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# Technical article on the removal of the foam layer from clarifiers in water treatment plants with intakes from a distant source

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**ABSTRACT**

The Kafr El-Sheikh Water Plants in Egypt, which are treating River Nile water, are confronted with high consumption of water for backwashing the rapid sand filters and elevated levels of turbidity in the effluent of the clarifiers and sand filters. It turned out that these problems are connected with the formation of foam layers in the clarifiers. The appearance of foam layers is attributed to the formation of tiny "air bubbles" in the water entering the clarifiers, resulting in the flotation of the sludge particles. Tiny "air bubbles'' are most likely formed due to supersaturation with air and/or oxygen of the raw water. Supersaturation might occur in the open channels through which the raw water travels over the long distances from the Nile to the plants. Such a supersaturation with air might be caused by increasing the temperature during the journey of the raw water and/or the growth of algae, which use to produce oxygen during day time. To mitigate the problems due to the formed sludge layers, low-cost gutters, and sprinkler devices are installed. These measures resulted in a substantial reduction of the consumption of water for backwashing the rapid sand filters and improved turbidity of the effluent of the clarifiers and filters.

*Keywords:* Foam layer; Clarifier; Sludge; Distant intakes; Water treatment plant

## 1. Introduction

Egypt depends on the Nile River water. Kafr El-Sheikh Company is far from the Nile so most of our plants receive water from distant canals. All plants that treat surface water depend on sedimentation, filtration, and disinfection. Large amounts of water can be wasted during treatment processes, especially those suffering from high levels of suspended matter present in the effluent of clarifiers. These high levels of suspended matter result in frequent backwashing of the rapid sand filters, causing high consumption of treated water. The main objective of this investigation was to obtain the best and most appropriate means to remove the foam layer from the clarifiers in water treatment plants fed with raw water that has been transported over long distances in open channels.

## 2. Materials and methods

Analysis of water samples was carried out according to the Standard Methods for Examination of Water and Wastewater [1].

All chemicals and reagents used were of analytical reagent grade and some of them were used as such without any further purification. Reagents used included magnesium oxide, potassium sulfates, boric acid, sodium bicarbonate, silver nitrate purchased from Merck-Sigma and mercury oxide purchased from Riedel-de Hean, Eriochrome Black T, Murexide, and Eriochromcyanin R were purchased from Merck.

Sodium hydroxide and potassium dichromate were purchased from Fluka, chemical oxygen demand vials

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were purchased from HACH 2000, while pH buffer 4,7 was purchased from Orion.

Nitric, sulphuric hydrogen peroxide were purchased from Merck KGaA, hydrochloric acid from Sigma, m-Endo agar LES medium obtained with m-FC agar medium from BD.

### *2.1. Solutions*

- 0.02 N and 0.01 M solutions of sulfuric acid were prepared by dilution with distilled water from a concentrated solution.

### *2.2. Physical parameters*

- Dissolved oxygen (DO) was measured using a DO meter, WTW Oxi 730.
- Turbidity was measured using benchtop WTW 555.
- Electrical conductivity (EC) was measured using JENWAY.
- Alkalinity, chlorides as $Cl^-$ and total hardness were detected by titration.

### *2.3. Chemical parameters*

- Major cations and heavy metals were measured using atomic absorption spectrometry.
- Major anions were measured using ion chromatography model Dionex IC3000.

### *2.4. Microbiological parameters*

- TC density was determined using a membrane filter technique according to standard method (APHA) on m-Endo agar medium.
- FC density was determined using membrane filter technique according to the standard method (APHA) on m-FC agar medium.

## 3. Discussion

The aim of this study which extended from June 2018 to May 2019 seasonally was to evaluate the impact of foam layer removal on water quality in the clarifier step. Evaluation processes include survey and monitoring of persistent inorganic and organic pollutants as concluded from analyses of physical, chemical and microbiological parameters for collecting water samples from different selected localities including sites from clarifiers in the Balteem water treatment plant before and after the construction of water sprinklers and sludge collection in a low-cost gutter which will collect all sludge particles before forming a large sticky layer which is very difficult to be removed as shown in Figs. 1 and 2.

