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Research Article

Study of some physicochemical and bacteriological properties for Produce Water of the Vortisand unit

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Abstract: The efficiency of the vortisand unit was tested on water treatment to produce water suitable for different purposes. Its efficiency was recorded in improving some of the physicochemical properties of raw water and the produced water and compared to Iraqi specifications. Samples were collected regularly from both raw and produced water during the months of December 2016 and January and May and June 2017. Both physical and chemical properties, including pH, Electrical conductivity µs \cm, Temperature °C, Turbidity NTU, Dissolved Oxygen mg\L ,Total Dissolved Solid mg\L and Total Suspended Solid mg\L were examined as well as Total plate count CFU \ ml and Total coliform cell\100ml.The results of the pH produced by the unit of vortisand showed that they were located within the weak base side, ranging from 7.3 to 7.93. The temperature of the produced water ranged from 9.66 to 30.5 while turbidity decreased from 343.33 to 2.88 NTU .The rates of electrical conductivity within the permissible limits, with the highest value of water produced 1026.66. While there was no good reduction in the number of total plate count and coliform bacteria with high soluble solids values.
Keywords: vortisand unit, raw water, cold month, bacteria, turbidity , Iraqi standard.

INTRODUCTION

Water represented 70% of the Earth's surface area, while freshwater accounts for 2% only of the total water [1]. Cultural development in all areas of life has created the necessary development in the establishment of stations for the purification of water suitable for human consumption, as well as attention to quality and conformity with local and global specifications [2]. The studies of the aquatic environment, inland waters, which are current and stagnant water, led to many suggestions to solve many of the problems of the times for different types of pollution due to technological progress. Studies and research have emerged to reduce the risks of pollution and other water purification. Al-Fatlawy [3] revealed a contamination of drinking water samples by 69%, as well as a correlation between the values of turbidity and the microbial content in drinking water. One of the signs of bacterial contamination is the total plate bacteria which gives an initial idea of the number of bacteria present and the colon bacteria because they are naturally present in the human intestine, so it is possible to pass through the drinking water inside the Filtration Stations [4]. Several techniques and treatments have been used to remove or reduce many physicochemical and microbiological standards to reach a better level in water purification processes. These techniques include the use of the vortisand unit to reduce some physical and chemical properties of water. This technique is used in many fields including water supply for swimming pools , drinking water production and many application. The turbidity is one of the most important physicochemical properties of water, as it is a measure of the amount of suspended particle's in it [5]. It is known that the amount of Turbidity in water sources is determined by a number of factors involving the characteristics of the region such as geology, topography, and the quantity of fallen precipitation and its vegetative cover that determines the amount of turbidity in raw water [5, 6]. Although turbidity has no direct effects on human health, it could form a safe haven for the growth of microorganisms, as well as its effect on disinfection and thus stimulates Bacterial growth, and its effects on the stages of treatment processes [7]. The pH is another important indicator, because of any increasing or decreasing in PH values affects the quality of the water; as its value rising causes Calcium carbonate deposition, while its decreasing effects on Corrosion properties which cause water pollution [8]. The appearance, taste and smell of public water also, represent the most

important physical properties, thus the turbid color could be explained due to the chemical or biological contaminants, water treatment or due to the presence of soluble substances, which cause problems like unsuitable of the consumers to use it in addition to the effect on the quality of water [9]. The percentage of dissolved oxygen in the water is an important factor affecting the quantities needed by the human body, on the taste of water when it is safe to drink, as well as its effect on the presence of organisms in the water environment [9]. Total dissolved solids represent the total ions of the solution and the ionic efficiency of the solutions, which have a poor effect on the quality of the water in the case of high values that increase the nature of water erosion [8]. The basis for the work of the vortisand unit is the removal of suspended materials and the reduction of turbidity; thus its increasing or non-removal form a good breeding ground for bacterial growth without the need for processes used in the traditional filtration system such as Coagulation and Flocculation. The sedimentation and filtration processes, as well as the Flocculation and coagulation processes, are the most important processes to be met in water filtration systems to obtain water conforming to local and international standards [6]. The aim of this study is to pay attention for a new type of units that can be used for different purposes in addition to the manner of filtering used to obtain water suitable for human consumption.

