be hard to find the right place to put point absorbers because you need good waves and a good place near the coast.

- Inhibition of other marine activities:

When there are things in the ocean that absorb energy, it might get in the way of other ocean activities like fishing, shipping, or people having fun by the beach. Deploying point absorbers in the ocean should be done carefully so that it does not clash with other ocean activities. This needs a well thought out plan.

Researchers are working to make point absorber technology better and cheaper.

REFERENCES

1. https://tethys-engineering.pnnl.gov/
2. https://www.mdpi.com/

MARINE ENERGY RESOURCE CONVERSION SYSTEM

(GOPIKA , 2020-2024)

Marine energy current conversion concerns electricity generation from the kinetic energy in freely flowing water . By traditional hydropower the amount of energy extracted from a river is dependent on head between the reservoir and water level below the dam thus the marine energy is converted for tidal areas with high tides a barrage is constructed in order to utilize the head between low and high water.

Marine current includes any kind of water currents be it tidal currents , unregulated rivers or other ocean currents driven for instance by thermal gradients or differences in salinity . Marine currents especially tidal currents are to a large extent predictable and less intermittent than for instance the windThe major types of marine energy resources include wave movements,currents,tides ,temperature,salinity.

MARINE ENERGY

Marine energy or marine power refers to the energy caused by ocean waves,tides,salinity and ocean temperature differences.The movement of water in the worlds ocean creates a vast store of kinetic energy,or energy in motion some of this energy can be harnessed to generate electricity to power homes,transport and industries

MARINE CURRENT POWER

Strong ocean currents are generated from a combination of temperature , wind , salinity , , bathymetry and the rotation of earth. The sun acts as the primary driving force causing winds and temperature differences , because there are only small fluctuations in current speed and steam location with no changes in direction , ocean currents may be suitable locations for developing energy extraction devices such as turbines. Energy is produced from temperature differences in ocean water . OTEC is a process technology for producing energy by harnessing the temperature difference(thermal gradients) between ocean surface waters and deep ocean waters.

OVERVIEW OF SOME COMMON MARINE ENERGY CONVERSION TECHNOLOGIES

1. Wave energy converters (WEC'S) : these devices capture the kinetic energy of ocean waves and convert it into electricity . WEC'S can be categorized into various types , including point absorbers , oscillating water columns and attenuators.
2. Underwater turbines : these turbines are designed to harness the kinetic energy of underwater currents , such as those found in river or ocean currents. They can be deployed in areas where there is a significant flow of water , such as near estuaries or coastal regions.
3. Tidal turbines : tidal turbines operate similarly to wind turbines , but they are specifically designed to generate electricity from the flow of tidal currents . They are typically installed in areas with strong tidal currents ,such as narrow channels or straits .
4. Ocean thermal energy conversion (OTEC systems) : OTEC utilizes the temperature difference between warm surface water and cold deep water to generate power. This technology typically involves the use of a heat exchanger and a working fluid to drive a turbine and produce electricity .
5. Salinity gradient energy conversion : these systems utilize the differences in salt concentration between sea water and fresh water to generate power by employing membranes or other technologies , they harness the osmotic pressure to produce electricity

These marine energy conversion systems have the potential to provide renewable and sustainable sources of power . They can contribute to reducing greenhouse gas emissions and diversifying the energy mix by utilizing the vast energy resources available in the world's oceans .They are still under development and deployment at varying scales , with ongoing efforts to improve efficiency , reliability and cost effectiveness.

REFERENCES

1. https://interestingengineering.com
2. https://www.dnatives.com

GATE CORNER

(HELOISE JOSE , 2022-2026)

1. **For a shell-and-tube heat exchanger, the overall heat transfer coefficient is calculated as 250 W m ^2 K−^1 for a specific process condition. It is expected that the heat exchanger may be fouled during the operation, and a fouling resistance of 0.001 m K^2 W^-1 is prescribed. The dirt overall heat transfer coefficient is _______ Wm^-2 K ^-1**

   (A) 200 (B) 100 (C) 150 (D) 250

2. **Heat transfer coefficient for a vapor condensing as a film on a vertical surface is given by**

   (A) Dittus-Boelter equation

   (B) Chilton-Colburn analogy

   (C) Sieder-Tate equation

   (D) Nusselt theory

3. **A batch settling experiment is performed in a long column using a dilute dispersion containing equal number of particles of type A and type B in water (density 1000 kg m^−3) at room temperature. Type A are spherical particles of diameter 30 mμ and density 1100 kg m^−3 . Type B are spherical particles of diameter 10 mμ and density 31900 kg m^−3 . Assuming that Stoke's law is valid throughout the duration of the experiment, the settled bed would**

   (A) Consist of type B particles only.

   (B) Be completely segregated with type B particles on top of type A particles.

(C) Consist of a homogeneous mixture of type A and type B particles.

(D) Be completely segregated with type A particles on top of type B particles.

