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RESEARCH ARTICLE

ANALYSIS OF WASTEWATER TREATED BY THE WASTEWATER PLANT OF THE BAMAKO DERMATOLOGICAL HOSPITAL

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Abstract

The study on the physicochemical quality of the treated water from the Bamako Dermatological Hospital (HDB) station, this station operating with activated sludge, was carried out to determine the physicochemical parameters of this treated water. The general objective of this study is to evaluate the effectiveness of the wastewater treatment system of the Bamako Dermatological Hospital. To obtain ten (10) water samples were taken in five (5) campaigns in the different compartments of the system at the entrance and exit of the station. The results and the abatement rates obtained indicate that the HDB WWTP treatment needs additional treatment ensuring environmental and health safety, the treated wastewater from the HDB (system inlet) presents abatement rates overload indicators such as phosphate with a value of (-47.67%), cobalt (-28.81%), silver (-10.29%), nitrite (-632.71%),nitrate (-85.40%), sulfate (-6.15%) and fluoride (-56.54%). Low removal values were noted for pH (0.03%), Conductivity (5.1%), Temperature (1.60%) and Dissolved Oxygen (35.82%). . Turbidity with a value of (67.42%), MES (48.63%), Chloride (53.69%), Nickel (83.69%) and Manganese (55.02%) presented considerable reduction rates. However, certain pollution parameters at the outlet were observed (MES, NO2- and PO43-) and are higher than the Malian standards for discharge into nature.

Introduction:-

Water quality is a determining factor, vital for humans, including their survival, health, food, agricultural and economic activities. The quality of its environment depends closely on it, however it is the universal receptacle of all types of pollution **[15]**. Environmental protection and the sustainability of surface and underground water resources require direct awareness to ensure sustainable development of an areacountry. Sanitation and wastewater treatment are techniques that have been perfected for decades in developed countries. On the other hand, in developing countries the lack of sanitation infrastructure has contributed to the trivialization of wastewater discharges into natural environments, exposing them to the risks of pollution and contamination of water resources, which which considerably aggravates the water crisis and reduces the potential of exploitable resources **[9]**

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Worldwide, the treatment of wastewater before its release into nature represents a major difficulty for many countries. This difficulty is more accentuated in developing countries which not only suffer from a lack of capital, but are faced with galloping urbanization and anarchic industrialization. In Africa, the situation of wastewater disposal and treatment is dramatic. Most of the wastewater evacuation networks connected to mechanized treatment plants set up after independence are today non-functional and the raw wastewater produced is evacuated to the lowlands **[30]** .THEDemographic, economic and urban increases are at the origin of different sources of environmental pollution (atmospheric pollution, pollution of surface and deep water, soil pollution, etc.), particularly in developing countries that are less concerned and less aware of health risks. Among these sources of pollution, the production of wastewater often discharged into the receiving environment (sea, river, river, soil) without prior treatment generates numerous water-borne diseases and the spread of epidemics **[15]**. In Morocco, the volume of wastewater was estimated at 500 mm3 in the year 2000 and is expected to reach 700 mm3 in the year 2020, of which 74% is transported through sanitation networks **[23]**. In Mali, the production of biomedical waste is estimated at 585 tonnes per year or 1603kg/day**[13]**. WasteBiomedical liquids are among those which represent the greatest risk to the health of the population **[28]**.

In February 1991, Mali took environmental measures regarding the establishment of industrial water discharge standards that could have a significant influence on the environment. Depending on the nature and extent of the pollution, a large number of processes can be implemented to treat waste water discharges depending on their specific characteristics.

With a view to reducing the toxicity of wastewater discharges, the Malian State through the National Agency for the Management of Wastewater Treatment Plants of Mali (ANGESEM) has installed a wastewater treatment plant to treat wastewater from the industrial zone of Bamako but also that of hospitals before their discharge into the Niger River. Like all wastewater discharges, industrial wastewater can contain pathogenic microorganisms, suspended solids, substances such as oil, grease and other chemicals **[26]**. Hence the need to know the concentrations of the physico-chemical parameters of the waste water discharged.

