Plasma-Based Dry Reforming: A Computational Study Ranging from Nanoseconds to Seconds Timescale

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Overview of the reactions included in the model.

Table 1: Electron impact reactions with the various molecules and radicals, included in the model. These reactions are treated by energy-dependent cross sections, and the references where these cross sections were adopted from, are also included. For the vibrational and electronic excitations, several individual excitations are included, as indicated by the number between brackets.

Momentum Transfer	e^-	+	CH_4	→	e^-	+	CH_4						[1]
Vibrational Excitation	e^-	+	CH_4	→	e^-	+	CH_4^*					**(2)**	[1]
Ionization	e^-	+	CH_4	→	$2e^-$	+	CH_4^+						[2]
Dissociative Ionization	e^-	+	CH_4	→	$2e^-$	+	CH_3^+	+	H				[2]
	e^-	+	CH_4	→	$2e^-$	+	CH_2^+	+	H_2				[2]
Dissociation	e^-	+	CH_4	→	e^-	+	CH_3	+	H				[3, 4]
	e^-	+	CH_4	→	e^-	+	CH_2	+	H_2				[3, 4]
	e^-	+	CH_4	→	e^-	+	CH	+	H_2	+	H		[3, 4]
	e^-	+	CH_4	→	e^-	+	C	+	$2H_2$				[3, 4]
Ionization	e^-	+	CH_3	→	$2e^-$	+	CH_3^+						[2]
Dissociative Ionization	e^-	+	CH_3	→	$2e^-$	+	CH_2^+	+	H				[2]
	e^-	+	CH_3	→	$2e^-$	+	CH^+	+	H_2				[2]
Dissociation	e^-	+	CH_3	→	e^-	+	CH_2	+	H				[3, 4]
	e^-	+	CH_3	→	e^-	+	CH	+	H_2				[3, 4]
Ionization	e^-	+	CH_2	→	$2e^-$	+	CH_2^+						[2]
Dissociation	e^-	+	CH_2	→	e^-	+	CH	+	H				[3, 4]
Ionization	e^-	+	CH	→	$2e^-$	+	CH^+						[2]
Dissociation	e^-	+	CH	→	e^-	+	C	+	H				[3, 4]
Momentum Transfer	e^-	+	C_2H_6	→	e^-	+	C_2H_6						[1]
Vibrational Excitation	e^-	+	C_2H_6	→	e^-	+	$C_2H_6^*$					**(3)**	[1]
Ionization	e^-	+	C_2H_6	→	$2e^-$	+	$C_2H_6^+$						[2]
Dissociative Ionization	e^-	+	C_2H_6	→	$2e^-$	+	$C_2H_5^+$	+	H				[2]
	e^-	+	C_2H_6	→	$2e^-$	+	$C_2H_4^+$	+	H_2				[2]
	e^-	+	C_2H_6	→	$2e^-$	+	$C_2H_3^+$	+	H_2	+	H		[2]
	e^-	+	C_2H_6	→	$2e^-$	+	$C_2H_2^+$	+	$2H_2$				[2]
	e^-	+	C_2H_6	→	$2e^-$	+	CH_3^+	+	CH_3				[2]
Dissociation	e^-	+	C_2H_6	→	e^-	+	C_2H_5	+	H				[5, 6]
	e^-	+	C_2H_6	→	e^-	+	C_2H_4	+	H_2				[5, 6]
Ionization	e^-	+	C_2H_5	→	$2e^-$	+	$C_2H_5^+$						[2]
Dissociative Ionization	e^-	+	C_2H_5	→	$2e^-$	+	$C_2H_4^+$	+	H				[2]
	e^-	+	C_2H_5	→	$2e^-$	+	$C_2H_3^+$	+	H_2				[2]

	e^-	+	C_2H_5	→	$2e^-$	+	$C_2H_2^+$	+	H_2	+	H		[2]
Dissociation	e^-	+	C_2H_5	→	e^-	+	C_2H_4	+	H				[5, 6]
	e^-	+	C_2H_5	→	e^-	+	C_2H_3	+	H_2				[5, 6]
Momentum Transfer	e^-	+	C_2H_4	→	e^-	+	C_2H_4						[1]
Vibrational Excitation	e^-	+	C_2H_4	→	e^-	+	$C_2H_4^*$					(2)	[1]
Ionization	e^-	+	C_2H_4	→	$2e^-$	+	$C_2H_4^+$						[2]
Dissociative Ionization	e^-	+	C_2H_4	→	$2e^-$	+	$C_2H_3^+$	+	H				[2]
	e^-	+	C_2H_4	→	$2e^-$	+	$C_2H_2^+$	+	H_2				[2]
Dissociation	e^-	+	C_2H_4	→	e^-	+	C_2H_3	+	H				[5, 6]
	e^-	+	C_2H_4	→	e^-	+	C_2H_2	+	H_2				[5, 6]
Ionization	e^-	+	C_2H_3	→	$2e^-$	+	$C_2H_3^+$						[2]
Dissociative Ionization	e^-	+	C_2H_3	→	$2e^-$	+	$C_2H_2^+$	+	H				[2]
Dissociation	e^-	+	C_2H_3	→	e^-	+	C_2H_2	+	H				[5, 6]
	e^-	+	C_2H_3	→	e^-	+	C_2H	+	H_2				[5, 6]
Momentum Transfer	e^-	+	C_2H_2	→	e^-	+	C_2H_2						[1]
Vibrational Excitation	e^-	+	C_2H_2	→	e^-	+	$C_2H_2^*$					(3)	[1]
Ionization	e^-	+	C_2H_2	→	$2e^-$	+	$C_2H_2^+$						[2]
Dissociation	e^-	+	C_2H_2	→	e^-	+	C_2H	+	H				[5, 6]
Dissociation	e^-	+	C_2H	→	e^-	+	C	+	CH				[5, 6]
Momentum Transfer	e^-	+	C_3H_8	→	e^-	+	C_3H_8						[1]
Vibrational Excitation	e^-	+	C_3H_8	→	e^-	+	$C_3H_8^*$					(2)	[1]
Dissociative Ionization	e^-	+	C_3H_8	→	$2e^-$	+	$C_2H_5^+$	+	CH_3				[2]
	e^-	+	C_3H_8	→	$2e^-$	+	$C_2H_4^+$	+	CH_4				[2]
Dissociation	e^-	+	C_3H_8	→	e^-	+	C_3H_7	+	H				[5, 6]
	e^-	+	C_3H_8	→	e^-	+	C_3H_6	+	H_2				[5, 6]
	e^-	+	C_3H_8	→	e^-	+	C_2H_4	+	CH_4				[5, 6]
Dissociative Ionization	e^-	+	C_3H_7	→	$2e^-$	+	$C_2H_5^+$	+	CH_2				[5, 6]
	e^-	+	C_3H_7	→	$2e^-$	+	$C_2H_4^+$	+	CH_3				[5, 6]
	e^-	+	C_3H_7	→	$2e^-$	+	$C_2H_3^+$	+	CH_4				[5, 6]
	e^-	+	C_3H_7	→	$2e^-$	+	CH_3^+	+	C_2H_4				[5, 6]
Dissociation	e^-	+	C_3H_7	→	e^-	+	C_3H_6	+	H				[5, 6]

	e^-	+	C_3H_7			→	e^-	+	C_2H_4	+	CH_3				[5, 6]
	e^-	+	C_3H_7			→	e^-	+	C_2H_3	+	CH_4				[5, 6]
Dissociative Ionization	e^-	+	C_3H_6			→	$2e^-$	+	$C_2H_5^+$	+	CH				[5, 6]
	e^-	+	C_3H_6			→	$2e^-$	+	$C_2H_4^+$	+	CH_2				[5, 6]
	e^-	+	C_3H_6			→	$2e^-$	+	$C_2H_3^+$	+	CH_3				[5, 6]
	e^-	+	C_3H_6			→	$2e^-$	+	$C_2H_2^+$	+	CH_4				[5, 6]
	e^-	+	C_3H_6			→	$2e^-$	+	CH_3^+	+	C_2H_3				[5, 6]
Dissociation	e^-	+	C_3H_6			→	e^-	+	C_2H_2	+	CH_4				[5, 6]
Momentum Transfer	e^-	+	H_2			→	e^-	+	H_2						[7]
Vibrational Excitation	e^-	+	H_2			→	e^-	+	H_2^*					**(3)**	[8]
Dissociation	e^-	+	H_2			→	e^-	+	2H						[9]
Momentum Transfer	e^-	+	O_2			→	e^-	+	O_2						[10]
Ionization	e^-	+	O_2			→	$2e^-$	+	O_2^+						[11]
Dissociative Attachment	e^-	+	O_2			→	O^-	+	O						[10]
Dissociation	e^-	+	O_2			→	e^-	+	2O					**(2)**	[10]
Momentum Transfer	e^-	+	O			→	e^-	+	O						[12]
Electronic Excitation	e^-	+	O			→	e^-	+	O^*					**(2)**	[13]
Attachment	e^-	+	O	+	O_2	→	O^-	+	O_2						[10]
Momentum Transfer	e^-	+	CO_2			→	e^-	+	CO_2						[14]
Vibrational Excitation	e^-	+	CO_2			→	e^-	+	CO_2^*					**(3)**	[14]
Electronic Excitation	e^-	+	CO_2			→	e^-	+	CO_2^*					**(2)**	[15]
Ionization	e^-	+	CO_2			→	$2e^-$	+	CO_2^+						[14]
Dissociative Attachment	e^-	+	CO_2			→	O^-	+	CO						[14]
Dissociation	e^-	+	CO_2			→	e^-	+	CO	+	O				[14]
Momentum Transfer	e^-	+	CO			→	e^-	+	CO						[8]
Vibrational Excitation	e^-	+	CO			→	e^-	+	CO^*					**(1)**	[8]
Electronic Excitation	e^-	+	CO			→	e^-	+	CO^*					**(5)**	[15]
Dissociative Attachment	e^-	+	CO			→	O^-	+	C						[16]
Dissociation	e^-	+	CO			→	e^-	+	C	+	O				[17]
Momentum Transfer	e^-	+	H_2O			→	e^-	+	H_2O						[18]
Vibrational Excitation	e^-	+	H_2O			→	e^-	+	H_2O^*					**(2)**	[18]

