Original Article: Investigating the principles of water treatment and industrial wastewater

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ABSTRACT

This article examines the principles of water treatment and industrial wastewater. The increasing expansion of human societies and advances in industrial fields, although they have brought special benefits, have also brought many problems to communities. One of these problems is sewage from residential areas and the activities of industrial units. Due to improper disposal of domestic and industrial wastewater has adverse effects on the environment, the more complete wastewater treatment becomes more important. Domestic wastewater and more importantly industrial wastewater due to the presence of organic and mineral materials, if discharged into the environment causes pollution of surface and groundwater and as a result reuse of water for its best use is difficult. The volume of wastewater in an industrial unit depends on factors such as the type of product, production method, tools and equipment, etc. Cattle and sheep slaughter units are among the industrial units that have a relatively high volume of sewage and very severe pollution. At present, in most cities of Iran, there is a slaughterhouse for slaughtering cattle and sheep. Sewage from these slaughterhouses is mostly discharged to wells, rivers, abandoned canals without the slightest treatment, and in the best case, the sewage is discharged into the environment after passing through a simple sedimentation pond. In addition to mineral and organic pollution occurring in this way, there is the spread of common diseases between humans and livestock through the disposal of sewage from slaughterhouses due to non-compliance with health issues.

Introduction

According to M.N. Baker, in the book "In Search of Pure and Healthy Water", this category dates back to two thousand years BC. But what has been written historically dates back to 400 ADS, where he recommended boiling water over a fire or dipping an iron rod into water to sanitize water.

The heating of water by the sun or its purification by passing it through the layers of sand is also mentioned [1-5]. This image was published by the University of Philadelphia in the US state of Pennsylvania and is dated to March or April 1335 BC. Of course, the industrial method of water treatment developed in the nineteenth century during the Industrial Revolution and its main foundations it "practically" matured. This industry,

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at the same time as using boilers to produce steam, was used and took an industrial form [6-9].

Most of the initial activities were to purify the water to solve the problems of the boilers. And since then, various methods and materials for different purifications have been recorded every day.

About one hundred years ago, when the relationship between the effect of pathogenic bacteria and germs on the spread and spread of diseases became apparent, humans began to think about purifying polluted water. Especially after the Second World War, as a result of the development of cities and industries, the risk of environmental pollution and as a result, the need for wastewater treatment increased with unprecedented intensity and at the same time many methods for wastewater treatment were proposed and used. Especially the use of wastewater for irrigation in agriculture due to its fertilizer properties has been common in European countries since one hundred years ago [10-15].

Table 1. The amount of water required for some industries

Gallen Per Unit	Unit of Production	Industry
7000	Ton of beets	Beet Sugar
1300-4000	ton	Meat
10000	Vehicle	Automobile
20000	100 eb	Cotton Goods
64000	100 ft2	Leather
20000-100000	ton	Paper
15000-50000	ton	Steel
3000	The barrel	Oil refinery

Scaramelli & Digiano, in their studies, consider the ways to control and operate the PACT system, including the measurement of mixed liquid solids, sludge volume index, chemical and biochemical oxygen demand, and oxygen consumption rate [16].

Adams (1973) in the study of the use of activated carbon powder in the activated sludge system for the treatment of various municipal and industrial wastewater, concluded that the above method has many advantages as follows:

1. Removes BOD_5 and COD even in case of quantitative and qualitative changes of wastewater compared to activated sludge system.
2. Improves the sedimentation of solids, reduces the number of suspended solids in the output and creates heavier and thicker sludge.
3. Absorbs dyes and toxic substances that are toxic to the biological system or inhibit growth or are biodegradable.
4. By absorbing detergents, it reduces the amount of foam in the aeration tank and in the outlet.
5. Eliminates the problem of sludge bulking or swelling by creating the appropriate F/M ratio.
6. Increases the capacity of the refinery with low operating costs and without any capital costs.
7. It makes the refining process uniform and creates an output with uniform quality.

