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Chemical Kinetics and Photochemical Data for Use in Atmospheric Studies

Evaluation Number 17

NASA Panel for Data Evaluation:

S. P. Sander
R. R. Friedl
NASA/Jet Propulsion Laboratory

J. P. D. Abbatt
University of Toronto

J. R. Barker
University of Michigan

J. B. Burkholder
NOAA Earth System Research Laboratory

D. M. Golden
Stanford University

C. E. Kolb
Aerodyne Research, Inc.

M. J. Kurylo
Goddard Earth Sciences, Technology and Research Program

G. K. Moortgat
Max-Planck Institute for Chemistry

P. H. Wine
Georgia Institute of Technology

R. E. Huie
V. L. Orkin
National Institute of Standards and Technology

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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SECTION 1. BIMOLECULAR REACTIONS

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1.1 Introduction

In Table 1 (Rate Constants for Second-Order Reactions) the reactions are grouped into the classes O_x, $O(^1D)$, Singlet O_2, HO_x, NO_x, Organic Compounds, FO_x, ClO_x, BrO_x, IO_x, SO_x and Metals. Some of the reactions in Table 1 are actually more complex than simple two-body reactions. To explain the pressure and temperature dependences occasionally seen in reactions of this type, it is necessary to consider the bimolecular class of reactions in terms of two subcategories, direct (concerted) and indirect (nonconcerted) reactions.

A direct or concerted bimolecular reaction is one in which the reactants A and B proceed to products C and D without the intermediate formation of an AB adduct that has appreciable bonding, i.e., there is no bound intermediate; only the transition state $(AB)^{\neq}$ lies between reactants and products.

$$A + B \rightarrow (AB)^{\neq} \rightarrow C + D$$

The reaction of OH with CH_4 forming $H_2O + CH_3$ is an example of a reaction of this class.

Very useful correlations between the expected structure of the transition state $[AB]^{\neq}$ and the A-Factor of the reaction rate constant can be made, especially in reactions that are constrained to follow a well-defined approach of the two reactants in order to minimize energy requirements in the making and breaking of bonds. The rate constants for these reactions are well represented by the Arrhenius expression $k = A \exp(-E/RT)$ in the 200–300 K temperature range. These rate constants are not pressure dependent.

The indirect or nonconcerted class of bimolecular reactions is characterized by a more complex reaction path involving a potential well between reactants and products, leading to a bound adduct (or reaction complex) formed between the reactants A and B:

$$A + B \leftrightarrow [AB]^* \rightarrow C + D$$

The intermediate $[AB]^*$ is different from the transition state $[AB]^{\neq}$, in that it is a bound molecule which can, in principle, be isolated. (Of course, transition states are involved in all of the above reactions, both forward and backward, but are not explicitly shown.) An example of this reaction type is ClO + NO, which normally produces $Cl + NO_2$. Reactions of the nonconcerted type can have a more complex temperature dependence and can exhibit a pressure dependence if the lifetime of $[AB]^*$ is comparable to the rate of collisional deactivation of $[AB]^*$. This arises because the relative rate at which $[AB]^*$ goes to products C + D vs. reactants A + B is a sensitive function of its excitation energy. Thus, in reactions of this type, the distinction between the bimolecular and termolecular classification becomes less meaningful, and it is especially necessary to study such reactions under the temperature and pressure conditions in which they are to be used in model calculation, or, alternatively, to develop a reliable theoretical basis for

extrapolation of data. In several cases where sufficient data exist, reactions of this type are treated in Table 2.

The rate constant tabulation for second-order reactions (Table 1) is given in Arrhenius form:

$$k(T)=A\bullet\exp\left(-\frac{E/R}{T}\right)$$

and contains the following information:

1. Reaction stoichiometry and products (if known). The pressure dependences are included, where appropriate.
2. Arrhenius A-factor: **A**
3. Temperature dependence ("activation temperature"): **E/R**
4. Rate constant at 298 K: **k(298 K)**
5. Rate constant uncertainty factor at 298 K: **f(298 K)** (see below)
6. A parameter used to calculate the rate constant uncertainty at temperatures other than 298 K: **g** (see below)
7. Index number for a detailed note containing references to the literature, the basis of recommendation and in several cases, alternative methods to calculate the rate constant.

For a few reactions, the A-factor, E/R and k(298 K) are italicized. These represent estimates by the Panel in cases where there are no literature data or where the existing data are judged to be of insufficient quality to base a recommendation.

1.2 Uncertainty Estimates

For bimolecular rate constants in Table 1, an estimate of the uncertainty at any given temperature, f(T), may be obtained from the following expression:

$$f(T)=f(298\text{ K})\exp\left|g\left(\frac{1}{T}-\frac{1}{298}\right)\right|$$

Note that the exponent is an absolute value. An upper or lower bound (corresponding approximately to one standard deviation) of the rate constant at any temperature T can be obtained by multiplying or dividing the recommended value of the rate constant at that temperature by the factor f(T). The quantity f(298 K) is the uncertainty in the rate constant at T = 298 K. The quantity g has been defined in this evaluation for use with f(298 K) in the above expression to obtain the rate constant uncertainty at different temperatures. It should not be interpreted as the uncertainty in the Arrhenius activation temperature (E/R). Both uncertainty factors, f(298 K) and g, do not necessarily result from a rigorous statistical analysis of the available data. Rather, they are chosen by the evaluators to construct the appropriate uncertainty factor, f(T), shown above.

This approach is based on the fact that rate constants are almost always known with minimum uncertainty at room temperature. The overall uncertainty normally increases at other temperatures, because there are usually fewer data at other temperatures. In addition, data obtained at temperatures far distant from 298 K may be less accurate than at room temperature due to various experimental difficulties.

The uncertainty represented by f(T) is normally symmetric; i.e., the rate constant may be greater than or less than the recommended value, k(T), by the factor f(T). In a few cases in Table 1 asymmetric uncertainties are given in the temperature coefficient. For these cases, the factors by which a rate constant is to be multiplied or divided to obtain, respectively, the upper and lower limits are not equal, except at 298 K where the factor is simply f(298 K). Explicit equations are given below for the case where g is given as (+a, –b):

For T > 298 K, multiply by the factor

$$f(298\text{ K})e^{\left[a\left(\frac{1}{298}-\frac{1}{T}\right)\right]}$$

and divide by the factor

$$f(298\text{ K})e^{\left[b\left(\frac{1}{298}-\frac{1}{T}\right)\right]}$$

For T < 298 K, multiply by the factor

$$f(298\text{ K})e^{\left[b\left(\frac{1}{T}-\frac{1}{298}\right)\right]}$$

and divide by the factor

$$f(298\text{ K})e^{\left[a\left(\frac{1}{T}-\frac{1}{298}\right)\right]}$$

Examples of symmetric and asymmetric error limits are shown in Figure 1.

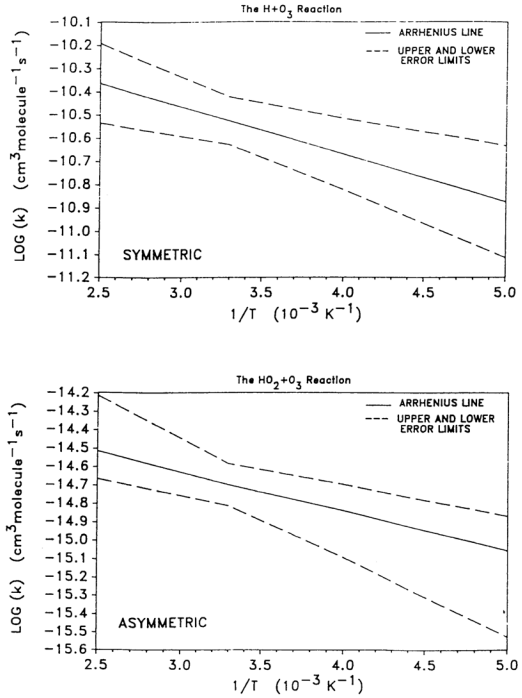

Figure 1. Symmetric and Asymmetric Error Limits

The assigned uncertainties represent the subjective judgment of the Panel. They are not determined by a rigorous, statistical analysis of the database, which generally is too limited to permit such an analysis. Rather, the uncertainties are based on knowledge of the techniques, the difficulties of the experiments, and the potential for systematic errors.

There is obviously no way to quantify these "unknown" errors. The spread in results among different techniques for a given reaction may provide some basis for an uncertainty, but the possibility of the same, or compensating, systematic errors in all the studies must be recognized.

Furthermore, the probability distribution may not follow the normal Gaussian form. For measurements subject to large systematic errors, the true rate constant may be much further from the recommended value than would be expected based on a Gaussian distribution with the stated uncertainty. As an example, in the past the recommended rate constants for the reactions $HO_2 + NO$ and $Cl + ClONO_2$ changed by factors of 30–50. These changes could not have been allowed for with any reasonable values of σ in a Gaussian distribution.

Table 1-1. Rate Constants for Second-Order Reactions

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
O_x Reactions						
$O + O_2 \xrightarrow{M} O_3$	(See Table 2)					
$O + O_3 \rightarrow O_2 + O_2$	8.0×10^{-12}	2060	8.0×10^{-15}	1.10	200	A1
$O(^1D)$ Reactions						A2
$O(^1D) + O_2 \rightarrow O + O_2$	3.3×10^{-11}	–55	3.95×10^{-11}	1.1	10	A3
$O(^1D) + O_3 \rightarrow O_2 + O_2$	1.2×10^{-10}	0	1.2×10^{-10}	1.2	50	A4
$\rightarrow O_2 + O + O$	1.2×10^{-10}	0	1.2×10^{-10}	1.2	50	A4
$O(^1D) + H_2 \rightarrow OH + H$	1.2×10^{-10}	0	1.2×10^{-10}	1.15	50	A5
$O(^1D) + H_2O \rightarrow OH + OH$	1.63×10^{-10}	-60	2.0×10^{-10}	1.08	20	A6
$O(^1D) + N_2 \rightarrow O + N_2$	2.15×10^{-11}	–110	3.1×10^{-11}	1.10	20	A7
$O(^1D) + N_2 \xrightarrow{M} N_2O$	(See Table 2-1)					
$O(^1D) + N_2O \rightarrow$ Overall $\rightarrow N_2 + O_2$ $\rightarrow NO + NO$	1.19×10^{-10} 4.63×10^{-11} 7.25×10^{-11}	-20	1.27×10^{-10} 4.95×10^{-11} 7.75×10^{-11}	1.10 1.10 1.10	25 25 25	A8
$O(^1D) + NH_3 \rightarrow OH + NH_2$	2.5×10^{-10}	0	2.5×10^{-10}	1.20	25	A9
$O(^1D) + CO_2 \rightarrow O + CO_2$	7.5×10^{-11}	–115	1.1×10^{-10}	1.15	20	A10
$O(^1D) + CH_4 \rightarrow$ Overall $\rightarrow CH_3 + OH$ $\rightarrow CH_3O$ or $CH_2OH + H$ $\rightarrow CH_2O + H_2$	1.75×10^{-10} 1.31×10^{-10} 0.35×10^{-10} 0.09×10^{-10}	0	1.75×10^{-10} 1.31×10^{-10} 0.35×10^{-10} 0.09×10^{-10}	1.15 1.15 1.15 1.15	25 25 25 25	A11
$O(^1D) + HCl \rightarrow$ Quenching and Reaction	1.5×10^{-10}	0	1.5×10^{-10}	1.10	25	A12
$O(^1D) + HF \rightarrow$ Quenching and Reaction	5.0×10^{-11}	0	5.0×10^{-11}	1.50	25	A13
$O(^1D) + NF_3 \rightarrow$ Quenching and Reaction	2.05×10^{-11}	-50	2.4×10^{-11}	1.20	25	A14
$O(^1D) + HBr \rightarrow$ Quenching and Reaction	1.5×10^{-10}	0	1.5×10^{-10}	1.50	25	A15

