The Configuration of Phenothiazine in Various Molecular Complexes

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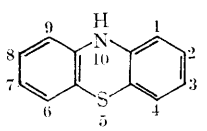
ONLY a few cases are known of two forms of a molecular species, differing only in total charge, that have been stable enough for structure analysis, and the changes in which are found to be small.[1] Changes in geometry with charge may



(I)

be observed in phenothiazine (I), since the cation of 2,8-bis(dimethylamino)phenothiazine has been shown[2] to be planar, whereas neutral phenothiazine is assumed to be nonplanar.[3] Proof of nonplanarity of phenothiazine and correlation of the degree of nonplanarity with charge would also be useful in constructing and evaluating models of complex bonding[4] in phenothiazine-based drugs.

We have reported[5] that in phenothiazine–trinitrobenzene (1 : 1) the phenothiazine moiety, although disordered, is most stable in a folded configuration, with a dihedral angle of 168 ± 4°. The S–C and N–C distances were estimated to be 1·76—1·81 and 1·40—1·45 Å. We report the configuration of phenothiazine in the crystal structure of phenothiazine–3,5-dinitrobenzoic acid (1 : 1), in which there is no disorder.

Crystals of phenothiazine–3,5-dinitrobenzoic acid (1 : 1) were prepared by slow cooling and evaporation of a 30 : 70 acetone–benzene solution equimolar in phenothiazine and the acid chloride. The crystal structure is triclinic, symmetry $P\bar{1}$, $z = 2$, $a = 7{\cdot}54 \pm 0{\cdot}01$, $b = 10{\cdot}00 \pm 0{\cdot}01$, $c = 13{\cdot}92 \pm 0{\cdot}01$ Å, $\alpha = 101{\cdot}79 \pm 0{\cdot}05$, $\beta = 105{\cdot}79 \pm 0{\cdot}05$, $\gamma = 105{\cdot}21 \pm 0{\cdot}05°$. These values were determined by least-squares fitting of 2θ measurements using a Picker four-circle diffractometer, and Cu-K_α radiation. The same diffractometer was used with a molybdenum X-ray target to collect all independent intensity data having $2\theta \leqslant 45°$.

Reflections were processed[6] and the structure solved by use of Patterson and successive electron-density functions. The structure has been refined by least squares[7] to $R = 9{\cdot}9$.

The structure is similar to the classical charge-transfer case, in that phenothiazine and dinitrobenzoic acid molecules occur alternately in a stack parallel with *a*, with virtually identical interplanar spacing (*ca.* 3·33 Å). However, each molecule overlaps one of its neighbours more extensively than the other. Furthermore, the phenothiazine moiety is not planar but consists of two planar halves folded along the N–S axis, with a dihedral angle of 156 ± 2°. Contrary to the trinitrobenzene complex, there seems to be no packing

influence to force this angle to differ from its intrinsic value, and it therefore seems that this degree of folding represents the configuration of free phenothiazine.

The interatomic distances also seem to indicate that there is little, if any, aromatic character to the central ring of phenothiazine. The C–N distance of 1·39 ± 0·02 Å is nearly the same as in pyrrole,[8] whereas the C–S distance is 1·76 ± 0·02 Å, virtually what is expected by correcting the C_{sp^3}–S distance[8] of 1·82 Å for the change (0·04 Å) expected on going from C_{sp^3} to C_{sp^2}. The C–S–C angle is 101 ± 1 and the C–N–C angle is 123 ± 1°; all other angles appear to be 120°. All C–C distances are equal to the benzene value.

If we assume the phenothiazine cation radical to be planar,[2,9] we can then conclude that the ground state in the present complex is essentially the no-bond structure (DA), in contrast with the situation in the complexes of phenothiazine with quinone and 2,3-dichloro-5,6-dicyanoquinone,[10] which appear to be essentially ionic (D^+A^-). Because of disorder, the position of the trinitrobenzene complex is unclear, but it is probably the no-bond type.

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