A STUDY OF DIELECTRIC RELAXATION OF TERRAMYCIN AT HIGH FREQUENCIES

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ABSTRACT

In this work the real and imaginary components of the complex permittivity of the antibiotic terramycin have been studied in the high frequency range and subjected to pressures of 5 to 8 tons in a shape of small wafer obtained by a special die. From the maximum values of the imaginary components, the dielectric relaxation time has been computed using Debye's theory. The dielectric relaxation time varies between 6.63 and 14.47 nsec for different pressures.

INTRODUCTION

TERRAMYCIN (figure 1) is an important tetracycline antibiotic and is very effective in the treatment of trachoma. The structure of terramycin was elucidated by Woodward[1,2]. The molecular formula of terramycin is $C_{22}H_{24}N_2O_9$ and the compound contains eight active hydrogen atoms. The compound shows the presence of dimethylamine and a carbonamido group and a C-methyl group. Moreover, diazomethane forms a dimethylether, which shows the presence of two acidic hydroxyl groups; the other two hydroxyl groups are alchoholic. Hence dielectric studies are important as they throw further light on the structure and behaviour of such a complex antibiotic compound specially when high frequency perturbations are imparted to it. Further the effect of high pressure on this complex molecule is to change its intermolecular structure yielding variations in its permittivity.
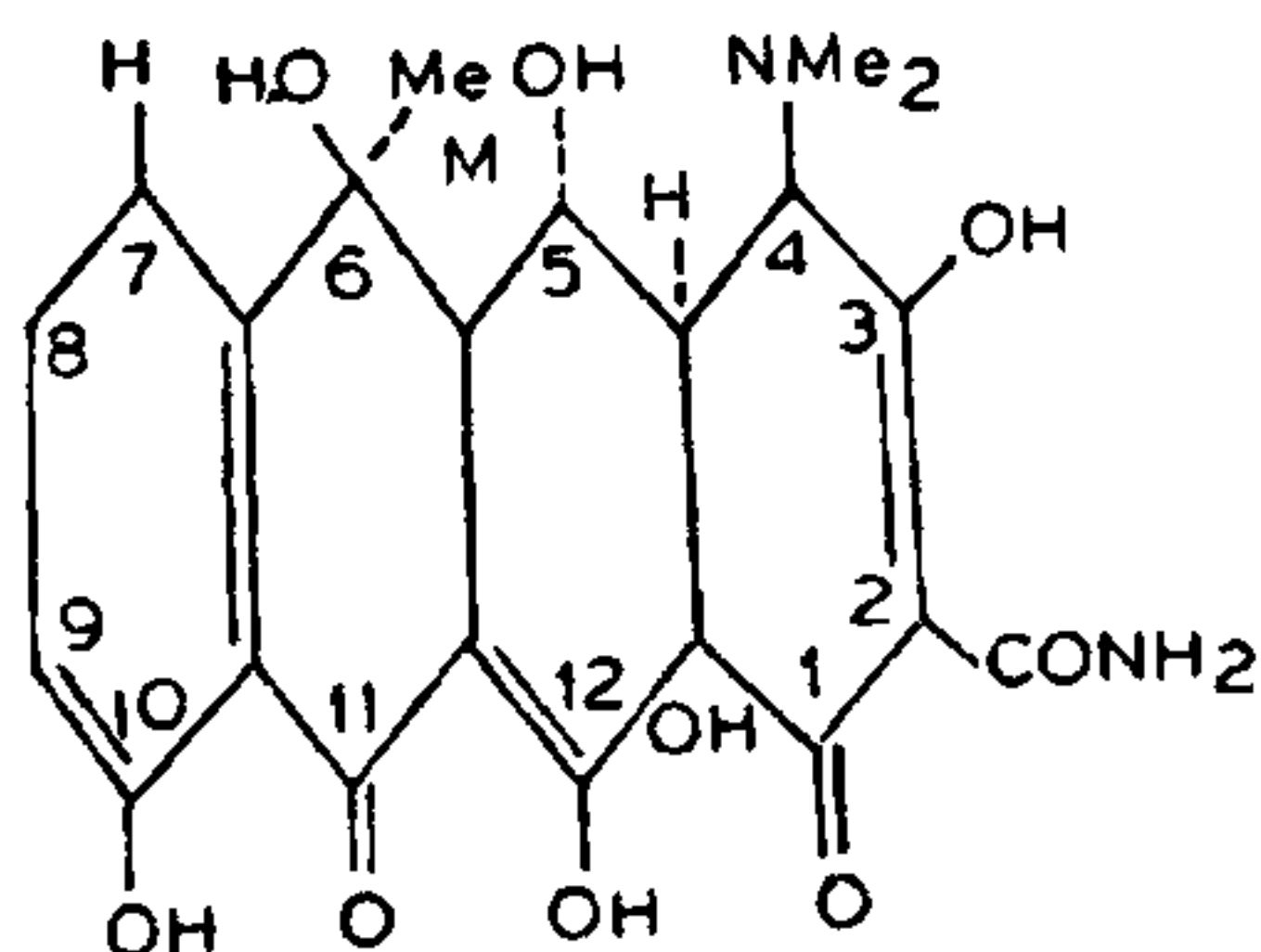

