A Product Study of the C_2H_3 + C_2H_3 and the C_2H_3 + CH_3 Reactions

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Low temperature vinyl radical reactions are important in the hydrocarbon photochemistry that occurs in the atmospheres of the outer planets and their satellites. Vinyl radical (C_2H_3) and methyl radical (C_2H_3) are products of hydrocarbon photochemistry and are found in the atmospheres of Jupiter, Saturn Titan, and Neptune. Reactions between free radicals take place on virtually every collision and there are multiple product paths, hence their study in the laboratory is very difficult. Both the total reaction rate constants and the fractional yields into the various product paths are needed as input information for models of planetary atmospheres. In the present work we have determined the product yields at low pressure (1 Torr He) and at T = 298K and 200K for the C_2H_3 + C_2H_3 and the C_2H_3 + C_2H_3 reactions.

The measurements were performed in a discharge flow system coupled with collision-free molecular beam sampling to a mass spectrometer operated at low ionizing energies. In both studies, atomic F was generated by microwave discharge of dilute F_2 in helium and entered the rear flow tube port. Vinyl was generated by the reaction of F with ethylene, and methyl by the reaction of F + methane. For the vinyl plus methyl studies a methane/ethylene mixture entered the flow tube through a movable injector. The parent molecule concentrations were adjusted so as to have methyl in 10 to 20 fold excess.

The results are:

$C_2H_3 + C_2H_3$	$\rightarrow C_4H_6$	not observed, detection limit = 1%	(1a)
	$\rightarrow C_2H_4 + C_2H_2$	100 %	(1b)

at 1 Torr and both 200K and 298K. For the vinyl plus methyl reaction:

$C_2H_3 + CH_3$	$\rightarrow C_3H_6$	10% at 298K, 30% at 200K	(2a)
	$\rightarrow CH_4 + C_2H_2$	90% at 298K, 70% at 200K	(2b)

These results are corroborated by a study of the CH_3D yield of the isotopic reaction, C_2D_3 + CH_3. The fractional yields determined at low pressure (1 Torr) in this study are an order of magnitude different from those observed at 100 Torr. This will impact the interpretation of observed product abundances on Titan as a function of altitude.

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