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A Review Article on "Treatment of Sewage by using Hybrid Technology"

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ABSTRACT*:* Soil biotechnology (SBT) is a green engineering approach for wastewater treatment and recycling. In the present study institutional waste water characterization has been performed followed by the design of Soil Biotechnology plant. Water is a very versatile resource and hence it is used for numerous domestic as well as industrial purposes. As water is a free resource and 70% of earth's surface is covered in water, Man has used it rapidly subsequently contaminating it with domestic as well as industrial wastes. Now, as we understand the importance of water and how we are contaminating it, we know that there is a need to reuse the water again and again so as to ease the pressure on the fresh water available on earth's surface. To reuse the contaminated water, it has to be treated so that the harmful impurities can be separated and removed. Depending upon the quality of waste water, volume of water to be treated and the use of the treated water, number of processes have been developed and implemented. One of such process is known as Soil Bio Technology which is a green technology wherein there is a minimum use of power for treatment without compromising the quality of treated water. The waste water is first passed through tube settlers and then through Tanks known as Bio-Reactors which are filled with Aggregates, Brick Bats and Bio Media (earthworms). Waste water flows through this layers which acts as filters by gravity and is treated through a natural and harmless process. This process has number of benefits over the conventional processes but also has its own limitations. Soil biotechnology (SBT) is a modern technology to treat the wastewater effectively, less costly, eco-friendly which uses the granular media like soil, gravels and sand, biological media like earthworms, bacteria and plants. This technology is useful where there is no sewer transportation is available. In this paper analysis of the domestic wastewater and treated water is being done by IS: 3025 methods and the parameters are pH, TDS, TSS, BOD, COD and Ammonical, Nitrogen.

KEYWORDS: Soil Biotechnology (SBT), Sewage, Earthworms, BOD, COD, TDS, TSS

I. INTRODUCTION

Waater becomes the scarest thing in some parts of the world as the availability is become limited due to the increasing contamination and environmental activities around the globe [1,2]. There are 1.2 billion people living on this earth today with no access to safe drinking water; typically two million people die annually of diarrhoea and about one third of the world's popula-tion lack satisfactory sanitation [3]. The high demand of fresh-water resources and growing environmental awareness give rise to the use of reclaimed wastewater as a new source of water supply [4]. Wastewaters are commonly categorized as domestic waste-water or industrial wastewater. Domestic wastewater refers to wastewater generated from "non-manufacturing activities" occurring in residential homes which includes sewage (from toi-lets) and grey water (from bathrooms and kitchens). There are many types of industrial wastewater based on the different industries and contaminants; each sector produces its own particular combination of pollutants. Wastewaters are typically con-taminated with physical, chemical and biological composition which has tremendous negative impact on environment, where it has the ability to destroy many animal habitats, and cause irre-parable damage to many ecosystems. Wastewater treatment processes are designed to achieve improvements of the wastewater quality. The two main reasons for collecting and treating waste-water are to prevent water-borne transmission of disease and to preserve the aquatic environment [5]. Physical composition in wastewater such as suspended solids can lead to the development of sludge deposits and anaerobic conditions when untreated wastewater is discharged in the aquatic environment. Therefore, an advance treatment method such as hybrid was-tewater treatment system has gained much attention in recent years for a more effective removal of pollutants from wastewater [6]. The concept of microbial fuel cell (MFC) in accomplishing wastewater treatment and to generate bioenergy simultaneously has also been a trend where much effort has been put in to maximize the power generation [7,8]. Wastewaters contain energy, in the form of biodegradable organic matter, that we expend energy to remove rather than trying to recover it [9]. Besides, there is a continuous global concern on environments and shortage of energy from fossil fuels like pollution and global warming

with the exponential growth of population [10,11]. This trend has triggered global movement towards the generation of renewable energy by developing new technology and engineering systems which are not only sustainable but clean and environmental-friendly. There are some hybrid technologies which are promising and yet completely different approach to wastewater treatment as the treatment process can become a method of capturing energy in the form of electricity or hydrogen gas, rather than a drain on electrical energy.

