Supplementary Information

Table S1. Graaf et al. original (Graaf et al., 1988) vs Fitted.

Kinetic parameter	Original	Units	Estimated with CO in the feed	Units
k_{CO}	$4.89 \times 10^{7} \cdot exp\left(\frac{-113000}{R \cdot T}\right)$	$mol \cdot kg_{cat}^{-1} \cdot s^{-1} \cdot bar^{-1}$	$8.15 \times 10^{-2} \cdot exp\left(\frac{-20300}{R \cdot T}\right)$	mol/h/g/bar²
kCO_2	$1.09 \times 10^{5} \cdot exp\left(\frac{-87500}{R \cdot T}\right)$	$mol \cdot kg_{cat}^{-1} \cdot s^{-1} \cdot bar^{-1}$	$4.66 \times 10^{8} \cdot exp\left(\frac{-111600}{R \cdot T}\right)$	mol/h/g/bar²
k_{RWGS}	$9.64 \times 10^{11} \cdot exp\left(\frac{-152900}{R \cdot T}\right)$	$mol \cdot kg_{cat}^{-1} \cdot s^{-1} \cdot bar^{-0.5}$	$1.29 \times 10^{16} \cdot exp\left(\frac{-173019}{R \cdot T}\right)$	mol/h/g/bar²
K_{CO}	$2.16 \times 10^{-5} \cdot exp\left(\frac{46800}{R \cdot T}\right)$	bar^{-1}	-	-
K_{CO2}	$7.05 \times 10^{-7} \cdot exp\left(\frac{61700}{R \cdot T}\right)$	bar^{-1}	-	-
			K_{H_2O} =1.5510	
	$\frac{K_{H_2O}}{K_{H_2}^{0.5}} = 6.37 \times 10^{-9} \cdot exp\left(\frac{84000}{R \cdot T}\right)$	$bar^{-0.5}$	$K_{H_2} = 7.65 \times 10^{9} \cdot exp\left(\frac{-109626.2}{R \cdot T}\right)$	bar^{-1}

Table S2. Vanden Bussche and Froment original (van den Bussche & Froment, 1996) vs fitted.

Kinetic parameter	Original	Units	Estimated with CO in the feed	Units
kCO_2	$1.07 \times 10^{-10} \cdot exp\left(\frac{36696}{R \cdot T}\right)$	$mol \cdot kg_{cat}^{-1} \cdot s^{-1} \cdot Pa^{-2}$	$20.86 \cdot \exp\left(\frac{-23908.8}{R \cdot T}\right)$	mol/h/g/bar²
k_{RWGS}	$1.22 \times 10^{5} \cdot exp\left(\frac{-94765}{R \cdot T}\right)$	$mol \cdot kg_{cat}^{-1} \cdot s^{-1} \cdot Pa^{-1}$	$6.8 \times 10^{8} \cdot \exp\left(\frac{-94381.3}{R \cdot T}\right)$	mol/h/g/bar²
	$\sqrt{K_{H_2}} = 1.578 \times 10^{-3} \cdot exp\left(\frac{17197}{R \cdot T}\right)$	$Pa^{-0.5}$	$K_{H_2} = 1.41 \cdot exp\left(\frac{-2689.8}{R \cdot T}\right)$	bar^{-1}
K_{H2O}	$6.62 \times 10^{-16} \cdot exp\left(\frac{124119}{R \cdot T}\right)$	Pa^{-1}	$1.20 \cdot exp\left(\frac{-5435.5}{R \cdot T}\right)$	bar^{-1}
	$\frac{K_{H_2O}}{K_8 K_9 K_{H_2}} = 3.45338$	-	$K_8 K_9 = 30.03 \cdot exp\left(\frac{-8959.6}{R \cdot T}\right)$	-

Table S3. Slotboom et al original 6 parameter model (Slotboom et al., 2020) vs fitted.

