

## 不确定度的计算

对于烷烃类标准气体

由表 1-1 配制记录表可计算出二次稀释后各组份气的摩尔浓度

已知:

$$\begin{aligned} M_{\text{CH}_4} &= 16.043 \text{ g/mol} & M_{\text{C}_3\text{H}_8} &= 44.097 \text{ g/mol} & M_{i\text{-C}_4\text{H}_{10}} &= 58.124 \text{ g/mol} \\ M_{\text{C}_2\text{H}_6} &= 30.070 \text{ g/mol} & M_{n\text{-C}_4\text{H}_{10}} &= 58.124 \text{ g/mol} & M_{\text{N}_2} &= 28.0134 \text{ g/mol} \end{aligned}$$

$$n_{\text{CH}_4} = 2.111 \times 2.850 / [(2.111 + 112.102) \times 16.043] = 0.00328 \text{ mol}$$

$$n_{\text{N}_2}^1 = 112.102 \times 2.850 / [(2.111 + 112.102) \times 28.0134] = 0.0999 \text{ mol}$$

$$n_{\text{C}_2\text{H}_6} = 2.411 \times 4.699 / [(2.411 + 114.001) \times 30.070] = 0.00324 \text{ mol}$$

$$n_{\text{N}_2}^2 = 114.001 \times 4.699 / [(2.411 + 114.001) \times 28.0134] = 0.164 \text{ mol}$$

$$n_{\text{C}_3\text{H}_8} = 3.550 \times 4.710 / [(3.550 + 111.402) \times 44.097] = 0.00330 \text{ mol}$$

$$n_{\text{N}_2}^3 = 111.402 \times 2.850 / [(3.550 + 111.402) \times 28.0134] = 0.163 \text{ mol}$$

$$n_{n\text{-C}_4\text{H}_{10}} = 4.712 \times 4.780 / [(4.712 + 112.311) \times 58.124] = 0.00331 \text{ mol}$$

$$n_{\text{N}_2}^4 = 112.311 \times 4.780 / [(4.712 + 112.311) \times 28.0134] = 0.164 \text{ mol}$$

$$n_{i\text{-C}_4\text{H}_{10}} = 4.648 \times 4.910 / [(4.648 + 113.609) \times 58.124] = 0.00332 \text{ mol}$$

$$n_{\text{N}_2}^5 = 113.609 \times 4.910 / [(4.648 + 113.609) \times 28.0134] = 0.168 \text{ mol}$$

$$n_{\text{N}_2}^6 = 904.410 / 28.0134 = 32.285 \text{ mol} \quad n = \sum n_i = 33.0604 \text{ mol}$$

则:  $X_{\text{CH}_4} = 0.00328 / 33.0604 = 99.2 \times 10^{-6}$

$$X_{\text{C}_2\text{H}_6} = 0.00324 / 33.0604 = 98.0 \times 10^{-6}$$

$$X_{\text{C}_3\text{H}_8} = 0.00330 / 33.0604 = 99.8 \times 10^{-6}$$

$$X_{n\text{-C}_4\text{H}_{10}} = 0.00331 / 33.0604 = 100.1 \times 10^{-6}$$

$$X_{i\text{-C}_4\text{H}_{10}} = 0.00332 / 33.0604 = 100.4 \times 10^{-6}$$

称量不确定度的计算:

$$\begin{aligned} \text{由于: } \Delta X_{2i}/X_{2i} \leq & \Delta \mu_1 (1-n \cdot \mu_1/N_{S_2} \cdot m) / \mu_1 \\ & + \Delta \mu_{d_1} \cdot N_{d_1} / \mu_{d_1} \cdot N_{S_2} \quad (7) \\ & + \Delta m_i \cdot [1-m_i/m - (X_i - m_i/m) \cdot n \cdot \mu_1/N_{S_2} \cdot m] / m_i \\ & + \sum \Delta m_j \cdot [m_j/m + (X_j - m_j/m) \cdot n \cdot \mu_1/N_{S_2} \cdot m] / m_j \end{aligned}$$