The composition of domestic wastewater and water from sanitary facilities are richer in detergents, chemicals and especially pathogenic germs and parasites **[22]**. The Bamako Dermatological Hospital (formerly CNAM) is one of the largest old hospitals in Mali.

As part of our end-of-studies project, we had the opportunity to do an internship at the National Water Laboratory and all the samples came from the HDB wastewater treatment plant in Djikoroni-Para which falls under ANGESEM, in order to monitor the various treatments that this wastewater undergoes. This study focuses on liquid discharges and focuses primarily on treated HDB wastewater. The work consists of characterizing the physicochemical quality of the treated water from the HDB WWTP.

Objectives Of The Study:-

General objective:

The general objective is to contribute to safeguarding the physicochemical quality of the water of the Niger River.

Specific objectives

- Characterize the waste water at the entrance and exit of the WWTP;
- Determine the state of pollution of waste water from the WWTP discharged to the Niger River.

Material and Methods:-

Material:-

This section generally details, all analytical equipment used during the various wastewater sampling campaigns and within the station. It also highlights the methodology applied to determine the content of each physico-chemical parameter in all the waste water collected during the practical training period. using devices

1-Multi-paramètre WTW model Multi 9620 IDS

2- TurbidimètreScienchem Tech SCT-JERA

3-Chromatographe ionique METROHM

4-Dispositif pour la détermination de la MES

Study area

Located in the old district of Djikoroni-Para, the Bamako Dermatology Hospital (HDB) extends throughout West Africa. Its history dates back to the times of French Sudan, built in 1934, the leprosy prophylactic service was inaugurated on January 31, 1935, under the name of the Central Leprosy Institute in French West Africa and named in 1945 the Marchoux Institute in homage to the famous French bacteriologist Emile Marchoux. A wastewater treatment plant (STEP) is installed within the center with a treatment capacity of 100 m3/day to respond to the infectious risks linked to hospital effluent. To supply the station, a 1286 mL sewer network was created with 77 manholes.

Methodology:-

Sampling:

The wastewater samples were collected from November to December 2022 at the entrance and exit of the HDB WWTP using a sampler and brought back to the laboratory for monitoring the physico-chemical parameters and organic. During the training period, a total of ten (10) wastewater samples were taken due to five (5) samples, i.e. 3 times a month over an interval of 10 days. Every ten (10) day these samples are taken between 8:30 a.m. and 9 a.m. Bottles of

1.5L were used for samples intended for physicochemical analyses.

However, precautionary measures were taken followed by the use of adequate and high-quality analytical equipment so that wastewater samples were taken under the best conditions. After each sampling, the water sample was labeled in the field with the letter of the corresponding month followed by the year, the location of sampling and the date. Once finished, the cans are stored in a cooler at low temperature to be immediately sent and analyzed at the National Water Laboratory and that of ANGESEM this time with a new reference (laboratory number).

Analysis of the Results:-

After having made a preliminary diagnosis of the study site, we carried out analyzes of the water at the entrance and exit of the station which allowed us to characterize the quality of the water discharged from the HDB WWTP by measuring of the different parameters.

Data processing:

The data is entered in Excel. The comparison of the averages at entry and exit was made at the 5% threshold to confirm or refute our initial objectives. It allowed us to observe the differences and variations of the parameters studied within a samplingcampaign and between the different samplings carried out. The results of the different parameters analyzed are expressed as mean ± deviation. kind. These averages are presented in the form of tables or histograms using Excel 2013 software.

Results:-

We determined the physicochemical characteristics of HDB wastewater, entering then leaving the station in order to assess their quality. The results obtained from the ten (10) water samples analyzed are presented and discussed.

