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Comparative Dielectric Behaviour of Ganga River Soil: Pre Monsoon verses Post Monsoon

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Abstract

Complex impedance data was collected and analyzed for 16 samples (8 pre monsoon and 8 post monsoon) collected from four different places of river Ganga between the frequency range of 1 kHz to 40 MHz and temperature range from room temperature to 50^0C. In the present paper dielectric data have been compared for the pre monsoon and post monsoon samples of Ganga river. For dielectric measurement impedance gain/phase analyser model (HP 4194 A) and for temperature measurement micro controller based device Julabo (F 25, Germany) was used.

Keywords: Dielectric constant, dielectric loss, soil, Ganga, monsoon.

1. Introduction

Indian rivers are mainly classified as Himalayan, peninsular, coastal and inland drainage basin rivers. Ganga is a main Himalayan and sacred river of India. In Indi rivers are associated with culture and many activities are performed at the bank of river. Rivers are also used in agricultural, industry, transportation, drinking and bathing etc.

The water from the Ganga river and the surrounding soil is enrich in the nutrient content and therefore very good for agricultural uses. The industries are the major source of pollution in river Ganga. [1]. Untreated sewage per day, inadequate cremation procedures, burnt or unburnt corpse floating down the Ganga mostly are also significant factor for the water pollution. The state of Uttar Pradesh alone is responsible for many pollutants, entering the river along its entire journey to the sea. The major polluting industries on the Ganga are the leather industries, especially near Kanpur.

In view of the different types of possible impurities present in the soil of Ganga river the present study may provide an idea of contamination in river soil in upstream and downstream pre monsoon and post monsoon.

2. Experimental Details

2.1. Sample Holder

The sample holder designed for specific material is an important aspect of measurement techniques. In the present study coaxial cylindrical sample holder has been fabricated for measurement of dielectric permittivity for use with the impedance gain/phase analyser. Its effective geometrical capacitance is 2.085 pF. Dimensions of sample holder should be large enough to avoid diffraction effects at the edges of sample. It was also found that larger plate area was necessary to provide better sensitivity in the measurement of dielectric loss. Spacing between the electrodes was maintained by annular base plate made of ½ inch Teflon sheet to hold the two electrodes in coaxial position. The brass tubing sections were cemented on the Teflon base ring using a Teflon bonder. It provides the electrical insulation and can be used with benzene or other active solvent for calibration purposes.
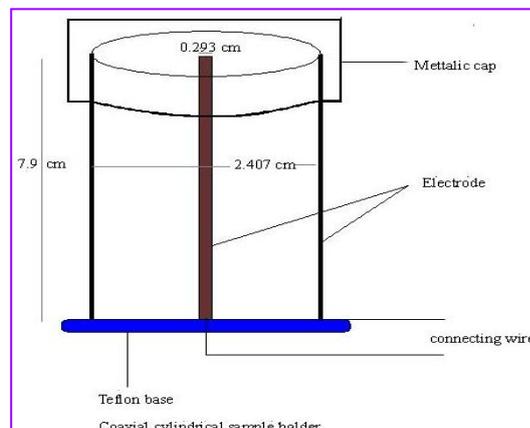

Fig. 1: Schematic diagram of sample holder

2.2 Determination of Dielectric Properties In present work dielectric studies have been carried out on a computer controlled impedance/gain phase analyzer model HP 4194A in frequency range 100 Hz to 40MHz within an accuracy of ± 0.17%. The values of capacitance and dissipation factor for with and without sample are recorded from the screen of the impedance gain phase analyzer. The real part of dielectric permittivity of the sample is obtained from the change in capacitance value of the sample holder due to presence of sample material using following equation

$$\varepsilon' = \frac{\Delta C \ln(b/a)}{0.556h} + 1 \qquad (1)$$

where a is the outside diameter of the inner conductor and b is inside diameter of the outer conductor, h is the height of the sample in the sample holder, ΔC is the change in capacitance of the sample holder and is equal to

$$\Delta C = C_p - C_0 \qquad (2)$$

where C_p is the capacitance of the sample holder with sample and C_o is the capacitance of the empty sample holder.