MATERIALS AND METHODS

Study Area

The study area included a conventional water purification station installed at the Ministry of Industry\ Al-Jadiriyah site\Iraq, which includes the following: a 3 × 3 × 18 m^3 water reservoir with a size of 162 m^3 filled with river water supplied through special pipes used for watering in the Jadiriyah area, agricultural soil was added to the area from the Rashidiya area to increase turbidity in this basin. It is equipped with fans to increase mixing, 2 x 2.5 m^3 sedimentary basins with three sloped walls, water collecting basin, Vertical and finally a reservoir for collecting and storing water produced. Vortisand was the objective of the current study, located on the same site linked to the traditional water purification station mentioned above with three lines to know its efficiency in reducing and improving the quality of raw water entering it, a tank height of about 1.250 m, contains four layers, each layer has a specific diameter of the particles as follows: Gravel (rock) diameter from 3.175-6.35 mm, second layer, third layer Sand diameter 0.5 mm and the final layer is Sand and a diameter of 0.15 mm. The pressure required for entering the water is 6 bar, with number of cycles 2860 RPM and the production capacity of the system is 23 m3/ h, the basis of its work is the movement of the vortex (centrifugal), which occurs as a result of the resulting pressure and then remove the contaminants from the surface of the first layer forcibly retrograde , The pollutant-free water is filtered through the sand layers and then into the final assembly

Collection of samples

The samples of the vortisand unit were collected in the cold and hot months, for both raw and produce water, which were in December 2016, January, May, and June 2017. The samples were collected once a month. The physical and chemical samples were collected using plastic bottles made of polyethylene of 500 ml, filled with sample water and closed tightly, then transferred to the laboratory directly to conducted directly [10]. Microbial samples were collected using glass bottles of 250 ml, Sterilized by the Autoclave at 121 °C and at 1.5 lb\ kg for 15 minutes, The tests were carried out immediately after reaching to the laboratory. Site tests were conducted which included measuring the water temperature using a mercury thermometer with gradients of 0 °C to 100 °C

Physicochemical tests

The PH was measured by using pH meter; the electrical conductivity was measured using electrical conductivity meter, while the turbidity was measured by turbidity meter. The modified Winkler method was used to measure the dissolved oxygen value 250 ml transparent bottles were used to collect raw and produce water samples, 2 ml of all manganese sulphate, azide, and sulfuric acid respectively [10, 11] .

Bacteriological tests

The total number of TPCs and total TC was measured using the Most Probable Number MPN [5].

RESULTS AND DISCUSSION

Physicochemical properties

Temperature

Temperature is one of the main environmental factors affecting water components, such as their effect on the dissolving of gases, taste and odor, as well as on the growth and survival of bacteria in water [12, 13]. Temperatures during the cold months (December and January) of raw water and sedimentation water were 10.16 ºC and 9.66 °C, respectively, while the temperature of the produce water from (raw and sedimentation lines) of the vortisand unit was 9.66ºC and 10° C respectively. Temperatures during the hot months (May and June) of the raw water and sedimentation unit water were 29 ºC and 31 ºC while the water temperatures produce from the raw and sedimentation lines were 28.33ºC and 30.5ºC respectively Fig(1). The results of the statistical analysis (T-test) of the water produced through the raw and sedimentation lines for the unit of vortisand during the cold and hot months showed no significant differences ($P<0.05$). The results indicate that there is a fluctuation in temperature, which originated from the sun like what observed in the study of Al Fatlawy [3].