Results of overall parameters at the entrance and exit of the HDB station

Variation of turbidity at the inlet and outle

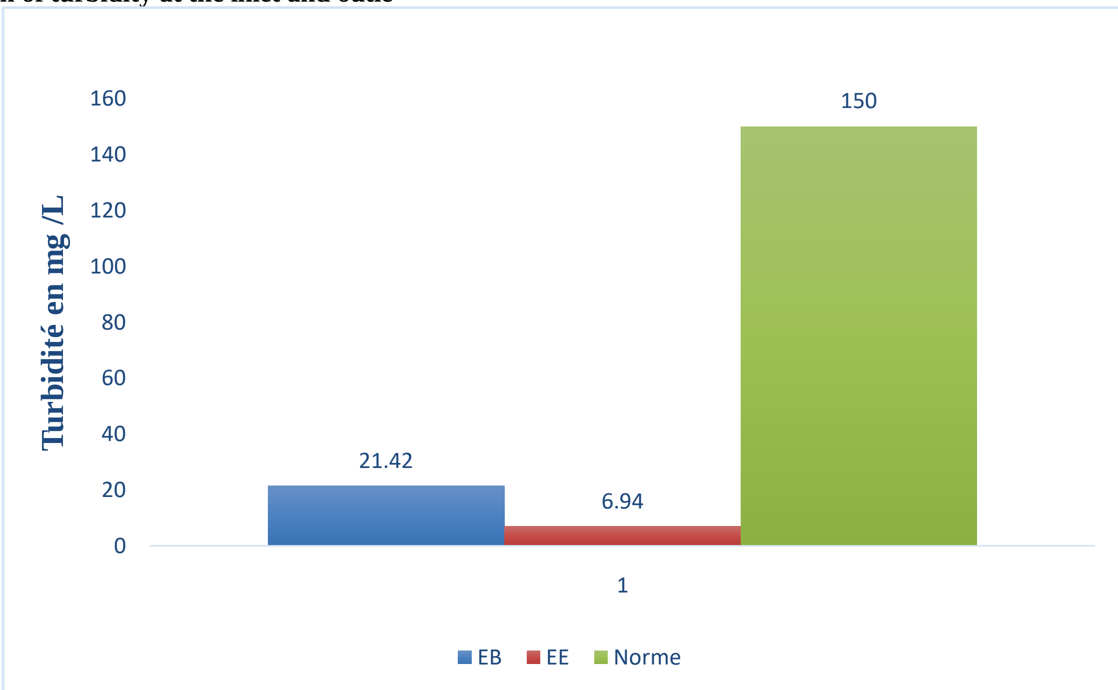

Figure 1:- Variation of turbidity at the entrance and exit of the station.

EB: Raw Water; EE: Purified Water.

We note that all the values obtained at the entrance and exit are well below the Malian standard for the discharge of wastewater into nature.

