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THEME

PERFORMANCE STUDY OF THE PHYSICO-CHEMICAL PARAMETERS OF BOUMERDES WASTEWATER TREATMENT PLANT.

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DEDICATION

I dedicate this work

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To all those that are close to my heart I dedicate this work to you.

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List of Abbreviation

CE: Electrical conductivities.

CO2: carbondioxide.

EN: Exploitation notice

VOC: Volatile Organic Compounds.

BOD: Biochemical Oxygen Demand.

COD: Chemical Oxygen Demand.

COnd: conductivity

H2O: water.

JO: Journal official

SM: Suspended matter.

SMM: Suspended mineral matter.

SS: Suspended solids

Min: minutes.

MMS: Mineral Matter in Suspension.

MO: Oxidisable matter.

MS: Dryness.

MVS: Suspended Volatile Matter.

$N\text{-}NH_4^+$: Ammonia nitrogen,

$N\text{-}NO_2$: Nitrites.

$N\text{-}NO_3^-$: Nitrates.

O2: Oxygen.

ONA: National Sanitation Office.

P: Present.

pH: Potential Hydrogen.

$P\text{-}PO_4^{-3}$: Orthophosphates

Pr: Stack Points.

PS: Dry Points.

Pv: Points empty.

PW: Purified water

Rpm: Rounds per minutes

RW: Purified water

SI: sludge indice

SR3: Lift Station number 3.

SS: Suspended solids

SM: suspended matter

SVM: suspended volatile matter

SMM: Suspended mineral matter

T°C: Temperature.

V: Volume.

VI: Nickel

VB30: Sludge volume obtained after 30 minutes.

VMS: Volatile matter in suspension

WWTP: Wastewater treatment plant.

Introduction

INTRODUCTION

Water is a necessity for survival of life on earth. About 70% of Earth (often called as Blue Planet) is covered with water and as far as we know, it is the only planet in our solar system containing liquid water. The percentage of water in human body having 70 kg of weight is 67.85%. [1]

Human activity, even the most basic, such as eating, generates solid and liquid waste which, by accumulating, would end up making our living environment inhabitable.

This is why since antiquity; Man has set up sanitation systems in cities. First, simple sewers to conduct wastewater and rainwater to the rivers.

With the development of urbanization and industrialization as well as the evolution of consumption patterns, wastewater discharges have evolved considerably in quality and quantity.

When waste water is not treated, the rivers are exceeded in their natural capacity of purification and find themselves polluted, therefore it was established the system of purification of these polluted rejections in the stations of purification. The purpose of the treatment or purification of waste water is therefore to reduce the pollutant load it carries.

Consequently, they should be directed to treatment plants whose role is to concentrate the pollution contained in the wastewater in the form of a small volume of residue, sludge and to reject purified water that meets very specific standards and this thanks to physico-chemical or biological processes.

In Algeria, the purification processes adopted are limited to two processes:

- By activatedsludge.
- Natural lagoon.

Today, wastewater treatment plants have become compact, covered, de-odorized, automated depollution plants. They implement increasingly efficient treatments capable of eliminating most pollutants. These stations are sized to handle a certain pollution load and ensure discharge in accordance with the standards in force.

This work is Performance study of the physico-chemical parameters of the Boumerdes wastewater treatment plant.

For this, we split our work into two main parts:

A theoretical part: Consisting of three chapters:

First chapter: General information on water.

Second chapter: General information on waste water.

Third chapter: Treatment of wastewater.

A practical part: Consisting of four chapters:

First chapter: Presentation of place of internship.

Second chapter: Wastewater treatment at the Boumerdes WWTP level.

Third chapter: Physico-chemical laboratory analysis.

Fourth chapter: Discussion and Results.

At the end we finished our work with a conclusion.

CHAPTER I

General Information On Water

I.1 Definition of water

Water is an inorganic compound with the chemical formula **H_2O**. It is a transparent, tasteless, odorless, and nearly colorless chemical substance, which are the main constituent of Earth's hydrosphere and the fluids of all known living organisms (in which it acts as a solvent). It is vital for all known forms of life, despite not providing food, energy or organic micronutrients. Its chemical formula, H_2O, indicates that each of its molecules contains one oxygen and two hydrogen atoms, connected by covalent bonds. The hydrogen atoms are attached to the oxygen atom at an angle of 104.45°. "Water" is also the name of the liquid state of H_2O at standard temperature and pressure.

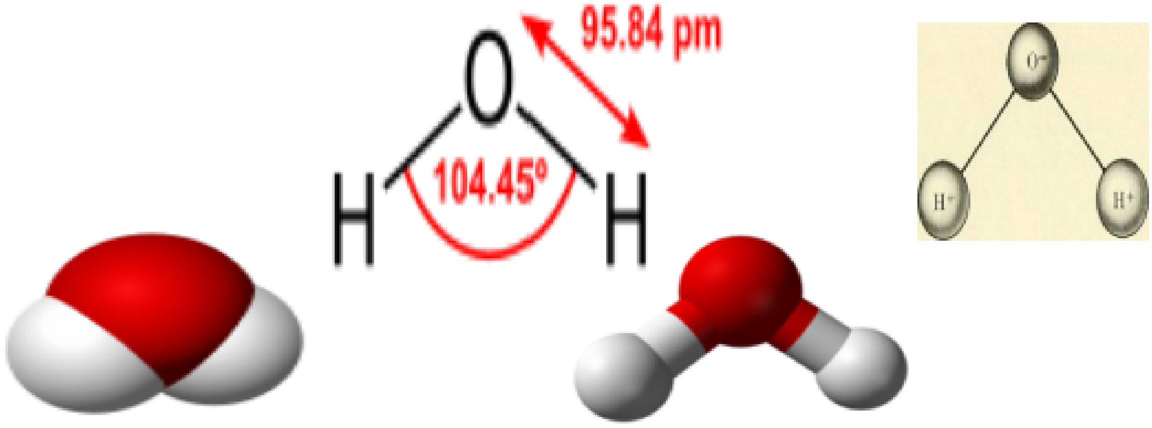


Figure I.1: Water molecule.

Because Earth's environment is relatively close to water's triple point, water exists on earth as a solid, liquid, and gas. It forms precipitation in the form of rain and aerosols in the form of fog. Clouds consist of suspended droplets of water and ice in its solid state. When finely divided, crystalline ice may precipitate in the form of snow. The gaseous state of water is steam or water vapor.

Water covers about 71% of the Earth's surface, with seas and oceans making up most of the water volume on earth (about 96.5%).Small portions of water occur as groundwater (1.7%), in the glaciers and the ice caps of Antarctiu moves continually through the water cycle of evaporation, transpiration (evapotranspiration), condensation, precipitation, and runoff, usually reaching the sea.

Water plays an important role in the world economy. Approximately 70% of the freshwater used by humans goes to agriculture. Fishing in salt and fresh water bodies has been, and continues to be, a major source of food for many parts of the world, providing 6.5% of global protein. Much of the long-distance trade of commodities (such as oil, natural gas, and manufactured products) is transported by boats through seas, rivers, lakes, and canals. Large quantities of water, ice, and steam are used for cooling and heating, in industry and homes. Water is an excellent solvent for a wide variety of substances both mineral and organic; as such it is widely used in industrial processes, and in cooking and washing. Water, ice and snow are also central to many sports and other forms of entertainment, such as swimming, pleasure boating, boat racing, surfing, sport fishing, diving, ice skating and skiing.[3]

I.2 PROPERTIES OF WATER

The structure of the water molecule creates weak attractions between the oxygen end of one molecule and the hydrogen ends of other water molecules. Even though these "polar" bonds are relatively weak and are constantly breaking and reforming, their existence results in many special properties of water compared to other substances on Earth. These properties of water are largely responsible for life on Earth.

Among all liquids, water can be identified by the following properties:

- **Appearance**: it is a mobile, colorless, transparent, odorless and tasteless liquid.
- **Thedensityofwater**: varies with the temperature it increases approximately, and at 4°C the density of water is 8 g/ml or 1000kg/m³
- **ThepresenceofH+andOH-ions**: gives water a certain electrical conductivity, that is to say a certain ability to conduct electrical currents.
- **Solvent**: water has a strong ability to solubilize a large number of substances, whether ionized or non-electric molecules. [4]

I.3.The natural water cycle

Three quarters of the earth's surface is covered in water.

Most of this water is in the oceans, some of it is in ice glaciers and at the poles. The rest is in rivers and lakes or trapped underground. The way that water travels from the earth's surface to the sky and then back to the earth's surface is called the water cycle.

The water journey takes place in several stages.

- **Evaporation** – water changes from a liquid into a gas, or water vapour.
- **Transpiration** – water is released as a water vapour through the leaves of plants.
- **Condensation** – water changes from a gas or water vapour, to liquid water droplets.
- **Precipitation** – water that falls from the clouds in the form of rain, hail, snow or sleet. [5]

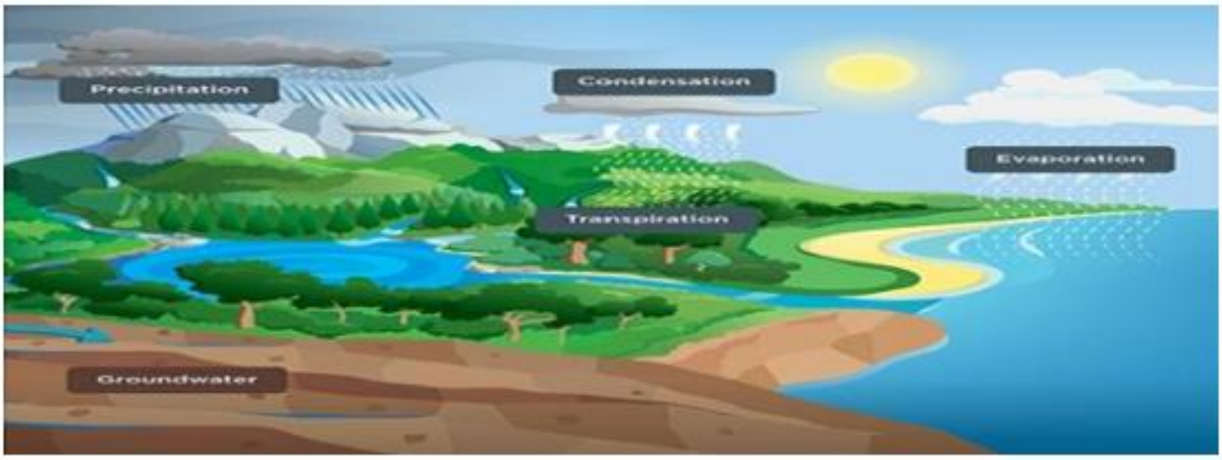


Figure I.2: Natural water cycle.

I.4 Water sources on earth

I.4.1. Surface water

Surface water is any body of water above ground, including streams, rivers, lakes, wetlands, reservoirs, and creeks. The ocean, despite being saltwater, is also considered surface water. Surface water participates in the hydrologic cycle, or water cycle, which involves the movement of water to and from the Earth's surface. Precipitation and water runoff feed bodies of surface water. Evaporation and seepage of water into theground, on the other hand, cause water bodies to lose water. Water that seeps deep into the ground is called groundwater.

I.4.2. Groundwater

Groundwater is the water present beneath Earth's surface in rock and soil pore spaces and in the fractures of rock formations. About 30 percent of all readily available freshwater in the world is groundwater. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water. The depth at which soil pore spaces or fractures and voids in rock become completely saturated with water is called the water table. Groundwater is recharged from the surface; it may discharge from the surface naturally at springs and seeps, and can form oases or wetlands. Groundwater is also often withdrawn for agricultural, municipal, and industrial use by constructing and operating extraction wells. The study of the distribution and movement of groundwater is hydrogeology, also called groundwater hydrology. [6]

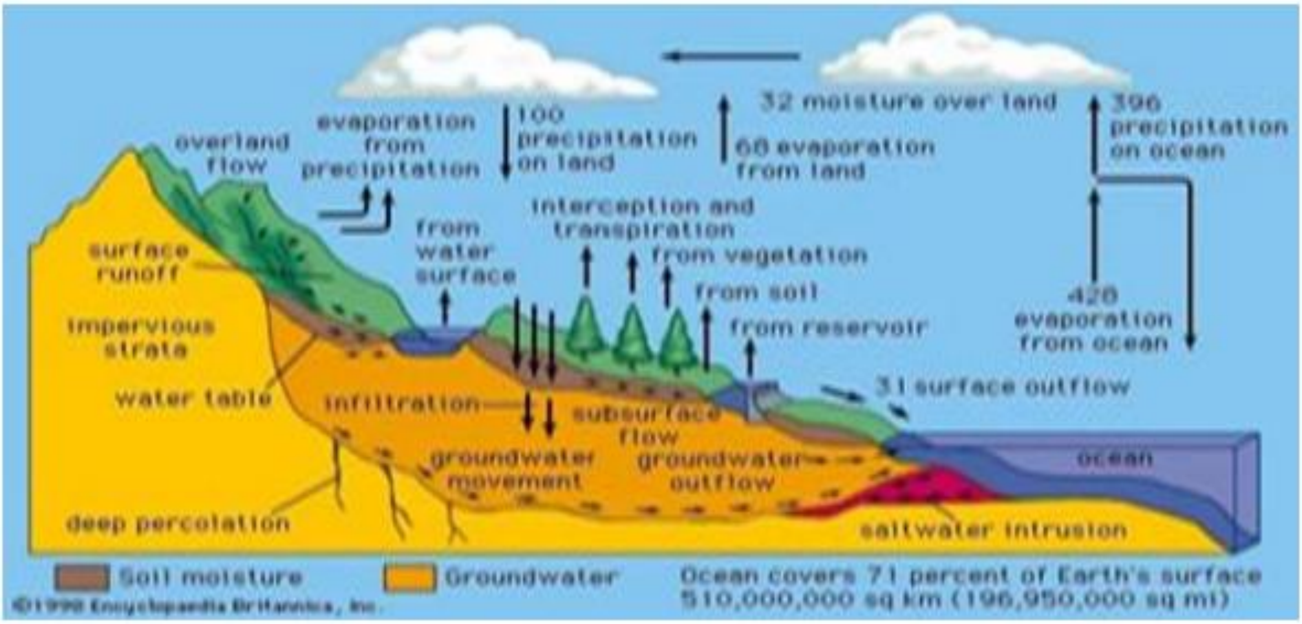


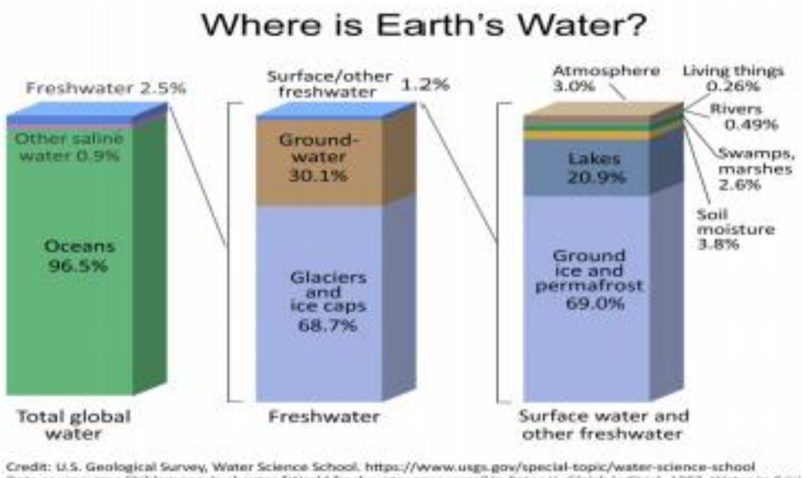
Figure I.3: The sources of water.