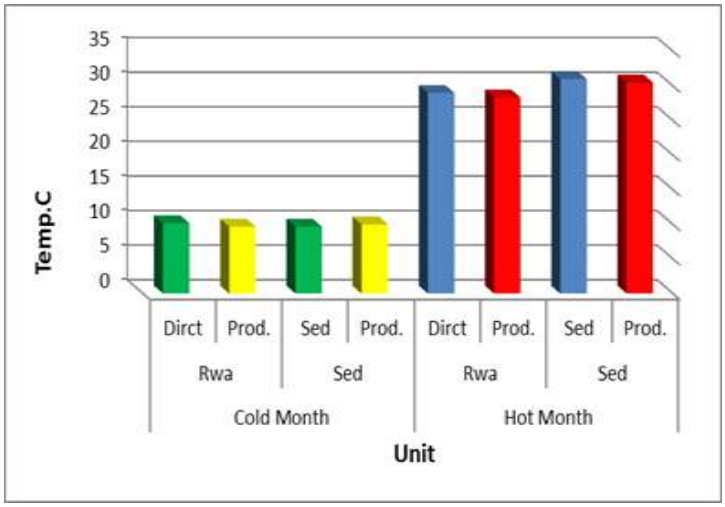

Fig-1: the average of temperature to raw and sedimentation water and Produced water from vortisand unit through the cold and hot month

pH

pH is an expression of the efficiency and activity of hydrogen ion in water [14]. It is also one of the most important factors for water solubility [15]. pH values were calculated during the cold months (December and January), for raw water and sedimentation unit water and found to be 7.5 and 7.56 respectively, moreover: the pH of the produced water from the unit of vortisand were 7.93 and 7.43 respectively, while pH during the hot months (May and June) of raw and sedimentation unit water was 7.63 and 7.73 respectively, in addition, the pH of the water produced from the unit of vortisand through raw and sedimentation lines were 7.7 and 7.3 respectively Fig.(2).The produced water was also located near the base and this may be due to the carbonate and bicarbonate in raw water which agreed with AL Mandeel and Mohammed study [16]. Furthermore, (T-test) statistical results for the water produced through the (raw and sedimentation) lines of the vortisand showed no significant differences ($P<0.05$). In addition, all the results of the pH for the produced water came within local and global standards [17, 18].

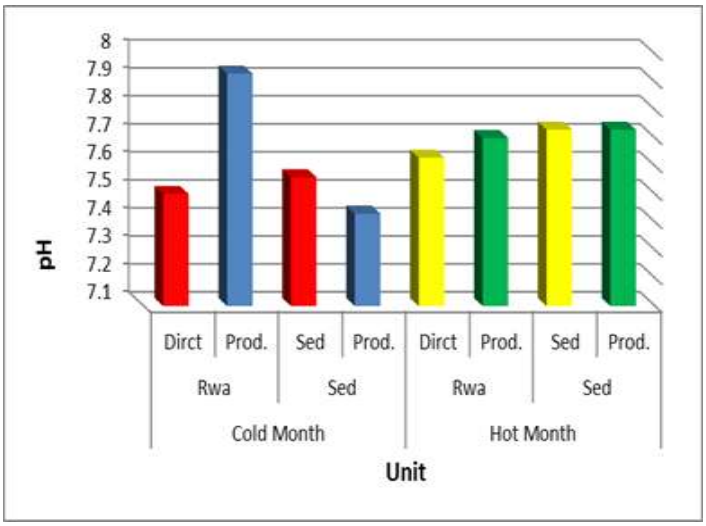

Fig-2: the average of pH to raw and sedimentation water and Produced water from vortisand unit through the cold and hot month

