Thermal Properties for CO_2 and N_2

The thermal properties for CO_2 and N_2 were obtained from Touloukian (1972) for temperature over the range from 250 K to 300 K. These properties were given for explicit temperatures. To gain property values based on Touloukian (1972) for any given temperature within the above mentioned range, a linear regression was performed for that temperature range which gave simple equations. The thermal conductivity, k, and the dynamic viscosity, μ, were approximated by a linear function of temperature for both CO_2 and N_2. The specific heat, C_p, was approximated by a linear function of temperature for CO_2 while for N_2 it was approximated by a 2nd degree polynomial in temperature.

In Table 1 the thermal properties of CO_2 and N_2 listed. In Table 2, 3 and 4 the equations for thermal conductivity, k, dynamic viscosity, μ, and specific heat, Cp, can be found. They are valid in the temperature range T = 250 K through T = 300 K. Property temperature plots based on Table 1 are given in Appendix.

Symbols

C_p	[J/kg.K]	Specific heat at constant pressure
k	[W/m.K]	Thermal conductivity
M	[kg/kgmol]	Molecular Weight (CO_2 = 44.01, N_2 = 22.02)
T	[K]	Temperature
μ	[kg/m·s]	Dynamic viscosity

Table 1: Properties for IGU Gas Fills

		Touloukian (1972)			ISO 15099		
	T [K]	k [W/m.K]	μ [κg/m.s]	Cp [J/Kg.K]	k [W/m.K]	μ [κg/m.s]	Cp [J/Kg.K]
CO_2	250	0.01289	1.2630E-05	806.867	0.01286	1.2641E-05	806.9650
	260	0.01360	1.3120E-05	816.147	0.01361	1.3113E-05	816.1518
	263			818.923	0.01383	1.3254E-05	818.9079
	270	0.01433	1.3590E-05	825.384	0.01435	1.3584E-05	825.3388
	273.15			828.285	0.01459	1.3733E-05	828.2327
	280	0.01508	1.4060E-05	834.576	0.01510	1.4056E-05	834.5258
	283			837.324	0.01533	1.4197E-05	837.2819
	290	0.01585	1.4530E-05	843.718	0.01585	1.4527E-05	843.7129
	293			846.450	0.01607	1.4669E-05	846.4690
	300	0.01662	1.4990E-05	852.806	0.01660	1.4999E-05	852.8999
N_2	250	0.02222	1.5480E-05	1042.52	0.02223	1.5486E-05	1042.51
	260	0.02298	1.5960E-05	1042.02	0.02298	1.5963E-05	1042.01
	263			1041.89	0.02321	1.6106E-05	1041.88
	270	0.02374	1.6450E-05	1041.62	0.02373	1.6440E-05	1041.62
	273.15			1041.52	0.02397	1.6590E-05	1041.51
	280	0.02449	1.6920E-05	1041.33	0.02448	1.6917E-05	1041.32
	283			1041.26	0.02471	1.7060E-05	1041.25
	290	0.02524	1.7400E-05	1041.14	0.02524	1.7394E-05	1041.13
	293			1041.10	0.02546	1.7537E-05	1041.09
	300	0.02598	1.7860E-05	1041.04	0.02599	1.7870E-05	1041.04

Table 2: Thermal Conductivity

k = a+bT [W/mK]	Coefficient a [W/mK]	Coefficient b [W/mK^2]
CO_2	-5.8181×10^{-3}	7.4714×10^{-5}
N_2	3.4205×10^{-3}	7.5229×10^{-5}

Table 3: Dynamic Viscosity

μ = a+bT [kg/m·s]	Coefficient a [kg/m·s]	Coefficient b [kg/m·s.K]
CO_2	8.5571×10^{-7}	4.7143×10^{-8}
N_2	3.5648×10^{-6}	4.7686×10^{-8}