He believes that among the above cases, foam removal, improvement of solids sediment and reduction of wastewater toxins have the greatest impact on improving the overall operation of industrial wastewater. In 1974, Adams considered the feasibility of using this method to treat municipal and industrial wastewater with high efficiency [17-19].

Using PACT process in joint wastewater treatment of polyethylene products and municipal wastewater with specifications BOD5=1700 mg/l and COD=3200 mg/l and comparing the results with activated sludge process, he reported a 25% increase in COD and 20% removal of BOD_5.

In the same studies, he concluded that even after cutting off carbon input for up to a month, the quality of the treated wastewater was still much better than that of the control unit.

1. The addition of activated carbon powder to the activated sludge treatment system eventually results in the production of sludge that is easily digested.

2. The presence of activated carbon reduces fat and foam in the digestive tract.
3. Activated carbon acts as a catalyst and therefore minimizes it by breaking organic components in the sludge [20].
4. Gas production in the system increases.
5. The sensitivity of the system to toxic substances is reduced and the recycling time is shorter.
6. The presence of activated carbon increases the suitable places for absorption and concentration of organic matter, thus increasing the anaerobic reaction and more complete digestion.
7. The more concentrated the digested sludge, the easier it is to transport and dispose of.

Hunsicker & Almmedia concluded that the use of activated carbon in the anaerobic digestion system of the sludge improves operations.

1. Adding activated carbon powder reduces unpleasant odors and digestion.
2. It reduces the number of digestible solids.
3. Gas production increases due to the addition of activated carbon powder.
4. Economically, this method is very suitable due to reducing the operational problem.

Based on studies conducted by Dejan & Adams on the study and comparison of efficiency and benefits of granular activated carbon column and PACT system in oil refinery , presenting the main advantages of the latter method and showing the entry points of carbon powder (reservoir) Aeration, sludge return line, secondary sedimentation) concluded that the use of PACT process for wastewater treatment of an oil refinery with an input BOD_5 of 400 mg/l increases BOD5 removal by up to 50% of the control unit, controlling the amount of foam in the aeration zone Minimize the effects of toxins and fats in the biological treatment process and improve sludge deposition.

Further studies showed that this process is well resistant to the entry of acidic waters containing sulfides as well as heavy metals and wastewater toxins and is economically preferable to the activated sludge process alone with a granular activated carbon column [21-25].

Flynn & Barry, while presenting the steps of selecting an option from the existing wastewater treatment methods, finally presented the reasons for choosing the PACT process along with the advantages of this method. Based on the theories of the above, the selection of a treatment method is done in four basic steps as follows [26].

1. Screening processes to eliminate methods that are not technically feasible.
2. Determining the economic conditions of the remaining methods and eliminating the methods that are not economically feasible.
3. Economic study of the remaining methods in optimal conditions to accurately determine the costs and benefits of each method.
4. Choosing a final method taking into account economic conditions as well as qualitative factors such as environmental policies, flexibility of methods and future considerations regarding water resources.

Finally, by examining the results of the facility's wastewater treatment system in southern Philadelphia, with more than 2,000 industrial units containing fully acidic wastewater, containing heavy metals, soluble dyes, and complex and variable compositions of organic matter, they concluded that:
1. PACT system is much more stable than activated sludge system and has a higher quality final effluent.
2. The PACT system acts as a third and advanced stage purification.
3. The performance of this method is completely comparable to an activated sludge unit equipped with a granular activated carbon column.
4. In terms of capital costs, the PACT method is cheaper than the method of using granular activated carbon column after biological treatment.

Ferguson *et al.*, while studying the treatment of industrial and human wastewater in Seattle, USA, presented the following benefits by adding activated carbon powder in the biological activated sludge treatment system as contact stabilization as follows:
1. This method shortens the hydraulic retention time due to rapid absorption and removal of organic matter.
2. Protects the biological system against sudden load or sudden drop in temperature.
3. Protects the system from toxins and growth inhibitors and heavy metals.
4. Biodegradable materials are absorbed by activated carbon.