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$O(^1D) + Cl_2 \rightarrow$ Quenching and Reaction	2.7×10^{-10}	0	2.7×10^{-10}	1.10	25	A16
$O(^1D) + CCl_2O \rightarrow$ Quenching and Reaction	2.2×10^{-10}	-30	2.4×10^{-10}	1.10	25	A17
$O(^1D) + CClFO \rightarrow$ Quenching and Reaction	1.9×10^{-10}	0	1.9×10^{-10}	1.50	25	A18
$O(^1D) + CF_2O \rightarrow$ Quenching and Reaction	7.4×10^{-11}	0	7.4×10^{-11}	1.50	25	A19
$O(^1D) + CCl_4 \rightarrow$ Quenching and Reaction (CFC-10)	3.3×10^{-10}	0	3.3×10^{-10}	1.2	50	A20
$O(^1D) + CH_3Br \rightarrow$ Quenching and Reaction	1.8×10^{-10}	0	1.8×10^{-10}	1.15	50	A21
$O(^1D) + CH_2Br_2 \rightarrow$ Quenching and Reaction	2.7×10^{-10}	0	2.7×10^{-10}	1.20	25	A22
$O(^1D) + CHBr_3 \rightarrow$ Quenching and Reaction	6.6×10^{-10}	0	6.6×10^{-10}	1.30	25	A23
$O(^1D) + CH_3F \rightarrow$ Quenching and Reaction (HFC-41)	1.5×10^{-10}	0	1.5×10^{-10}	1.15	50	A24
$O(^1D) + CH_2F_2 \rightarrow$ Quenching and Reaction (HFC-32)	5.1×10^{-11}	0	5.1×10^{-11}	1.20	50	A25
$O(^1D) + CHF_3 \rightarrow$ Quenching and Reaction (HFC-23)	9.1×10^{-12}	0	9.1×10^{-12}	1.10	50	A26
$O(^1D) + CHCl_2F \rightarrow$ Quenching and Reaction (HCFC-21)	1.9×10^{-10}	0	1.9×10^{-10}	1.15	50	A27
$O(^1D) + CHClF_2 \rightarrow$ Quenching and Reaction (HCFC-22)	1.0×10^{-10}	0	1.0×10^{-10}	1.15	50	A28
$O(^1D) + CHF_2Br \rightarrow$ Quenching and Reaction	1.75×10^{-10}	-70	2.2×10^{-10}	1.15	25	A29
$O(^1D) + CCl_3F \rightarrow$ Quenching and Reaction (CFC-11)	2.3×10^{-10}	0	2.3×10^{-10}	1.2	50	A30
$O(^1D) + CCl_2F_2 \rightarrow$ Quenching and Reaction (CFC-12)	1.4×10^{-10}	0	1.4×10^{-10}	1.25	50	A31
$O(^1D) + CClF_3 \rightarrow$ Quenching and Reaction (CFC-13)	8.7×10^{-11}	0	8.7×10^{-11}	1.20	50	A32
$O(^1D) + CClBrF_2 \rightarrow$ Quenching and Reaction (Halon-1211)	1.5×10^{-10}	0	1.5×10^{-10}	1.20	50	A33
$O(^1D) + CBr_2F_2 \rightarrow$ Quenching and Reaction (Halon-1202)	2.2×10^{-10}	0	2.2×10^{-10}	1.20	50	A34
$O(^1D) + CBrF_3 \rightarrow$ Quenching and Reaction (Halon-1301)	1.0×10^{-10}	0	1.0×10^{-10}	1.20	50	A35

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$O(^1D) + CF_4 \rightarrow CF_4 + O$ (PFC-14)			$<2\times10^{-14}$			A36
$O(^1D) + CH_3CH_2F \rightarrow$ Quenching and Reaction (HFC-161)	2.6×10^{-10}	0	2.6×10^{-10}	1.20	25	A37
$O(^1D) + CH_3CHF_2 \rightarrow$ Quenching and Reaction (HFC-152a)	1.75×10^{-10}	0	1.75×10^{-10}	1.20	50	A38
$O(^1D) + CH_3CCl_2F \rightarrow$ Quenching and Reaction (HCFC-141b)	2.6×10^{-10}	0	2.6×10^{-10}	1.20	50	A39
$O(^1D) + CH_3CClF_2 \rightarrow$ Quenching and Reaction (HCFC-142b)	2.2×10^{-10}	0	2.2×10^{-10}	1.20	50	A40
$O(^1D) + CH_3CF_3 \rightarrow$ Quenching and Reaction (HFC-143a)	4.4×10^{-11}	0	4.4×10^{-11}	1.50	25	A41
$O(^1D) + CH_2ClCClF_2 \rightarrow$ Quenching and Reaction (HCFC-132b)	1.6×10^{-10}	0	1.6×10^{-10}	1.50	50	A42
$O(^1D) + CH_2ClCF_3 \rightarrow$ Quenching and Reaction (HCFC-133a)	1.2×10^{-10}	0	1.2×10^{-10}	1.25	50	A43
$O(^1D) + CH_2FCF_3 \rightarrow$ Quenching and Reaction (HFC-134a)	4.9×10^{-11}	0	4.9×10^{-11}	1.15	50	A44
$O(^1D) + CHCl_2CF_3 \rightarrow$ Quenching and Reaction (HCFC-123)	2.0×10^{-10}	0	2.0×10^{-10}	1.20	50	A45
$O(^1D) + CHClFCF_3 \rightarrow$ Quenching and Reaction (HCFC-124)	8.6×10^{-11}	0	8.6×10^{-11}	1.20	50	A46
$O(^1D) + CHF_2CF_3 \rightarrow$ Quenching and Reaction (HFC-125)	1.2×10^{-10}	0	1.2×10^{-10}	1.15	50	A47
$O(^1D) + CCl_3CF_3 \rightarrow$ Quenching and Reaction (CFC-113a)	2×10^{-10}	0	2×10^{-10}	1.50	50	A48
$O(^1D) + CCl_2FCClF_2 \rightarrow$ Quenching and Reaction (CFC-113)	2×10^{-10}	0	2×10^{-10}	1.50	50	A49
$O(^1D) + CCl_2FCF_3 \rightarrow$ Quenching and Reaction (CFC-114a)	1×10^{-10}	0	1×10^{-10}	1.50	50	A50
$O(^1D) + CClF_2CClF_2 \rightarrow$ Quenching and Reaction (CFC-114)	1.3×10^{-10}	0	1.3×10^{-10}	1.20	50	A51
$O(^1D) + CClF_2CF_3 \rightarrow$ Quenching and Reaction (CFC-115)	5×10^{-11}	0	5×10^{-11}	1.20	25	A52
$O(^1D) + CBrF_2CBrF_2 \rightarrow$ Quenching and Reaction	1.6×10^{-10}	0	1.6×10^{-10}	1.20	50	A53

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
(Halon-2402)						
$O(^1D) + CF_3CF_3 \rightarrow$ Quenching and Reaction (PFC-116)			$<1.5\times10^{-13}$			A54
$O(^1D) + CHF_2CF_2CF_2CHF_2 \rightarrow$ Quenching and Reaction (HFC-338pcc)	1.8×10^{-11}	0	1.8×10^{-11}	1.30	50	A55
$O(^1D) + c\text{-}C_4F_8 \rightarrow$ Quenching and Reaction			$<8\times10^{-13}$			A56
$O(^1D) + CF_3CHFCHFCF_2CF_3 \rightarrow$ Quenching and Reaction (HFC-43-10mee)	2.1×10^{-10}	0	2.1×10^{-10}	2	50	A57
$O(^1D) + C_5F_{12} \rightarrow$ Quenching and Reaction (PFC-41-12)			$<4\times10^{-13}$			A58
$O(^1D) + C_6F_{14} \rightarrow$ Quenching and Reaction (PFC-51-14)			$<1\times10^{-12}$			A59
$O(^1D) + 1,2\text{-}(CF_3)_2c\text{-}C_4F_6 \rightarrow$ Quenching and Reaction			$<3\times10^{-13}$			A60
$O(^1D) + C_4F_{10} \rightarrow$ Quenching and Reaction			$<5\times10^{-13}$			A61
$O(^1D) + SF_6 \rightarrow$ Quenching and Reaction			$<1.8\times10^{-14}$			A62
$O(^1D) + SO_2 \rightarrow$ Quenching and Reaction	2.2×10^{-10}	0	2.2×10^{-10}	1.30	30	A63
$O(^1D) + SO_2F_2 \rightarrow$ Quenching and Reaction	9×10^{-11}	-100	1.25×10^{-10}	1.30	30	A64
$O(^1D) + SF_5CF_3 \rightarrow$ Quenching and Reaction			$<2\times10^{-13}$			A65
Singlet O_2 Reactions						
$O_2(^1\Delta) + O \rightarrow$ products			$<2\times10^{-16}$			A66
$O_2(^1\Delta) + O_2 \rightarrow$ products	3.6×10^{-18}	220	1.7×10^{-18}	1.2	100	A67
$O_2(^1\Delta) + O_3 \rightarrow O + 2O_2$	5.2×10^{-11}	2840	3.8×10^{-15}	1.2	500	A68
$O_2(^1\Delta) + H_2O \rightarrow$ products			4.8×10^{-18}	1.5		A69
$O_2(^1\Delta) + N \rightarrow NO + O$			$<9\times10^{-17}$			A70
$O_2(^1\Delta) + N_2 \rightarrow$ products			$<10^{-20}$			A71
$O_2(^1\Delta) + CO_2 \rightarrow$ products			$<2\times10^{-20}$			A72

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$O_2(^1\Sigma) + O \rightarrow$ products			8×10^{-14}	5.0		A73
$O_2(^1\Sigma) + O_2 \rightarrow$ products			3.9×10^{-17}	1.5		A74
$O_2(^1\Sigma) + O_3 \rightarrow$ products	3.5×10^{-11}	135	2.2×10^{-11}	1.15	50	A75
$O_2(^1\Sigma) + H_2 \rightarrow$ products $O_2(^1\Sigma) + H_2 \rightarrow 2$ OH	6.4×10^{-12}	600	8.5×10^{-13} $<4\times10^{-17}$ (see note)	1.15	100	A76
$O_2(^1\Sigma) + H_2O \rightarrow O_2 + H_2O$	3.9×10^{-12}	-125	5.9×10^{-12}	1.3	100	A77
$O_2(^1\Sigma) + N \rightarrow$ products			$<10^{-13}$			A78
$O_2(^1\Sigma) + N_2 \rightarrow$ products	1.8×10^{-15}	-45	2.1×10^{-15}	1.1	100	A79
$O_2(^1\Sigma) + N_2O \rightarrow$ products $O_2(^1\Sigma) + N_2O \rightarrow NO + NO_2$	7.0×10^{-14}	-75	9.0×10^{-14} $< 2\times10^{-17}$ (see Note)	1.3	50	A80
$O_2(^1\Sigma) + CO_2 \rightarrow$ products	4.2×10^{-13}	0	4.2×10^{-13}	1.2	200	A81
HO_x Reactions						
$O + OH \rightarrow O_2 + H$	1.8×10^{-11}	-180	3.3×10^{-11}	1.15	50	B1
$O + HO_2 \rightarrow OH + O_2$	3.0×10^{-11}	–200	5.9×10^{-11}	1.05	50	B2
$O + H_2O_2 \rightarrow OH + HO_2$	1.4×10^{-12}	2000	1.7×10^{-15}	1.2	100	B3
$H + O_2 \xrightarrow{M} HO_2$	See Table 2-1					
$H + O_3 \rightarrow OH + O_2$	1.4×10^{-10}	470	2.9×10^{-11}	1.1	40	B4
$H + HO_2 \rightarrow 2$ OH	7.2×10^{-11}	0	7.2×10^{-11}	1.2	100	B5
$\rightarrow O + H_2O$	1.6×10^{-12}	0	1.6×10^{-12}	1.5	100	
$\rightarrow H_2 + O_2$	6.9×10^{-12}	0	6.9×10^{-12}	1.4	100	
$OH + O_3 \rightarrow HO_2 + O_2$	1.7×10^{-12}	940	7.3×10^{-14}	1.15	50	B6
$OH + H_2 \rightarrow H_2O + H$	2.8×10^{-12}	1800	6.7×10^{-15}	1.05	100	B7
$OH + HD \rightarrow$ products	5.0×10^{-12}	2130	4.0×10^{-15}	1.15	50	B8
$OH + OH \rightarrow H_2O + O$	1.8×10^{-12}	0	1.8×10^{-12}	1.25	50	B9
$\xrightarrow{M} H_2O_2$	See Table 2-1					
$OH + HO_2 \rightarrow H_2O + O_2$	4.8×10^{-11}	–250	1.1×10^{-10}	1.15	50	B10

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$OH + H_2O_2 \rightarrow H_2O + HO_2$	See Note					B11
$HO_2 + O_3 \rightarrow OH + 2O_2$	1.0×10^{-14}	490	1.9×10^{-15}	1.15	80	B12
$HO_2 + HO_2 \rightarrow H_2O_2 + O_2$	3.0×10^{-13}	-460	1.4×10^{-12}	1.15	100	B13
$\xrightarrow{M} H_2O_2 + O_2$	2.1×10^{-33} [M]	–920	4.6×10^{-32} [M]	1.2	200	
$HO_2 + HO_2 \cdot H_2O \rightarrow$ products	5.4×10^{-11}	410	1.4×10^{-11}	2	100	B14
NO_x Reactions						
$O + NO \xrightarrow{M} NO_2$	(See Table 2-1)					
$O + NO_2 \rightarrow NO + O_2$	5.1×10^{-12}	-210	1.04×10^{-11}	1.1	20	C 1
$O + NO_2 \xrightarrow{M} NO_3$	(See Table 2-1)					
$O + NO_3 \rightarrow O_2 + NO_2$	1.0×10^{-11}	0	1.0×10^{-11}	1.5	150	C 2
$O + N_2O_5 \rightarrow$ products			$<3.0\times10^{-16}$			C 3
$O + HNO_3 \rightarrow OH + NO_3$			$<3.0\times10^{-17}$			C 4
$O + HO_2NO_2 \rightarrow$ products	7.8×10^{-11}	3400	8.6×10^{-16}	3.0	750	C 5
$H + NO_2 \rightarrow OH + NO$	4.0×10^{-10}	340	1.3×10^{-10}	1.3	300	C 6
$OH + NO \xrightarrow{M} HONO$	(See Table 2-1)					
$OH + NO_2 \xrightarrow{M} HNO_3$	(See Table 2-1)					
$OH + NO_3 \rightarrow$ products			2.2×10^{-11}	1.5		C 7
$OH + HONO \rightarrow H_2O + NO_2$	1.8×10^{-11}	390	4.5×10^{-12}	1.5	+200 –	C 8
$OH + HNO_3 \rightarrow H_2O + NO_3$	(See Note)			1.2		C 9
$OH + HO_2NO_2 \rightarrow$ products	1.3×10^{-12}	–380	4.6×10^{-12}	1.3	+270 –500	C10
$OH + NH_3 \rightarrow H_2O + NH_2$	1.7×10^{-12}	710	1.6×10^{-13}	1.2	200	C11
$HO_2 + NO \rightarrow NO_2 + OH$	3.3×10^{-12}	–270	8.0×10^{-12}	1.15	20	C12
$H_2O + NO_2^* \rightarrow OH + HONO$		see note				C13
$HO_2 + NO_2 \xrightarrow{M} HO_2NO_2$	(See Table 2-1)					
$HO_2 + NO_2 \rightarrow HONO + O_2$	(See Note)					C14

