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RADIATION LABORATORY

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Radiation Laboratory

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SUMMARY OF THE RESEARCH PROGRESS MEETING OF DECEMBER 21, 1950

R. K. Wakerling

March 12, 1951

"Some of the results reported in this document may be of a preliminary or incomplete nature. It is the request of the Radiation Laboratory that the document not be circulated off the project nor the results quoted without permission."

Berkeley, California

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Radiation Chemistry of Alcohols - A. Newton.

Not a great deal of work has been done on the effects of radiation on organic materials since it was thought that the effects could better be studies on small molecules. However, work done at M. I. T. seemed to indicate that actually the effects on complex molecules become more specific. The present study is being done to discover the systematic effects of radiation.

Most of the bombardments were done on materials in the liquid state at the 60-inch cyclotron using 28 Mev alpha particles. The primary processes that are thought to occur are exitation and ionization with the formation of free radicals. One gets reduced products, oxidized products, and products in which no change occurs. The oxidized products are hard to determine and the yields seem to follow no consistant pattern. Acids have been found in small yield but they may be secondary products.

The results of the bombardment were summarized in Table I. At present, even in favorable cases, the oxidized products do not balance the reduced products, so some oxidized products are apparently being missed. In the gas phase from every alcohol there is mass spectrometer evidence of several compounds in low yield which cannot be accounted for by the spectra of ordinary compounds. The only peroxide seen to date has been dimethyl peroxide and the only ether dimethyl ether, both from methenol. If peroxides and ethers are formed in higher alcohol bombardments their yields are small. This indicates a lack of reactivity of the H on the hydroxyl except in the methyl case.

From the ratio of H_2 to methane it is seen that as the alcohol becomes more branched the lower is the yield of H_2 and the higher that of methane. If this is coupled with the glycol results in which non-adjacent glycols have not been observed, it follows that the hydrogen on the carbon to which the hydroxyl is attached must be especially susceptible to attack. In tertiary butanol no hydrogens are available at this point so that yield of methane is enhanced.

It is hoped that by careful distillation procedures some of the higher molecular weight materials can be identified. Even though the yield is small they will throw considerable light on the behavior of radicals in the liquid state. No evidence of large polymers has appeared and possibly these are not primary products in the bombardment of alcohols.

Angular Distribution of Neutrons - L. Schecter.

The spatial distribution of neutrons produced by the impact of deuterons of maximum energy 20 Mev on various fixed targets has been investigated using the 60-inch cyclotron. The materials bombarded were aluminum, beryllium, copper, tin, lead and uranium. The distributions vary in a non-regular way from element to element, the characteristic features being the width at half maximum and the angular position of the maximum. Among the elements investigated, beryllium and copper yielded neutrons, which, above 20 Mev, have their spatial maxima displaced from the direction of the incident neutron beam. At lower energies this apparent double peak is smoothed out, indicating that the distribution results from the superposition of several nuclear processes of comparable importance. This is to be compared to the distributions resulting from 190 Mev deuteron impacts, which agree quantitatively with the single process of stripping.

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TABLE I

Yields of Products from Alcohols

(Yields in Molecules Product Formed/100 e.v.)

Product/Alcohol	Methanol	Ethanol	n-Propanol	Iso-Propanol	Tert-Butanol
Total gases	4.5	2.8	3.03	3.68	2.11
H_2	3.60	2.03	1.96	1.61	0.63
CO	0.34	0.081	0.28	0.051	<0.05
CH_4	0.22	0.27	0.125	0.78	0.72
C_2H_6	0.011	0.096	0.36	0.125	0.27
C_2H_4		0.086	0.12	0.031	0.06
C_2H_2		0.015	--	0.010	
C_3H_8			0.11	0.02	
C_3H_6			0.04	0.105	
"Butenes"				0.005	
Acetaldehyde				0.201	
Isobutane					0.14
Acetone?					0.04
Dimethyl ether	0.113				
Dimethyl peroxide	0.005				
Acid (H^+)	0.021	0.019	0.024	0.007	0.007
H_2O	0.97	0.94	N.D.	N.D.	N.D.
Formaldehyde	1.58	0.34	0.6	None	None
Higher aldehydes	None	1.26	0.7	0.75	None
Total carbonyl	None	1.67	1.4	1.85	1.4
Ethylene glycol	1.18				
Adjacent $-\overset{OH}{C}-\overset{OH}{C}-$	1.18	0.93	N.D.	0.27	
CH_2OH residue	2.36	0.25	N.D.	<0.03	N.D.
RCHOH residue	None	1.6	N.D.	0.16	N.D.
R_2COH residue	None	None	N.D.	0.33	N.D.
Non-adjacent glycols	None	Small	N.D.	Very Small	N.D.
Total glycols	1.18	0.93	N.D.	0.27	N.D.
Ketones	None	Small	Small	1.0	1.4

N.D. = Not Determined.

Glycol residues are shown by the aldehyde or ketone formed on periodic acid splitting. The yield is given for the residue in each case so the glycol would have half the yield if combined with a like residue.