The textile sector uses high amount of water, and various chemicals, such as inorganic compounds, elements, polymers and organic products are used in this sector [1, 2].

The textile wastewater is characterized by high pH and alkalinity, and contains highly organic matter and dyes [3]. Color in textile wastewater is an important parameter that must be removed due to the resulting reduction in light penetration, which precludes photosynthesis and is aesthetically undesirable in receiving media [4].

Although the dyes that are the source of the color are at low concentrations in the wastewater, they form undesired visual pollution [5]. There are more than 100000 commercial dyestuffs, and over 7.10^5 tons of dyes are produced each year [6].

Removing the color of dyes from wastewater is difficult because of their chemical structure and synthetic origin. The methods most commonly used for color removal from textile wastewater are the coagulation/flocculation process [7, 8], coagulation, Fenton and adsorption processes [9], coagulation-
floculation and advanced oxidation processes [10], biological and chemical treatments [11, 12], aerobic biological treatment [13], anaerobic biological treatment [14], microfiltration [15], electrocoagulation [16, 17], solar photocatalysis [18], ozonation, adsorption and biological treatment [19], reverse osmosis and nanofiltration [20, 21], adsorption and ultrafiltration [22], electrocoagulation/nanofiltration [23], and advanced oxidation processes [24, 25].

In the literature, color removal from textile wastewater by different treatment methods was investigated and higher removal efficiencies were obtained. Ilhan et al. [26] studied the Fenton process on acrylic yarn dye-house wastewater and achieved 82.8% COD, 96.2% color, 75.6% TOC removal. Yadav et al. [9] applied coagulation, Fenton oxidation and adsorption on textile wastewater and 100% color and over 83% COD removal efficiencies were obtained at optimum conditions. The UASB reactor was evaluated for color and COD removal from real textile wastewater, and 30% color and 96% COD removal efficiency due to biodegradation was achieved by Amaral et al. [27], while Buthelezi et al. [28] obtained 97% color removal efficiency from textile wastewater by indigenous bacteria. Dhaouefi et al. [29] obtained 78% of TOC, 47% of nitrogen and 26% of phosphorus removal from synthetic textile wastewater using anaerobic/aerobic treatment process.

Color removal by coagulation and adsorption methods was studied by different researchers in the literature. Coagulation with FeSO₄ followed by adsorption processes was applied and 99% of the color was removed [9]. Sadaf et al. [30] investigated dye removal by adsorption using bagasse, an agricultural waste. The results showed that a maximum dye removal was obtained, and Langmuir isotherm is appropriate. According to the results, the bagasse is an efficient biosorbent for the removal of Indosol Turquoise FBL. In another study conducted by Baseri et al. [31], basic dyes from synthetic textile effluent were removed by activated carbon prepared from wood, and color removal efficiencies up to 98% were obtained.

Color removal by adsorption is one of the most effective of the physico-chemical treatment methods. The activated carbon is an adsorbent commonly used for color removal; however, its cost is quite high. Therefore, cheaper and newer adsorbents are required for use in the adsorption process [32]. Different adsorbents, such as tree crumbs, volatile ash-cool mixtures, silica gels, natural clays, and corncobs could be used for color removal from wastewater. The cheap prices and ease of supply of these adsorbents make them favourable [33].

The aim of this study is to investigate color removal from textile industry by coagulation and adsorption methods. For this purpose, corncobs of different sizes were used as an agricultural waste adsorbent. In addition, the operating costs of coagulation and adsorption processes were calculated.

### Materials and Methods

#### Wastewater Samples

The samples were obtained from the common effluent of a textile dyeing factory in Bursa (western Turkey) and analyzed according to Standard Methods [34]. The color was measured using a UV-vis spectrophotometer (Hach Lange, DR5000) according to Method 2120 C defined in Standard Methods [34]. The wastewater samples were composite samples taken during a 24 hour period at three different times. The flow rate of the wastewater originating from the textile factory was determined to be 1200 m³/day. The characterization of the wastewater is shown in Table 1.