Kinetic parameter	Original	Units	Estimated with CO in the feed	Units
kCO_2	$7.414 \times 10^{14} \cdot exp\left(\frac{-166000}{R \cdot T}\right)$	$mol \cdot kg_{cat}^{-1} \cdot s^{-1} \cdot bar^{-1}$	$2.19 \times 10^{2} \cdot exp\left(\frac{-43921.4}{R \cdot T}\right)$	mol/h/g/bar²
k_{RWGS}	$1.111 \times 10^{19} \cdot exp\left(\frac{-203700}{R \cdot T}\right)$	$mol \cdot kg_{cat}^{-1} \cdot s^{-1} \cdot bar^{-1}$	$2.75 \times 10^{10} \cdot exp\left(\frac{-110563}{R \cdot T}\right)$	mol/h/g/bar²
K_{H_2}	1.099	$bar^{-0.5}$	13.62	$bar^{-0.5}$
$K_{H_2O/9}$	126.4	bar^{-1}	41.55	bar^{-1}

Table S4. Seidel et al original (Seidel et al., 2018; Seidel et al., 2020) vs fitted.

Kinetic parameter	Original	Units	Estimated with CO in the feed	Units
ΔG_1	-1134.8	J/mol	-	-
ΔG_2	-769.3	J/mol	-	-
ΔG_3	-365.5	J/mol	-	-
k_{CO}	$3.074 \times 10^{12} \cdot exp\left(\frac{-154400}{R \cdot T}\right)$	$mol \cdot kg_{cat}^{-1} \cdot s^{-1} \cdot bar^{-1}$	$1.99 \times 10^{-2} \cdot exp\left(\frac{-12024.4}{R \cdot T}\right)$	mol/h/g/bar²
kCO_2	$4.613 \times 10^{7} \cdot exp\left(\frac{-96820}{R \cdot T}\right)$	$mol \cdot kg_{cat}^{-1} \cdot s^{-1} \cdot bar^{-1}$	$9.14 \cdot exp\left(\frac{-5406.3}{R \cdot T}\right)$	mol/h/g/bar²
k_{RWGS}	$6.107 \times 10^{13} \cdot exp\left(\frac{-161000}{R \cdot T}\right)$	$mol \cdot kg_{cat}^{-1} \cdot s^{-1} \cdot bar^{-1}$	$1.56 \times 10^{6} \cdot exp\left(\frac{-76382}{R \cdot T}\right)$	mol/h/g/bar²
K_{CO}	0.1470	bar^{-1}	$1.87 \times 10^{33} \cdot exp\left(\frac{-309237.6}{R \cdot T}\right)$	bar^{-1}
$K_{CH_3OH}^{\odot}$	0	-	0	-
$K_{CO_2}^{\odot}$	0	-	0	-
	$\frac{K_{H_2O}K_O}{K_{H_2}} = 34.9226$	-	$K_O = 1.79 \times 10^{-1} \cdot exp\left(\frac{-5000.9}{R \cdot T}\right)$	-
Kco_2	0.04712	bar^{-1}	0	-
$K_{CH_3OH}^{*}$	0		0	-
K_{H_2O}	0.0297	bar^{-1}	$2.34 \cdot exp\left(\frac{-10922.9}{R \cdot T}\right)$	bar^{-1}
	$\sqrt{K_{H_2}}$ =1.1665	$bar^{-0.5}$	$K_{H_2} = 1.96 \times 10^{1} \cdot exp\left(\frac{-4086.1}{R \cdot T}\right)$	$bar^{-0.5}$

Table S5. MOD parameters.

Kinetic parameter	Estimated with CO in the feed	Units
ΔG_1	-	-
ΔG_2	-	-
ΔG_3	-	-
kCO_2	$3.77 \times 10^2 \cdot exp\left(\frac{-25000}{R \cdot T}\right)$	mol/h/g/bar²
k_{RWGS}	$3.60 \times 10^8 \cdot exp\left(\frac{-98200}{R \cdot T}\right)$	mol/h/g/bar²
K_{CO}	$1.87 \times 10^7 \cdot exp\left(\frac{-68434.8}{R \cdot T}\right)$	bar^{-1}
$K^{\odot}_{CH_3OH}$	0	-
$K^{\odot}_{CO_2}$	0	-
K_O	178.17	-
Kco_2	0	-
$K^{*}_{CH_3OH}$	0	-
K_{H_2O}	0.0581	bar^{-1}
K_{H_2}	3.786	$bar^{-0.5}$

Table S6. Plug flow calculation, this follows the criteria discussed in reference (Ertl et al., 1997; Delgado, 2006).

Geometrical Characteristics			
d_t (mm)	**10.1**	**d_t/d_p**	107.4
h_{bed} (mm)	3.82	h_{bed}/dp	40.7
d_p (µm)	94		

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