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$HO_2 + NO_3 \rightarrow$ products			3.5×10^{-12}	1.5		C15
$HO_2 + NH_2 \rightarrow$ products			3.4×10^{-11}	2.0		C16
$N + O_2 \rightarrow NO + O$	1.5×10^{-11}	3600	8.5×10^{-17}	1.25	400	C17
$N + O_3 \rightarrow NO + O_2$			$<2.0\times10^{-16}$			C18
$N + NO \rightarrow N_2 + O$	2.1×10^{-11}	–100	3.0×10^{-11}	1.3	100	C19
$N + NO_2 \rightarrow N_2O + O$	5.8×10^{-12}	–220	1.2×10^{-11}	1.5	100	C20
$NO + O_3 \rightarrow NO_2 + O_2$	3.0×10^{-12}	1500	1.9×10^{-14}	1.1	200	C21
$NO + NO_3 \rightarrow 2NO_2$	1.5×10^{-11}	–170	2.6×10^{-11}	1.3	100	C22
$NO_2 + O_3 \rightarrow NO_3 + O_2$	1.2×10^{-13}	2450	3.2×10^{-17}	1.15	150	C23
$NO_2 + NO_3 \rightarrow NO + NO_2 + O_2$	(See Note)					C24
$NO_2 + NO_3 \xrightarrow{M} N_2O_5$	(See Table 2-1)					
$NO_3 + NO_3 \rightarrow 2NO_2 + O_2$	8.5×10^{-13}	2450	2.3×10^{-16}	1.5	500	C25
$NH_2 + O_2 \rightarrow$ products			$<6.0\times10^{-21}$			C26
$NH_2 + O_3 \rightarrow$ products	4.3×10^{-12}	930	1.9×10^{-13}	3.0	500	C27
$NH_2 + NO \rightarrow$ products	4.0×10^{-12}	–450	1.8×10^{-11}	1.3	150	C28
$NH_2 + NO_2 \rightarrow$ products	2.1×10^{-12}	–650	1.9×10^{-11}	3.0	250	C29
$NH + NO \rightarrow$ products	4.9×10^{-11}	0	4.9×10^{-11}	1.5	300	C30
$NH + NO_2 \rightarrow$ products	3.5×10^{-13}	–1140	1.6×10^{-11}	2.0	500	C31
$O_3 + HNO_2 \rightarrow O_2 + HNO_3$			$<5.0\times10^{-19}$			C32
$N_2O_5 + H_2O \rightarrow 2HNO_3$			$<2.0\times10^{-21}$			C33
$N_2(A,v) + O_2 \rightarrow$ products			2.5×10^{-12}, v=0	1.5		C34
$N_2(A,v) + O_3 \rightarrow$ products			4.1×10^{-11}, v=0	2.0		C34
Reactions of Organic Compounds						
$O + CH_3 \rightarrow$ products	1.1×10^{-10}	0	1.1×10^{-10}	1.3	250	D 1
$O + HCN \rightarrow$ products	1.0×10^{-11}	4000	1.5×10^{-17}	10	1000	D 2

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$O + C_2H_2 \rightarrow$ products	3.0×10^{-11}	1600	1.4×10^{-13}	1.3	250	D 3
$O + H_2CO \rightarrow$ products	3.4×10^{-11}	1600	1.6×10^{-13}	1.25	250	D 4
$O + CH_3CHO \rightarrow CH_3CO + OH$	1.8×10^{-11}	1100	4.5×10^{-13}	1.25	200	D 5
$O_2 + HOCO \rightarrow HO_2 + CO_2$			2×10^{-12} (See Note)	2		D 6
$O_3 + C_2H_2 \rightarrow$ products	1.0×10^{-14}	4100	1.0×10^{-20}	3	500	D 7
$O_3 + C_2H_4 \rightarrow$ products	1.2×10^{-14}	2630	1.7×10^{-18}	1.25	100	D 8
$O_3 + C_3H_6 \rightarrow$ products	6.5×10^{-15}	1900	1.1×10^{-17}	1.15	200	D 9
$O_3 + CH_2=C(CH_3)CH=CH_2 \rightarrow$ products	1.0×10^{-14}	1970	1.3×10^{-17}	1.1	150	D10
$OH + CO \rightarrow$ Products	(See Table 2-1)					D11
$OH + CH_4 \rightarrow CH_3 + H_2O$	2.45×10^{-12}	1775	6.3×10^{-15}	1.1	100	D12
$OH + {}^{13}CH_4 \rightarrow {}^{13}CH_3 + H_2O$	(See Note)					D13
$OH + CH_3D \rightarrow$ products	3.5×10^{-12}	1950	5.0×10^{-15}	1.15	200	D14
$OH + H_2CO \rightarrow H_2O + HCO$	5.5×10^{-12}	-125	8.5×10^{-12}	1.15	50	D15
$OH + CH_3OH \rightarrow$ products	2.9×10^{-12}	345	9.1×10^{-13}	1.10	60	D16
$OH + CH_3OOH \rightarrow$ products	3.8×10^{-12}	–200	7.4×10^{-12}	1.4	150	D17
$OH + HC(O)OH \rightarrow$ products	4.0×10^{-13}	0	4.0×10^{-13}	1.2	100	D18
$OH + HC(O)C(O)H \rightarrow$ products	1.15×10^{-11}	0	1.15×10^{-11}	1.5	200	D19
$OH + HOCH_2CHO \rightarrow$ products	1.1×10^{-11}	0	1.1×10^{-11}	1.2	200	D20
$OH + HCN \rightarrow$ products	1.2×10^{-13}	400	3.1×10^{-14}	3	150	D21
$OH + C_2H_2 \xrightarrow{M}$ products	(See Table 2)					
$OH + C_2H_4 \xrightarrow{M}$ products	(See Table 2)					
$OH + C_2H_6 \rightarrow H_2O + C_2H_5$	7.66×10^{-12}	1020	2.5×10^{-13}	1.07	50	D22
$OH + CH_3CHO \rightarrow$ products	4.63×10^{-12}	–350	1.5×10^{-11}	1.05	20	D23
$OH + CH_3CH_2OH \rightarrow$ products	3.35×10^{-12}	0	3.35×10^{-12}	1.05	20	D24
$OH + CH_3C(O)OH \rightarrow$ products	3.15×10^{-14}	–920	6.9×10^{-13}	1.15	100	D25

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$OH + C_3H_8 \rightarrow$ products	8.7×10^{-12}	615	1.1×10^{-12}	1.05	50	D26
$OH + C_2H_5CHO \rightarrow C_2H_5CO + H_2O$	4.9×10^{-12}	–405	1.9×10^{-11}	1.05	80	D27
$OH + 1\text{–}C_3H_7OH \rightarrow$ products	4.4×10^{-12}	–70	5.6×10^{-12}	1.05	80	D28
$OH + 2\text{–}C_3H_7OH \rightarrow$ products	3.0×10^{-12}	–180	5.5×10^{-12}	1.05	80	D29
$OH + C_2H_5C(O)OH \rightarrow$ products	1.2×10^{-12}	0	1.2×10^{-12}	1.1	200	D30
$OH + CH_3C(O)CH_3 \rightarrow H_2O + CH_3C(O)CH_2$ $\rightarrow CH_3 + CH_3C(O)OH$	See Note		< 2% of k			D31
$OH + CH_2=C(CH_3)CH=CH_2 \rightarrow$ products	3.1×10^{-11}	−350	1.0×10^{-10}	1.1	100	D32
$OH + CH_3CN \rightarrow$ products	7.8×10^{-13}	1050	2.3×10^{-14}	1.5	200	D33
$OH + CH_3ONO_2 \rightarrow$ products	8.0×10^{-13}	1000	2.8×10^{-14}	1.7	200	D34
$OH + CH_3C(O)O_2NO_2$ (PAN) $\rightarrow$ products			$<4\times10^{-14}$			D35
$OH + C_2H_5ONO_2 \rightarrow$ products	1.0×10^{-12}	490	2.0×10^{-13}	1.4	150	D36
$OH + 1\text{–}C_3H_7ONO_2 \rightarrow$ products	7.1×10^{-13}	0	7.1×10^{-13}	1.5	200	D37
$OH + 2\text{–}C_3H_7ONO_2 \rightarrow$ products	1.2×10^{-12}	320	4.1×10^{-13}	1.5	200	D38
$HO_2 + CH_2O \rightarrow$ adduct	6.7×10^{-15}	–600	5.0×10^{-14}	5	600	D39
$HO_2 + CH_3O_2 \rightarrow CH_3OOH + O_2$	4.1×10^{-13}	–750	5.2×10^{-12}	1.3	150	D40
$HO_2 + C_2H_5O_2 \rightarrow C_2H_5OOH + O_2$	7.5×10^{-13}	–700	8.0×10^{-12}	1.5	250	D41
$HO_2 + CH_3C(O)O_2 \rightarrow$ products	4.3×10^{-13}	–1040	1.4×10^{-11}	2	500	D42
$HO_2 + CH_3C(O)CH_2O_2 \rightarrow$ products	8.6×10^{-13}	–700	9.0×10^{-12}	2	300	D43
$NO_3 + CO \rightarrow$ products			$<4.0\times10^{-19}$			D44
$NO_3 + CH_2O \rightarrow$ products			5.8×10^{-16}	1.3		D45
$NO_3 + CH_3CHO \rightarrow$ products	1.4×10^{-12}	1900	2.4×10^{-15}	1.3	300	D46
$CH_3 + O_2 \rightarrow$ products			$<3.0\times10^{-16}$			D47
$CH_3 + O_2 \xrightarrow{M} CH_3O_2$	(See Table 2-1)					
$CH_3 + O_3 \rightarrow$ products	5.4×10^{-12}	220	2.6×10^{-12}	2	150	D48

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$HCO + O_2 \rightarrow CO + HO_2$	5.2×10^{-12}	0	5.2×10^{-12}	1.4	100	D49
$CH_2OH + O_2 \rightarrow CH_2O + HO_2$	9.1×10^{-12}	0	9.1×10^{-12}	1.3	200	D50
$CH_3O + O_2 \rightarrow CH_2O + HO_2$	3.9×10^{-14}	900	1.9×10^{-15}	1.5	300	D51
$CH_3O + NO \rightarrow CH_2O + HNO$ $CH_3O + NO \xrightarrow{M} CH_3ONO$	(See Note) (See Table 2-1)					D52
$CH_3O + NO_2 \rightarrow CH_2O + HONO$	1.1×10^{-11}	1200	2.0×10^{-13}	5	600	D53
$CH_3O + NO_2 \xrightarrow{M} CH_3ONO_2$	(See Table 2-1)					
$CH_3O_2 + O_3 \rightarrow$ products	2.9×10^{-16}	1000	1.0×10^{-17}	3	500	D54
$CH_3O_2 + CH_3O_2 \rightarrow$ products	9.5×10^{-14}	–390	3.5×10^{-13}	1.2	100	D55
$CH_3O_2 + NO \rightarrow CH_3O + NO_2$	2.8×10^{-12}	–300	7.7×10^{-12}	1.15	100	D56
$CH_3O_2 + NO_2 \xrightarrow{M} CH_3O_2NO_2$	(See Table 2-1)					
$CH_3O_2 + CH_3C(O)O_2 \rightarrow$ products	2.0×10^{-12}	–500	1.1×10^{-11}	1.5	250	D57
$CH_3O_2 + CH_3C(O)CH_2O_2 \rightarrow$ products	7.5×10^{-13}	–500	4.0×10^{-12}	2	300	D58
$C_2H_5 + O_2 \rightarrow C_2H_4 + HO_2$ $C_2H_5 + O_2 \xrightarrow{M} C_2H_5O_2$	(See Table 2-1)		$<2.0\times10^{-14}$			D59
$C_2H_5O + O_2 \rightarrow CH_3CHO + HO_2$	6.3×10^{-14}	550	1.0×10^{-14}	1.5	200	D60
$C_2H_5O + NO \xrightarrow{M}$ products	(See Table 2-1)					
$C_2H_5O + NO_2 \xrightarrow{M}$ products	(See Table 2-1)					
$C_2H_5O_2 + C_2H_5O_2 \rightarrow$ products	6.8×10^{-14}	0	6.8×10^{-14}	2	300	D61
$C_2H_5O_2 + NO \rightarrow$ products	2.6×10^{-12}	–365	8.7×10^{-12}	1.2	150	D62
$CH_3C(O)O_2 + CH_3C(O)O_2 \rightarrow$ products	2.9×10^{-12}	–500	1.5×10^{-11}	1.5	150	D63
$CH_3C(O)O_2 + NO \rightarrow$ products	8.1×10^{-12}	–270	2.0×10^{-11}	1.5	100	D64
$CH_3C(O)O_2 + NO_2 \xrightarrow{M}$ products	(See Table 2-1)					
$CH_3C(O)CH_2O_2 + NO \rightarrow$ products	2.9×10^{-12}	–300	8.0×10^{-12}	1.5	300	D65
$CH_2=C(CH_3)CH=CH_2 + NO_3 \rightarrow$ products	3.3×10^{-12}	450	7.3×10^{-13}	1.25	100	D66