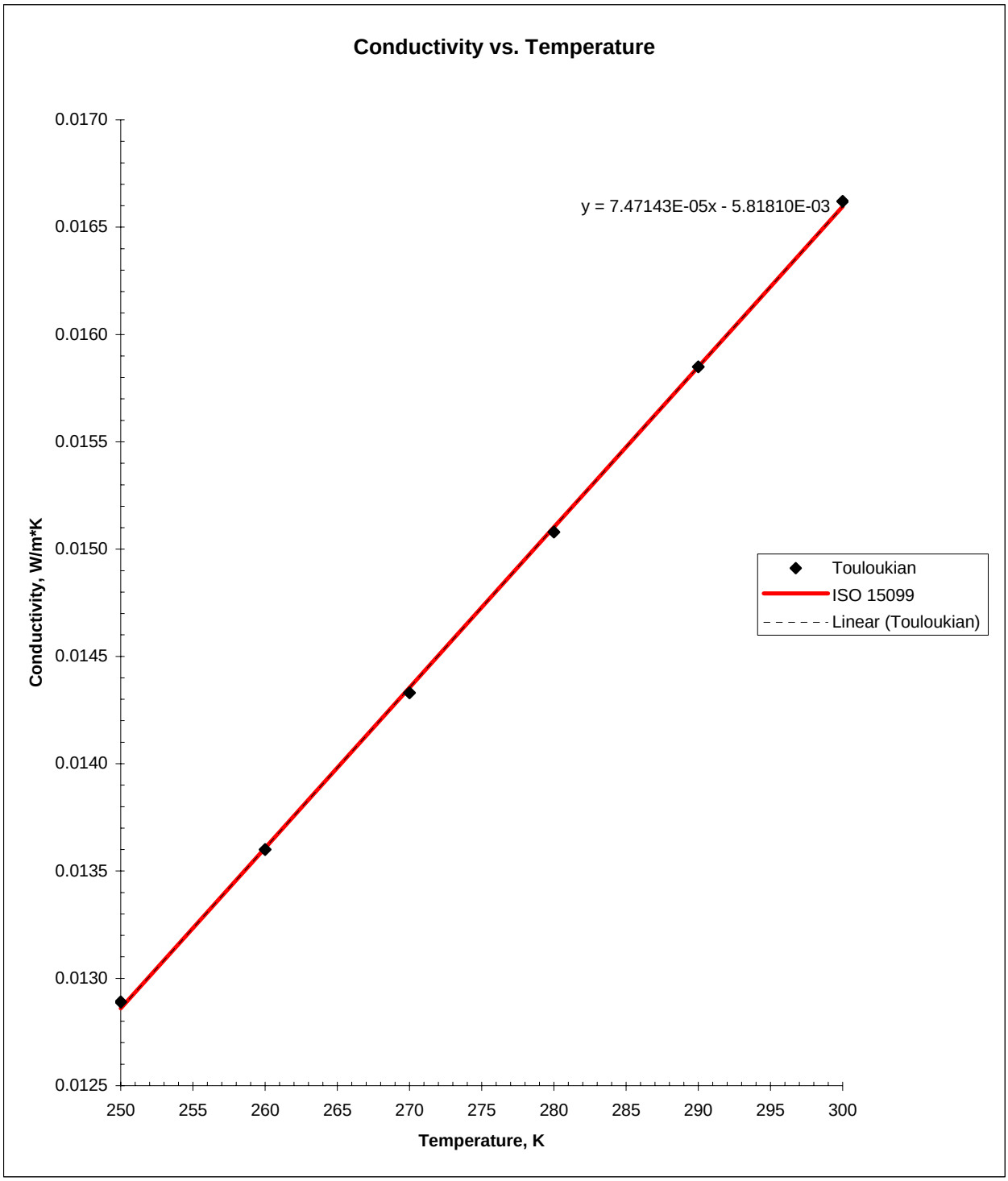
Table 3: Specific Heat

$\mu = a+bT+cT^2$ [J/kg.K]	Coefficient a [J/kg.K]	Coefficient b [J/kg.K^2]	Coefficient c [J/kg.K^3]
CO_2	5.7729×10^{2}	9.1870×10^{-1}	0
N_2	1.0882×10^{3}	-3.1010×10^{-1}	5.1020×10^{-4}

