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Editorial

'Quest' is intend to provide students of ARIBAS a platform to learn 'art and science of scientific writing '. It helps to expand knowledge, deepen skills and enhance practice of science.

Laser ablation is the process of removing material from a solid surface by irradiating it with a laser beam. Terahertz emitters is a photoconductive antenna, comprising two electric contacts thin film semiconductors. Ablating the material with femtosecond laser pulses creates microscale groovs and ripples that increase its light absorption. After this process GaAs terahertz output is enhanced by up to 65 percent if pumped by a sufficiently powerful laser. While still no cheap and efficient way to mass produce terahertz emitters, laser ablation can increase the output of GaAs, a common semiconductor used in these devices.

As we know antibiotic are powerful medicines that fight against bacterial infection. But using antibiotic when you don't need them or not using them properly can add to antibiotic resistance. As a result of such reckless use, deadly strains of life-taking bacteria that are resistant to even the latest generation of antibiotics have been found to be rampant in India. So think twice before consuming it !! The issue also focuses on third generation biofuel. The term third generation refers to biofuel derived from algae. When it comes to the potential to poduce fuel, no feedstock can match algae in terms of diversity.

Water is vital to all forms of life, all plants, animals and humans. And water pollution is one of the serious ecological threats we face today. Dairy industry is among the most polluting of food industries in regard to its large water consumption. Waste water generated in a dairy contains highly purtrescible organic constituents. Al most all the organic constituents of dairy waste are easily biodegradable. The issue also present the effort to evaluate the treatment of wastewater generated by dairy industry.

We invite you to read this month's articles and contribute to these discussions.

Editorial Office
Quest, ARIBAS,
New Vallabh Vidyanagar,
Vitthal Udyognagar - 388121,
Dist- Anand, Gujarat, India.
Phone: +91-2692-229189, 231894
Fax: +91-2692-229189
Email: editor@aribas.edu.in
Website: www.aribas.edu.in

Published By
Director ARIBAS,
New Vallabh Vidyanagar,
Vitthal Udyognagar - 388121,
Dist- Anand, Gujarat, India.
Phone: +91-2692-229189, 231894
Fax: +91-2692-229189
Email: head@aribas.edu.in
Website: www.aribas.edu.in

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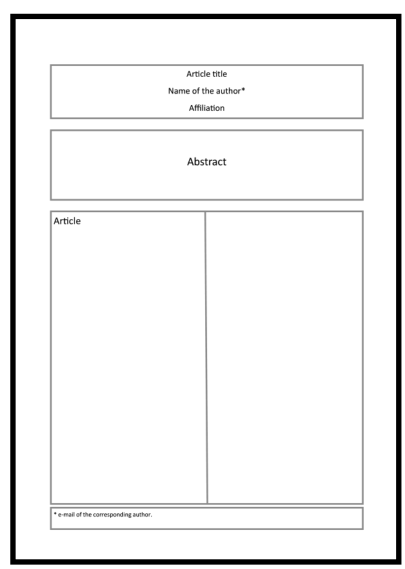
Notice to Authors

Manuscripts submitted to Quest should adhere to below mentioned criteria.
Research News: About 400 words (1 page)
Research Article: About 2000 words (4 pages)

Common for all: -
Font: Calibri
Font Size: 14
Columns: 2
Line Spacing: 1
Margin: Narrow
References: 1) In text citing, S No, Superscript.
2) Author's name (s), *Journal name*, **Volume No**, Page No**,** (year).
3) Maximum number of references should not exceed than 25.



Laser ablation boosts terahertz emission

Summary: From almost instantaneous wireless transfer of huge amounts of data and easy detection of explosives, weapons, or harmful gases, to safe 3-D medical imaging and new advances in spectroscopy - technologies based on terahertz (THz) radiation, the electro-magnetic band with wavelengths from 0.1 to 1 mm, can transform science fiction into reality. However, scientists and engineers still do not have cheap and efficient solutions for mass production of THz-based devices.

The THz portion of the spectrum remained unused, giving rise to the term "terahertz gap." Research, recently published in *Optics Letters* by the Femtosecond Spectroscopy Unit at the Okinawa Institute of Science and Technology Graduate University (OIST), suggests one possible solution for this problem: a method to increase efficiency of THz emission gallium arsenide (GaAs)-based devices.

THz radiation lies between infrared and microwave radiationin the electro-magnetic spectrum. It is absorbed by water which limits the use of THz devices in the Earth's atmosphere, laden with water vapour, to short distances but it can penetrate fabrics, paper, cardboard, plastics, wood, and ceramics. Many materials have a unique "fingerprint"in the THz band allowing their easy identification with THz scanners. Moreover, unlike X-rays and ultraviolet light, THz radiation is safe for live tissues and DNA, due to its non iosnising properties. THz technology could be a next important breakthrough in medicine, security, chemistry, and information technol- Generation of THz waves is difficult since the frequency is too high for conventional radio transmitters, but too low for optical transmitters, like the majority of lasers. Therefore, researchers have to come up with new innovative devices.

One of the most frequently used THz emitters is a photoconductive antenna, comprising two electric contacts and a thin film of semiconductor, often GaAs, between them. When the antenna is exposed to a short pulse from a laser, the photons excite electrons in the semiconductor, and a short burst of THz radiation is produced.