5. The required sludge return ratio is reduced.
6. Due to the biological reduction of activated carbon in the activated sludge treatment process, the performance of this material is better than physical and chemical treatment systems [27-30].

Robrtaccio *et al.*, in their study of some of the problems raised by other researchers, examined different treatment plants and provided a complete classification of materials in wastewater, including four groups (non-degradable and non-degradable). Absorbable, degradable and non-absorbable, non-degradable and absorbable, and finally degradable and absorbable). Finally, it was concluded that problems such as carbon sequestration by metabolic by-products would not occur in practice. In addition, they offered other advantages for this PAC method to the activated sludge system as follows:
1. Increasing the speed of biological treatment.
2. Compatibility of the above method with the existing facilities of the treatment plant.
3. Possibility of increasing the average residence time of the biological mass.

They came to the general conclusion that the entry of PAC into the aeration zone continuously creates a diverse network of microorganisms and carbon particles [31-35].

In this case, carbon absorbs some of the organic matter and in addition to acting as a weighting agent and improving the sedimentation and concentration of sludge, it also accelerates their removal, regardless of the degradability of organic matter. The carbon adsorption property controls the fluctuation of wastewater organic matter, enables the absorption of toxic substances, and absorbs substances that inhibit biological growth and surfactants that cause foaming in aeration.

The presence of carbon facilitates transport and dehydration, anaerobic digestion and sludge disposal. In the end, they suggested that in order to create more suitable economic conditions, the amount of carbon consumption can be reduced from the age of high sludge [36].

In the study of new methods of industrial wastewater treatment Akenfelder the use of activated carbon powder for wastewater treatment of oil refineries due to the biological removal of ammonia through the process of nitrification - denitrification and regeneration of materials Organic recommends non-biodegradation.

Chao and Xie conducted a study on the wastewater treatment plant of a steel plant. The results of this study are as follows:
1. The purification capacity of the as unit will be more than double the normal value when PAC is added to the aeration reactor at a rate of 300 mg / l, taking into account the removal of COD, cyanide and thiocyanate.
2. Adsorption, a fraction of COD that is biodegradable, has been identified by PAC as a major adsorption mechanism and will ultimately lead to improved COD removal and the usefulness of PAC-containing units.
3. Addition of PAC will stimulate the microbial oxidation of cyanide and thiocyanate in as process [37-39].
4. There is a stoichiometric relationship between the number of nitrogen's released from cyanide and thiocyanate by microbial oxidation and the increase in the amount of nitrogen in the effluent.

Review of Refining Operations

Purification is done to the extent that the contaminant reaches its permissible level and there should be a standard for measuring them.
-Allowed amount for mineral acids ---------- 30 ppm
-Permissible value for phenols ----------- 0.002 ppm
-Allowable value for mercaptans ----------- 2.5 ppm
-Allowable value for H_2S -------------------- 1-3ppm
-Permissible amount for naphthenic acid--- 0.2 ppm
-Permissible value for SO_2 -------------- 0.1-0.5ppm

Agricultural water standard: Optimal water for agriculture is not suitable for some salt-sensitive crops. It has a negative effect on many crops. Very salty water can be used for summer work.

Factors to consider in wastewater treatment:
1. The amount of effluent produced in 24 hours with the maximum flow of sewage.
2. The type of pollution, each of which requires special treatment.
3. The amount of pollution, which mostly refers to wastewater-soluble organic matter (BOD).
4. The geography of the place [40].

Table 2. Permissible amount for field water (soluble elements)

Elements	Allowed value (ppm)
Al	1
As	1
Be	0.5
B	0.75
Co	0.2
Cu	0.2
Pb	5
Li	5
Mn	2
Mo	0.005
Ni	0.5
Se	0.05
V	10

Important Parameters

Sewage flow measurement

1-1- Direct discharge method in the laboratory and where the flow is low.
1-2-Velocity Area: Measure the linear velocity and multiply by the cross section to obtain the flow rate [41-45].