Turbidity

It is a measure of the degree of water transparency [19], as well as a good shelter for many microorganisms from the effects of sterile materials. During the cold months (December and January), the water levels of the raw and sedimentation unit were 215 and 36.80 NTU respectively, while the Produced water levels of the raw and sedimentation lines and the vortisand unit were 2.88NTU and 2.88 NTU, respectively Moreover: the water levels of the raw and sedimentation unit were 343.66 NTU and 4.95 NTU during the hot months (May and June) while the water produced for the raw and sedimentation lines was 125.33NTU and 2.88 NTU respectively Fig (3).The results indicated a clear removal of turbidity through vortisand unit of the suspended materials and others and

this is due to the quality of the treatment used and the movement of the vortisand as well as the constituents of the media which form the filter, this confirmed by Salman study [20] on the same unit of the site. The reason for this increase in Turbidity in raw water during the hot months is due to the high level of Tigris River as a result of the opening of the Mosul Dam, which led to the carrying of dust and mud during the run. The results of the statistical analysis (T-test) during the cold and hot months showed significant differences of water produced from the raw line (P>0.05) and no significant difference of water produced from the sedimentation line (P>0.05). In comparison to local standards of 2009 5 NTU and WHO (2011) 0-50 NTU standards, water produced from the raw water line for the vortisand unit of local standards despite the fact that there is a clear elimination of the droughts [17, 21].

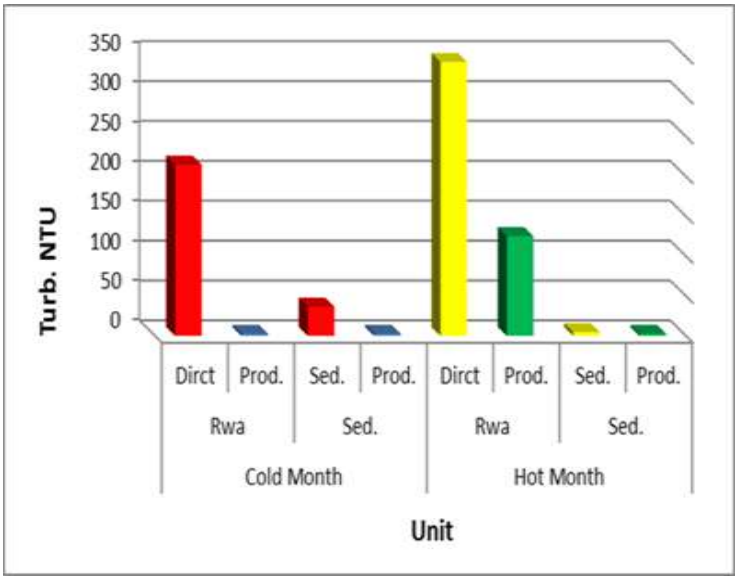

Fig-3: the average of turbidity to raw and sedimentation water and Produced water from vortisand unit through the cold and hot month

Electrical conductivity

Electrical conductivity is the ability of aqueous solutions to transmit electricity. It depends on the temperature, quality and concentration of ions contained in the water, as well as an estimate of the total dissolved solids in water, and evidence of water purity [22]. Hem showed that electrical conductivity increased by 2% in the case of temperature increase of the water by one thermal degree [23]. The electrical conductivity levels during the cold months (December and January) of the raw water and the sedimentation unit water were 858.33µs/cm and 876.33 µs/ cm respectively Fig.(4), The results of the (T-test) statistical analysis of the water produced from the raw and sedimentation lines through the vortisand unit showed significant differences and high levels (P>0.05) While the electrical conductivity levels during the hot months (May and June) of the raw water and the water of the sedimentation unit were 1054µs/cm and 936.66 µs/ cm respectively Fig.(4). The results of the (T-test) of the produced water through the vortisand unit showed no significant differences for the water produced by the raw line (P >0.05), but significant difference of water produced from the sedimentation line (P<0.05) The reason for these high differences in values may be due to technical reasons related to the quality of the treatment processes used and the quality of raw water containing some pollutants and can be removed during the unit because it does not have a mechanism to remove the salts [24] as well as study results matched with Al Hamdani and Al Faidal study [2]. The final results of electrical conductivity were shown to be within the local standards for 2009 which detected by 2000 µs / cm and WHO standards (WHO) by 2500 µs/ cm and the samples studied did not exceed the limits of [18].