-laser-ablation, in which the material is exposed to ultrashort bursts of high energy, creates micrometre-scale grooves and ripples on the surface of GaAs. "The light gets trapped in these ripples," says Athanasios Margiolakis, a Special Research Student at OIST. Since more light is absorbed by the ablated material, the efficiency of THz emission, given a sufficiently powerful laser, increases by 65%.

Other properties of the material change as well. For example, ablated GaAs shows only a third of the electrical current of non-ablated GaAs. "We observe counter-intuitive phenomena,"the researchers write, "One generally expects that the material showing the higher photocurrent would give the best THz emitter." They explain this phenomenon by shorter carrier lifetimes. That is, electrons in ablated samples return to non-agitated states much faster than in control samples.

Dr Julien Madéo, one of the OIST team members, says that "femtosecond-laser ablation allows us to engineer the properties of materials and to overcome their intrinsic limitations, leading, for example, to near 100% photon absorption as well as broader absorption bandwidth, control of the electron concentration and lifetime." This technique is a fast, lower-cost alternative to existing methods of manufacturing materials for THz applications.

-Contributed by Krishna Saraiya
IGBT IV

‘Antibiotic addict’ India losing fight against lethal bacteria

LONDON: India is the world's antibiotic popping capital, recording the highest number of such pills consumed annually — 13 billion pills as against 10 billion in China and 7 billion in the US.

As a result of such reckless use, deadly strains of life-taking bacteria that are resistant to even the latest generation of antibiotics have been found to be rampant in India. The first State of the World's Antibiotics report 2015, to be revealed by Washington-based Centre for Disease Dynamics, Economics and Policy (CDDEP) has found that the bacteria strain *Klebsiella pneumoniae's* resistance to last-resort antibiotic class, Carbapenems, was a whopping 57% in India in 2014, up from 29% earlier.

This is a dangerous superbug found in hospitals whose resistance rate in Europe is below 5%.

Klebsiella's resistance to a variety of drugs is high — the bug is around 80% resistance to the class III generation Cephalosporin’s, 73% resistant to fluoroquinolones and 63% to aminoglycosides. For four of five drug classes tested, *Klebsiella* was more than 60% resistant in India.

The report confirms the findings of a Princeton University study in 2014 which said Indians consume the highest number of antibiotics in the world.With antibiotic use increasing by 43% in India from 2000 to 2010, resistance to the deadly *E.coli*, which causes serious food poisoning, abdominal cramps and severe diarrhea, too has been growing in India. For three different drug classes, *E.coli* resistance in India was currently over 80%. It is one of the pathogens for which across the world, resistance is becoming a huge concern.

In Europe, north America, southeast Asia and Africa, resistance to amino penicillins — a broad-spectrum antibiotic class that treats a variety of infections hovers around 50%. In India, 13% of E coli were resistant to the latest generation of antibiotics, Carbapenems, in 2013.

In further bad news, in India, a steep increase in MRSA, a contagious and antibiotic-resistant bacterium, was recorded by a large private laboratory network, from 29% of Staphylococcus aureus isolates in 2009 to 47% in 2014.

Staphylococcus aureus is one of the five most common causes of infections after injury or surgery.

The report which reveals global trends in drug resistance in 39 countries and antibiotic use in 69 countries says India has the highest amount of overall antibiotic consumption of all the countries. As many as 58,000 neonatal sepsis deaths are attributable to drug-resistant infections in India alone.

Ramanan Laxminarayan, CDDEP Director and report co-author said, "A rampant rise in antibiotic use poses a major threat to public health, especially when there's no oversight on appropriate prescribing. Antibiotic use drives antibiotic resistance". "Carbapenem antibiotics are for use in the most direcircumstances — when someone's life is in danger and no other drug will cure the infection," said Sumanth Gandra, an infectious diseases physician and CDDEP resident scholar. "We're seeing unprecedented resistance to these precious antibiotics globally, and especially in India. If these trends continue, infections that could once be treated in a week or two could become routinely life threatening and endanger millions of lives."

Since their introduction into medicine in the 1940s, antibiotics have been used from treating serious infections to preventing infections in surgical patients, protecting cancer patients and people with compromised immune systems.

Now, however, once-treatable infections are becoming difficult to cure, raising costs to healthcare facilities, and patient mortality is rising.Antibiotic resistance is a direct result of antibiotic use. The greater the volume of antibiotics used, the greater the chances that will prevail. The report says, "Rising incomes are increasing access to antibiotics. That is saving lives but also increasing use — both appropriate and inappropriate—which in turn is driving resistance".

Experts say the Indian Council of Medical Research had begun setting up the Anti-Microbial Resistance Surveillance Network in 2011. When complete, its seven nodes will focus on diarrhea, enteric fever, sepsis, gram-positive bacteria, fungal infections and respiratory pathogens.

Think Once Before Consuming

First of all what is an antibiotic?? In simple term an antibiotic is essentially a substance used for curing illness by killing or injuring microbes. Antibiotics are good if it is prescribed by a physician. Now it is seen that with its increasing usage the resistance by the microbes towards antibiotic has also increased. This is a serious threat for human being. Some precautions can be helpful if taken care. If doctors are not sure about their diagnoses, they shouldn’t give their patients antibiotics. Patients without consulting the doctor they should never take antibiotic and even when the symptom of the disease is not seen they should complete the dose given by the physician.

