Supplementary Materials
(Gas Properties)

The relevant fluid properties should be known to evaluate the extent of the departure, the Busse parameter Q. Thermophysical properties of gaseous CO_2 required to calculate Q is given in detail by de Bruyn *et al.* (1996). Here, we derive some important fluid properties for SF_6 [1].

At pressure P in bar and at temperature T in Kelvin, we consider the virial equation of state with specific gas constant $R_{SF_6} = 0.569268$ bar cm^3 K^{-1} gr^{-1}

$$\frac{P}{RT} = \rho + C_1(T)\,\rho^2 + C_2(T)\,\rho^3 + \ldots \quad (1)$$

where $C_1(T)$ and $C_2(T)$ are the second and the third virial coefficient, respectively and the higher order corrections are ignored. We obtain virial coefficients as a function of T (270 K$\leq T \leq$340 K) from polynomial fits to the coefficient data of Funke *et al.* (2002)

$$C_k(T) = \sum_{i=0}^{i=4} c_{ik} T^i, \;\; k = 1, 2 \quad (2)$$

where $C_1(T)$ and $C_2(T)$ are given in cm^3 mol^{-1} and (cm^3 mol^{-1})^2, respectively. The coefficients c_{ik} are given in Tab. 1. We obtain the density at a given T and P by solving Eq.(1) numerically. Density values we obtain reproduce the data of Scalabrin *et al.* (2007) (275 K $\leq T \leq$ 325 K and 5 bar $\leq P \leq$ 20 bar) with a mean deviation of less than 0.005% and the data of Guder & Wagner (2002) (275 K $\leq T \leq$ 340 K and 5 bar $\leq P \leq$ 20 bar) with

[1] There is also a program (named RBC) developed by the UC Santa Barbara fluid group to evaluate fluid properties (private communication with G. Ahlers). Here, we present extended calculations based on measurement data published recently for SF_6.

	0	1	2	3	4
$c_{i1} \times 10^4$	-94931165.6619	1051704.8834	-4667.2570	9.4947	-0.0074
$c_{i2} \times 10^{-2}$	-16795674.7744	330474.4810	-2705.6297	11.7975	-0.0289

Table 1: Coefficients c_{ik} are obtained from a fit of the polynomial in Eq.(2) to the virial coefficient data in Funke *et al.* (2002).

less than 0.009%. The isobaric thermal expansion coefficient

$$\alpha = -\frac{1}{\rho}\left(\frac{\partial \rho}{\partial T}\right)_P \tag{3}$$

is computed with a central differencing scheme for ρ.

We acquire the heat capacity c_p from bilinear interpolations in the data of Guder & Wagner (2002) for the range of pressure 5 to 20 bar and temperature 270 to 350 K with 68 points.

We obtain the thermal conductivity λ ($\mathrm{W\,m^{-1}\,K^{-1}}$) from a polynomial fit

$$\lambda = \sum_{i=0}^{i=3}\sum_{j=0}^{j=3} a_{ij}^{\lambda} P^i T^j \tag{4}$$

$$\tag{5}$$

to the data of Tanaka *et al.* (1979) and of Bakulin & Ulybin (1978) for a range of pressures (4.90 to 20.60 bar) and temperatures (268.60 to 348.15 K). The empirical coefficients a_{ij}^{λ} are given in Tab. 2. Conductivities obtained agree with the data of Kestin & Imaishi (1985) ($T \approx 297$ K and 7.99 bar $\leq P \leq$ 22.00 bar) by 3.9%.

We obtain the shear viscosity μ (Pa s) from a polynomial fit

$$\mu = \sum_{i=0}^{i=3}\sum_{j=0}^{j=3} a_{ij}^{\mu} P^i T^j \tag{6}$$

to the data of Hurly *et al.* (2003) and of Wilhelm *et al.* (2005) for a range of pressures (4.85 to 20.43 bar) and temperatures (298.15 to 350.00 K). The coefficients a_{ij}^{μ} are given in Tab. 3. Once μ is known, the kinematic viscosity ν can be calculated at a given P and T, i.e, $\nu = \mu/\rho$. Shear viscosities agree to within 0.17% of the data of Hoogland *et al.* (1985) (298.11 K $\leq T \leq$ 333.17

$a_{ij}^{\lambda} \times 10^{11}$	0	1	2	3
0	4248430.0260	29225606.1780	172185442.3803	-4617277.2550
1	10739592.7164	-3447062.4355	-1309520.2822	37256.4981
2	-51910.1832	21484.9321	3069.1498	-94.3400
3	100.4146	-34.0530	-2.0780	0.0729

Table 2: Coefficients a_{ij}^{λ} for sulfur hexafluoride are obtained from a fit of the polynomial in Eq.(4) to the data in Tanaka *et al.* (1979) and Bakulin & Ulybin (1978) with 33 points. The max and mean percent deviations between the data and the conductivities acquired from Eq.(4) are 1.651% and 0.425%, respectively.

$a_{ij}^{\mu} \times 10^{18}$	0	1	2	3
0	580221655.2301	17745159.5046	765985668.2402	17029295511.9589
1	62338302128.7037	-1289044132.6356	-164423494.2827	-142487979.0229
2	-54783204.4993	8257433.7738	938241.1101	400175.0561
3	56901.8434	-12689.3967	-1322.4966	-376.9547

Table 3: Coefficients a_{ij}^{μ} for sulfur hexafluoride are obtained from a fit of the polynomial in Eq.(6) to the data in Hurly *et al.* (2003) and Wilhelm *et al.* (2005) with 174 points. The max and mean percent deviations between the data and the shear viscosities acquired from Eq.(6) are 0.161% and 0.028%, respectively.

K and 1.04 bar $\leq P \leq$ 22.27 bar). The kinematic viscosities derived by an extrapolation agrees to within 1.85% of the data of Estrada-Alexanders & Hurly (2008) ($T = 273.16$ K and 4.92 bar $\leq P \leq$ 10.00 bar).

The calculations, for example, yield the following properties of SF_6 at 15 bar and 35 °C; $\rho = 103.19\,\mathrm{kg\,m^{-3}}$, $\alpha = 6.01\times10^{-3}\,\mathrm{K^{-1}}$, $c_p = 779.84\,\mathrm{J\,kg^{-1}\,K^{-1}}$, $\nu = 1.58\times10^{-7}\,\mathrm{m^2\,s^{-1}}$, $\lambda = 14.49\times10^{-3}\,\mathrm{W\,m^{-1}\,K^{-1}}$ and the Prandtl number $\sigma = 0.88$.

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