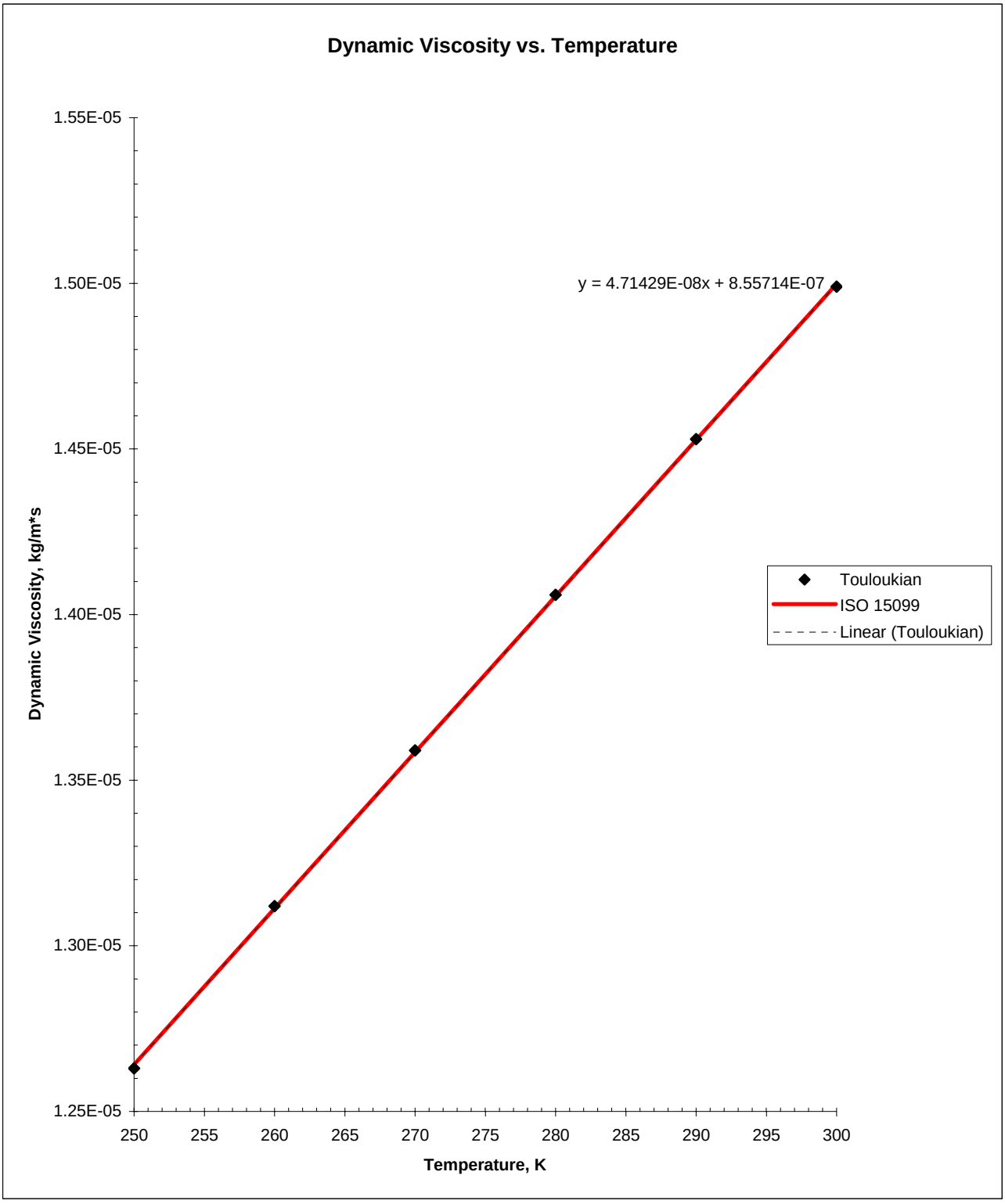
Note : The coefficients a, b and c are based on the W5 methodology.