Variation of Conductivity at input andoutput

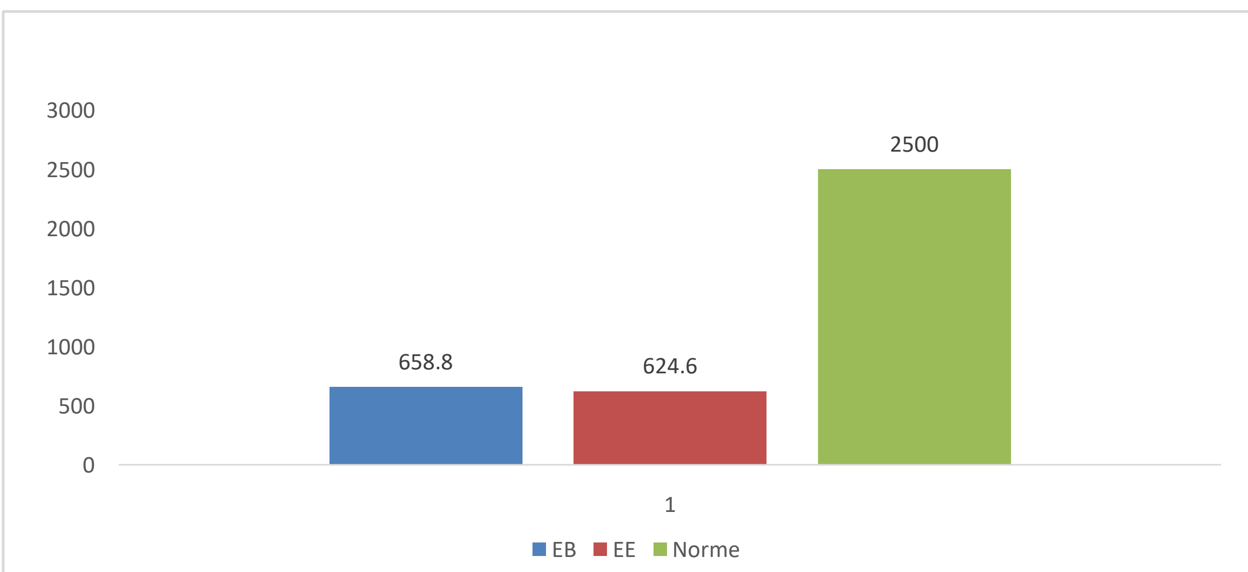

Figure 1:- Variation of Conductivity at input and output.

From these results, we note that the value of the conductivity of the raw water at the inlet recording an average of 658.80 µs/cm while that of the purified water at the outlet is around 624.6 µs/cm as the average. All these values are below the rejection standard. This slight fluctuation that was recorded between the values of raw water and purified water is due to the loss of portions of salinity during the purification stages. (Figure 2)

Evolution of dissolved oxygen mg/L

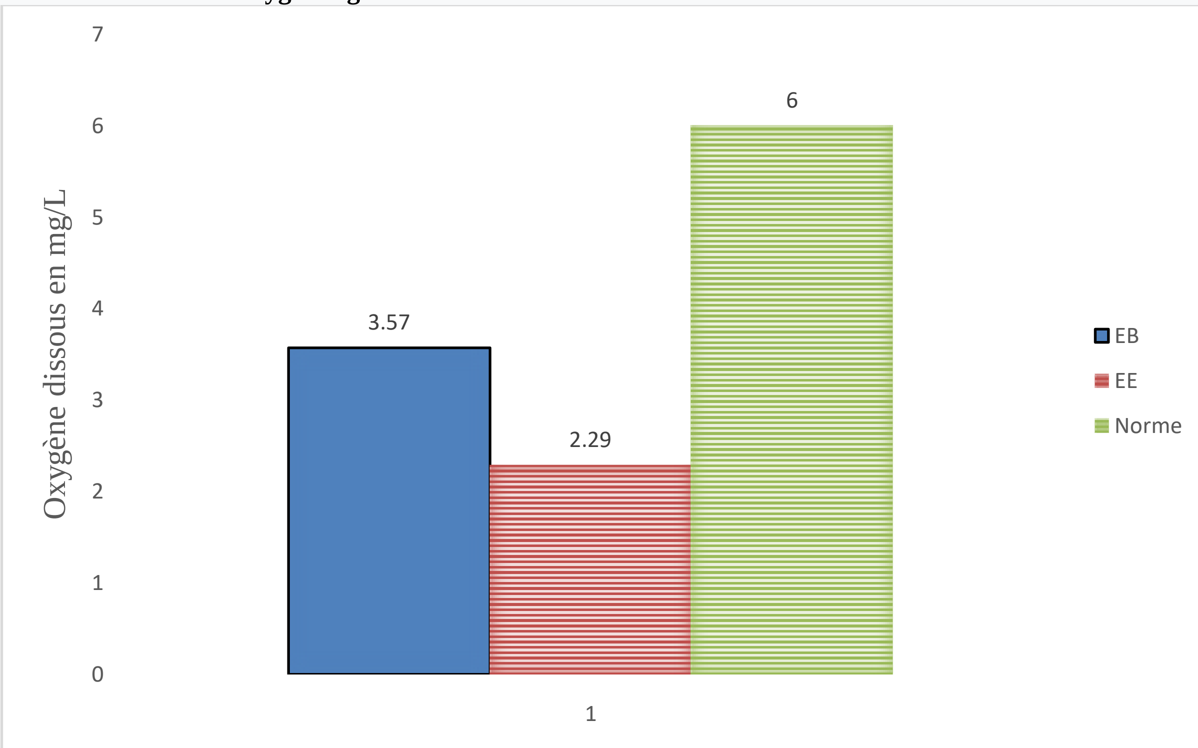

Figure 2:- Evolution of dissolved oxygen at the inlet and outlet.