SBT is a hybrid wastewater treatment process, which is based on a bio-conversion process where fundamental reactions of nature, namely respiration, photosynthesis and mineral weathering take place in a media housing micro & macro organisms which bring about the desired purification. SBT is an oxygen supplying biological engine and so the process can treat all types of water – domestic, municipal and industrial. Soil Biotechnology (SBT) used as an option for decentralized wastewater treatment. The current sanitation scenario of urban India is one of severe lack of collection, treatment and disposal systems for domestic sewage. In order to tackle this problem and protect water resources from contamination, while also augmenting usable water resources, there is an urgent requirement to identify appropriate technologies for wastewater treatment. Decentralized technologies are increasingly attractive because of several advantages, especially in the Indian context.

II. LITERATURE REVIEW

[1] Hybrid constructed wetlands for wastewater treatment: A worldwide review (2012)- The utilization of environmentally friendly and eco-safe wastewater treatment plan is nowadays widespread. This study aimed to assess the potentiality of hybrid constructed wetlands for treating of landfill leachate, river polluted water, domestic, industrial, hospital, runoff and agricultural wastewaters in lab-scale, pilot-scale and full-scale with various configurations. The results revealed that the hybrid constructed wetlands are effective to remove organic matter (BOD5, COD) and suspended solid, while in terms of nutrient removal such as N and P components, the removal efficiencies were depending to system properties and operational condition. Additionally, it is very useful system to remove the heavy metals and pharmaceuticals pollutants from different wastewaters. Combination of constructed wetlands enhances pollutants removal efficiency as hybrid constructed wetlands could cover the limitation of each single constructed wetlands. It could be concluded that the hybrid constructed wetlands ensure a more stable removal rate of pollutants from various wastewaters in comparison with other wastewaters treatment plans.

[2] Application of chemically modified rice husk for the removal of heavy metals from aqueous solution (2010)- The removal efficiency of lead, cadmium and zinc from aqueous solution on adsorption by using rice husk, a non-conventional material in its natural and chemically modified form has been presented in this paper. It has been observed that rate of adsorption is dependent on the nature of the adsorbent, adsorbent dose, particle size of the adsorbent, concentration, pH, contact time, temperature, etc. Under identical experimental condition chemically modified rice husk was found to possess greater adsorption capacity for all metals than untreated rice husk and chemically modified rice husk ash. Chemically modified rice husk could remove 99.8% Pb, 95% Cd and 97% Zn from aqueous solution at room temperature.

[3] Domestic wastewater treatment by soil biotechnology (2017)- Soil biotechnology (SBT) is a modern technology to treat the wastewater effectively, less costly, eco-friendly which uses the granular media like soil, gravels and sand, biological media like earthworms, bacteria and plants. This technology is useful where there is no sewer transportation is available. In this project I used alluvial soil, E-fetida earthworms and aloe vera plant to treat domestic wastewater of Shertha village, Gandhinagar. Analysis of the domestic wastewater and treated water is being done by IS: 3025 methods and the parameters are pH, TDS, TSS, BOD, COD and Ammonical Nitrogen. Experiments done on different intervals with HRT of 6, 8, 10 hours. As per results the range of percentage removal efficiency of TDS, TSS, BOD, COD and Ammonical Nitrogen are 65-75%, 64-74%, 75-90%, 75-92%, 55-65% respectively. Domestic wastewater is collected from open drainage of Shertha village near kalol, Gandhinagar. Treated water by SBT plant meets the discharge norms of pollution control board. There are no moving parts except the pump so, noise pollution is eliminated.

