discharge vessel and which prevents the surface recombination of N_2^+ ions and electrons.

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Derivation of Maxwellian Relaxation Times from Tensile Data

MAXWELL'S[1] relaxation time (t_r) is defined as the ratio of viscosity (η) to shear modulus (n), and is derived from the expression $-\,\delta(\log S)/\delta t$, of which it is the reciprocal (S is the shear stress dissipating at constant strain).

It is well known that for fluids $\eta = \tau/3$, where τ is the "coefficient of viscous traction" (Trouton[2]), and for elastic solids, that $n = E/2\,(1 + \Pi)$, where E is Young's modulus and Π is Poisson's ratio, which is $\frac{1}{2}$ for fluids. But it is often overlooked that the latter expression is only applicable to small strains; there is also the question of isotropy, which will not be discussed here. Further, the validity of the former to flow conditions depends on the special nature of liquids (see especially Love[3]).

Now that the theory of elasticity is being increasingly applied to 'high-elastic' materials for which so-called 'moderate strains' may be of the order of several hundred per cent, it is important that the limitation of the $2(1 + \Pi)$ expression should be more widely realized. A number of authors (Schofield and Scott Blair[4], Kuhn[5], Bennewitz and Rötgers[6], Taylor[7], Robinson, Ruggy and Slantz[8], etc.) have derived relaxation times from tensile data for large strains using the $2(1 + \Pi)$ expression. In some cases it is quite clear that it is only the order of magnitude of t_r that is significant: in others the limitations of the treatment are not made clear. The applicability of the expression does not depend only, as Simha[9] appears to suggest, on the constancy of Π or on the validity of Hooke's Law: in fact, the meaning of this latter criterion is liable to ambiguity where large strains are concerned. The essential point is that the original calculation of $2(1 + \Pi)$ depends fundamentally on the deformations being small.

Fluid behaviour is defined in such a way that large strains must be expressed by the 'natural' formula

$$\int_{l}^{l_0} \frac{dl}{l} = \log_e l_0/l$$

(for a length increase from l_0 to l) and such strains are additive. The usual 'engineering' formula, $l - l_0/l_0$, is not additive for large strains and the 'extension ratio', l/l_0, which is much used in the theory of rubber structure (see Wall[10], Treloar[11], etc.), is multiplicative, being numerically equal to the antilogarithm of the 'natural' strain. Some authors, such as Latshaw[12], do not appear to be clear about this. The extension ratio has the advantage that it relates tensile to shear strains by a simple expression irrespective of strain magnitude[3].

Modern 'high-elasticity' theory is based largely on the work of Kuhn[5] and that of Alexandrof and Lazurkin[13], Lazurkin[14] and Gurevich and Kobeko[15]. This latter school is concerned with what are called by the authors 'relaxation times' but, being quite different from those of Maxwell, are now generally known as 'orientation times'.

The orientation time is the time required for a strain to reach $1 - 1/e$ of its equilibrium value under constant stress. Although said to apply only to super-cooled liquids, the materials concerned do not have that property of liquids which justifies the use of the classical expression relating tensile to shear conditions, since there is no unique rate of shear for any given stress. It is not clear whether orientation times refer to shear or to tensile-compressive strains. Alexandrof did compression tests whereas Gurevich and Kobeko used shearing conditions. The discrepancy does not appear to have been noted.

In fitting equations such as that of Nutting[16] which do not involve entities like viscosity and relaxation time, the empirical use of $2(1 + \Pi)$ is justifiable; but this is scarcely the case in deriving values of η and t_r, unless it be made quite clear that the treatment may be only very approximate for large strains. For materials of high consistency, a relaxation time defined in terms of the dissipation of tensile stress and a coefficient of viscous traction would really be preferable to the more usual t_r and η.

I have been helped in the unravelling of this very confusing situation by so many friends that individual acknowledgment is impossible.

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Smoke and Rain

IN a paper published in 1929[1] the conclusion was drawn from observations made in two or three different ways that smoke discharged into the atmosphere tends to promote rainfall and to precipitate rain in highly moist air when, without smoke, it would not have fallen. One test was to compute the rainfall on each day of the week, and the result showed that on an average of thirty years, Sundays had rather less rain than weekdays by about 6 per cent, or more correctly, the average of weekdays had an excess over Sundays by this amount. As factories in Rochdale and neighbouring Lancashire towns do not work on Sundays there is then a general absence of smoke in the air, although