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
FO_x Reactions						
$O + FO \rightarrow F + O_2$	2.7×10^{-11}	0	2.7×10^{-11}	3.0	250	E 1
$O + FO_2 \rightarrow FO + O_2$	5.0×10^{-11}	0	5.0×10^{-11}	5.0	250	E 2
$OH + CH_3F \rightarrow CH_2F + H_2O$ (HFC–41)	2.5×10^{-12}	1430	2.1×10^{-14}	1.15	150	E 3
$OH + CH_2F_2 \rightarrow CHF_2 + H_2O$ (HFC-32)	1.7×10^{-12}	1500	1.1×10^{-14}	1.15	150	E 4
$OH + CHF_3 \rightarrow CF_3 + H_2O$ (HFC-23)	5.2×10–13	2210	3.1×10–16	1.15	100	E 5
$OH + CH_3CH_2F \rightarrow$ products (HFC-161)	2.5×10^{-12}	730	2.2×10^{-13}	1.15	150	E 6
$OH + CH_3CHF_2 \rightarrow$ products (HFC-152a)	8.7×10^{-13}	975	3.3×10^{-14}	1.07	50	E 7
$OH + CH_2FCH_2F \rightarrow CHFCH_2F + H_2O$ (HFC-152)	1.05×10^{-12}	710	9.7×10^{-14}	1.07	100	E 8
$OH + CH_3CF_3 \rightarrow CH_2CF_3 + H_2O$ (HFC-143a)	1.1×10^{-12}	2010	1.3×10^{-15}	1.1	100	E 9
$OH + CH_2FCHF_2 \rightarrow$ products (HFC-143)	3.9×10^{-12}	1620	1.7×10^{-14}	1.2	200	E10
$OH + CH_2FCF_3 \rightarrow CHFCF_3 + H_2O$ (HFC-134a)	1.05×10^{-12}	1630	4.4×10^{-15}	1.1	200	E11
$OH + CHF_2CHF_2 \rightarrow CF_2CHF_2 + H_2O$ (HFC-134)	1.6×10^{-12}	1660	6.1×10^{-15}	1.2	200	E12
$OH + CHF_2CF_3 \rightarrow CF_2CF_3 + H_2O$ (HFC-125)	6.0×10^{-13}	1700	2.0×10^{-15}	1.2	150	E13
$OH + CH_3CHFCH_3 \rightarrow$ products (HFC-281ea)	3.0×10^{-12}	490	5.8×10^{-13}	1.2	100	E14
$OH + CH_3CH_2CF_3 \rightarrow$ products (HFC-263fb)	3.7×10^{-12}	1290	4.9×10^{-14}	1.15	100	E15
$OH + CH_2FCF_2CHF_2 \rightarrow$ products (HFC-245ca)	2.1×10^{-12}	1620	9.2×10^{-15}	1.2	150	E16
$OH + CHF_2CHFCHF_2 \rightarrow$ products (HFC-245ea)	1.53×10^{-12}	1340	1.7×10^{-14}	1.1	150	E17
$OH + CH_2FCHFCF_3 \rightarrow$ products (HFC-245eb)	1.16×10^{-12}	1260	1.7×10^{-14}	1.15	100	E18
$OH + CHF_2CH_2CF_3 \rightarrow$ products (HFC-245fa)	6.1×10^{-13}	1330	7.0×10^{-15}	1.2	150	E19
$OH + CH_2FCF_2CF_3 \rightarrow CHFCF_2CF_3 + H_2O$ (HFC-236cb)	*1.05×10^{-12}*	*1630*	*4.4×10^{-15}*	*2.0*	*200*	E20
$OH + CHF_2CHFCF_3 \rightarrow$ products (HFC-236ea)	9.4×10^{-13}	1550	5.2×10^{-15}	1.2	200	E21
$OH + CF_3CH_2CF_3 \rightarrow CF_3CHCF_3 + H_2O$ (HFC–236fa)	1.45×10^{-12}	2500	3.3×10^{-16}	1.15	150	E22
$OH + CF_3CHFCF_3 \rightarrow CF_3CFCF_3 + H_2O$ (HFC-227ea)	6.3×10^{-13}	1800	1.5×10^{-15}	1.15	150	E23

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
OH + $CH_3CF_2CH_2CF_3$ → products (HFC-365mfc)	1.8×10^{-12}	1660	6.9×10^{-15}	1.3	100	E24
OH + $CF_3CH_2CH_2CF_3$ → products (HFC-356mff)	3.4×10^{-12}	1820	7.6×10^{-15}	1.2	300	E25
OH + $CH_2FCH_2CF_2CF_3$ → products (HFC-356mcf)	1.7×10^{-12}	1100	4.2×10^{-14}	1.3	150	E26
OH + $CHF_2CF_2CF_2CF_2H$ → products (HFC-338pcc)	7.7×10^{-13}	1540	4.4×10^{-15}	1.2	150	E27
OH + $CF_3CH_2CF_2CH_2CF_3$ → products (HFC-458mfcf)	1.1×10^{-12}	1800	2.6×10^{-15}	1.5	200	E28
OH + CF3CHFCHFCF2CF3 → products (HFC-43-10mee)	5.2×10^{-13}	1500	3.4×10^{-15}	1.2	150	E29
OH + $CF_3CF_2CH_2CH_2CF_2CF_3$ → products (HFC–55-10-mcff)	*3.5×10^{-12}*	*1800*	8.3×10^{-15}	1.5	*300*	E30
OH + CH_2=CHF → products	1.77×10^{-12}	–310	5.0×10^{-12}	1.07	50	E31
OH + CH_2=CF_2 → products	1.75×10^{-12}	–140	2.8×10^{-12}	1.1	20	E32
OH + CF_2=CF_2 → products	3.4×10^{-12}	–320	1.0×10^{-11}	1.15	100	E33
OH + CH_2=$CHCH_2F$ → products	6.0×10^{-12}	-290	1.6×10^{-11}	1.3	100	E34
OH + CH_2=$CHCF_3$ → products	7.9×10^{-13}	-180	1.45×10^{-12}	1.1	50	E35
OH + CH_2=$CFCF_3$ → products	1.1×10^{-12}	0	1.1×10^{-12}	1.05	0	E36
OH + *E*-CHF=$CHCF_3$ → products	6.1×10^{-13}	–40	7.0×10^{-13}	1.1	0	E37
OH + *E*-CHF=$CFCF_3$ → products	*1.65×10^{-12}*	*–100*	2.3×10^{-12}	1.3	50	E38
OH + *Z*-CHF=$CFCF_3$ → products	7.5×10^{-13}	–165	1.3×10^{-12}	1.07	50	E39
OH + CF_2=$CFCF_3$ → products	8.0×10^{-13}	–300	2.2×10^{-12}	1.1	50	E40
OH + CH_2=$CHCF_2CF_3$ → products	*7.6×10^{-13}*	*-180*	1.4×10^{-12}	1.2	50	E41
OH + CF_3OH → CF_3O + H_2O			$<2\times10^{-17}$			E42
OH + CH_2FCH_2OH → products	1.86×10^{-12}	200	9.5×10^{-13}	1.05	50	E43
OH + CHF_2CH_2OH → products	1.4×10^{-12}	500	2.6×10^{-13}	1.05	100	E44
OH + CF_3CH_2OH → products	1.04×10^{-12}	700	9.9×10^{-14}	1.05	100	E45
OH + $CF_3CF_2CH_2OH$ → products	1.15×10^{-12}	730	1.0×10^{-13}	1.05	100	E46
OH + $(CF_3)_2CHOH$ → products	5.1×10^{-13}	900	2.5×10^{-14}	1.2	200	E47
OH + $CF_3CF_2CF_2CF_2CH_2OH$ → products	*1.16×10^{-12}*	*730*	1.0×10^{-13}	1.1	200	E48

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
OH + CH_3OCHF_2 → products (HFE-152a)	6.0×10^{-12}	1530	3.5×10^{-14}	1.3	200	E49
OH + CH_3OCF_3 → CH_2OCF_3 + H_2O (HFE-143a)	1.84×10^{-12}	1500	1.2×10^{-14}	1.1	150	E50
OH + CHF_2OCHF_2 → CF_2OCHF_2 +H_2O (HFE-134)	1.1×10^{-12}	1830	2.4×10^{-15}	1.15	150	E51
OH + CHF_2OCF_3 → CF_2OCF_3 + H_2O (HFE-125)	4.6×10^{-13}	2040	4.9×10^{-16}	1.2	200	E52
OH + $CH_3OCHFCF_3$ → products	1.62×10^{-12}	690	1.6×10^{-13}	1.15	50	E53
OH + $CH_3OCF_2CHF_2$ → products	1.7×10^{-12}	1300	2.2×10^{-14}	1.3	200	E54
OH + $CH_3OCF_2CF_3$ → products	1.1×10^{-12}	1370	1.1×10^{-14}	1.2	150	E55
OH + $CHF_2OCH_2CF_3$ → products (HFE-245fa)	2.9×10^{-12}	1660	1.1×10^{-14}	1.15	200	E56
OH + $CHF_2OCHFCF_3$ → products	*2.4×10^{-12}*	*1800*	5.7×10^{-15}	1.4	200	E57
OH + $CHF_2OCF_2CHF_2$ → products	5.8×10^{-13}	1600	2.7×10^{-15}	1.2	50	E58
OH + $CF_3OCHFCF_3$ → products	3.6×10^{-13}	1700	1.2×10^{-15}	1.15	100	E59
OH + $CH_3OCF_2CF_2CF_3$ → products	1.4×10^{-12}	1440	1.1×10^{-14}	1.15	150	E60
OH + $CH_3OCF(CF_3)_2$ → products	1.3×10^{-12}	1330	1.5×10^{-14}	1.15	100	E61
OH + $CH_3OC_4F_9$ → products	*1.3×10^{-12}*	*1400*	1.2×10^{-14}	1.15	150	E62
OH + $CHF_2OCH_2CF_2CHF_2$ → products	1.8×10^{-12}	1410	1.6×10^{-14}	1.3	200	E63
OH + $CHF_2OCH_2CF_2CF_3$ → products	1.6×10^{-12}	1510	1.0×10^{-14}	1.3	200	E64
OH + $CHF_2OCH(CF_3)_2$ → products	1.03×10^{-12}	1760	2.8×10^{-15}	1.2	150	E65
OH + $CH_3CH_2OCF_2CHF_2$ → products	2.1×10^{-12}	670	2.2×10^{-13}	1.1	100	E66
OH + $CF_3CH_2OCH_2CF_3$ → products	2.8×10^{-12}	890	1.4×10^{-13}	1.1	100	E67
OH + $CF_3CH_2OCF_2CHF_2$ → products (HFE-347pcf2)	1.32×10^{-12}	1470	9.5×10^{-15}	1.1	50	E68
OH + $CHF_2OCF_2OCHF_2$ → products	*1.0×10^{-12}*	*1800*	2.4×10^{-15}	1.4	200	E69
OH + $CHF_2OCF_2CF_2OCHF_2$ → products	*2.0×10^{-12}*	*1800*	4.7×10^{-15}	1.5	200	E70
OH + $CHF_2OCF_2CF_2OCF_2OCHF_2$ → products	*1.9×10^{-12}*	*1800*	4.6×10^{-15}	1.5	200	E71
$F + O_2 \xrightarrow{M} FO_2$	(See Table 2-1)					
F + O_3 → FO + O_2	2.2×10^{-11}	230	1.0×10^{-11}	1.5	200	E72

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$F + H_2 \rightarrow HF + H$	1.4×10^{-10}	500	2.6×10^{-11}	1.2	200	E73
$F + H_2O \rightarrow HF + OH$	1.4×10^{-11}	0	1.4×10^{-11}	1.3	200	E74
$F + NO \xrightarrow{M} FNO$	(See Table 2-1)					
$F + NO_2 \xrightarrow{M} FNO_2$	(See Table 2-1)					
$F + HNO_3 \rightarrow HF + NO_3$	6.0×10^{-12}	–400	2.3×10^{-11}	1.3	200	E75
$F + CH_4 \rightarrow HF + CH_3$	1.6×10^{-10}	260	6.7×10^{-11}	1.4	200	E76
$FO + O_3 \rightarrow$ products			$<1 \times 10^{-14}$			E77
$FO + NO \rightarrow NO_2 + F$	8.2×10^{-12}	–300	2.2×10^{-11}	1.5	200	E78
$FO + NO_2 \xrightarrow{M} FONO_2$	(See Table 2-1)					
$FO + FO \rightarrow 2F + O_2$	1.0×10^{-11}	0	1.0×10^{-11}	1.5	250	E79
$FO_2 + O_3 \rightarrow$ products			$<3.4\times10^{-16}$			E80
$FO_2 + NO \rightarrow FNO + O_2$	7.5×10^{-12}	690	7.5×10^{-13}	2.0	400	E81
$FO_2 + NO_2 \rightarrow$ products	3.8×10^{-11}	2040	4.0×10^{-14}	2.0	500	E82
$FO_2 + CO \rightarrow$ products			$<5.1\times10^{-16}$			E83
$FO_2 + CH_4 \rightarrow$ products			$<2\times10^{-16}$			E84
$CF_3 + O_2 \xrightarrow{M} CF_3O_2$	(See Table 2-1)					
$CF_3O + M \rightarrow F + CF_2O + M$	(See Table 2-1)					
$CF_3O + O_2 \rightarrow FO_2 + CF_2O$	$<3 \times 10^{-11}$	5000	$<1.5 \times 10^{-18}$	1.3	–	E85
$CF_3O + O_3 \rightarrow CF_3O_2 + O_2$	2×10^{-12}	1400	1.8×10^{-14}		600	E86
$CF_3O + H_2O \rightarrow OH + CF_3OH$	3×10^{-12}	>3600	$<2 \times 10^{-17}$	1.2	–	E87
$CF_3O + NO \rightarrow CF_2O + FNO$	3.7×10^{-11}	–110	5.4×10^{-11}		70	E88
$CF_3O + NO_2 \rightarrow$ products $\xrightarrow{M} CF_3ONO_2$	(See Note) (See Table 2-1)					E89
$CF_3O + CO \rightarrow$ products $\xrightarrow{M} CF_3OCO$	(See Table 2-1)		$<2 \times 10^{-15}$			E90

