Characterize the Tap Water Collected During Texas Winter Storm in 2021 with Power Failure

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ABSTRACT: This study was focused on characterizing the tap water sample collected during Texas power due to the winter storm in 2021. For the study the resistance of the water sample was monitored for 2 weeks using the two Probe method. Also, pH, Oxidation Reduction Potential (ORP) of the water sample was compared with regular potable tap water. Initial Resistivity value of the water sample collected in Texas Power Crisis is 33.72% less than the tap water. The resistivity of the bottom configuration was reduced by 18% in 2 weeks where the resistivity of the top configuration was increased by 66% in 2 weeks.

1. INTRODUCTION:

United States Environmental Protection Agency has standard for water. Nearly 90 parameters listed in the standard and monitored for water quality. Resistivity can be used as a suitable method to identify the contamination of the water. In many studies, resistivity was used as a measure for the identification of ground water contamination. The study by Eugeniusz, Andrzej, Mariusz and Piotr (2017) [1], the relationship between conductivity of the water with dissolved suspension were discussed. Higher the concentration of suspension, higher the electrical conductivity of the water. Thus, the resistivity of the contaminated water is less compared to potable water.

Even though, no national standards in USA have limitation on drinking water resistivity, EPA recommends the resistivity value of less than 1000 µS/cm [2]. The National Drinking Water Quality Standard in Malaysia limited the maximum conductivity values as 1000 µS/cm [3]. The Two probe resistivity method will allow to measure the resistivity of different depth of the water, thus better monitoring of resistivity can be achieved.

2. OBJECTIVES:

The objective of this study was to characterize the tap water during power failure, using the two-probe resistivity method.

3. MATERIALS AND METHODS:

Water sample was collected from tap during Texas Power Crisis – 2021. During this period the tap water was recognized as non-potable water. A cylindrical mold of 2” diameter and 4” height was used in the study. The wire configuration is shown in Figure 1. The LCR meter was used to measure the impendence of the water in the frequency range of 20 Hz to 300 kHz. The conductivity of the water sample was measured using conductivity meter. The ORP values were measure from ORP meter. The pH of the sample also measured from pH meter.

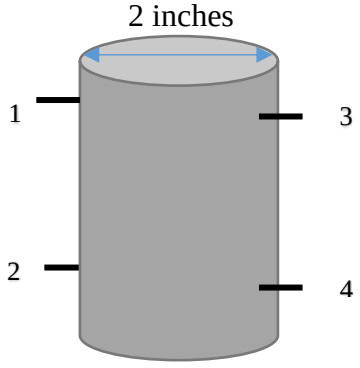

Figure 1 Wire configuration

4. RESULTS:

The initial conductivity was measured from 2" of the top of the sample. The initial conductivity value of the potable tap water 440 µS/cm whereas the non-potable tap water was 664 µS/cm. Thus, the resistivity values were 22.72 Ohm-meter and 15.06 Ohm-meter respectively for potable and non-potable tap water. There is a 33.71% reduction in the resistivity of the tap water sample collected during Texas crisis compared to tap water. The ORP values and pH values are given in Table 1. ORP and pH values are almost similar to both types of water.

Table 1 Parameters of water sample collected during Texas power crisis and tap water

Water Quality Parameters	**Water type**		**EPA Standards limitation**
	Potable drinking water from tap	**Non potable drinking water collected from Texas Power Crisis 2021**	
Conductivity (µS/cm)	440	664	Not included in the standards
Resistivity (Ohm-meter)	22.72	15.06	Not included in the standards
pH Value	7.50	7.58	6.5-8.5
ORP value (mV)	+230	+222	Not included in the standards

The impedance spectroscopy results of the non-potable water sample for day 1, day 7 and day 14 are shown in Figure 2, 3 and 4 respectively.