The WHO also recommended that government ensure rational use of antibiotics by educating healthcare workers and the public. Strict regulations over the use of antibiotics should be present in India. In many cases patients take antibiotic for common cold also. It should be taken into consideration that antibiotics don’t cure viral infection. About 1, 40,000 people every year have serious adverse reactions to antibiotics. With repeated usage the health of the patient may worse and sometimes leads to death. Here the struggle is between the individual’s short-term good and the community good, which will inevitable, affect the individual. Here doctors can play a major role they must do more to convince patients that they do not need antibiotics and should explain the side effects. So as long as the antibacterial drugs are easily available and used the antibiotic drug resistance problem will remain a challenge. But the educational and behavioral interventions for modifying drug prescribing practice for health care providers and patients on appropriate use of antibiotics and adherence to prescription instructions are only the ways to reduce the emergence of bacterial resistance against antibiotics.

-Contributed by Palak shah
IGBT II

Third Generation Biofuel: A Renewable fuel from algae

Mukund Chandra Thakur*

Ashok & Rita Patel Institute of Integrated Study and Research in Biotechnology and Allied Sciences (ARIBAS), New Vallabh Vidyanagar-388121, Anand, Gujarat, India.

Abstract: Constant increasing price of crude oil has led the world to think of an efficient and cost effective alternative such as biodiesel. Biodiesel can be blend with petroleum fuel to reduce the consumption of fossil fuel can be served as a solution. As first generation biofuel has raised the debate on food vs. fuel debate, macroalgae and microalgae provide a potential feedstock for the production of third generation biofuel. With the advancement in production strategies and ground breaking genetic engineering technologies such as introduction of good strains of macroalgae, increasing carbohydrate content in the species and cost reduction in biodiesel production could be applied for successful alternative as biodiesel in future.

Introduction

Constant and rapid consumption of fossil fuels in daily life has increased concerns for alterative source of energy consumption and has been widely unaccepted. In the year 2008, fossil fuel accounted for 88% of the global primary energy consumption[1]. This energy consumption is due to increasing use of fossil fuels for transport, electricity and thermal energy generation. Thus change in climate has been observed simultaneously with increasing amount of greenhouse gases (GHGs) and carbon dioxide level in the atmosphere due to consumption of energy at higher rate. Increasing crude oil price and accelerating global warming has led worldwide interest in use of renewable energy sources such as biofuels. Use of fossil fuel is now widely accepted as unsustainable due to depleting resources and the accumulation of green house gases in the environment that has increased at the threshold of 450ppm[2]. Thus it has been of prime importance to develop abatement techniques and adopt policies to promote those renewable energy sources that are capable of sequestering the atmospheric CO_2 and also to maintain the environmental and economic sustainability[3].

History of biofuel

The process of converting bio-renewable into useful and higher value compounds is not new. Since 600 BC bioethanol production was done using sugarcane. Lactic acid was first discovered by C. W. Scheele in 1780. Biofuels are renewable fuels that can be utilized for heat, electricity and fuel. Biofuels in today's world fall apart as an alternative to non renewable sources used as petroleum for transportation as a major breakthrough for replacing the petroleum based transportation fuels thus reducing the CO_2 emissions and maintaining environmental and economical sustainability[4]. Liquid fuels are of prime importance in energy consumption as 40% of the energy consumption is in the form of liquid fuels.

Sources of biofuel

Preliminary stages of research have shown that algae can be considered as a potential feedstock and a new generation fuel for biodiesel and bio ethanol production.

** Corresponding Author: mukundthakur@aribas.edu.in*

Bioethanol is an environmental friendly renewable liquid biofuel, and can be produced from several different biomass feedstocks. Biomass can be classified into "First generation fuels", "Second generation fuels" and "Third generation fuels" depending on the feedstock used. Bioethanol from sugar/starch crops from traditional production technologies is considered in the production of First generation biofuels while bioethanol from lignocellulosic biomass is considered as Second generation biofuels[5].

Problems in first and second generation biofuel production

Crops having high energetic values such as edible oil and sugarcane are exploited by the technologies used for biodiesel and bioethanol production respectively. While there is rapid development in the production of biofuel from biomass, certain ethical issues and principles have been raised by first generation biofuels based on edible crops as there are millions of people around the world still suffering from hunger and malnutrition. The most concern related to the first generation biofuel system is that competition increases along with the agricultural land used for food production as the production capacities increases. In order to overcome this issue bioethanol refined from lignocellulosic biomass, namely second generation fuels dealt a great alternative which is compatible with economic growth and morality issues. However second generation biofuels offers a great option with its non-edible feedstock, it is much debated because the cultivation of terrestrial land requires the resources that could be used as a food. Based on the agricultural products where land is the main criteria, biofuel production have different magnitude in relation to fossil fuel[9].