The average dissolved oxygen values at the inlet and outlet are 3.57mg/L and 2.29mg/L respectively. All these values are well below the discharge standard, which could slow down the photosynthetic phenomena which contribute to the re-aeration of the water. This phenomenon can be accelerated by the presence of a high proportion of organic matter that consumes oxygen (figure 3).

Variation des phosphates à l'entrée et à la sortie

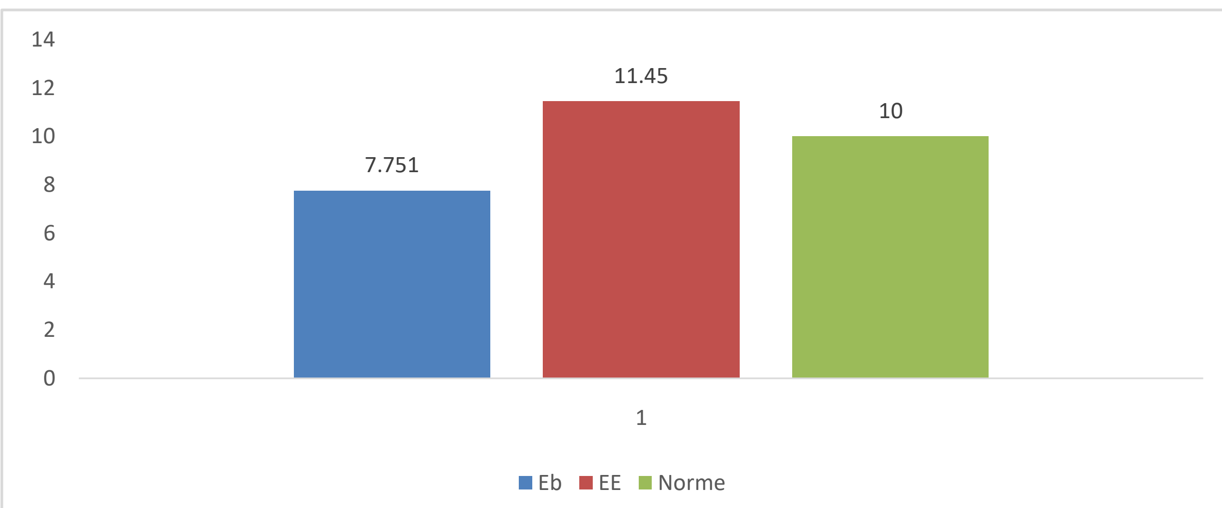

Figure 3:- Variation des phosphates à l'entrée et à la sortie.

The values of phosphates at the outlet have exceeded the discharge standards. This is due to the heavy use of products which are very rich in detergents, which could lead to eutrophication of watercourses, characterizing the anarchic proliferation of algae and an excess of consumption of oxygen dissolved in water (figure 4).

