Introduction of Acyl Substituents on to the Azepine Nucleus: *N*-Ethoxycarbonylazepinetricarbonyliron(0)

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Summary Acylation of *N*-ethoxycarbonylazepinetricarbonyliron(0) gives the 3-acyl substitution products.

We report the first examples of the direct introduction of substituents on to the azepine nucleus. Although there are various procedures available for the synthesis of polysubstituted azepines, the preparation of the simpler mono- or di-substituted compounds is much more difficult, particularly if the substituents are to be in the 3- or 4-positions. The chemical and physical properties of *N*-ethoxycarbonylazepine,[1] and of other 1-substituted azepines, leave no doubts about their essentially olefinic nature. Such properties include *X*-ray crystallographic determination of bond lengths and of bond angles,[2] the rearrangement to phenylurethane in the presence of acids,[3] and the formation of Diels–Alder adducts.[4] The *N*-methoxycarbonylazepine also readily forms a tricarbonyliron(0) complex (*cf.* I), which recently has been examined by *X*-ray crystallography.[2] This indicates the existence of a localised C-2–C-3 double bond, a degree of delocalisation at C-4–C-7, (the carbon atoms π-bonded to the metal atom), a dihedral angle of 133° between the approximately planar C-4–C-7, and the N, C-2–C-4 atomic arrangements.

Reaction of (I) in acetic anhydride with fluoroboric acid at −15° gives a yellow fluoroborate salt which was decomposed by bases. However, at 0°, the product is a yellow crystalline solid, m.p. 144—145° (42%) which has been assigned the structure (III). The acetyl derivative (III) has also been prepared (22%) by the action of acetic anhydride and tin(IV) chloride on (I). The corresponding propionyl derivative, m.p. 95—96° (20%) can be prepared by the fluoroboric acid method, using propionic anhydride as the solvent. The action of *NN*-dimethylformamide and phosphorus oxychloride on (I) gives the 3-formyl compound

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(II), m.p. 126—127° (19%). The *N*-ethoxycarbonyl group of (III) is removed by the action of methanolic sodium methoxide to give 3-acetyl-1*H*-azepinetricarbonyliron(0), the i.r. spectrum of which indicated appreciable intermolecular hydrogen-bonded interactions between the acetyl carbonyl and the imino-hydrogen. This 1*H*-compound is methylated by methyl iodide and sodium hydride to the 1-methyl analogue (IV).