The loss tangent of the dissipation factor D can be calculated as-

$$\tan\delta = D = \frac{C_p D_p - C_0 D_0}{C_p - C_0} \qquad (3)$$

where D_p is the dissipation factor of the sample holder with sample and D_o is the dissipation factor of empty sample holder.

2.3 Materials

For the present investigation soil samples of Ganga river were taken from Kanpur. The sample sites were, Rani Ghat, Ganga Nagar, Lachhana Katari and Jajmau Bridge as shown in the path of river near Kanpur. Some soil samples were taken from the surface of the earth and were designated as 1A, 2A, 3A and 4A respectively and the some soil samples were taken at the depth of 1feet from the surface and were designated as 1B, 2B, 3B and 4B respectively. The samples were taken pre monsoon in month of May and post monsoon in the month of October.

3. Results and Discussions

From figures 2 and 3 it can be seen that the dielectric constant decreases with increase in frequency for all the samples (pre and post monsoon). This type of behaviour has also been reported by several other workers [1-5]. It can be seen that the dielectric constant for post monsoon samples is more than pre monsoon samples. This may be because the flooding water during monsoon season removes the metallic and other impurities from the subsurface of soil/sand of the river. The decrease in mobility of water molecules in presence of ionic impurities may also lead to decrease in dielectric constant of the samples [5].
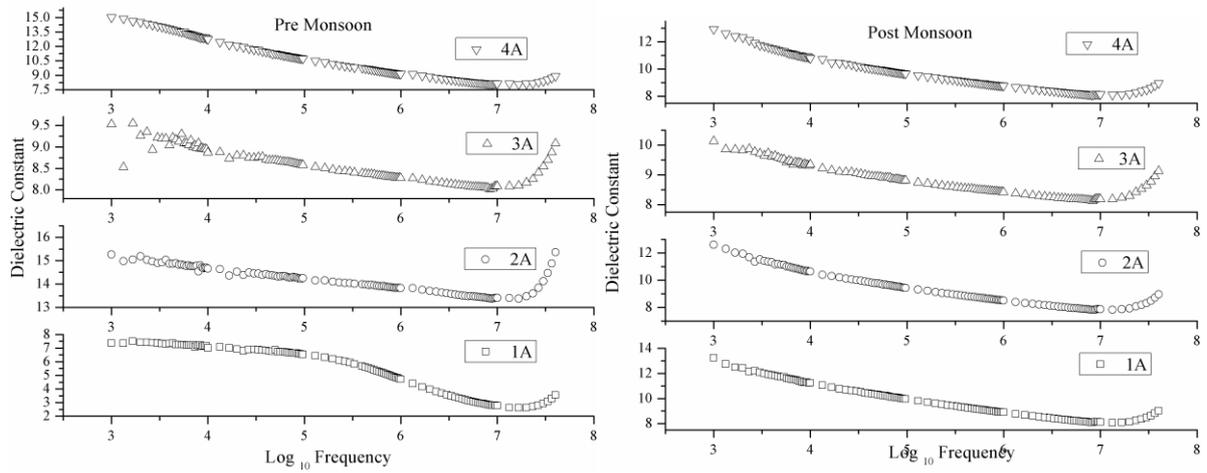
Fig. 2: Variation of Dielectric Constant with Log_{10} Frequency for the samples 1A, 2A, 3A and 4A (Pre and post monsoon) at Temperature 40^0C
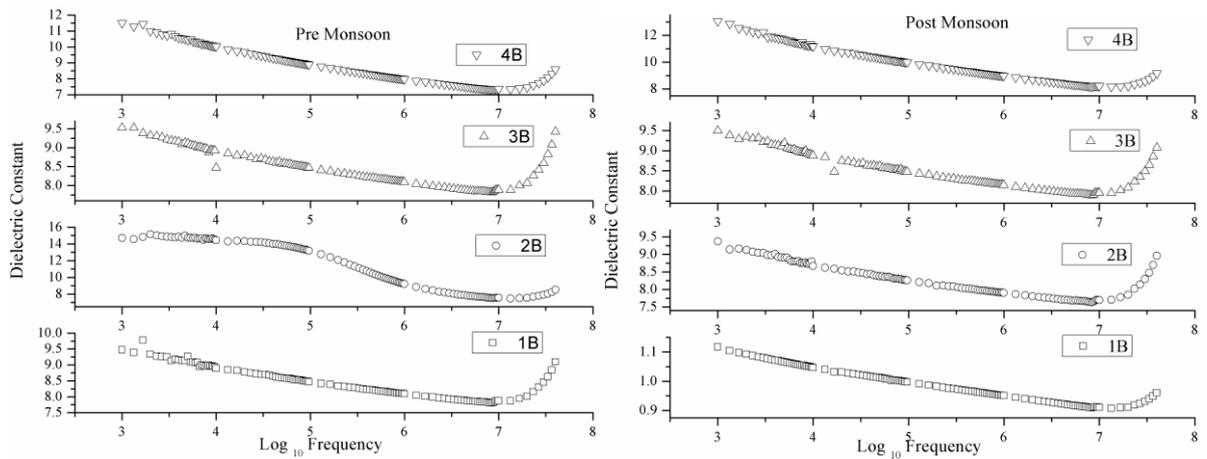