Figure 1. Structures of terramycin.

EXPERIMENTAL TECHNIQUE

Terramycin powder was filled up in a special die of area of cross-section 1.76 cm². The powder, subjected to a pressure of 5 tons, formed a dielectric wafer for the present investigations. The Q-meter (EE-13) was used for the measurements at high frequencies. The Q-meter was set for resonance and the capacitance and the corresponding Q-factor were read. The high frequency cable was connected and again the capacitance and the Q-factor were read at resonance for the full frequency range. Finally the terramycin wafer was sandwiched between the two electrodes and the capacitance and the Q-factor were obtained at resonance. The observations for the sample were made in the complete high frequency range of the instrument (10 MHz to 30 MHz). Finally, the experiment was repeated by using wafers prepared by the application of pressures of
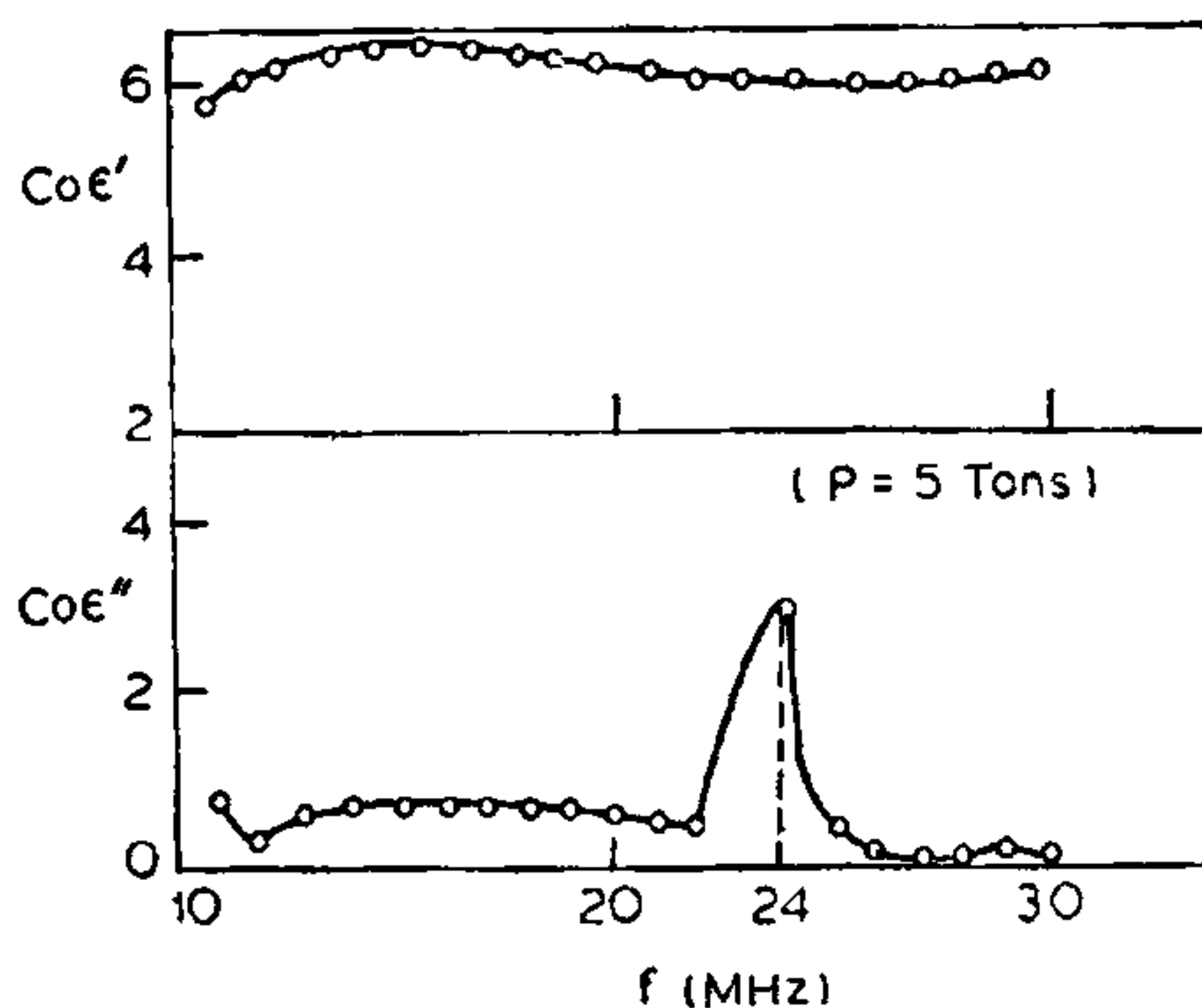