#### Chemical Coagulation Experiments

Chemical coagulation were performed using a Jar test (Velp Scientifica FC6S model, Italy) at room temperature (20±1°C) with the reagents Al₃(SO₄),18H₂O, FeCl₃·6H₂O and FeSO₄·7H₂O (Merck, Germany) used at variable dosages between 250 and 600 mg/L and optimum pH values determined at constant coagulant dosages (250 mg/L) (pH = 6.5 for Al₃(SO₄),18H₂O, pH = 8.0 for FeCl₃·6H₂O and pH = 8.0 for FeSO₄·7H₂O). For each chemical, the optimum reagent dosages were determined. The pH was adjusted with the addition of 1 M H₂SO₄ and NaOH. One liter samples of the wastewater were added with each chemical at different dosages. One and a half hours of sedimentation was carried out after a coagulation period of 30 min (20 rpm) and flash mixing of 1-2 minutes (120 rpm).

### Table 1. Characterization of textile dyeing process wastewater.

| Parameter    | Unit  | Results of analysis of raw wastewater |
|--------------|-------|--------------------------------------|
| pH           | mg/L  | 8.1±0.55                             |
| COD          | mg/L  | 1100±85                              |
| BOD₅         | mg/L  | 440±32                               |
| TKN          | mg/L  | 48±2.7                                |
| Total P      | mg/L  | 11±0.85                               |
| Oil-grease   | mg/L  | 74±5.5                                |
| SS           | mg/L  | 110±8.6                               |
| Total Cr     | mg/L  | <0.1                                 |
| Pb           | mg/L  | 0.22±0.05                            |
| Cd           | mg/L  | 0.12±0.02                            |
| Cu           | mg/L  | 1.8±0.2                              |
| Zn           | mg/L  | 2.9±0.2                              |
| Total CN     | mg/L  | -                                    |
| Color (Absorbance) | abs-585 nm | 0.492±0.032 |
Adsorption Experiments

Adsorption experiments using different sizes of corncob were carried out. For this purpose, the corncobs which were obtained from a local agricultural field in Bursa city were ground to sizes of 0.25, 0.50, 0.85, and 1.25 mm, and then 5 g of corncob from each size class were weighed and added to the Jar Test apparatus with 1 L of effluent from the chemical coagulation. The length, diameter, and grain size of corncob were 21 cm, 4 cm, 0.8 cm, respectively. Flash mixing (400 rpm) was applied for five days, and the color removal efficiencies of each size of corncob particles were determined as absorbance removal efficiencies. The experiments were also conducted with granular activated carbon (GAC; Jacobi; 0.5-1.0 mm) to compare the results with corncob. For this purpose, 10 g GAC per liter was added to the chemically treated effluent having varying dilution ratios, and flash mixing was applied for 24 h. After the 24 h reaction time, the color was analysed.

Results and Discussion
Chemical Coagulation Experiments

The chemical coagulation process has been extensively applied to textile wastewater for removing organic compounds and color [35]. Gilpavas et al. [36] reported 48% COD and 98% of turbidity removal was achieved using 700 mg/L of Al2(SO4)3 as a coagulant at pH 9.96 by the coagulation-flocculation process. In another study conducted by Sher et al. [37], Al2(SO4)3·18H2O and anionic polyacrylamide were used as coagulant and flocculant, respectively and 91% COD removal was obtained. Rodrigues et al. [4] carried out treatability studies on cotton, acrylic and polyester dyeing wastewaters using FeSO4·7H2O and examined the color and dissolved organic carbon (DOC) removal. At the end of the study, a significant amount of color (91% for cotton, 94% for acrylic effluents and 100% for polyester effluent) and insufficient DOC removal were observed (33% for polyester, 45% for cotton and 28% for acrylic effluents).