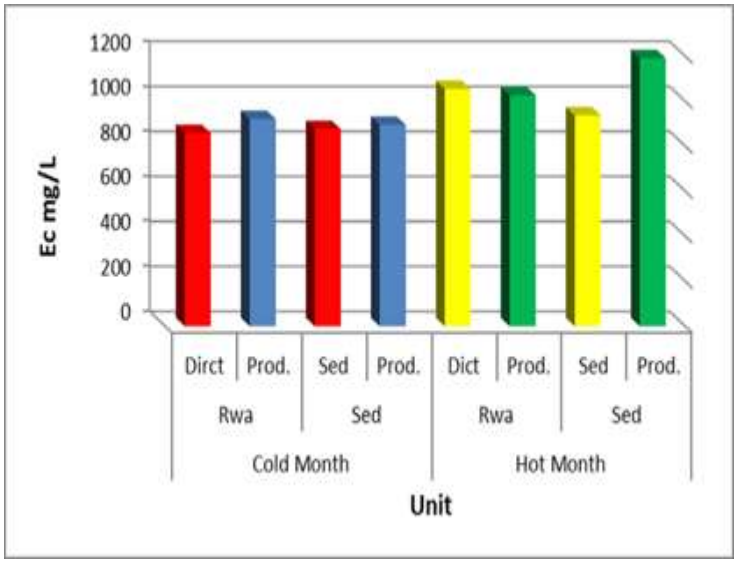

Fig-4: the average of electrical conductivity to raw and sedimentation water and Produced water from vortisand unit through the cold and hot month

Total dissolved solids

The primary source of dissolved solids in water is the compounds consisting of negative and positive ions [25]. During the cold months (December and January), the raw water and sedimentation water levels were 539mg/L and 550 mg/L respectively, while the produced water through (raw and sedimentation) lines and through the vortisand unit 540mg/L and 554 mg / L respectively Fig(5), While the dissolved solids during the hot months (May and June) of the raw water and the water of the sedimentation unit were 613.33 mg/L and 559 mg /L and the water produced from the lines of (raw and sedimentation) 612.66mg/L and 712.66 mg /L Fig (5). The results indicate that the vortisand unit is unable to remove the dissolved solids as described by Salman [20] in addition to the rise in solids during the hot days in the raw water in the traditional station due to the presence of the remaining samples of previous experiments for the high turbid of the river water added to the ground tank resulting in higher concentrations. The present study did not agree with previous studies including Al-Badr and Artin study [26]. and Al Fatlawy study [3]. The results of the statistical analysis (T-test) during the cold months showed no significant differences ($P>0.05$) for the water produced from the sedimentation line and significant difference of water ($P< 0.05$) during the hot months of water produced from the raw and sediment lines through the same unit.

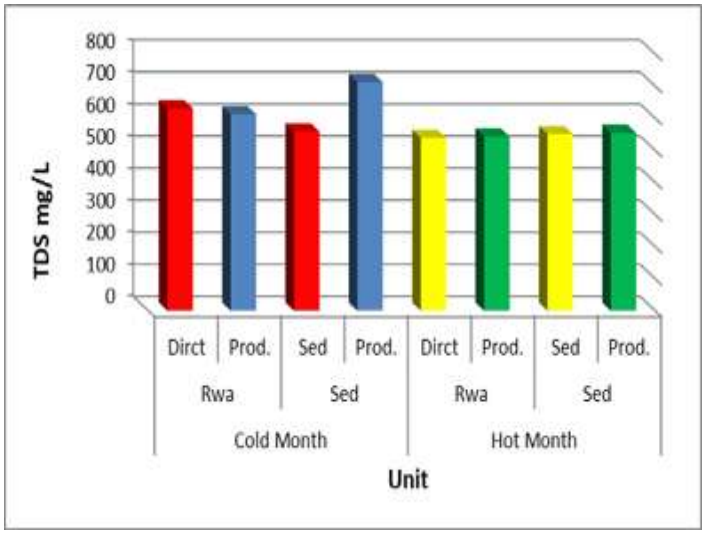

Fig-5: the average of Total dissolved solid to raw and sedimentation water and Produced water from vortisand unit through the cold and hot month

