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PREFERENTIAL ATTACK OF OXYGEN AT o-POSITION OF t-BUTYLATED PHENOLS IN BASE CATALYZED OXYGENATION

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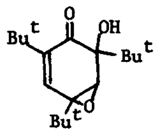
In the oxygenation of 2,6-di-t-butyl-4-alkylphenols in aqueous and alcoholic alkaline solutions normally p-position of the phenols is attacked by oxygen primarily to give 4-hydroxy-2,5-cyclohexadienone derivatives,[1,2] of which dissociated forms (peroxy anions) undergo intramolecular decomposition in DMF, DMSO, or HMPA containing Bu^tOK to afford 4-hydroxy-5,6-epoxy-2-cyclohexenones (epoxy-p-quinols).[3] We now find that the oxygenation of t-butylated phenols in Bu^tOH containing Bu^tOK unexpectedly leads to the preferential attack of oxygen at o-position of the phenols.

When oxygen was bubbled through a solution of 2,4,6-tri-t-butylphenol in Bu^tOH containing Bu^tOK at room temperature, one of O_2 was taken up within 4 hr. The reaction mixture was diluted with water, acidified, and extracted with ether. Evaporation of the extract directly gave epoxy-o-quinol(1), mp 59-60°C, in 91% yield: $\tau(CDCl_3)$; 9.01(s,9,Bu^t), 8.92(s,9,Bu^t), 8.77(s,9,Bu^t), 6.20(d,1,$H\text{-}\overset{O}{C\text{—}C}\text{-}$,J=1.0 Hz), and 3.02(d,1,H-C=C,J=1.0 Hz)ppm: ν(Nujol); 3520(OH), 1680(C=O)cm^{-1}: λ_{max}^{MeOH}; 255 nm(ε=7,100). No epoxy-p-quinol(2) which is quantitatively obtained in DMF-Bu^tOK system was detected in the reaction mixture. As the anionic form of the hydroperoxide(3) has been demonstrated to be the intermediate for the formation of 2 in the DMF-Bu^tOK system,[3] whether or not 1 can also be formed via the anionic form of 3 has been examined. The hydroperoxide(3) is, however, quite stable in the Bu^tOH-Bu^tOK system neither to give 1 nor 2, indicating that the anion of 3 may not become the direct precursor of 1, or that the hydroperoxy group in 3 may not be migrated to the o-position in this system. In addition, 1 and 2 are both quite stable in each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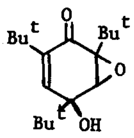
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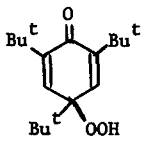
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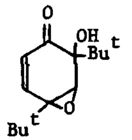
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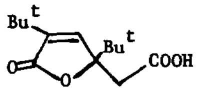
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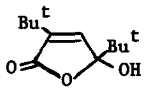
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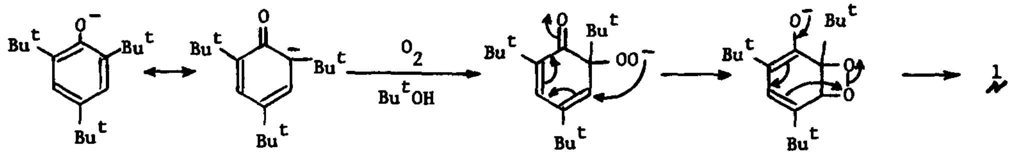
of the Bu^{t}OH-Bu^{t}OK and DMF-Bu^{t}OK systems. This eliminates another possibility that one of these products 1 and 2 may become the intermediate of the other. Therefore, the present oxygenation in Bu^{t}OH-Bu^{t}OK system is rationalized only by assuming that the reaction site being attacked by O_2 is fixed at *o*-position of the phenol, and the mechanism of the following scheme envisaging intramolecular decomposition of dioxetane intermediate by interaction with the π-system is reasonably suggested.



The preferential attack of oxygen in the Bu^{t}OH-Bu^{t}OK system is obviously demonstrated in the oxygenation of 2,4-di-*t*-butylphenol, where oxidatve cleavage of the phenolic ring takes place at *o*-position. The oxygenation of this phenol in Bu^{t}OH cotaining Bu^{t}OK afforded the lactone carboxylic acid(5)[4] and the hydroxylactone(6)[5] in 51 and 10 % yields, respectively, besides the epoxy-*o*-quinol(4), mp 80-81°C, yield 17%, whose elemental analysis and spectral data(nmr,ir, and uv) are consistent with the structure. No epoxy-*p*-quinol of type 2 was detected in the reaction mixture, while it was only the product in the DMF-Bu^{t}OK system. 2,4-di-*t*-butylphenol is fairly insusceptible to the oxygenation in methanolic or ethanolic alkaline solution. The formation of 5 and 6 is considered to proceed via 3,5-di-*t*-butyl-*o*-benzoquinone as the intermediate because the oxygenation of this quinone afforded 5 (64%) and 6 (7%), while 3,5-di-*t*-butylcatechol characteristically gave a dimeric product, $C_{26}H_{40}O_4$, mp 199-201°C, in the Bu^{t}OH-Bu^{t}OK system.

The selective oxygenation at the *o*-position of 2,4,6-tri-*t*-butylphenol is also observed in Bu^{t}NH$_2$ and Am^{t}OH. The selectivity is diminished with decreasing size of *p*-alkyl group of 2,6-di-*t*-butylphenols.

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