[4] Recent advances on pollutants removal by rice husk as a bio-based adsorbent: A critical review (2019)- Rice husk is an attractive bio-based adsorbent material for pollutant removal since it is one of the low-cost and renewable resources. The objective of this review is to give a summary of the key scientific features related to pollutants removal

using rice husk, with a specific emphasis on the effect of factors on adsorption capacity of rice husk. According to the results, rice husk has the removal potential of various pollutants and it can be more used in the wastewater treatment. On the other hand, untreated bio-based adsorbent in large-scale application can usually cause some difficulties and selection of appropriate pretreatment method for rice husk is also one of the major challenges. Therefore, this review studies different pretreatment methods as well as regeneration of adsorbent and the fate of adsorbed contaminants. According to the literature, pretreatment methods increase the rice husk capability and adsorption capacity and the chemical treatments have been more used than thermal treatments. Also, regeneration of rice husk adsorbent and adsorbed contaminants is applicable. Finally, examples of some applications and possibility of biocatalyst immobilization on the rice husk as a promising approach are presented. Results confirmed that rice husk has an excellent prospective potential for biocatalysts immobilization.

[5] Study of Soil Biotechnology for Waste Water Treatment (2020)- Water is one of the world's most valuable resources, yet it is under constant threat due to climate changes, resulting in drought, explosive population growth, and waste. India is completely dependent on the monsoons to meet its annual water demand. Reclamation and reuse of the Wastewater would help minimize the overall supply of water. The amount of non-potable water generated in the Class 1 Cities has a population of n more than 1 la, is approximately 35,558 Million liters/day. This water goes directly into the septic tanks and becomes Wastewater. SBT involves removing organic matter by adsorption, followed by biological degradation and oxygen supply by natural aeration to the treatment system. The photosynthetic activity of green cover serves as a bio-indicator for the kind of micro-habitat in SBT. The SBT is designed to provide the requisite filtration, aeration, and biochemical processing to remove toxicity, including BOD, COD, nitrate, phosphate, suspended solids, color, odor, and bacteria. Unlike a conventional STP or septic tank where periodically the sludge has to be offloaded, everything is consumed within the plant in this SBT based STP. Raw sewage is pumped to a customized media bed for around five hours (dependent on load and capacity), and clean water flows into the collection tank.

[6] Alternative treatments to improve the potential of rice husk as adsorbent for methylene blue (2017)- Alternative treatments, such as, NaOH, ultrasound assisted (UA) and supercritical CO2 (SCO2), were performed to improve the potential of rice husk as adsorbent to remove methylene blue (MB) from aqueous media. All the treatments improved the surface characteristics of rice husk, exposing its organic fraction and/or providing more adsorption sites. The Langmuir and Hill models were able to explain the MB adsorption for all adsorbents in all studied temperatures. The experimental and modeled parameters demonstrated that the MB adsorption was favored by the temperature increase and by the use of NaOH-rice husk. The maximum adsorption capacities for the MB solutions (ranging from 10 to 100 mg L-1), estimated from the Langmuir model at 328 K, were in the following order: NaOH rice-husk (65.0 mg g-1) > UA-rice husk (58.7 mg g-1) > SCO2-rice husk (56.4 mg g-1) > raw rice husk (52.2 mg g-1). The adsorption was a spontaneous, favorable and endothermic process. In general, this work demonstrated that NaOH, UA and SCO2 treatments are alternatives to improve the potential of rice husk as adsorbent.

[7] Removal of heavy metal ions from wastewater by chemically modified plant wastes as adsorbents: a review (2008)- The application of low-cost adsorbents obtained from plant wastes as a replacement for costly conventional methods of removing heavy metal ions from wastewater has been reviewed. It is well known that cellulosic waste materials can be obtained and employed as cheap adsorbents and their performance to remove heavy metal ions can be affected upon chemical treatment. In general, chemically modified plant wastes exhibit higher adsorption capacities than unmodified forms. Numerous chemicals have been used for modifications which include mineral and organic acids, bases, oxidizing agent, organic compounds, etc. In this review, an extensive list of plant wastes as adsorbents including rice husks, spent grain, sawdust, sugarcane bagasse, fruit wastes, weeds and others has been compiled. Some of the treated adsorbents show good adsorption capacities for Cd, Cu, Pb, Zn and Ni.