Total suspended solids

Suspended solids are solids that are not soluble in water such as clay, sand, etc, [25]. During the cold months (December and January), the suspended solids levels in raw and the sedimentation water were 44 mg/L and 32 mg/ L respectively. The water produced through

the raw and sedimentation lines of the vortisand unit was 39.33mg/L and 41.33 mg/ L respectively, During the hot months (May and June), the suspended solids recorded 51.33mg/L and 41.33 mg / L respectively. While the water produced through the (raw and sedimentation) lines of the vortisand unit were 40mg/L and 37.66 mg/ L respectively Fig.(6), the results indicate rising of solid materials in raw water, but its reduced in water produced through the unit. The results of the statistical analysis (T-test) showed that there were significant and highly differences during the cold months of the water produced from the sedimentation and raw lines (P <0.05) and no statistical analysis of water produced from the same lines during the months Warm and through same unit (P>0.05) .

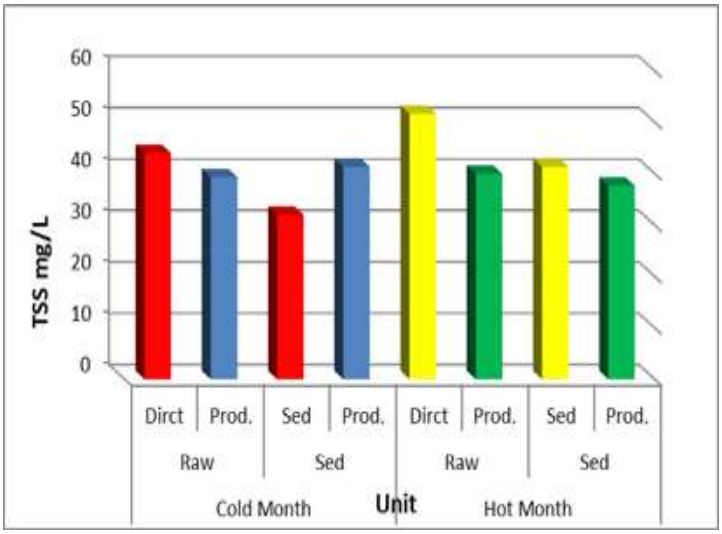

Fig-6: the average of Total suspended solid to raw and sedimentation water and Produced water from vortisand unit through the cold and hot month

Dissolved oxygen

Dissolved oxygen is the most important evidence for water quality assessment, therefore its effect on chemical and physical processes occurring in water [27], which represents an important element that directly controls the biological processes of living organisms, where its depletion or activation causes anaerobic degradation and leads to the formation of compounds and harmful odors [28].Dissolved oxygen is affected by several factors, including temperature, pressure and salinity [29]. During the cold months (December and January), the raw water and the water of the sedimentation unit were recorded in8.73 mg/L and 10.93 mg/L respectively, while the water produced by (raw and sedimentation) lines of the vortisand unit was9.33 mg/L and 8.63 mg/L respectively, the results indicated an increase in oxygen attributable to the low temperature of the water in addition to the vortex movement that helps to increase oxygen. While the dissolved oxygen rates during the hot months (May and June) of the raw water and the water of the sedimentation unit were 6.3mg/L and 5.6 mg/ L respectively, but it were 7mg/L and 6.1 mg / L for the produced water respectively Fig.(7). The reason for the low dissolved oxygen rates in the raw water is due to the presence of some pollutants that oxidize them and thus cause oxygen depletion[30]. While there is an increase in the amount of oxygen in the produced water due to the vortex movement. The results of the statistical analysis (T-test) showed no significant differences during the cold month of water produced from the raw line through the vortisand unit (P>0.05) and the significant difference of water produced through the sedimentation line (P<0.05), while there were no significant differences of water produced from tow lines through hot month (P >0.05). In comparison with the standards of the Iraqi Standard for 2009, all the produced water rates were within the limits detected by more than (5) mg/L also within the WHO standards (2011) which was detected at (6.8) mg/L [17, 21].