I.5 Distribution of Earth's Water

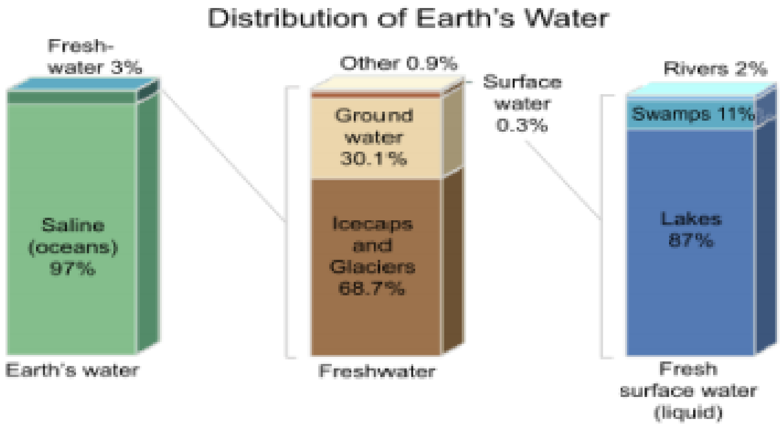
The Earth is a watery place. But just how much water exists on, in, and above our planet? About 71 percent of the Earth's surface is water-covered, and the oceans hold about 96.5 percent of all Earth's water. Water also exists in the air as water vapour in rivers and lakes, in icecaps and glaciers, in the ground as soil moisture and in aquifers, and even in you and your dog.

This bar chart shows how almost all of Earth's water is saline and is found in the oceans. Of the small amount that is actually freshwater, only a relatively small portion is available to sustain human, plant, and animal life.

- In the first bar, notice how only 2.5% of Earth's water is freshwater - the amount needed for life to survive.
- The middle bar shows the breakdown of freshwater. Almost all of it is locked up in ice and in the ground. Only a little more than 1.2% of all freshwater is surface water, which serves most of life's needs.
- The right bar shows the breakdown of surface freshwater. Most of this water is locked up in ice, and another 20.9% is found in lakes. Rivers make up 0.49% of surface freshwater. Although rivers account for only a small amount of freshwater, this is where humans get a large portion of their water from.[7]



Credit: U.S. Geological Survey, Water Science School. https://www.usgs.gov/special-topic/water-science-school
Data source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources. (Numbers are rounded).



FigureI.4: Distribution of earth's water.

I.6 Water consumption pattern

According to the World Health Organization, 100 liters of water per day are needed to optimally meet an individual's basic needs.[8]

External and internal factors affect household water consumption. External factors such as climate, price, public policies and population growth tend to be indirect and cannot be controlled by the user. However, internal factors like dwelling type, devices, number of household members, and lifestyle directly impact and are controlled by the user. Moreover, these factors imply water usage patterns and infrastructure, which constitute the differences in water consumption in various districts.[9]

The uses of water by man are multiple; they concern agriculture (70% of world consumption of fresh water), industry (20% world consumption of fresh water) and domestic consumption [10].

I.6.1Agricultural needs

The agricultural industry requires huge quantities of water for

- Irrigation
- watering farm animals

The relative importance of the case needs recess depending on the various types of agriculture and the abundance of precipitation.

Plants need huge amounts of water.

The production of one kg of wheat requires 1400 kg of water.

Large cereal crops consume 5 million kg of water per hectare directly.

This water intended for agricultural needs is drawn directly from rivers or groundwater without undergoing any treatment.

I.6.2 Industrial needs

Industrial needs are very considerable but very variable depending on the type of industry.

Establishments that require large amounts of water usually settlenear a watercourse, examples of which are:

Stationery.

Textile factory.

Metallurgical plants.

I.6.3.The needs of urban agglomerations

Water distribution networks must meet domestic and commercial needs, as well as network dependent industries.

These quantitative needs are generally expressed in units of volume per inhabitant per day.[11]

I.7 Water use in Algeria

Algeria has limited natural water resources, and these are irregular and unequally distributed. The country's natural water potential is estimated at 19 BCM/yr, but demand continues to increase.

The overall demand has quadrupled over the last 40 years and currently exceeds more than half the volume of potentially mobilizable resources. At this rate, the maximum limit of hydraulic potential is projected to be reached before 2050. In this context, strong competition is developing between the major users, adding to imbalances in resource availability between regions and making allocation decisions difficult. [12]

Drinking water has acquired a clear priority over other uses, a priority that is enshrined in Algerian water legislation. The share of drinking water has grown considerably from 16% of overall consumption in 1975 to 36% in 2019. By contrast, during the same period, agriculture's share fell from 80% to 60%, even though it remains the leading consumer. [13]

The water supply mainly comes from surface water allocated through reservoirs, storage facilities and transfers. Groundwater is the main water source in the south. Non-conventional water resources, such as desalination and treated wastewater, are becoming increasingly important.

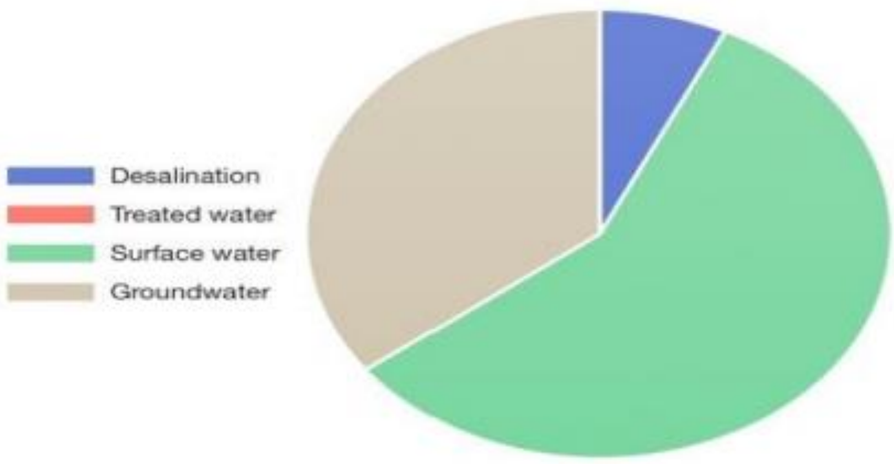


Figure I.5: Percentage of water withdrawals by source.

CHAPTER II

General Information on Wastewater

II.1.Definition of wastewater

Wastewater is the polluted form of water generated from rainwater runoff and human activities. It is also called sewage. It is typically categorized by the manner in which it is generated specifically, as domestic sewage, industrial sewage, or storm sewage (storm water). [14]

Table II.1: The quantity of daily pollution per inhabitant [15].

Type of polluants.	Daily quantity in (g)
Suspendedmatter (SS)	90
Oxydable matter (MO)	57
Nitrogenreduced	15
Total phosphorus	4
Toxicmetals(METOX)	0.23
Organohalogen compounds (AOX)	0.05

II.2. Nature and origin of wastewater

Nature of wastewater

Wastewater is a complex mixture of natural inorganic and organic material mixed with man-made substances. It contains everything discharged to the sewer, including material washed from roads and roofs, and of course where the sewer is damaged groundwater will also gain entry. This complex mixture ends up at the wastewater treatment plant for purification. In its broadest sense wastewaters can be split into domestic (sanitary) wastewater also known as sewage, industrial (trade) wastewaters and, finally, municipal wastewater which is a mixture of the two.

- Domestic wastewater.
- Industrial wastewater.
- Rainfall origin.
- Agricultural origin. [16]

II.3. Domestic wastewater

Sewage (or **domestic sewage**, **domestic wastewater**, **municipal wastewater**) is a type of wastewater that is produced by a community of people. It is typically transported through a sewer system. Sewage consists of wastewater discharged from residences and from commercial, institutional and public facilities that exist in the locality. Sub-types of sewage are grey water (from sinks, bathtubs, showers, dishwashers, and clothes washers) and black water (the water used to flush toilets, combined with the human waste that it flushes away). Sewage also contains soaps and detergents. Food waste may be present from dishwashing, and food quantities may be increased where garbage disposal units are used. In regions where toilet paper is used rather than bidets, that paper is also added to the sewage. Sewage contains macro-pollutants and micro-pollutants, and may incorporate some municipal solid waste and pollutants from industrial wastewater.

Sewage usually travels from a building's plumbing either into a sewer, which will carry it elsewhere, or into an onsite sewage facility. Collection of sewage of several households together usually takes places in either sanitary sewers or combined sewers. The former is designed to exclude storm water flows whereas the latter is designed to take storm water. The production of sewage generally corresponds to the water consumption. A range of factors influences water consumption and hence the sewage flow rates per person. These includes Water availability (the opposite of water scarcity), water supply options, climate (warmer climates may lead to greater water consumption), community size, economic level of the community, level of industrialization, metering of household consumption, water cost and water pressure.

The main parameters in sewage that are measured to assess the sewage strength or quality as well as treatment options include solids, indicators of organic matter, nitrogen, phosphorus, and indicators of fecal contamination. These can be considered the main macro-pollutants in sewage. Sewage contains pathogens, which stem from fecal matter. The following four types of pathogens are found in sewage:

pathogenic bacteria, viruses, protozoa (in the form of cysts or oocysts) and helminths (in the form of eggs). In order to quantify the organic matter, indirect methods are commonly used:

Mainly the Biochemical Oxygen Demand (**BOD**) and the Chemical Oxygen Demand (**COD**).

Management of sewage includes collection and transport for release into the environment, after a treatment level that is compatible with the local requirements for discharge into water bodies, onto soil or for reuse applications. Disposal options include dilution (self-purification of water bodies, making use of their assimilative capacity if possible), marine outfalls, land disposal and sewage farms. All disposal options may run risks of causing water pollution. [17]

II.4 Industrial wastewater

Industrial wastewater is an aqueous discard and by-product from most production industries like food and beverage, cloth and shoe production, electronic production, and heavy production sites such as mining, oil and gas, as well as chemical manufacturing. Water is used in the production process of commercial products across every industry or for cleaning activities taking place along with the process. Once the water has been used, it is considered wastewater.

Metal finishers are an example of an industry producing high amounts of wastewater. Metal finishers are producing significant amounts of sludge containing heavy metals, drastically harming the environment and the health of people and animals. That is why strict regulations for industrial wastewater treatment encompass the metal finish industry.

Industrial laundries produce large amounts of industrial wastewater as well. The wastewater generated by cleaning towels, uniforms, and doormats contains matters such as oil, grease, lint, sand, grit, heavy metals, and VOCs that must be treated before discharge. These industries are just a fraction of many producing industrial wastewater, which is essential to treat before being discharged into the environment.

To comply with existing laws and discharge limits, any organic and inorganic pollutants in the water used in industrial production must be managed. Organic matter, metals, and other suspended solids in the industrial wastewater must be removed before the water can be safely discharged back to land and water environments or reused in plant operations. [18]

II.5 Rainwater

Rainfall origin:

It is runoff water that forms after precipitation: On the one hand, it can be polluted, particularly at the start of the rain, by two processes: -

- The washing of soils and waterproofed surfaces.
- The suspension of collector deposits. They are similar in nature to domestic wastewater with heavy metals and toxic elements (lead, zinc, hydrocarbons), mainly from car traffic. These are runoff water (rainwater, irrigation water, public roads, washing water from gutters, markets and courtyards).

Water flowing over roofs, waterways, gardens, green spaces, public roads and steps causing all kinds of mineral and organic waste from the earth, silt, plant waste, etc., and all types of micro pollutants (hydrocarbons, pesticides, detergents, etc.

This rainwater is not necessarily polluted, but can constitute a significant source of pollution of watercourses. Rainwater includes air impurities (case of pollutants from industries and runoff on land surfaces that contain residues hydrocarbons, heavy metals, oils, etc.

When the sanitation system is called "unitary", rainwater is mixed with domestic wastewater.

During heavy rainfall, the inconvenience of preserving purification facilities may require this very polluted compound to be discharged into nature. [19]

II.6.Agricultural origin

These waters have been polluted by substances used in agriculture. In order to perform agriculture, is led to use different products of industrial or agricultural origin in some of which present risks for the environment and mainly for the quality of water.

These are essentially:

- Fertilizers (commercial mineral fertilizers or animal digests produced or not on the farm).
- Direct inputs due to the treatment of aquatic and semi-aquatic environments such as

weeding of water bodies, flood-prone areas(Chemical weeding) and ditches, as well as the demonstration of water bodies and flood-prone areas (ponds and marshes).

- Indirect contributions due in particular to the environment by runoff, to the rinsing water of the treatment devices, to the residues present in the packaging that is not strictly rinsed or to the waste water from the manufacturing and packaging plants.[20]

The agricultural sector remains the largest consumer of water resources. Pollution due to agricultural activities is of several types:

- Irrigation of surface waters of nitrate and phosphorus used as fertilizer.

- Irrigation of sulphide, copper and arsenical compounds intended for the protection of vines in wine-growing regions.

-Irrigation of chlorinated or phosphate pesticides, weed killers, insecticides. They contain, on the one hand, zoo technical effluents (slurry, slurry) and, on the other hand, runoff water which can carry pesticide and fertilizer residues. Livestock plays an essential part in this pollution. A farm of 500 cows represents a pollution load of 5000 or 7000 inhabitants. [21]

II.7. Water Pollution

Water pollution occurs when harmful substances—often chemicals or microorganisms—contaminate a stream, river, lake, ocean, aquifer, or other body of water, degrading water quality and rendering it toxic to humans or the environment. This widespread problem of water pollution is jeopardizing our health. Unsafe water kills more people each year than war and all other forms of violence combined. Meanwhile, our drinkable water sources are finite: Less than 1 percent of the earth's freshwater are actually accessible to us. Without action, the challenges will only increase by 2050, when global demand for freshwater is expected to be one-third greater than it is now. [22]

Figure II.6: Water pollution.

II.8 Types of Water Pollution

The types of water pollution include:

- **Groundwater Pollution**
- **SuspendedMatter**
- **OilSpillages**
- **Microbiological Pollution**
- **Chemical Water Pollution**
- **Thermal Pollution[23]**.

II.9 Diseases caused by water pollution

Contaminated water and poor sanitation are linked to transmission of diseases which are:

Bacterial diseases

Faecal contamination of drinking or insufficient wastewater treatment processes, are the leading cause of bacterial diseases. The mostcommonamongtheseinclude:

- Cholera
- Diarrhea
- Salmonellosis
- Shigellosis

Viral diseases

Contaminated water provides the perfect breeding ground for viruses to develop and multiply. Once consumed, theycantake the followingforms:

- Hepatitis
- Encephalitis
- Polio
- Gastroenteritis

Parasiticdiseases

As the name suggests, parasitic diseases are transmitted by parasites through contaminated water. Some of the mostcommonplace to affect humansinclude:

- Cryptosporidiosis
- Gallopingamoeba
- Giardiasis
- Schistosomiasis [24]

II.10.Characteristics of wastewater

Wastewater is characterized according to its physical, chemical and biological composition. Depending on the level of pollutants and local regulations, physical, chemical and/or biological treatment will be used. Most of the time, the three treatments are combined to obtain the best water quality. Wastewater is comprised of liquid and solid waste that is discharged from domestic residences, commercial properties, industrial plants, and agriculture facilities or land. Wastewater contains a wide range of contaminants at various concentrations.

- **Color**

Fresh wastewater is normally brown and yellowish, but over time it turns black.
It is normally greyish. The black color indicates partial decomposition. The othershades are of industrialorigin. [25]

- **The smell**

Fresh sewage has a bland smell that is not unpleasant. A foul odor indicates water that begins to ferment by stagnation either in the sewer system or before its discharge **[25].**

- **Suspended solids**

These are insoluble solids suspended in a liquid and visible to the naked eye.