[8] Sewage/Wastewater Treatment Technologies: A Review (2011)
Users must concentrate their Sewage/Wastewater treatment process to ensure that it complies with regulatory guidelines. The main purpose of Sewage treatment process is to remove the various constituents of the polluting load: solids, organic carbon, nutrients, inorganic salts, metals, pathogens etc. Effective wastewater collection and treatment are of great importance from the standpoint of both; environmental and public health. Sewage/Wastewater treatment operations are done by various methods in order to reduce its water and organic content, and the ultimate goal of wastewater management is the protection of the environment in a manner commensurate with public health and socio-economic concerns. In this article, Sewage/Wastewater treatment techniques, factors affecting selection and design Sewage/Wastewater systems are discussed briefly. The ultimate goal of wastewater management is the protection of the environment in a manner commensurate with public health and socio-economic concerns. Based on the nature of wastewater, it is suggested whether primary, secondary and tertiary treatment will be carried out before final disposal. Understanding the nature of wastewater is fundamental to design appropriate wastewater treatment process, to adopt an appropriate procedure, determination of acceptable criteria for the residues, determination of a degree of evaluation

required to validate the procedure and decision on the residues to be tested based on toxicity therefore, it is necessary to ensure the safety, efficacy and quality of the treated wastewater.

[9] Application of Biosorption for Removal of Heavy Metals from Wastewater (2018)- Fresh water accounts for 3% of water resources on the Earth. Human and industrial activities produce and discharge wastes containing heavy metals into the water resources making them unavailable and threatening human health and the ecosystem. Conventional methods for the removal of metal ions such as chemical precipitation and membrane filtration are extremely expensive when treating large amounts of water, inefficient at low concentrations of metal (incomplete metal removal) and generate large quantities of sludge and other toxic products that require careful disposal. Biosorption and bioaccumulation are ecofriendly alternatives. These alternative methods have advantages over conventional methods. Abundant natural materials like microbial biomass, agro-wastes, and industrial byproducts have been suggested as potential biosorbents for heavy metal removal due to the presence of metal-binding functional groups. Biosorption is influenced by various process parameters such as pH, temperature, initial concentration of the metal ions, biosorbent dose, and speed of agitation. Also, the biomass can be modified by physical and chemical treatment before use. The process can be made economical by regenerating and reusing the biosorbent after removing the heavy metals. Various bioreactors can be used in biosorption for the removal of metal ions from large volumes of water or effluents. The recent developments and the future scope for biosorption as a wastewater treatment option are discussed.

[10] A review on activated carbon: process, application and prospects (2016)- Activated carbon (AC) is used in different states of applications after its discovery as a strong and reliable adsorbent. An overview on AC is presented together with revisiting the sources of AC generation; methods used to generate AC comprising of pyrolysis activation; physical activation; chemical activation and steam pyrolysis. The important factors affecting the AC production, the possible applications of AC and their future prospects are also discussed. AC is applied in water, wastewater and leachate treatments in many countries, especially to polish the color, remove the odor and some heavy metals. It is cheap and available, and can be produced from agricultural waste materials, e.g., rice husk, palm oil shell and coconut shell. The AC's fine and porous structure and an extremely large particle surface area (>1000 m2 /g) results in making it possessed powerful adsorptive properties. Therefore, the adsorption process using AC is found to be a potentially viable method of removing pollutants from aqueous solutions. Conclusively, it is seen from the findings that, the importance and advantages of AC cannot be overestimated as it almost fulfills the needs in every sector that need adsorbent for purification of liquid, gas and solid matters. Consequently, there is a great obligation from the authorities to assist (physically and economically) researchers in finding easy and viable ways to boost the production of AC at best possible quality. These efforts will definitely ensure the protection of our environment that is facing multiple challenges day by day from been contaminated. It will as well serve as a way of creating job opportunities for the youth and the citizens of every nation.