4. **Consider a fluid confined between two horizontal parallel plates and subjected to shear flow. In the first experiment, the plates are separated by a distance of 1 mm. It is found that a shear stress of 2 2 Nm− has to be applied to keep the top plate moving with a velocity of 2 ms^-1 while the other plate is fixed. In the second experiment, the plates are separated by a distance of 0.25 mm. It is found that a shear stress of 3 Nm^-2 has to be applied to keep the top plate moving with a velocity of 1 ms^-1 while the other plate is fixed. In the range of shear rates studied, the rheological character of the fluid is**

(A) Newtonian

(B) Ideal and inviscid

(C) Pseudoplastic

(D) Dilatant

5. **A feedforward controller can be used only if**

(A) the disturbance variable can be ignored

(B) regulatory control is not required

(C) the disturbance variable can be measured

(D) the disturbance variable can be manipulated

6. **The operating temperature range for the Haber process is 350-500°C. It is used for the production of ammonia at**

(A) 20 MPa using Fe catalyst in an exothermic reaction

(B) 0.1 MPa using Fe catalyst in an exothermic reaction

(C) 20 MPa using Fe catalyst in an endothermic reaction

(D) 20 MPa using zeolite catalyst in an endothermic

7. **Consider a batch distillation process for an equimolar mixture of benzene and toluene at atmospheric pressure. The mole fraction of benzene in the distillate collected after 10 minutes is 0.6. The process in further continued for additional 10 minutes. The mole fraction of benzene in the total distillate collected after 20 minutes of operation is**

(A) Less than 0.6

(B) Exactly equal to 0.7

(C) Greater than 0.7

(D) Exactly equal to 0.6

8. **Which one of the following is NOT CORRECT?**

(A) NYLON-6,6 is produced by condensation polymerization.

(B) Phenol-formaldehyde resin is a thermosetting polymer

(C) High density polyethylene (HDPE) is produced by condensation polymerization

(D) Poly (ethylene terephthalate) (PET) is a polyester

9. **Consider an incompressible flow of a constant property fluid over a smooth, thin and wide flat plate. The free stream flows parallel to the surface of the plate along its length and its velocity is constant. Value of the Reynolds number at a distance of 2.0 m from the leading edge of the plate is 8000. The flow within the boundary layer at a distance of 1.0 m from the leading edge of the plate is**

(A) Laminar

(B) Turbulent

(C) Transitioning from laminar to turbulent

(D) Inviscid

10. Ratio of momentum diffusivity to thermal diffusivity is

(A) Peclet number

(B) Nusselt number

(C) Reynolds number

11. Leiden frost phenomena is true for

(A) Condensation of vapor on a cold surface

(B) The melting of frost

(C) The exchange of heat between two solids

(D) Film boiling evaporation of liquid droplets falling on a very hot surface

12. Two film theory applies for absorption of a solute from a gas mixture into a liquid solvent. The interfacial mass transfer coefficient (in mol m^-2 s^-1) for the gas side is 0.1 and for the liquid side is 3. The equilibrium relationship is * y = 2x , where * x y and are mole fractions of the solute in the liquid and gas phases, respectively. The ratio of the mass transfer resistance in the liquid film to the overall resistance is

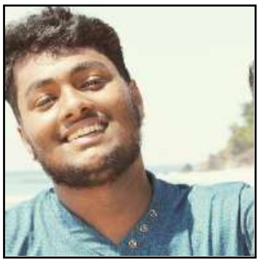
(A) 0.0161

(B) 0.0322

(C) 0.0625

(D) 0.0645

STUDENT ACHIEVEMENTS

1. The team comprising Afzana, Arjun Shankar, Justin Reji, and Muhammad Ijas N (2019-23 batch) who did their final year project on the topic titled “Fabrication of Composite Material using SiO_2, Fe_2O_3, Plastic Waste & PU Foam” received the “Best Chemical Engineering Project” award in the National Level Technical Competition “SRISHTI-2023” held at Saintgits College of Engineering, Kottayam, Kerala in March 2023. They also secured the “The Best Socially Relevant Engineering Project” award in the Project Expo held at TKM College of Engineering, Kollam in May 2023.

2. Ajith P Mangottil (2019-23 batch) took part in the State Level Evaluation of the Young Innovators Programme (YIP) 2020 and was recognized by the body for his idea titled “Semi-Automatic Jaggery Making Machine”.

3. R Sahaana (2019-23 batch) was one of the authors of the paper “Reformation of Existing Manufacturing Technologies through the Concepts of Modular Chemical

Process Intensification (MCPI)" that got published in the Proc. 1st Virtual International Conference on Green Technologies for Sustainable Development.

4. Manu M Johnson (2019-23 batch) was a part of the team of the students of our department that secured runners-up in Chem-E-Debate, an international debate competition conducted by the AIChE VIT Student Chapter on behalf of AIChE.

5. Anjana K Mohan (2020-24 batch) was selected to represent the APJAKTU NSS Cell in the Pre-Republic Day Parade Camp 2023.

6. Joseph Sabu (2019-23 batch) was accepted into the Indian Institute of Technology, Kharagpur (IIT-KGP) in June 2023 for the two-year Master's in Technology programme.

7. Shreya L (2019-23 batch) was accepted into both the Indian Institute of Management, Visakhapatnam and the Indian Institute of Management, Nagpur for the two-year Master's in Business Administration programme.


TKM COLLEGE OF ENGINEERING
DEPARTMENT OF CHEMICAL ENGINEERING
GATE'23 QUALIFIERS
Joseph Sabu
Akash S Babu
Manu M Johnson
Uthara M Maravoor
Shamshida Muhammed T P
Afzana
Muhammed Shabeeb C P
Sreya Das C V
Hafiz H
Jeevandersh S
Abdul Mujeeb Rahman