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RESEARCH ARTICLE

COMPARATIVE STUDY OF TWO DYNAMIC DECANTERS USED AT THE PASPANGA WATER TREATMENT PLANT IN BURKINA FASO: CASE OF ACCELATOR AND PULSATOR

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Abstract

Water is a basic resource for humans because their survival and some of their activities depend on it. There are several types of water depending on their sources including groundwater and surface water. In its natural state, most water needs to be treated before consumption. The National Water and Sanitation Office (ONEA) is one of the structures responsible at the national level for the purification of this water. The Paspanga water treatment station is an ONEA structure which exploits the water from the Loumbila and Ouaga 3 dams. This raw water follows an entire treatment process which involves the use of hydraulic structures such as decanters before being drinkable. The analysis of turbidity was carried out by nephelometry, pH and conductivity by electrochemistry, and organic matter by titrimetry. The results obtained made it possible to compare the accelator and pulsator decanters. For the same raw water we observed a drop in turbidity ranging from 58 to 83% for the accelator and from 51 to 75% for the pulsator. For a minimum average pH of the raw water of 6.76, the decanted water of the accelator has a minimum average pH of 6.49 and that of the pulsator of 6.46. For the same raw water we observed a drop in organic matter ranging from 22 to 52% for the accelator and from 16 to 41% for the pulsator. From all these results, it appears that the accelator is more efficient than the pulsator.

Introduction:-

Water is an essential resource for human life and activities.It is an abundant natural resource on a global scale but whose sources sometimes limit its use by humans [1].In Burkina Faso, as in many other developing African countries, water is an important issue for the populations and activities that depend on it.As groundwater reserves are discontinuous due to the poverty of the lateritic soil which does not retain water, the country has resorted to the use of surface water for drinking water supply [1].Surface water in Burkina Faso includes bodies of running or stagnant water, fresh or brackish, which are in direct contact with the atmosphere.They include artificial bodies of water such as dams, as well as natural rivers, lakes and ponds distributed throughout national watersheds.The country has four main river basins: the Comoé, the Niger, the Nakambé and the Mouhoun, subdivided into 17 sub-

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basins.The Mouhoun and the Comoé are permanent rivers, while the Nakambé and the tributaries of the Niger are temporary.Burkina Faso has 1,794 surface water resource mobilization works with a water retention capacity of approximately 5 billion cubic meters, including 2.7 billion cubic meters stored on average per year, according to the 2011 inventory of the General Directorate of Water Resources [2].It loses a total volume of 7.5 billion cubic meters of water to neighboring countries.To reduce these losses, major hydraulic structures were built, notably dams.The Nakambé basin has around 400 dams, among which the most important are the Bagré dam, the Kompienga dam, the Ziga dam and the Toécé dam (KANAZOE).These dams fulfill different functions, including hydroelectric, hydro-agricultural and drinking water supply.Indeed, 40% of the country's population lives in the Nakambé basin and especially the city of Ouagadougou is almost entirely dependent on the surface waters of this basin [3].Surface water often contains a lot of suspended natural matter as well as dissolved substances which vary depending on the rainfall and the geological quality of the reliefs which surround them.Surface waters as well as aquifers are very often sites of various pollution whose causes are numerous and varied, the best known being those linked to human activity and in particular urbanization and industrialization [4].According to the Burkina Faso environmental code, water pollution is characterized by an alteration of the physical, chemical and bacteriological properties of water, resulting from human activities.An aquatic environment is considered polluted when it suffers a lasting disturbance of its balance, due to the excessive introduction of potentially toxic substances, whether of natural or anthropogenic origin.The main sources of pollution linked to different human activities are domestic pollution, agricultural pollution and industrial pollution in addition to rainwater [5]. These suspended matters may contain polluting effluents which mean that surface water cannot be used in its raw state either for domestic purposes or for industrial purposes.Potabilization treatments are then extremely necessary before any use. Between 1920 and 2008, more than 1202 reservoirs were built [6].But the surface waters of the city of Ouagadougou are particularly affected by pollution.Indeed, certain studies have shown that these reservoirs are generally subject to multiple constraints due to strong population growth.In addition to groundwater, the National Water and Sanitation Office (ONEA) exploits the same surface water.In order to make this surface water drinkable, ONEA follows a whole process.Monitoring the different processes involves the use of hydraulic structures.Among the various hydraulic structures used by ONEA in the purification process, there are decanters which make the raw water entering the Paspanga station less turbid.In fact, the raw water which enters the station is very rich in suspended matter.The use of decanters is then a necessity for the reduction of these suspended materials.ONEA particularly uses several types of decanters at the Paspanga station, including the pulsator decanter, the accelator decanter and the lamellar decanter.It is in this sense that the choice of our theme focused on the comparative study of accelator and pulsator decanters.The overall objective of this study is to compare the two types of decanters used at the Paspanga station.