III. SOIL BIOTECHNOLOGY CASE STUDIES

1. 3000 KLD PLANT IN BMC WORLI, MUMBAI

Client	Brihanmumbai Municipal Corporation
Project	SBT type STP
Designed Capacity	3000 cum/day
Year	2005
Area	2500 sqM

Features of Worli Soil Biotechnology Plant:-

- 3 MLD waste water is pumping out for treatment from 800 MLD
- Direct pumping over top of BR without any primary treatment
- Facility is constructed in half masonry and half media bund
- Power 0.05 kWH/kL

Results:- Plant performance of plant for 6 months

2. 600 KLD PLANT IN MAHUVA VILLAGE, SURAT

Client	Dept of Rural Development Gujarat
Project	CAMUS SBT type STP
Designed Capacity	600 cum/day
Year	2014
Area	600 sqM

Features of Mahua Soil Biotechnology plant:-

- Project proposed by Dept of Rural Development Gujarat as a special demonstration case for CAMUS SBT.
- 0.6 MLD sewage is generated from village.
- Preliminary, Primary, secondary treatment, administrative and control room all facilities are RCC structures
- Power requirement is less than 0.1 kWh/ kL
- Using Water for farming

Results:- In recent study of water tests shows that BOD is less than 4.5 and COD is less than 40 with removal efficiency of BOD and COD are greater than 98% and greater than 92% respectively and treated water discharging into the lake.

3. 1400 KLD PLANT IN MES, JAISALMER

Client	Military Engineering Service
Project	CAMUS SBT type STP
Designed Capacity	1400 cum/day
Year	2011
Area	2000 sqM

Features of Jaisalmer Soil Biotechnology Plant:-

- Project in desert area with variant atmosphere.
- Preliminary, Primary, secondary treatment administrative and control room all facilities are RCC structures
- Plant is designed to give treated water for irrigation standards.
- Power requirement is 0.1 kWh/KLD
- Using water Gardening.

Results:- Water tests shows that BOD is less than 10 and COD is less than 80 with removal efficiency of BOD and COD are greater than 91% and greater than 80% respectively and treated water is using for watering for garden and lawn.

4. 650 KLD PLANT IN HDIL, VIRAR

Client	Housing Development and Infrastructure Limited
Project	CAMUS SBT type STP
Capacity	650 cum/day
Year	2012
Area	700 sqM

Features of HDIL Virar Soil Biotechnology Plant:-

- Project proposed in the median of wide 6m on road between two residential buildings.
- Preliminary, Primary, secondary treatment and tertiary treatment, administrative and control room all facilities are RCC structures
- CAMUS SBT itself acts as a secondary and tertiary treatment
- Treated water for reuse.
- Power requirement is 0.1-0.15 kWh/KLD
- Using the water for flushing, car washing, construction and Gardening

Results:- In recent study of water tests shows that BOD and COD are less than 5 with removal efficiency of BOD and COD are greater than 99% and treated water quality nearly equal to drinking water. Treated water is used for construction, flushing, plantation, car washing and floor cleaning.

5. **500 KLD SBT PLANT AT GUJARAT STATE ELECTRICITY BOARD, PANANDRO**

Client	Gujarat State Electricity Board
Project	CAMUS SBT type STP
Capacity	500 cum/day
Year	2014
Area	600 sqM

Features of GSEB Panandhro Soil Biotechnology plant :-

- Project in desert area with variant atmosphere.
- Preliminary, Primary, secondary treatment, administrative and control room all facilities are RCC structures
- Plant is designed to reuse the treated water for gardening and irrigation.
- Power requirement is less than 0.1 kWh/kL
- Using the water for gardening

Results:- Water tests shows that BOD is less than 8.5 and COD is less than 59 with removal efficiency of BOD and COD are greater than 96% and greater than 81% respectively and treated water is using for watering for garden and lawn.

