

electrode rather than the voltage polarity of the particular electrodes [31]. In that matter, the definition of the anode is based on the electrode through which conventional current (positive charge) flows into the device from the external circuit, while an electrode through which conventional current flows out of the device is known as cathode. That is to say, if the direction of the current through the electrodes is reversed, as an example of a rechargeable battery when being charged, the naming of the electrodes is also reversed.

As previously mentioned, the material is among the important factors in the performance of electrochemical methods [32]. In the market, there are already many types of electrode materials used for wastewater treatment, such as; aluminum (Al), graphite (Gr), titanium (Ti), as well as iron (Fe). There are two main features for an electrode material, which are; being electronically conductive, and having the capacity to interact with the molecule.

Electrochemical methods for wastewater treatment include electrocoagulation-electro flocculation and electroflotation [23], electro-reduction [33], direct and, indirect electrooxidation using redox mediators, and hydrogen peroxide [34], and photo-assisted electrochemical methods like photoelectron-Fenton and photo-electrocatalysis [35]. Electrocoagulation (EC) based on the in-situ production of coagulants from a soluble anode material such as iron and/or aluminum that is oxidized due to the applied current has piqued attention among these approaches.

The general treatment mechanism starts with connecting the EC system to a power source. Then immediately an oxidation process starts to occur in the anode, the process that makes the electrode electrochemically corroded, meanwhile the passivation process occurs in the cathode. The process generates $M_{(aq)}^{3+}$ and OH^- ions which react to form various hydroxo monomeric and polymeric species. However, the formation of various hydroxo monomeric and polymeric species is highly dependent on the pH range. From the reaction of the two ions, $M(OH)_3$ is formed according to complex precipitation kinetics. Lastly, the pollutants dissolved and suspended in the wastewater are then adsorbed by the coagulants and then removed by either sedimentation or flotation [36].

However, the performance of electrochemical treatment approaches for wastewater treatment can be highly influenced by the type of electrodes used, arrangement of the electrodes as well as the type or characteristics of the wastewater to be treated. However, the potential effect of electrode polarity on the removal of pollutants from poultry slaughterhouse wastewater is still scarce.

In the current work, the effect of the polarity direction on the removal of pollutants from poultry slaughterhouse wastewater is investigated based on Ti and Al electrode materials. The study is generally divided into two cases; the first case is based on the wastewater being subjected to the Ti (anode)-Al (cathode) arrangement, and case II is when the wastewater is subjected to the Al (anode)-Ti (cathode) arrangement. The two cases were designed to investigate whether the polarity direction for the selected electrode materials will affect the removal of pollutants or not.

2. Results and Discussion

2.1. Data Distribution in the Raw Wastewater

Figure 1, shows that the selected water quality parameters had data distribution ranging from positive unsymmetrical nature to negative unsymmetrical as well as some potential equal distribution. For instance, the computed boxplot for turbidity is seen with the median approaching the lower quartile; a phenomenon that defines the data distribution to be positively skewed. In contrast to the turbidity data distribution, the color plot demonstrates that the series of concentration values had an equal distribution between high and low concentration values. While the TSS plot depicts that the series of concentration values has more low concentration values than high concentration values, with the median closer to the upper quartile, the data distribution is negatively skewed.