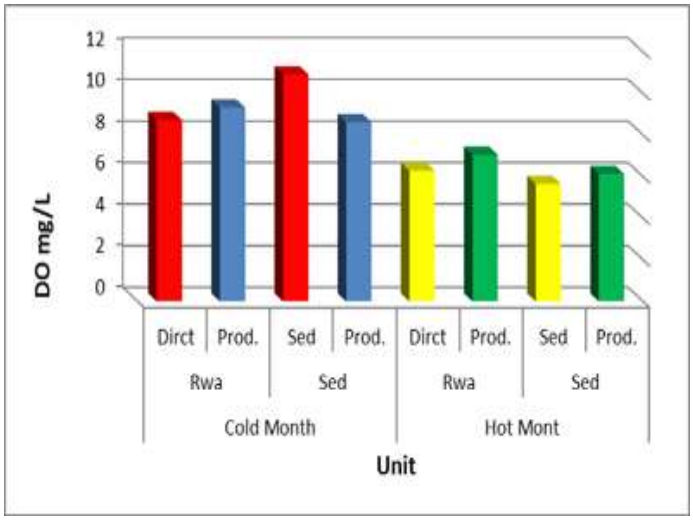

Fig-7: the average of dissolved oxygen to raw and sedimentation water and Produced water from vortisand unit through the cold and hot month

Bacteriological characteristics

Total Plate Count

Total Plate Count is one of the components of the ecosystem, which represent the living components. The reason for the increase or decline in its numbers in raw water due to the presence of a source of pollution [2]. It is one of the first and most important tests that can be conducted on water after transactions and treatments [31]. During the cold months (December and January), the number of TPC in raw water and sedimentation water was 2500 CFU /ml and 1900 CFU / ml respectively. The water count was 2300CFU/ml and 1800 CFU/ ml, 2300 and 1400 CFU/ ml respectively, the water produced was 2200CFU/ml and 2000 CFU/ml respectively Fig.(8). The results indicated that there was an increase in bacterial numbers in raw water as a result of the construction, cleaning and logging operations carried out near the station site, while the numbers were high in the produced water to adsorption of bacteria to sand grains, leading to contamination of filters [32]. Furthermore; the instability of the biophysics on the upper surface of the sand layer, which acts as a trap for the microorganisms due to the movement of vortisand that sweep the contaminants and that the bacteria are also affected by the presence of dissolved salts in water [33]. The results of the statistical analysis (T-test) showed no significant differences of water produced through the unit of vortisand ($P < 0.05$) during the cold and hot months. The study of Al-Aney [34], found that the increase in Numbers of bacteria during the rise in temperature. In comparison to the Iraqi standard of 2011, which determined Total Plate counts by 100 CFU/ml, did not match the measurements of water produced from the unit Specification.

