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ADDITION REACTION OF NITRILE OXIDES ON CYCLOOLEFINS

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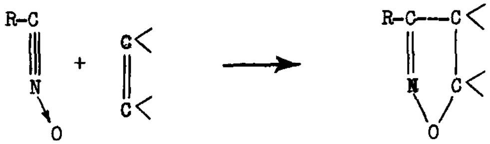
IN pursuing our studies on the addition reaction of nitrile oxides on olefins[1] to give Δ^2-isoxazolines:



we have examined the reactions of semicyclic and endocyclic ethylenic double bonds, in order to establish some rules which could be useful in differentiating several orders of reactivity. Analogous study has been made for instance by Alder and Stein[2] on the addition reaction of phenylazide and olefins.

It was already known that some cycloethylenic derivatives, such as benzo- and naphtho-quinone,[3] bicyclopentadiene,[4] 3,6-endomethylene-1,2,3,6-

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[1] A. Quilico, G. Stagno d'Alcontres and P. Grünanger, Nature, Lond.166, 226 (1950); A. Quilico and coworkers, Gazz. Chim. Ital. 80 140, 479, 741, 831 (1950) and following papers; The ethylenic derivatives tested up to now are over 200.

[2] Alder and Stein Liebigs Ann. 485, 211 (1931); 515, 165, 185 (1935).

[3] A. Quilico and G. Stagno d'Alcontres, Gazz. Chim. Ital. 80, 140 (1950).

[4] A. Quilico, P. Grünanger and R. Mazzini, Gazz.Chim.Ital.82,349 (1952).

tetrahydrophthalic anhydride,[5] indene[6] and fulvenes,[4] are reactive towards benzonitrile oxide, while some other double bonds taking part in aromatic systems, such as benzene, furan, thiophene, pyrrole, indole, etc. do not react, at least under normal experimental conditions.

We have now tested with positive results the compounds listed in Table 1, and have obtained in every case the corresponding Δ^2-isoxazoline.

TABLE 1

Ethylenic compound	No.	Adduct with benzonitrile oxide m.p. or b.p./mm	Yield %
Cyclopentene	I	38.5-39.5°; 145°/1 mm	85
1-Methylcyclopentene	II	54-56°	41
1-Phenylcyclopentene	III	99-100°	55
Cyclopentadiene	IV	(mol.1:1) 47-48°; 137°/0.5	48
Cyclopentadiene	V	(mol.1:2) 182.5-184°	40
Cyclopent-1-en-3-one	VI	95-96°	almost quant
Cyclopent-1-en-3, 5-dione	VII	202° dec.	61
Cyclohex-1-en-3-one	VIII	oxime m.p. 167-168°	22
3,5-Dibromocyclopent-1-ene	IX	109°	56
Acenaphthylene	X	201°	96
Methylenecyclopentane	XI	79.5-80°	almost quant
Methylenecyclohexane	XII	84-84.5°	80
Methylenecycloheptane	XIII	65-67°	69,5
β-Pinene	XIV	97.5-98.5°	91
3,6-Endoxo-1,2,3,6-tetrahydro-phthalic anhydride	XV	215°	90

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[5] A. Quilico and P. Grünanger, Gazz.Chim.Ital. 82, 140 (1952).

[6] G. Stagno d'Alcontres and P. Grünanger, Gazz.Chim.Ital.80, 831(1950); G.W. Perold and F.V.K. v.Reiche, J.S.Afr.Chem.Inst. 10, 5 (1957).

All the products have been obtained by reaction at ordinary temperature or slightly above, and, except for compound VIII, with good to quantitative yields. Cyclopentadiene reacts, as expected, with 1 or 2 moles of benzonitrile oxide. The adduct with cyclohexenone was formed in low yield (22%). The structure of the Δ^2-isoxazolines has been demonstrated, when necessary, on the base of the $LiAlH_4$ reduction products[7].

On the contrary, the following compounds do not react with benzonitrile oxide, at least under usual conditions (reaction in ethereal solution at room temperature or on slight boiling):

cyclohexene
1-methylcyclohexene
1-phenylcyclohexene
phenanthrene

From the foregoing results, experimental details of which will be published elsewhere, we might deduce the following conclusions:

(a) ethylenic double bonds present in a five-membered ring react easily with nitrile oxides, whereas double bonds present in six-membered rings do not react, unless they are activated by conjungation, i.e. with a carbonyl group.

(b) whereas endocyclic double bonds are reactive only in cyclopentene series, semicyclic double bonds of methylenecycloalkanes are always reactive, giving spirocompounds.

Considering the ready preparation of the reagent, the easiness of execution of the test and the fact that Δ^2-isoxazolines are usually well crystallizable solids, the addition reaction with nitrile oxides represents a useful discriminating tool for the identification of cycloethylenic double bonds.

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[7] G.W. Perold and F.V.K. v.Reiche, J.Amer.Chem.Soc.79,465 (1957).