Dissociative Attachment	e^-	+	H_2O	→	O^-	+	H_2				[18]
	e^-	+	H_2O	→	OH^-	+	H				[18]
Dissociation	e^-	+	H_2O	→	e^-	+	OH	+	H		[18]
	e^-	+	H_2O	→	e^-	+	O	+	H_2		[18]
Dissociation	e^-	+	OH	→	e^-	+	O	+	H		[19]

Table 2: Electron-ion recombination reactions included in the model, as well as the corresponding rate coefficients for 300 K and the references where these data were adopted from.

e^-	+	CH_5^+	→	CH_3	+	2H			2.57×10^{-07}	$cm^3\ s^{-1}$	[3, 20]
e^-	+	CH_5^+	→	CH_2	+	H_2	+	H	6.10×10^{-08}	$cm^3\ s^{-1}$	[3, 20]
e^-	+	CH_4^+	→	CH_3	+	H			1.18×10^{-08}	$cm^3\ s^{-1}$	[3, 20]
e^-	+	CH_4^+	→	CH_2	+	2H			2.42×10^{-08}	$cm^3\ s^{-1}$	[3, 20]
e^-	+	CH_4^+	→	CH	+	H_2	+	H	1.41×10^{-08}	$cm^3\ s^{-1}$	[3, 20]
e^-	+	CH_3^+	→	CH_2	+	H			2.25×10^{-08}	$cm^3\ s^{-1}$	[3, 20]
e^-	+	CH_3^+	→	CH	+	H_2			7.88×10^{-09}	$cm^3\ s^{-1}$	[3, 20]
e^-	+	CH_3^+	→	CH	+	2H			9.00×10^{-09}	$cm^3\ s^{-1}$	[3, 20]
e^-	+	CH_3^+	→	C	+	H_2	+	H	1.69×10^{-08}	$cm^3\ s^{-1}$	[3, 20]
e^-	+	CH_2^+	→	CH	+	H			1.00×10^{-08}	$cm^3\ s^{-1}$	[3, 20]
e^-	+	CH_2^+	→	C	+	H_2			4.82×10^{-09}	$cm^3\ s^{-1}$	[3, 20]
e^-	+	CH_2^+	→	C	+	2H			2.53×10^{-08}	$cm^3\ s^{-1}$	[3, 20]
e^-	+	CH^+	→	C	+	H			3.23×10^{-08}	$cm^3\ s^{-1}$	[3, 20]
e^-	+	$C_2H_6^+$	→	C_2H_5	+	H			2.19×10^{-08}	$cm^3\ s^{-1}$	[6]
e^-	+	$C_2H_6^+$	→	C_2H_4	+	2H			3.36×10^{-08}	$cm^3\ s^{-1}$	[6]
e^-	+	$C_2H_5^+$	→	C_2H_4	+	H			7.70×10^{-09}	$cm^3\ s^{-1}$	[6]
e^-	+	$C_2H_5^+$	→	C_2H_3	+	2H			1.92×10^{-08}	$cm^3\ s^{-1}$	[6]
e^-	+	$C_2H_5^+$	→	C_2H_2	+	H_2	+	H	1.9×10^{-08}	$cm^3\ s^{-1}$	[6]
e^-	+	$C_2H_5^+$	→	C_2H_2	+	3H			8.98×10^{-09}	$cm^3\ s^{-1}$	[6]
e^-	+	$C_2H_5^+$	→	CH_3	+	CH_2			9.62×10^{-09}	$cm^3\ s^{-1}$	[6]
e^-	+	$C_2H_4^+$	→	C_2H_3	+	H			8.29×10^{-09}	$cm^3\ s^{-1}$	[6]
e^-	+	$C_2H_4^+$	→	C_2H_2	+	2H			3.43×10^{-08}	$cm^3\ s^{-1}$	[6]
e^-	+	$C_2H_4^+$	→	C_2H	+	H_2	+	H	5.53×10^{-09}	$cm^3\ s^{-1}$	[6]
e^-	+	$C_2H_3^+$	→	C_2H_2	+	H			1.34×10^{-08}	$cm^3\ s^{-1}$	[6]

e^-	+	$C_2H_3^+$	→	C_2H	+	2H	2.74×10^{-08}	$cm^3\ s^{-1}$	6
e^-	+	$C_2H_2^+$	→	C_2H	+	H	1.87×10^{-08}	$cm^3\ s^{-1}$	6
e^-	+	$C_2H_2^+$	→	2CH			4.87×10^{-09}	$cm^3\ s^{-1}$	6
e^-	+	O_2^+	→	O	+	O	1.94×10^{-20}	$cm^3\ s^{-1}$	21
e^-	+	$O_2^+ + O_2$	→	O_2	+	O_2	1.00×10^{-26}	$cm^3\ s^{-1}$	21
e^-	+	CO_2^+	→	CO	+	O	2.71×10^{-07}	$cm^3\ s^{-1}$	20
e^-	+	H_3O^+	→	H_2O	+	H	2.45×10^{-08}	$cm^3\ s^{-1}$	20
e^-	+	H_3O^+	→	OH	+	H_2	6.58×10^{-09}	$cm^3\ s^{-1}$	20
e^-	+	H_3O^+	→	OH	+	2H	4.02×10^{-09}	$cm^3\ s^{-1}$	20

Table 3: Neutral-neutral reactions included in the model, as well as the corresponding rate coefficients for 300 K and the references where these data were adopted from. Note a means that this value is an estimated value; note b means that the rate coefficient is adjusted in the model for a three-body collision by dividing by 2.446 x 10^{19} cm^{-3}, i.e., the density of the background gas.

CH_4	+	CH_2			→	CH_3	+	CH_3	3.01×10^{-19}	$cm^3\ s^{-1}$	22
CH_4	+	CH			→	C_2H_4	+	H	9.74×10^{-11}	$cm^3\ s^{-1}$	23
CH_4	+	C_2H_5			→	C_2H_6	+	CH_3	1.83×10^{-24}	$cm^3\ s^{-1}$	22
CH_4	+	C_2H_3			→	C_2H_4	+	CH_3	2.28×10^{-18}	$cm^3\ s^{-1}$	22
CH_4	+	C_2H			→	C_2H_2	+	CH_3	1.31×10^{-12}	$cm^3\ s^{-1}$	22
CH_4	+	C_3H_7			→	C_3H_8	+	CH_3	4.38×10^{-24}	$cm^3\ s^{-1}$	24
CH_4	+	H			→	CH_3	+	H_2	8.43×10^{-19}	$cm^3\ s^{-1}$	23
CH_3	+	CH_3			→	C_2H_5	+	H	2.71×10^{-19}	$cm^3\ s^{-1}$	25
CH_3	+	CH_3	+	M	→	C_2H_6	+	M	1.56×10^{-26}	$cm^6\ s^{-1}$	23
CH_3	+	CH_2			→	C_2H_4	+	H	7.01×10^{-11}	$cm^3\ s^{-1}$	23
CH_3	+	C_2H_6			→	C_2H_5	+	CH_4	7.21×10^{-21}	$cm^3\ s^{-1}$	23
CH_3	+	C_2H_5			→	C_2H_4	+	CH_4	1.91×10^{-12}	$cm^3\ s^{-1}$	23
CH_3	+	C_2H_5	+	M	→	C_3H_8	+	M	1.00×10^{-28}	$cm^6\ s^{-1}$	a
CH_3	+	C_2H_4			→	C_2H_3	+	CH_4	1.94×10^{-21}	$cm^3\ s^{-1}$	22
CH_3	+	C_2H_3			→	C_2H_2	+	CH_4	6.51×10^{-13}	$cm^3\ s^{-1}$	22
CH_3	+	C_2H_3	+	M	→	C_3H_6	+	M	1.20×10^{-10}	$cm^3\ s^{-1}$	26
									4.91×10^{-30}	$cm^6\ s^{-1}$	b
CH_3	+	C_2H_2			→	CH_4	+	C_2H	7.65×10^{-26}	$cm^3\ s^{-1}$	22
CH_3	+	C_3H_8			→	C_3H_7	+	CH_4	1.02×10^{-20}	$cm^3\ s^{-1}$	24
CH_3	+	C_3H_7			→	C_3H_6	+	CH_4	3.07×10^{-12}	$cm^3\ s^{-1}$	24
CH_3	+	H_2			→	CH_4	+	H	9.9×10^{-21}	$cm^3\ s^{-1}$	23
CH_3	+	H			→	CH_2	+	H_2	9.96×10^{-22}	$cm^3\ s^{-1}$	23
CH_3	+	H	+	M	→	CH_4	+	M	2.97×10^{-28}	$cm^6\ s^{-1}$	23