Total Solid Size (TS)

Size of settling material

It is done by weight and volume method:

Weighing method: The weight of sludge in one liter of water is measured after passing through filter paper and drying at 105 ° C.

Volumetric method: Fill the sewer with the help of a settling funnel called Imhaf and leave it for an hour.

Determination of alkalinity: Total alkalinity is expressed in terms of ppm $CaCo_3$ and is equal to the number of milliliters of sulfuric acid N / 50 used near the methyl orange reagent to neutralize one liter of filtered wastewater.

Alkalinity of hydroxide: In terms of ppm $CaCo_3$ is the number of milliliters of sulfuric acid N/50 that is required in the vicinity of phenolphthalein to neutralize the filtered wastewater. Gases in wastewater: include N_2, O_2, CO, H_2S, NH_4, CH_4, CH_3SH, sulfide and disulfide.

Measurement of organic matter

It is very important for treatment and to control the amount of wastewater pollution. Organic matter can be converted to CO_2 and water and stable minerals such as nitrate and phosphate by aeration and aerobic microorganisms. The amount of oxygen required for biological oxidation is:
Biochemical Oxygen Demand (BOD)
Chemical Oxygen Demand (COD)
Total Organic Carbon (TOC)
Total Oxygen Demand (TOD)
Theorical Oxygen Demand (THOD)

BOD

The amount of oxygen in ppm for the biological oxidation of effluent by aerobic bacteria and the conversion of organic matter to CO_2 and water at 20 °C. This parameter is used for both wastewater and industrial water [46-48].

(BOD after 5 days of stay time) is a slow process that theoretically takes an infinite amount of time to complete, but in 5 days the removal of organic matter with the help of microorganisms is exponential.

Factors affecting the concentration of water-soluble O_2:

Photosynthesis increases the concentration of O_2. Greens in water produce near the breath and produce O_2. (Active from 6 am to 6 pm.)
Aquatic respiration (O_2 consumption)
Re-aeration due to turbulence increases O_2

COD (Chemical Oxygen Demand)

It is always higher than BOD because it is chemical oxidation. ppm.COD is the oxygen required for oxidation of wastewater organic matter by a chemical oxidizer.

TOC

Measurement of organic carbon by burning in an electric furnace and measurement of CO_2 in the vicinity of catalysts (CuO) by IR spectroscopy

THOD

1. Nitrogenous organic matter + O+ ammonia + Co_2 + H_2O
2. NH_3+O➔HNO_2+H_2O
3. HNO_2+O➔HNO_3

In terms of value: THOD> COD> BOD5> TOC

Physical treatment methods

It includes screening, grit chamber, equalization, physical adsorption, and finally "simple sedimentation".

Chemical purification methods: including neutralization, coagulation and flocculation of ion exchange and chemical adsorption [50-52].

Biological treatment methods

Classification of wastewater treatment methods based on the degree of activity and efficiency

1. Primary treatment, which includes most methods of physical treatment.
2. Conventional or secondary treatment (Secondary Treatment) which includes most chemical and biological treatment methods.
3. Advanced treatment (Tertiary Treatment) which is a combination of chemical and biological treatment processes [5].

Common methods of industrial wastewater treatment

Due to the characteristics and specifications of industrial wastewater and the existence of broader parameters than municipal wastewater, the selection of wastewater treatment processes has a special feature. One of the important parameters in industrial wastewater is the presence of pigments, heavy and complex materials, high organic matter and dangerous and toxic pollutants, which also makes the use of various processes, especially the use of chemical processes, inevitable in some cases. Therefore, the choice of process type is different according to the characteristics of each industry, which is briefly explained in some of these processes [43].

Physical-chemical treatment

One of the major problems of industrial wastewater is the presence of complex compounds and various pollutants that cannot be degraded by nature in a short time and pose many risks to the environment and aquatic environments.