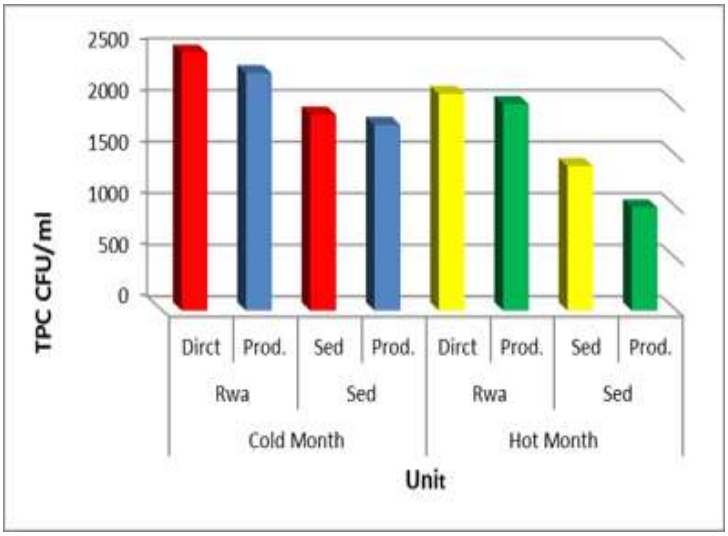

Fig-8: the average of Total plate count to raw and sedimentation water and Produced water from vortisand unit through the cold and hot month

Coliform bacteria

Those bacteria are a clear indication of the quality and validity of water for human use [35]. In the cold months, Coliform bacteria levels were recorded in raw water and sedimentation water for 1400 cell/100ml and 900 cell/ 100 ml respectively. The water produced from the raw and sedimentation lines by the vortisand unit were 23.0 cell/100ml and 12.0 cell/ 100 ml respectively Fig. (8). The results indicated rising in the number of coliform bacteria in water, this is mainly due to the lack of quality of the filtration station, which is why the number of bacteria increased after the water was released from the vortisand unit, which was explained by the [36]. In the hot months (May and June), the number of raw water and sedimentation water were 700 cell/100 ml, respectively, while the coliform rates of the water produced by the raw and sedimentation lines and through the vortisand unit were 23.0cell/100ml and 16.1 cell /100 ml respectively Fig. (8). The results indicated that there was pollution in the water produced by the vortisand unit due to the lack of sediments addition in sedimentation basins and also the lack of chlorine for water sterilization [37]. Compared with the standards of the 2011 Iraqi standard for coliform bacteria and the WHO standards identified by Zero cell /100 ml, the water samples produced through the vortisand unit were found to exceed the permissible limit [35].

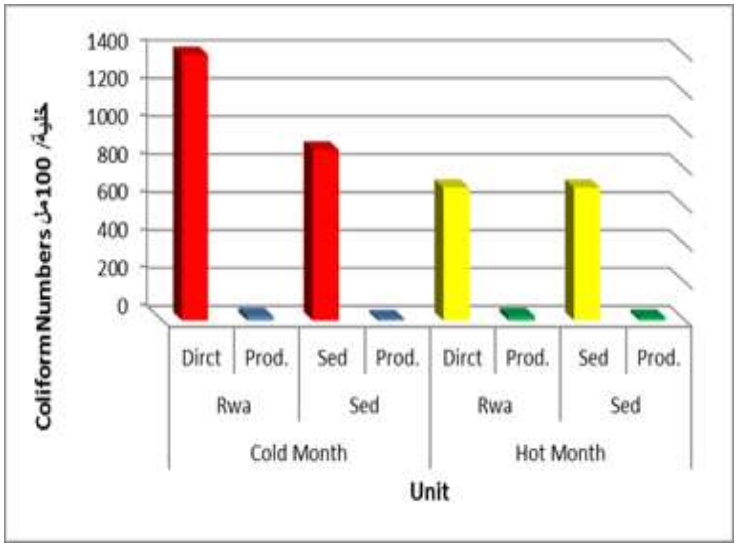

Fig-9: the average of Coliform bacteria to raw and sedimentation water and Produced water from vortisand unit through the cold and hot month

CONCLUSIONS

- The results obtained from the sedimentation line were better than from the raw line.
- The vortisand unit is not able to remove dissolved solids.
- The vortisand unit has a high capacity to remove turbidity by 99.6%
- There are rising in the values of dissolved oxygen by the movement of vortices.
- When the unit is used for the production of special water for human consumption, an RO unit is added to remove the dissolved salts and a unit for the final production of water.
- There's need to add a layer of charcoal or a substance that has microbial properties on the surface sand layer to reduce or eliminate bacterial preparations.

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