Variation of Nitrites at entry and exit

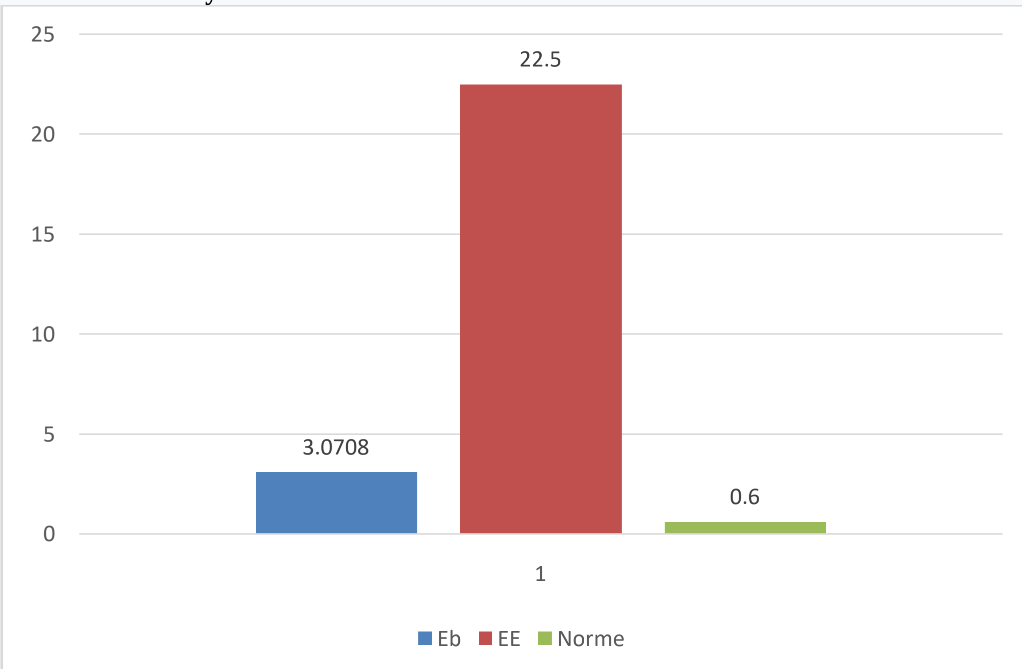

Figure 4:- Variation des Nitrites à l'entrée et à la sortie.

The recorded values of nitrites (NO2-) in the samples are between 3.0708 mg/L at the inlet and 22. mg/L at the outlet are greater than the rejection guide value (figure 5)

Variation de la MES à l'entrée et à la sortie de STEP de HDB

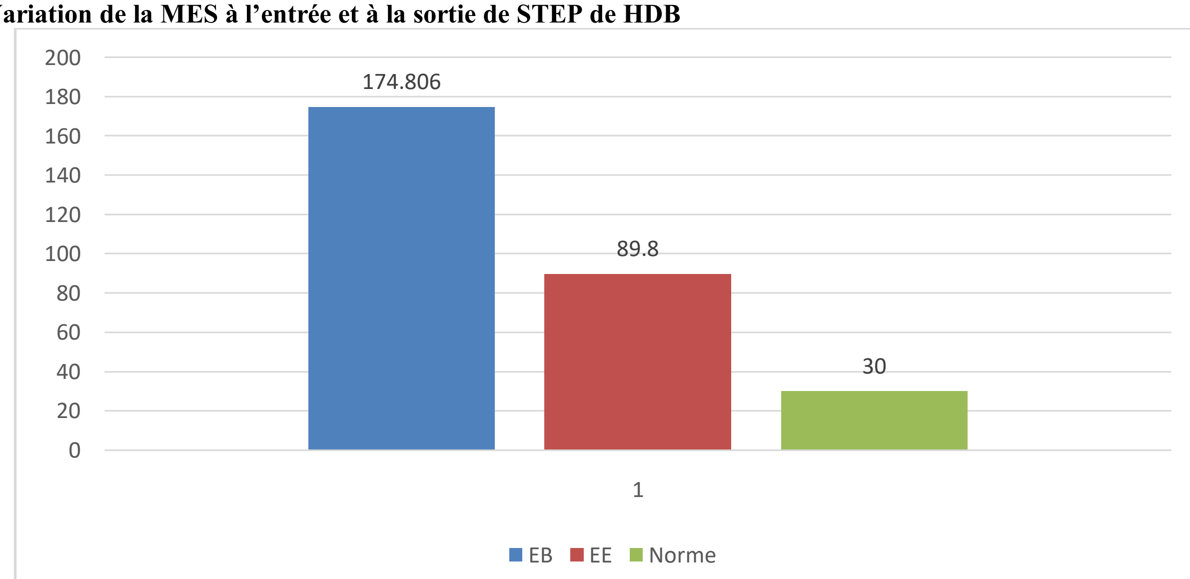

Figure 5:- Variation de la MES à l'entrée et à la sortie.