Suspended solids (SS)

They represent the fraction constituted by all particles of mineral origin (sand, silt, clay,...) or organic (products of the decomposition of plant or animal matter, humic acids ...). To these compounds are added microorganisms such as bacteria, plankton, algae and viruses. These substances are responsible, in particular, for the turbidity and colour of the water.

a)- Suspended volatile matter (SVM)

They represent the organic fraction of suspended solids. These materials disappear during combustion and are measured from suspended solids (residue at 105°C) by calcined them in a furnace at 525°±25°C for two hours.

b)- Suspended mineral matter (SMM)

It is the rest after calcination of suspended solids at 525 ° ± 25 ° C for two hours and volatilization of all volatile matter; it represents soluble materials such as chlorides and phosphates.

Temperature

For wastewater, it is correlated to the outside temperature while being warmer because almost nobody takes a cold shower.

It is essential to know the temperature of the water. Indeed, it plays a very important role in the solubility of salts and especially gases, temperature measurement is very useful for limnological studies and the calculation of ion exchanges. It also acts as physiological factor acting on the growth metabolism of microorganisms living in water [5].

- **Turbidity**

Due to suspended solids, wastewater will have higher turbidity. Turbidity represents the disorder due to the more or less significant presence of suspended solids of organic or mineral origin in the water. It is inversely proportional to the transparency of the water [26].

- **Conductivity**

Conductivity is the property that water has to promote the passage of an electric current. It provides a precise indication of the dissolved salt content (salinity of the water). Conductivity is express in micro-siemens per centimeter and is the inverse of resistivity. Conductivity measurement makes it possible to evaluate the overall mineralization of the water. [27]

- **Dissolvedoxygen**

Dissolved oxygen is an essential compound of the aqueous environment since it is the limiting reagent of the main biodegradable pathway of organic pollution, its concentration is low and most often close to zero in raw waste water given the high concentrations of reducing compounds (oxidizable) and it increases by aeration in biological basins or the natural environment.[28]

- **The hydrogenpotential (pH)**

The determination of PH is a measure of the concentration of H^+ ions present in the water it indicates whether the water is acidic or alkaline, its measurement must take place as frequently as possible because it influences in:

- The physico-chemical properties of water (acidity, alkalinity);
- The effectiveness of certain treatment procedures (coagulation, flocculation);
- The biological processes (some of which require very narrow pH limits).[29]

II.10.2 Chemical characteristics of wastewater

Wastewater contains different chemicals in various forms, as shown below.

Chemicaloxygendemand (COD)

This is a measure of the amount of organic matter in wastewater based on the oxygen required to oxidize it. Chemical Oxygen Demand (COD) is the amount of oxygen needed to oxidized the organic matter (biodegradable or not) of a water using an oxidant, potassium dichromate. This parameter provides a more or less complete representation of the oxidizable materials present in the sample. It is express in mg O_2/l. Generally, the COD is 1.5 to 2 times BOD_5 for urban water and 1 to 10 for all industrial wastewater. The empirical relationship of organic matter (OM) as a function of BOD_5 and COD is given by the following equation. [30]

$$MO= \frac{(2BOD_5 + COD)}{3}$$

●**Nitrogen**: It is measured in its different forms: nitrite, nitrate, ammonia, and organic nitrogen (which are the amount of nitrogen present in organic compounds).

●**Phosphorus**: It is generally measured in its mineral and organic form, total phosphorus.

●**Chlorine (Cl-).**

●**Sulfates (SO_4^{-2}).**

●**Heavy metals.**

II.10.3 Biological parameters of wastewater

- **Biochemicaloxygendemand (BOD_5)**

BOD is the amount of oxygen required to stabilize organic matter using micro-organisms. It is the amount of oxygen consumed at 20°C and in the dark for a given time to ensure the biological oxidation of biodegradable organic matter present in the water. BOD_5 is conventionally used, i.e. the amount of oxygen consumed after 5 days of incubation. BOD_5 is normally representative only in biodegradable carbon organic pollution.[31]

●Oil and Grease – Oil and grease are generated from food waste and petroleum products.

●Microbial life in wastewater: Wastewater contains the following microbes:

●Bacteria.

●Protozoa.

- Mushrooms.
- Virus.
- Seaweed.
- Rotifers.
- Nematodes.

II.11. Wastewater collection

II.11.1. Sanitation

Water purification constitutes all the provisions relating to the evacuation of liquids from an agglomeration and their treatment, so that they cannot cause anya harem to public hygiene.

II.11.2. The wastewater treatment system

This is all the works that allow the collection and processing of wastewater before being discharged into the natural environment.

There are two sanitation systems:

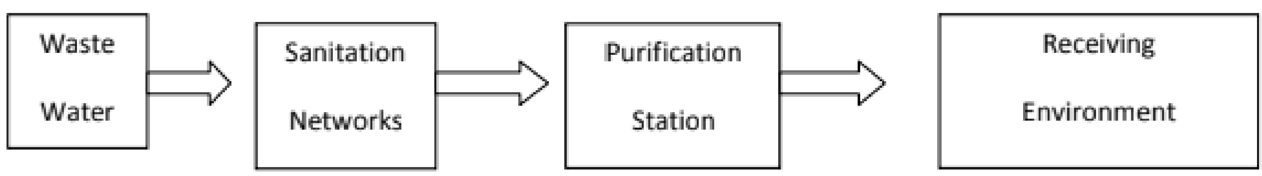
- **Collective sanitation**

The collection system is common for a large number of users and all wastewater is treated at a treatment station (purification station).

- **Individualsanitation**

For isolated dwellings, wastewater is treated on the production site because it is not possible to discharge it into a collection system. The water undergoes pre-treatment at the level of a septic tank, and then the final treatment is done at ground level.

The first system is the most common and it is this that we will describe from the point of view of its operation and monitoring. It is made up of four essential and inseparable components:



The first two condition the pollution flow to be treated in terms of quantity, quality and variability. The receiving environment, due to its sensitivity, determines the efficiency and reliability of pollution control works. The regulations impose maximum quantities of pollution that can be discharged into the receiving environment and which will depend on its sensitivity. [32]

II.12. The different collection methods

The sanitation network is made up of all the structures responsible for collecting the transport to the wastewater treatment plant. It includes all the pipes but also the lifting stations and special structures such as storm or settling basins. Generally, the circulation of water is done by gravity according to the slope given to the pipes.

At certain points in the network, it is mandatory to raise the level of the pipes so that traffic continues to flow by gravity. In this case, a lifting or lifting station is set up which, thanks to a pump, makes it possible to raise the level by several meters.

The network must not lose the pollution it transports along the way, nor drain the underground or surface water it runs alongside which could disrupt the operation of the treatment plant. It must be as tight as possible.

The channeled effluents must arrive "fresh" (unfermented) at the treatment plant, which implies rapid circulation of the effluents.

A network must not include a discharge connection that could degrade it or degrade the station. There must be selectivity and control of connections.

Responding to these requirements, it excites two main types of grating: separative grating and unitary gratings. [33]

II.12.1 -The separative network

Two separate networks are put in place:

One to evacuate rainwater, and the other to evacuate wastewater. In this system, only the domestic water arrives at the treatment plant system allows:

-To decrease the average diameter of the domestic water collection network because its flow is much lower than that of rainwater.

-To guarantee better operation of the treatment plant because the quantity of traitor used remains the same whatever the atmospheric conditions.

-To limit certain operating costs, in particular for raising effluents.

II.12.2 -The combined network (mains drainage)

A single collector ensures the transport of both domestic water and rainwater.

In principle, all this water must arrive at the station with an effluent of very variable quality. To limit the problems, diversion structures are provided on the network so that it does not bring to the station a flow higher than a maximum prefix flow.

Of simple design, it reduces the clutter of the basement, insofar as only one collector is used for the transport of wastewater. It is also economical because the sizing of the network is calculated according to rainwater, the flow rate of which is greater than that of domestic water.

The major drawback comes from the variability in quantity and quality of the pollution that arrives at the treatment plant during a storm, for example, domestic water will be greatly diluted by the high flow rates of rainwater and therefore a volume significant amount of diluted pollution will arrive or level of the sewage treatment plant. On the other hand, during the first rains. After a long period of drought, the leaching of the soil can lead to a significant flood of pollution, which is added to the pollution of domestic water.

II.12.3-The mixed system

This is a situation where, in the same agglomeration, there are residential areas served by a unitary type network (generally the city center) and areas served by a separative type network (newallotments to the preferred).[34]

This is the type of system used at the Boumerdes WWTP.

II.13. The re-use of wastewater

II.13.1. The global balance sheet

During the last years, the re-use of wastewater has been a very rapid development with a growth of the volumes of wastewater re-use in the order of 10 to 29% per year, in Europe, in the United States and in China, and up to 41% in Australia.

The current daily volume of re-used water reaches the impressive figure of 1.5 to 1.7 million m³ per day in several countries, such as California, Florida, Mexico and China.

In general, practically all the other countries around the Mediterranean, from Spain to Syria, re-use wastewater (treated and untreated) for various applications. Indeed, the Mediterranean basin is a region where water shortage is particularly felt. It is also one of the regions where the agricultural re-use of urban effluents is practiced. In some countries, this re-use has become the object of a national policy such as Tunisia, Greece and Jordan.

II.13.2. Case of Algeria

In Algeria, 60% of treated wastewater is discharged either far from irrigation perimeters and dams are at sea, which makes their re-use in irrigation unprofitable. Thus, only 240 million m' can potentially be used for irrigation due to the location of the discharge points.

A program for the re-use and modernization of treatment works intended for the re-use of wastewater in irrigation is currently being implemented.

The ratio of wastewater re-use to resource allocation makes it possible to estimate the contribution of the re-use of wastewater in irrigation. This contribution is 13.37% in the ChelifZahrez hydrographic region, 21.4% in the OranieChottChergui hydrographic region. The latter is clearly lacking in rainfall compared to other regions of northern Algeria (about 400 mm/year). The re-use component of wastewater in irrigation even becomes preponderant with a ratio of 45%, or even 100% in the case of the Muléta perimeter in the Oranie region of western Algeria. [35]

II.14. Ways of re-using wastewater

The re-use of wastewater is widespread throughout the mode with several types of valuations. There are thousands of wastewater re-use projects. There are five categories of reuse:

II.14.1. Agricultural re-use

The amount of wastewater discharged encourages farmers to use this source of water. In addition, the richness in fertilizing elements such as nitrogen, phosphorus and potassium, necessary for the development of plants and for fertilizing the soil, makes it possible to save on the purchase of fertilizers and to increase agricultural production.

The agricultural reuse of treated water as a means of saving resources was therefore one of the first ways of developing projects for the reuse of treated wastewater.

Re-use for irrigation is mainly present in countries known to be agricultural but whose water resources are low, such as the Mediterranean basin and the southern United States.

The largest reuse projects have been developed in the western and state regions of the United States, the Mediterranean, Australia, South Africa and in the semi-arid areas of the South America and South Asia.[36]

II.14.2. Industrial re-use

The industrial re-use of wastewater and internal recycling are now a technical and economic reality. For some industrialized countries, recycled water provides 85% of global water needs.

Thermal and nuclear power plants (cooling water) are among the sectors that use large quantities of wastewater. The amount of reused water depends on the industry or industrial production.

The re-use of industrial wastewater can be interesting in the sector of energy, in closed or open cooling circuits. Other possible applications include industrial laundries, car washes, paper industry, steel production, textiles, electronics and semiconductor industries.

II.14.3. Re-use in urban areas

In urban and peri-urban areas, the re-use of wastewater is an important source.

The most common uses are the irrigation of green spaces (parks, sports grounds), landscaping (waterfalls, fountains, and water plants), washing streets or vehicles and protection against fire. Another important application is recycling in buildings, for example the use of treated household water for washing.

The countries at the forefront of urban wastewater re-use are mostly developed and highly urbanized countries:

United States, Japan, South Korea, Germany, the possible uses of treated water in urban areas are extremely numerous, and there are many examples throughout the world. These projects concern:

-The watering of parks, sports fields, golf courses, playgrounds.

-Amenity ponds, swimming pools, pond for fishing and pleasure boating.

-Water from the sanitary facilities of a building or a group of buildings.

- Washing of roads, firefighting tanks. [37]

CHAPTER III

Laboratory Physico-Chemical Analysis

III. Water

The general principle of urban wastewater treatment is biological purification, depending on the characteristics of the water can distinguish several types, but before arriving at biological treatment, the water must pass through a purely physical or physico-chemical treatment which consists of the removal of large impurities, sand and oils[38].

III.1. Definition of wastewater treatment

Wastewater treatment is the process of improving the quality of wastewater and converting it into an effluent that can either be returned to nature, incorporated into the water cycle with minimal environmental problems or reused. [39]

III.1.1. Pre-treatment

This phase consists of retaining solid waste (paper, plastic, etc.) as well as part of the grease and sand contained in the worn water in order to eliminate the largest elements likely to hinder the processes of subsequent treatments or damage the equipment.

III.1.1.1. Screening

The principle of screening consists in passing wastewater through a gridwhose bars, more or less spaced, retain the coarsest elements. Their main objectives are: elimination of bulky materials which could impair the effectiveness of subsequent treatments and lead to the risk of clogging in the various installation units; Depending on the spacing of the bars or the diameter of the meshes, a distinction is made between the following types:

- **Coarse screening:** For grid with bars spaced 50 to 100 mm apart.
- **Medium screening**: For grid with bars spaced 10 to 25 mm apart.
- **Fine screening:** For grid with bars spaced 5 to 10 mm/20 mm apart.

There are two types of grids:

1. **Manual Grids**

They are reserved for very small installations, the grid forte mere.Inclined (angle from 70° to 80°). The cleaning of these grids is manually.

2. Mechanical grids (automatic)

As soon as the capacity of the station is elevated, the treatment plant must be equipped with a mechanical grid to size a grid:

The principle of screening consists in passing the wastewater through a grid whose bars, more or less spaced, retain the coarsest elements.

Their main objectives are: the elimination of bulky materials that could affect the effectiveness of subsequent treatments and lead to the risk of clogging in the various units of the installation.

$S = Hmax \times L(1-b)\delta/\sin\alpha$

- A: the nail of the inclination.
- Hmax: maximum height of water.
- Δ: clogging coefficients.
- β: coefficient corresponds to the fraction of the surface area relative to the brush.

$\beta=0.25 \rightarrow$ Manual grids or $\beta=0.5 \rightarrow$ Mechanical grids

S: grid area

III.1.1.2. Sandblasting

The purpose of desanding is to extract raw water, gravel, sand and particlesmore or less fine minerals. Sand removal is essential to protect pipes and pumpsagainst brazing and corrosion and avoid clogging of pipes.

III.1.1.3 Deoiling - degreasing

Knowing the density of the oils, they remain suspended in contact with water, this phenomenon prevents the infiltration of air (oxygen) and blocks biological activity in the water.

III.1.2 Secondary Treatment/Biological Treatment

The biological treatment is done by putting in contact the purified water and

Microorganisms. These will feed on the organic matter present in the wastewater and will transform it into pollutants:

- By absorption of polluting materials on bacterial floc (agglomerate of microorganisms).
- By conversion into cellular matter.

- By oxidation to CO_2 and H_2Owhich produces the energy necessary for the operation and production of cellular materials.

Secondary treatments include material removal techniques

soluble pollutants. There are a large number of waste water treatment processes, the application of which depends both on the characteristics of the waste to be treated and on the degree of purification desired.[40]

COD/**(DB05**) report gives an estimate of the biodegradability of materialspresent in wastewater.