APPENDIX

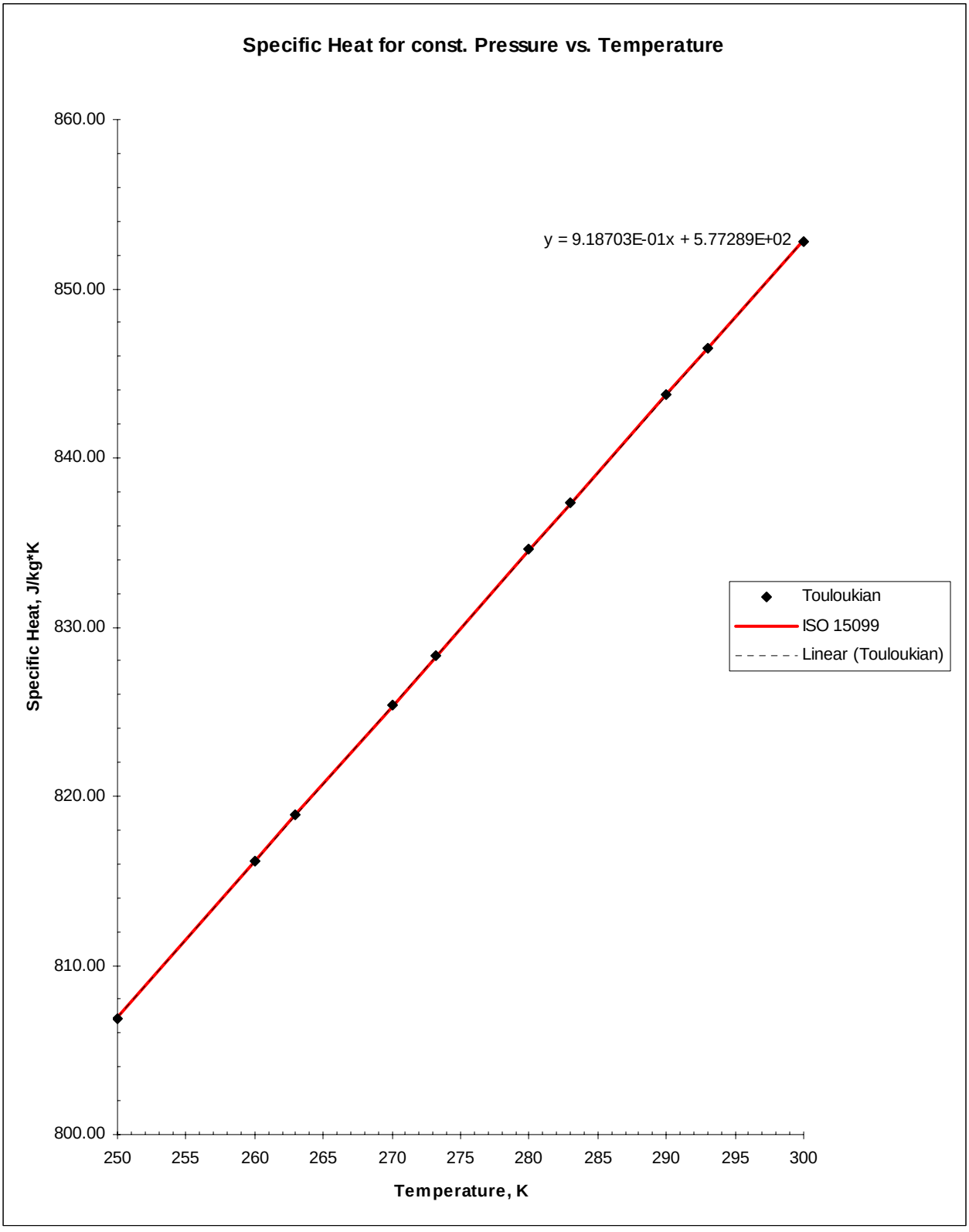
CO_2



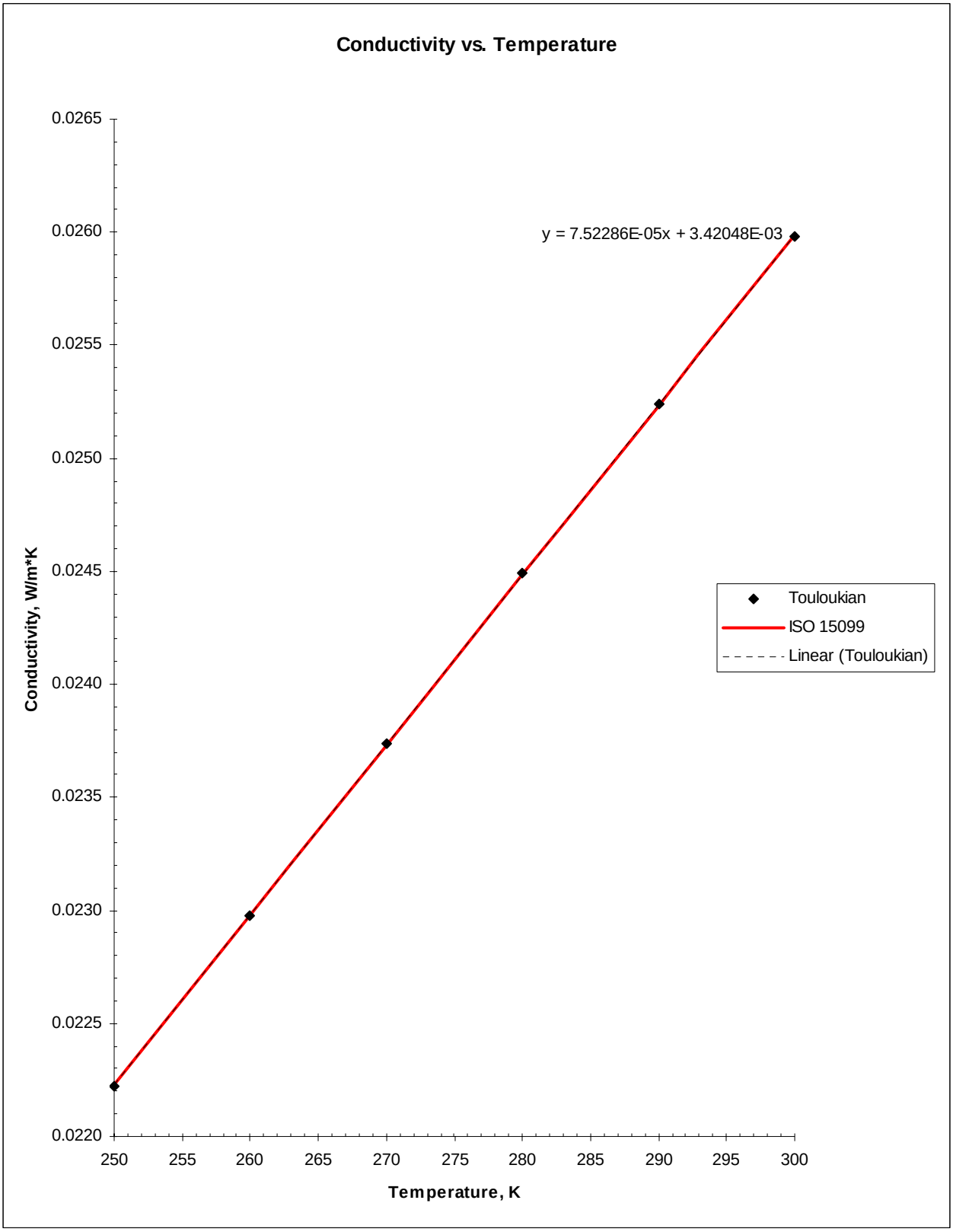
CO_2


Dynamic Viscosity vs. Temperature
y = 4.71429E-08x + 8.55714E-07
Dynamic Viscosity, kg/m*s
1.55E-05
1.50E-05
1.45E-05
1.40E-05
1.35E-05
1.30E-05
1.25E-05
250
255
260
265
270
275
280
285
290
295
300
Temperature, K
Touloukian
ISO 15099
Linear (Touloukian)