Figure 2. $C_0\epsilon'$ and $C_0\epsilon''$ vs frequency for terramycin at 35°C.
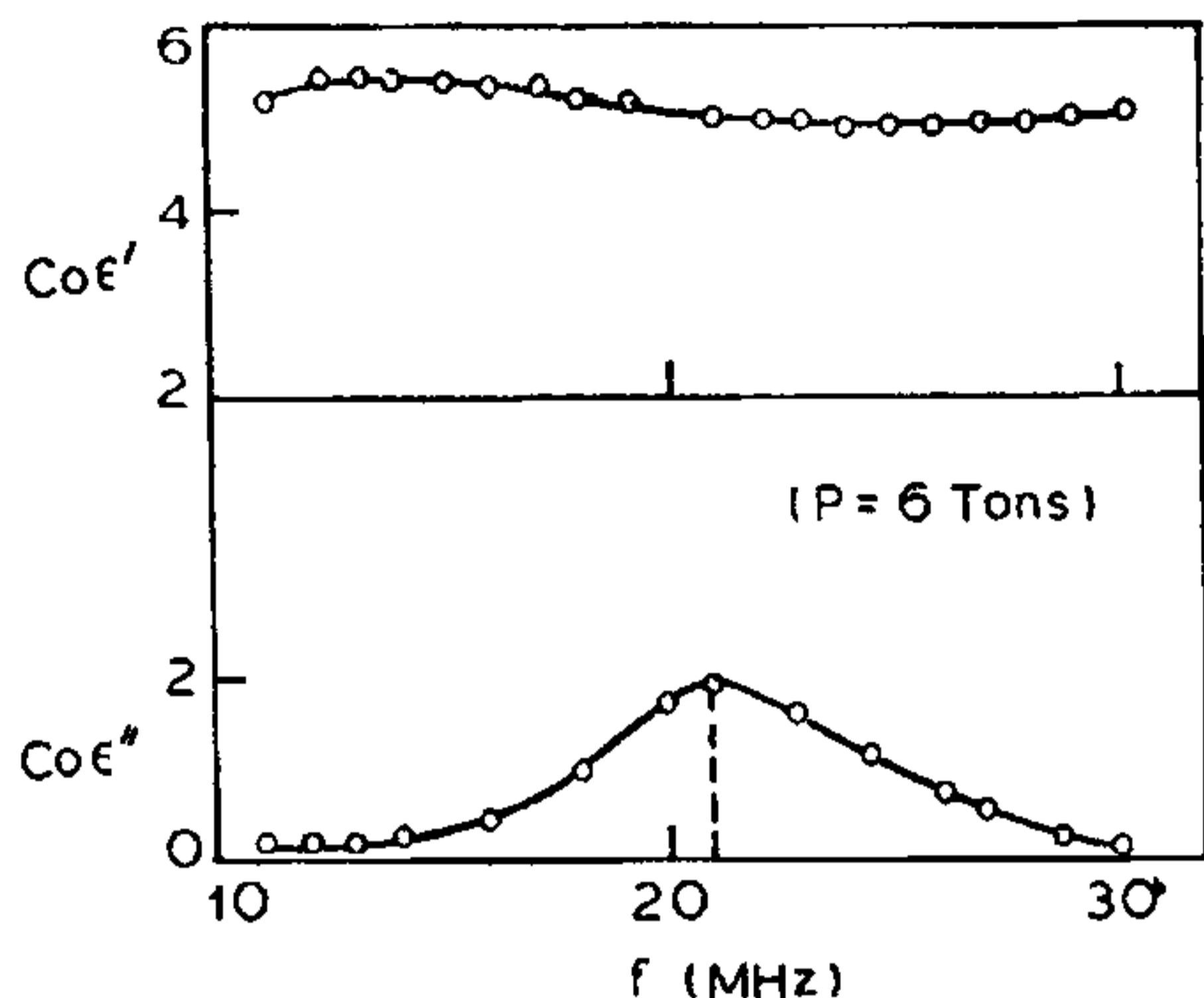
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Figure 3. $C_0 \varepsilon'$ and $C_0 \varepsilon''$ vs frequency for terramycin at 35°C.