Specifically it will be:
-Characterize the raw water at the entrance to the two (02) decanters;
-Characterize the water at the outlet of the two (02) decanters;
-Evaluate the clarification efficiency of the two (02) decanters;
-Compare the efficiency of the two (02) decanters.

Our work is structured in two parts.Firstly we will present the materials and methods and secondly we will present and discuss the results obtained.

Experimental study

Presentation of the study area

Our study was carried out in the city of Ouagadougou. Since 1947, the city of Ouagadougou, capital of the province of Kadiogo, has been the capital of Burkina Faso. Located in the center of the country, its geographical coordinates are 12°37'North in latitude and 1°53'West in longitude. According to the Population data website, the city of Ouagadougou has a total area of 2805 km². Its population is estimated at 3,030,384 inhabitants including 14.8% of the total population and a population growth rate of 4.42% according to the 5th [7]. It has a Sudano-Sahelian type climate characterized mainly by two seasons which are a dry season and a rainy season. The dry season is characterized by dry harmattan winds which blow from the North-East to the South-West from October to May. The rainy season is characterized by humid winds with rains lasting June to September. Its average annual rainfall is between 600 and 900 mm [8].

Parameters taken into account as part of our study

In order to carry out our study, a certain number of parameters were taken into account. These include, among others, the following parameters:

Turbidity

Turbidity refers to the content of suspended matter contained in water. Cloudy water can contain suspended particles, disease-causing microorganisms, chemicals and heavy metals, all of which can make the water treatment process more difficult and less effective and even pose health risks. According to World Health Organization (WHO) standard, the turbidity of drinking water should be less than or equal to 5 NTU.

Hydrogen potential (pH)

The pH is a unit of measurement of acidity, on a scale from 1 to 14. When the pH is 7, the solution is neutral, that is to say neither acidic nor basic. pH can influence the effectiveness of disinfection, coagulation, and flocculation processes. In terms of human health, water with a pH that is too high or too low can be corrosive and damage pipes, which could lead to contamination of drinking water with heavy metals such as lead. According to WHO standards, the pH of drinking water should be between 6.5 and 8.5.

Conductivity

Water's conductivity is its ability to conduct electric current. It allows us to have a good idea of the quantity of materials dissolved in the water. It makes it possible to evaluate the overall mineralization of water and is measured using a conductivity meter, its unit of measurement is the Siemens micron per centimeter (μs/cm) [12]. The WHO standard says that the conductivity of drinking water should not exceed 1000 μS/cm. In the control of drinking water, the continuous determination of this measurement makes it possible to detect variations in the ionic composition of the water which may reflect parasitic water inflows [9].

Organic matter (OM) by oxidizability with potassium permanganate

The organic matter of surface water includes living or dead cells, animal or plant, and all molecules resulting from the decomposition of these cells [10]. Organic matter can react with treatment chemicals, reducing their effectiveness. This could result in the need to use higher doses of chemicals or other treatment methods to obtain sufficient water quality. With respect to human health, organic matter could provide an environment conducive to the growth of pathogenic microorganisms such as viruses, bacteria, and parasites. The WHO recommends a maximum OM content of raw water of 10 mg O2/l; and a maximum OM content of the treated water of 5 mg O2/l.

Materials and Methods:-

Sampling

The study was carried out from December 18, 2023 to February 9, 2024. The different samples are, among others, the raw water from Loumbila in order to characterize it, the decanted water from the decanter of the Candy treatment unit (accelator decanter) and the decanted water from the decanter of the Dywidag treatment unit (pulsator decanter) in order to evaluate the clarification efficiency of each type of decanter and compare the two types of decanted water.

Specimens

A total of thirty-seven (37) samples were taken at the rate of one (01) sample per day.The water parameters measured at the decanter inlet and outlet are: turbidity, pH, conductivity and organic matter.

Turbidity measurement

Materials used

Turbidity is measured by nephelometric method. The equipment used for determining turbidity:

1. Polyethylene bottle for sampling;
2. WTW brand turbidimeter, TURB 430 IR type;
3. Tank;
4. Wiping paper;
5. Wash bottle of distilled water.