Thus the effluent is estimated:

1. If COD/(DB05) <2.5: the effluent is excellent for biological treatment.
2. If COD/(DBO5) > 2.5: biological is not possible, physico-chemical treatment must be carried out. Exploitation notice (EN).

III.1.2.1 Pathogens (microorganism)

These are the cause of the main restrictionsimposed on the reuse of used ones.

Microbiological quality is the most important criterion for workers whowork in the field as well as for the public that may be exposed directly orindirectly to purified wastewater.

Among the most encountered pathogenic elements are:

1. Helminths

These elements are frequently encountered in thehelminth eggs, which can be evaluated between 10 and 103/l.The infectious stage of some helminths is the adult organism or larva, while for others it is the eggs.

2. Eggs and larvae are resistant in the environment and the risk associated with their presence should be considered for the treatment and reuse of residual products.

Protozoa

Among the most important protozoa from a health point of view, we must mention Entamoebahistolytica, responsible for amoebic dysentery and Giardia lamblia

During their life cycle, protozoa go through a form of resistance (the cysts) that can be carried by wastewater.

Figure III.7: The diameter of protozoa between 5 and 200µ.

1. Bacteria

Urban wastewater contains approximately 106 to 107 bacteria/100 ml, of which 103are pathogenic. The best known are salmonella responsible for typhoid and intestinal disorders, not to mention E. coli which have a lifespan of 2 to 3 months and multiply in the environment.

Secondary treatments include material removal techniquessoluble pollutants. There are a large number of wastewater treatment processes, the application of which depends both on the characteristics of the waste to be treated and on the degree of purification desired.[41]

III.1.3 Decantation

Consists of the separation of suspended mineral or organic matter whose density is greater than that of water, under the effect of gravity. The solids are deposited at the bottom of a structure called a decanter to form sludge, which will then be recovered by means of a mechanical scraping system. However, the overall clarification of discharges requires the additional elimination of colloidal or finely dispersed particulate pollution.

The outgoing water of the aeration works is directed to 3 clarifiers of diameter 24 m the dimensioning base being 0.8m / h per tip.

III.1.4. Tertiary or finishing treatment

Finishing is a complementary treatment to obtain a higher quality of treated effluent by pushing the purification as far as possible and aiming at one or more of the following objectives:

1° Improve the performance of purification on conventional parameters (SS, B0D5, COD), using different techniques: sand filtration, microsieving, biofiltration, lagooning, etc.

2° Disinfect WWTP discharges, i.e. reduce bacterial pollution by using chlorine, ozone or ultraviolet (UV).

3°Eliminate nutrients (nitrogen or phosphorus) eutrophication factors, by biological treatments (nitrification and denitrification of nitrogen) or physicochemical treatments (precipitation, settling, etc.)[42]

Note:

This is something that is not done at the level of a step of Boumerdes, the purified water is stored in a large basin where it will be diverted to two final destinations:

1- Ouedtatareg then the natural receiving environment (the sea).
2- The two farmers of the region (Corso)/after a balance sheet in accordance with the interministerial decree of JO 2012 .(Exploitation notice of Boumerdes WWTP)

Wastewater evacuates faeces and urine from populations. They areloaded with commensal germs usual to man, and pathogenic germs from healthy carriers or sick people.

III.2: Sludge

III.2.1 Activated sludge

- Activated sludge is the most responsive aerobic biological treatment (WHO, 1979). The process consists in provoking the development of a dispersed bacterial culture in the form of flakes (activated sludge), in a stirred and aerated basin (aeration tank) and supplied with water to be purified. In this basin, the purpose of brewing is to avoid deposits and homogenize the mixture of bacterial flakes and wastewater (mixed liquor); Aeration can be done from the oxygen of the water, oxygen-enriched gas, or even pure oxygen, is intended to dissolve this gas in the mixed liquor, in order to meet the needs of aerobic purifying bacteria.

- After sufficient contact time, the mixed liquor is sent to a clarifier sometimes called a secondary settler, intended to separate the purified water from the sludge. These are recycled in the aeration tank to maintain a sufficient concentration of purifying bacteria. The excess (excess secondary sludge) is extracted from the system and discharged to sludge treatment [43].

III.2.2. Recycled Sludge

The sludge collected must be taken at the exit of the corridor where the sludge recycled flows at the aeration tank to ensure a constant concentration at the level of the aeration tank

III.2.3. Thickened sludge

The thickened sludge is sampled at the thickener valve (we start the valve for a few seconds, then we take our sample).[44]

III.2.4. Dewatered sludge

Dewatered sludge is sampled at the belt filter, taking a representative average sample (cake or mud paste)

The choice of sludge treatment process depends on its origin and final destination.

The treatment has two main objectives:

- Volume reduction.(thickening, dehydration) .
- Reduction of fermentable power.(stabilization)Different treatment channels but the objective remains the same.The sludge treatment processes that may exist within a WWTP.
- Thickening (static or dynamic).
- Digestion or stabilization (aerobic, anaerobic and chemical).
- Dehydration (belt filter, filter press, centrifuge, drying bed)
- Thermal drying .

• Incineration [45].

III.2.5. **Thickening**

Gravity thickeners (harrowed or not) have the function of thickening and not storing. The residence times of the sludge are a maximum of three days. The management method of these structures provides that supernatant water is evacuated. Storage thickeners are mixed structures providing simultaneous thickening and short storage. The use of this method of management should be prohibited. It is indeed responsible for many dysfunctions. Both on the water and sludge lines. In practice, their use is unfortunately still quite common. The sole function of silosis to store sludge without draining water. In practice and for reasons often justified relating to the difficulties encountered in the disposal of sludge, the operator seeks to optimize its storage time by regularly evacuating supernatant water, and thus greatly increases the risk of biological malfunctions. Goal:¬ Reduction of sludge volume. [46].

Experimental Part

CHAPTER I

Presentation Of Place Of Internship

I.1. History

The BOUMERDES sanitation unit was started in July 2004 date of its creation for decision N°: 250/ONA/ARA/KH/2004 of July 18, 2004. Since its creation, several objectives have been achieved of which we quote.

- Adoption of the land and recognition of the environment of the State.

-Reception of transfers from the DHW (infrastructure and equipment).

-Maintenance and upkeep of the sanitation systems of the State

-Establishment of the organizational chart of the unit by adapting to new data and its realization on the ground, namely, the reaction of 04 sanitation centers

(BOUMERDES, ISSER, BAGHLIA and BOUDOUAOU) the operations department and its services as well as the administration and finance department.

I.2. Full name of the company: National sanitation office-ONA.

I.3. Address: Rue BoukerrouchaBoumerdes.

I.4.Capacity: The unit has the capacity to treat 15,000 m³/day, the equivalent of 75,000 inhabitants.

I.5. The operations department

The operations department has been active since the transfer of the sewerage system:

Composed of 3 treatment plants; 12 lifting stations and about 1000km of network all confused diameter; from DHW to ONA. It is structured as follows:

-The laboratory.

-The maintenance department.

-The studies and projects department.

-Operation follow-up service.

I.6. Activity of the Enterprise

Urban wastewater treatment.

I.7. Presentation of the laboratory

a- Laboratory units: There is only one ana lysis unit.

b- Main duties.

The unit has a central laboratory located at the wastewater treatment plantBOUMERDES.

This laboratory is responsible for:

Taking charge of the analysis of the 3 stations (BOUMERDES, ZEMMOURI, and THENIA) from the arrival of domestic waste water (untreated water) until the purified water is obtained; it goes through the different stages of treatmentt.

c) Material means

The laboratory is equipped with the necessary equipment to carry out water analyzes and sludge (pH-meter, microscope, spectrophotometer, BOD-meter.....)

I.8. The sanitation network

The sanitation network is of the unitary type. The main collectors move towards the sewage treatment plant under gravity and are forced to use lifting stations.

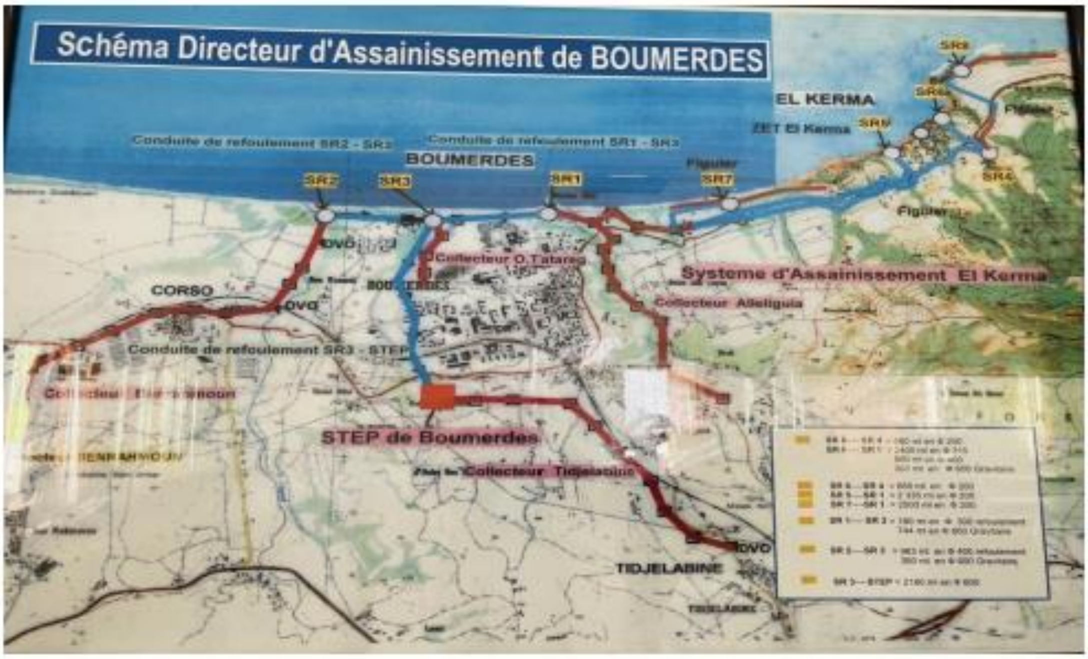


Figure I.8: Sanitation network.

I.9. Basic station data

-Date of commissioning: January 2001.

-Type of network: Unitary.

-Nature of untreated: Urban.

-Type of treatment: activated sludge.

-Equivalent number par in habitant: 75000.

-Daily volume: 15000 m^3/d

-Consumption par dwelling: 200 lt/d.

-Average daily flow: 625 m^3/d.

-Average hourly flow : 26,04 m^3 /h.

-Dry weather point flow: 1063 m^3/h.

-Flow of dry water rainy flow: 1944 m^3/h.

-BOD, eliminated: 4050 kg/d.

-SS eliminated: 5250 kg/d.

I.10. TheBoumerdés WWTP works

1.10.1. Arrival of the untreated water at the STEP (at the level of the lifting station).

- 03 electric pump units specially designed for water.

- Charged: flow ......150m/h.

- HMT......6m.

- Actual power....4.7KW.

- Speed........1500 rpm.

-04 float switches.

- 01 rotating jib crane.

I.10.2. Storm basin

- 02 electric pumps.

- Power..... 380V.

- 01 Cofferdam valve, bypass.

Figure I.9: Storm basin.

I.10.3. Rake

- Curved grid

- Number......01.

-Type.........DC 3

- Material.......Galvanized steel.

- Radius...........1,5m.

- Width......1 m.

-Spacing between the bars ....20 mm.

- Automatic cleaning.

- Output speed......2.5tr/mm

Feed........380V.

•Engine

-Type ......DJ 80 NAC.

-Power...0.55KW

-Feed.....380V.

-Efferent limiter with electrical contact cutting off the motor in the event of overload.

-Limit switch to stop the arm in the horizontal position.

Figure I.10: Curved grid.

V Fixed grid

- Space between the bars ......20 mm.

- Width.....1m.

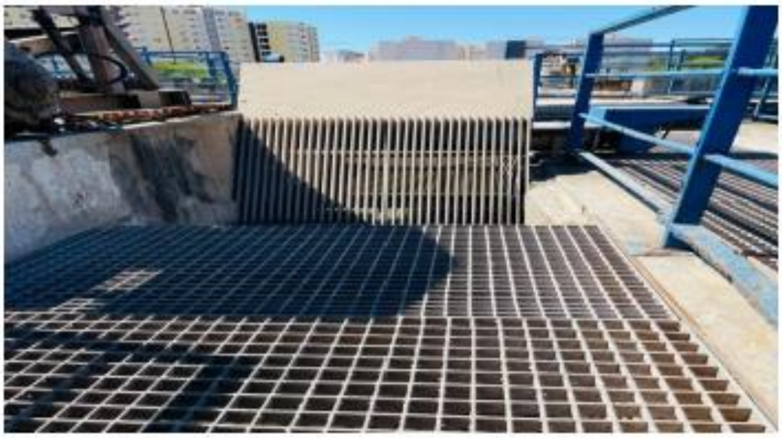


Figure I.11: Fixed grid.

Aim conveyor

-Number.... ... 01.

-Debit....... 0.5 to 1 m³/h.

-Screw length.......Sm.

-Rotation speed.......21 rpm.

•Engine

-Power.........1.5KW.

-Speed..........1,500rpm.

-Power supply.......380V-50HZ.

Figure I.12 : Convoyer.

I.10.4. De-sander, degreaser

✔Aero flotation fine bubbles.

- Number........01.

- Motor..........1.5KW to 15000t/min.

- Absorbed power......5KW.

✔ Ejector aeration unit (Air lift) powered for an Air booster for the extraction of sands

- Number.......01.

- Surface scraper.

- Number.......01.

- Power......0.55KW.

Figure.I.13: Ejector aeration unit (Air lift).

✔ A spiral classifier common to the two (02) works :

- Flow.........30 m^3/h.
- Breaking capacity.......180/350µ.a
- Power installed........0.55KW.
- Screw speed.......11 to 13 rpm.(revolutions per minute

Figure.I.14: Desander- Degrease.

I.10. 5. Repair and By-pass work

✔By-passcofferdam

- Number......02.
- Material...... Aluminium.

Dimensions

- Widths.......1m.
- Height.........0.3m.

Fig.I.15: By-pass coffer dam.

I.10.6. Biological ventilation

✔Aeration basin:

- Number......03.
- Useful volume......3600m³.
- Depth......4 ,5.

Figure.I.16: Aerationtank**.**

-These three aeration basins each composed of: three acti-rotor turbines in carbon steel sheet.

- Number......09.
- Type...RN6518.
- Rotation speed.......57 rpm.
- Absorbed power.....45.3KW.
- Outside Diameter.........2.15m.

Figure.I.17: Acti-rotor turbines.

Reductor group:

- Power. .... 5.5kW.
- Speed .... 1500t / min.
- Class .... E.

I.10.7. Clarifier

- Number........... 03.

-Diameter.............. 24m.

- Cylindrical water height........ 2.6m.

  - Security............. Torque limiter.
  - Power .... 0.25KW.
  - Speed .... 1500t / min.

Figure.I.18: Clarifier

1.10.8. Sludge recirculation and Extraction

> **Recirculation** station:

- Electric submersible pumps:
    - Number........02.
    - Nominal flow......210m³/ hr.
- HMT........2mCE.
    - Power input......5.9KW.
    - Speed........1470rpm.
- Power supply.......380V/50HZ

>Float level switches:

- Number........06
- Brand.......E+M.

Figure.1.19: Recirculation station.

> Extraction station

- Flow......$11m^3/h$.
- HMT.......3m.
- Installed power.....0.9KW.

1.10.9. CANAL OF CONTRIBUTION AND DISINFECTION (chlorination)

> CANAL CONTRICATION

• Scale ......0 to 1200 m^3/ h.