In this study, two different experiments were carried out. The first one is chemical coagulation with various coagulants and the second one is adsorption with different sizes of corncob. During chemical coagulation, the optimum pH values were determined to be 6.5, 8.0 and 8.0 for Al2(SO4)3·18H2O, FeCl3·6H2O and FeSO4·7H2O, respectively. The best COD and color removal was obtained with Al2(SO4)3·18H2O in chemical coagulation of the textile wastewater effluent. COD removal at an Al2(SO4)3·18H2O dose of 300 mg/L resulted in an effluent COD of 300 mg/L (62%) and color of 0.256 (48%) (at pH 6.5). COD of 440 mg/L (60%) and color of 0.28 (43%) removal were obtained in coagulation using FeCl3·6H2O with a dose of 350 mg/L (at pH 8.0), while COD removal at a FeSO4·7H2O dose of 400 mg/L resulted in an effluent COD of 440 mg/L (60%) and color of 0.271 (45%) (at pH 8.0). The coagulant dosage effects on the removal of COD and color are shown in Fig. 1 and 2.

Adsorption Experiments

Corn is the third one after wheat and rice from the point of cultivation area and the first one in terms of production area in the world. In Turkey, corn has the largest acreage of grain after wheat and barley. Corn planting area in our country is 6.82 million decar and 6.3 million tons of corn is produced in 2016 [38]. Corncob, an agricultural waste is abundantly available and low-cost adsorbent for organic compounds removal from wastewater due to its good adsorption capacity and chemical stability [39]. Corncobs can also be dried and burnt after the adsorption process to obtain energy. The adsorption experiments were executed at acidic pH values due to the cellulosic structure of corncobs, which is known to increase in adsorption capacity under acidic conditions [40].

There are some studies in the literature related to the removal of color by adsorption using corncob. The corncob was used for dye removal in a study conducted by El-Geundi [41] and high adsorption capacity (160 mg dye/g maize cob for Astrazon Blue) was observed. Robinson et al. [42] used 10 gram/L of...
600 mm corncob and obtained 92% dyes removal in 48 h, while the adsorption capacity for methylene blue was obtained 163.93 mg/g on the magnetic carbonaceous adsorbent derived from corncob [43]. Safranin basic dye from aqueous solutions was removed by adsorption using corncob by Preethi et al. [44], and the results indicated that corncob, an agricultural waste biomass, proved to be an excellent low-cost sorbent. All these experimental results show that corncob is effective adsorbent concerning the removal of color from textile wastewater.

In this study, the adsorption experiments were conducted in two stages:
- Adsorption on raw wastewater
- Adsorption on chemically treated wastewater

The Langmuir and Freundlich Isotetherms are frequently used in adsorption process. The Langmuir isotherm can be indicated in Eq. (1).

$$\frac{C_e}{q_e} = \frac{1}{q_o b} + \frac{C_e}{q_o}$$  \hspace{1cm} (1)

In Eq. (1), $C_e$ is the equilibrium concentration (mg/L), $q_e$ is the adsorbed amount at equilibrium (mg/g), $q_o$ is the adsorption capacity (mg/g), and $b$ is the adsorption energy (l/mg) [45].

In Eq. (2), the Freundlich isotherm model is shown:

$$q_e = K_f C_e^{1/n}$$  \hspace{1cm} (2)

In Eq. (2), $q_e$ is the adsorbed amount at equilibrium (mg/g), $C_e$ is the equilibrium concentration of the adsorbate and $K_f$ and $n$ are the Freundlich constants in which $n$ indicates the favorability of the adsorption process and $K_f$ (mg/g (l/mg)$^n$) is the adsorption capacity of the adsorbent [46].

The adsorption process was carried out on raw wastewater with the size of 1.25, 0.85, 0.5 and 0.25 mm corncob particles. The $R^2$ values were found for Langmuir and Freundlich Isotherms are 0.988 and 0.72, respectively. Fig. 3 shows that the plots of $C_e/q_e$ versus $C_e$ for corncob for Langmuir Isotherm Graph on raw wastewater. As it can be seen from Fig. 3, sufficient amounts of color could not be removed by adsorption on raw wastewater. The $Q^o$ is calculated as 0.036 Abs unit/g corncob according to Fig. 3. Parallel to these results, amount (weight/volume) of corncob for color/COD removal from studied wastewater samples will be increased without the application of physico-chemical pre-treatment. Therefore, the physico-chemical pretreatment step after these results is necessary to reduce the excessive usage of corncob for the reduction of waste adsorbent disposal. The absorbance values of the chemically treated wastewater were measured as 0.023, 0.013, 0.0051 and 0.00255 Abs (Table 2) at the end of the mixing period.