CH_2	+	CH_2			→	C_2H_2	+	2H	5.27×10^{-11}	$cm^3 s^{-1}$	23
CH_2	+	C_2H_5			→	C_2H_4	+	CH_3	3.01×10^{-11}	$cm^3 s^{-1}$	22
CH_2	+	C_2H_3			→	C_2H_2	+	CH_3	3.01×10^{-11}	$cm^3 s^{-1}$	22
CH_2	+	C_2H			→	C_2H_2	+	CH	3.01×10^{-11}	$cm^3 s^{-1}$	22
CH_2	+	C_3H_8			→	C_3H_7	+	CH_3	1.02×10^{-20}	$cm^3 s^{-1}$	24
CH_2	+	C_3H_7			→	C_2H_4	+	C_2H_5	3.01×10^{-11}	$cm^3 s^{-1}$	24
CH_2	+	C_3H_7			→	C_3H_6	+	CH_3	3.01×10^{-12}	$cm^3 s^{-1}$	24
CH_2	+	H_2			→	CH_3	+	H	5.00×10^{-15}	$cm^3 s^{-1}$	22
CH_2	+	H			→	CH	+	H_2	2.01×10^{-10}	$cm^3 s^{-1}$	23
CH	+	C_2H_6	+	M	→	C_3H_7	+	M	2.78×10^{-10} 1.14×10^{-29}	$cm^3 s^{-1}$ $cm^6 s^{-1}$	23 b
CH	+	H_2			→	CH_2	+	H	6.80×10^{-13}	$cm^3 s^{-1}$	23
CH	+	H			→	C	+	H_2	1.00×10^{-10}	$cm^3 s^{-1}$	27
C	+	H_2			→	CH	+	H	1.50×10^{-10}	$cm^3 s^{-1}$	28
C_2H_6	+	C_2H_3			→	C_2H_5	+	C_2H_4	3.39×10^{-21}	$cm^3 s^{-1}$	22
C_2H_6	+	C_2H			→	C_2H_2	+	C_2H_5	5.99×10^{-12}	$cm^3 s^{-1}$	22
C_2H_6	+	C_3H_7			→	C_3H_8	+	C_2H_5	3.16×10^{-22}	$cm^3 s^{-1}$	24
C_2H_6	+	H			→	C_2H_5	+	H_2	4.96×10^{-17}	$cm^3 s^{-1}$	23
C_2H_5	+	C_2H_5			→	C_2H_6	+	C_2H_4	2.41×10^{-12}	$cm^3 s^{-1}$	23
C_2H_5	+	C_2H			→	C_2H_4	+	C_2H_2	3.01×10^{-12}	$cm^3 s^{-1}$	22
C_2H_5	+	C_3H_8			→	C_2H_6	+	C_3H_7	3.62×10^{-22}	$cm^3 s^{-1}$	24
C_2H_5	+	C_3H_7			→	C_3H_8	+	C_2H_4	1.91×10^{-12}	$cm^3 s^{-1}$	24
C_2H_5	+	C_3H_7			→	C_3H_6	+	C_2H_6	2.41×10^{-12}	$cm^3 s^{-1}$	24
C_2H_5	+	H_2			→	C_2H_6	+	H	2.97×10^{-21}	$cm^3 s^{-1}$	22
C_2H_5	+	H			→	CH_3	+	CH_3	5.99×10^{-11}	$cm^3 s^{-1}$	23
C_2H_5	+	H			→	C_2H_4	+	H_2	3.01×10^{-12}	$cm^3 s^{-1}$	22
C_2H_5	+	H	+	M	→	C_2H_6	+	M	2.25×10^{-10} 9.20×10^{-30}	$cm^3 s^{-1}$ $cm^6 s^{-1}$	29 b
C_2H_4	+	C_2H			→	C_2H_2	+	C_2H_3	1.40×10^{-10}	$cm^3 s^{-1}$	26
C_2H_4	+	H			→	C_2H_3	+	H_2	4.92×10^{-21}	$cm^3 s^{-1}$	22
C_2H_4	+	H	+	M	→	C_2H_5	+	M	3.66×10^{-30}	$cm^6 s^{-1}$	23

C_2H_3	+	C_2H_3			→	C_2H_4	+	C_2H_2			1.9×10^{-12}	$cm^3\ s^{-1}$	[22]
C_2H_3	+	C_2H			→	C_2H_2	+	C_2H_2			1.9×10^{-12}	$cm^3\ s^{-1}$	[22]
C_2H_3	+	C_3H_8			→	C_2H_4	+	C_3H_7			3.40×10^{-21}	$cm^3\ s^{-1}$	[24]
C_2H_3	+	C_3H_7			→	C_3H_8	+	C_2H_2			2.01×10^{-12}	$cm^3\ s^{-1}$	[24]
C_2H_3	+	C_3H_7			→	C_3H_6	+	C_2H_4			2.01×10^{-12}	$cm^3\ s^{-1}$	[24]
C_2H_3	+	H_2			→	C_2H_4	+	H			9.78×10^{-20}	$cm^3\ s^{-1}$	[22]
C_2H_3	+	H			→	C_2H_2	+	H_2			2.01×10^{-11}	$cm^3\ s^{-1}$	[23]
C_2H_3	+	H	+	M	→	C_2H_4	+	M			2.02×10^{-10}	$cm^3\ s^{-1}$	[29]
											8.26×10^{-30}	$cm^6\ s^{-1}$	[b]
C_2H_2	+	C_2H			→	C_4H_2	+	H			1.50×10^{-10}	$cm^3\ s^{-1}$	[30]
C_2H_2	+	H			→	C_2H	+	H_2			6.12×10^{-27}	$cm^3\ s^{-1}$	[22]
C_2H_2	+	H	+	M	→	C_2H_3	+	M			2.81×10^{-31}	$cm^6\ s^{-1}$	[23]
C_2H	+	C_3H_8			→	C_2H_2	+	C_3H_7			5.99×10^{-12}	$cm^3\ s^{-1}$	[24]
C_2H	+	C_3H_7			→	C_3H_6	+	C_2H_2			1.00×10^{-11}	$cm^3\ s^{-1}$	[24]
C_2H	+	H_2			→	C_2H_2	+	H			1.52×10^{-13}	$cm^3\ s^{-1}$	[22]
C_2H	+	H	+	M	→	C_2H_2	+	M			2.31×10^{-10}	$cm^3\ s^{-1}$	[29]
											9.44×10^{-30}	$cm^6\ s^{-1}$	[b]
C_3H_8	+	H			→	C_3H_7	+	H_2			5.15×10^{-17}	$cm^3\ s^{-1}$	[24]
C_3H_7	+	C_3H_7			→	C_3H_6	+	C_3H_8			2.81×10^{-12}	$cm^3\ s^{-1}$	[24]
C_3H_7	+	H_2			→	C_3H_8	+	H			7.12×10^{-21}	$cm^3\ s^{-1}$	[24]
C_3H_7	+	H			→	C_3H_6	+	H_2			3.01×10^{-12}	$cm^3\ s^{-1}$	[24]
C_3H_7	+	H	+	M	→	C_3H_8	+	M			9.68×10^{-11}	$cm^3\ s^{-1}$	[29]
											3.96×10^{-30}	$cm^6\ s^{-1}$	[b]
C_3H_6	+	H	+	M	→	C_3H_7	+	M			9.26×10^{-14}	$cm^3\ s^{-1}$	[31]
											3.79×10^{-33}	$cm^6\ s^{-1}$	[b]
H	+	H	+	M	→	H_2	+	M			6.00×10^{-33}	$cm^6\ s^{-1}$	[23]
O	+	O	+	O	→	O_2	+	O			5.09×10^{-33}	$cm^6\ s^{-1}$	[32]
O	+	O	+	M	→	O_2	+	M			7.19×10^{-33}	$cm^6\ s^{-1}$	[32]
CH4	+	O			→	CH_3	+	OH			5.54×10^{-18}	$cm^3\ s^{-1}$	[23]
CH3	+	O			→	CH_2O	+	H			1.12×10^{-10}	$cm^3\ s^{-1}$	[32]
CH3	+	O			→	CO	+	H_2	+	H	2.80×10^{-11}	$cm^3\ s^{-1}$	[33]