> Chlorination

- Vacuum chlorometry:

• Number ...... 02.

• Chlorine flow meter ... 0 to 20 kg / Cl2 / h.

• Cl2 flow adjustment valve.

• Range deregulation .... 0 to 9.5 kg / h.

• Water pressure Food ... 05 bars.

• Motor water flows... ...15 m^3 / h.

• Disc burst. .20 bars.

• Chlorine leak detector ... ...02.

• Chlorine tank ....08.

• Breathing devices .... 02.

• Gas masks .... 02.

• Cabinet 01

Figure.I.20: Chlorination basin.

Note: Chlorination is no longer done at the WWTP because the injected dose is harmful to the plants; the chlorination basin currently serves as the collection basin.

1.10.10. Thickener

- Number .... 01.

- Diameter ....13m.

With thickening bridge with central drive fitted with a bottom scraping and thickening blades. Made of galvanized steel.

> And a gear motor:

- Speed..1500t / min.

- Power..... 0.37KW.

- Power supply ...... 380V.

> Sludge pump

- Number .... 01.

- Nominal flow .... 2 to 15 m^3 / br.

- Pressure .... 02 bars.

- **Engine**

• Power..... 3 kW.

• Speed........ 1450r / min.

- Power supply ...... 380V.

Figure.I.21: Thickener.

1.10.11. Mechanical dehydration of the sludge:

- Dehydration apparatus:

- Type Super Press........ ST3.
- Dropping band .... 2 m.
- Length.. ....4.49m.
- Height without tones .... 2, 065m.
- Weight. ....04 tonnes.

-With sludge power supply distributor set fitted with an agitator with gear motor :

- Speed .... 21 to 150 rpm.
- Power supply ..... 380V.

Figure.I.22: Dehydrationdevice (super-press).

1.10.12. Polymer preparation station:

- Total volume........ 2000L.
- Number of bins........ 03.
- Transfer .... by baffle.

-With a laying dispenser (laying polymer) and metering pump.

- Flow........ 200 to 1000L / h.
- Motor:

• Speed. ....1450r / min.

Figure.I.23: Polymer preparation station.

CHAPTER II

TreatementOf Wastewater At The WWTP Level

II.1. Operation of the WWTP

The BOUMERDES WWTP receives two flows of raw wastewater: a flow pumped from eight lifting stations, in particular the one located at the stadium in the town of Boumerdes (SR3), and the second flow by gravity from Tidjelabine.

The target objective according to the operating manual required at the station exit is as follows:

Parameters	Norms /Standards
T°C	30 °C
Ph	6,5-8 ,5
COD	30 mg/l
DBO_5	90mg/l
MES	30mg/l
NTK	40mg/l
Phosphorus	20mg/l
Nitrate	40mg/l

Table II.2 : Discharge standards.

II.2. The principle of wastewater treatment

At the Boumerdes WWTP, treatment is based on biological purification by activated sludge at low load by prolonged aeration.

The purification of this water is carried out in two ways:

Wastewater treatment sector :

> The pre-treatment

- Screening.
- Desanding-Degreasing.

> Biological treatment

> Settling-Clarification.

Sludge treatment sector

> Thickening.

> Mechanical dehydration.

II.3. The arrival of wastewater at the WWTP:

II.3.1. Lifting station:

The transport of wastewater in the collectors is generally done by gravity, under the effect of their weight, but also by pumping lower than pollution control facilities. This water lifting operation is carried out usingpumps.

II.3.2. Supply channel

The two inlets by gravity and by pumping are met in the WWTP lifting station and routed to the pre-treatment by a supply channel.

This lifting station allows:

- The downstream pre-treatment feed.
- The total bypass of the installations by operating a control cofferdam at the general entrance to the station.

II.3.3. Storm basin

An overflow feeds the storm basin with any flow greater than or accepted by the installation, following the number of aeration basins in service, two submersible electric pumps are used to lift this water towards the pre-treatment.

II.4.The various stages of wastewater treatment

II.4.1.Pre-treatment

The pre-treatment was developed to eliminate large particles carried by the water in order to protect the station structures from clogging and sludge deposits. Pre-treatment includes:

- **Finescreening:** The purpose of screening is to eliminate fine waste. The retained materials are then evacuated by conveyor to all the storage devices. It should however be noted that a pre-screening upstream is carried out at the level of the lifting stations using a coarse screen.

• **Desanding-Degreasing :** This operation has the role of extracting the floating body less dense than water to avoid any risk of clogging by flotation effect. The oils are recovered from the surface using a manual or mechanical scraper. It is an operation intended to reduce fats and oils by simple physical sedimentation at the surface.

The aim of desanding-degreasing is to:

- Eliminate by settling most of the sand from dimensions greater than (150-200 mm).

Eliminate a large part of floating matter (grease, oils).

The retention of sandy particles contained in urban waste water is essential, because it allows:

- Overloads in subsequent processing steps.
- The accumulation of sand in later stages of processing.
- The abrasion of mechanical gear.
- Quantity of trapped sand (15-40mg/l).
- Degreasing (or de-oiling) consists of recovering, using a scraper, the grease that is found on the surface of the wastewater, naturally or by flotation (injection of fine air bubbles).

The elimination of fat allows

- To improve the visual quality of the surface of subsequent works.
- Limit the amount of float and grease likely to stick, clump together and float in the works located downstream, which can cause fermentation problems.

Amount of fat trapped: 5-15(mg/l).

II.4.2. Secondary treatment (biological)

Secondary treatments include all biological purification processes. These biological processes involve the presence of microorganisms which degrade the dissolved organic pollution contained in the wastewater. For this, microorganisms need oxygen. And the latter is provided artificially by an aeration system.

-II.4.3. Decantation - Clarification

Waters, outingwaters ventilation works are directed to **threeclarifiers** to separate the mud and water part by classic decantation. The decanted sludge at the bottom of each structure is directed using a scraper to a central collection well. The whole is taken up by a piping transporting them to the recirculation tarpaulin adjoining the ventilation tanks. Part of the sludge is collected at the air head under the name of mixed liquor and part is extracted to be sent to the thickener. The decanted waters are collected by over verse in a peripheral channel to be directed to disinfection.

II.4.4. Chlorination basin

The clarified water is directed to a contact cover sized for 20 minutes of retention time at full flow, **i.e.** a volume of 385 m³. The first part of the structure serves as a counting and disinfection channel for servoing the injection of chlorine (something that is no longer done today, since chlorine is considered to be a toxic element for fauna and flora).

II.5. Treatment and elimination of sludge

Sewage sludge is the main waste produced by a treatment plant from liquid effluents. These residual sediments consist mainly of dead bacteria and mineralized organic matter. An average installation produces approximately 30 g of dry matter per day per capital. They are characterized by their dry matter rate and their organic matter rate. These two parameters depend on the mode of treatment of the effluents. The treatment process applied to theBoumerdes station is the free culture biological treatment (the activated sludge).

II.6. Destination of sludge and its treatment

After the sludge settles in the clarifier, it will be divided into two parts. A part will be reinjected into the biological basin, we are talking here about recirculation. The other part, will undergo two stages of treatment: static thickening and mechanical dewatering.

II.6.1. Sludge thickening

It is the separation of the solid (thick mud) and the liquid (overflow water) by decantation, the mud passes through a thickener (which has the role of a decanter), and then it is pushed back thanks to a pump towards dehydration.

II.6.2. Mechanical dehydration

The thickened sludge is first flocculated by adding a polymer to improve the filterability of the sludge, then the sludge goes through a pressing belt (super-press), where it undergoes dewatering. Finally, what is called dehydrated sludge is obtained, the latter being destined for the Technical Landfill Center (CET).

- **Super Press**

The sludge is introduced with a polyelectrolyte into a flocculator equipped with a vertical stirrer with adjustable speed and pours onto the first fabric in a dewatering zone.

After draining, the sludge is taken between the two cloths and subjected to progressive compression in a wedge-shaped inlet followed by rolling on a large diameter perforated drum until tightness due to the tensioning of the cloths. .

The two webs then pass over a series of small diameter idler rollers which increase the squeeze pressure at the same time as a shearing effect breaks up the sludge structure, opens cake squeeze channels and improves final dewatering.

II.7. Preparation of the polymer

The automatic station for the preparation and dosing of liquid polymer from powdered polymer and drinking water. The concentration should not exceed 4 to 5g/l after adjustments of the poly electrolyte screw and potable water. We will retain after 60 minutes of maturation.

II.8. Re-use of treated water from the WWTP

Physico-chemical analyzes were carried out on the treated water at the Boumerdes WWTP laboratory. In order to check whether the quality of the purified water complies with the Algerian standard (2012 inter-ministerial decree on purified wastewater used for irrigation purposes).

The results of the physico-chemical analyzes are shown in the tablebelow :

- Algerian standards for the use of purified water in irrigation.

Parameters	AveragesObtained	Standards
COD	28.19	90
DBO_5	6.69	30
MES	11.5	30
PH	7.27	6.5-8.5
NO_3	7.99	30

Conductivity	995.75	3000

Table II.3: Settings Averages obtained.

- Salinity is an essential parameter for judging the quality of water.
- Analyzes of heavy metals from purified wastewater (the results of analyzes show the existence of some heavy metals in purified water at low concentrations (traces). In relation to the interministerial decree 2012 of the purified water used for irrigation purposes.

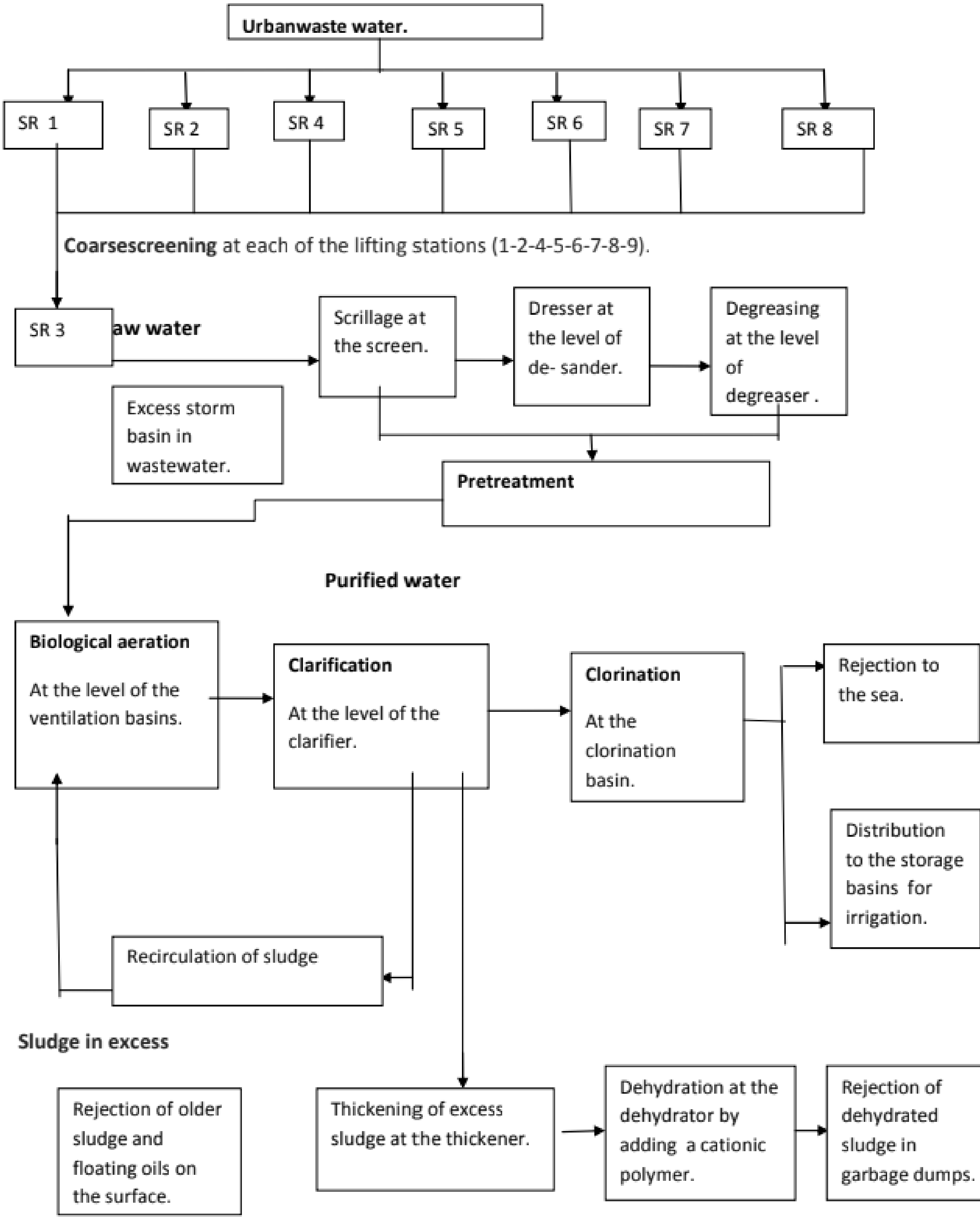
- Bacteriological analyzes of treated water

The results of analyzes show the absence of helminth eggs and as the re-use of purified wastewater depends on the three essential parameters, namely the presence of traces of heavy metals, the physico-chemical and bacteriological parameters. Done according to the results of analyzes obtained we note that this water is conforming to the Standard (Interministerial decree 2012 for agricultural irrigation purposes). And another part goes in the sea.

Year 2017	**Total**
Volume of treated wastewater from WWTP	7 555 696 m^3
Volume of refined wastewater re-used	476 492 m^3
Percentage of re-use	6,306 %
Volume of refined wastewater re-used in irrigation	475 480 m^3
Percentage of re-used in irrigation	6,293 %
Volume of purified wastewater re-used in watering	1011,80 m^3
Percentage of re-use in watering	0,0113 %

Table II.4: Re-use of the purified wastewater from the BOUMERDES WWTP.

-Diagram of the different stages of wastewater treatment in the STEP :



CHAPTER III

Laboratory Physico-Chemical Analysis

III.1. Sample collection

- Water sampling is carried out at two well-defined points:

●At the raw water inlets at the supply channel.

●At the entrance of the purified water to the chlorination basin.

- The sample is taken every hour, a constant volume is sampled for a period of 09 hours, to form an average water sample raw and purified water.

- For sampling, bottles or flasks (polyethylene) are needed and collection cups.

-Rinse the bottles twice with the water to be analyzed then fill to the top.

-Fill the vials ensuring a flow of water to properly quantify the pollution load.

-The cap is placed in such a way that there are no air bubbles and that it is not ejected during transport.

-Record basic data such as: name, date, place, and time.

-Samples are transported in an icebox.

-The conservation of the samples will be refrigerated; the temperature of the enclosure will be between 2 to 5°C.

Bring the sample back to the laboratory as soon as possible.

III.2. Wastewater analysis

- Physical water analysis (pH, Temperature and conductivity) are carried out 05 times per week.

- The chemical analysis of the waters (COD, BOD_5, SS) are carried out 02 times per week, (P-PO_4^{-3}, N-NO^-_3, N-NO^-_2 and N-NH^-_4.) are carried out 02 times per month.

Equipment and method of analysis

III.2.1. Physical analysis

III.2.1.1. The pH and T°C

Temperature

It is essential to know the temperature of the water. Indeed, it plays a very important role in the solubility of salts and especially gases, the measurement of temperature is very useful for limnological studies and the calculation of ion exchanges. It also acts as a physiological factor acting on the growth metabolism of micro-organisms living in water.