$$m = m_i + \sum m_j \quad n = n_i + \sum n_j$$

$N_{S_2}$  为所得混合气的总摩尔数

$$\text{由 } \Delta \mu_1 = \Delta m_1 = 0.024\text{g}; \quad \Delta \mu_{d_1} = \Delta m_2 = 0.0742\text{g}$$

$$\text{推出: } \Delta \mu_1 / \mu_1 = 0.024 / 2.850 = 8.421 \times 10^{-3}$$

$$\Delta \mu_{d_1} / \mu_{d_1} = 0.0742 / 904.410 = 8.204 \times 10^{-5}$$

$$\text{已知: } N_{2i} = 0.00328$$

$$N_{d_1} = 32.285$$

$$N_{S_2} = 33.0604$$

$$m_1/m = 2.111 / (2.111 + 112.102) = 0.01848$$

$$m_2/m = 112.102 / (2.111 + 112.102) = 0.98152$$

$$n \cdot \mu_1 / N_{S_2} \cdot m = 3.12 \times 10^{-3}$$

$$N_{d_1} / N_{S_2} = 0.976546$$

$$X_1 - m_1/m = 0.013515$$

$$X_2 - m_2/m = -0.013515$$

代入(7)式计算  $X_{CH_4}$  的相对不确定度

$$\Delta X_{CH_4} / X_{CH_4} \leq 8.555 \times 10^{-3}$$

$$\text{则 } \Delta X_{\text{CH}_4} \leq 8.555 \times 10^{-3} \times 99.2 \times 10^{-6} \leq 1 \times 10^{-6}$$

$$\text{即 } X_{\text{CH}_4} = 99.2 \times 10^{-6} \pm 1 \times 10^{-6}$$

同理可推出其他组份的不确定度

$$\Delta X_{\text{C}_2\text{H}_6} / X_{\text{C}_2\text{H}_6} = 8.6 \times 10^{-3}$$

$$\Delta X_{\text{C}_3\text{H}_8} / X_{\text{C}_3\text{H}_8} = 8.7 \times 10^{-3}$$

$$\Delta X_{\text{n-C}_4\text{H}_{10}} / \Delta X_{\text{n-C}_4\text{H}_{10}} = 8.4 \times 10^{-3}$$

$$\Delta X_{\text{I-C}_4\text{H}_{10}} / X_{\text{I-C}_4\text{H}_{10}} = 8.5 \times 10^{-3}$$

则：

$$\Delta X_{\text{C}_2\text{H}_6} = 1.0 \times 10^{-6} \quad \text{即 } X_{\text{C}_2\text{H}_6} = 98.0 \times 10^{-6} \pm 1.0 \times 10^{-6}$$

$$\Delta X_{\text{C}_3\text{H}_8} = 1.0 \times 10^{-6} \quad \text{即 } X_{\text{C}_3\text{H}_8} = 99.8 \times 10^{-6} \pm 1.0 \times 10^{-6}$$

$$\Delta X_{\text{n-C}_4\text{H}_{10}} = 1.0 \times 10^{-6} \quad \text{即 } \Delta X_{\text{n-C}_4\text{H}_{10}} = 100.1 \times 10^{-6} \pm 1.0 \times 10^{-6}$$

$$\Delta X_{\text{I-C}_4\text{H}_{10}} = 1.0 \times 10^{-6} \quad \text{即 } X_{\text{I-C}_4\text{H}_{10}} = 100.4 \times 10^{-6} \pm 1.0 \times 10^{-6}$$

对于烯烃类标准气体

由表 1-2 配制记录表可计算出二次稀释后各组份气的摩尔浓度

已知:  $M_{C_2H_2}=26.038\text{g/mol}$        $M_{C_2H_4}=28.054\text{g/mol}$        $M_{C_3H_4}=40.065\text{g/mol}$   
 $M_{C_3H_6}=42.081\text{g/mol}$        $M_{C_4H_6}=54.092\text{g/mol}$        $M_{C_4H_8}=56.108\text{g/mol}$

$$n_{C_2H_2}=2.411 \times 3.981 / [(2.411 + 109.201) \times 26.038] = 0.00330 \text{ mol}$$