6. 500 KLD SBT PLANT AT GUJARAT STATE ELECTRICITY BOARD, SIKKA

Client	Gujarat State Electricity Board
Project	CAMUS SBT type STP
Capacity	500 cum/day
Year	2014
Area	600 sqM

Features of GSEB Sikka Soil Biotechnology plant:-

- Project in desert area with variant atmosphere.
- Preliminary, Primary, secondary treatment, administrative and control room all facilities are RCC structures
- Plant is designed to reuse the treated water for gardening and irrigation.
- Power requirement is less than 0.1 kWh/kL
- Using the water for gardening

Results:- Water tests shows that BOD is less than 8.5 and COD is less than 59 with removal efficiency of BOD and COD are greater than 96% and greater than 81% respectively and treated water is using for watering for garden and lawn.

7. 250 KLD SBT PLANT AT COMMAND HOSPITAL AIR FORCE, BANGALORE

Client	Command Hospital Air Force
Project	CAMUS SBT type STP
Capacity	250 cum/day, Designed for 400 cum/day
Year	2011
Area	400 sqM

Features of CHAF Bangalore Soil Biotechnology plant:-

- Project in Hospital, all the waste water will come including blood, tissues.
- Preliminary, Primary, secondary treatment, administrative and control room all facilities are RCC structures
- Power requirement is 0.2 kWh/kL
- Using water for farming.

Results:- Water tests shows that BOD is less than 5 and COD is less than 26 with removal efficiency of BOD and COD are greater than 98% and greater than 99% respectively and treated water is using for watering for irrigation of CHAF farming fields to recover the investments.

8. 165 KLD SBT PLANT AT AIRPORT AUTHORITY OF INDIA, LUCKNOW

Client	Airport Authority of India
Project	CAMUS SBT type STP
Capacity	165 cum/day

Year	2011
Area	400 sqM

Features:-

- Project in Airport area with variant atmosphere.
- Preliminary, Primary, secondary treatment, administrative and control room all facilities are RCC structures
- Power requirement is 0.2 kWh/kL
- Using water for gardening

Results:- Water tests analysis for 8 months in 2014 which shows the treated water quality is also consistent with variable load. Treated water is used for gardening.

9. 75 KLD SBT PLANT AT DLF REAL STATE GARDEN, GURGAON HARYANA

Client	DLF Real State Garden
Project	CAMUS SBT type STP
Capacity	75 cum/day,
Year	2015
Area	200 sqM

Features of DLF Garden Estate Soil Biotechnology plant:-

- Project in VIP area with peaceful atmosphere.
- Preliminary, Primary, secondary treatment, administrative and control room all facilities are RCC structures
- Power requirement is 0.2 kWh/kL
- Using the water gardening, Car washing and road cleaning.

Results:- Water tests shows that BOD is less than 14 and COD is less than 37 with removal efficiency of BOD and COD are greater than 98% and greater than 99% respectively and treated water is using for watering for gardening.

10. 1500 KLD PLANT IN HEROHALLI LAKE, BANGALORE

Client	Bruhat Bengaluru Mahanagara Palike
Project	CAMUS SBT type STP
Designed Capacity	1400 cum/day
Year	2011
Area	1650 sqM

Features of BBMP Bangalore Soil Biotechnology Plant:-

- Project proposed by Task Force for Quality Assurance in public construction, secretariat office, Government of Karnataka as a special demonstration case for CAMUS SBT.
- For restoration of Lake
- 1.4 MLD sewage is separated from 8 MLD inflow which contains the effluents from textile industry.
- Preliminary, Primary, secondary treatment, administrative and control room all facilities are RCC structures

- Power requirement is less than 0.1 kWh/ kL

Results:- In recent study of water tests shows that BOD is less than 4.5 and COD is less than 40 with removal efficiency of BOD and COD are greater than 98% and greater than 92% respectively and treated water discharging into the lake.

IV.CONCLUSION

From the literature surveyed and case studies it can be said that Soil Biotechnology is one of the environment friendly technology. SBT is having very high potential in minimal requirement of power; Power is needed only when pumping system is required to pump water in and out of the reactor. This requirement can be reduced further if the water is allowed to flow by gravity. Further, the plant does not require uninterrupted operation and is meant to be run for a few hours a day. Thus SBT is a strong technology where uninterrupted power supply is problematic or not possible. Also for operating SBT skilled manpower id not required.