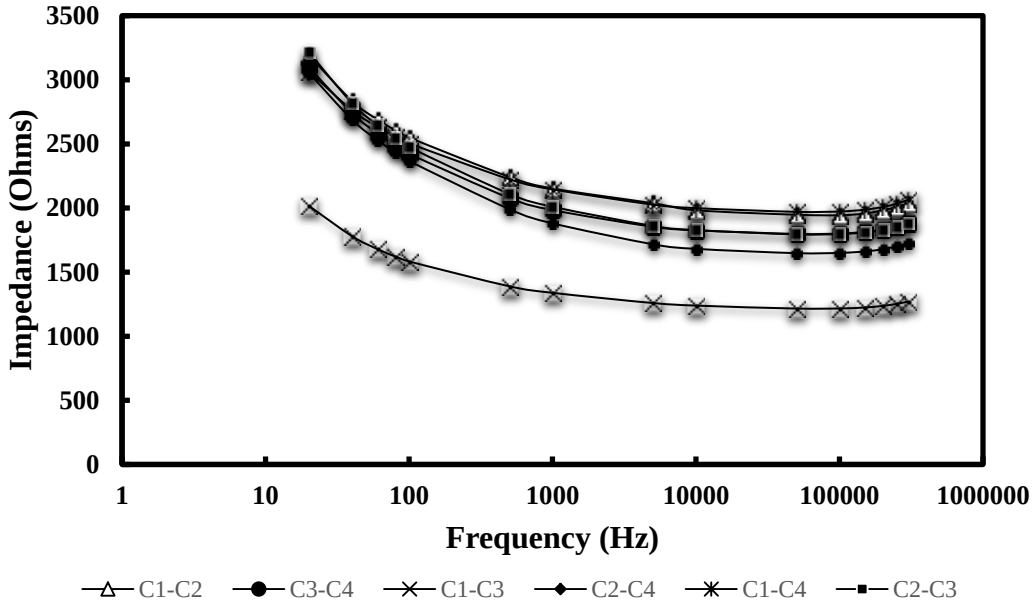

Figure 2 Day - One Impedance vs Frequency for the water sample collected during the Texas Power Crisis

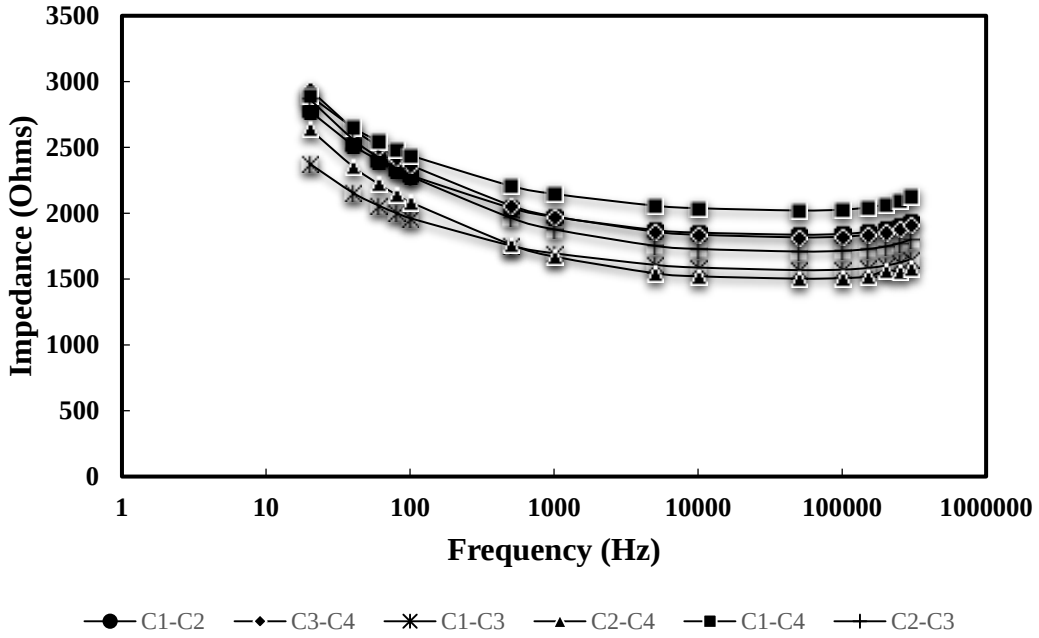

Figure 3 Day - seven Impedance vs Frequency for water sample collected in Texas Power Crisis