CH_2	+	O			→	CO	+	H_2			5.53×10^{-11}	$cm^3\ s^{-1}$	[33]
CH_2	+	O			→	CO	+	2H			8.29×10^{-11}	$cm^3\ s^{-1}$	[33]
CH_2	+	O_2			→	CO_2	+	H_2			1.42×10^{-12}	$cm^3\ s^{-1}$	[23, 34]
CH_2	+	O_2			→	CO	+	H_2O			1.42×10^{-12}	$cm^3\ s^{-1}$	[23, 34]
CH_2	+	O_2			→	CH_2O	+	O			5.39×10^{-13}	$cm^3\ s^{-1}$	[23, 34]
CH	+	O			→	CO	+	H			6.9×10^{-11}	$cm^3\ s^{-1}$	[23]
CH	+	O_2			→	CO_2	+	H			1.20×10^{-11}	$cm^3\ s^{-1}$	[33]
CH	+	O_2			→	CO	+	OH			8.00×10^{-12}	$cm^3\ s^{-1}$	[33]
CH	+	O_2			→	CHO	+	O			8.00×10^{-12}	$cm^3\ s^{-1}$	[33]
CH	+	O_2			→	CO	+	H	+	O	1.20×10^{-11}	$cm^3\ s^{-1}$	[33]
C	+	O_2			→	CO	+	O			2.45×10^{-13}	$cm^3\ s^{-1}$	[35]
C_2H_6	+	O			→	C_2H_5	+	OH			5.11×10^{-16}	$cm^3\ s^{-1}$	[23]
C_2H_5	+	O			→	CH_3CHO	+	H			8.80×10^{-11}	$cm^3\ s^{-1}$	[33]
C_2H_5	+	O			→	CH_2O	+	CH_3			6.9×10^{-11}	$cm^3\ s^{-1}$	[33]
C_2H_5	+	O			→	C_2H_4	+	OH			4.40×10^{-11}	$cm^3\ s^{-1}$	[33]
C_2H_5	+	O_2			→	C_2H_4	+	HO_2			3.80×10^{-15}	$cm^3\ s^{-1}$	[36]
C_2H_5	+	O_2	+	CH_4	→	$C_2H_5O_2$	+	CH_4			5.75×10^{-29}	$cm^6\ s^{-1}$	[36]
C_2H_4	+	O			→	CH_2CHO	+	H			2.63×10^{-13}	$cm^3\ s^{-1}$	[33]
C_2H_4	+	O			→	CHO	+	CH_3			4.51×10^{-13}	$cm^3\ s^{-1}$	[33]
C_2H_3	+	O			→	C_2H_2	+	OH			1.25×10^{-11}	$cm^3\ s^{-1}$	[33]
C_2H_3	+	O			→	CO	+	CH_3			1.25×10^{-11}	$cm^3\ s^{-1}$	[33]
C_2H_3	+	O			→	CHO	+	CH_2			1.25×10^{-11}	$cm^3\ s^{-1}$	[33]
C_2H_3	+	O			→	CH_2CO	+	H			1.25×10^{-11}	$cm^3\ s^{-1}$	[33]
C_2H_3	+	O_2			→	CH_2O	+	CHO			9.00×10^{-12}	$cm^3\ s^{-1}$	[23]
C_2H_2	+	O			→	CH_2	+	CO			6.75×10^{-14}	$cm^3\ s^{-1}$	[23]
C_2H_2	+	O			→	C_2HO	+	H			6.75×10^{-14}	$cm^3\ s^{-1}$	[23]
C_2H	+	O			→	CH	+	CO			1.70×10^{-11}	$cm^3\ s^{-1}$	[23]
C_2H	+	O_2			→	CHO	+	CO			3.00×10^{-11}	$cm^3\ s^{-1}$	[23]
C_2H	+	O_2			→	C_2HO	+	O			1.00×10^{-12}	$cm^3\ s^{-1}$	[22]
C_3H_8	+	O			→	C_3H_7	+	OH			2.73×10^{-15}	$cm^3\ s^{-1}$	[24]
H_2	+	O			→	OH	+	H			9.32×10^{-18}	$cm^3\ s^{-1}$	[23]

H	+	O	+	CH_4	→	OH	+	CH_4	4.33×10^{-32}	$cm^6\ s^{-1}$	22
H	+	O_2			→	OH	+	O	1.87×10^{-22}	$cm^3\ s^{-1}$	23
H	+	O_2	+	CH_4	→	HO_2	+	CH_4	5.40×10^{-32}	$cm^6\ s^{-1}$	37
CH_4	+	OH			→	CH_3	+	H_2O	6.62×10^{-15}	$cm^3\ s^{-1}$	36
CH_4	+	HO_2			→	CH_3	+	H_2O_2	8.76×10^{-27}	$cm^3\ s^{-1}$	22
CH_4	+	CHO			→	CH_3	+	CH_2O	6.07×10^{-30}	$cm^3\ s^{-1}$	22
CH_4	+	CH_3O			→	CH_3OH	+	CH_3	9.42×10^{-20}	$cm^3\ s^{-1}$	22
CH_3	+	CO	+	CH_4	→	CH_3CO	+	CH_4	4.19×10^{-36}	$cm^6\ s^{-1}$	30
CH_3	+	H_2O			→	CH_4	+	OH	1.82×10^{-25}	$cm^3\ s^{-1}$	22
CH_3	+	OH			→	CH_2	+	H_2O	1.13×10^{-12}	$cm^3\ s^{-1}$	30
CH_3	+	OH			→	CH_2OH	+	H	1.31×10^{-11}	$cm^3\ s^{-1}$	38
CH_3	+	OH			→	CH_3O	+	H	1.9×10^{-10}	$cm^3\ s^{-1}$	38
CH_3	+	OH	+	M	→	CH_3OH	+	M	2.30×10^{-27}	$cm^6\ s^{-1}$	30
CH_3	+	HO_2			→	CH_3O	+	OH	3.00×10^{-11}	$cm^3\ s^{-1}$	23
CH_3	+	HO_2			→	CH_4	+	O_2	5.99×10^{-12}	$cm^3\ s^{-1}$	22
CH_3	+	CH_2O			→	CH_4	+	CHO	6.14×10^{-18}	$cm^3\ s^{-1}$	30
CH_3	+	CHO			→	CH_4	+	CO	2.00×10^{-10}	$cm^3\ s^{-1}$	22
CH_3	+	CH_3O			→	CH_4	+	CH_2O	4.00×10^{-11}	$cm^3\ s^{-1}$	22
CH_3	+	CH_3CHO			→	CH_4	+	CH_3CO	4.95×10^{-18}	$cm^3\ s^{-1}$	23
CH_2	+	CO_2			→	CH_2O	+	CO	3.90×10^{-14}	$cm^3\ s^{-1}$	22
CH_2	+	H_2O			→	CH_3	+	OH	1.9×10^{-16}	$cm^3\ s^{-1}$	22
CH_2	+	OH			→	CH_2O	+	H	3.00×10^{-11}	$cm^3\ s^{-1}$	22
CH_2	+	HO_2			→	CH_2O	+	OH	3.00×10^{-11}	$cm^3\ s^{-1}$	22
CH_2	+	CH_2O			→	CH_3	+	CHO	1.00×10^{-14}	$cm^3\ s^{-1}$	22
CH_2	+	CHO			→	CH_3	+	CO	3.00×10^{-11}	$cm^3\ s^{-1}$	22
CH_2	+	CH_3O			→	CH_3	+	CH_2O	3.00×10^{-11}	$cm^3\ s^{-1}$	22
CH	+	CO_2			→	CHO	+	CO	9.68×10^{-13}	$cm^3\ s^{-1}$	33
CH	+	CO_2			→	2CO	+	H	9.68×10^{-13}	$cm^3\ s^{-1}$	33
CH	+	CO	+	M	→	C_2HO	+	M	4.04×10^{-30}	$cm^6\ s^{-1}$	33
C_2H_6	+	OH			→	C_2H_5	+	H_2O	2.46×10^{-13}	$cm^3\ s^{-1}$	36
C_2H_6	+	HO_2			→	C_2H_5	+	H_2O_2	6.36×10^{-24}	$cm^3\ s^{-1}$	22

