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Zeolite Effective Use in Treatment of Physical and Chemical Properties of Sewage Water Discharged from General Samarra Hospital

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Abstract. The current study was conducted to evaluate the sewage water and its processing in General Samarra Hospital, Salah Ad Din Governorate, Iraq in 2019–2020. The study included the analysis and measurement of physical and chemical properties with low-cost natural processing with no side effects to reduce the harmful water pollution in Tigris River. The results of the present study showed that the conductivity, turbidity and total hardness of Sewage water decreased from 1596 µs/cm to 727 µs/cm, 332 NTU to 28 NTU, 633 ml/l to 491 ml/l, respectively. The concentrations of biological dissolved oxygen, total suspended solid, and total dissolved solid increased, and those of preprocessing nitrates (104, 0.53, 966, and 25.2) varied significantly with the results of post processing (52, 0.03, 361, and 12.0, respectively). The results showed the efficient processing of sewage water when treated with zeolite rocks powder.

Keywords: Zeolite, Sewage water, General Samarra hospital

INTRODUCTION

Nowadays, water pollution is becoming a serious threaten for public health and agriculture production beside industries and economy. To remove pollutants from water there are conventional methods including filtration, sedimentation, biological treatment, chemical coagulation, crystallization and adsorption. Among these methods, adsorption by using zeolite conceded to be one of the most prospective approaches. Zeolite in the recent years has received much attention in scientific field due to its special properties and low cost so far Sewage water treatment by zeolite can reduce turbidity and chromaticity, degrade ammonium, heavy metal cations and other pollutants.

Zeolite are porous hydrated minerals with anionic framework, the pore is formed by different tetrahedral combination. Thus, zeolite have the cations exchange ability in structures, accepting or losing water molecules. The removal mechanism of pollutant is below a) ordered and communicated holes or channels in the crystals interior. b) excess negative charges of zeolite framework could be balanced by monovalent or to valence cations (Na^+, K^+, Mg^{2+}, Ca^{2+}) [1]. The results of zeolite adsorption show good performance for removal of ammonium. Besides it is a potential adsorbent for removal of heavy metals cations. [2]. The process of collecting and disposing liquid waste from its sources during the production of sewage water and pollutants of hospitals and factories and dumping it into the Tigris River has a great impact on the general health of humans and the rest of the community [3]. Hospitals produce relatively large quantities of Sewage water which may contain various hazardous materials [4].

Sewage water is affected by various properties, and the concentration of hydrogen ions present in a medium determines pH and is considered an indicator of the nature of the site, whether basic or acidic [5]. The water leaving hospital departments contain total dissolved solid (TDS) and total suspended solid (TSS). Given their quantity, TDS

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and TSS are considered one of the main pollutants of hospital Sewage water, a portion of which may contain highly toxic substances that are flow, discarded from the hospital and dumped into the Tigris River. In this study, all the values obtained after treatment was less than [6]. those observed in other Sewage water studies due to the efficiency of processors, such as nitrates, which are formed in water when dissolved oxygen is available, resulting in the oxidation of nitrates into nitrates [7]. Given that the nitrite ion is unstable, it transforms into the more stable form which is nitrate [8]. The low values of nitrite result from the decreased reduction of nitrate to nitrite in winter, and the presence of nitrite increases with the decrease in dissolved oxygen [9]. Hospital Sewage water is one of the most important sources of drug waste in all Sewage water treatment plants, and the removal of these pollutants permanently is ineffective. Chemical pollutants, heavy materials, disinfectants, and specific detergents originating from diagnosis, laboratory, research activities, and drug excretion by patients result in the negative impact of hospital Sewage water on human health and the environment [10]. Mineral absorption in plants presents a great opportunity to use suitable plant species to clean the environment. Although increasing studies are now examining this issue, a limited number have reported the simultaneous removal of nitrogen and phosphorous in real Sewage water using nanomaterials [11].

OBJECTIVES OF THE STUDY

1. To shed light on the current situation and the use of Sewage water for various purposes, whether agricultural or for human use, in conditions of water scarcity;
2. To find natural and environmentally friendly alternatives in water purification at low economic costs.