Turbidity analysis procedure

Turn on the device by pressing ON. The turbidimeter should be calibrated once a week or as necessary; carefully place the reading well tank; rinse the tank well (inside and outside) with distilled water and dry the outside with paper towels; fill the tank with the sample and introduce it into the measuring well; press the validate key; read the value in NTU after the display has stabilized; and remove the cell from the device, empty the sample and clean the cell with distilled water and wipe dry. Figure 1 shows us the photo of the turbidimeter.

Figure 1:- WTW 430 IR type turbidimeter.

pH measurement

Material:-

It is determined using an electrochemical method.
The equipment used for determining the pH:
- Polyethylene bottle for sampling;
- WTW brand pH meter and type pH 7310 equipped with a combined electrode;
- Wash bottle of distilled water

Experimental pH analysis protocol

Switch on the device; carefully remove the electrode from the protective cap; rinse the electrode with water then with the measuring sample; fill the measuring vessel with the measuring sample; carefully immerse the electrode in the vessel containing the sample; press the measurement button; read the pH directly when the value has stabilized;

At the end of the measurements, rinse well with distilled water and immerse again in its protective cap containing the KCl solution.

Conductivity measurement

Conductivity is measured by the electrochemical method.
Conductivity measurement equipment:
- Polyethylene bottle for sampling;
- WTW brand conductivity meter and Cond 7310 type;
- Wash bottle of distilled water.

Conductivity analysis procedure

Turn on the device by pressing ON; rinse the probe with distilled water and dry it carefully with paper towels; immerse in the vase containing the sample to be analyzed (the cell must be completely submerged); press AR then RUN ENTER; directly read the conductivity when the value has stabilized; Take careful note of the conductivity unit displayed on the screen during reading. Figure 2 shows us the photo of the conductivity meter.

Figure 2:- WTW 7310 type conductivity meter.

Results and Discussions:-

For us, it is a matter of presenting the results obtained and analyzing them.

Characteristics of Loumbila raw water

Turbidity

Figure 3 below presents the results obtained from the analysis of the turbidity of the raw water from Loumbila collected at the entrance to the decanters grouped per week for 08 weeks. We obtained a minimum average raw water turbidity of 6.4 NTU and maximum of 12.1 NTU respectively for week 3 and week 8. The turbidity is therefore very low for raw water. The low turbidity could be explained by the fact that our study took place during a period of dry season where there is no longer any water supply at the dam, resulting in water stagnation; which helps to reduce its turbidity. Our results are lower than those obtained by [1] who obtained a turbidity of Loumbila raw water of between 32 and 68 NTU during a study period similar to ours.