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$CF_3O + CH_4 \rightarrow CH_3 + CF_3OH$	2.6×10^{-12}	1420	2.2×10^{-14}	1.1	200	E91
$CF_3O + C_2H_6 \rightarrow C_2H_5 + CF_3OH$	4.9×10^{-12}	400	1.3×10^{-12}	1.2	100	E92
$CF_3O_2 + O_3 \rightarrow CF_3O + 2O_2$			$<3 \times 10^{-15}$			E93
$CF_3O_2 + CO \rightarrow CF_3O + CO_2$			$<5 \times 10^{-16}$			E94
$CF_3O_2 + NO \rightarrow CF_3O + NO_2$	5.4×10^{-12}	–320	1.6×10^{-11}	1.1	150	E95
$CF_3O_2 + NO_2 \xrightarrow{M} CF_3O_2NO_2$	(See Table 2-1)					
ClO_x Reactions						
$O + ClO \rightarrow Cl + O_2$	2.8×10^{-11}	-85	3.7×10^{-11}	1.05	50	F 1
$O + OClO \rightarrow ClO + O_2$	2.4×10^{-12}	960	1.0×10^{-13}	2.0	300	F 2
$O + OClO \xrightarrow{M} ClO_3$	(See Table 2-1)					
$O + Cl_2O \rightarrow ClO + ClO$	2.7×10^{-11}	530	4.5×10^{-12}	1.2	100	F 3
$O + HCl \rightarrow OH + Cl$	1.0×10^{-11}	3300	1.5×10^{-16}	1.5	350	F 4
$O + HOCl \rightarrow OH + ClO$	1.7×10^{-13}	0	1.7×10^{-13}	3.0	300	F 5
$O + ClONO_2 \rightarrow$ products	3.6×10^{-12}	840	2.1×10^{-13}	1.2	100	F 6
$O_3 + OClO \rightarrow$ products	2.1×10^{-12}	4700	3.0×10^{-19}	2.5	1000	F 7
$O_3 + Cl_2O_2 \rightarrow$ products			$<1.0\times10^{-19}$			F 8
$OH + Cl_2 \rightarrow HOCl + Cl$	2.6×10^{-12}	1100	6.5×10^{-14}	1.1	200	F 9
$OH + ClO \rightarrow Cl + HO_2$ $\rightarrow HCl + O_2$	7.4×10^{-12} 6.0×10^{-13}	–270 –230	1.8×10^{-11} 1.3×10^{-12}	1.2 1.7	50 100	F10
$OH + OClO \rightarrow HOCl + O_2$	1.4×10^{-12}	–600	1.0×10^{-11}	1.5	150	F11
$OH + Cl_2O \rightarrow HOCl + ClO$	4.7×10^{-12}	-140	7.5×10^{-12}	1.2	100	F12
$OH + Cl_2O_2 \rightarrow HOCl + ClOO$	6.0×10^{-13}	-670	5.7×10^{-12}	1.3	100	F13
$OH + HCl \rightarrow H_2O + Cl$	1.8×10^{-12}	250	7.8×10^{-13}	1.1	50	F14
$OH + HOCl \rightarrow H_2O + ClO$	3.0×10^{-12}	500	5.0×10^{-13}	3.0	500	F15
$OH + ClNO_2 \rightarrow HOCl + NO_2$	2.4×10^{-12}	1250	3.6×10^{-14}	2.0	300	F16
$OH + ClONO_2 \rightarrow$ products	1.2×10^{-12}	330	3.9×10^{-13}	1.5	200	F17

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$OH + CH_3Cl \rightarrow CH_2Cl + H_2O$	2.4×10^{-12}	1250	3.6×10^{-14}	1.15	100	F18
$OH + CH_2Cl_2 \rightarrow CHCl_2 + H_2O$	1.9×10^{-12}	870	1.0×10^{-13}	1.15	100	F19
$OH + CHCl_3 \rightarrow CCl_3 + H_2O$	2.2×10^{-12}	920	1.0×10^{-13}	1.15	150	F20
$OH + CCl_4 \rightarrow$ products	*~1.0×10⁻¹²*	*>2300*	$<5.0\times10^{-16}$	–	–	F21
$OH + CH_2FCl \rightarrow CHClF + H_2O$ (HCFC-31)	2.4×10^{-12}	1210	4.1×10^{-14}	1.15	200	F22
$OH + CHFCl_2 \rightarrow CFCl_2 + H_2O$ (HCFC-21)	1.2×10^{-12}	1100	3.0×10^{-14}	1.2	150	F23
$OH + CHF_2Cl \rightarrow CF_2Cl + H_2O$ (HCFC-22)	1.05×10^{-12}	1600	4.8×10^{-15}	1.1	150	F24
$OH + CFCl_3 \rightarrow$ products (CFC-11)	*~1.0×10⁻¹²*	*>3700*	$<5.0\times10^{-18}$			F25
$OH + CF_2Cl_2 \rightarrow$ products (CFC-12)	*~1.0×10⁻¹²*	*>3600*	$<6.0\times10^{-18}$			F26
$OH + CH_2ClCH_3 \rightarrow$ products	5.4×10^{-12}	800	3.7×10^{-13}	1.2	100	F27
$OH + CH_3CCl_3 \rightarrow CH_2CCl_3 + H_2O$	1.64×10^{-12}	1520	1.0×10^{-14}	1.15	100	F28
$OH + CH_3CFCl_2 \rightarrow CH_2CFCl_2 + H_2O$ (HCFC-141b)	1.25×10^{-12}	1600	5.8×10^{-15}	1.15	150	F29
$OH + CH_3CF_2Cl \rightarrow CH_2CF_2Cl + H_2O$ (HCFC-142b)	1.3×10^{-12}	1770	3.4×10^{-15}	1.2	150	F30
$OH + CH_2ClCF_2Cl \rightarrow CHClCF_2Cl + H_2O$ (HCFC-132b)	3.6×10^{-12}	1600	1.7×10^{-14}	1.5	200	F31
$OH + CH_2ClCF_3 \rightarrow CHClCF_3 + H_2O$ (HCFC-133a)	1.43×10^{-12}	1400	1.3×10^{-14}	1.3	150	F32
$OH + CHCl_2CF_2Cl \rightarrow CCl_2CF_2Cl$ (HCFC-122) + H_2O	7.7×10^{-13}	810	5.1×10^{-14}	1.2	150	F33
$OH + CHFClCFCl_2 \rightarrow CFClCFCl_2$ (HCFC-122a) + H_2O	7.1×10^{-13}	1140	1.6×10^{-14}	1.3	150	F34
$OH + CHCl_2CF_3 \rightarrow CCl_2CF_3 + H_2O$ (HCFC-123)	6.3×10^{-13}	850	3.6×10^{-14}	1.2	100	F35
$OH + CHFClCF_2Cl \rightarrow CFClCF_2Cl + H_2O$ (HCFC-123a)	8.6×10^{-13}	1250	1.3×10^{-14}	1.3	200	F36
$OH + CHFClCF_3 \rightarrow CFClCF_3 + H_2O$ (HCFC-124)	7.1×10^{-13}	1300	9.0×10^{-15}	1.15	100	F37
$OH + CH_3CF_2CFCl_2 \rightarrow$ products [7] (HCFC-243cc)	7.7×10^{-13}	1720	2.4×10^{-15}	1.3	200	F38
$OH + CHCl_2CF_2CF_3 \rightarrow$ products (HCFC-225ca)	6.3×10^{-13}	960	2.5×10^{-14}	1.2	200	F39
$OH + CHFClCF_2CF_2Cl \rightarrow$ products (HCFC-225cb)	5.5×10^{-13}	1230	8.9×10^{-15}	1.2	150	F40
$OH + CF_3CH_2CFCl_2 \rightarrow CF_3CHCFCl_2 + H_2O$	*1.8×10⁻¹²*	*2300*	8.0×10^{-16}	1.5	200	F41
$OH + CH_2{=}CHCl \rightarrow$ products	1.3×10^{-12}	–500	6.9×10^{-12}	1.2	100	F42

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$OH + CH_2{=}CCl_2 \rightarrow$ products	1.9×10^{-12}	–530	1.1×10^{-11}	1.15	150	F43
$OH + CHCl{=}CCl_2 \rightarrow$ products	8.0×10^{-13}	–300	2.2×10^{-12}	1.2	100	F44
$OH + CCl_2{=}CCl_2 \rightarrow$ products	4.7×10^{-12}	990	1.7×10^{-13}	1.2	200	F45
$OH + CHF_2OCHClCF_3 \rightarrow$ products	1.1×10^{-12}	1275	1.5×10^{-14}	1.1	50	F46
$OH + CH_3OCl \rightarrow$ products	2.5×10^{-12}	370	7.1×10^{-13}	2.0	150	F47
$OH + CCl_3CHO \rightarrow H_2O + CCl_3CO$	9.1×10^{-12}	580	1.3×10^{-12}	1.3	200	F48
$HO_2 + Cl \rightarrow HCl + O_2$	1.4×10^{-11}	–270	3.5×10^{-11}	1.2	100	F49
$\rightarrow OH + ClO$	3.6×10^{-11}	375	1.0×10^{-11}	1.4	150	
$HO_2 + ClO \rightarrow HOCl + O_2$	2.6×10^{-12}	–290	6.9×10^{-12}	1.2	150	F50
$H_2O + ClONO_2 \rightarrow$ products			$<2.0\times10^{-21}$			F51
$NO + OClO \rightarrow NO_2 + ClO$	2.5×10^{-12}	600	3.4×10^{-13}	2.0	300	F52
$NO + Cl_2O_2 \rightarrow$ products			$<1.0\times10^{-15}$			F53
$NO_3 + OClO \xrightarrow{M} O_2ClONO_2$	(See Table 2-1)					
$NO_3 + HCl \rightarrow HNO_3 + Cl$			$<5.0\times10^{-17}$			F54
$HO_2NO_2 + HCl \rightarrow$ products			$<1.0\times10^{-21}$			F55
$Cl + O_2 \xrightarrow{M} ClOO$	(See Table 2-1)					
$Cl + O_3 \rightarrow ClO + O_2$	2.3×10^{-11}	200	1.2×10^{-11}	1.15	50	F56
$Cl + H_2 \rightarrow HCl + H$	3.05×10^{-11}	2270	1.5×10^{-14}	1.1	100	F57
$Cl + H_2O_2 \rightarrow HCl + HO_2$	1.1×10^{-11}	980	4.1×10^{-13}	1.3	300	F58
$Cl + NO \xrightarrow{M} NOCl$	(See Table 2-1)					
$Cl + NO_2 \xrightarrow{M} ClONO\ (ClNO_2)$	(See Table 2-1)					
$Cl + NO_3 \rightarrow ClO + NO_2$	2.4×10^{-11}	0	2.4×10^{-11}	1.5	400	F59
$Cl + N_2O \rightarrow ClO + N_2$	(See Note)					F60
$Cl + HNO_3 \rightarrow$ products			$<2.0\times10^{-16}$			F61
$Cl + HO_2NO_2 \rightarrow$ products			$<1\times10^{-13}$			F62