Geological And Structural Description of The Study Area

The region generally consists of river deposits, whether it is the ancient or modern delta, as well as the air deposits represented by sand dunes in the eastern part. As for the old river deposits, it includes gravel deposits, represented in the western region of the region with simple wavy surfaces. Under the river sediments, it was mentioned [12,13] That there are gravel and conglomerate sediments that belong to the Bakhtiari Formation, and this formation appear clearly in the Tigris River in Samarra, and at the bottom of these gravel sediments rests Injana formation (Upper Miocen) with components mostly sand stone, siltstone and claystone in addition to the presence of a percentage of secondary gypsum in some of its parts, The Fatha formation (Middle Miocene) at the bottom of these sediments consist mainly of limestone layers, mudstone, siltstone, shale and mass deposits of gypsum and anhydrite in addition to rock salt deposits [12]. and these formations appear clearly In Hamrin, Fatha formation rocks in hamrin considered the main source of salt.

The structural situation of the study area is that the area is located in the northern part of the mesopotamian zone within the unstable shelf according to Boday [14]. Specifically in the northern part of the Tigris Range [15] mentioned this part of the range had been strongly affected by the alpine movement. also mentioned the existence of a transverse fault of a general direction (WSW-ENE) that extends hundreds of kilometers and enters the Iranian border, which is the result of a vertical movement with anticline under the surface extending in the same direction as It is determined based on the results of geophysical measurements, and that the distinctive structure in the region is the presence of a Syncline, it was mentioned [13] that the Bakhtiari Formation appears exposed in the western part of the region and on the banks of the Tigris River, in which the layers are slightly inclined towards the northeast (NE) as for the northern wing The fold appears at Hamrin , and the slope of the layers is in the southwest direction (SW), so the study area is located in low structural area.

Topography of the Study Area

From the topography side there are found many Different feature of topography as slopes, valleys, depressions, and plains. the sediments of the Injana formation constitute the main upper Aquifer of the region that placed to the west of the Tigris River, while Quaternary sediments constitute the upper aquifer of the area, where these deposits are an appropriate thickness helps to store water and keep it within the general area. The general direction of groundwater movement is in line with the topography of the region in general is towards the south generally [16].

Properties of zeolite

The zeolite structure is very interesting complex. The units are Sio_4 and ALO_4. Via oxygen ions unit (primary building units (PBU) transfer into (secondary building units (SBU)), which are linked into three-dimensional crystalline structure of zeolite. The chemical reactions of Si and Al define the negative charge; therefor, zeolite appears as cation exchangers. Via aqueous bridges, the water molecules can bonded to ions framework and exchangeable ions. PBUs are linking and formation the unique structural units. This unique structure is highly porous with cavities and channels that have ultimate result of treating Sewage water [17].

Sewage water treatment

One of the most perspective area and oldest is the use of zeolite in Sewage water treatment. The heavy metals in Sewage water is a big challenge in the environment and there removal by natural product such as zeolite, have been studied for long time with other technologies like ion exchange, adsorption, chemical precipitation, membrane filtration, flotation, coagulation flocculation and electrochemical space.[18]. Recent studies of zeolite as adsorbent in Sewage water treatment, showed the properties and possible modification such as ion exchange capacities for cations. The modifications can be performed by several methods like acid treatment and surfactant functionalization which can show high adsorption capacity for organic matter and anions (heavy metals).[19].

Selection a zeolite treatment

Zeolite is a 100% natural product that was created as a result of geological processes, such as the decomposition of volcanic glass and its interaction with alkaline water, millions of years ago. Zeolites are mainly composed of aluminum silicate minerals and are distinguished by numerous qualities due to their unique structural composition. They belong to the most popular and widely available natural ion exchangers, which consist of an aluminosilicate molecular structure with weak positive bonding sites [20].

Zeolite is used as a major material in the treatment aimed at the removal and reduction of certain physical and chemical characteristics that cause pollution. In this study, zeolite was milled and used on samples obtained from the Sewage water plants of the Samarra General Hospital and left for a period of time to reach the maximum treatment.

Materials and methods

The changes in the estimation of some physical and chemical characteristics for Sewage water of Samarra General Hospital is shown in Table 1.