The determination of pH

It is a measure of the concentration of H^+ ions present in the water, it indicates whether the water has an acidic or alkaline tendency, its measurement must take place as frequently as possible because it influences the physico-chemical properties of water (acidity, alkalinity); The effectiveness of certain treatment procedures (coagulation, flocculation) biological processes (some of which require very narrow limits of pH).

Purpose of the analysis

Determine the acidity, neutrality, basicity of water.

Materials used

pH meter.

Beaker.

Procedure

-The electrode is immersed in the solution to be analyzed.

-The pH meter is commissioned according to the manufacturer's procedure.

We read the pH and the temperature.

-The Electrode is rinsed well after each use and the electrode is always kept in demineralized water.

III.2.1.2 Conductivity

Conductivity is the property that water possesses of favoring the passage of a Electric power.

It provides a precise indication of the content of dissolved salts (salinity some water). Conductivity is expressed in micro-siemens per centimeter and is the inverse of

resistivity. The measurement of the conductivity makes it possible to evaluate the global mineralization of the water.

Purpose of analysis

The measurement of conductivity makes it possible to assess the quantity of salts

Materials used

-Conductivity meter.

-Distilled water.

-Beaker.

Procedure

-Turning on the device.

-Fill a beaker with the water to be analyzed.

-Rinse the measuring cell with distilled water.

-Immerse the conductivity meter electrode in the sample.

-Put the device into operation.

-Note the results and the results are given directly in µS/cm.

III.2.2. Chemical analysis

III.2.2.1 Chemical oxygen demand (COD): The Chemical Oxygen Demand (COD) is the amount of oxygen needed to oxidize organic matter (biodegradable or not) in water using an oxidant, potassium dichromate. This parameter provides a more or less representation completeness of the oxidizable materials present in the sample. It is expressed in mgO2/l. Generally the COD is 1.5 to 2 times the BOD for urban waters and 1 to 10 for all industrial waste products.

Purpose of analysis

The measurement of the COD of the raw water and the purified water informs us of the proper functioning of the biological basins and allowing us to estimate the biological demand of oxygen.

Materials used

Spectrophotometer.
2ml volumetric pipette.
Thermo reactor 148°C.
Stopwatch.
COD kit 21258 - 51.

Procedure

-Homogenizes 1001m lof sample for 30 seconds (for samples containing large amounts of solid matter 2min).

-Activate the thermo reactor at 148°C.

-Remove the caps from both reagent tubes (blank, sample).

-Hold the tubes positioned at 45° and pipette 2ml of distilled water (blank) and 2ml of sample.

-Seal the tubes tightly.

-Mix the contents of the tubes by holding them by caps (reaction exothermic).

-Heat the tubes for 2 hours at 148°Cin the thermo reactor preheated.

-Allow the tubes to cool for 20 min.

-Remove the tubes from the thermo reactor; shake the still hot tubes then place in a rack to cool to room temperature.

-Introduce the blank into the spectrophotometer then the sample to make the analyse.

III.2.1.2. The Biological demand of oxygen (BOD)

It is the quantity of oxygen consumed at 20°C and in the dark for a time given to ensure biological oxidation of organic matter, biodegradable substances present in the water. BOD5 is conventionally used, i.e. The amount of oxygen consumed after 5 days of incubation. BOD is normally only representative of biogradable organic carbon pollution.

Purpose of analyzes

Determine the biological oxidation of the raw water allowing us to estimate the sludge production in the aeration basin and the quality of the treated water.

Materials used

Incubator at a temperature of 20°C.

One magnetic stirrer per bottle.

Bottle.

Oxitopes.

2 to 3 tablets of KOH or NaOH.

Procedure

The COD is determined to know the volumes to be analyzed for the BOD5.

BOD_5, estimates = COD(X). 80%.

Compare the value in the table to select the appropriate volume of the water to be analyzed and the corresponding factor **x** is noted.

Volume in ml	**Concentrations mg/l**	**Factor**
432	0 – 40	1
365	0 – 80	25
250	0 – 200	10
164	0 – 400	50
97	0 – 800	100
43.5	0 – 2000	100
22.7	0 – 4000	100

Table III.5: Estimated table of sample BOD volume to be analyzed.

-The bottle and the magnetic bar are rinsed with the solution to be analyzed.

-This volume is introduced into the bottle.

-Close with the cup and introduce two KOH pellets inside.

-The bottle is hermetically closed with the oxitop.

-At the same time, both buttons (M and S) of the oxitop are pressed until appearance of the two zeros.

-The bottle is introduced into a BODs incubator at 20°C.

-The results are checked daily for a period of 5 days by pressing on the set button the final value will be obtained in the same day by the factor x to get the final BOD_5 value.

BOD_5 = reader after 5 days x factor.

III.2.1.3 Suspended Solids

They represent the fraction constituted by all the original particles mineral (sand, silt, clay, etc.) or organic (products of the decomposition of vegetable or animal matter, humic acids, etc.). To these compounds are added, the micro-organisms such as bacteria, plankton, algae and viruses. These substances are responsible, in particular for the turbidity and color of the water.

Purpose of analysis

Determine the suspended matter content in raw or treated water.

Materials used

For the dry residue

The oven at 105°C.

Desiccator.

Precision scale 1/10 in g.

Dig.

Clamp.

For vacuum filtration:

The oven at 105°C.

Quick filter consists of a funnel.

One liter flask.

Precision scale 1/10 in g.

100ml test tube.

70mm diameter filter paper.

Caps.

Clamp.

Procedure

For the dry residue

-Put the cups in the oven at 150°C for drying, take the cups out and put directly into the "10min" desiccator to absorb moisture, after 10min the empty reuses are weighed and noted on the hollow Po and P1.

-Repeat the same method until constant mass.

-Towards 105°C ml of used water in the cruses, using tongs puts the capsules in the oven at 105°C until constant mass.

-After drying in put directly in the desiccator, then weighed the hollow ones and notenthe weight after drying.

The SS is calculated by the following equation:

$$\mathbf{SS} = \frac{P_1 - P_0}{V} \mathbf{\times 1000}$$

For vacuum filtration

-We put an empty filter paper in a capsule in the oven at 105°C, and take out the capsule containing the oven filter and put some in a desiccator.

-Check If the balance ball is in the middle.

-We weigh the capsule containing the filter and note Pv "g"

-Place the empty filter paper in the funnel of the vacuum filter.

-A volume V of the sample to be analyzed is passed through this filter; V100ml for water, and 20ml for sludge.

-The filter is placed in its capsule using pliers.

-The capsule is placed in an oven at 105° C. for 2 hours.

--The capsule is removed from the oven and placed in a desiccator.

-The Ps "g" capsule is weighed.

SS is calculated by the following equation

$$SS= \frac{Ps - Pv}{V} \times 1000$$

Note: This method of analysis is not used at the Boumerdes WWTP laboratory.

III.2.1.4:Total KJELDAHL Nitrogen (TKN)

Purpose analysis

Determine the sum of organic and ammoniacal nitrogen.

Materials used

Spectrophotometer.

TKN 1.14763 measuring kit.

Pipette 01ml.

Pipette 10ml.

Special test tube with screw cap.

tube rack.

Procedure

-Put 01 ml of water for analysis in a dry tube.

-Add 09 ml of distilled or demineralized water.

-Add one scoop of N-1K blue cap reagent.

-Add 06 drops of N-2K reagent, stopper the tube and shake vigorously.

-Heat the tube for 1 hour at 120°C

-Cool the digested sample.

-Take 01 ml of this solution and introduce it into the measuring cell without shaking.

-Add 01 ml of N-3K reagent.

-Cap the tube tightly and shake.

-Be careful the tube becomes hot and always grab the tube by the cap.

-Leave the tube to stand for 10 minutes.

-Read the concentration using a spectrophotometer .

-Repeat the read operation several times.

Note: The analysis TKN is done at the central laboratory at BARAKI/ALGER.

III.2.1.5 -Nitrite "N-NO_2"

Purpose of analysis

Determination of the value of nitrites (N-NO_2) in raw and purified water.

Materials used

Spectrophotometer.

2 tanks of 10ml.

1 test tube.

Pear.

10ml dropper.

Procedure

-Select the saved analysis program.

-Pipette 10ml of the sample into a test tube.

-Transfer the contents of one NitriVer 3 reagent pouch into a test tube.

-Close the tube with the rubber stopper.

-Shake the test tube vigorously until the nitrite dissolves.

-Pour the contents of the test tube into the 10ml tank.

-Tap the timer icon.

-Press OK, a 20 minute reaction period will begin.

-Fill another 10ml square cuvette with the sample (blank).

-Wipe the outside of the blank and introduce it into the tank compartment and directing the fill stroke to the right.

-Select on the screen 0 mg/l NO^-_2-N.

-Wipe the outside of the cuvette containing the sample and introduce it into the tank compartment direct the fill line to the right.

Results are shown on the display in mg/NO_2-N.

III.2.1.6 Nitrate (N-NO_3^-)

Purpose of analysis

This analysis informs us about the oxygenation of the basins.

Materials used

Spectrophotometer.

2 tanks of 10ml.

Pear.

10ml dropper.

1 test tube.

Procedure

- Select the saved analysis program.
- Press START.
- Pipette 10ml of the sample into a test tube.
- Transfer the contents of one Nitra **Ver5** Nitrate Reagent pouch to the test tube.
- Close the tube with the rubber stopper.
- Press the timer icon.
- Press OK, a 1 minute reaction period will begin.
- Shake the tube vigorously until the timer sounds.

-Pour the contents of the test tube into the 10ml tank.

- Press the timer icon again.

-Press OK, a 5-minute reaction period will begin and an amber coloration will appear in the presence of nitrate.

-Fill another 10 ml square tank with the sample (white).

-Wipe the outside of the white and insert it into the tank compartment directing the filling line towards the right.

- Select on the screen: **zeroindicationonthescreen(0.0mg/lNO_3^--N).**

-Within the minute of the timer, wipe the outside of the tank containing the sample and insert it into the tank compartment, direct the filling line to the right.

-Select on the screen (measure). The results are indicated in **mg/lNO_3^--N**.

III.2.1.7 ORTHOPHOSPHATE (P-PO_4^{-3})

Purpose of analysis

Determination of the phosphate content of raw and refined waters.

Materials used

Spectrophotometer.
2 tanks of 10 ml.
1 beaker.
A pipette of 5ml and 20ml.
Pear.
Magnetic agitator.

Procedure

-Wearing of blouses and gloves, glasses/googgles and a mask are compulsory /mandatory before each manipulation.
-Pipette 5ml of the sample in a beaker, complete with 20ml of distilled water.
-Transfer the contents of a reagent pouch for phosphate ver3 into the beaker.
- Homogenize the contents of beaker for 30 seconds with a magnetic agitator.
-Press the recorded program.
- Select the 490p React analysis program. Pv.
- Press Start.
- Fill the tank up to the 10 ml line with the contents of the beaker.
- Press the icon representing the timer.
- Press OK.
-A reaction period of 2 minutes will begin and a blue coloration will appear in the presence of phosphorus.
- Fill another tank up to a 10ml line with the sample (blank).

-Wipe the outside of the white and introduce it to a tank compartment by directing the filling line to the right.

-Selects on the screen: Zero indication on the screen: 0.0mg /l.

Within a minute of slowing the timer.

-Wipe the outside of the sample container and insert it into thecell compartment with the fill line pointing to the right.

-SelectontheMEASUREscreen, theresultsareindicated **in mg/l P-PO_4^{-3}.**

III.2.1.8 Ammoniacal nitrogen (N-NH_4^+)

Purpose of analysis

Determination of ammoniacal nitrogen (NH_4^+) in raw and purified water.

Materials used

Spectrophotometer.

02 tanks of 10 ml.

Graduated cylinder.

Volumetric flask.

Procedure

-Wearing blouses, gloves, glasses and a mask are mandatory before each manipulation.

-Touch recorded programs.

- Select the 385N ammonia salic analysis program.

- Press START.

-Preparation of the sample fill a square cuvette up to the 10ml line with the sample.

- Preparation of the white fill another square tank up to the line of distilled water.

-Transfer the contents of a reagent pouch to the ammonia "salicylate" in each tank.

-Butcher and shake until the powder reagent is dissolved.

- Press the icon representing the timer, press OK, a 3-minute reaction period will begin.

- When the timer slows down transfer the contents of a reagent pouch to the ammonia "cyanurât" in each tank.

-Butcher and shake until the reagent powder is dissolved.

-Press the icon representing the timer, press OK, a 15-minute reaction period will begin. A green coloration will appear in the **presence** of ammoniacal nitrogen.

-When the timer sounds, wipe the outside of the white and insert it into the tank compartment by directing the filling line to the right.

-Selects on the screen: zero.

-Indication on screen: 0.00mg /l N-NH_4^+.

-Wipe the outside of the tank Contacts the sample prepares and insert it into the tank compartment by directing the filling line to the right.

-Selects on the screen: Measure.

The results are indicated in mg /l N-NH_4^+.

Note : Chemical analysis of nitrogen and phosphorus forms are done at the central laboratory (BARAKI/ALGER) because of lack of stock(chemical products).

III.3. Sludge analysis

III.3.1 Collection of samples

III.3.1.1- Activated sludge

The activated sludge sample must be representative of the biomass developed in the aeration tank. Sampling takes place at a defined point, during significant mixing of the system.

For this the ventilation must be in operation for 10 to 15 minutes.

III.3.1.2 -Recycled sludge

Sampling of the recirculated sludge must be carried out at the exit of the corridor where the recirculated sludge flows at the level of the aeration basin.

III.3.1.3 -Thickened sludge

The thickened sludge is sampled at the level of the thickener (we start the valve for a few seconds, then we take our sample).

III.3.1.4 : Dehydrated sludge

The dewatered sludge is sampled at the band filter, taking an average sample.

III.3.2.The physical analysis carried out on the sludge from the basins (activated sludge and recycled sludge)

Settling analyzes are carried out 5 times per week.

SS analyzes and SI calculation are carried out twice a week.

III.3.2.1 Decanting after 30 minutes

Purpose of analysis

Measures the ability of sludge to settle.

Evaluate the concentration of the mud(sludge)¥ (activated and recirculated).

Facilitate the diagnosis of the main origins of treatment dysfunction.

Materials used

The test tubes.

Timer.

Procedure

- A sample of homogeneous sludge is taken is representative.
- The specimens are placed on the stable bench.
- They are filled with 1 liter of activated sludge and well-recirculated sludge mixed.
- We set the timer to 30 minutes.

-After 30 minutes, the sludge blanket level (sludge-water interface) is noted in each specimen. -This value must be between 100 and 400 ml for activated sludge .

Otherwise:

- The test tubes are emptied and rinsed.

-One introduces 500 ml of purified water corresponds to a dilution ½ and one follows the preceding procedure must be redone.

- It is diluted several times until the desired value is obtained.

-Suspended matter

Purpose of analysis

Determine biomass load.

Materials used

Test tube of 100ml.

10ml dropper.

Distilled water.

Spectrophotometer and accessory (02 tanks of 10 ml).

Procedure

-Dilution of each sludge sample (10 ml of sample in 100 ml of purified water).

- Fill the 01 tanks with belon (distilled water) up to the line.
- Take 10 ml of each of the samples using the pipette and introduce it into the 02 tanks of the spectrophotometer.

III.3.2.2 The sludge index

Purpose of analysis:

Appreciate the ability of the sludge to settling.

Definition

The sludge index represents the volume occupied by one gram of sludge after 30 minutes of static settling in transparent graduated 1-litre test tubes. It is defined by the following formula:

With .

$$\mathbf{SI\ (ml/g)} = \frac{\mathbf{VB30}}{\mathbf{TSS}}$$

VB30: volume of settled sludge for 30 minutes (ml/l).

