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THE REACTION BETWEEN ETHYLENE OXIDE AND PHOSPHORUS PENTOXIDE[1]

Robert D. Wilcox,[a] Guy H. Harris,[b] and Robert S. Olson[b]

Varian Associates,[a] Palo Alto, California, U.S.A., and

The Dow Chemical Company,[b] Walnut Creek, California, U.S.A.

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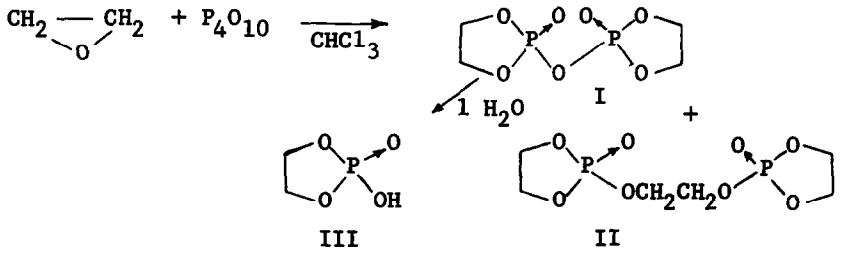
The reaction between olefin oxides and phosphorus pentoxide was first studied by Woodstock,[2] but discrete products were not reported. In the present work, ethylene oxide was added to a refluxing slurry of phosphorus pentoxide in chloroform, adding the oxide slowly until the solids dissolved. Chilling the resulting mixture resulted in the precipitation of bis-ethylene pyrophosphate I from solution in a 21 to 27% yield. Mp. 120-124°C. The solvent was removed under vacuum from the remaining solution leaving an oily product that was identified as ethylene-bis(ethylene phosphate) II.



Bis-ethylene pyrophosphate reacts violently with water with a considerable evolution of heat, demonstrating the energetic nature of the compound. In spite of its reactivity, it may be handled for short periods of time in the air,

due to a protective coating of hydrolysis products. The addition of one mole of water to a solution of bis-ethylene pyrophosphate results in the rapid formation of ethylene phosphate III Mp. 133-135°C. The NMR spectrum shows a doublet at 4.50 ppm, and J_{H-P} was 11 Hz, consistant with the 11 Hz coupling reported for barium ethylene phosphate.[3,4,5] Compounds II and III are also hydrolytically sensitive, but do not posses the large energy associated with bis-ethylene pyrophosphate. They also show a tendency to polymerize on standing, forming gelatinous materials which are only partly water soluble.

The compounds mentioned above exhibit a large number of interesting reactions, which include cleavage of the pyrophosphate with alcohols, forming ethylene phosphate and alkyl ethylene phosphates. Ethylene-bis(ethylene phosphate) II will also react with alcohols, forming both ring opened and alkyl cleaved products. Substituted olefin oxides react with phosphorus pentoxide, forming discrete products similar to those shown above.

The elucidation of the structures produced from the reaction of ethylene oxide with phosphorus pentoxide offers new avenues for the exploration of the chemistry of phosphorus pentoxide, as well as easier access to five membered ring phosphates than has previously been the case.

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