### *3.1. Disadvantages of a foam layer*

- Algal and bacterial growth;
- Consumes chemicals;

Fig. 1. Before modification, a foam layer was formed.

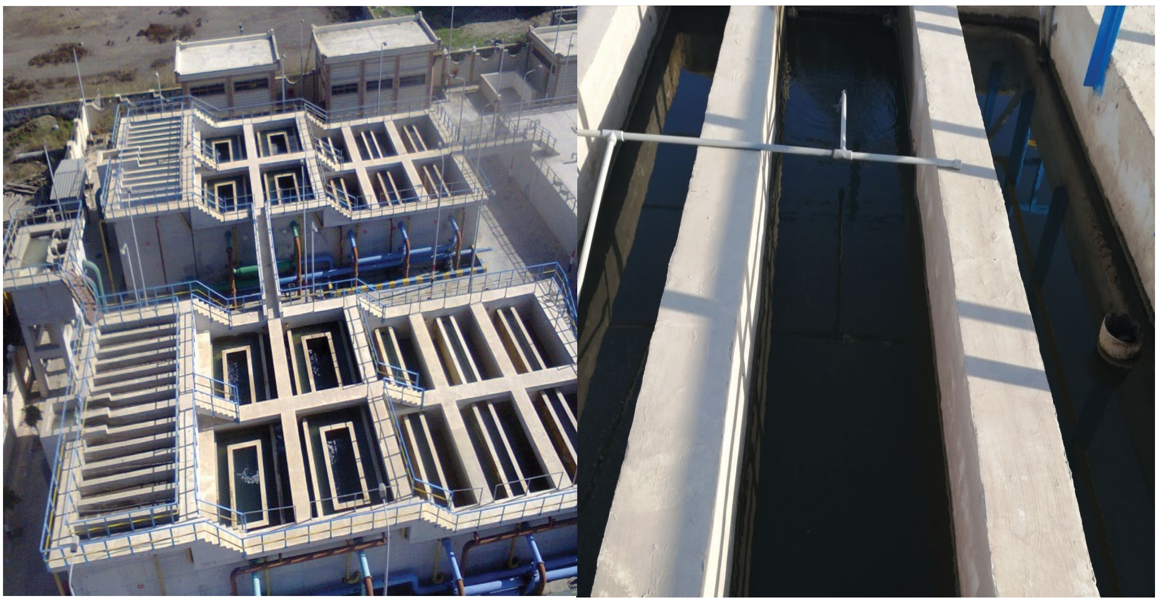

Fig. 2. After modification, the foam layer is removed.

- Increases water turbidity;
- Washing consumes huge amounts of water (approximately 1,000 $m^3/d$);
- Very hard to clean manually;

Water sprayers break down the sludge layer and by using a low-cost gutter all sludge particles will be collected before forming a large sticky layer which is very difficult to remove.

The results obtained from this study can be summarized in the following main categories:

- Evaluation of water quality for collected samples before and after modification.
- The physical-chemical parameters of water samples. [pH – EC – total dissolved solid (TDS) – DO – nitrates – ammonia – all heavy metals] concentrations.
- The microbiological parameters of samples. (TC – FC – algal count).

Most results were within the permissible limits of 48/1982.

### 3.2. Turbidity

The turbidity values (Table 1)[ represent the number of impurities and suspended solids in water. These values show the difference in turbidity before and after modification in one clarifier as shown in Fig. 3.