Fig. 3: Variation of Dielectric Constant with Log_{10} Frequency for the samples 1B, 2B, 3B and 4B (Pre and post monsoon) at Temperature 40^0C

In figures 4 and 5 the dielectric loss decreases with increase in frequency for all the samples. This type of behaviour has also reported by Francisca and Rinaldi [2, 5]. In figure 4 samples 1A and 4A are showing some relaxation type of mechanism probably Maxwell – Wagner relaxation while in figure 5 only sample 2B is showing some relaxation mechanism. The post monsoon samples are showing similar nature in of the dielectric loss as the pre monsoon samples, but none of them are showing any relaxation mechanism.
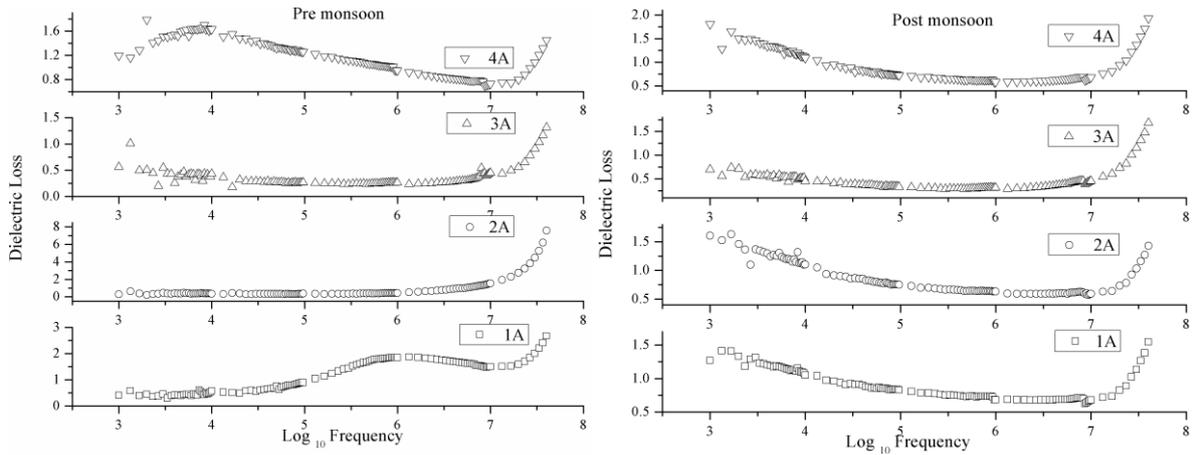
Fig. 4: Variation of Dielectric Loss with Log_{10} Frequency for the samples 1A, 2A, 3A and 4A (Pre and post monsoon) at Temperature 40^0C
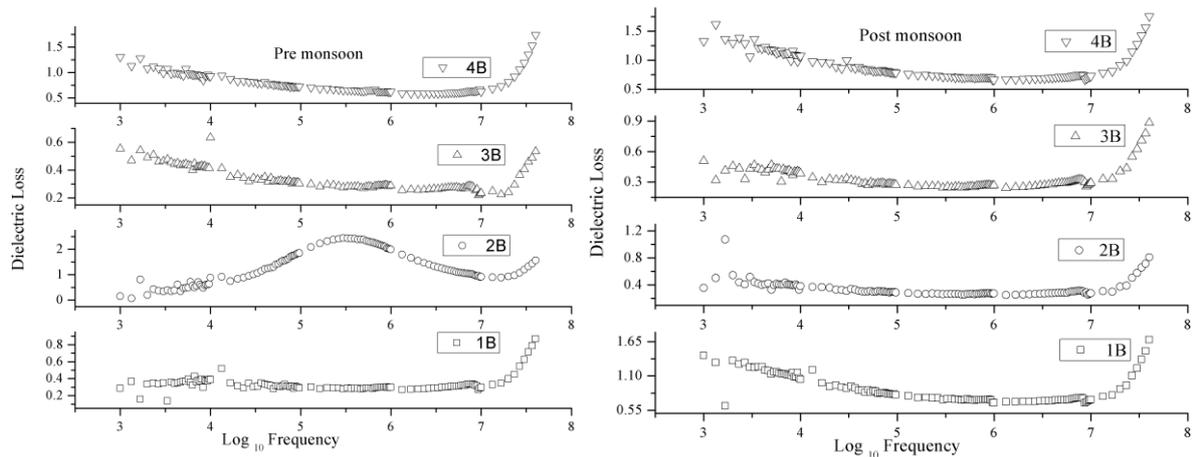