C_2H_6	+	CHO	→	C_2H_5	+	CH_2O	2.19×10^{-26}	$cm^3\ s^{-1}$	22
C_2H_6	+	CH_3O	→	C_2H_5	+	CH_3OH	2.72×10^{-18}	$cm^3\ s^{-1}$	22
C_2H_5	+	OH	→	C_2H_4	+	H_2O	4.00×10^{-11}	$cm^3\ s^{-1}$	22
C_2H_5	+	HO_2	→	C_2H_6	+	O_2	5.00×10^{-13}	$cm^3\ s^{-1}$	22
C_2H_5	+	HO_2	→	C_2H_4	+	H_2O_2	5.00×10^{-13}	$cm^3\ s^{-1}$	22
C_2H_5	+	CH_2O	→	C_2H_6	+	CHO	4.47×10^{-18}	$cm^3\ s^{-1}$	22
C_2H_5	+	CHO	→	C_2H_6	+	CO	2.00×10^{-10}	$cm^3\ s^{-1}$	22
C_2H_5	+	CH_3O	→	C_2H_6	+	CH_2O	4.00×10^{-11}	$cm^3\ s^{-1}$	22
C_2H_4	+	OH	→	C_2H_3	+	H_2O	1.54×10^{-16}	$cm^3\ s^{-1}$	22
C_2H_4	+	HO_2	→	CH_3CHO	+	OH	1.62×10^{-20}	$cm^3\ s^{-1}$	22
C_2H_3	+	H_2O	→	C_2H_4	+	OH	1.82×10^{-25}	$cm^3\ s^{-1}$	22
C_2H_3	+	OH	→	C_2H_2	+	H_2O	5.00×10^{-11}	$cm^3\ s^{-1}$	22
C_2H_3	+	CH_2O	→	C_2H_4	+	CHO	4.41×10^{-18}	$cm^3\ s^{-1}$	22
C_2H_3	+	CHO	→	C_2H_4	+	CO	1.50×10^{-10}	$cm^3\ s^{-1}$	22
C_2H_3	+	CH_3O	→	C_2H_4	+	CH_2O	4.00×10^{-11}	$cm^3\ s^{-1}$	22
C_2H_2	+	OH	→	C_2H	+	H_2O	1.77×10^{-22}	$cm^3\ s^{-1}$	22
C_2H_2	+	HO_2	→	CH_2CO	+	OH	1.62×10^{-20}	$cm^3\ s^{-1}$	22
C_2H	+	OH	→	CH_2	+	CO	3.00×10^{-11}	$cm^3\ s^{-1}$	22
C_2H	+	OH	→	C_2H_2	+	O	3.00×10^{-11}	$cm^3\ s^{-1}$	22
C_2H	+	HO_2	→	C_2H_2	+	O_2	3.00×10^{-11}	$cm^3\ s^{-1}$	22
C_2H	+	HO_2	→	C_2HO	+	OH	3.00×10^{-11}	$cm^3\ s^{-1}$	22
C_2H	+	CHO	→	C_2H_2	+	CO	1.00×10^{-10}	$cm^3\ s^{-1}$	22
C_2H	+	CH_3O	→	C_2H_2	+	CH_2O	4.00×10^{-11}	$cm^3\ s^{-1}$	22
C_3H_8	+	OH	→	C_3H_7	+	H_2O	3.76×10^{-15}	$cm^3\ s^{-1}$	24
C_3H_8	+	CH_3O	→	C_3H_7	+	CH_3OH	1.42×10^{-17}	$cm^3\ s^{-1}$	24
C_3H_7	+	CH_2O	→	C_3H_8	+	CHO	4.10×10^{-18}	$cm^3\ s^{-1}$	24
C_3H_7	+	CHO	→	C_3H_8	+	CO	1.00×10^{-10}	$cm^3\ s^{-1}$	24
C_3H_7	+	CH_3O	→	C_3H_8	+	CH_2O	4.00×10^{-11}	$cm^3\ s^{-1}$	24
H_2	+	OH	→	H	+	H_2O	7.02×10^{-15}	$cm^3\ s^{-1}$	37
H_2	+	CHO	→	H	+	CH_2O	2.78×10^{-26}	$cm^3\ s^{-1}$	22
H	+	CO_2	→	CO	+	OH	1.40×10^{-29}	$cm^3\ s^{-1}$	22

H	**+**	**CO**	**+**	**M**	**→**	**CHO**	**+**	**M**			**1.54 x 10^{-34}**	**cm^6 s^{-1}**	**30**
H	**+**	**H_2O**			**→**	**H_2**	**+**	**OH**			**5.86 x 10^{-26}**	**cm^3 s^{-1}**	**23**
H	**+**	**OH**			**→**	**H_2**	**+**	**O**			**1.05 x 10^{-16}**	**cm^3 s^{-1}**	**22**
H	**+**	**OH**	**+**	**M**	**→**	**H_2O**	**+**	**M**			**4.33 x 10^{-30}**	**cm^6 s^{-1}**	**23**
H	**+**	**HO_2**			**→**	**H_2**	**+**	**O_2**			**5.9 x 10^{-12}**	**cm^3 s^{-1}**	**37**
H	**+**	**HO_2**			**→**	**H_2O**	**+**	**O**			**2.40 x 10^{-12}**	**cm^3 s^{-1}**	**37**
H	**+**	**HO_2**			**→**	**OH**	**+**	**OH**			**7.20 x 10^{-11}**	**cm^3 s^{-1}**	**37**
H	**+**	**CH_2O**			**→**	**H_2**	**+**	**CHO**			**5.72 x 10^{-14}**	**cm^3 s^{-1}**	**30**
H	**+**	**CHO**			**→**	**H_2**	**+**	**CO**			**1.50 x 10^{-10}**	**cm^3 s^{-1}**	**23**
H	**+**	**CH_3O**			**→**	**H_2**	**+**	**CH_2O**			**2.32 x 10^{-11}**	**cm^3 s^{-1}**	**33**
H	**+**	**CH_3O**			**→**	**CH_3**	**+**	**OH**			**9.93 x 10^{-12}**	**cm^3 s^{-1}**	**33**
H	**+**	**CH_3CHO**			**→**	**H_2**	**+**	**CH_3CO**			**8.98 x 10^{-14}**	**cm^3 s^{-1}**	**23**
H	**+**	**CH_2CO**			**→**	**CH_3**	**+**	**CO**			**1.04 x 10^{-13}**	**cm^3 s^{-1}**	**23**
H	**+**	**C_2HO**			**→**	**CH_2**	**+**	**CO**			**2.50 x 10^{-10}**	**cm^3 s^{-1}**	**23**
O	**+**	**CO**	**+**	**M**	**→**	**CO_2**	**+**	**M**			**1.11 x 10^{-35}**	**cm^6 s^{-1}**	**22**
O	**+**	**H_2O**			**→**	**OH**	**+**	**OH**			**4.48 x 10^{-24}**	**cm^3 s^{-1}**	**22**
O	**+**	**OH**			**→**	**H**	**+**	**O_2**			**3.46 x 10^{-11}**	**cm^3 s^{-1}**	**37**
O	**+**	**HO_2**			**→**	**O_2**	**+**	**OH**			**5.70 x 10^{-11}**	**cm^3 s^{-1}**	**37**
O	**+**	**CH_2O**			**→**	**OH**	**+**	**CHO**			**1.73 x 10^{-13}**	**cm^3 s^{-1}**	**23**
O	**+**	**CHO**			**→**	**CO**	**+**	**OH**			**5.00 x 10^{-11}**	**cm^3 s^{-1}**	**23**
O	**+**	**CHO**			**→**	**H**	**+**	**CO_2**			**5.00 x 10^{-11}**	**cm^3 s^{-1}**	**23**
O	**+**	**CH_3O**			**→**	**CH3**	**+**	**O_2**			**2.20 x 10^{-11}**	**cm^3 s^{-1}**	**23**
O	**+**	**CH_3O**			**→**	**OH**	**+**	**CH_2O**			**3.00 x 10^{-12}**	**cm^3 s^{-1}**	**23**
O	**+**	**CH_3CHO**			**→**	**OH**	**+**	**CH_3CO**			**4.68 x 10^{-13}**	**cm^3 s^{-1}**	**23**
O	**+**	**CH_2CO**			**→**	**CH_2**	**+**	**CO_2**			**2.29 x 10^{-13}**	**cm^3 s^{-1}**	**23, 39**
O	**+**	**CH_2CO**			**→**	**CH_2O**	**+**	**CO**			**7.88 x 10^{-14}**	**cm^3 s^{-1}**	**23, 39**
O	**+**	**CH_2CO**			**→**	**CHO**	**+**	**CO**	**+**	**H**	**4.33 x 10^{-14}**	**cm^3 s^{-1}**	**23, 39**
O	**+**	**CH_2CO**			**→**	**CHO**	**+**	**CHO**			**4.33 x 10^{-14}**	**cm^3 s^{-1}**	**23, 39**
O	**+**	**C_2HO**			**→**	**CO**	**+**	**CO**	**+**	**H**	**1.9 x 10^{-10}**	**cm^3 s^{-1}**	**23**
O_2	**+**	**CHO**			**→**	**CO**	**+**	**HO_2**			**5.10 x 10^{-12}**	**cm^3 s^{-1}**	**36**
O_2	**+**	**CH_3O**			**→**	**CH_2O**	**+**	**HO_2**			**1.97 x 10^{-15}**	**cm^3 s^{-1}**	**36**