These substances are even harmful to microorganisms and decomposing organisms and sometimes "cause them to lose their ability to reproduce and grow. Therefore, for the optimal treatment of these wastes, conditions must be created so that biological processes can function easily." For this purpose, the use of physical-chemical processes as biological pretreatment is used in most industrial wastewaters. Coagulants used in water and wastewater, in addition to having coagulation power, must also be economically viable and have some problems Do not have poisoning, harmful compounds, increase of unwanted salts, etc. for the receiving waters. The most common of these materials are shown in Table 3.

Table 3. Chemicals used in wastewater treatment

Density (lb./ft3) Drier		Molecular weight	Formula	Chemical substance
83-85	60-75	594.3	$Al_2(SO4)_3.14H_2O$	
78-80	60-75	666.7	$Al_2(SO4)_3.18H_2O$	
84-93	-------	162.1	$FeCl_3$	Alum - Alum
-------	-------	400	$Fe_2(SO_4)_3$	Iron chloride
-------	70-72	454	$Fe_2(SO_4)_3.3H_2O$	
-------	61-62	278	$FeSO_4.7H_2O$	Ferrous sulfate (II)
-------	35-50	56 In the form of CaO	$Ca(OH)_2$	Ferrous sulfate (III)

In addition to coagulants, there are some coagulants that are added in very low concentrations during the coagulation or flocculation stage, accelerating the coagulation process and the efficiency of this process [44].

Biological treatment

In general, in most cases, different types of wastewater can be treated biologically. The main purpose of biological wastewater treatment is to separate colloidal solids. In addition, the stabilization of organic matter is another goal of biological treatment so that there is no problem in the environment. Mainly in industrial wastewater, the goal is to separate or reduce the concentration of organic and inorganic compounds. Therefore, in order to achieve this, biological treatment of wastewater uses a variety of organisms, whose large mass is formed by bacteria. Bacteria are so important that they can be considered the heart of a biological treatment plant. Removal of carbonated BOD, flocculation of non-precipitating colloidal solids, and stabilization of organic matter are performed biologically using a variety of microorganisms [9].

Anaerobic purification

The process of anaerobic treatment occurs in many places, such as the stomachs of ruminants, swamps and sediments of ponds and lakes, landfills or sewers, and sewage pipes that contain organic matter and do not contain molecularly dissolved oxygen. Using the anaerobic process in wastewater treatment can be done without the use of sophisticated technology and only with the usual methods, wastewater treatment can be done at a much lower cost, both capital and current. Anaerobic treatment has been considered as an advanced biotechnology method since the seventies in order to conserve energy and reduce land requirements. High-speed reactors have been built, which in many cases have been successful. These reactors have a high concentration of active microbial mass.

In industrial wastewater treatment with high pollution load, it is possible to first treat the wastewater by anaerobic method and then complete the treatment by anaerobic method. In anaerobic-wastewater treatment, since most of the load is removed anaerobically and at a lower cost, the overall cost of the process is significantly reduced.

The effect of temperature on microbial growth

One of the physical factors affecting microbial growth in any environment is temperature. Microorganisms do not have a temperature control mechanism, so the temperature inside the cell is the same as outside, in other words, the speed of all vital reactions inside the cell is a function of temperature [60].

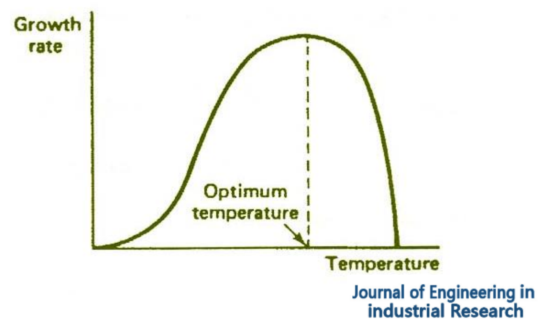

Figure 1. The effect of temperature on the rate of microbial growth

As is obvious for any microorganism, there is a temperature range at which growth stops more or less completely, the optimal temperature is the temperature range at which the growth rate is maximum, based on the temperature range at which microorganisms can grow. Have divided them into the following categories:
1. Forced thermophilic microorganisms
2. Optional thermophilic microorganisms
3. Intermediate microorganisms
4. Optional cryogenic microorganisms
5. Forced cold-loving microorganisms

The following diagram shows the classification of microorganisms in terms of temperature and suitable temperature for their growth. The saline dots in this diagram represent the optimal temperature range for maximum growth [2].