A shift is observed in the land used for bioenergy crop place the world in a global dilemma, as the need to feed humanity versus the greater economic returns to farmers through incorporation of lands for agro energy. The shift of land use from food crops to energy crops leads to increase in the food price and fall in the stocks of food products, with respective decline of exports[6]. The increased pressure on arable land currently used for food production could also lead to severe food shortages, in particular for the developing world where already more than 800 million people suffer from hunger and malnutrition.

The second most serious problem raised from the biofuel production is the constant increase in prices as more and more arable land is used for biomass production which is ultimately used for biofuel production. There is also a negative impact observed in biofuel in concern to environmental aspects as biofuel production causes ozone layer depletion and acidification. Energy plants are cultivated using many pesticides and fertilizers causing surface waters contamination. As a consequence, such intensive way of cultivation leads to eutrophication and ecological toxification[7].

Biofuel conceivability has been in menace due to utilization of the large arable lands and depleting water resources. The water footprint and land use for the production of biomass by cultivating various energy crops depicts that all bioethanol and biodiesel crops are utilizing vast amount of land area in comparison to algal biodiesel production. It is estimated that apart from drinking farmers would need 400 km^3 of water in 2050, as against current 2700 km^3, if no new technologies are incorporated[8]. Shortage of various basic foods such as mustard, soy, corn, barley, cereals, etc may arise as these plants are used as a raw material for biofuel production and extremely large utilization of arable land is used for biofuel production.

Third generation biofuel

Third generation biofuel is based on microalgae and seaweeds (macroalgae) which offers a great alternative to fossil fuels. Algae can be considered as an only alternative to the current biofuel crops such as corn and soybean and do not require the use of arable lands[9]. The current studies have shown that algae provide the natural raw material in the form of a lipid-rich feedstock for biofuel production[10]. However, their water demand is as high as 11–13 million L ha^{-1} for cultivation in open ponds[11]. Oswald[12] proposed the process of phycoremediation of wastewaters and suggested a number of by-product applications for the biomass generated.

Macroalgae, an abundant and carbon neutral renewable resource are now considered as third generation biomass that can be used in the bioenergy production. Several species of macroalgal biomass known are rich in carbohydrates and is known to contain low lignin or no lignin at all. This biomass is suitable for bioethanol production[13]. The absolute absence or near absence of lignin makes the enzymatic hydrolysis of algal cellulose simple. The production of this crop is said to be sustainable. Many macroalgae are non edible that are used for bioethanol production have no competition or reduced competition with agricultural food and crops .It has also several other advantages such as high yield per area, non dependence on agricultural fertilizer , pesticide, no land for farming and it also do not require freshwater for growth and cultivation so there can be no future threat to fresh water scarcity due to biofuel production[14].

Algae contain large number of photosynthetic species present naturally in the environment. In terrestrial feedstock possessing biofuel capacity, carbon dioxide is absorbed from the atmosphere. At higher photosynthetic efficiencies relative to terrestrial biofuel feedstock, carbon dioxide is absorbed from the atmosphere and from water hydrogen is separated to form carbohydrates. These carbohydrates have single oxygen on single carbon atom[15]. CO_2 is consumed on a large scale by macroalgae and so there are markets available for bioethanol macroalgae wastes. Most of the macroalgae are rich in carbohydrates and many species contain phycocolloids which are of commercial importance, very few studies have been related to saccharification and fermentation[16]. There are basic steps for bioethanol production. It includes pre-treatment, enzymatic hydrolysis, fermentation and distillation. The saccharification of macroalgae is important prior to ethanol fermentation. Saccharification efficiency can be increased by physical, chemical and biological pre-treatments.

Photosynthetic algal species may be autotrophic or heterotrophic. There are three processes from which algae can produce carbohydrates, lipids and proteins in a very short time. These carbohydrates can be later processed for biofuel production.

1. Autotrophic algae capture sunlight for photosynthesis and absorb CO_2 from the atmosphere which assimilates to form carbohydrates.

2. Heterotrophic algae mainly produce fat or oil and protein by taking up small organic molecules from the environment.
3. Certain algal species use either inorganic carbon (CO_2) from the atmosphere or organic carbon from the environment. This process is termed as mixotrophy.

Since algae are cultured on non-arable land, there is no suspicion on fuel-food feud. Due to the rich content of nitrogenous compounds released from the sediments during the decomposition of organic matter, coastal site can be considered favourable for algal cultivating.

Macroalgae, namely seaweeds, can be cultivated by tying them to anchored floating lines at sea. Therefore, algal cultivation is not limited by agricultural expansion over terrestrial plants. On the other hand, the growth rate of algae is tremendously high relative to land cultivation crops. In other words, there is a promising supply of biomass with only simple inputs: sea water, sunlight and carbon dioxide. So the question of fresh water crises also not arises due to utilization of sea water. From the ecological point of view macroalgae contributes by lowering the level of atmospheric CO_2 and supply of oxygen to the sea. In addition, some seaweeds species are known for their ability to remove heavy metals from the water which can be very beneficial to the environment[17]. Algae are also well-known of their capability to withstand harsh conditions and survive in stressed environment.

Many different species of macroalgae such as *Laminaria* sp.[18], *Sacchoriza* sp. and *Alaria* sp., belonging to brown seaweed, and red algal species such as *Gelidium amansii*[19], *Kappaphycus alvarezii*[20], *Gracilaria salicornia*[21] and *Ulva* spp., a green algae[22] have been considered as potential sources for bioethanol. *Sargassum cinereum* is brown seaweed which was found feasible for bioethanol production.