O_2	+	CH_2CHO			→	CH_2O	+	CO	+	OH	3.00×10^{-14}	$cm^3\ s^{-1}$	[23,40,41]
O_2	+	C_2HO			→	CO	+	CO	+	OH	6.46×10^{-13}	$cm^3\ s^{-1}$	[23]
CO	+	OH			→	CO_2	+	H			1.25×10^{-13}	$cm^3\ s^{-1}$	[23]
CO	+	CH_3O			→	CO_2	+	CH_3			6.56×10^{-20}	$cm^3\ s^{-1}$	[22]
H_2O	+	CH_3O			→	CH_3OH	+	OH			1.67×10^{-14}	$cm^3\ s^{-1}$	[42]
OH	+	OH			→	H_2O	+	O			1.47×10^{-12}	$cm^3\ s^{-1}$	[37]
OH	+	OH	+	M	→	H_2O_2	+	M			6.86×10^{-31}	$cm^6\ s^{-1}$	[37]
OH	+	HO_2			→	O_2	+	H_2O			1.10×10^{-10}	$cm^3\ s^{-1}$	[37]
OH	+	CH_2O			→	H_2O	+	CHO			8.47×10^{-12}	$cm^3\ s^{-1}$	[36]
OH	+	CHO			→	CO	+	H_2O			1.70×10^{-10}	$cm^3\ s^{-1}$	[23]
OH	+	CH_3O			→	CH_2O	+	H_2O			3.00×10^{-11}	$cm^3\ s^{-1}$	[22]
OH	+	CH_3CHO			→	CH_3CO	+	H_2O			1.49×10^{-11}	$cm^3\ s^{-1}$	[36]
OH	+	CH_2CO			→	CO	+	CH_2OH			1.14×10^{-11}	$cm^3\ s^{-1}$	[23, 43]
HO_2	+	HO_2			→	H_2O_2	+	O_2			1.63×10^{-12}	$cm^3\ s^{-1}$	[37]
HO_2	+	CH_2O			→	CHO	+	H_2O_2			1.05×10^{-20}	$cm^3\ s^{-1}$	[22]
HO_2	+	CHO			→	OH	+	H	+	CO_2	5.00×10^{-11}	$cm^3\ s^{-1}$	[22]
HO_2	+	CH_3O			→	CH_2O	+	H_2O_2			5.00×10^{-13}	$cm^3\ s^{-1}$	[22]
CH_2O	+	CH_3O			→	CH_3OH	+	CHO			1.14×10^{-15}	$cm^3\ s^{-1}$	[22]
CHO	+	CHO			→	CH_2O	+	CO			5.00×10^{-11}	$cm^3\ s^{-1}$	[23]
CHO	+	CH_3O			→	CH_3OH	+	CO			1.50×10^{-10}	$cm^3\ s^{-1}$	[22]
CH_3O	+	CH_3O			→	CH_2O	+	CH_3OH			1.00×10^{-10}	$cm^3\ s^{-1}$	[22]
CH_4	+	CH_3CO			→	CH_3CHO	+	CH_3			1.14×10^{-29}	$cm^3\ s^{-1}$	[22]
CH_4	+	CH_2OH			→	CH_3OH	+	CH_3			2.55×10^{-27}	$cm^3\ s^{-1}$	[44]
CH_3	+	H_2O_2			→	CH_4	+	HO_2			5.46×10^{-14}	$cm^3\ s^{-1}$	[22]
CH_3	+	CH_3OH			→	CH_4	+	CH_3O			1.01×10^{-20}	$cm^3\ s^{-1}$	[44]
CH_3	+	CH_3OH			→	CH_4	+	CH_2OH			2.66×10^{-20}	$cm^3\ s^{-1}$	[44]
CH_3	+	CH_2OH			→	CH_4	+	CH_2O			4.00×10^{-12}	$cm^3\ s^{-1}$	[44]
CH_2	+	H_2O_2			→	CH_3	+	HO_2			1.00×10^{-14}	$cm^3\ s^{-1}$	[22]
CH_2	+	CH_3CO			→	CH_2CO	+	CH_3			3.00×10^{-11}	$cm^3\ s^{-1}$	[22]
CH_2	+	CH_3OH			→	CH_3O	+	CH_3			1.01×10^{-20}	$cm^3\ s^{-1}$	[44]
CH_2	+	CH_3OH			→	CH_2OH	+	CH_3			2.66×10^{-20}	$cm^3\ s^{-1}$	[44]

CH_2	+	CH_2OH		→	CH_2O	+	CH_3		2.00×10^{-12}	$cm^3\ s^{-1}$	44
CH_2	+	CH_2OH		→	C_2H_4	+	OH		4.00×10^{-11}	$cm^3\ s^{-1}$	44
C_2H_5	+	H_2O_2		→	C_2H_6	+	HO_2		2.83×10^{-15}	$cm^3\ s^{-1}$	22
C_2H_5	+	CH_3OH		→	C_2H_6	+	CH_3O		3.50×10^{-22}	$cm^3\ s^{-1}$	44
C_2H_5	+	CH_3OH		→	C_2H_6	+	CH_2OH		9.49×10^{-22}	$cm^3\ s^{-1}$	44
C_2H_5	+	CH_2OH		→	C_2H_6	+	CH_2O		4.00×10^{-12}	$cm^3\ s^{-1}$	44
C_2H_5	+	CH_2OH		→	CH_3OH	+	C_2H_4		4.00×10^{-12}	$cm^3\ s^{-1}$	44
C_2H_3	+	H_2O_2		→	C_2H_4	+	HO_2		5.46×10^{-14}	$cm^3\ s^{-1}$	22
C_2H_3	+	CH_3OH		→	C_2H_4	+	CH_3O		1.01×10^{-20}	$cm^3\ s^{-1}$	44
C_2H_3	+	CH_3OH		→	C_2H_4	+	CH_2OH		2.66×10^{-20}	$cm^3\ s^{-1}$	44
C_2H_3	+	CH_2OH		→	C_2H_4	+	CH_2O		5.00×10^{-11}	$cm^3\ s^{-1}$	44
C_2H_2	+	CH_2OH		→	C_2H_3	+	CH_2O		3.32×10^{-19}	$cm^3\ s^{-1}$	44
C_2H	+	CH_3OH		→	C_2H_2	+	CH_3O		2.00×10^{-12}	$cm^3\ s^{-1}$	44
C_2H	+	CH_3OH		→	C_2H_2	+	CH_2OH		1.00×10^{-11}	$cm^3\ s^{-1}$	44
C_2H	+	CH_2OH		→	C_2H_2	+	CH_2O		5.99×10^{-11}	$cm^3\ s^{-1}$	44
C_3H_7	+	OH		→	C_3H_6	+	H_2O		4.00×10^{-11}	$cm^3\ s^{-1}$	24
C_3H_7	+	H_2O_2		→	C_3H_8	+	HO_2		7.08×10^{-17}	$cm^3\ s^{-1}$	24
C_3H_7	+	CH_3OH		→	C_3H_8	+	CH_3O		3.51×10^{-22}	$cm^3\ s^{-1}$	24
C_3H_7	+	CH_3OH		→	C_3H_8	+	CH_2OH		8.45×10^{-22}	$cm^3\ s^{-1}$	24
C_3H_7	+	CH_2OH		→	C_3H_8	+	CH_2O		1.9×10^{-12}	$cm^3\ s^{-1}$	24
C_3H_7	+	CH_2OH		→	C_3H_6	+	CH_3OH		8.00×10^{-13}	$cm^3\ s^{-1}$	24
H	+	H_2O_2		→	H_2O	+	OH		4.20×10^{-14}	$cm^3\ s^{-1}$	23
H	+	H_2O_2		→	H_2	+	HO_2		5.15×10^{-15}	$cm^3\ s^{-1}$	23
H	+	CH_3OH		→	CH_2OH	+	H_2		1.27×10^{-15}	$cm^3\ s^{-1}$	44
H	+	CH_3OH		→	CH_3O	+	H_2		3.18×10^{-16}	$cm^3\ s^{-1}$	44
H	+	CH_2OH		→	CH_2O	+	H_2		1.00×10^{-11}	$cm^3\ s^{-1}$	44
H	+	CH_2OH		→	CH_3	+	OH		1.9×10^{-10}	$cm^3\ s^{-1}$	44
H	+	CH_2OH	+ M	→	CH_3OH	+	M		2.89×10^{-10}	$cm^3\ s^{-1}$	45
									1.18×10^{-29}	$cm^6\ s^{-1}$	b
O	+	H_2O_2		→	HO_2	+	OH		8.91×10^{-16}	$cm^3\ s^{-1}$	33
O	+	H_2O_2		→	O_2	+	H_2O		8.91×10^{-16}	$cm^3\ s^{-1}$	33