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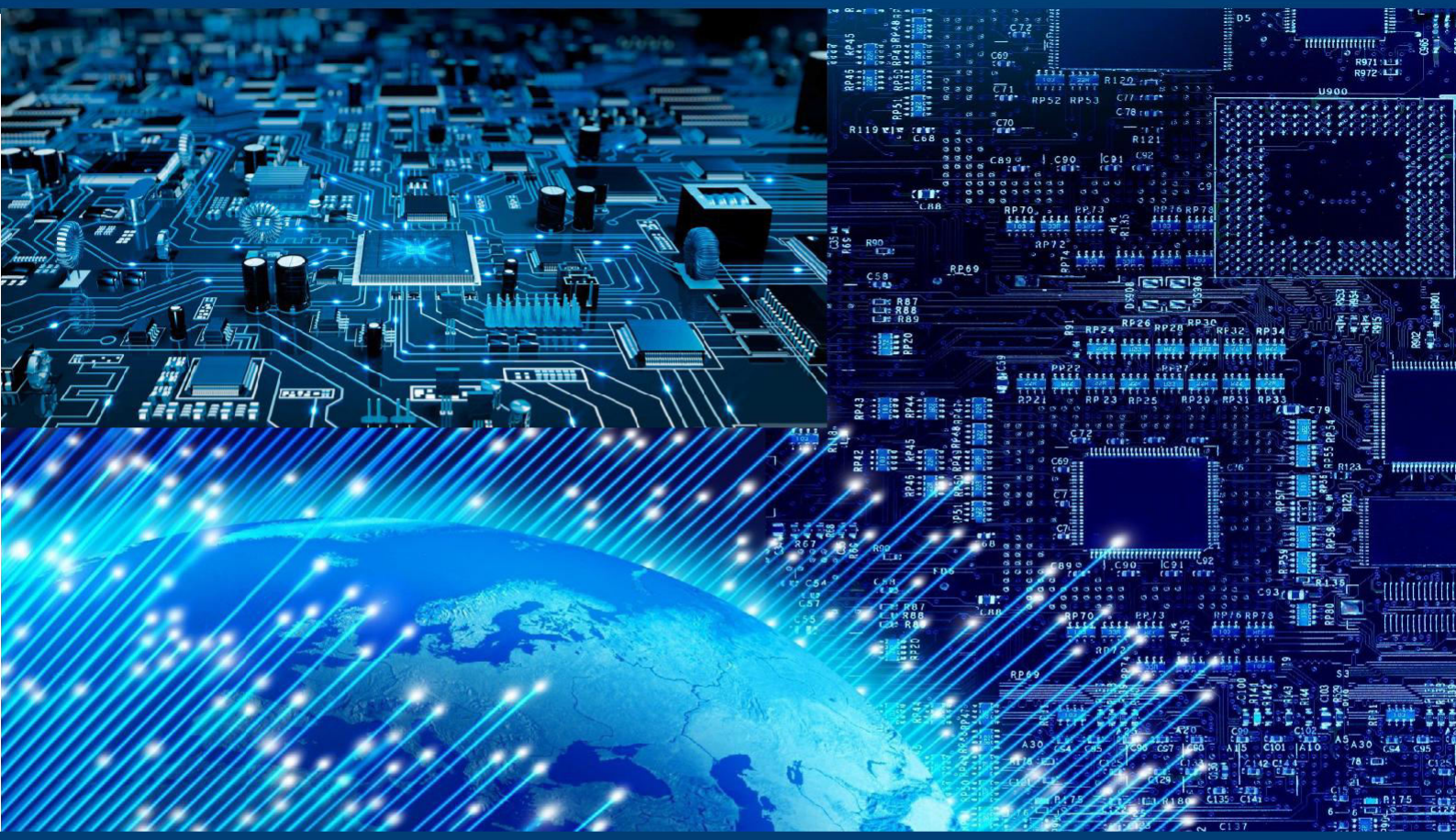

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