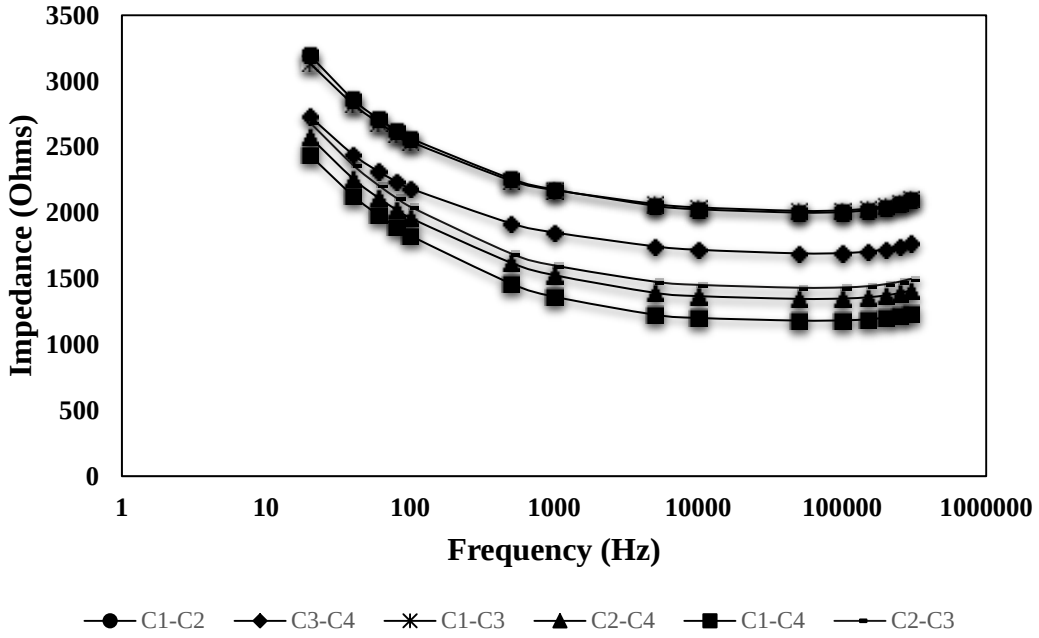

Figure 4 Day - fourteen Impedance vs Frequency for water sample collected in Texas Power Crisis

From the results it can be observed that the impedance values decreasing with frequency for all the configurations. For day 1 day 7 and day14 beyond 100k Hz the impedance values are level offing. This result corresponds to Case 2 of special bulk resistance only [4]. The Equivalent circuit for case 2 formula is given as below.

$$Z = R_b + \frac{R_c}{1 + \omega^2 R_c^2 C_c^2} + \frac{R_i}{1 + \omega^2 R_i^2 C_i^2}$$

The $Z_{predicted}$ and $Z_{experiment}$ are shown in Figure 5 for Bottom Horizontal configuration (C2-C4) of Day 14.