Determination of the most appropriate correlation for the equilibrium data is necessary to optimize the system. Both the Langmuir and Freundlich isotherm models were examined in this study.

The value of $q_o$ was calculated from plots given in Table 3. The correlation coefficient values for corncob and GAC were calculated as 0.9995 and 0.998, respectively. These values show that the adsorption of color onto the corncob or GAC was a well fit with the Langmuir model (Fig. 4).

The value of $K_f$ was obtained from the intercept is given in Table 3. The $R^2$ values for corncob and GAC were calculated as 0.995 and 0.999, respectively. These values show that the adsorption of color onto the corncob or GAC was a well fit with the Langmuir model (Fig. 4).

Table 2. Color removal efficiencies depending on the sizes of the corncob particles.

| Sizes of corncob particles (mm) | Absorbance Values (585 nm) | Color Removal Efficiency (%) |
|--------------------------------|-----------------------------|-----------------------------|
| 1.25                           | 0.046                       | 82                          |
| 0.85                           | 0.033                       | 87                          |
| 0.5                            | 0.028                       | 89                          |
| 0.25                           | 0.0256                      | 90                          |

Fig. 3. Langmuir Isotherm Graph on raw wastewater.

Fig. 4. Langmuir Isotherm Graph on chemically treated wastewater.
are 0.92 and 0.878, respectively. This means that the adsorption of color onto the corncob or GAC was not favorable with the Freundlich isotherm model.

When compared adsorption by corncob and GAC, it is shown that $R^2$ value in adsorption by GAC is a bit higher than adsorption by corncob. Moreover, adsorption capacity in GAC is five times higher than corncob.

In addition to the calculations, adsorption columns incorporating corncobs were designed to investigate the usage of corncob for the removal of color from the chemically treated textile wastewater, which had a flow rate of 10000 m$^3$/day. The density of corncob was assumed to be 0.28 ton/m$^3$ [47] and the filtration rate was taken to be 10 m/h [48]. An adsorption unit including 12 columns was designed according to the experimental data. The amount of corncobs necessary to effectively remove color from the textile wastewater was determined to be 84 tons.

### Cost Evaluation

The capital and operating costs and maintenance are the cost of treatment plants. The operating costs (reagents costs and electricity consumption) of the applied processes were considered (Table 4) in this study. The price of reagents [49] and electricity [50] was taken from market prices. The labor and sludge disposal costs were excluded.

According to Table 4, the treatment cost of coagulation with Al$_2$(SO$_4$)$_3$.18H$_2$O was the lowest when compared the treatment cost of coagulation with FeSO$_4$.7H$_2$O and coagulation with FeCl$_3$.6H$_2$O. The adsorption with corncob resulted in 90% color removal while the adsorption with GAC resulted in 99% color removal (Table 4). On the other hand, the treatment cost of adsorption with corncob is five times cheaper than adsorption with GAC.

### Conclusions

Color removal by chemical coagulation and adsorption processes in textile wastewater was studied. The wastewater contained colorful material and organic substances. The conclusions of this study can be given as:

- The maximum removal efficiencies obtained from the chemical coagulation experiments were 62% and 48% for COD and color, respectively.
- The adsorption capacity was calculated as 0.046 Abs unit/g corncob.
- The operating cost of adsorption with corncob was calculated as 175.53 €/ton.
- The optimal treatment cost was calculated as 0.008 €/m$^3$ in coagulation with Al$_2$(SO$_4$)$_3$.18H$_2$O.
- Adsorption by corncob is an efficient and economical solution for chemically treated textile wastewater when compared to GAC.