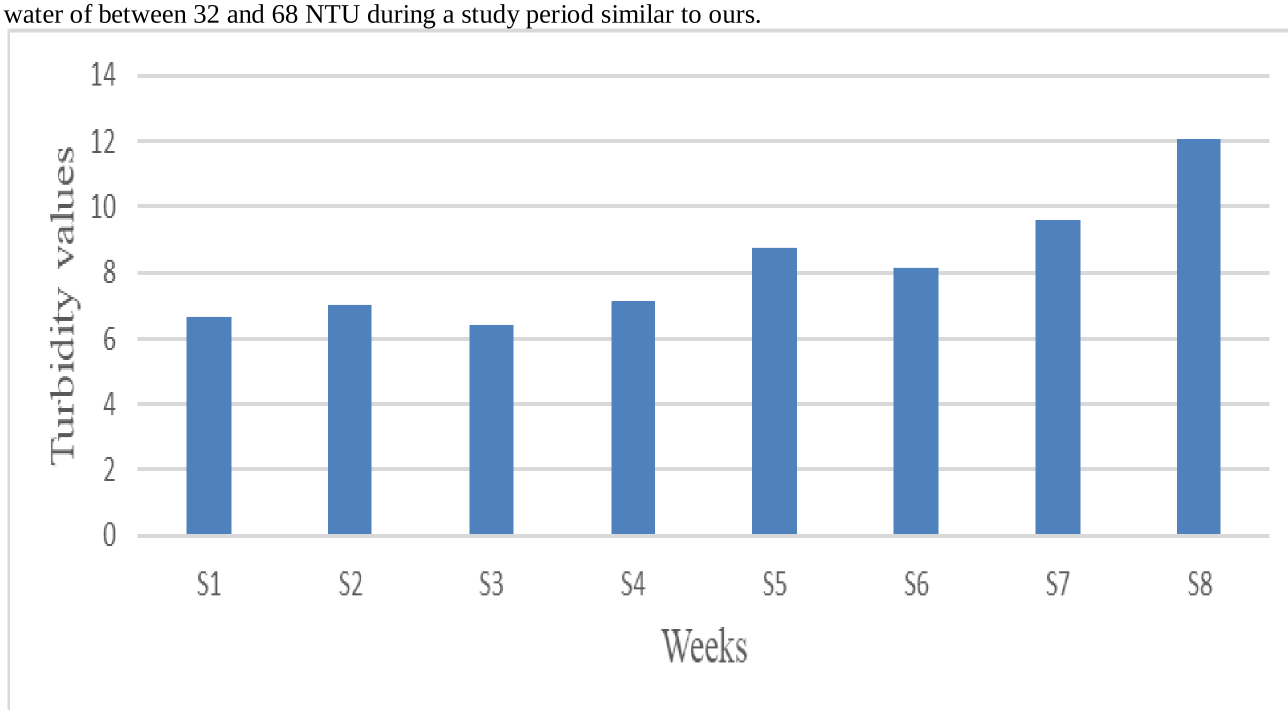

Figure 3:- Raw water turbidity.

pH

Regarding pH; the values were between 6.85 and 7.16 for week 6 and week 8 respectively.The pH range obtained would be due to the lack of water supply at the dam, since water supply could contribute to degrading the pH of the water, which could tend towards acidity. Figure 4 below shows the results obtained from the pH analysis

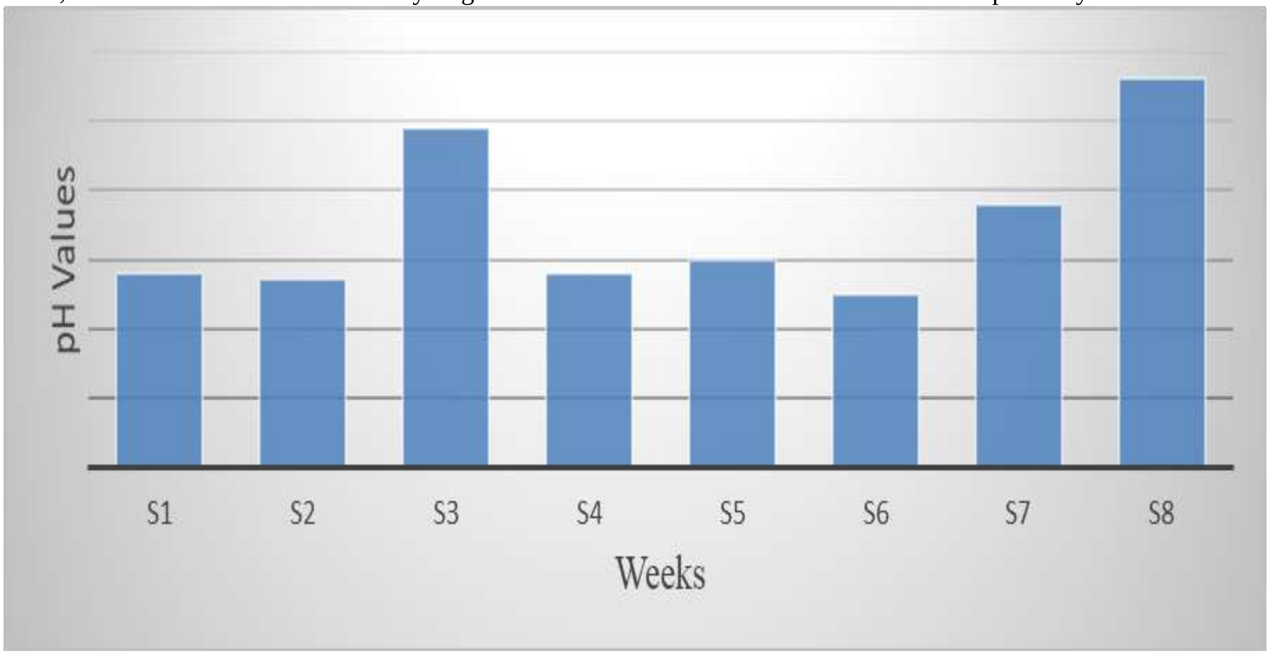

Figure 4:- Raw water pH.