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$Cl + CO \xrightarrow{M} ClCO$	(See Table 2-1)					
$Cl + CH_4 \rightarrow HCl + CH_3$	$7.3x10^{-12}$	1280	$1.0x10^{-13}$	1.05	50	F63
$Cl + CH_3D \rightarrow$ products	$7.0x10^{-12}$	1380	$6.8x10^{-14}$	1.07	50	F64
$Cl + H_2CO \rightarrow HCl + HCO$	8.1×10^{-11}	30	7.3×10^{-11}	1.15	100	F65
$Cl + HC(O)OH \rightarrow$ products			2.0×10^{-13}	1.5		F66
$Cl + CH_3O_2 \rightarrow$ products			1.6×10^{-10}	1.5		F67
$Cl + CH_3OH \rightarrow CH_2OH + HCl$	5.5×10^{-11}	0	5.5×10^{-11}	1.2	100	F68
$Cl + CH_3OOH \rightarrow$ products			5.7×10^{-11}	2.0		F69
$Cl + CH_3ONO_2 \rightarrow$ products	*1.3×10^{-11}*	*1200*	2.3×10^{-13}	1.5	*300*	F70
$Cl + C_2H_2 \xrightarrow{M} ClC_2H_2$	(See Table 2-1)					
$Cl + C_2H_4 \xrightarrow{M} ClC_2H_4$	(See Table 2-1)					
$Cl + C_2H_6 \rightarrow HCl + C_2H_5$	$7.2x10^{-11}$	70	$5.7x10^{-11}$	1.07	20	F71
$Cl + C_2H_5O_2 \rightarrow ClO + C_2H_5O$			7.4×10^{-11}	2.0		F72
$\rightarrow HCl + C_2H_4O_2$			7.7×10^{-11}	2.0		
$Cl + CH_3CH_2OH \rightarrow$ products	9.6×10^{-11}	0	9.6×10^{-11}	1.2	100	F73
$Cl + CH_3C(O)OH \rightarrow$ products			2.8×10^{-14}	2.0		F74
$Cl + CH_3CN \rightarrow$ products	1.6×10^{-11}	2140	1.2×10^{-14}	2.0	300	F75
$Cl + C_2H_5ONO_2 \rightarrow$ products	*1.5×10^{-11}*	*400*	3.9×10^{-12}	1.5	*200*	F76
$Cl + CH_3CO_3NO_2 \rightarrow$ products			$<1\times10^{-14}$			F77
$Cl + C_3H_8 \rightarrow HCl + CH_3CHCH_3$	6.54×10^{-11}		8.0×10^{-11}	1.1	20	F78
$\rightarrow HCl + CH_2CH_2CH_3$	7.85×10^{-11}	80	6.0×10^{-11}	1.05	20	
$Cl + CH_3C(O)CH_3 \rightarrow CH_3C(O)CH_2 + HCl$	7.7×10^{-11}	1000	2.7×10^{-12}	1.3	500	F79
$Cl + CH_2=C(CH_3)CH=CH_2 \rightarrow$ products	7.7×10^{-11}	−500	4.1×10^{-10}	1.15	100	F80
$Cl + C_2H_5CO_3NO_2 \rightarrow$ products			1.1×10^{-12}	2.0		F81
$Cl + 1\text{-}C_3H_7ONO_2 \rightarrow$ products			2.3×10^{-11}	1.5		F82

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$Cl + 2\text{-}C_3H_7ONO_2 \rightarrow$ products			4.0×10^{-12}	2.0		F83
$Cl + OClO \rightarrow ClO + ClO$	3.4×10^{-11}	–160	5.8×10^{-11}	1.25	200	F84
$Cl + ClOO \rightarrow Cl_2 + O_2$	2.3×10^{-10}	0	2.3×10^{-10}	2.0	200	F85
$\rightarrow ClO + ClO$	1.2×10^{-11}	0	1.2×10^{-11}	2.0	200	
$Cl + Cl_2O \rightarrow Cl_2 + ClO$	6.2×10^{-11}	–130	9.6×10^{-11}	1.2	130	F86
$Cl + Cl_2O_2 \rightarrow$ products	$7.6x10^{-11}$	$9.4x10^{-11}$	1.0×10^{-10}	1.2	100	F87
$Cl + HOCl \rightarrow$ products	3.4×10^{-12}	130	2.2×10^{-12}	1.3	200	F88
$Cl + ClNO \rightarrow NO + Cl_2$	5.8×10^{-11}	–100	8.1×10^{-11}	1.5	200	F89
$Cl + ClONO_2 \rightarrow$ products	6.5×10^{-12}	–135	1.0×10^{-11}	1.1	50	F90
$Cl + CH_3Cl \rightarrow CH_2Cl + HCl$	$2.17x10^{-11}$	1130	$4.9x10^{-13}$	1.07	50	F91
$Cl + CH_2Cl_2 \rightarrow HCl + CHCl_2$	$7.4x10^{-12}$	910	$3.5x10^{-13}$	1.07	100	F92
$Cl + CHCl_3 \rightarrow HCl + CCl_3$	3.310^{-12}	990	$1.2x10^{-13}$	1.15	100	F93
$Cl + CH_3F \rightarrow HCl + CH_2F$ (HFC-41)	$1.96x10^{-11}$	1200	$3.5x10^{-13}$	1.15	150	F94
$Cl + CH_2F_2 \rightarrow HCl + CHF_2$ (HFC-32)	*$4.9x10^{-12}$*	*1500*	$3.2x10^{-14}$	1.5	200	F95
$Cl + CHF_3 \rightarrow HCl + CF_3$ (HFC-23)			$<5.0x10^{-16}$			F96
$Cl + CH_2FCl \rightarrow HCl + CHFCl$ (HCFC-31)	*$5.9x10^{-12}$*	*1200*	$1.05x10^{-13}$	1.1	200	F97
$Cl + CHFCl_2 \rightarrow HCl + CFCl_2$ (HCFC-21)	$6.0x10^{-12}$	1700	$2.0x10^{-14}$	1.2	200	F98
$Cl + CHF_2Cl \rightarrow HCl + CF_2Cl$ (HCFC-22)	$5.6x10^{-12}$	2430	$1.6x10^{-15}$	1.15	200	F99
$Cl + CH_3CCl_3 \rightarrow CH_2CCl_3 + HCl$	$3.23x10^{-12}$	1770	$8.5x10^{-15}$	1.2	200	F100
$Cl + CH_3CH_2F \rightarrow HCl + CH_3CHF$ (HFC-161)	$1.82x10^{-11}$	330	$6.0x10^{-12}$	1.1	100	F101
$\rightarrow HCl + CH_2CH_2F$	$1.4x10^{-11}$	940	$6.0x10^{-13}$	1.15	100	
$Cl + CH_3CHF_2 \rightarrow HCl + CH_3CF_2$ (HFC-152a)	$5.8x10^{-12}$	950	$2.4x10^{-13}$	1.1	100	F102
$\rightarrow HCl + CH_2CHF_2$	$6.25x10^{-12}$	2320	$2.6x10^{-15}$	1.15	200	
$Cl + CH_2FCH_2F \rightarrow HCl + CHFCH_2F$ (HFC-152)	$2.27x10^{-11}$	1050	$6.7x10^{-13}$	1.15	200	F103
$Cl + CH_3CFCl_2 \rightarrow HCl + CH_2CFCl_2$ (HCFC-141b)	$3.4x10^{-12}$	2200	$2.1x10^{-15}$	1.15	200	F104

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$Cl + CH_3CF_2Cl \rightarrow HCl + CH_2CF_2Cl$ (HCFC-142b)	$1.35x10^{-12}$	2400	$4.3x10^{-16}$	1.15	200	F105
$Cl + CH_3CF_3 \rightarrow HCl + CH_2CF_3$ (HFC-143a)	$1.44x10^{-11}$	3940	$2.6x10^{-17}$	3.0	300	F106
$Cl + CH_2FCHF_2 \rightarrow HCl + CH_2FCF_2$ (HFC-143)	$6.8x10^{-12}$	1670	$2.5x10^{-14}$	1.3	200	F107
$\rightarrow HCl + CHFCHF_2$	$9.1x10^{-12}$	1770	$2.4x10^{-14}$	1.3	200	
$Cl + CH_2ClCF_3 \rightarrow HCl + CHClCF_3$ (HCFC-133a)	$1.83x10^{-12}$	1680	$6.5x10^{-15}$	1.2	200	F108
$Cl + CH_2FCF_3 \rightarrow HCl + CHFCF_3$ (HFC-134a)	$2.4x10^{-12}$	2200	$1.5x10^{-15}$	1.1	200	F109
$Cl + CHF_2CHF_2 \rightarrow HCl + CF_2CHF_2$ (HCF-134)	$7.0x10^{-12}$	2430	$2.0x10^{-15}$	1.2	200	F110
$Cl + CHCl_2CF_3 \rightarrow HCl + CCl_2CF_3$ (HCFC-123)	$5.0x10^{-12}$	1800	$1.2x10^{-14}$	1.15	200	F111
$Cl + CHFClCF_3 \rightarrow HCl + CFClCF_3$ (HCFC-124)	$1.13x10^{-12}$	1800	$2.7x10^{-15}$	1.2	200	F112
$Cl + CHF_2CF_3 \rightarrow HCl + CF_2CF_3$ (HFC-125)	*$1.8x10^{-12}$*	*2600*	$3.0x10^{-16}$	1.5	300	F113
$Cl + C_2Cl_4 \xrightarrow{M} C_2Cl_5$	(See Table 2-1)					
$ClO + O_3 \rightarrow ClOO + O_2$			$<1.4x10^{-17}$			F114
$\rightarrow OClO + O_2$	*$1.0x10^{-12}$*	*>4000*	$<1.0x10^{-18}$			
$ClO + H_2 \rightarrow$ products	*~$1.0x10^{-12}$*	*>4800*	$<1.0x10^{-19}$			F115
$ClO + NO \rightarrow NO_2 + Cl$	$6.4x10^{-12}$	–290	$1.7x10^{-11}$	1.15	100	F116
$ClO + NO_2 \xrightarrow{M} ClONO_2$	(See Table 2-1)					
$ClO + NO_3 \rightarrow ClOO + NO_2$	$4.7x10^{-13}$	0	$4.7x10^{-13}$	1.5	400	F117
$ClO + N_2O \rightarrow$ products	$\sim1.0x10^{-12}$	>4300	$<6.0x10^{-19}$			F118
$ClO + CO \rightarrow$ products	$\sim1.0x10^{-12}$	>3700	$<4.0x10^{-18}$			F119
$ClO + CH_4 \rightarrow$ products	$\sim1.0x10^{-12}$	>3700	$<4.0x10^{-18}$			F120
$ClO + H_2CO \rightarrow$ products	$\sim1.0x10^{-12}$	>2100	$<1.0x10^{-15}$			F121
$ClO + CH_3O_2 \rightarrow$ products	$3.3x10^{-12}$	115	$2.2x10^{-12}$	1.5	115	F122
$ClO + ClO \rightarrow Cl_2 + O_2$	$1.0x10^{-12}$	1590	$4.8x10^{-15}$	1.5	300	F123
$\rightarrow ClOO + Cl$	$3.0x10^{-11}$	2450	$8.0x10^{-15}$	1.5	500	
$\rightarrow OClO + Cl$	$3.5x10^{-13}$	1370	$3.5x10^{-15}$	1.5	300	

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$ClO + ClO \xrightarrow{M} Cl_2O_2$	(See Table 2-1)					
$ClO + OClO \xrightarrow{M} Cl_2O_3$	(See Table 2-1)					
$HCl + ClONO_2 \rightarrow$ products			$<1.0\times10^{-20}$			F124
$CH_2Cl + O_2 \xrightarrow{M} CH_2ClO_2$	(See Table 2-1)					
$CHCl_2 + O_2 \xrightarrow{M} CHCl_2O_2$	(See Table 2-1)					
$CCl_3 + O_2 \xrightarrow{M} CCl_3O_2$	(See Table 2-1)					
$CFCl_2 + O_2 \xrightarrow{M} CFCl_2O_2$	(See Table 2-1)					
$CF_2Cl + O_2 \xrightarrow{M} CF_2ClO_2$	(See Table 2-1)					
$CCl_3O_2 + NO_2 \xrightarrow{M} CCl_3O_2NO_2$	(See Table 2-1)					
$CFCl_2O_2 + NO_2 \xrightarrow{M} CFCl_2O_2NO_2$	(See Table 2-1)					
$CF_2ClO_2 + NO_2 \xrightarrow{M} CF_2ClO_2NO_2$	(See Table 2-1)					
$CH_2ClO + O_2 \rightarrow CHClO + HO_2$			6×10^{-14}	5		F125
$CH_2ClO_2 + HO_2 \rightarrow CH_2ClO_2H + O_2$	3.3×10^{-13}	–820	5.2×10^{-12}	1.5	200	F126
$CH_2ClO_2 + NO \rightarrow CH_2ClO + NO_2$	7×10^{-12}	–300	1.9×10^{-11}	1.5	200	F127
$CCl_3O_2 + NO \rightarrow CCl_2O + NO_2 + Cl$	7.3×10^{-12}	–270	1.8×10^{-11}	1.3	200	F128
$CCl_2FO_2 + NO \rightarrow CClFO + NO_2 + Cl$	4.5×10^{-12}	–350	1.5×10^{-11}	1.3	200	F129
$CClF_2O_2 + NO \rightarrow CF_2O + NO_2 + Cl$	3.8×10^{-12}	–400	1.5×10^{-11}	1.2	200	F130
BrO_x Reactions						
$O + BrO \rightarrow Br + O_2$	1.9×10^{-11}	–230	4.1×10^{-11}	1.5	150	G 1
$O + HBr \rightarrow OH + Br$	5.8×10^{-12}	1500	3.8×10^{-14}	1.3	200	G 2
$O + HOBr \rightarrow OH + BrO$	1.2×10^{-10}	430	2.8×10^{-11}	3.0	300	G 3
$O + BrONO_2 \rightarrow NO_3 + BrO$	$1.9x10^{-11}$	-215	$3.9x10^{-11}$	1.25	40	G 4
$OH + Br_2 \rightarrow HOBr + Br$	2.1×10^{-11}	-240	4.6×10^{-11}	1.1	50	G 5
$OH + BrO \rightarrow$ products	$1.7x10^{-11}$	-250	3.9×10^{-11}	1.4	100	G 6
$OH + HBr \rightarrow H_2O + Br$	$5.5x10^{-12}$	-200	1.1×10^{-11}	1.1	100	G 7