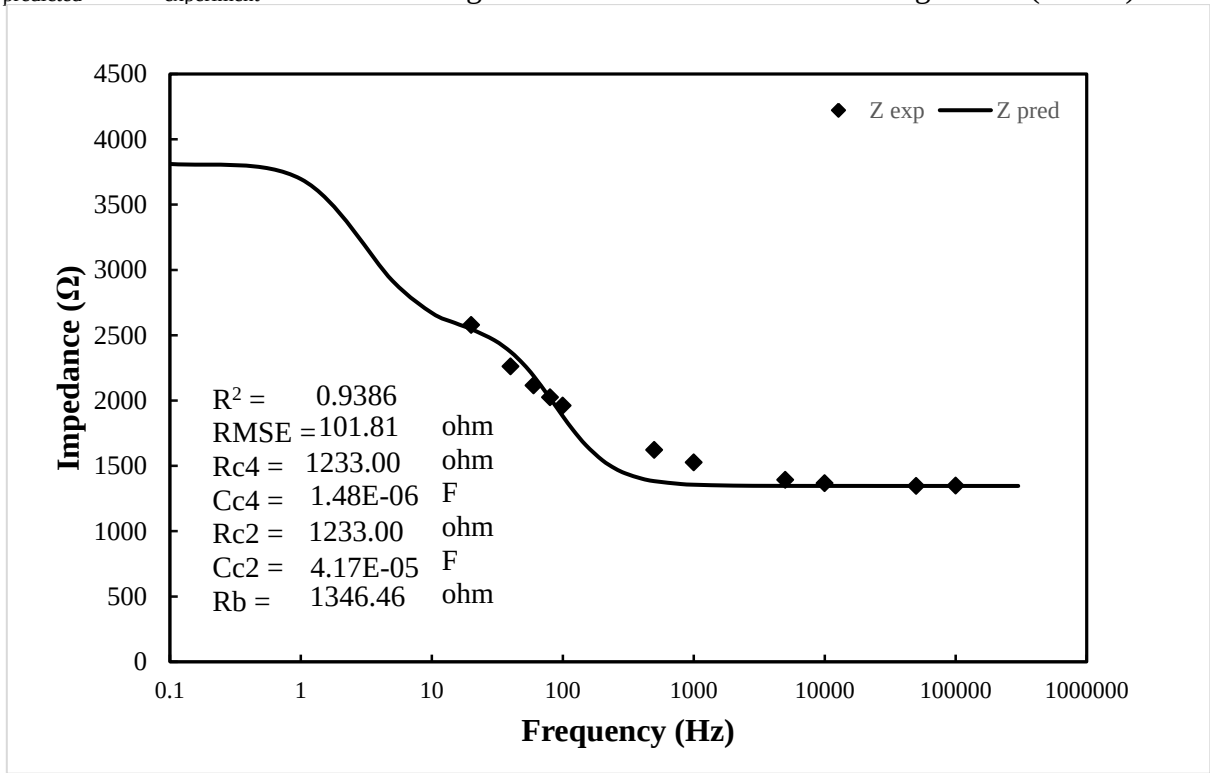

Figure 5: Impedance Spectroscopy for Bottom Horizontal configuration (C2-C4) in day 14

R_{bulk}, $R_{contact}$, $C_{contact}$ can be determined using the equivalent circuit formula. The relationship of R_{bulk} vs days for top (C1-C3) and bottom (C2-C4) configurations is shown in Figure 6. From the Figure the R_{bulk} of the bottom (C2-C4) configurations is decreasing whereas R_{bulk} of the top (C1-C3) is increasing.