Conductivity

Over a period of 08 weeks, we obtained results from analyzes of the conductivity of raw water shown in Figure 5 below. The results obtained show that the average conductivity of raw water is between 66.1 µS/cm and 85.54 µS/cm. This means that there is little mineralization of the water during the eight (08) weeks of analysis. This low mineralization would be due to our study period which is the dry season where there is no water supply at the dam. In fact, the mineral particles are more suitable for natural settling because they are of high density, hence a low turbidity during this period [11] justified the increase in conductivity in the winter period by the contribution of mineral colloids into the detention.

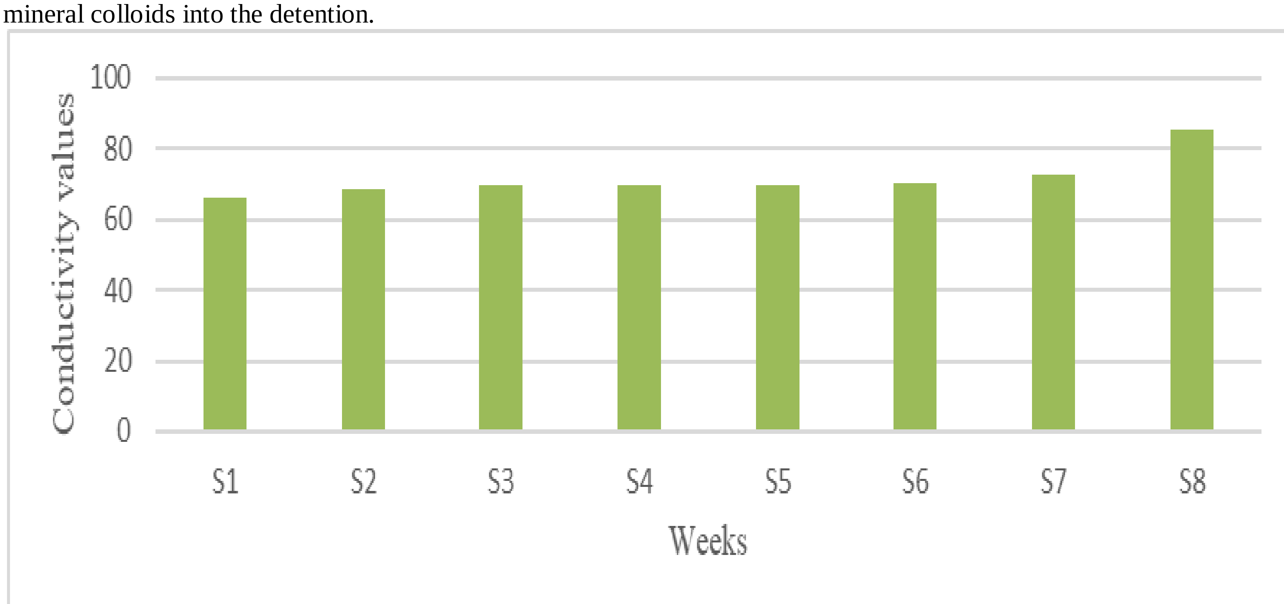

Figure 5:- Raw water conductivity.

Organic matter

Below are presented the results obtained from the analysis of organic matter by oxidizability with potassium permanganate for 08 weeks in Figure 6. The results show that the average MO values are between 6.7 mg O2/l and 9.7 mg O2/l respectively for week 1 and week 6. These low OM contents would be linked to low turbidities which would be due to the lack of water supply at the source due to the fact that our study has took place in the dry season.