The results show a considerable exceeding of the MES guide values at the entrance and exit of the station. The presence of MES can prevent the penetration of light and cause a weakening of the dissolved oxygen concentration. This can lead to a limitation of aquatic development in the long term and eutrophication of the receiving environment or even the Niger River (figure 6).

Reduction rate:

This part aims to evaluate the treatment efficiency of the HDB wastewater treatment plant. The purification performance study of the station was carried out in different operating parameters of the treatment plant, namely: pH, conductivity. At the biochemical reactor level to evaluate the MES, phosphorus, nitrite for the development of microorganisms. And at the level of trace metal elements such as: Manganese, nickel and iron. The performance of the STEP is expressed in terms of reduction rate on the parameters. The reduction rate is calculated using the following formula:

$$\mathbf{R(\%)=\frac{Pe-Ps}{Pe}\times 100}$$

R (%): is the reduction rate for a given parameter;

Pe: is the value of the parameter at the station entrance;

Ps: is the value of the parameter at the station output.

The results obtained are recorded in table 5 below:

The reduction rate obtained from the various analyzes of the physico-chemical parameters shows that the HDB station's purification system presents a failure in the elimination of certain parameters, notably heavy metals (nickel and copper (0.00%) , cobalt (-28.81%) and silver (-10.29%) and certain anions (nitrites (-632.71%), nitrate (-85.40) and sulfate (-6. 15%)). It should also be noted a low rate of reduction of temperature (1.60%), conductivity (5.19%). The other parameters have a higher rate of reduction such as (MES: 48 .63%, Turbidity: 67.42% and Dissolved Oxygen: 35.82%) These rates show good operation of the station which is a chemical and biological process. It is based on the degradation of organic matter thanks to. heterotrophic micro-organisms to which the oxygen necessary for their development is provided. This makes it possible to destabilize colloidal particles and artificially increase the size of the particles. We therefore witness a very strong reduction in the resistance of the mud, thus allowing a. faster drainage.

Discussions:-

The analysis of the physicochemical parameters of the treated water thus discharged are superior to the standards applied in several countries. In addition, they contain dangerous chemical substances which come from analysis laboratories, pathogenic germs linked to contamination and the activity of radiology. This spill contributes to the pollution, contamination and eutrophication of the Niger River and constitutes a serious risk of spreading water-borne diseases among the population, some of whom use the waters of this river for several purposes including agriculture. housekeeping, fish farming and gardening. This pollution also leads to a reduction in natural biodiversity and the introduction into food chains of dangerous substances such as heavy metals [32].