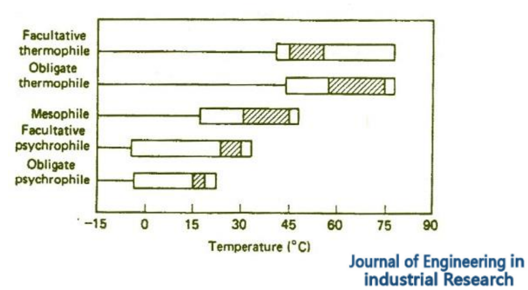

Figure 2. Classification of microorganisms according to temperature range

Effect of acidity (PH) on microbial growth

Another important factor that affects the rate of microbial growth, such as temperature, is the concentration of hydrogen ions or pH. Like temperature, there is a certain range for pH in which it is not possible to grow at more or less. In the right pH range for growth, there is an optimal pH at which the growth rate is maximum and this point is usually between the minimum and maximum growth range.

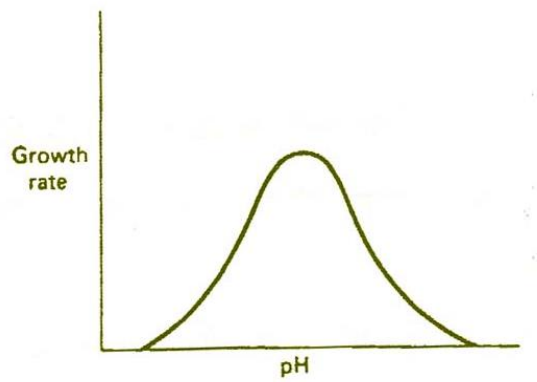

Figure 3. The effect of acidity on the rate of microbial growth

However, for most microorganisms, growth in the pH range of 4-9 is possible and the optimal pH for most of them is 6.5-7.5. It should be noted that the effect of PH on microbial activity is mainly due to the effect on their enzymes. In general, the following comments about the effect of PH on the activity of various microorganisms are presented:
1- Most fungi have an optimal pH near neutral.
2. Most fungi prefer an acidic environment with an optimum pH of about 5, with a minimum pH of their growth range of 1-3.
3. For most green-blue algae, the optimum pH is more than 7.
4. Most protozoa are able to grow at pH between 5-8 (with an optimal pH close to 7)

Microbial growth needs for oxygen

Microorganisms are divided into several categories in terms of oxygen demand:
1. Absolute aerobic microorganisms, which require molecularly dissolved oxygen.
2. Absolute anaerobic microorganisms, which cannot function in the presence of molecularly dissolved oxygen.
3. Optional microorganisms, which are able to function both in the presence and in the absence of molecularly dissolved oxygen.
4. Microaerophilic microorganisms, which require low concentrations of molecularly dissolved oxygen.

Oxygen is required for aerobic microorganisms for two tasks

1. In the reaction of energy production, oxygen is needed as the final acceptor of electrons. (Main use).
2. Some enzymatic reactions require small amounts of oxygen. For example, the oxidation of hydrocarbons requires the addition of oxygen to break down molecules.

Industrial wastewater and how to deal with it

Textile, chemical, petrochemical and refining industries are important industries that can play a positive and valuable role and, conversely, cause irreparable damage and destruction to human beings.

The wastes of these industries are finally introduced into the environment as solid and liquid wastes, which can be economically useful if treated and recycled to a standard level. In order to prevent the problems caused by the discharge of industrial wastewater into the environment, wastewater is used various methods are used.