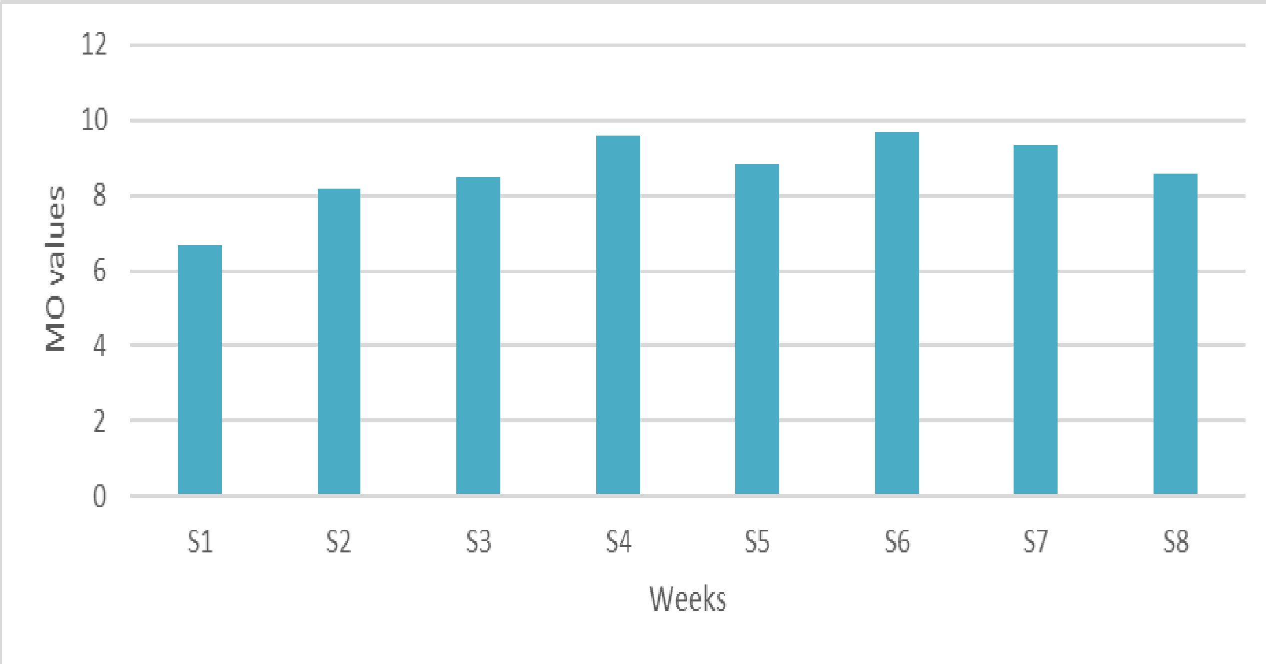

Figure 6:- Organic matter in raw water.

Processing efficiency of the accelerator decanter of the Candy processing unit

In this part, we will present and discuss the results obtained from the analysis of parameters such as turbidity and organic matter, carried out on the water at the inlet and outlet of the accelator decanter. used at the Candy processing unit as well as the yields obtained for these two parameters

Turbidity

Below, table 1 shows that the analysis carried out on the turbidity of the raw water and the settled water from the accelator decanter gave an average turbidity of the settled water of between 1.37 and 4.34;for an average raw water turbidity of between 6.4 and 12.1 NTU, with a reduction efficiency of between 58 and 83%.A large reduction in raw water turbidity was noted.This shows that the use of the decanter is of great necessity in the context of reducing the turbidity of charged water.

Table 1:- Water turbidity at the inlet (EB) and outlet (ED) of the accelerator decanter.

Turbidity (NTU)	S1	S2	S3	S4	S5	S6	S7	S8
EB	6,68	7,03	6,4	7,16	8,76	8,15	9,63	12,1
ED	2,04	2,96	2,04	2,37	2,13	1,37	1,83	4,34
Yield (%)	69%	58%	68%	67%	76%	83%	81%	64%

Organic Matter

The determination of organic matter on the raw water and on the decanted water from the accelerator decanter gave results shown in Table 2 below. According to the results obtained, the OM content of the raw water is between 6.7 and 9.7 mg O2/l. As for the OM content of the decanted water from the accelator decanter, it is between 4.7 and 6.6 mg O2/l, i.e. an OM reduction yield of between 22 and 52%. This shows that there was a significant reduction in the organic matter of the raw water.

Table 2:- Organic matter in the water at the inlet (EB) and outlet (ED) of the accelerator decanter.

MO (mg O_2/l)	S1	S2	S3	S4	S5	S6	S7	S8
EB	6,7	8,2	8,5	9,6	8,83	9,7	9,34	8,59
ED	5,2	6,1	5,8	6,6	5,4	4,7	5,3	6,1
Yield (%)	22%	26%	32%	31%	39%	52%	43%	29%

Comparison of the two decanters based on yields

Turbidity

Figure 7 below shows the yields obtained from the analysis of the turbidity of the raw water after passing through the accelator and pulsator decanters. The results obtained show that in terms of reducing water turbidity (clarification), both decanters are operational. However, for future installations, we will favor the use of the accelator decanter because it gives more satisfactory results than the pulsator decanter. Indeed, we noted that during our study, for the same raw water which enters the two (02) types of decanters, the water collected at the outlet of the accelerator decanter has a lower turbidity than the water collected at the outlet of the pulsator decanter. This is demonstrated by the yields of 58 to 83% for the accelator decanter and 51 to 75% for the pulsator decanter. The lower turbidities observed at the accelerator level are due to its design. The accelator uses centrifugal force to speed up the clarification process while the pulsator uses pulsations to help separate particles. The centrifugal force in the accelerator decanter provides almost complete and rapid separation of the solid and liquid phases.