Unlike microalgae, macroalgae are the large sized algae having the ability to grow at a very fast rate and huge amount of biomass can be obtained. They are grown three dimensional upon binding to a net. Macroalgal high yield is due to the less energy requirement for the production of supporting tissue than land plants. In fact entire surface of macroalgae absorb nutrients. Red algal biomass produce great amount of bioenergy than other algal biomass[19]. The surrounding water provides buoyancy and certain macroalgae have gas-filled bladders. As on land, macroalgae can be cultivated on three dimensional rather than two dimensional by binding on a net or string for growth and can be suspended over a larger horizontal rope by seeding them onto thin weighed strings[19]. Oleaginous algal residue after extraction of oil also can be used for obtaining fermentable sugar for bioethanol synthesis.

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Treatment kinetic coefficients studies of effluent treatment plant of dairy industry and laboratory batch reactor

Swati Narolkar [*] ***and Dixit Patel***

Ashok & Rita Patel Institute of Integrated Study & Research in Biotechnology and Allied Sciences (ARIBAS), New Vallabh Vidyanagar

Abstract: As Dairy industries consume large volume of water are considered as "wet industries". Dairy industries discharging untreated/partially treated wastewater cause serious environmental problems. Milk-Processing industrial wastewater is generally treated using secondary (biological) methods such as up-flow anaerobic sludge blanket reactor (UASB), activated sludge process, trickling filter, sequencing batch reactor (SBR) and anaerobic filters etc. For the rational design of effluent treatment facilities the determination of the treatment kinetic coefficients are necessary. The objective of the research was to evaluate the performance of a laboratory scale biological treatment unit for dairy industrial effluent and determination of the kinetic parameters like K_s, K_d, k and Y for activated sludge process. The kinetic coefficients for laboratory batch scale process for dairy effluent treatment *i.e.* k (maximum substrate utilization rate), K_s (half velocity constant), Y (cell yield coefficient), and K_d (decay coefficient) were found to be 4.43 g bsCOD/g VSS day^{-1}, 535 mg/l BOD, 0.28 mg VSS/mg BOD and 0.038 g VSS/g VSS day^{-1}, respectively. These coefficients may be used for the design of activated sludge process facilities for dairy wastewater.

Introduction

Water pollution is define as any type of physical, chemical or biological change in water quality which leads to detrimental impacts on living organisms in the environment. The quality of life depends on the availability and quality of water. Water is vital to all forms of life, all plants, animals and humans. In all fields like agriculture, manufacturing, transportation and many other human activities and despite its importance, water is the most poorly managed resource in the world. An industrial effluent discharge is responsible for presence of heavy metals in streams of water and reflects the type and diversity of aquatic biota, water quality and pollution [1]. Most of the industries in India are placed along the river banks for easy availability of water and disposal of the waste. Main pollutants present in waste water are biodegradable and volatile organics, recalcitrant xenobiotics, toxic metals, suspended solids, nutrients (Nitrogen & Phosphorus), microbial pathogens and parasites [2].

The degradation of various ecosystems on which human life relies on occurs due to continued population growth and industrialization from the last century. Pollution is primarily caused by the discharge of inadequately treated industrial and municipal wastewater.

The dairy waste consists of raw materials lost during handling and processing and materials carried into processing water. The composition involves a substantial concentration of lactose, lactic acid, minerals, detergents and sanitizers. The majority of the pollutants are dissolved in either organic or inorganic form. The unavoidable waste generation process include rinsing, cleaning and sanitizing of pipelines and equipment start up, losses during the filling operations spill over of lubricants from pipelines, joints, valves, and pumps etc [3]. Wastewater from dairies contains mainly organic and biodegradable materials that can disrupt aquatic and terrestrial ecosystems [4].

** Corresponding Author: swatinarolkar@aribas.edu.in*

Sediment in dairy effluent can change the color, clarity, temperature of water ways, reduce light penetration and can clog up fish gills. The organic material responsible for excessive growth of bacterial and fungal slimes and the inorganic nutrients can increase algal blooms result into eutrophication. Effluent may contaminant groundwater and penetrates the surface soil layer, deterioration in soil structure and weed growth [5]. So a cost-effective and efficient effluent treatment technology has to be developed. The main objective of this study was the determination of kinetic parameters *Y, K_d, k* and K_s and the treatment efficiency evaluation of dairy effluent treatment plant with and laboratory designed batch aeration treatment process.

Materials and Methods:

Effluent samples for kinetic coefficient calculation and laboratory scale reactor were collected from a local dairy. The dairy effluent treatment process has primary treatment plant comprising of equalization tank and secondary treatment plant comprising of anaerobic reactor (UASB) followed by aeration tank and settling tank. The total detention times in equalization tank, anaerobic and aerobic process at maximum wastewater flow of 600-650$m^3.d^{-1}$ were 4-5 days.