TABLE 1. physical and chemical characteristics for Sewage water of Samarra General Hospital

Processing type	**ZEOLITE**		**Liquefaction plant water before and after zeolite treatment**		**Measurements of the Tigris River in the district of Samarra**	**Allowed limits**
Measurements						
	Before Tr	After Tr	Before Tr	After Tr		
pH	7.2	7.6	7.8	7.5	7.4	6-9.5
EC µs/cm	1596	727	257	169	1632	1600
TSS ml/L	0.75	0.11	0.11	0.05	68	60
TDS ml/ L	978	364	182	152	547	1000
BOD_5 ml/L	104	45	11	5.2	95	40
Turbidity NUT	332	28	318	21	142	-
Total Hardness ml/L	633	491	141	109	364	250
No_3 ml/L	22.3	12.0	10.2	4.9	52	50

Sample Collection

The experiment samples included zeolite powder. Zeolite was obtained from Istanbul–Turkey and milled with a laboratory electric grinder until a fine powder was obtained. Then, the powder was passed through a sieve with a hole diameter of (0.5 mm). Finally, the powder was placed in sealed plastic bags and kept until use.

How To Use Hydrotherapy

Specific proportions [4,6, and 10] of zeolite rock powder were used per 100 ml contaminated water. Then, the most efficient concentration was selected for the treatment.

Physical And Chemical Characteristics

Electrical Conductivity (EC)

After its calibration, a multi-parameter analyzer (Lovibond, con200 model) was used to measure the EC of the samples, and the results were expressed in (µs/cm).

pH

A consort-type pH meter (C830) was used after calibration with buffer solutions with a pH of (4, 7, and 9).

Biological Oxygen Demand (BOD)

The same method of measuring dissolved oxygen was used, and the BOD bottles were filled with (250 ml) sample, transferred to the laboratory, and then kept for five days in a water bath at 25 ° C. The results were expressed in mg/l depending on [21].

Turbidity

Water turbidity was measured by a HANNA-LP2000 turbidity meter, with the device expressing standard solutions in naphthalene unit (NTU) as the brownish unit after the device has been calibrated.

TDS

The dissolved materials were measured in accordance with the method mentioned in [10], filtering (100 ml) sample on a filter paper (0.45 µm) and collecting the filtrate in a vessel of known weight (B). Then, the filtrate was evaporated in an oven at a temperature of 103–105 (c) for a period of (24) h and weighed afterward (A):[22].

TSS

The suspended solids were measured by filtering (100 ml) sample on a filter paper (0.45 µm) with a given weight (B). Then, the filtrate was evaporated in an oven at a temperature of 103–105 m for a period of (24) h, after which it was weighed (A).

Nitrate

Nitrate was measured by ultraviolet spectrophotometry screening method [23]. using the ultraviolet-visible Biochromic LKB Spectrophotometer. The absorbance was measured for each sample at the wavelengths of (220 and 275 nm), and through standard solutions, the nitrate concentration (mg/l) was determined from the equation for each.

RESULTS AND DISCUSSION

pH

The results of the study (Table (1)) indicated significant differences in the pH of the Sewage water discarded from the hospital under study. The type of treatment had an effect on reducing pH, agreeing with a study on zeolite efficiency (16) which showed a removing maximum efficiency up to 85%.

EC

The EC represents the positive and negative ions present in the discarded water from the sites covered by the study. The results of the current study showed that the discarded water from the different study sites varied in terms of EC in a highly significant manner (Table (1)). The EC of the water discharged from the hospital increased to **(1586** µs/cm), but decreased to (**268** µs/cm), in the liquefaction water.

The observed rise in EC was due to the various dissolved substances contained in the water leaving hospital departments, resulting from the effective operations in these sites. The presence of dissolved materials led to an increase in the solution degree and thus increased the conductivity values. As for the effect of treatment methods, the studied results in Table (1) indicate the effectiveness of the treatment with zeolite powder in reducing these values, with EC reaching **(719** and **164** µS/cm) for hospital water and liquefaction water, respectively.

TDS

Total dissolved materials are one of the main components of the water discharged from hospital departments. They represent the wastes originating from raw materials during operations, laboratory analyses. Table (1) indicates differences in the values of TDS in the study site. The highest value of total soluble substances was observed in the Sewage water from General Samarra Hospital (**957** mg/l), and the value decreased to **(354** mg/l) after treatment. The value of **TDS** in the water sample of the liquefaction plant was (**178** mg/l). The high concentration of dissolved substances may be caused by the large number of wastes produced during and after the end of the operations and during cleaning of polluted halls. Table (1) shows the effect of the treatment methods on these materials. The water treatment with zeolite powder achieved positive results in reducing the concentration of total solids. The concentration of these substances decreased to 361 mg/l after the treatment with zeolite powder. The concentration of dissolved salts in the water in the treated sites showed agreement with previous results [24] and is similar to the finding obtained in [25].