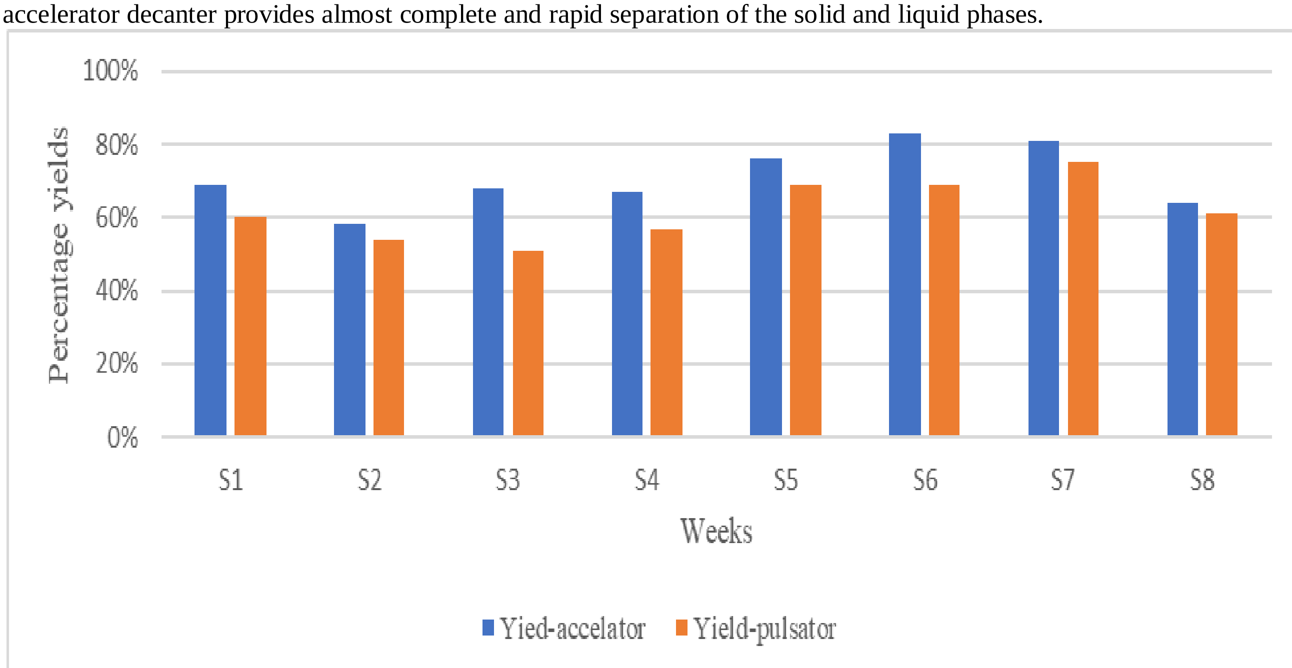

Figure 7:- Turbidity performance of the two types of decanters.

MO

Below, Figure 8 shows the yields obtained after analysis of the organic matter on the water at the inlet and outlet of the accelator and pulsator decanters. The results obtained show that in terms of reducing organic matter in water, both decanters give good results. However, given that the use of decanters aims to reduce colloidal matter in water, we can say that the accelator decanter is the best. In fact, the accelator decanter gives more good performance in terms of reduction of MO because we We noted that during our study, for the same raw water entering the two (02) types of decanters, the water collected at the outlet of the accelator decanter has a lower OM than that collected at the outlet of the pulsator decanter. This is demonstrated by the reduction yields of 22 to 52% for the accelator decanter and 16 to 41% for the pulsator decanter. The higher clarification yields observed at the accelerator level could be explained by its design model. Its design therefore facilitates decantation more than that of the pulsator.

