VP 1: Dielectric Constant with 3 cm microwave

Goal:

* To measure the real and imaginary parts of the dielectric constant of t-butyl-chloride
* To observe their variation with temperature.

Related Theories:

The dielectric constant of a material is in general a complex function for the electromagnetic wave frequency, temperature and etc. In a simple language the real part of the dielectric constant (epsilon') determines the wave traveling speed in the material (we are all too familiar with the light deflection in a piece of glass.) The imaginary part (epsilon'') of the dielectric constant is responsible for the "damping" of the wave traveling in the material. There are different ways of measure the dielectric constants. The one used in this experiment is to comparing the standing waves in a microwave resonator with and without the target material. Introducing a section of dielectric material is in effect changing the length of the resonator and putting in damping.

Experiment:

A fixed length wave guide forms a resonator in which a microwave with ~3cm wavelength is introduced. By slightly vary the wavelength a standing wave can be established with minima~0. Introducing a section of the target dielectric material (t-butyl-chloride) into the wave guide the previous standing wave condition will, in general, not valid. By slightly adjust the wavelength a new standing wave can be reestablished with minima>0. The dielectric constants of the target material are responsible for the changes in the standing wave conditions and properties.

Experiment apparatus:

* resonator
  + klystron (microwave generator) + power supply
  + wave attenuator
  + wave guide
* standing wave detector (prob+meter)
* target sample (t-butyl-chloride) + its warm bath

Documentation:

* introduction manual of the apparatus
* formula note book

Measurement:

* A thorough understanding of the principle and the setup of the experiment and the working conditions of all the apparatus is essential.
* A proper determination of standing waves is the important basic step. (It may seem trivial.)
* Some creativity is needed to achieve different temperature conditions.

Data Analysis:
Requires proper error analysis.

Reference:
College level Electral Magnetic Dynamics books.