6,7 and 8 tons. The real and imaginary components of the complex permittivity of terramycin were computed[3-5], and their variations with frequencies are indicated in figures 2 to 5 for different pressure values.

RESULTS AND DISCUSSION

Figure 2-5 show that the terramycin compound follows the Debye's dispersion relations given by[6-8]

$$\varepsilon' = \varepsilon_\alpha + \frac{(\varepsilon_0 - \varepsilon_\alpha)}{1 + \omega^2 \tau^2} \tag{1}$$

and,
$$\varepsilon'' = \frac{(\varepsilon_0 - \varepsilon_\alpha)\omega\tau}{1 + \omega^2 \tau^2} \tag{2}$$
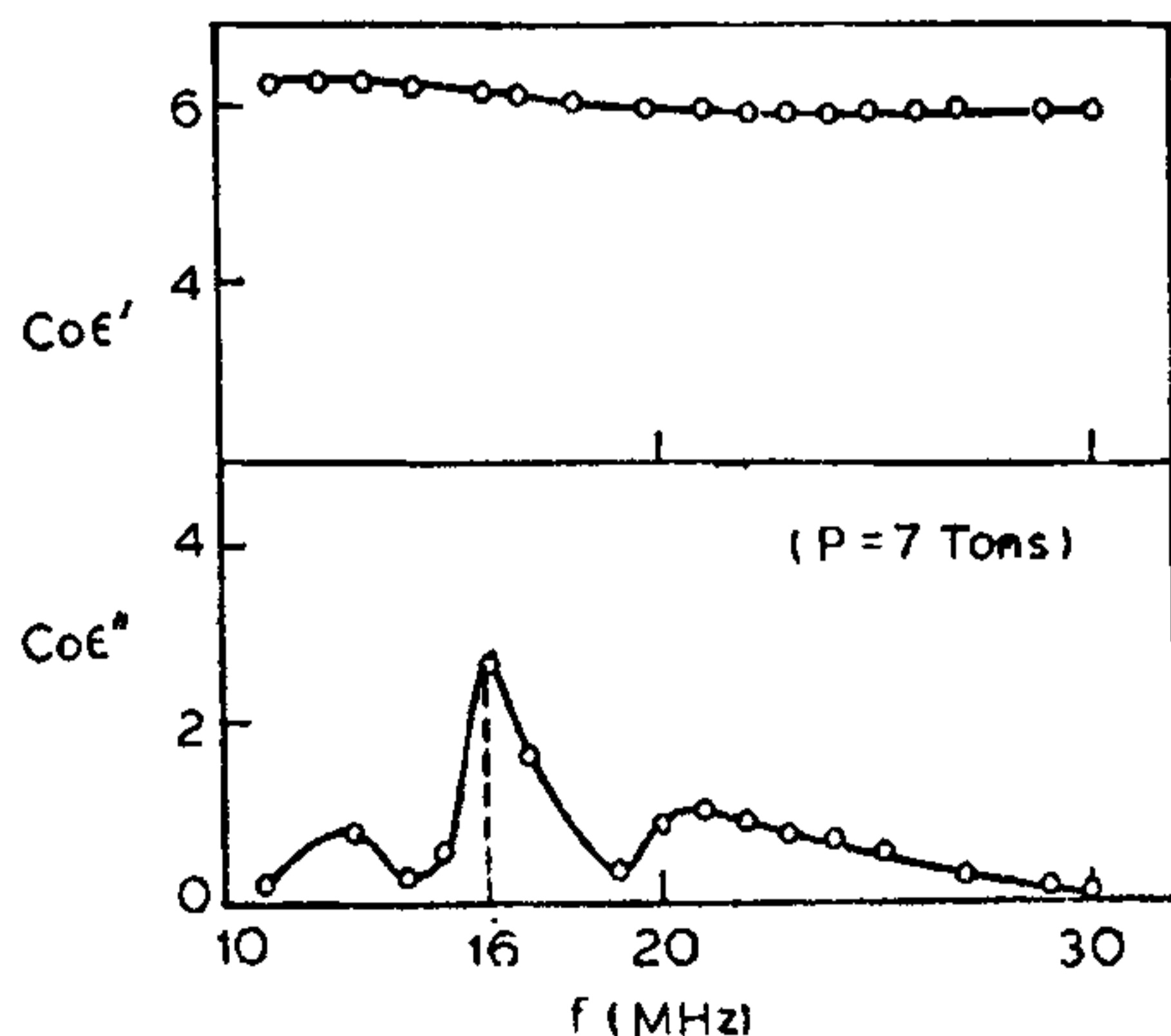