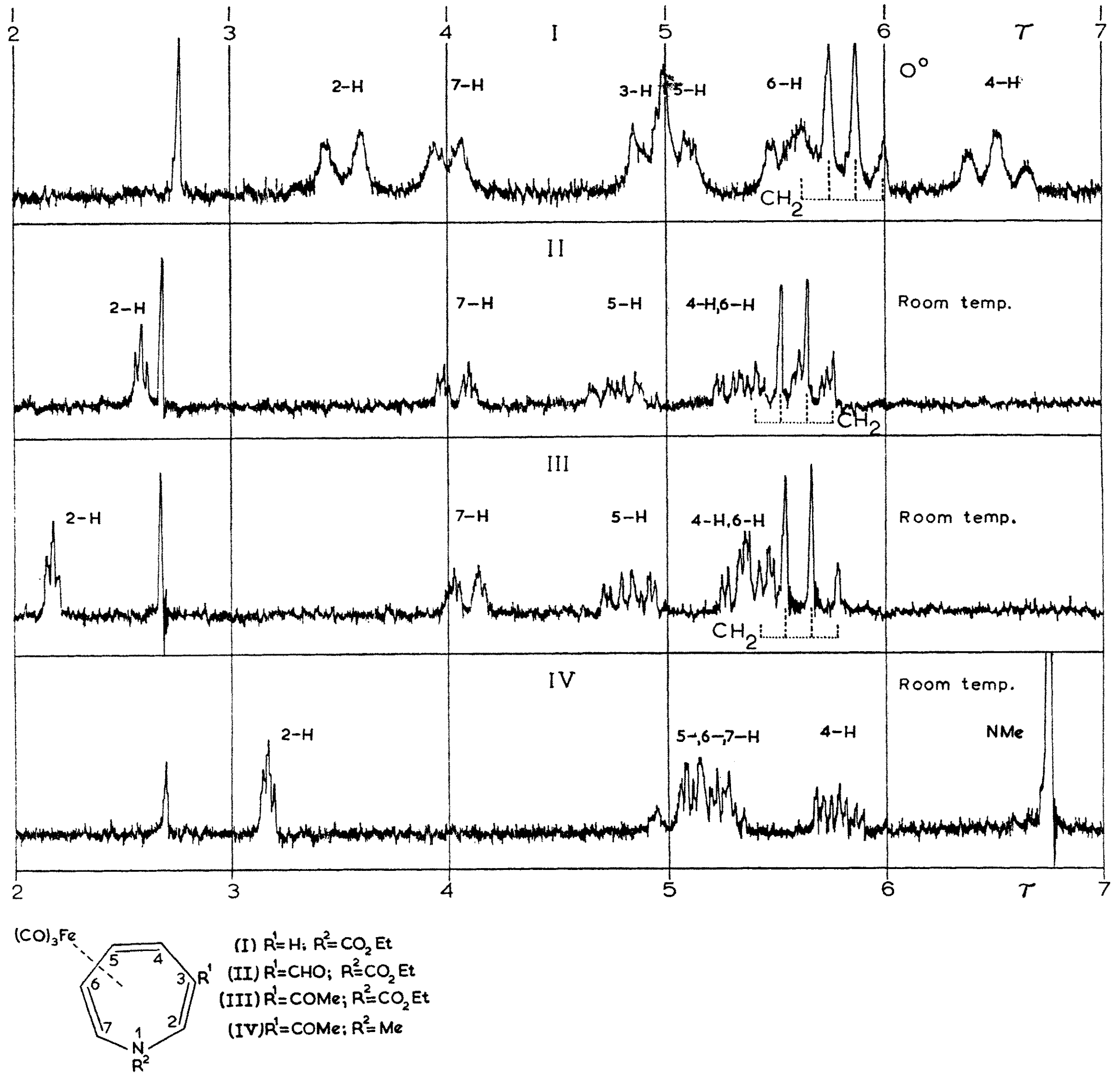

FIGURE. *60 MHz. n.m.r. spectra of some azepinetricarbonyliron*(0) *complexes in* $CDCl_3$ *solution.*

The identities of the compounds (II)—(IV), and of the related compounds described above, are deduced from microanalyses, mass spectra, and the i.r., u.v., and n.m.r. spectra. The orientation of the substitution is deduced from the n.m.r. spectra which are reproduced (τ 2—7 region only) in the Figure. These n.m.r. spectra were run in dilute solution in $CDCl_3$, using $SiMe_4$ as internal standard, at 60 MHz. at 0° or at room temperature. The appreciable broadening of the olefinic proton resonances apparent in spectrum I is consistent with the relatively slow tautomeric rearrangement of (I) at 0° to the chemically equivalent structure in which the iron atom is π-bonded to the C-2–C-5 butadiene unit.[5] The absence of broadening in spectra II—IV indicates the reduce dimportance of tautomeric bond-switching in compounds (II)—(IV) in solution at room temperature. The powerful shielding influence imposed by the back-donation of electrons from the metal atom in (I) particularly affects the protons at the termini of the complexed 1,3-diene. Thus the 7-H, 6-H, and 4-H resonances are shifted upfield with respect to their counterparts 2-H, 3-H, and 5-H. An electron-withdrawing substituent in position 3 of (I) should mainly deshield the 2-H and 4-H protons, whereas 5-H, 6-H, and 7-H should remain largely unaffected. Spectra II and III of the Figure are therefore consistent with the suggested substitution pattern in compounds (II) and (III). In the *N*-methyl compound (IV) the 2-H and 7-H resonances should be shifted sharply upfield relative to the corresponding absorptions in spectrum III. 4-H should also experience a similar, but smaller, shielding effect because of the reduced electron-withdrawing power of the acetyl function owing to its increased interaction with the more basic lone pair on the nitrogen atom in (IV). Spectrum IV is also consistent with the suggested substitution pattern. The conclusions are supported by the results of double-resonance experiments performed using a 100 MHz. instrument.

The values of the coupling constants among the various olefinic protons in spectra I—IV cannot be obtained from a first-order analysis of the spectra, and we have a computer-based theoretical analysis for these parameters under way. The various resonances not within the scale of the Figure are: (I) at τ 8·77 (triplet, CH_3; J 7·2 Hz.); (II) at τ −0·09 (singlet, aldehyde H) and at τ 8·59 (triplet, CH_3; J 7·2 Hz.); (III) at τ 7·68 (singlet, acetyl CH_3) and at τ 8·57 (triplet, ester CH_3; J 7·1 Hz.); (IV) at τ 7·80 (singlet, acetyl CH_3).

An *X*-ray examination of the acetyl derivative of the unsubstituted azepine (I; R^1 = Ac, R^2 = H) is being undertaken by Professor G. A. Sim, University of Sussex.

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