and to proceed by analyzing experimental data for clear-cut evidence as to their occurrence.

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A NEW CALCULATION OF THE C=C BOND STRENGTH AND OF CERTAIN RESONANCE ENERGIES[1]

IN the current table of bond energies[2] used for interrelating the structures of molecules and thermal data relating to them and for predicting resonance energies, a strength of 100 is assigned to the C=C bond. (Bond strengths are given in kcal./mole units, bond lengths in Ångstroms.) This value appears to be at variance with the data relating to ethylene and allene.

The heat of combustion of gaseous ethylene[3] is 337.28. The heat of combustion of gaseous methane[3] is 212.79. Writing 4d for the amount by which the ethylene C–H bonds exceed the methane bonds in strength, we deduce that the C=C bond in ethylene has the strength 94.29-4d. Using the heat of hydrogenation[4] of ethylene 32.58 and the heat of combustion of ethane[3] 372.81, it follows that this bond strength is 94.51-4d. Correspondingly, from the heat of hydrogenation[4] of allene 71.28 and the heat of combustion of gaseous propane[3] 530.57, it follows that the strength of the C=C bond in allene is 92.57-2d′, where d′ is the amount by which each allene C–H bond exceeds the methane bond in strength. The C–H bond length[5] in ethylene and in allene is quoted at 1.087, which is smaller than the C–H bond length[2] in methane, quoted at 1.093. Hence it must be presumed that d and d′ are positive and that the C=C bond strengths in ethylene and allene are less than 94.29 and 92.57, respectively.

This considerable modification in the C=C bond strength implies a considerable modification in the resonance energies of benzene, naphthalene, etc., as at present defined.[2] For example, the resonance energy of benzene, defined as E–E′, where E is the heat of formation and E′ the sum of the strengths of 3C–C +3C=C +6C–H, is now increased by at least 17: naphthalene correspondingly, whose E′ function includes 5C=C bonds, has its resonance energy increased by at least 28, and for anthracene and phenanthrene the increase is at least 39. Other molecules have their resonance energies increased at least by the following amounts: pyridine, furan, pyrrole and thiophene 11, quinoline and indole, 22, carbazole 34, and so on.

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[1] Contribution from the Chemical Laboratory of the Johns Hopkins University, Baltimore, Md.
[2] Pauling, "Nature of the Chemical Bond," 1939, 1940.
[3] Rossini, *Ind. and Eng. Chem.*, 29: 1424, 1937.
[4] Kistiakowsky *et al.*, *Jour. Am. Chem. Soc.*, 58: 137, 1936.
[5] Eyster, *Jour. Chem. Phys.*, 6: 580, 1938.

AVOIDING OBVIOUS RESIDUE FROM NICOTINE-BENTONITE SPRAYS[1]

BECAUSE of reports, from many places, of the unsatisfactory obviously heavy residue on fruit and foliage resulting from the use of nicotine-bentonite combinations, we wish again to call attention to our experience.

Using Wyo-Jel bentonite obtained from the Wyodak Chemical Company, Chicago, Illinois, we proceeded first to wet weighed portions of bentonite, using a mechanical stirrer, before adding the nicotine. The spray resulting from this method left a very marked residue on fruit and foliage which was quite obvious from some distance. The trees gave the appearance of vegetation which has been covered with dust along a very dusty dirt road. McCrory and Vinson[2] described in 1938 a method of mixing nicotine sulfate (Black Leaf 40) and bentonite which gave *no obvious* residue when the material was used as a spray. The method consists in adding a known quantity of Black Leaf 40 to a weighed portion of *dry* bentonite. The materials are mixed *in the dry condition* with a stick or other suitable stirrer. The mixture is then allowed to stand in a tightly closed container over night. By the following morning the lumps crumble and all is passed through an eighteen-mesh screen. The screened combination disperses readily in the spray tank to form a stable suspension. Such a spray gives *no obvious* residue on fruit or foliage. Eight sprays of such a preparation in 1938 and six in 1939 resulted in *no obvious* residue. Certainly there was no suggestion from the appearance of the fruit at harvest that any kind of cleaning was necessary or desirable.

Control of codling moth by such a nicotine-bentonite combination gave results which compared very favorably with that obtained by the standard spray of lead arsenate. About eighty-seven thousand apples were counted from the sprayed plots in 1939. The percentage of clean fruit from plots sprayed with the nicotine-bentonite combinations was 92.4 and the percentage of clean fruit from the lead arsenate plot was 91.3. The number of entries was slightly reduced and the number of stings was greatly reduced under those for the lead arsenate.

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[1] Contribution from the Department of Horticulture, Missouri Agricultural Experiment Station Journal Series No. 634.
[2] S. A. McCrory and C. G. Vinson, *Mo. Agr. Exp. Sta. Res. Bull. No.* 292, 1938.