SS: concentration of suspended matter in the settled sludge in the specimen in (g/l).

The sludge index is valid when the decanted volume is between 100 and 400 ml otherwise a dilution is necessary in this case, the calculation of the sludge index and the following:

Results interpretation

SI<100 Corresponds to sludge which sediments easily.
100<SI<200 Difficult settling (a few filaments).
SI>200 Decantation mallows (mud rich in filaments).
The SIstandard is 100-150ml/g.

III.3.3.Physical analyzes carried out on thickened sludge and dehydrated sludge:

Analyzes are performed daily.

III.3.3.1 Dryness (MS)

Purpose of analysis

Determine the dry matter content of dewatered sludge and thickened sludgethis factor informs us about the smooth running of the treatment

Materials used

Oven at 105°C.
Ceramic crucibles.
Crucible tongs.
Precision scale 1/10(g).
Desiccator.

Procedure

- The empty crucible is weighed and Pv is noted in (g).
- A quantity of thickened and dehydrated sludge is introduced into the crucibles.
- The crucibles filled with mud are weighed and Pr is noted in (g).
- The crucibles are placed in an oven at 105°C to dry for 24 hours.

-The crucibles are taken out of the oven and placed in a desiccator.

- Finally, the crucibles are weighed and the dry weights are noted (Ps in g).
- And we calculate the MS by the following equation:

$$\text{MS (\%)} = \frac{\text{PS-PV}}{\text{PR-PV}} \times 100$$

III.3.2 Suspended volatile matter (SVM)

Purpose of analysis

Determining the volatile matter content of thickened sludge and dewatered sludge this factor provides information on the stability of the sludge.

Materials used

Muffle furnace 550°C.

Ceramic crucible.

Crucible tongs.

Precision scale 1/10(g).

Desiccator.

Procedure

-The crucibles dried at 105° C are weighed and the dry weights (Ps in g) are recorded.

- The crucibles are introduced into a mold furnace at 550° C. for 2 hours.

-The crucibles are taken out using tongs.

- The crucibles are introduced into a desiccator.
- Weigh the crucibles and note the calcined weight (Pc in g).
- And we calculate the MVS by the following equation:

$$\text{MVS (\%)} = \frac{\text{PS-PC}}{\text{PS-PV}} \times 100$$

III.3.4. Microscopic observation of activated sludge

Microscopic analyzes are carried out twice a week.

Purpose of analysis

Determine the different components of activated sludge (characterization ofbacterial flocs).

Materials used

Optical microscope.

Blades.

Slats.

Syringe.

Procedure

- The color of the activated sludge sample is noted.

-A drop of mud is introduced on a slide using a syringe and then a cover slip is carefully placed
on this droplet.

- A microscopic observation is carried out at magnification (X10 and X40).

- The name of the bacteria found is noted based on the biological book of bacteria.

Definition of the norm

Rule, principle, criterion to which all judgment refers: Be based on the accepted standard in a company

- Discharge standards:

The standards for discharges into the natural environment are set by executive decree:"Executive decree n°06-141 of 20 Rabie El Aouel 1427 corresponding to April 19, 2006 defining the values discharge limits for 'industrial liquid effluents', the following values can be cited.

N°	Parameters	Units	Limit Values
01	Temperature	C°	30
02	pH	/	6,5 – 8,5
03	SS	mg/l	35

04	BOD5	mg O2/l	35
05	COD	mg O2/l	120
06	Kjeldahl Nitrogen	mg/l	30
07	Total Phosphorous	mg/l	10
08	Aluminium	mg/l	3
09	Cyanide	mg/l	0,1
10	Fluorine	mg/l	15
11	Cadmium	mg/l	0,2
12	Mercury	mg/l	0,01

Table III.6 Operation of an activated sludge WWTP

We can also cite:

Executive Decree No. 09-209 of JoumadaEthania 17, 1430 corresponding to June 11, 2009 laying down the terms and conditions for wastewater, other public sanitation or the granting of the authorization of dumping that domestic in a network in a purification station.

Executive Decree No. 10-23 of January 12, 2010 setting the technical characteristics of wastewater treatment systems.

The concept of biodegradability

– Definition of Biodegradation

Biodegradation is the decomposition of organic materials by microorganisms such as bacteria, fungi or agues .

To talk about biodegradability, the following two conditions must be verified.

The biodegradability coefficient (K);

> Nutritional balance (C/N/P).

- **The biodegradability coefficient (K)**

This coefficient tells us about the biodegradability of organic matter. 'is a parameter revealing the presence of industrial pollution on the one hand and the mode treatment on the other hand [31. This coefficient (K) is given by the following relation.

K = COD/BOD5

In general if:

K ≤ 1,5: All organic matter is biodegradable.

1.5< K≤2.5: Biological purification takes place.

2.5 < K≤3: Biological treatment combined with physico-chemical treatment.

K> 3: A physico-chemical treatment should be considered.

CHAPTER IV

Results and Discussion

For an optimized control of the purification process, several parameters must be analyzed, calculated, determined, interpreted and checked regularly each according to a reference.

	Parameters	**Reference of comparison and control**
Raw water	**T° ,conductivity, turbidity, pH, BOD_5, COD, SS, N , P.**	**Data design/nominal values**
Purified water		**Discharge standard or purification objectives**
Purification process	**SM, SVM, V30, O_2, Redox**	**Operating Instructions**

Table IV.7: The analyzed parameters.

Note: it was deemed sufficient to take a single measurement of each of the physico-chemical analysis parameters seen; that we had a stability of the measurements during the 4 months of study.

The results show that the water sampled:

- At the entrance is gray in color with a strong odor, which highlights a significant pollutant load.
- At the outlet it is transparent and free of any odor, which demonstrates the elimination of pollutants.

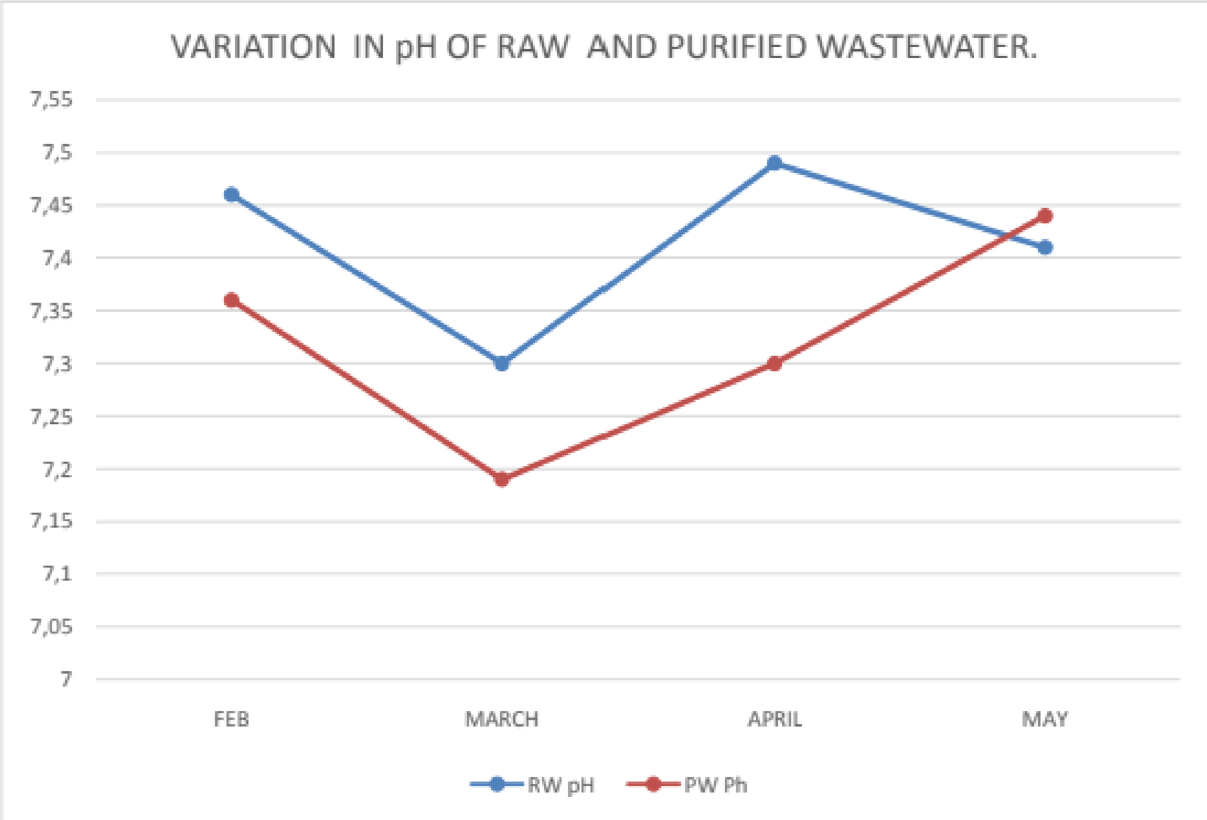


Figure 1

IV.1 Hydrogen potential (pH)

The pH of the water, taken at the outlet of the station, complies with the limit values (6.5-8.5) according to the standard for discharge and irrigation, given the graph above, the pH of the water of the Boumerdes WWTP comply with discharge standards.

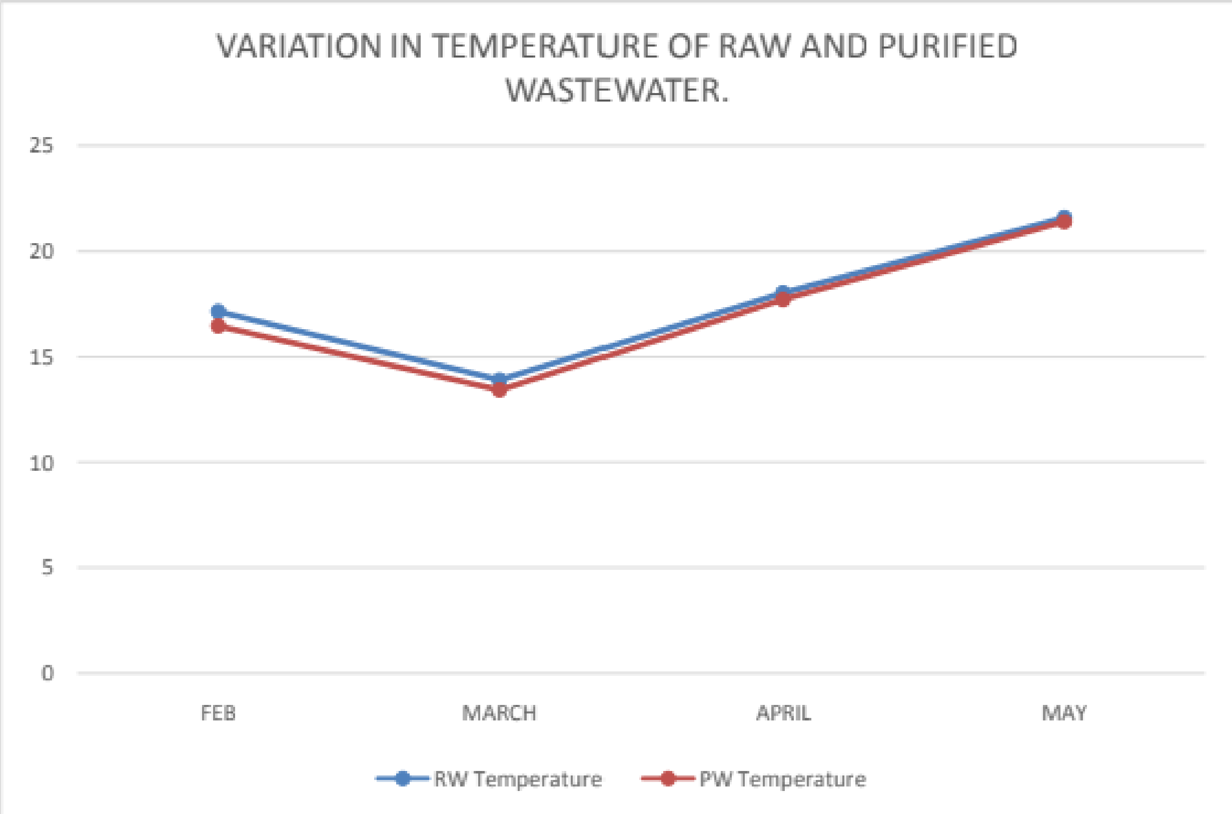


Figure 2

IV.2 Temperature

The superimposition of the temperature curves, measured at each treatment point, reflects its great stability during the hours of purification, which ensures the proper functioning of the biological treatment.

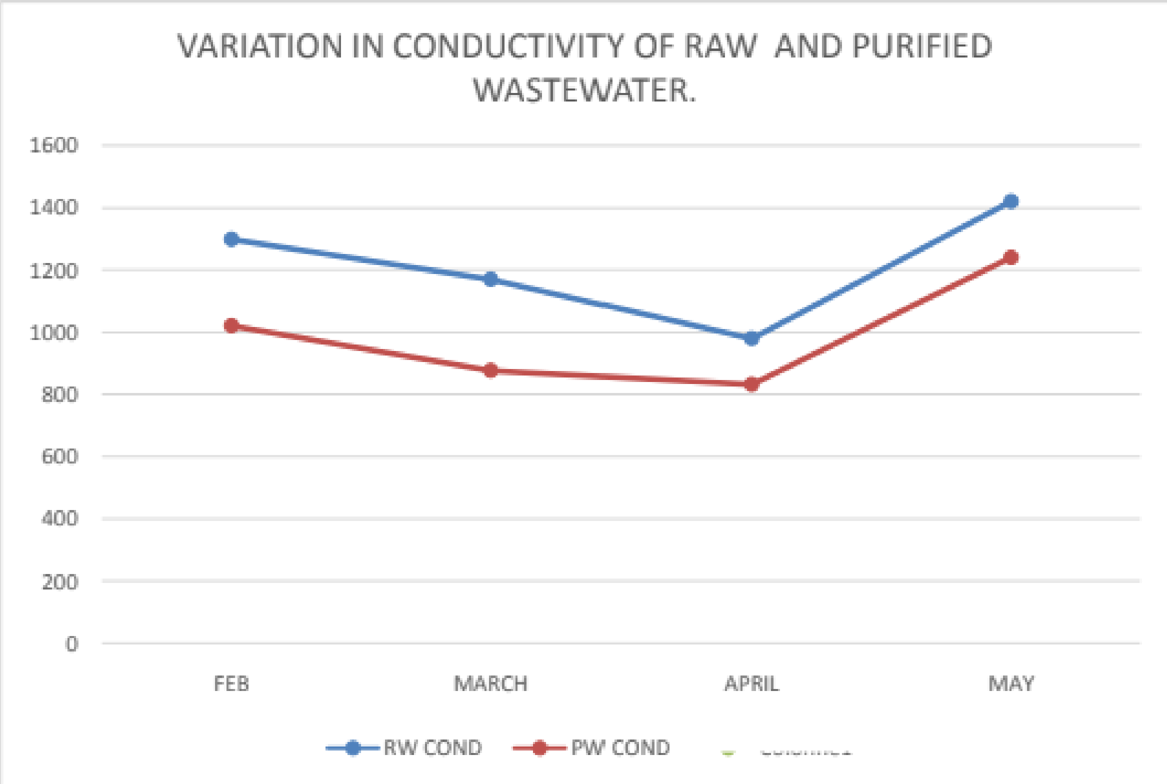


Figure 3

IV.3 Conductivity

The curves demonstrate a reliable variation in conductivity between the raw water and the purified water (the two curves are proportional) which confirms the reliable impact of biological treatment on this parameter.