Sample collection and analysis of wastewater samples

The reliability of the results of analysis of waste water samples depends upon the proper collection of sample. The sample after collection should be transported to the laboratory in well conserved condition so that it will still represent fairly, accurately to the waste in its original state. Sample has been collected for the plant operation controls. The samples collected from the various units should be transported to laboratory as early as possible. The analysis of the samples should be taken up within the shortest time gap between collection and testing. The analysis which is carried out for different samples should broadly consider the following major parameters: COD, BOD, TS, TSS, TDS, MLSS and MLVSS (X) [6].

Samples from the inlet of the reactor and effluent from the final clarifier were simultaneously collected to carry out COD tests. Samples from the reactor were collected to find out MLSS, dissolved oxygen (DO), pH and temperature. Mean values of S_0, S and X at various ϑ_c were used to find out kinetic coefficients while DO, pH and temperature tests were carried out to ensure favorable environmental conditions in the reactor for biological treatment [7, 8].

Dairy effluent treatment kinetic coefficients study at laboratory scale

Laboratory batch scale processes are normally used to determine kinetic coefficients. Completely mixed batch reactor without recycle was employed for its easy operational control. In such a reactor, detention time (θ) is equals to mean cell residence time (ϑ_c). The procedure was to operate the unit over a range of effluent substrate concentrations. Hence, several different ϑ_c (at least five) were selected for operation ranging from 4 to 10 days. Using the data collected at steady state conditions, mean values were determined for influent COD (S_o), effluent COD (S), and mixed liquor suspended solids (MLSS) of the batch rector (denoted by X) to find out the kinetic coefficients.

Determination of kinetic coefficients

Design of biological treatment systems should be based on the kinetic approach. Knowledge of the kinetics and determination of the kinetic coefficients for a particular wastewater are, therefore, imperative for the rational design of treatment facilities. Samples from the influent to the reactor and effluent from the final clarifier were simultaneously collected to carry out BOD tests. Samples from the reactor were collected to find out MLSS, dissolved oxygen (DO), pH and temperature. Mean values of S_0, S and X at various time interval were used to find out kinetic coefficients while DO, pH and temperature tests were carried out to ensure favorable environmental conditions in the reactor for biological treatment.

The following linearized equation used to find *k* and K_s.

$$\frac{X\theta c}{S_0 - S} = \frac{Ks}{k}\frac{1}{S} + \frac{1}{k}$$

The following linearized equation used to find Y and K_d.

$$\frac{1}{\theta c} = Y\frac{S_0 - S}{X\theta c} - Kd$$

Where, S_0 = Influent substrate concentration, mg sCOD/L; S = Effluent substrate concentration, mg sCOD/L; X = Biomass concentration, mg MLVSS/L; *k* = Maximum rate of substrate utilization per unit mass of microorganisms, time^{-1} ; K_d= Endogenous decay coefficient, time^{-1}; K_s = Half velocity constant, substrate

concentration at one-half of the maximum growth rate, mass/unit volume; *Y*= Cell yield coefficient, mg/mg (defined as the ratio of the mass of cells formed to the mass of substrate consumed).

Results and Discussion

Kinetic coefficient calculation of existing effluent treatment plant of dairy industry

The general characteristic of dairy industrial wastewater is shown in table 1. Kinetic coefficients of interest for the design of activated sludge process are: *k,* K_s, *Y,* and K_d where value of *k* is use to find out the volume of biological reactors. Mean values depicted in table 2 were used to find out kinetic coefficients for dairy effluent treatment plant.

Table 1. Characteristics of dairy industrial wastewater

No.	Characteristics	Value
1.	pH	6.8-7.5
2.	COD	2000-4660 ppm
3.	TS	970-1170 (mg/L)
4.	TSS	282-380 (mg/L)
5.	TDS	670-810 (mg/L)

Greater is the value of *k*, smaller will be the size of the reactor. K_s have no direct relevance in process design (figure 1). It gives an idea about the change in the specific growth rate of bacteria with a change in the concentration of the growth limiting substrate. *Y* is used to estimate the total amount of sludge produced as a result of wastewater treatment. K_d is used to find out the net quantity of sludge to be handled and hence the size and cost of the sludge handling facilities can be found out (figure 2). A comparison of kinetic coefficients for dairy effluent with other industrial wastewaters would be interesting. However, the results obtained for initial two kinetic coefficient i.e. *k* (substrate utilization rate) was within the range and half velocity coefficient K_s was less than the standard value noted for the kinetic coefficients of other industrial wastewaters as shows in table 3.

Table 2. Mean values of dairy effluent treatment kinetic parameters

θ_c (days)	n[1]	S_o (mg/l)		S (mg/l)		X (mg MLSS/l)	
		Range	Mean[2]	Range	Mean[2]	Range	Mean[2]
3	4	3754-3846	3800±36	114-129	121±6	328-388	358±23
4	4	3602-3678	3640±30	92-104	98±6	290-402	346±44
5	4	3382-3538	3460±52	85-65	75±8	338-386	362±18
7	4	3214-3346	3280±24	68-56	62±5	287-383	335±20
10	4	3396-3284	3382±44	52-44	48±3	287-383	340±37