While the adsorption capacity of GAC is higher than corncob in this study, the operating cost of adsorption with corncob is lower than GAC. Consequently, the

| Reagents            | Basis | Cost (€) | Process                                      | Treatment Cost |
|---------------------|-------|----------|----------------------------------------------|----------------|
| Al$_2$(SO$_4$)$_3$.18H$_2$O | ton   | 95.75    | Coagulation with Al$_2$(SO$_4$)$_3$.18H$_2$O | 0.008 €/m$^3$  |
| FeSO$_4$.7H$_2$O    | ton   | 63.83    | Coagulation with FeSO$_4$.7H$_2$O             | 0.009 €/m$^3$  |
| FeCl$_3$.6H$_2$O    | ton   | 95.75    | Coagulation with FeCl$_3$.6H$_2$O             | 0.01 €/m$^3$   |
| Electricity         | kWh   | 0.11     | Color removal with corncob (Following chemical precipitation) | 0.04 €/m$^3$  |
| Sulphuric acid      | ton   | 85.11    | Color removal with corncob (On raw wastewater) | 0.1 €/m$^3$   |
| Sodium Hydroxide    | ton   | 95.75    | Color removal with GAC (Following chemical precipitation) | 0.2 €/m$^3$  |
| Corncob             | ton   | 175.53   | Corncob                                      | 90             |
| GAC                 | ton   | 1514.89  | GAC                                          | 99             |
application of adsorption by corncob following chemical coagulation is an economical and applicable choice for color removal from textile wastewater.

Acknowledgements

The author acknowledges Prof. Taner Yonar for his endless help and Bursa Uludag University for the editing support of this study.

Conflict of Interest

The author declare no conflict of interest.

References

1. VERMA A.K., DASH R.R., BHUNIA P. A review on chemical coagulation/flocculation technologies for removal of colour from textile wastewaters. Journal of Environmental Management. 93, 154, 2012.

2. BILINSKA L., GMUREK M., LEDAKOWICZ S. Comparison between industrial and simulated textile wastewater treatment by AOPs – Biodegradability, toxicity and cost assessment. Chemical Engineering Journal. 306, 550, 2016.

3. BILINSKA L., BLUS, K., GMUREK M., LEDAKOWICZ S. Coupling of electrocoagulation and ozone treatment for textile wastewater reuse. Chemical Engineering Journal. 358, 992, 2019.

4. RODRIGUES C.S.D., MADEIRA L.M., BOAVENTURA R.A.R. Treatment of textile dye wastewaters using ferrous sulphate in a chemical coagulation/flocculation process. Environmental Technology. 34 (6), 719, 2013.

5. LIU S., GE H., WANG C., ZOU Y., LIU J. Agricultural waste/graphene oxide 3D bio-adsorbent for highly efficient removal of methylene blue from water pollution. Science of the Total Environment. 628-629, 959, 2018.

6. SARAYU K., SANDHYA S. Current technologies for biological treatment of textile wastewater – a review. Applied Biochemistry and Biotechnology. 167, 645, 2012.

7. DOTTO J., FAGUNDES-KLEN M.R., VEIT M.T., PALACIO S.M., BERGAMASCO R. Performance of different coagulants in the coagulation/flocculation process of textile wastewater. Journal of Cleaner Production. 208, 656, 2019.

8. ZHAO S., GAO B., YUE Q., WANG Y. Effect of Enteromorpha polysaccharides on coagulation performance and kinetics for dye removal. Colloids and Surfaces A: Physicochemical and Engineering Aspects. 456, 253, 2014.

9. YADAV A., MUKHERJI S., GARG A. Removal of chemical oxygen demand and color from simulated textile wastewater using a combination of chemical/physicochemical processes. Industrial & Engineering Chemistry Research. 52 (30), 10063, 2013.

10. LOPEZ-LOPEZ C., MARTIN-PASCUAL J., LEYVA-DIAZ J.C., MARTINEZTOLEDO M.V., MUNIO M.M., POYATOS J.M. Combined treatment of textile wastewater by coagulation-flocculation and advanced oxidation processes. Desalination and Water Treatment. 57 (30), 13987, 2016.

11. HAYAT H., MAHMOOD Q., PERVEZ A., BHATTI Z.A., BAIG S.A. Comparative decolorization of dyes in textile wastewater using biological and chemical treatment. Separation and Purification Technology. 154, 149, 2015.