Fig. 5: Variation of Dielectric Loss with Log_{10} Frequency for the samples 1B, 2B, 3B and 4B (Pre and post monsoon) at Temperature 40^0C

In figures 6 and 7 dielectric constant is increasing with increase in temperature for all the samples. It may be noted that some samples are showing slow increase in dielectric constant while some samples are showing a fast increase in dielectric constant, it may be because of presence of some contamination in the sample as they are collected from different locations of the river. The increase in dielectric constant may be because as the increase in temperature may increase the mobility of water molecules within the pores of the samples. In figures 8 and 9 dielectric loss is increasing with increase in temperature for all the samples. Here it can be seen that in lower temperature range the increase in loss is slow than in higher temperature range. The variation of dielectric loss for post monsoon samples is similar to pre monsoon one and it was also expected.
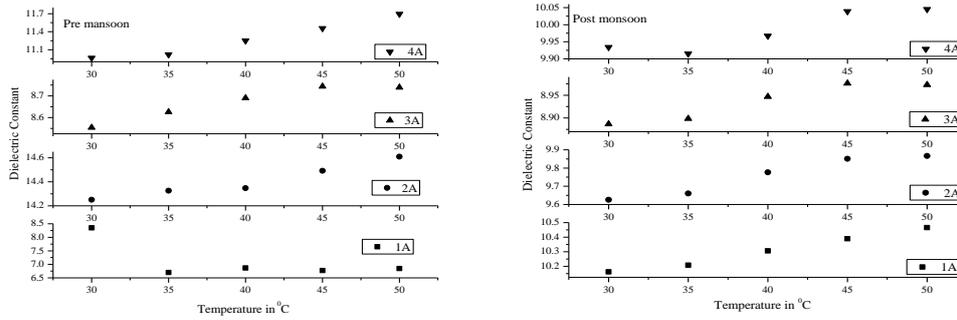
Fig. 6: Variation of Dielectric Constant with Temperature (in ^{0}C) for the samples 1A, 2A, 3A and 4A (Pre and post monsoon) at Frequency 50 kHz