Figure 4. $C_0 \varepsilon'$ and $C_0 \varepsilon''$ vs frequency for terramycin at 35°C.
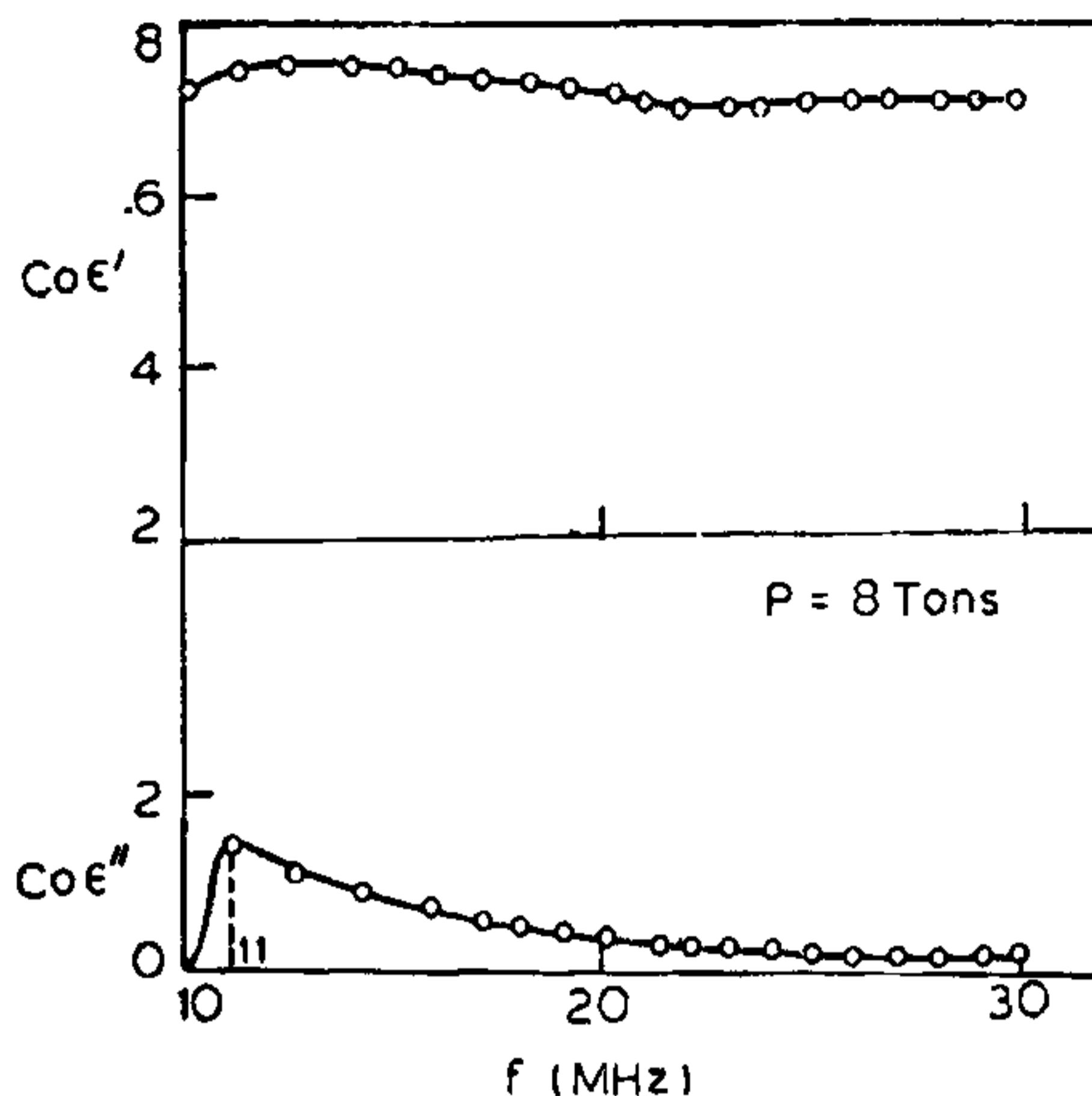