12. UYSAL Y., BILGIC M. Color removal from wastewater by using two-step (biological and chemical) aerobic reactors. Global Nest Journal. 20 (1), 7, 2018.

13. CHE NORAINI C.H., MORAD N., NORLI I., TENG T.T., OGUGIBUE C.J. Methylene blue degradation by Sphingomonas paucimobilis under aerobic conditions. Water Air Soil Pollution. 223, 5131, 2012.

14. FAZAL S., HUANG S., ZHANG Y., ULLAH Z., ALI A., XI H. Biological treatment of red bronze dye through anaerobic process. Arabian Journal of Geosciences. 12, 415, 2019.

15. AMARAL M.C.S., NETA L.S.F., SOUZA M., CERQUEIRA N., de CARVALHO R.B. Evaluation of operational parameters from a microfiltration system for indigo blue dye recovery from textile dye effluent. Desalination and Water Treatment. 52 (1-3), 257, 2014.

16. MAHMOODI N.M., DALVAND A. Treatment of colored textile wastewater containing acid dye using electrocoagulation process. Desalination and Water Treatment. 51 (31-33), 5959, 2013.

17. SHAHRIARI T, SAEB B. Assessment of effective operational parameters on dyeing wastewater treatment by electrocoagulation process. Pollution. 3 (3), 517, 2017.

18. KHANNA A., VIDYA SHETTY K. Solar photocatalysis for treatment of acid yellow-17 (AY-17) dye contaminated water using Ag@TiO

19. ZOU X.L. Combination of ozonation, activated carbon, and biological aerated filter for advanced treatment of dyeing wastewater for reuse. Environmental Science and Pollution Research. 22, 8174, 2015.

20. ABID M.F., ZABLOUK M.A., ABID-ALAMEER A.M. Experimental study of dye removal from industrial wastewater by membrane technologies of reverse osmosis and nanofiltration. Iranian Journal of Environmental Health Science & Engineering. 9 (17), 1, 2012.

21. KURT E., KOSEOGLU-IMER D.Y., DIZGE N., CHELLAM S., KOYUNCU I. Pilot-scale evaluation of nanofiltration and reverse osmosis for process reuse of segregated textile dyewash wastewater. Desalination. 302, 24, 2012.

22. KATSOU E., MALAMIS S., KOSANOVIC T., SOUMA K., HARALAMBOUS K.J. Application of adsorption and biological treatment of textile wastewater using two-step (biological and chemical) aerobic reactors. Water Air Soil Pollution. 223, 5519, 2012.

23. TAVANGAR T., JALALI K., SHAHMIRZADI M.A.A., KHALEDI M., TAVANGAR S. Comparative decolorization of dyes/inorganic salts using a hybrid electrocoagulation - nanofiltration process. Separation and Purification Technology. 216, 115, 2019.

24. ASGHAR A., ABDUL RAMAN A.A., WAN DAUD W.M.A. Advanced oxidation processes for in-situ production of hydrogen peroxide/hydroxyl radical for textile wastewater treatment: a review. Journal of Cleaner Production. 87, 826, 2015.