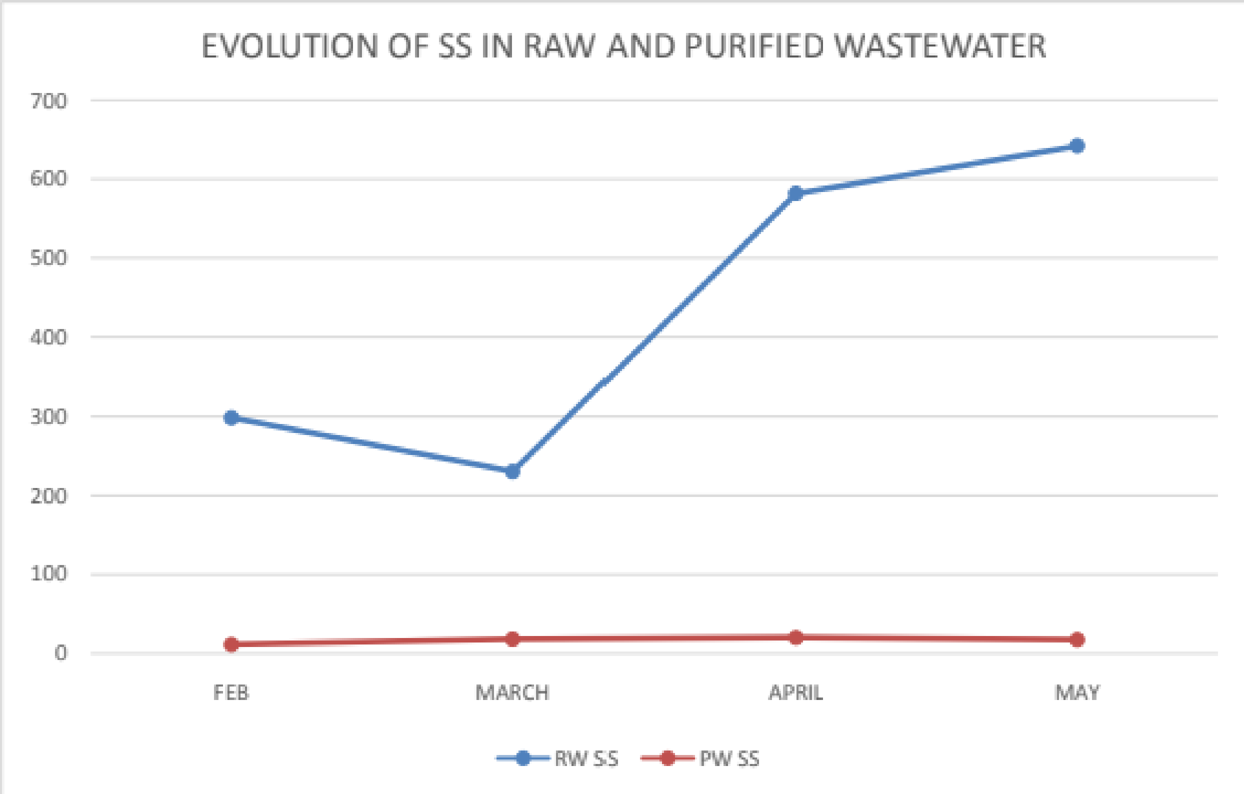


Figure 4

IV.4 Suspended matter (SM)

The measurement of the outfits in SS, allowed us to note that:

- In the treated water, the suspended solids comply with the discharge limit of the WWTP and that of irrigation (30mg/l)

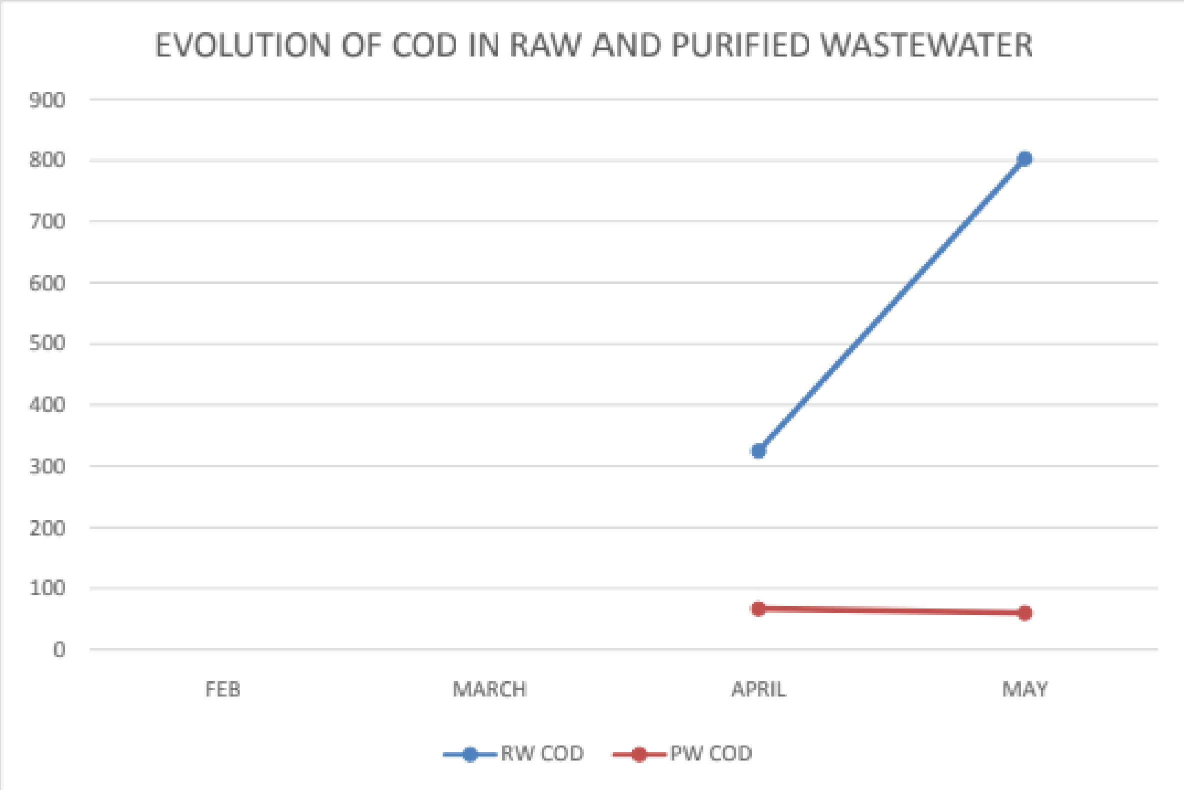


Figure 5

IV.5 Chemical oxygen demand

The quantity of oxidizable chemical matter has decreased at the outlet of the station to concentrations in accordance with the limit values indicated in the exploitation notice EN./BOUMERDES WWTP.

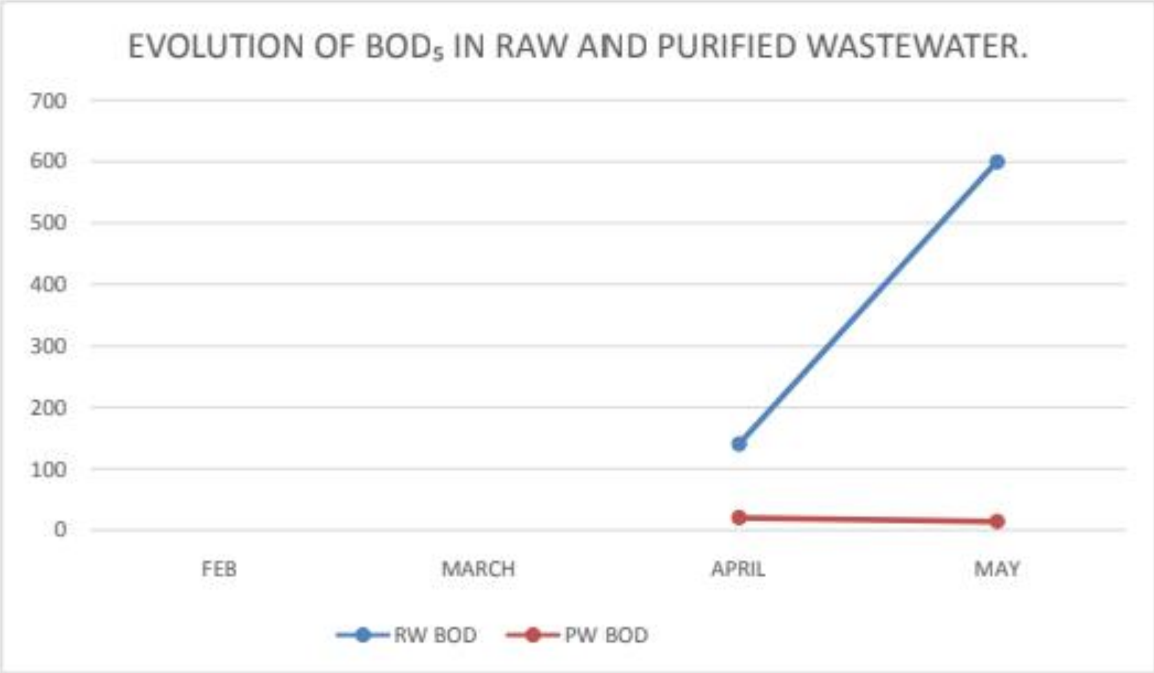


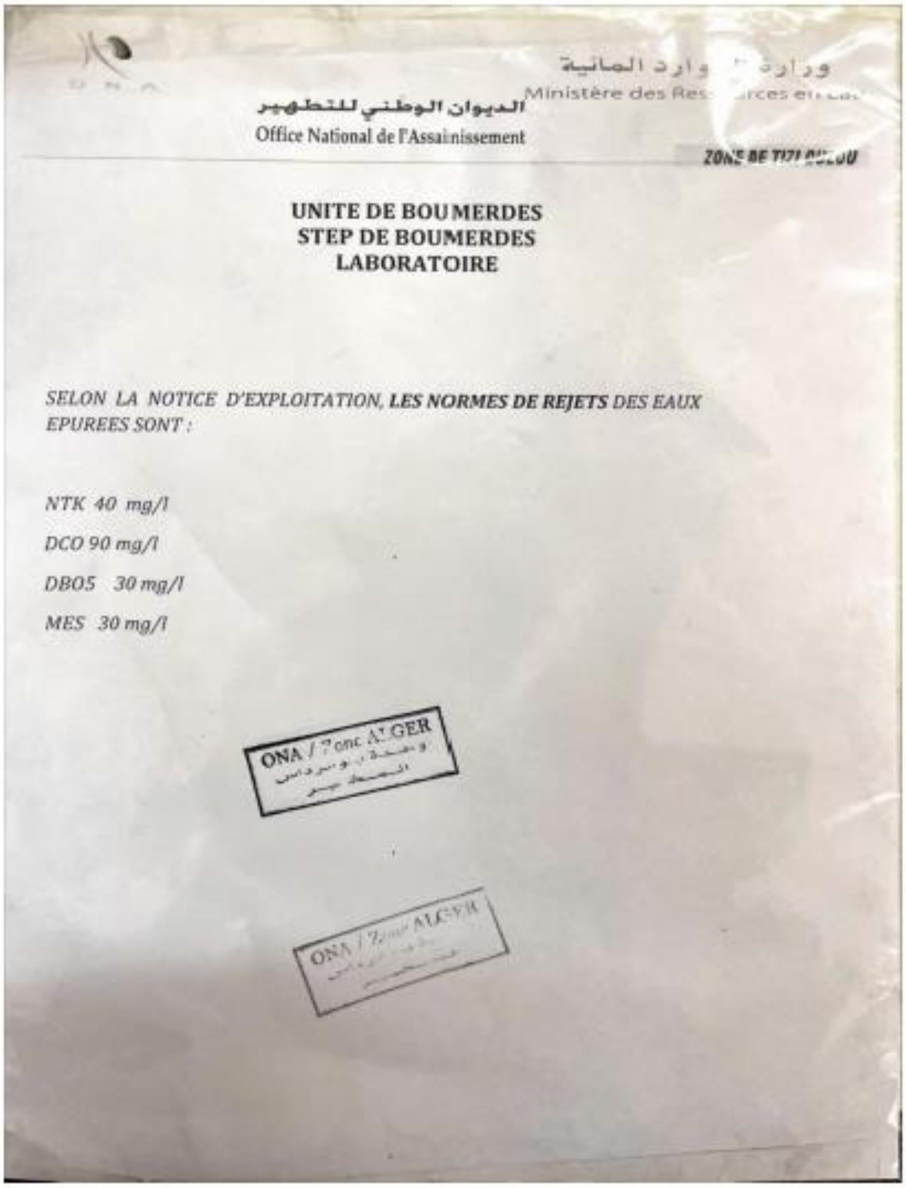
Figure 6

IV.5 Biochemical oxygen demand (BOD_5)

The BOD_5 values at the WWTP outlet are well below the discharge standard (< 30 mgO2/L); which reflects a good biological purification

The average of the COD/BOD_5 (K) ratio compared to raw water is equal to 1,3 which means that the effluent entering the station is biodegradable.

Note: For the interpretation of the analysis results of the treated wastewater from the Boumerdes plant, the laboratory refers to the following document:



الديوان الوطني للتطهير

Office National de l'Assainissement

UNITE DE BOUMERDES
STEP DE BOUMERDES
LABORATOIRE

SELON LA NOTICE D'EXPLOITATION, ***LES NORMES DE REJETS*** *DES EAUX EPUREES SONT :*

NTK 40 mg/l

DCO 90 mg/l

DBO5 30 mg/l

MES 30 mg/l

ONA / Zone ALGER

FigureIV.24: Document of wastewater discharge standards.

Conclusion

Conclusion

The evaluation of the efficiency of the urban wastewater treatment plant of the wilaya of Boumerdes allows us to note the following points:

- ✓ The plant's polluting load elimination efficiency is around 98%, indicating excellent operation of the station.

- ✓ Nitrification and denitrification accompanied with biological treatment take place under adequate conditions.

- ✓ The results of analyzes of the physico-chemical parameters pH, T°, Conductivity, COD, BOD_5, SS and other pollution indicators, in treated wastewater comply with the discharge standards indicated in the Operating Instructions (EN).

- ✓ A quantity of treated water from the Boumerdes WWTP (only 10%) is reused in irrigation; in the fields of two farmers in the region, on the side of the city of CORSO, by the drop by drop system, according to the requirements of the decree interministerial of the JO 2012.

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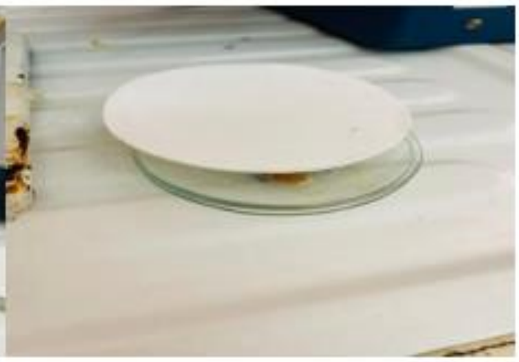
ANNEX

The COD for RW and PW .

Centrifuge.Thermoreactor at 145°C.



Vacuum filtration.Filter paper.

ANNEX

Precision scale.Crusible.

Muffle furnance 550°C

Desiccator.

Oven at 150^{o}C **Conductimeter.**

pH meter.

Bottle of distilled water.Microscope.

Spectrophotometer.

Settling of activated sludge.Settling of recycled sludge.

Synotptic of the stages of treatment of waste water and sludge from Boumerdes.

Bottle to analyze the DBO_5.Polymer.

Super press