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$OH + CH_3Br \rightarrow CH_2Br + H_2O$	2.35×10^{-12}	1300	3.0×10^{-14}	1.1	100	G 8
$OH + CH_2Br_2 \rightarrow CHBr_2 + H_2O$	2.0×10^{-12}	840	1.2×10^{-13}	1.15	150	G 9
$OH + CHBr_3 \rightarrow CBr_3 + H_2O$	1.35×10^{-12}	600	1.8×10^{-13}	1.5	100	G10
$OH + CHF_2Br \rightarrow CF_2Br + H_2O$	1.0×10^{-12}	1380	1.0×10^{-14}	1.1	100	G11
$OH + CH_2ClBr \rightarrow CHClBr + H_2O$	2.4×10^{-12}	920	1.1×10^{-13}	1.1	100	G12
$OH + CF_2Br_2 \rightarrow$ products (Halon-1202)	*~1×10⁻¹²*	*>2200*	<5.0×10^{-16}			G13
$OH + CF_3Br \rightarrow$ products (Halon-1301)	*~1×10⁻¹²*	*>3600*	*<6.0×10⁻¹⁸*			G14
$OH + CF_2ClBr \rightarrow$ products (Halon-1211)	*~1×10⁻¹²*	*>2600*	<1.5×10^{-16}			G15
$OH + CH_2BrCH_3 \rightarrow$ products	2.9×10^{-12}	640	3.4×10^{-13}	1.2	150	G16
$OH + CH_2BrCF_3 \rightarrow CHBrCF_3 + H_2O$	1.4×10^{-12}	1340	1.6×10^{-14}	1.2	150	G17
$OH + CHFBrCF_3 \rightarrow CFBrCF_3 + H_2O$	7.3×10^{-13}	1120	1.7×10^{-14}	1.2	100	G18
$OH + CHClBrCF_3 \rightarrow CClBrCF_3 + H_2O$	1.1×10^{-12}	940	4.7×10^{-14}	1.2	150	G19
$OH + CHFClCF_2Br \rightarrow CFClCF_2Br + H_2O$	8.4×10^{-13}	1220	1.4×10^{-14}	1.3	200	G20
$OH + CF_2BrCF_2Br \rightarrow$ products (Halon-2402)	*~1×10⁻¹²*	*>3600*	*<6×10⁻¹⁸*			G21
$OH + CH_2BrCH_2CH_3 \rightarrow$ products	3.0×10^{-12}	330	1.0×10^{-12}	1.05	50	G22
$OH + CH_3CHBrCH_3 \rightarrow$ products	1.85×10^{-12}	270	7.5×10^{-13}	1.05	50	G23
$HO_2 + Br \rightarrow HBr + O_2$	4.8×10^{-12}	310	1.7×10^{-12}	1.3	150	G24
$HO_2 + BrO \rightarrow$ products	4.5×10^{-12}	–460	2.1×10^{-11}	1.15	100	G25
$NO_3 + HBr \rightarrow HNO_3 + Br$			<1.0×10^{-16}			G26
$Cl + CH_3Br \rightarrow HCl + CH_2Br$	1.4×10^{-11}	1030	4.4×10^{-13}	1.05	50	G27
$Cl + CH_2Br_2 \rightarrow HCl + CHBr_2$	6.3×10^{-12}	800	4.3×10^{-13}	1.1	50	G28
$Cl + CHBr_3 \rightarrow CBr_3 + HCl$	4.85×10^{-12}	850	2.8×10^{-13}	1.3	200	G29
$Cl + CH_2ClBr \rightarrow HCl + CHClBr$	*6.8x10⁻¹²*	*870*	3.7×10^{-13}	1.2	100	G30
$Br + O_3 \rightarrow BrO + O_2$	1.6×10^{-11}	780	1.2×10^{-12}	1.15	100	G31
$Br + H_2O_2 \rightarrow HBr + HO_2$	1.0×10^{-11}	>3000	<5.0×10^{-16}			G32

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$Br + NO_2 \xrightarrow{M} BrNO_2$	(See Table 2-1)					
$Br + NO_3 \rightarrow BrO + NO_2$			1.6×10^{-11}	2.0		G33
$Br + H_2CO \rightarrow HBr + HCO$	1.7×10^{-11}	800	1.1×10^{-12}	1.2	125	G34
$Br + CH_2=C(CH_3)CH=CH_2 \overset{M}{\leftrightarrow} X \overset{O_2}{\rightarrow}$ products	(see note)					G35
$Br + OClO \rightarrow BrO + ClO$	2.6×10^{-11}	1300	3.4×10^{-13}	2.0	300	G36
$Br + Cl_2O \rightarrow BrCl + ClO$	2.1×10^{-11}	470	4.3×10^{-12}	1.3	150	G37
$Br + Cl_2O_2 \rightarrow$ products	5.9×10^{-12}	170	3.3×10^{-12}	1.3	200	G38
$BrO + O_3 \rightarrow$ products	~1.0×10^{-12}	>3200	<2.0×10^{-17}			G39
$BrO + NO \rightarrow NO_2 + Br$	8.8×10^{-12}	–260	2.1×10^{-11}	1.15	130	G40
$BrO + NO_2 \xrightarrow{M} BrONO_2$	(See Table 2-1)					
$BrO + NO_3 \rightarrow$ products			1.0×10^{-12}	3.0		G41
$BrO + ClO \rightarrow Br + OClO$	9.5×10^{-13}	–550	6.0×10^{-12}	1.2	100	G42
$\rightarrow Br + ClOO$	2.3×10^{-12}	–260	5.5×10^{-12}	1.2	100	
$\rightarrow BrCl + O_2$	4.1×10^{-13}	–290	1.1×10^{-12}	1.2	100	
$BrO + BrO \rightarrow$ products	1.5×10^{-12}	–230	3.2×10^{-12}	1.15	150	G43
$OBrO + O_3 \rightarrow$ Products			< 1.5×10^{-15}			G44
OBrO + NO → Products	2.4×10^{-13}	-610	1.8×10^{-12}	3	200	G45
$CH_2BrO_2 + NO \rightarrow CH_2O + NO_2 + Br$	4×10^{-12}	–300	1.1×10^{-11}	1.5	200	G46
IO_x Reactions						
$O + I_2 \rightarrow IO + I$	1.4×10^{-10}	0	1.4×10^{-10}	1.4	250	H 1
$O + IO \rightarrow O_2 + I$			1.2×10^{-10}	2.0		H 2
$OH + I_2 \rightarrow HOI + I$			1.8×10^{-10}	2.0		H 3
$OH + HI \rightarrow H_2O + I$			3.0×10^{-11}	2.0		H 4
$OH + CH_3I \rightarrow H_2O + CH_2I$	2.9×10^{-12}	1100	7.2×10^{-14}	1.5	300	H 5
$OH + CF_3I \rightarrow HOI + CF_3$	2.5×10^{-11}	2070	2.4×10^{-14}	1.3	200	H 6

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$HO_2 + I \rightarrow HI + O_2$	1.5×10^{-11}	1090	3.8×10^{-13}	2.0	500	H 7
$HO_2 + IO \rightarrow HOI + O_2$			8.4×10^{-11}	1.5		H 8
$NO_3 + HI \rightarrow HNO_3 + I$	(See Note)					H 9
$Cl + CH_3I \rightarrow CH_2I + HCl$	2.9×10^{-11}	1000	1.0×10^{-12}	1.5	250	H10
$I + O_3 \rightarrow IO + O_2$	2.3×10^{-11}	870	1.2×10^{-12}	1.2	200	H11
$I + NO \xrightarrow{M} INO$	(See Table 2-1)					
$I + NO_2 \xrightarrow{M} INO_2$	(See Table 2-1)					
$I + BrO \rightarrow IO + Br$			1.2×10^{-11}	2.0		H12
$IO + NO \rightarrow I + NO_2$	9.1×10^{-12}	–240	2.0×10^{-11}	1.2	150	H13
$IO + NO_2 \xrightarrow{M} IONO_2$	(See Table 2-1)					
$IO + ClO \rightarrow$ products	5.1×10^{-12}	–280	1.3×10^{-11}	2.0	200	H14
$IO + BrO \rightarrow$ products			6.9×10^{-11}	1.5		H15
$IO + IO \rightarrow$ products	1.5×10^{-11}	–500	8.0×10^{-11}	1.5	500	H16
$INO + INO \rightarrow I_2 + 2NO$	8.4×10^{-11}	2620	1.3×10^{-14}	2.5	600	H17
$INO_2 + INO_2 \rightarrow I_2 + 2NO_2$	2.9×10^{-11}	2600	4.7×10^{-15}	3.0	1000	H18
SO_x Reactions						
$O + SH \rightarrow SO + H$			1.6×10^{-10}	5.0		I 1
$O + CS \rightarrow CO + S$	2.7×10^{-10}	760	2.1×10^{-11}	1.1	250	I 2
$O + H_2S \rightarrow OH + SH$	9.2×10^{-12}	1800	2.2×10^{-14}	1.7	550	I 3
$O + OCS \rightarrow CO + SO$	2.1×10^{-11}	2200	1.3×10^{-14}	1.15	150	I 4
$O + CS_2 \rightarrow CS + SO$	3.2×10^{-11}	650	3.6×10^{-12}	1.2	150	I 5
$O + SO_2 \xrightarrow{M} SO_3$	(See Table 2-1)					
$O + CH_3SCH_3 \rightarrow CH_3SO + CH_3$	1.3×10^{-11}	–410	5.0×10^{-11}	1.1	100	I 6
$O + CH_3SSCH_3 \rightarrow CH_3SO + CH_3S$	3.9×10^{-11}	–290	1.03×10^{-10}	1.1	100	I 7
$O + CH_3S(O)CH_3 \rightarrow$ products	2.0×10^{-12}	–440	8.8×10^{-12}	1.2	200	I 8

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$O_3 + H_2S \rightarrow$ products			$<2.0\times10^{-20}$			I 9
$O_3 + CH_3SCH_3 \rightarrow$ products			$<1.5\times10^{-19}$			I10
$O_3 + SO_2 \rightarrow SO_3 + O_2$	3.0×10^{-12}	>7000	$<2.0\times10^{-22}$			I11
$O_3 + SO_2F_2 \rightarrow$ products			$<1.0\times10^{-23}$			I12
$OH + H_2S \rightarrow SH + H_2O$	6.1×10^{-12}	75	4.7×10^{-12}	1.1	75	I13
$OH + OCS \rightarrow$ products	1.1×10^{-13}	1200	1.9×10^{-15}	2.0	500	I14
$OH + CS_2 \rightarrow SH + OCS$			$<2.0\times10^{-15}$			I15
$OH + CS_2 \rightarrow CS_2OH \xrightarrow{O_2}$ products	(See Note)	(See Note)	1.2×10^{-12} at P_{air} = 1 atm	1.25		I16
$CS_2OH + O_2 \rightarrow$ products	2.8×10^{-14}	0	2.8×10^{-14}	1.2	100	I17
$OH + CH_3SH \rightarrow CH_3S + H_2O$	9.9×10^{-12}	–360	3.3×10^{-11}	1.07	75	I18
$OH + CH_3SCH_3 \rightarrow H_2O + CH_2SCH_3$	1.2×10^{-11}	280	4.7×10^{-12}	1.1	100	I19
$OH + CH_3SCH_3 \overset{M}{\leftrightarrow} (CH_3)_2SOH \xrightarrow{O_2}$ products	(See Note)	(See Note)	2.0×10^{-12} at P_{air} = 1 atm	1.2		I20
$(CH_3)_2SOH + O_2 \rightarrow$ products	8.5×10^{-13}	0	8.5×10^{-13}	1.25	0	I21
$OH + CH_3SCH_2Cl \rightarrow$ products			2.5×10^{-12}	2.0		I22
$OH + CH_3SSCH_3 \rightarrow$ products	6.0×10^{-11}	–400	2.3×10^{-10}	1.2	200	I23
$OH + CH_3S(O)CH_3 \rightarrow$ products	6.1×10^{-12}	–800	8.9×10^{-11}	1.2	500	I24
$OH + CH_3S(O)OH \rightarrow$ products			9.0×10^{-11}	1.4		I25
$OH + S \rightarrow H + SO$			6.6×10^{-11}	3.0		I26
$OH + SO \rightarrow H + SO_2$	2.7×10^{-11}	–335	8.3×10^{-11}	1.2	150	I27
$OH + SO_2 \xrightarrow{M} HOSO_2$	(See Table 2-1)					
$OH + SO_2F_2 \rightarrow$ products			$<1.0\times10^{-16}$			I28
$HO_2 + H_2S \rightarrow$ products			$<3.0\times10^{-15}$			I29
$HO_2 + CH_3SH \rightarrow$ products			$<4.0\times10^{-15}$			I29
$HO_2 + CH_3SCH_3 \rightarrow$ products			$<5.0\times10^{-15}$			I29