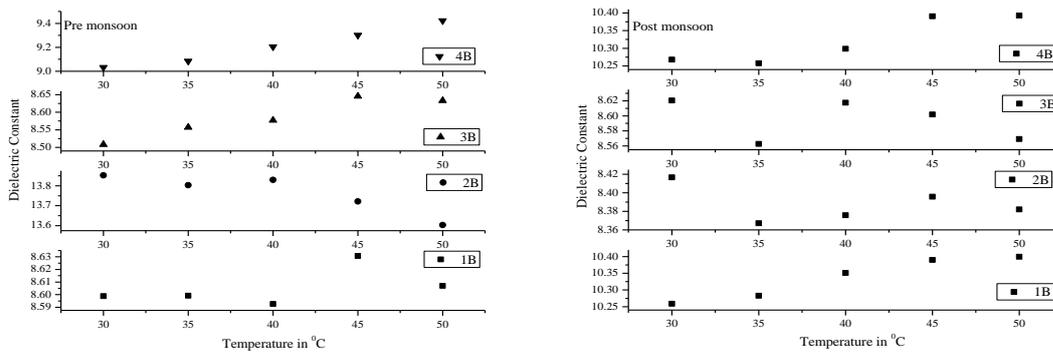
Fig. 7: Variation of Dielectric Constant with Temperature (in ^{0}C) for the samples 1B, 2B, 3B and 4B (Pre monsoon) at Frequency 50 kHz
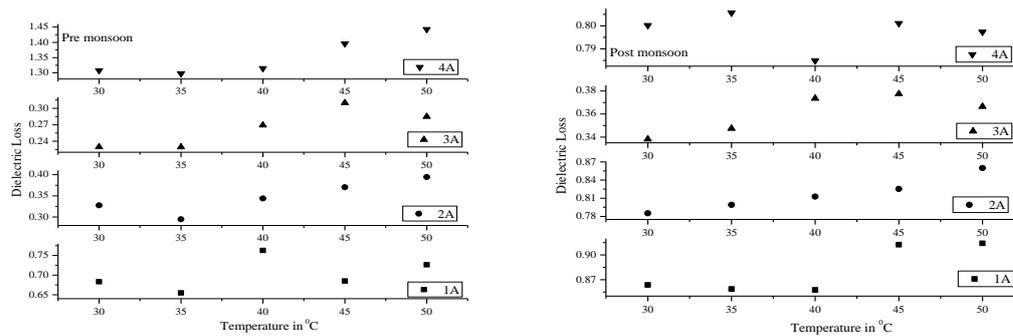

Fig.8: Variation of Dielectric Loss with Temperature (in ^{0}C) for the samples 1A, 2A, 3A and 4A (Pre and post monsoon) at Frequency 50 kHz

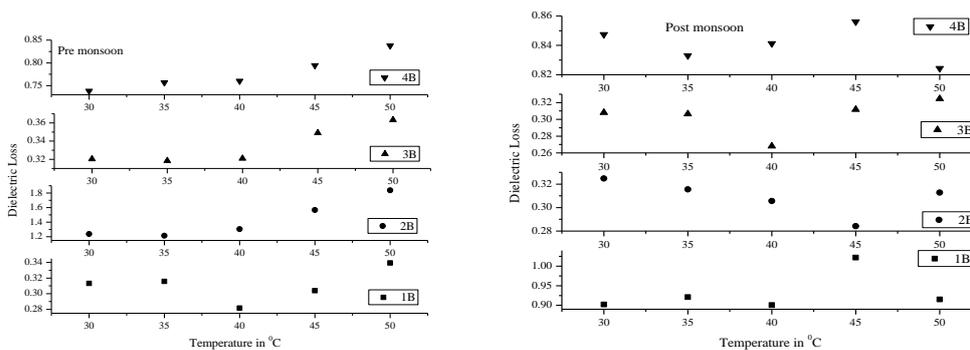Fig. 9: Variation of Dielectric Loss with Temperature (in ^{0}C) for the samples 1B, 2B, 3B and 4B (Pre monsoon) at Frequency 50 kHz

4. Conclusions

It can be concluded that the dielectric constant and dielectric loss decrease with increase in frequency for all soil samples. This type of behaviour has also been reported by other workers. Maxwell- Wagner type of relaxation is also observed in some soil samples at low frequency range.

It can also be concluded that the dielectric constant and dielectric loss increase with increase in temperature. Some unusual type of behaviour has also seen for some soil samples.

There is no certainty about the nature of dielectric constant and dielectric loss after monsoon. Some samples are showing that after monsoon dielectric constant and dielectric loss decrease while some other samples are showing the opposite nature. Thus, the value of dielectric constant and dielectric loss is highly dependent on the local atmospheric conditions of the sample sites.

5. Acknowledgment

6. References

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