### 3.3. Total dissolved solids

Total dissolved salts are a measure of the number of particulate solids that are in solution and indicator of non-point source pollution problems associated with various

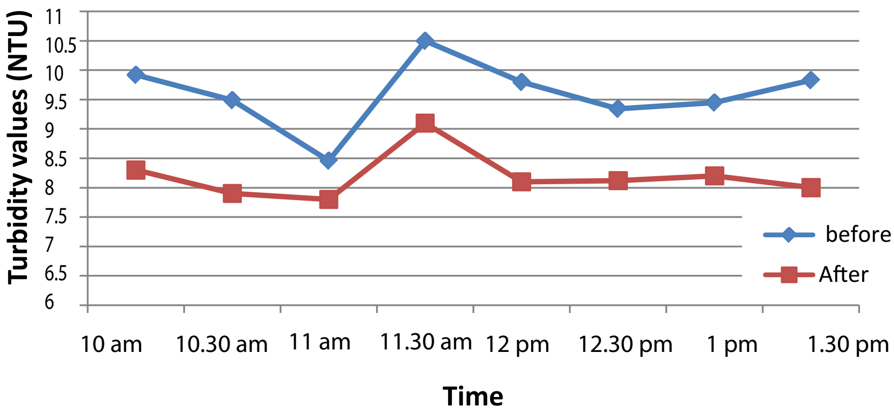


Fig. 3. Turbidity values decrease after modification.

Table 1
Turbidity values with time

| No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Time | 10 am | 10.30 am | 11 am | 11.30 am | 12 am | 12.30 am | 1 am | 1.30 am |
| Before | 9.92 | 9.49 | 8.46 | 10.5 | 9.8 | 9.34 | 9.45 | 9.83 |
| After | 8.3 | 7.9 | 7.8 | 9.1 | 8.1 | 8.12 | 8.2 | 8 |

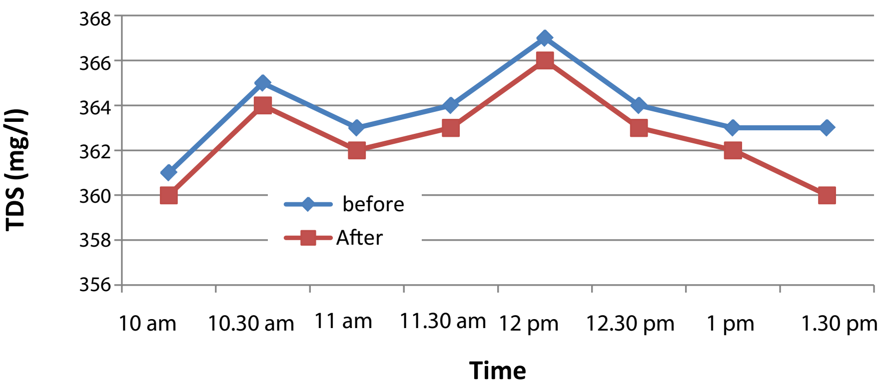


Fig. 4. TDS values decrease after modification.

Table 2
TDS values with time

| No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Time | 10 am | 10.30 am | 11 am | 11.30 am | 12 am | 12.30 am | 1 am | 1.30 am |
| Before | 361 | 365 | 363 | 364 | 367 | 364 | 363 | 363 |
| After | 360 | 364 | 362 | 363 | 366 | 363 | 362 | 360 |

land-use practices [2]. Fig. 4 shows the effect in one clarifier on after modification.

The only reason for the lower TDS content after the modification is that they could operate the clarifier with a lower dose of coagulant, for example, aluminum sulfate, as are the sulfate concentration will be lower and consequently the TDS.

The reason for the lower TDS after modification is attributed to the lower required coagulant dose, for example, aluminum sulfate, resulting in a lower sulfate concentration.

## 4. Conclusions and recommendations

Removal of the foam layer improves the water quality effectively; and it saves a lot of water needed that can be lost by the usual backwashing washing the sand filters process (approximately 1,000 $m^3/d$), so we recommend the use of water sprinklers and installing sludge collection gutter in all water treatment plants where the similar problem appears.

## References

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[2] M.E.M. Goher, Chemical Studies on the Precipitation and Dissolution of Some Chemical Elements in Lake Qarun, Ph.D. Thesis, Faculty of Science, Al-Azhar University, Egypt, 2002.