Throughout the period of this study, the pH was greater than 7, which suggests the existence of a slightly alkaline environment. The average values at entry and exit are between 7.43 and 7.44. These results are in line with the work of [4] who found pH values between 5 and 9 allow normal development of fauna and flora. This result is also similar to those found by [34], [1] and [2] in the case of different types of wastewater from several Moroccan cities. The measured pH values are acceptable according to Moroccan quality standards for wastewater intended for irrigation [13].. Likewise, these values are generally between 6.5 and 8.5 considered as limit values for direct discharges into the receiving environment. Analysis of the results shows that the average chloride concentrations in HDB wastewater range between 29.86mg/L and 11.85mg/L. In comparison with the Malian rejection standard (≤ 1200 mg/L), the concentrations recorded are well below the discharge guideline value. SS concentrations also give the water a cloudy appearance, a bad taste and a bad odor [18]; they oscillate between 308 mg/L at the entrance and 89.80 mg/L at the exit. They are higher than the standards required by (WHO) which are 30 mg/L. Suspended Matter represents all the mineral and organic particles contained in wastewater. Their effects on the physicochemical characteristics of water are very harmful (modification of water turbidity, reduction of light penetration and therefore photosynthesis). The variations in phosphates present high concentrations with a peak of 11.45 mg/L at the outlet and low concentrations of 7.75 mg/L at the inlet. This would be due to the high use of detergents in hospitals. According to [7]. Phosphates come from leaching. They participate on the front line in the eutrophication process, a phenomenon with environmental and health consequences (release of algal toxins). The recorded values of phosphates are similar to those described by[5]in the rivers of Ouagadougou and those of [10] in the mountainous waters of the Ganges in India. The maximum values obtained of the order of (0.025; 0.48; 0.134; 0.247; 0.005; 0.247; 0.0077; 0.032; 0.363) of metallic trace elements such as (Cu, Ni, Co, Mn, Cd, Zn, Pb , Ag, Fe) are well below the rejection standard and the minimum values are remained insignificant (0.008; 0.03; 0.041; 0.013; 0.002; 0.009; 0.007; 0.021; 0.022). It should be noted that radiology activity is a source of heavy metal releases. However, their concentration in WWTP discharges could cause dangers for humans. The results of the dissolved oxygen analysis obtained during the measurement campaigns show that the averages at the inlet display 3.75 mg/L and 2.29 mg/L at the outlet are lower than the discharge guide value. This value is higher than the average obtained by [13]which is 0.3 and 2.1 mg/L with an average concentration of 1.7 mg/L. The meaning of this parameter is very clear since the presence of dissolved oxygen conditions the reactions of aerobic degradation of organic matter and more generally the biological balance of water environments. In the HDB of wastewater, its complete disappearance is generally accompanied by the appearance of H2S in the air, coming from the reduction of sulfur compounds present in the effluents, and correlatively from the phenomenon of acid attack on the concrete of the pipes. [12]. As we can see, the lack of legislation or the non-enforcement of regulations in force regarding the management of industrial wastewater exposes aquatic and terrestrial environments to any form of pollution whose consequences, in the short or long term, will ultimately reach humans and animals.

The recorded values of nitrates (NO3-) in the samples are between 3.99 mg/l at the inlet and 7.39 mg/l at the outlet. These results are directly in line with the work of (Slim et al. 2005) who noted that ainfinite quantity of nitrates in surface waters is linked either to increased algal growth in these sites, or to the joint phenomenon of denitrification which transforms nitrate NO3- into nitrogen N2 thanks to the presence of organic matter. The recorded values of nitrites (NO2-) in the samples are between 3.07 mg/l at the inlet and 22.5 mg/l at the outlet and exceeded the rejection guideline value. The values found for nitrites are well above the WHO standards (2001). According to [29], nitrites present an unstable transient form during nitrification or denitrification, their presence in the natural environment is low. The concentrations obtained for nitrites agree with those of (Derradji al., 2007) for surface waters in northeast Algeria, [27] for the waters of the Soummam wadi in Algeria and (Baig al.,2009) for surface waters of the town of Jamshoro in Pakistan.

Conclusion:-

The activated sludge treatment plant (STEP) which was built to treat HDB effluent has been operational for several years, like several others existing in the country. This results in the discharge of treated wastewater from the Bamako Dermatological Hospital into an aquatic environment. The waters of the receiving environment are used downstream by populations for various purposes,despite the risks of pollution, contamination and toxicity that they present. Thestudy carried out to contribute to the characterization of these waters used to evaluate and then assess the effectiveness of the WWTP. The results and information obtained during the study, the physico-chemical quality of the treated water from the WWTP shows that the degree of physico-chemical pollution, in all the parameters studied (turbidity, Cond, pH, dissolved O2, N03- , SO42-) are in the low concentration range and those of trace metallic elements or heavy metals remained insignificant.

All these values comply with the Malian standard for wastewater discharge but with the exception of MES, PO43-, NO2-) which have values higher than the guide value for wastewater discharge. This poor purification performance could be explained by the increase in volume and the variation in flow rate compared to the capacity of the station. The constraints of the results are due to the new connection at any time of the station which could disrupt the quantity of wastewater in the basin, the flow as well as the treatment. They also affect the effectiveness of the treatment. In view of the harmful effects of these effluents on the environment and on humans (toxicity, eutrophication, contamination of the receiving environment, contamination and pollution of groundwater, spread of water-borne diseases), they should be completely purified before being released. rejection in the environment. Therefore, the treated water from the WWTP during the study period cannot be discharged into the receiving environment.

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