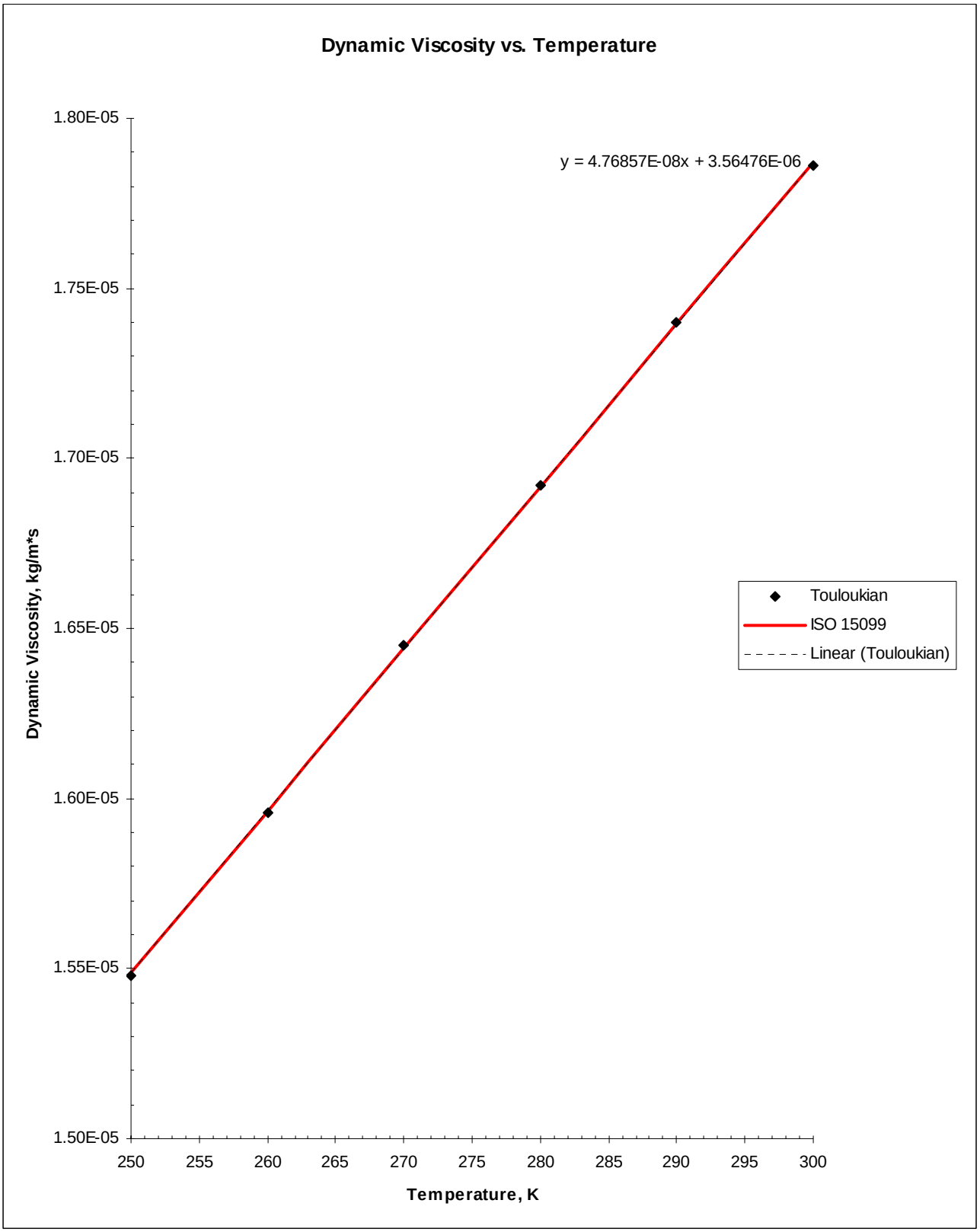
CO_2


Specific Heat for const. Pressure vs. Temperature
y = 9.18703E-01x + 5.77289E+02
Specific Heat, J/kg*K
860.00
850.00
840.00
830.00
820.00
810.00
800.00
250
255
260
265
270
275
280
285
290
295
300
Temperature, K
Touloukian
ISO 15099
Linear (Touloukian)