[1]Number of samples [2]Mean ± Standard Deviation

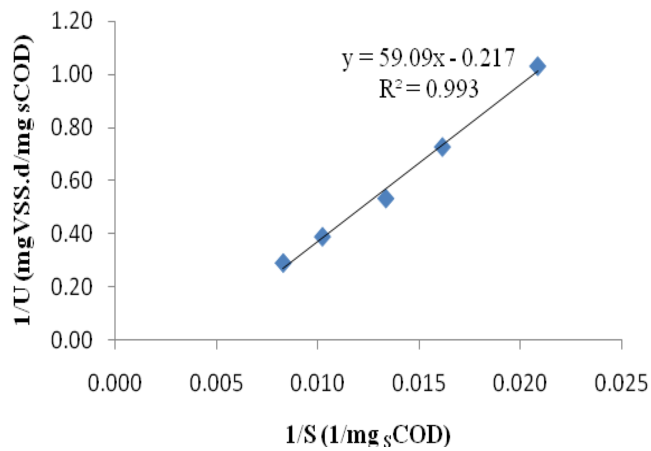

Figure 1. Determination of k and K_s for dairy effluent treatment plant

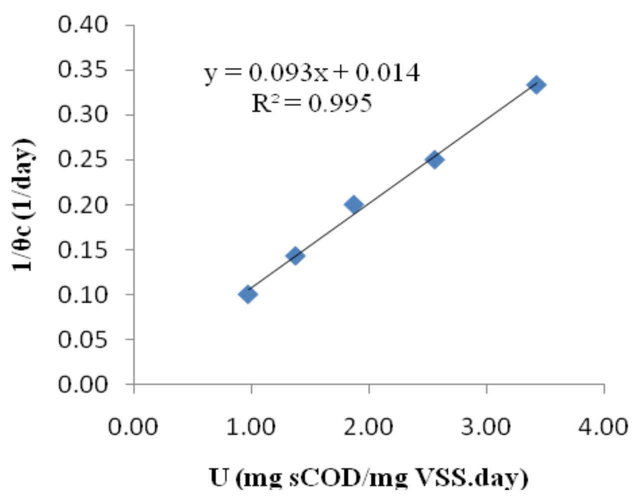

Figure 2. Determinations of Y and K_d for dairy effluent treatment

Decay coefficient K_d was quite less for dairy wastewater when compared with other industrial wastewaters, which indicates larger net sludge volumes resulting from biological treatment. Cell yield coefficient (Y) was quite lower than other industrial wastewaters which would have direct impact on lower half velocity substrate coefficient.

Kinetic coefficient study at laboratory scale for the treatment of dairy effluent

In dairy wastewater treatment all the processes are carried out as continuous operations and wastes originating there of vary considerably in composition. Mean values of selected treatment parameters represent in table 4 were used to obtain kinetic coefficients for laboratory reactor used for dairy industrial wastewater.

Therefore ranges of detention time and substrate concentration have been analyzed to optimize the value of treatment kinetic coefficient.

Table 3. Kinetic coefficients of dairy effluent treatment plant

Coefficient	Unit	Value
k	g bsCOD/g	4.60
K_s	mg/L BOD	271.84
Y	mg VSS/mg BOD mgVSS/mg bsCOD	0.093
K_d	g VSS/g VSS day^{-1}	0.015

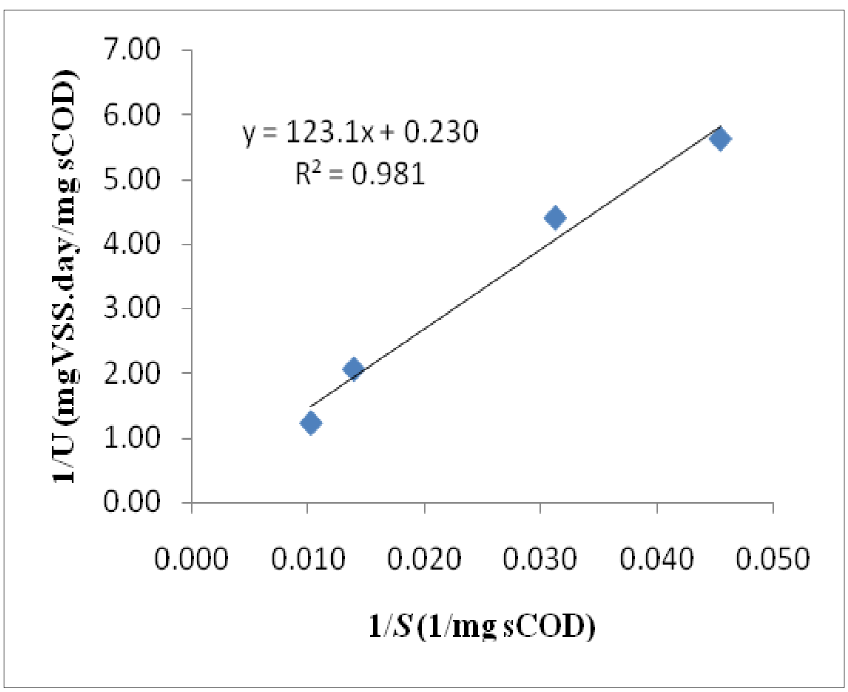

Figure 3. Determination of k and K_s for laboratory scale process

Table 4. Mean values of dairy effluent treatment parameters for laboratory batch process