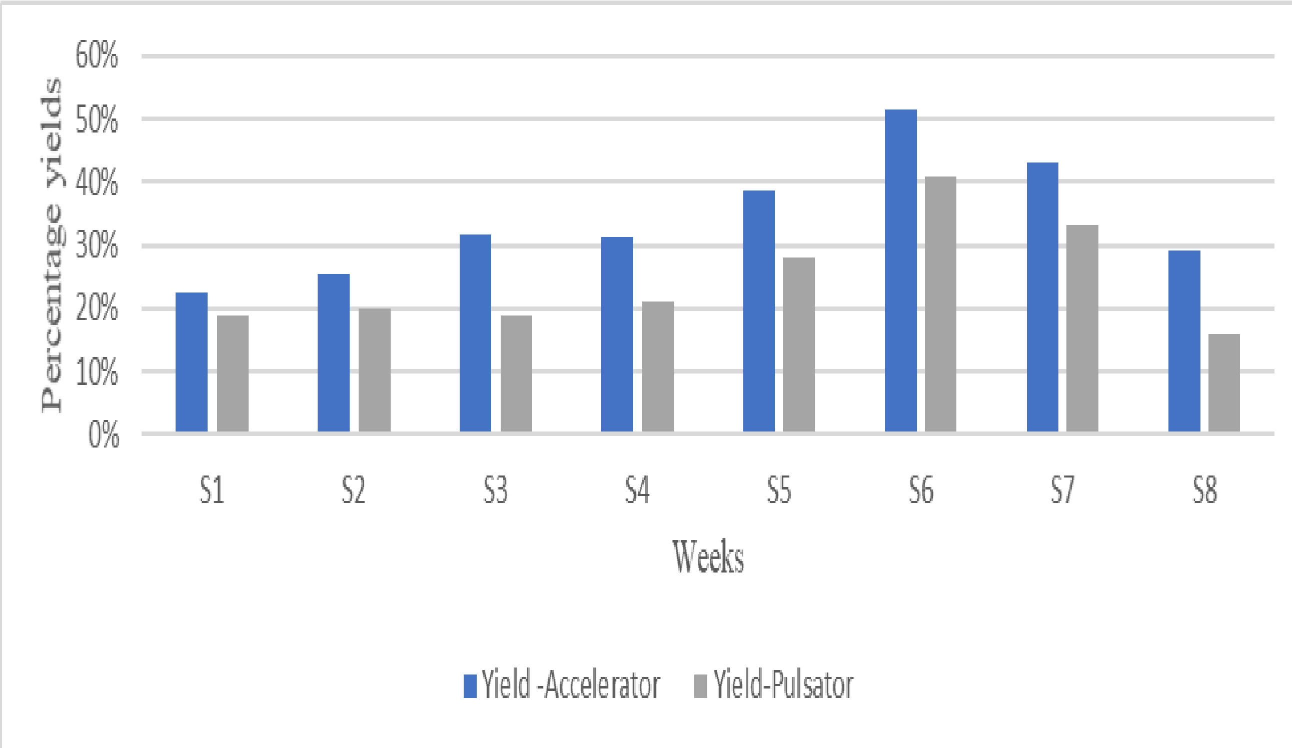

Figure 8:- MO yield of the two types of decanters.

Conclusion:-

At the end of our study, we can say that the two decanters are very efficient because both give good results. First with regard to the turbidity parameter, for values ranging from 6.4 to 12.1 NTU for raw water, we obtained a reduction ranging from 58 to 83% for the water decanted from the accelator decanter and from 51 to 75% for the water decanted from the pulsator decanter. Then for the pH, the values are of the order of 6.85 to 7.16 for the raw water, from 6.49 to 6.76 for the decanted water from the accelerator and from 6.46 to 6. .81 for the settled water from the pulsator. Regarding the conductivity, the results are 66.1 to 85.54 µS/cm for the raw water, 69.4 to 123.78 µS/cm for the settled water from the accelator and 67. 8 to 145 µS/cm for the pulsator. Finally the analysis on OM gave results of 6.7 to 9.34 mg O2/l for raw water, from 4.7 to 6.6 mg O2/l, a reduction of 22 to 52% and from 5.2 to 7.6 mg O2/l, i.e. a reduction of 16 to 41% respectively for the decanted water from the accelator and the pulsator. From the above, we see that the accelator gives better performance for turbidity and MO. In conclusion, we can say that both decanters give satisfactory results in terms of clarification, but that the accelator decanter is more effective because it gave better results during our study.

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