25. TEZCANLI GUYER G., NADEEM K., DIZGE N. Recycling of pad-batch washing textile wastewater through advanced oxidation processes and its reusability.
assessment for Turkish textile industry. Journal of Cleaner Production. 139, 488, 2016.
26. ILHAN F., ULCAN-ALTUNTAS K., DOGAN C., KURT U. Treatability of raw textile wastewater using Fenton process and its comparison with chemical coagulation. Desalination and Water Treatment. 162, 142, 2019.
27. AMARAL F.M., KATO M.T., FLORENCIO L., GAFAZZA S. Color, organic matter and sulfate removal from textile effluents by anaerobic and aerobic processes. Bioresource Technology. 163, 364, 2014.
28. BUTHELEZI S.P., OLANIRAN A.O., PILLAY B. Textile dye removal from wastewater effluents using bioflocculants produced by indigenous bacterial isolates. Molecules. 17, 14260, 2012.
29. DHAOUIFI Z., TOLEDO-CERVANTES A., GHEDIRA K., CHEKIR-GHEDIRA L., MUNOZ R. Decolorization and phytotoxicity reduction in an innovative anaerobic/aerobic photobioreactor treating textile wastewater. Chemosphere. 234, 356, 2019.
30. SADAF S., BHATTI H.N., ALI S., REHMAN K. Removal of indosol turquoise FBL dye from aqueous solution by bagasse, a low cost agricultural waste: batch and column study. Desalination and Water Treatment. 52 (1-3), 184, 2014.
31. BASERI J.R., PALANISAMY P.N., KUMAR P.S. Adsorption of basic dyes from synthetic textile effluent by activated carbon prepared from thevetia peruviana. Indian Journal of Chemical Technology. 19 (5), 311, 2012.
32. DEMIR DELİL A, GÜLÇİÇEK, O., GÖREN N. Optimization of adsorption for the removal of cadmium from aqueous solution using turkish coffee grounds. International Journal of Environmental Research. 13, 861, 2019.
33. KATHERESAN V., KANSEDO J., YON LAU S. Efficiency of various recent wastewater dye removal methods: A review. Journal of Environmental Chemical Engineering. 6, 4676, 2018.
34. APHA, AWWA, WPCF Standard Methods for the Examination of Water and Wastewater, 20th Ed., American Public Health Association, Washington DC, 1998.
35. AZBAR N., YONAR T., KESTIOGLU K. Comparison of various advanced oxidation processes and chemical treatment methods for COD and color removal from a polyester and acetate fiber dyeing effluent. Chemosphere. 55, 35, 2004.
36. GILPAVAS E., DOBROSZ-GOMEZ I., GOMEZ-GARCIA M.A. Coagulation-flocculation sequential with Fenton or Photo-Fenton processes as an alternative for the industrial textile wastewater treatment. Journal of Environmental Management. 191, 189, 2017.
37. SHER F., MALIK A., LIU H. Industrial polymer effluent treatment by chemical coagulation and flocculation. Journal of Environmental Chemical Engineering. 1, 684, 2013.
38. ANONYMOUS, www.zmo.org.tr, (Date of access: 28.06.2018), 2018.
39. SONG Y., PENG R., CHEN S., XIONG Y. Adsorption of crystal violet onto epichlorohydrin modified corncob. Desalination and Water Treatment. 154, 376, 2019.
40. KESTIOGLU K. Color removal by adsorption technique in textile effluents, in H.Z. Sarikaya, L. Akca (eds.), Proceedings of the ITU 3rd Industrial Pollution Symposium, 87-98, Istanbul, Turkey, 1992.
41. EL-GEUNDI M. Colour removal from textile effluents by adsorption techniques. Water Research. 25 (3), 271, 1991.
42. ROBINSON T., CHANDRAN B., NIGAM P. Removal of dyes an artifical textile dye effluent by two agricultural waste residues, corncob and barley husk. Environment International. 28, 29, 2002.
43. MA H., LI J.B., LIU W.W., MIAO M., CHENG B.J., ZHU S.W. Novel synthesis of a versatile magnetic adsorbent derived from corncob for dye removal. Bioresource Technology. 190, 13, 2015.
44. PREETHI S., SIVASAMY A., SIVANESAN S., RAMAMURTHI V., SWAMINATHAN G. Removal of safranin basic dye from aqueous solutions by adsorption onto corncob activated carbon. Industrial Engineering Chemistry Research. 45, 7627, 2006.
45. LANGMUIR I. The absorption of gases on plane surfaces of glass, mica and platinum. Journal of the American Chemical Society. 40 (9), 1361, 1918.
46. FREUNDLICH H.M.F. Über die adsorption in lösungen. Journal of Physical Chemistry. 57A, 385, 1906.
47. ZHANG Y., GHALY A.E., LI B. Physical properties of corn residues. American Journal of Biochemical and Biotechnology. 8 (2), 44, 2012.
48. ANONYMOUS, Water Treatment Plant Design. McGraw – Hill, 1997.
49. ANONYMOUS, www.labor.com.tr, (Date of access: 28.06.2018), 2018.
50. ANONYMOUS, www.uedas.com.tr, (Date of access: 28.06.2018), 2018.