Although activated sludge processes, after pre-treatment and initial treatment stages, have the ability to treat many industrial effluents, but this method is very sensitive to toxic compounds and sudden shocks. In addition, due to the increasing number of new organic materials, many of which are not biodegradable or slightly decomposed, or know that some of these compounds have carcinogenic properties or cell mutations, primary and secondary treatment is not enough. The effluent from these systems is not suitable for discharge to receiving waters and agricultural lands.

Therefore, it is common in many countries to achieve the required standards of third-party treatment. The third treatment may consist of a simple sand filter, activated carbon columns, and oxidation by ozone, chlorine and the like.

Many organic materials resistant to biodegradation can be removed using activated carbon. Although this method is common in the world, it is very expensive and may cost more than the activated sludge process.

Therefore, in order to increase the quality of effluent from activated sludge, increase its resistance and efficiency, a new initiative has been used in which activated carbon powder is added to the aeration pond, thus the efficiency of the system is dramatically without the need for additional and expensive equipment. In addition, this method can remove dyes, some heavy metals, aromatics and their chlorine compounds, pesticides, phenols and compounds that disrupt the work of the biological treatment plant and the system's resistance to changes in organic load. And various toxins increase.

This method is called pact powdered, activated carbon treatment, which was founded by du.pont company and marketed commercially by zimpro company.

The role of activated carbon powder in the optimization of industrial wastewater treatment systems

PACT process and pollution removal theory: This process is a modified method of activated sludge process. In this process, activated carbon powder is added to the aeration tank without spending much money. To keep the concentration of activated carbon in the process constant, activated carbon powder is continuously added to the aeration tank to compensate for the amount of carbon leaving the system with excess sludge or treated effluent. The following figure shows a simple diagram of the PACT process.Activated carbon particles absorb organic compounds, oxygen and bacteria and act as carriers. The adsorbed compounds are then gradually degraded by the bacteria and the carbon is reactivated. Although many contaminants are not biodegradable in conventional activated sludge systems, they may be degraded by prolonged contact with the biological mass.

Because it may take hours to days from the moment of absorption of contamination by activated carbon powder to their deposition with the balloon and evacuation. Bacteria that break down resistant molecules grow slowly on activated charcoal. These bacteria break down most of the material that is adsorbed on the surface. Therefore, higher carbon concentrations make more organic matter available to microorganisms. In this process, carbon not only acts as a preservative but also has a biological effect. Thus, the property of physical adsorption of activated carbon raises the concentration of organic matter at the surface and easily provides it to the microorganism. This indicates that the improvement of effluent quality by pact is a biological physical phenomenon.

On the outer surface and large pores of activated carbon, there are suitable and safe places for the attachment and growth of microbial assemblies.

Bacteria as small as 1 micrometer become accustomed to and break down biodegradable compounds such as dyes and toxins through mutation. This is also the biological reduction of carbon. And their lives cannot be endangered by microorganisms such as protozoa with a diameter of 19-200 micrometers, which are much larger than the accustomed bacteria because these microorganisms cannot enter the pores and the location of these bacteria.

Therefore, these bacteria can grow without hindrance and consume compounds that are highly resistant to decomposition and have absorbed carbon. In fact, due to prolonged contact between bacteria and adsorbed substances on activated carbon - carbon is reactivated (biological reduction). In this process, more than 95% of non-biodegradable organic pollutants are removed and several mechanisms have been proposed to remove organic matter by activated carbon.

1. Reduction of organic matter that is not easily biodegradable is the result of physical absorption by activated carbon.
2. The reduction of the above substances is the result of increasing the rate of biological decomposition by bacteria adhering to activated carbon powder, i.e., removal by biological oxidation adsorption.

It should be noted that the removal of completely non-biodegradable materials is done only through adsorption. Therefore, due to the removal of non-biodegradable contaminants in this process, the effluent will be treated to the extent that conventional biological treatment systems alone are not able to do so.

Investigating the benefits of using activated carbon powder

The use of activated carbon powder in wastewater treatment is not a new idea, as experiments have been performed since 1935 to increase the coagulation and flocculation of solids, anaerobic digestion, sludge and dewatering. These experiments showed that activated carbon powder as an auxiliary substance increases the hydraulic load of the wastewater while increasing the hydraulic load of the wastewater, increases the compaction of the sludge and facilitates its dewatering.