O	**+**	**CH_3CO**	**→**	**OH**	**+**	**CH_2CO**			**8.75×10^{-11}**	**$cm^3\ s^{-1}$**	**33**
O	**+**	**CH_3CO**	**→**	**CO_2**	**+**	**CH_3**			**2.63×10^{-10}**	**$cm^3\ s^{-1}$**	**33**
O	**+**	**CH_3OH**	**→**	**OH**	**+**	**CH_2OH**			**1.12×10^{-14}**	**$cm^3\ s^{-1}$**	**46**
O	**+**	**CH_3OH**	**→**	**OH**	**+**	**CH_3O**			**1.68×10^{-15}**	**$cm^3\ s^{-1}$**	**46**
O	**+**	**CH_2OH**	**→**	**CH_2O**	**+**	**OH**			**7.00×10^{-11}**	**$cm^3\ s^{-1}$**	**44**
O_2	**+**	**CH_2OH**	**→**	**CH_2O**	**+**	**HO_2**			**9.70×10^{-12}**	**$cm^3\ s^{-1}$**	**36**
OH	**+**	**H_2O_2**	**→**	**HO_2**	**+**	**H_2O**			**1.70×10^{-12}**	**$cm^3\ s^{-1}$**	**37**
OH	**+**	**CH_3CO**	**→**	**CH_2CO**	**+**	**H_2O**			**2.00×10^{-11}**	**$cm^3\ s^{-1}$**	**22**
OH	**+**	**CH_3CO**	**→**	**CH_3**	**+**	**CO**	**+**	**OH**	**5.00×10^{-11}**	**$cm^3\ s^{-1}$**	**22**
OH	**+**	**CH_3OH**	**→**	**H_2O**	**+**	**CH_2OH**			**7.67×10^{-13}**	**$cm^3\ s^{-1}$**	**36**
OH	**+**	**CH_3OH**	**→**	**H_2O**	**+**	**CH_3O**			**1.35×10^{-13}**	**$cm^3\ s^{-1}$**	**36**
OH	**+**	**CH_2OH**	**→**	**CH_2O**	**+**	**H_2O**			**4.00×10^{-11}**	**$cm^3\ s^{-1}$**	**44**
HO_2	**+**	**CH_3CO**	**→**	**CH_3**	**+**	**CO_2**	**+**	**OH**	**5.00×10^{-11}**	**$cm^3\ s^{-1}$**	**22**
HO_2	**+**	**CH_3OH**	**→**	**CH_2OH**	**+**	**H_2O_2**			**1.10×10^{-22}**	**$cm^3\ s^{-1}$**	**44**
HO_2	**+**	**CH_2OH**	**→**	**CH_2O**	**+**	**H_2O_2**			**2.00×10^{-11}**	**$cm^3\ s^{-1}$**	**44**
CH_2O	**+**	**CH_3CO**	**→**	**CH_3CHO**	**+**	**CHO**			**1.17×10^{-22}**	**$cm^3\ s^{-1}$**	**22**
CH_2O	**+**	**CH_2OH**	**→**	**CH_3OH**	**+**	**CHO**			**4.22×10^{-18}**	**$cm^3\ s^{-1}$**	**44**
CHO	**+**	**H_2O_2**	**→**	**CH_2O**	**+**	**HO_2**			**1.50×10^{-18}**	**$cm^3\ s^{-1}$**	**22**
CHO	**+**	**CH_3CO**	**→**	**CH_3CHO**	**+**	**CO**			**1.50×10^{-11}**	**$cm^3\ s^{-1}$**	**22**
CHO	**+**	**CH_3OH**	**→**	**CH_2O**	**+**	**CH_2OH**			**6.85×10^{-23}**	**$cm^3\ s^{-1}$**	**44**
CHO	**+**	**CH_2OH**	**→**	**CH_2O**	**+**	**CH_2O**			**3.00×10^{-10}**	**$cm^3\ s^{-1}$**	**44**
CHO	**+**	**CH_2OH**	**→**	**CH_3OH**	**+**	**CO**			**2.00×10^{-10}**	**$cm^3\ s^{-1}$**	**44**
CH_3O	**+**	**CH_3CO**	**→**	**CH_3OH**	**+**	**CH_2CO**			**1.00×10^{-11}**	**$cm^3\ s^{-1}$**	**22**
CH_3O	**+**	**CH_3OH**	**→**	**CH_3OH**	**+**	**CH_2OH**			**5.38×10^{-16}**	**$cm^3\ s^{-1}$**	**44**
CH_3O	**+**	**CH_2OH**	**→**	**CH_2O**	**+**	**CH_3OH**			**4.00×10^{-11}**	**$cm^3\ s^{-1}$**	**44**
H_2O_2	**+**	**CH_3CO**	**→**	**CH_3CHO**	**+**	**HO_2**			**3.05×10^{-19}**	**$cm^3\ s^{-1}$**	**22**
H_2O_2	**+**	**CH_2OH**	**→**	**CH_3OH**	**+**	**HO_2**			**6.56×10^{-17}**	**$cm^3\ s^{-1}$**	**44**
CH_3CO	**+**	**CH_3OH**	**→**	**CH_3CHO**	**+**	**CH_2OH**			**2.22×10^{-22}**	**$cm^3\ s^{-1}$**	**44**
CH_2OH	**+**	**CH_2OH**	**→**	**CH_2O**	**+**	**CH_3OH**			**8.00×10^{-12}**	**$cm^3\ s^{-1}$**	**44**

Table 4: Ion-neutral and ion-ion reactions included in the model, as well as the corresponding rate coefficients and the references where these data were adopted from.

CH_5^+	+	CH_2	→	CH_3^+	+	CH_4			9.9×10^{-10}	$cm^3\ s^{-1}$	[47]
CH_5^+	+	CH	→	CH_2^+	+	CH_4			6.90×10^{-10}	$cm^3\ s^{-1}$	[47]
CH_5^+	+	C	→	CH^+	+	CH_4			1.20×10^{-09}	$cm^3\ s^{-1}$	[47]
CH_5^+	+	C_2H_6	→	$C_2H_5^+$	+	H_2	+	CH_4	2.25×10^{-10}	$cm^3\ s^{-1}$	[48]
CH_5^+	+	C_2H_4	→	$C_2H_5^+$	+	CH_4			1.50×10^{-09}	$cm^3\ s^{-1}$	[47]
CH_5^+	+	C_2H_2	→	$C_2H_3^+$	+	CH_4			1.9×10^{-09}	$cm^3\ s^{-1}$	[47]
CH_5^+	+	C_2H	→	$C_2H_2^+$	+	CH_4			9.00×10^{-10}	$cm^3\ s^{-1}$	[47]
CH_5^+	+	H	→	CH_4^+	+	H_2			1.50×10^{-10}	$cm^3\ s^{-1}$	[47]
CH_5^+	+	O	→	H_3O^+	+	CH_2			2.20×10^{-10}	$cm^3\ s^{-1}$	[47]
CH_5^+	+	H_2O	→	H_3O^+	+	CH_4			3.70×10^{-09}	$cm^3\ s^{-1}$	[47]
CH_4^+	+	CH_4	→	CH_5^+	+	CH_3			1.50×10^{-09}	$cm^3\ s^{-1}$	[47]
CH_4^+	+	C_2H_6	→	$C_2H_4^+$	+	CH_4	+	H_2	1.91×10^{-09}	$cm^3\ s^{-1}$	[48]
CH_4^+	+	C_2H_4	→	$C_2H_5^+$	+	CH_3			4.23×10^{-10}	$cm^3\ s^{-1}$	[47]
CH_4^+	+	C_2H_4	→	$C_2H_4^+$	+	CH_4			1.38×10^{-09}	$cm^3\ s^{-1}$	[47]
CH_4^+	+	C_2H_2	→	$C_2H_3^+$	+	CH_3			1.23×10^{-09}	$cm^3\ s^{-1}$	[47]
CH_4^+	+	C_2H_2	→	$C_2H_2^+$	+	CH_4			1.13×10^{-09}	$cm^3\ s^{-1}$	[47]
CH_4^+	+	H_2	→	CH_5^+	+	H			3.30×10^{-11}	$cm^3\ s^{-1}$	[47]
CH_4^+	+	H	→	CH_3^+	+	H_2			1.00×10^{-11}	$cm^3\ s^{-1}$	[47]
CH_4^+	+	O	→	CH_3^+	+	OH			1.00×10^{-09}	$cm^3\ s^{-1}$	[47]
CH_4^+	+	O_2	→	O_2^+	+	CH_4			3.90×10^{-10}	$cm^3\ s^{-1}$	[47]
CH_4^+	+	H_2O	→	H_3O^+	+	CH_3			2.9×10^{-09}	$cm^3\ s^{-1}$	[47]
CH_3^+	+	CH_4	→	CH_4^+	+	CH_3			1.36×10^{-10}	$cm^3\ s^{-1}$	[49]
CH_3^+	+	CH_4	→	$C_2H_5^+$	+	H_2			1.20×10^{-09}	$cm^3\ s^{-1}$	[47]
CH_3^+	+	CH_2	→	$C_2H_3^+$	+	H_2			9.90×10^{-10}	$cm^3\ s^{-1}$	[47]
CH_3^+	+	CH	→	$C_2H_2^+$	+	H_2			7.10×10^{-10}	$cm^3\ s^{-1}$	[47]
CH_3^+	+	C_2H_6	→	$C_2H_5^+$	+	CH_4			1.48×10^{-09}	$cm^3\ s^{-1}$	[47]