Figure 5. $C_0 \varepsilon'$ and $C_0 \varepsilon''$ vs frequency for terramycin at 35°C.

where, ε_0 and ε_α are the static and instantaneous values of the dielectric constant, ω the circular frequency and the τ dielectric relaxation time. The relaxation time for terramycin is obtained using ε'' peaks for different pressures[9,10]. It is found that ε''_{max} for a pressure of 5 tons is at the frequency of 24 MHz (figure 2). For pressures of 6, 7 and 8 tons the frequencies corresponding to ε'' maximum are 21, 16 and 11 MHz respectively (figures 3−5), (table 1)

The relaxation time and pressure graph (figure 6) show the relaxation time increases with increase in pressure on the sample.

CONCLUSION

The antibiotic sample terramycin follows Debye's theory in the high frequency range and the dielectric relaxation time increases as the pressure is increased. However, as the molecule is complex in structure,

Table 1 *Pressure and relaxation time for the terramycin sample*

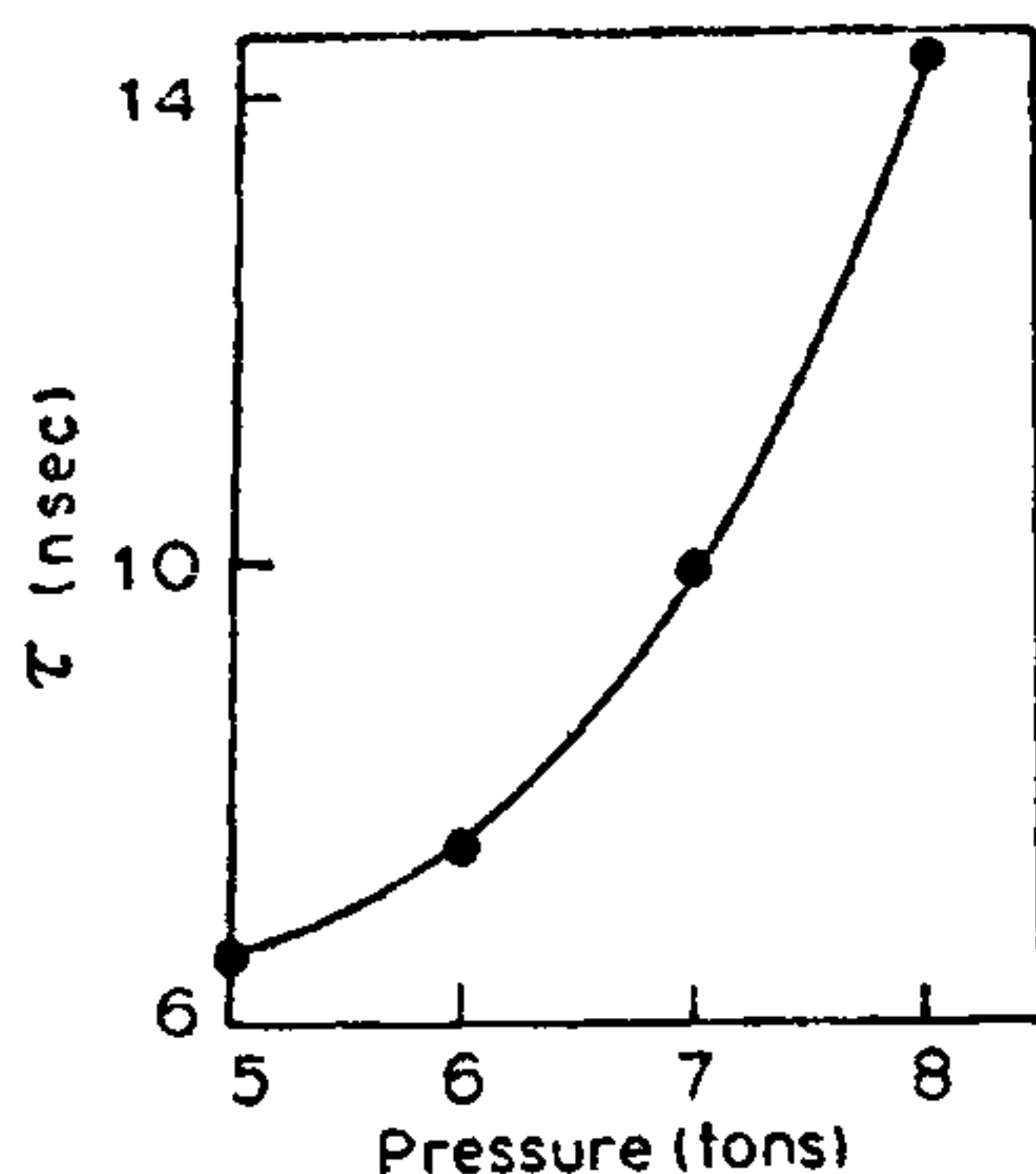| Pressure (tons)	Thickness of sample (cm)	Frequency for ε'' peak (MHz)	Relaxation time (nsec)
5	0.144	24	6 63
6	0.136	21	7.58
7	0.132	16	9 95
8	0 129	11	14 47

Figure 6 Dielectric relaxation time vs pressure for terramycin sample.

detailed studies with many other methods are essential for elaboration of the behaviour of this compound.

ACKNOWLEDGEMENTS

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NEWS

1987 PRIESTLEY MEDALIST

..."At the American Chemical Society [ACS] national meeting in Denver [in April], John D. Roberts, Institute Professor of Chemistry at [the] California Inst. of Technology and 1987 Priestley Medal recipient...said he used to think the Priestley was 'awarded almost exclusively to those much-admired and selfless individuals who were not only great chemists in their own right, but also served with distinction as the ACS president, chairman of the board, or the like." He explained that, being an experimentalist, he investigated this theory and found that the most important factor common to the past 20 Priestley Medalists is not ACS service. It is maturity... As he approaches formal retirement age, Roberts remains very optimistic about chemistry. 'It is fabulous that chemistry is taking over research in such things as superconductors. Furthermore, chemistry disguised as "molecular biology" is leading us down the road to understanding life. Ultimately, sometime in some way, chemistry will even help us understand how we possess and use the marvelous gifts of cognition, of reasoning, of humour and love, of appreciating in the small constrained way that we can, despite the pain and anguish we may feel at times, the miracle of being alive". [(Michael Heylin in Chemical and Engineering News, 27 April 87, p. 54.) Reproduced with permission from Press Digest, Current Contents®, No. 26, June 29, 1987, p. 14. (Published by the Institute for Scientific Information®, Philadelphia, PA, USA.)]