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$HO_2 + SO_2 \rightarrow$ products			$<1.0\times10^{-18}$			I30
$NO_2 + SO_2 \rightarrow$ products			$<2.0\times10^{-26}$			I31
$NO_3 + H_2S \rightarrow$ products			$<8.0\times10^{-16}$			I32
$NO_3 + OCS \rightarrow$ products			$<1.0\times10^{-16}$			I33
$NO_3 + CS_2 \rightarrow$ products			$<4.0\times10^{-16}$			I34
$NO_3 + CH_3SH \rightarrow$ products	4.4×10^{-13}	–210	8.9×10^{-13}	1.25	210	I35
$NO_3 + CH_3SCH_3 \rightarrow CH_3SCH_2 + HNO_3$	1.9×10^{-13}	–530	1.1×10^{-12}	1.1	150	I36
$NO_3 + CH_3SSCH_3 \rightarrow$ products	1.3×10^{-12}	270	5.3×10^{-13}	1.4	270	I37
$NO_3 + CH_3S(O)CH_3 \rightarrow$ products			2.9×10^{-13}	1.6		I38
$NO_3 + SO_2 \rightarrow$ products			$<7.0\times10^{-21}$			I39
$N_2O_5 + CH_3SCH_3 \rightarrow$ products			$<1.0\times10^{-17}$			I40
$CH_3O_2 + SO_2 \rightarrow$ products			$<5.0\times10^{-17}$			I41
$F + CH_3SCH_3 \rightarrow$ products			$2.4.\times10^{-10}$	2.0		I42
$Cl + H_2S \rightarrow HCl + SH$	3.7×10^{-11}	–210	7.4×10^{-11}	1.2	100	I43
$Cl + SO_2F_2 \rightarrow$ products			$<1.5\times10^{-18}$			I44
$Cl + OCS \rightarrow$ products			$<1.0\times10^{-16}$			I45
$Cl + CS_2 \rightarrow$ products	(See Table 2-1)					
$CS_2Cl + O_2 \rightarrow$ products			$<2.5\times10^{-16}$			I46
$Cl + CH_3SH \rightarrow CH_3S + HCl$	1.2×10^{-10}	–150	2.0×10^{-10}	1.1	100	I47
$Cl + CH_3SCH_3 \rightarrow CH_3SCH_2 + HCl$	9.4×10^{-11}	−190	1.8×10^{-10}	+1.2/ −2.5	0	I48
$Cl + CH_3SCH_3 \rightarrow$ products (P = 1 atm)	3.5×10^{-10}	0	3.5×10^{-10}	1.2	0	
$(CH_3)_2SCl + O_2 \rightarrow$ products			$<4.0\times10^{-18}$			I49
$(CH_3)_2SCl + NO \rightarrow$ products			1.2×10^{-11}	1.25		I49
$(CH_3)_2SCl + NO_2 \rightarrow$ products			2.7×10^{-11}	1.25		I49
$Cl + CH_3S(O)CH_3 \rightarrow CH_3S(O)CH_2 + HCl$	1.4×10^{-11}	0	1.4×10^{-11}	1.2	150	I50

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$Cl + CH_3S(O)CH_3 \xrightarrow{M} CH_3(Cl)S(O)CH_3$	(See Note)					I50
$CH_3(Cl)S(O)CH_3 + O_2 \rightarrow$ products			$<3.0\times10^{-18}$			I51
$CH_3(Cl)S(O)CH_3 + NO \rightarrow$ products			1.2×10^{-11}	1.5		I51
$CH_3(Cl)S(O)CH_3 + NO_2 \rightarrow$ products			2.1×10^{-11}	1.5		I51
$Cl_2 + CH_3SCH_3 \rightarrow$ products			$<5.0\times10^{-14}$			I52
$ClO + OCS \rightarrow$ products			$<2.0\times10^{-16}$			I53
$ClO + CH_3SCH_3 \rightarrow$ products	2.1×10^{-15}	–340	6.6×10^{-15}	1.5	300	I54
$ClO + CH_3S(O)CH_3 \rightarrow$ products			$<2.0\times10^{-14}$			I55
$ClO + SO \rightarrow Cl + SO_2$	2.8×10^{-11}	0	2.8×10^{-11}	1.3	50	I56
$ClO + SO_2 \rightarrow Cl + SO_3$			$<4.0\times10^{-18}$			I53
$Br + H_2S \rightarrow HBr + SH$	1.4×10^{-11}	2750	1.4×10^{-15}	2.0	300	I57
$Br + CH_3SH \rightarrow CH_3S + HBr$	9.2×10^{-12}	390	2.5×10^{-12}	2.0	100	I57
$Br + CH_3SCH_3 \rightarrow CH_3SCH_2 + HBr$	9.0×10^{-11}	2390	3.0×10^{-14}	1.4	150	I58
$Br + CH_3SCH_3 \xrightarrow{M} (CH_3)_2SBr$	(See Table 2-1)					
$Br + CH_3S(O)CH_3 \rightarrow$ products			1.2×10^{-14}	1.5		I59
$BrO + CH_3SH \rightarrow$ products	(see note)					I60
$BrO + CH_3SCH_3 \rightarrow$ products	1.4×10^{-14}	–950	3.4×10^{-13}	1.25	200	I61
$BrO + CH_3SSCH_3 \rightarrow$ products			1.5×10^{-14}	2.0		I62
$BrO + CH_3S(O)CH_3 \rightarrow$ products			1.0×10^{-14}	2.0		I63
$BrO + SO \rightarrow Br + SO_2$			5.7×10^{-11}	1.4		I64
$IO + CH_3SH \rightarrow$ products			6.6×10^{-16}	2.0		I65
$IO + CH_3SCH_3 \rightarrow$ products	2.4×10^{-12}	1470	1.7×10^{-14}	1.5	400	I66
$S + O_2 \rightarrow SO + O$	2.3×10^{-12}	0	2.3×10^{-12}	1.2	200	I67
$S + O_3 \rightarrow SO + O_2$			1.2×10^{-11}	2.0		I68
$SO + O_2 \rightarrow SO_2 + O$	1.25×10^{-13}	2190	8.0×10^{-17}	1.3	350	I69

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$SO + O_3 \rightarrow SO_2 + O_2$	3.4×10^{-12}	1100	8.4×10^{-14}	1.1	150	I70
$SO + NO_2 \rightarrow SO_2 + NO$	1.4×10^{-11}	0	1.4×10^{-11}	1.2	50	I71
$SO + OClO \rightarrow SO_2 + ClO$			1.9×10^{-12}	3.0		I72
$SO_3 + 2\ H_2O \rightarrow$ products	(See Note)	(See Note)	(See Note)	1.2	200	I73
$SO_3 + NH_3 \rightarrow$ products	(See Table 2-1)					
$SO_3 + NO_2 \rightarrow$ products			1.0×10^{-19}	10.0		I74
$SH + O_2 \rightarrow OH + SO$			$<4.0\times10^{-19}$			I75
$SH + O_3 \rightarrow HSO + O_2$	9.0×10^{-12}	280	3.5×10^{-12}	1.2	200	I76
$SH + H_2O_2 \rightarrow$ products			$<5.0\times10^{-15}$			I77
$SH + NO \xrightarrow{M} HSNO$	(See Table 2-1)					
$SH + NO_2 \rightarrow HSO + NO$	3.0×10^{-11}	–250	7.0×10^{-11}	1.1	50	I78
$SH + N_2O \rightarrow HSO + N_2$			$<5.0\times10^{-16}$			I79
$SH + Cl_2 \rightarrow ClSH + Cl$	1.4×10^{-11}	690	1.4×10^{-12}	1.15	200	I80
$SH + BrCl \rightarrow$ products	2.3×10^{-11}	–350	7.4×10^{-11}	2.0	200	I81
$SH + Br_2 \rightarrow BrSH + Br$	6.0×10^{-11}	–160	1.0×10^{-10}	2.0	160	I81
$SH + F_2 \rightarrow FSH + F$	4.3×10^{-11}	1390	4.0×10^{-13}	2.0	200	I81
$HSO + O_2 \rightarrow$ products			$<2.0\times10^{-17}$			I82
$HSO + O_3 \rightarrow$ products			1.0×10^{-13}	1.3		I83
$HSO + NO \rightarrow$ products			$<1.0\times10^{-15}$			I84
$HSO + NO_2 \rightarrow HSO_2 + NO$			9.6×10^{-12}	2.0		I84
$HSO_2 + O_2 \rightarrow HO_2 + SO_2$			3.0×10^{-13}	3.0		I85
$HOSO_2 + O_2 \rightarrow HO_2 + SO_3$	1.3×10^{-12}	330	4.3×10^{-13}	1.15	200	I86
$CS + O_2 \rightarrow OCS + O$			2.9×10^{-19}	2.0		I87
$CS + O_3 \rightarrow OCS + O_2$			3.0×10^{-16}	3.0		I88
$CS + NO_2 \rightarrow OCS + NO$			7.6×10^{-17}	3.0		I88

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$CH_3S + O_2 \rightarrow$ products			$<3.0\times10^{-18}$			I89
$CH_3S + O_3 \rightarrow$ products	1.5×10^{-12}	–360	5.0×10^{-12}	1.15	100	I90
$CH_3S + NO \rightarrow$ products			$<1.0\times10^{-13}$			I91
$CH_3S + NO \xrightarrow{M}$ products	(See Table 2-1)					
$CH_3S + NO_2 \rightarrow CH_3SO + NO$	3.0×10^{-11}	–240	6.7×10^{-11}	1.2	150	I92
$CH_2SH + O_2 \rightarrow$ products			6.5×10^{-12}	2.0		I93
$CH_2SH + O_3 \rightarrow$ products			3.5×10^{-11}	2.0		I94
$CH_2SH + NO \rightarrow$ products			1.9×10^{-11}	2.0		I95
$CH_2SH + NO_2 \rightarrow$ products			5.2×10^{-11}	2.0		I96
$CH_3SO + O_3 \rightarrow$ products			4.0×10^{-13}	1.5		I97
$CH_3SO + NO_2 \rightarrow CH_3SO_2 + NO$			1.2×10^{-11}	1.2		I98
$CH_3SOO + O_3 \rightarrow$ products			$<8.0\times10^{-13}$			I99
$CH_3SOO + NO \rightarrow$ products	1.1×10^{-11}	0	1.1×10^{-11}	2.0	100	I99
$CH_3SO_2 + NO_2 \rightarrow$ products	2.2×10^{-11}	0	2.2×10^{-11}	2.0	100	I100
$CH_3SCH_2 + O_2 \xrightarrow{M} CH_3SCH_2O_2$	(See Table 2-1)					
$CH_3SCH_2 + NO_3 \rightarrow$ products			3.0×10^{-10}	2.0		I101
$CH_3SCH_2O_2 + NO \rightarrow CH_3S + CH_2O + NO_2$	4.9×10^{-12}	–260	1.2×10^{-11}	1.3	200	I102
$CH_3SCH_2O_2 + CH_3SCH_2O_2 \rightarrow$ products			1.0×10^{-11}	1.25		I103
$CH_3SS + O_3 \rightarrow$ products			4.6×10^{-13}	2.0		I104
$CH_3SS + NO_2 \rightarrow$ products			1.8×10^{-11}	2.0		I105
$CH_3SSO + NO_2 \rightarrow$ products			4.5×10^{-12}	2.0		I105
Sodium Reactions						
$Na + O_2 \xrightarrow{M} NaO_2$	(See Table 2-1)					
$Na + O_3 \rightarrow NaO + O_2$	1.0×10^{-9}	95	7.3×10^{-10}	1.2	50	J 1
$\rightarrow NaO_2 + O$			$<4.0\times10^{-11}$			J 1

Reaction	A-Factor[a]	E/R	k(298 K)[a]	f(298 K)[b]	g	Notes
$Na + N_2O \rightarrow NaO + N_2$	2.8×10^{-10}	1600	1.3×10^{-12}	1.2	400	J 2
$Na + Cl_2 \rightarrow NaCl + Cl$	7.3×10^{-10}	0	7.3×10^{-10}	1.3	200	J 3
$NaO + O \rightarrow Na + O_2$	4.4×10^{-10}	0	4.4×10^{-10}	1.5	200	J 4
$NaO + O_2 \xrightarrow{M} NaO_3$	(See Table 2-1)					
$NaO + O_3 \rightarrow NaO_2 + O_2$	1.1×10^{-9}	570	1.6×10^{-10}	1.5	300	J 5
$\rightarrow Na + 2O_2$	6.0×10^{-11}	0	6.0×10^{-11}	3.0	800	J 5
$NaO + H_2 \rightarrow NaOH + H$	2.6×10^{-11}	0	2.6×10^{-11}	2.0	600	J 6
$NaO + H_2O \rightarrow NaOH + OH$	4.3×10^{-10}	500	8.0×10^{-11}	1.5	200	J 7
$NaO + NO \rightarrow Na + NO_2$	1.5×10^{-10}	0	1.5×10^{-10}	4.0	400	J 8
$NaO + CO_2 \xrightarrow{M} NaCO_3$	(See Table 2-1)					
$NaO + HCl \rightarrow products$	2.8×10^{-10}	0	2.8×10^{-10}	3.0	400	J 9
$NaO_2 + O \rightarrow NaO + O_2$	2.2×10^{-11}	0	2.2×10^{-11}	5.0	600	J10
$NaO_2 + NO \rightarrow NaO + NO_2$			$<10^{-14}$			J11
$NaO_2 + HCl \rightarrow products$	2.3×10^{-10}	0	2.3×10^{-10}	3.0	400	J12
$NaOH + HCl \rightarrow NaCl + H_2O$	2.8×10^{-10}	0	2.8×10^{-10}	3.0	400	J13
$NaHCO_3 + H \rightarrow Na + H_2O + CO_2$	1.4×10^{-11}	1000	5×10^{-13}	2.0	100	J14
$NaOH + CO_2 \xrightarrow{M} NaHCO_3$	(See Table 2-1)					

Shaded areas indicate changes or additions since JPL 06-2/JPL 09-31. Italicized entries denote estimates.

[a] Units are cm^3 $molecule^{-1}$ s^{-1}.

[b] f(298 K) is the uncertainty factor at 298 K. To calculate the uncertainty at other temperatures, use the expression:

$$f(T) = f(298)\exp\left|g\left(\frac{1}{T}-\frac{1}{298}\right)\right|$$

Note that the exponent is absolute value.