TSS

The TSS in environmental studies represents the number of solid plankton in water, whether drinking water or Sewage water. The presence of planktons in large proportions renders water unfit for human uses. The increase in TSS is depend on the frequent use of formaldehyde, which is considered the most dangerous pollutant of Sewage water by virtue of its use in pathological laboratories and surgical departments for preserving samples and sterilizing medical devices and tools [26].

Therefore, environmental research has been concerned with measuring the concentration of these substances and how to treat them to remove or reduce their amount in water. The treatment of Sewage water with zeolite powder showed high efficiency in reducing the amount of TSS present in water outside the hospital. The treatment with this substance reduced the TSS concentration from (**0.48** mg/l) to (**0.06** mg/l). Reducing the concentration of these substances from the water leaving hospitals that is destined for the waters of the Tigris River will lead to contamination of the river and the arrival of suspended materials to water liquefaction stations. Water is pumped to vital homes and facilities. The reduction of TSS implies preventing these materials from ending up in drinking water.

BOD

Table (1) shows that the highest concentration of bio-oxygen in hospital Sewage water was 101 mg/l, whereas the concentration after treatment was (48 mg/l). The reason for this increase in the vital oxygen requirement may be the increase in organic excreta caused by the vital activities of patients. The increase in BOD in the discharged Sewage water is an indication of pollution [3]. As for the treatment parameters of water, Table (1) also reveals that the treatment with zeolite powder achieved the best results in reducing BOD. The concentration of vital oxygen requirement after the treatment of liquefied water was (**11** mg/l) compared with that before treatment. The reason for this decrease may be the chemicals that can bind to biological oxygen, which led to a decrease in its concentration in the aqueous medium, or the increase in the percentage of solvents used by hospitals and medical laboratories, and the increase in medical waste of mercury, which is highly toxic, that is used in medical clinics and is discharged into the sewage network. The results for the BOD of the treated samples matched that of a study [27]. but differed from that of another research.

Total Hardness

The highest total hardness value (Table 1) was observed in the hospital water (**628** mg/l), but it decreased to (491 mg/l), after treatment. The increase in hardness may be due to the nature of the chemicals introduced in these waters and used in surgical procedures. The reason is that the waste added to the river. This finding agrees with numerous studies which indicated a high total hardness in Iraqi waters. After treatment, the water becomes suitable for human use, according to the Iraqi Standard Specifications and the specifications of the World Health Organization [28].

Turbidity

Sewage water is extremely cloudy because it contains large quantities of suspended matter, which reduce the temperature of water by dispersing and absorbing light [28]. The treatment methods for discarded water show a significant effectiveness in reducing the brownish color. The results in Table (1) indicate that zeolite powder had a significantly strong effect in reducing the brownishness of Sewage water. The brownish color before treatment was (339 NTU), and it reduced to (18 NTU), after the zeolite treatment. The capability of zeolite powder to reduce brownish values is due to the containment of this powder, which consists of grains of limestone and the limestone, and its capability to catch plankton and raise its molecular weights, which leads to sedimentation at the bottom and clarity of water. The results for the brownish values were in agreement with those of a study [29].

Nitrate (NO3)

The nitrate value before the treatment with zeolite powder was 27.6 mg/l. This number differed significantly from the result after treatment (14 mg/l). The high nitrate value in Sewage water may be due to the tests and analyses conducted in hospitals, in which the main component is nitrogen. When combined with dissolved oxygen in water, this element transforms into nitrate. The Sewage water treatment with zeolite chemical powder affects nitrate concentration [30-34].

Conclusions

1- The low level of contamination in the treated water resulted from the use of zeolite during treatment, which showed high efficiency.

2- The results showed that zeolite rock powder distinctly removed pollutants from hospital Sewage water.

3- The study showed alternatives, which consist of low-cost and highly effective procedures, to traditional treatment methods of treating polluted water.

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