Θ_c (days)	n[1]	S_o (mg/l)		S (mg/l)		X (mg MLSS/l)	
		Range	Mean[2]	Range	Mean[2]	Range	Mean[2]
3	4	4150-4370	4260±86	48-148	98±39	1202-1378	1290±69
4	4	3764-3916	3840±60	36-90	72±28	1244-1356	1300±44
5	4	3636-3724	3680±34	30-86	58±22	1278-1402	1340±49
7	4	3424-3536	3480±44	24-60	42±14	1310-1410	1360±39
10	4	3460-3580	3520±47	8-44	32±18	1236-1324	1280±34

[1]Number of samples
[2]Mean ± Standard Deviation

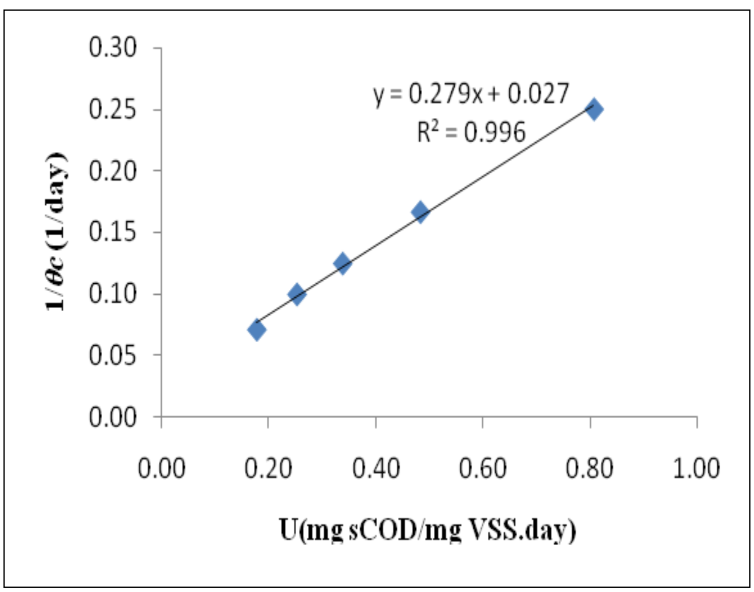

Figure 4. Determination of Y and K_d for laboratory scale process

Table 5 clearly shows that values of the bio kinetic coefficients vary significantly with the change in MLSS concentration in each proc-ess. The results obtained for initial two kinetic coefficient i.e. k (substrate utilization rate) was within the range and half velocity coeffi-cient K_s was also in the range (4-5) noted for the kinetic coefficients of other industrial wastewaters as shows in table 6.

Conclusion

The determination of treatment kinetic coeffi-cients may be helpful in (1) understanding the kinetics of substrate utilization (2) sludge pro-duction and (3) design of biological treatment facilities. Thus coefficients have both aca-demic value and practical significance .

The kinetic coefficient values obtained of ex-isting dairy effluent treatment plant: k (substrate utilization rate) was within the range and half velocity coefficient K_s and Cell yield coefficient (Y) were less than the other industrial effluent treatment processes. Decay coefficient K_d was quite less which indicates larger net sludge volumes resulting from bio-

Table 5. Kinetic coefficients of laboratory scale batch process for dairy effluent treatment

Coefficient	**Unit**	**Lab batch reactor experimental values**	**Standard values**
k	g bsCOD/g VSS day^{-1}	4.34	4-6
K_s	mg/L BOD mg/L bsCOD	535	400-500 (conventional process)
Y	mg VSS/mg BOD mgVSS/mg bsCOD	0.28	0.4-0.6
K_d	g VSS/g VSS day^{-1}	0.02	0.1-0.2

Table 6. Kinetic coefficients of various industrial effluent treatment processes

Reference	***k* (day^{-1})**	**K_s (mg/l)**	***Y* (mg VSS/mg BOD)**	**K_d (day^{-1})**	**Wastewater type**
Metcalf & Eddy[8]	5	60	0.6	0.10	Municipal
Haydar and Aziz[9]	3.125	488	0.64	0.03	Tannery industry
Demirel[10]	9.3	482.5	0.20	0.25	Dairy (anaerobic treatment)
Bertola[11]	0.09	0.006	0.45	0.024	Potato industry
Gupta and Sharma[12]	0.216	56		0.068	Fertilizer industry

logical treatment. Laboratory scale batch reactor studies showed that the kinetic coefficients k (maximum substrate utilization rate), K_s (half velocity constant), Y (cell yield coefficient) and K_d (decay coefficient) were found to be 4.6 day^{-1}, 535 mg/L, 0.28 and 0.02 day^{-1}, respectively which were in the range of other industrial wastewaters treatment processes.

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ज्ञानेन शीलम्

Do send us your comments and suggestion at e-mail:

quest@aribas.edu.in

ASHOK & RITA PATEL INSTITUTE OF INTEGRATED STUDY & RESEARCH IN BIOTECHNOLOGY AND ALLIED SCIENCES

P.O. Box No. 61, New Vallabh Vidyanagar, Vitthal Udyognagar - 388121, Dist- Anand, Gujarat, India.
Phone: +91-2692-229189, 231894 Fax: +912692-229189