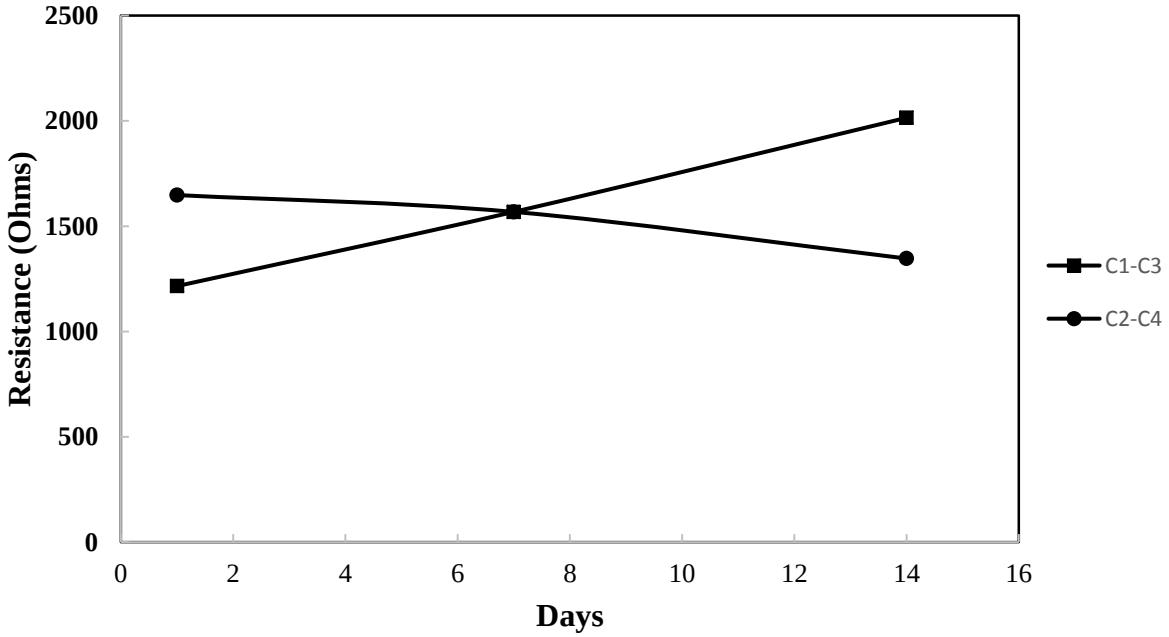

Figure 6 R_{bulk} vs Days for Horizontal Configurations

The resistivity vs days relationship for top (C1-C2) and bottom (C2-C4) configurations is given in Figure 7. From the figure, it can be observed that the resistivity of the top configuration increasing with days while the resistivity of the bottom configuration is decreasing.

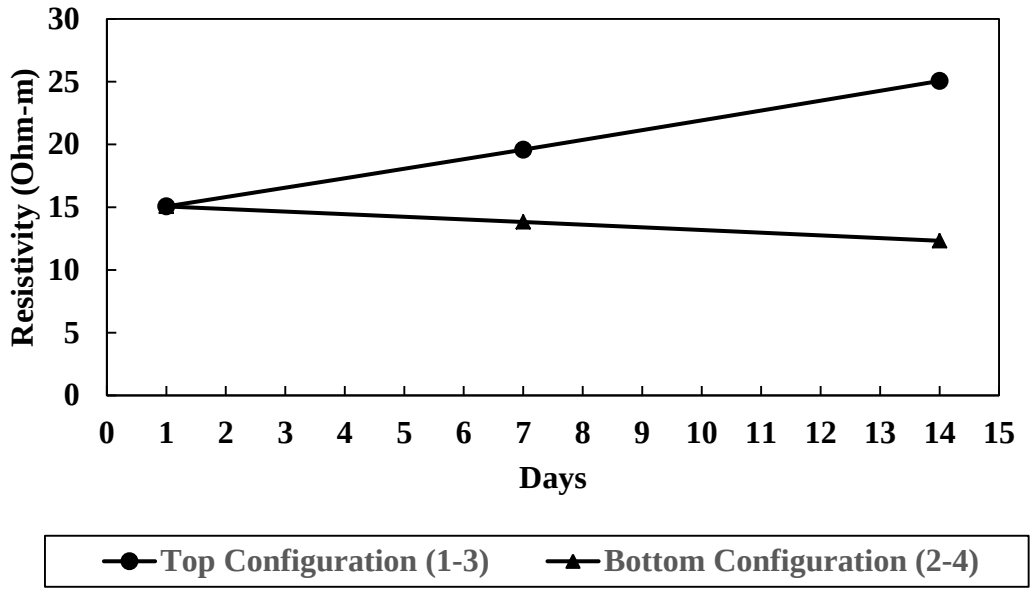

Figure 7 Resistivity vs days relationship for water sample collected in Texas Power Crisis

5. CONCLUSIONS:

Based on the experimental results and modelling following conclusions are advanced:

1. Initial Resistivity value of the water sample collected in Texas Power Crisis is 33.72% less than the tap water.
2. The resistivity for the top case (1-3 Combination) increased with days by 66.40% whereas resistivity for the bottom case (2- 4 combination) reduced with days by 18.16%. This could be due to the settlements of impurities. From the literature, it was found that lower resistivity of the water indicates contamination.
3. The impedance values beyond 100 kHz are approaching a constant value for all configurations., Equivalent circuit of case 2 of Vipulanandan model can be used to determine the bulk resistance with time.

6. ACKNOWLEDGEMENT:

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7. REFERENCES:

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