In these initial experiments, the usefulness of PAC was recognized but was not fully accepted due to economic reasons and the fact that high levels of purification were generally not required. In the past, GAC granular activated carbon was often used more than PAC and was more efficient in the wastewater treatment process, but then until the early 1970 s the use of activated carbon powder in biological processes was forgotten and only in this period. The use of activated carbon powder in the aeration unit of activated sludge system was considered by the researchers of Do Pont Chemical and Petrochemical Company and they finally concluded that such an action would increase the efficiency of disposal of wastewater organic matter without any investment or operating costs. The researchers finally registered the whole method with the acronym PACT in the name of the above company by modifying the proposed system and presenting maintenance and operation methods. In the following years, ICI Company followed the studies and conducted many studies on the simultaneous use of activated carbon powder and activated sludge system for the treatment of various municipal and industrial wastewaters.

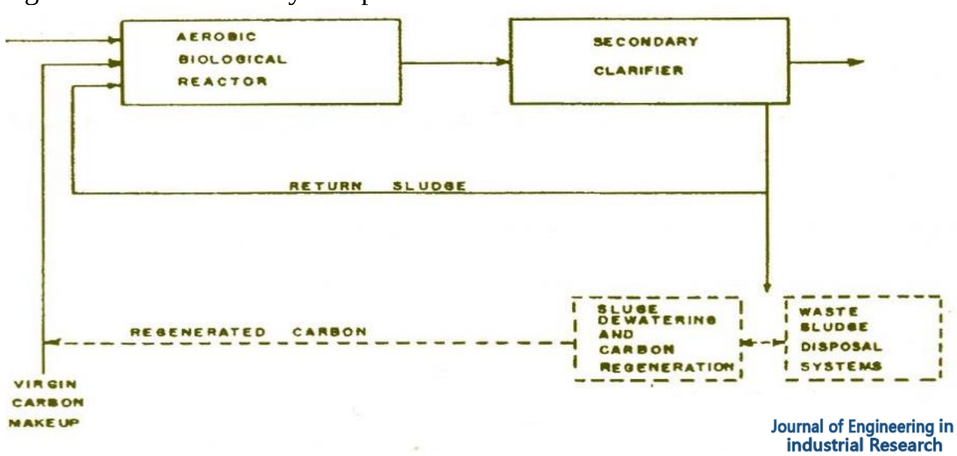

Figure 4. Schematic diagram of Davent PACT purification process

Conclusion

Biological treatment is the most important and main stage of most treatment systems. To understand biological processes as well as scientific and principled design, implementation and management of these processes or modeling and using biochemical and physical relationships in the design and control of these systems, must First of all, get acquainted with the microbiology of wastewater treatment, which includes the behaviors and characteristics of microorganisms active in wastewater treatment. Biological treatment systems are living systems that rely on heterogeneous populations of microbes. The mixture of microorganisms decomposes the organic matter and separates it from the solution. In general, the main purpose of biological treatment processes is to convert or remove organic matter into other products, so that the products produced are either harmless or easily separable. What is important is that in all biological processes, the main and vital role is played by microorganisms and in fact they are considered as purifiers. Generally, various types of microorganisms are active in purification systems, although bacteria play a major role among them. One of the most important and main products produced in biological processes is microbial growth or the production of extra cells. It is important to note that if these cells that are produced during the removal of organic matter are not isolated from the solution, purification is not performed, because cells that are actually of organic origin are measured as BOD or COD in the effluent. Bacteria, fungi, algae, protozoa, rotifers, crustaceans, and viruses are important microorganisms in wastewater treatment engineering. The basis of all processes used in biological wastewater treatment is the nutritional needs of microorganisms. In the activated sludge system, for example, colloidal and soluble organic matter is removed by microorganisms because they meet the growth and vital needs of cells.

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