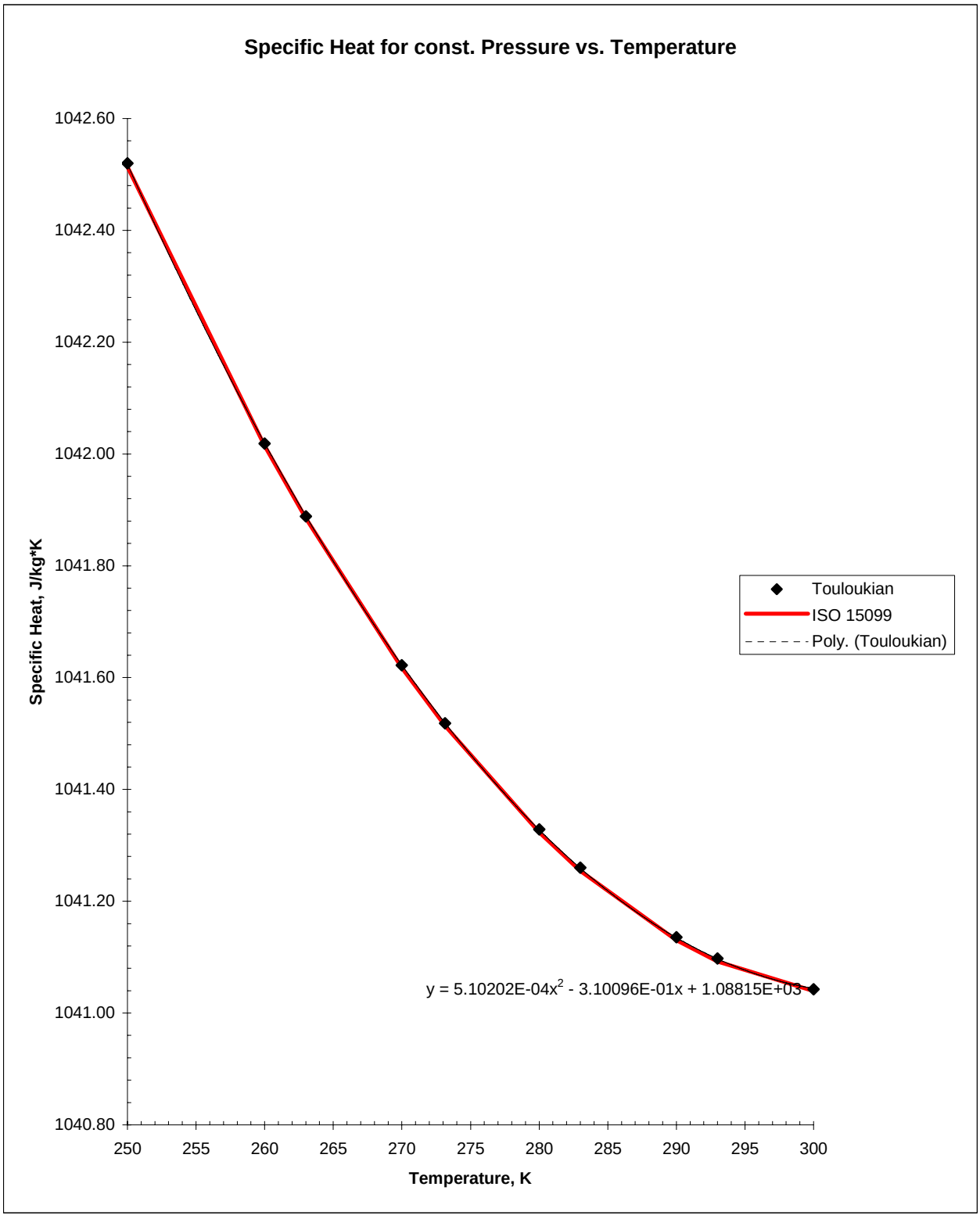
N_2


Conductivity vs. Temperature
y = 7.52286E-05x + 3.42048E-03
Conductivity, W/m*K
Temperature, K
0.0265
0.0260
0.0255
0.0250
0.0245
0.0240
0.0235
0.0230
0.0225
0.0220
250
255
260
265
270
275
280
285
290
295
300
Touloukian
ISO 15099
Linear (Touloukian)

N_2


Dynamic Viscosity vs. Temperature
y = 4.76857E-08x + 3.56476E-06
1.80E-05
1.75E-05
1.70E-05
1.65E-05
1.60E-05
1.55E-05
1.50E-05
Dynamic Viscosity, kg/m*s
250
255
260
265
270
275
280
285
290
295
300
Temperature, K
Touloukian
ISO 15099
Linear (Touloukian)

N_2


Specific Heat for const. Pressure vs. Temperature
Specific Heat, J/kg*K
1042.60
1042.40
1042.20
1042.00
1041.80
1041.60
1041.40
1041.20
1041.00
1040.80
250
255
260
265
270
275
280
285
290
295
300
Temperature, K
Touloukian
ISO 15099
Poly. (Touloukian)
y = 5.10202E-04x2 - 3.10096E-01x + 1.08815E+03

Reference:

Touloukian, Y.S., and C.Y. Ho. Thermophysical properties of matter. Plenum Press, New York, 1972.