Table SI-1 Thermodynamics parameters of the gas species [1]

Species	$\Delta_f H_m^{\theta}\times10^{-5}$	a_{cp}	b_{cp}	$c_{cp}\times10^{3}$	$d_{cp}\times10^{7}$	$\lambda_{To}\times10^{2}$	$k_{\lambda}\times10^{4}$
	J/kg	J/kg/K	J/kg/K	J/kg/K	J/kg/K	K/m	1/m
C_2H_4	18.68	135.93	5.59	-2.98	6.27	-1.90	1.41
C_3H_6	4.86	88.33	5.58	-2.76	5.25	-2.02	1.31
C_4H_8	0.02	-53.46	6.31	-3.55	7.97	-2.22	1.27
C_5H_{10}	-3.48	-1.91	6.18	-3.31	6.69	-2.02	1.00
CH_4	-46.81	1203.13	3.26	0.75	-7.08	-2.46	1.92
C_3H_8	-23.61	-96.00	6.96	-3.60	7.31	-2.31	1.44
CH_3OH	-62.91	660.94	2.22	0.81	-8.91	-2.38	1.08
H_2O	-134.44	1791.11	0.11	0.59	-2.00	0.80	1.26

Table SI-2 Dual-cycle reaction kinetics for the DMTO [1]

Classification	Reaction equation	Reaction rate
Olefins-based cycle (Happened on active site *S*)		
	$MeOH \xrightarrow{S} CH_4+H_2O$	$r_1=k_1\rho_{MeOH}Ys\Phi$
	$MeOH \xrightarrow{S} C_2H_4+H_2O$	$r_2=k_2\rho_{MeOH}Ys\Phi$
	$MeOH \xrightarrow{S} C_3H_6+H_2O$	$r_3=k_3\rho_{MeOH}Ys\Phi$
	$MeOH \xrightarrow{S} C_3H_8+H_2O$	$r_4=k_4\rho_{MeOH}Ys\Phi$
	$MeOH \xrightarrow{S} C_4H_8+H_2O$	$r_5=k_5\rho_{MeOH}Ys\Phi$
	$MeOH \xrightarrow{S} C_{5+}+H_2O$	$r_6=k_6\rho_{MeOH}Ys\Phi$
	$MeOH+C_2H_4 \xrightarrow{S} C_3H_6+H_2O$	$r_7=k_7\rho_{MeOH}\rho_{C2H4}Ys\Phi$
Transformation		

Classification	Reaction equation	Reaction rate
	$MeOH+S \rightarrow R+H_2O$	$r_8=k_8\rho_{MeOH}^{0.3}Ys$
	$C_2H_4+S \rightarrow R$	$r_9=k_9\rho_{C2H4}^{0.3}Ys$
	$C_3H_6+S \rightarrow R$	$r_{10}=k_{10}\rho_{C3H6}^{0.3}Ys$
	$C_4H_8+S \rightarrow R$	$r_{11}=k_{11}\rho_{C4H8}^{0.3}Ys$
	$C_{5+}+S \rightarrow R$	$r_{12}=k_{12}\rho_{C5+}^{0.3}Ys$
Aromatics-based cycle (Happened on protonated aromatics *R*)		
	$MeOH \xrightarrow{R} CH_4+H_2O$	$r_{13}=k_{13}\rho_{MeOH}Y_R\Phi$
	$MeOH \xrightarrow{R} C_2H_4+H_2O$	$r_{14}=k_{14}\rho_{MeOH}Y_R\Phi$
	$MeOH \xrightarrow{R} C_3H_6+H_2O$	$r_{15}=k_{15}\rho_{MeOH}Y_R\Phi$
	$MeOH \xrightarrow{R} C_3H_8+H_2O$	$r_{16}=k_{16}\rho_{MeOH}Y_R\Phi$
	$MeOH \xrightarrow{R} C_4H_8+H_2O$	$r_{17}=k_{17}\rho_{MeOH}Y_R\Phi$

k_i (i=1, 2, …, 17) is the reaction rate constant of reaction i, which is obtained from the Arrhenius equation:

$$k_i = k_{0i}\exp[-\frac{E_{ai}}{R}(\frac{1}{T}-\frac{1}{T_0})], \quad (1)$$

where T_0 is the reference and is 723 K in this study, and k_{0i} and E_{ai} are the reaction rate coefficient and activation energy of reaction i at T_0. R is the molar gas constant, and T is the temperature of the reaction. The detailed values of the k_{0i} and E_{ai} of the reaction network are listed in Table SI-3.

Table SI-3 Kinetic parameters of dual-cycle reaction model[2]

k_i	k_{i0}	E_{ai}	k_i	k_{i0}	E_{ai}
k_1	0.013	-0.04	k_{10}	0.00020	35.05
k_2	0.17	0.78	k_{11}	0.00073	35.03
k_3	0.24	1.23.	k_{12}	0.00073	35.06
k_4	0.032	-0.78	k_{13}	0.011	-10.13
k_5	0.12	0.82	k_{14}	0.77	28.23
k_6	0.10	-1.11	k_{15}	0.61	-17.82
k_7	0.41	1.97	k_{16}	0.019	1.20
k_8	0.00028	-1.47	k_{17}	0.11	-18.39
k_9	0.00012	35.02			

Table SI-4 Reaction network of dual-cycle reaction model for each specie [2]

Species	Reaction
MeOH	$R_{MeOH} = -(\sum_{i=1}^{6} r_i + \frac{8}{15} r_7 + r_8 + \sum_{i=13}^{17} r_i) m_{cat}$
Coke	$R_{coke} = \frac{14}{32} r_8 + r_9 + r_{10} + r_{11} + r_{12}$
CH_4	$R_{CH_4} = \frac{14}{32}(r_1 + r_{13}) m_{cat}$
C_2H_4	$R_{C_2H_4} = [\frac{14}{32}(r_2 + r_{14}) - (\frac{7}{15} r_7 + r_9)] m_{cat}$
C_3H_6	$R_{C_3H_6} = [\frac{14}{32}(r_3 + r_{15}) + \frac{7}{10} r_7 - r_{10}] m_{cat}$
C_3H_8	$R_{C_3H_8} = \frac{14}{32}(r_4 + r_{16}) m_{cat}$

Species	Reaction
C_4	$R_{C_4} = [\frac{14}{32}(r_5 + r_{17}) - r_{11}]m_{cat}$
C_{5+}	$R_{C_{5+}} = (\frac{14}{32}r_6 - r_{12})m_{cat}$
H_2O	$R_{H_2O} = \frac{18}{32}(\sum_{i=1}^{6} r_i + \frac{8}{15}r_7 + r_8 + \sum_{i=13}^{17} r_i)m_{cat}$

[1] B.E. Poling, J.M. Prausnitz, J.P. O'Connell, The properties of gases and liquids, Mcgraw-hill New York 2001.

[2] X. Yuan, H. Li, M. Ye, Z. Liu, Kinetic modeling of methanol to olefins process over SAPO-34 catalyst based on the dual-cycle reaction mechanism, AlChE J. 65(2) (2019) 662-674.