CH_3^+	+	C_2H_4	→	$C_2H_3^+$	+	CH_4					3.50×10^{-10}	$cm^3\ s^{-1}$	[47]
CH_3^+	+	C_2H_3	→	$C_2H_3^+$	+	CH_3					3.00×10^{-10}	$cm^3\ s^{-1}$	[47]
CH_2^+	+	CH_4	→	CH_3^+	+	CH_3					1.38×10^{-10}	$cm^3\ s^{-1}$	[50]
CH_2^+	+	CH_4	→	$C_2H_5^+$	+	H					3.9×10^{-10}	$cm^3\ s^{-1}$	[47]
CH_2^+	+	CH_4	→	$C_2H_4^+$	+	H_2					8.40×10^{-10}	$cm^3\ s^{-1}$	[47]
CH_2^+	+	CH_4	→	$C_2H_3^+$	+	H_2	+	H			2.31×10^{-10}	$cm^3\ s^{-1}$	[50]
CH_2^+	+	CH_4	→	$C_2H_2^+$	+	$2H_2$					3.97×10^{-10}	$cm^3\ s^{-1}$	[50]
CH_2^+	+	H_2	→	CH_3^+	+	H					1.9×10^{-09}	$cm^3\ s^{-1}$	[47]
CH^+	+	CH_4	→	$C_2H_4^+$	+	H					6.50×10^{-11}	$cm^3\ s^{-1}$	[47]
CH^+	+	CH_4	→	$C_2H_3^+$	+	H_2					1.09×10^{-09}	$cm^3\ s^{-1}$	[47]
CH^+	+	CH_4	→	$C_2H_2^+$	+	H_2	+	H			1.43×10^{-10}	$cm^3\ s^{-1}$	[47]
CH^+	+	H_2	→	CH_2^+	+	H					1.20×10^{-09}	$cm^3\ s^{-1}$	[47]
CH^+	+	H_2O	→	H_3O^+	+	C					5.80×10^{-10}	$cm^3\ s^{-1}$	[47]
$C_2H_6^+$	+	C_2H_4	→	$C_2H_4^+$	+	C_2H_6					1.15×10^{-09}	$cm^3\ s^{-1}$	[47]
$C_2H_6^+$	+	C_2H_2	→	$C_2H_5^+$	+	C_2H_3					2.47×10^{-10}	$cm^3\ s^{-1}$	[47]
$C_2H_6^+$	+	H	→	$C_2H_5^+$	+	H_2					1.00×10^{-10}	$cm^3\ s^{-1}$	[47]
$C_2H_6^+$	+	H_2O	→	H_3O^+	+	C_2H_5					2.95×10^{-09}	$cm^3\ s^{-1}$	[47]
$C_2H_5^+$	+	H	→	$C_2H_4^+$	+	H_2					1.00×10^{-11}	$cm^3\ s^{-1}$	[47]
$C_2H_5^+$	+	H_2O	→	H_3O^+	+	C_2H_4					1.40×10^{-09}	$cm^3\ s^{-1}$	[47]
$C_2H_4^+$	+	C_2H_3	→	$C_2H_5^+$	+	C_2H_2					5.00×10^{-10}	$cm^3\ s^{-1}$	[47]
$C_2H_4^+$	+	C_2H_3	→	$C_2H_3^+$	+	C_2H_4					5.00×10^{-10}	$cm^3\ s^{-1}$	[47]
$C_2H_4^+$	+	H	→	$C_2H_3^+$	+	H_2					3.00×10^{-10}	$cm^3\ s^{-1}$	[47]
$C_2H_4^+$	+	O	→	CH_3^+	+	CHO					1.08×10^{-10}	$cm^3\ s^{-1}$	[47]
$C_2H_3^+$	+	C_2H_6	→	$C_2H_5^+$	+	C_2H_4					2.91×10^{-10}	$cm^3\ s^{-1}$	[47]
$C_2H_3^+$	+	C_2H_4	→	$C_2H_5^+$	+	C_2H_2					8.90×10^{-10}	$cm^3\ s^{-1}$	[47]
$C_2H_3^+$	+	C_2H_3	→	$C_2H_5^+$	+	C_2H					5.00×10^{-10}	$cm^3\ s^{-1}$	[47]
$C_2H_3^+$	+	C_2H	→	$C_2H_2^+$	+	C_2H_2					3.30×10^{-10}	$cm^3\ s^{-1}$	[47]
$C_2H_3^+$	+	H	→	$C_2H_2^+$	+	H_2					6.80×10^{-11}	$cm^3\ s^{-1}$	[47]
$C_2H_3^+$	+	H_2O	→	H_3O^+	+	C_2H_2					1.11×10^{-09}	$cm^3\ s^{-1}$	[47]
$C_2H_2^+$	+	CH_4	→	$C_2H_3^+$	+	CH_3					4.10×10^{-09}	$cm^3\ s^{-1}$	[50]
$C_2H_2^+$	+	C_2H_6	→	$C_2H_5^+$	+	C_2H_3					1.31×10^{-10}	$cm^3\ s^{-1}$	[48]

$C_2H_2^+$	+	C_2H_6	→	$C_2H_4^+$	+	C_2H_4					2.48×10^{-10}	$cm^3\ s^{-1}$	47
$C_2H_2^+$	+	C_2H_4	→	$C_2H_4^+$	+	C_2H_2					4.14×10^{-10}	$cm^3\ s^{-1}$	47
$C_2H_2^+$	+	C_2H_3	→	$C_2H_3^+$	+	C_2H_2					3.30×10^{-10}	$cm^3\ s^{-1}$	47
$C_2H_2^+$	+	H_2	→	$C_2H_3^+$	+	H					1.00×10^{-11}	$cm^3\ s^{-1}$	47
$C_2H_2^+$	+	H_2O	→	H_3O^+	+	C_2H					2.20×10^{-10}	$cm^3\ s^{-1}$	47
O_2^+	+	CH_2	→	CH_2^+	+	O_2					4.30×10^{-10}	$cm^3\ s^{-1}$	47
O_2^+	+	CH	→	CH^+	+	O_2					3.10×10^{-10}	$cm^3\ s^{-1}$	47
O_2^+	+	C_2H_4	→	$C_2H_4^+$	+	O_2					6.80×10^{-10}	$cm^3\ s^{-1}$	47
O_2^+	+	C_2H_2	→	$C_2H_2^+$	+	O_2					1.11×10^{-09}	$cm^3\ s^{-1}$	47
O_2^+	+	O^-	→	O	+	O_2					2.9×10^{-08}	$cm^3\ s^{-1}$	51
O_2^+	+	O^-	→	O	+	O	+	O			2.9×10^{-08}	$cm^3\ s^{-1}$	51
O^-	+	CH_4	→	OH^-	+	CH_3					1.00×10^{-10}	$cm^3\ s^{-1}$	47
O^-	+	C	→	CO	+	e^-					5.00×10^{-10}	$cm^3\ s^{-1}$	47
O^-	+	H_2	→	H_2O	+	e^-					7.00×10^{-10}	$cm^3\ s^{-1}$	47
O^-	+	H_2	→	OH^-	+	H					3.00×10^{-11}	$cm^3\ s^{-1}$	47
O^-	+	H	→	OH	+	e^-					5.00×10^{-10}	$cm^3\ s^{-1}$	47
O^-	+	O	→	O_2	+	e^-					2.30×10^{-10}	$cm^3\ s^{-1}$	51
O^-	+	O_2	→	O	+	O_2	+	e^-			k = f(E/N)		10
O^-	+	CO	→	CO_2	+	e^-					6.50×10^{-10}	$cm^3\ s^{-1}$	47
CO_2^+	+	CH_4	→	CH_4^+	+	CO_2					5.50×10^{-10}	$cm^3\ s^{-1}$	47
CO_2^+	+	C_2H_4	→	$C_2H_4^+$	+	CO_2					1.50×10^{-10}	$cm^3\ s^{-1}$	47
CO_2^+	+	C_2H_2	→	$C_2H_2^+$	+	CO_2					7.30×10^{-10}	$cm^3\ s^{-1}$	47
CO_2^+	+	O_2	→	O_2^+	+	CO_2					5.30×10^{-11}	$cm^3\ s^{-1}$	47
CO_2^+	+	O	→	O_2^+	+	CO					1.64×10^{-10}	$cm^3\ s^{-1}$	47
H_3O^+	+	CH_2	→	CH_3^+	+	H_2O					9.40×10^{-10}	$cm^3\ s^{-1}$	47
H_3O^+	+	CH	→	CH_2^+	+	H_2O					6.80×10^{-10}	$cm^3\ s^{-1}$	47
H_3O^+	+	C_2H_3	→	$C_2H_4^+$	+	H_2O					2.00×10^{-09}	$cm^3\ s^{-1}$	47
OH^-	+	CH_3	→	CH_3OH	+	e^-					1.00×10^{-09}	$cm^3\ s^{-1}$	47
OH^-	+	CH	→	CH_2O	+	e^-					5.00×10^{-10}	$cm^3\ s^{-1}$	47
OH^-	+	C	→	CHO	+	e^-					5.00×10^{-10}	$cm^3\ s^{-1}$	47
OH^-	+	H	→	H_2O	+	e^-					1.40×10^{-09}	$cm^3\ s^{-1}$	47

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