

3. Materials and Methods

3.1. Case Study, Water Samples, and Analytical Methods

The research work used samples collected from one of the biggest poultry farms in Central Asia located in Izhevsk village, in Kazakhstan. A discrete sampling approach was used to collect wastewater samples in 5 L plastic bottles. To preserve the natural condition of the samples, had to be stored at 4 °C before being subjected to transportation, analysis, and treatment. Generally, nine physical and chemical water quality parameters were considered in this research work, namely; turbidity, color, total suspended solids (TSS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammonia (NH₄)-nutrient, as well as potentially toxic elements; chromium (Cr), nickel (Ni), and manganese (Mn).

After transporting the samples to the lab, were then analyzed to check the quality characteristics of the raw wastewater (Table 4), and after treatment samples were again collected to check the quality of the treated effluent. During the analysis, several scientific procedures, test kits, and reagents were used to assess the quality of the water. The ammonia concentration levels in the samples were determined using the multiparameter 7500 Photometer (Palintest, CO, USA), with standard reagents as well as the test kits. The potentially toxic elements (chromium (Cr), nickel (Ni), manganese (Mn)) in the water samples were determined using the Atomic Absorption Spectrometry (Analytik Jena, Upland, CA, USA). In summary, the analysis of all the investigated water quality parameters was accomplished following the recommendations in the APHA Standard Methods for the Examination of Water and Wastewater [38].

Table 4. General characteristics of the poultry slaughterhouse wastewater (no = 12).

Parameter	Min	Max	Median	Mean	STD	Guideline	Agency	Unit
Turbidity	45.4	902	664	600.88	301.505	5	WHO	FAU *
Color	422	5340	4235	3694.4	1705.302	5	WHO	degree
TSS	126	2264	1814	1528.8	738.1153	500	KZ	mg/L
COD	358	5998	3480	3359	1901.393	125	KZ	mg/L
BOD	139.6	2214	1625	1419.52	717.577	30	KZ	mg/L
Ammonium	2.21	5.66	4.03	3.836	1.208	0.5	KZ	mg/L
Manganese	0.387	4.26	1.44	1.6934	1.403	0.1	WHO	mg/L
Nickel	3.73	8.61	6.06	6.5684	1.834	0.1	WHO	mg/L
Chromium	0.56	4.62	2.16	2.255	1.426	0.1	WHO	mg/L

* FAU = Formazin Attenuation Units.

3.2. Experimental Setup

The EC experiments were carried out at 22 ± 1 °C, while the wastewater within the reactor (1.7 L) was stirred continuously by a magnetic stir bar. The electrochemical reactor used in this study had a dimension of $15 \times 13 \times 11$ cm³. The ranges of power supply were 0 to 50 V, and 0 to 10 A, with 24 V and 5.5 A being the average values (Table 5). Two main cases were investigated based on electrode materials and arrangement (polarity) (Figure 1); in the first case titanium electrode ($10.8 \times 11.8 \times 0.2$ cm³) was used as anode and aluminium electrode ($10.8 \times 11.8 \times 0.2$ cm³) was used as cathode. In the second case, the aluminium electrode was used as an anode and the titanium electrode was as a cathode. Also, in the study, anode and cathode electrodes were placed parallel with 2 cm.

Table 5. General technical specifications.

Parameter	Value	Unit
Initial water temperature	5–10	°C
Potential (voltage)	24	V
Average current density	5.5	A
Average power	132	W
Hydraulic retention time	40	min