$$n_{N_2}^1 = 109.201 \times 3.981 / [(2.411 + 109.201) \times 28.0134] = 0.1390 \text{ mol}$$

$$n_{C_2H_4}=2.530 \times 4.120 / [(2.530 + 110.302) \times 28.054] = 0.00329 \text{ mol}$$

$$n_{N_2}^2 = 110.302 \times 4.120 / [(2.530 + 110.302) \times 28.0134] = 0.144 \text{ mol}$$

$$n_{C_3H_4}=4.091 \times 3.711 / [(4.091 + 110.801) \times 40.065] = 0.00330 \text{ mol}$$

$$n_{N_2}^3 = 110.801 \times 3.711 / [(4.091 + 110.801) \times 28.0134] = 0.128 \text{ mol}$$

$$n_{C_3H_6}=4.240 \times 3.834 / [(4.240 + 113.101) \times 42.081] = 0.00330 \text{ mol}$$

$$n_{N_2}^4 = 113.101 \times 3.834 / [(4.240 + 113.101) \times 28.0134] = 0.132 \text{ mol}$$

$$n_{C_4H_6}=5.631 \times 3.731 / [(5.631 + 111.402) \times 54.092] = 0.00332 \text{ mol}$$

$$n_{N_2}^5 = 111.402 \times 3.731 / [(5.631 + 111.402) \times 28.0134] = 0.530 \text{ mol}$$

$$n_{C_4H_8}=5.720 \times 3.770 / [(5.720 + 110.702) \times 56.108] = 0.00330 \text{ mol}$$

$$n_{N_2}^6 = 110.702 \times 3.770 / [(5.720 + 110.702) \times 28.0134] = 0.532 \text{ mol}$$

$$n_{N_2}^7 = 902.152 / 28.0134 = 32.204 \text{ mol} \quad n = \sum n_i = 33.8288 \text{ mol}$$

则:  $X_{C_2H_2} = 0.00330 / 33.8288 = 97.6 \times 10^{-6}$

$$X_{C_2H_4} = 0.00329 / 33.8288 = 97.3 \times 10^{-6}$$

$$X_{C_3H_4} = 0.00330 / 33.8288 = 97.6 \times 10^{-6}$$

$$X_{C_3H_6} = 0.00330 / 33.8288 = 97.6 \times 10^{-6}$$

$$X_{C_4H_6} = 0.00332 / 33.8288 = 98.1 \times 10^{-6}$$

$$X_{C_4H_8} = 0.00330 / 33.8288 = 97.6 \times 10^{-6}$$

同理根据(7)式可推出各组份的不确定度

$$\Delta X_{C_2H_2} / X_{C_2H_2} = 8.5 \times 10^{-3}$$

$$\Delta X_{C_2H_4} / X_{C_2H_4} = 8.7 \times 10^{-3}$$

$$\Delta X_{C_3H_4} / X_{C_3H_4} = 8.8 \times 10^{-3}$$

$$\Delta X_{C_3H_6} / X_{C_3H_6} = 8.3 \times 10^{-3}$$

$$\Delta X_{C_4H_6} / X_{C_4H_6} = 9.0 \times 10^{-3}$$

$$\Delta X_{C_4H_8} / X_{C_4H_8} = 8.7 \times 10^{-3}$$

$$\Delta X_{C_2H_2} = 1.0 \times 10^{-6} \quad \text{即} \quad X_{C_2H_2} = 97.6 \times 10^{-6} \pm 1.0 \times 10^{-6}$$

$$\Delta X_{C_2H_4} = 1.0 \times 10^{-6} \quad \text{即} \quad X_{C_2H_4} = 97.3 \times 10^{-6} \pm 1.0 \times 10^{-6}$$

$$\Delta X_{C_3H_4} = 1.0 \times 10^{-6} \quad \text{即} \quad X_{C_3H_4} = 97.6 \times 10^{-6} \pm 1.0 \times 10^{-6}$$

$$\Delta X_{C_3H_6} = 1.0 \times 10^{-6} \quad \text{即} \quad X_{C_3H_6} = 97.6 \times 10^{-6} \pm 1.0 \times 10^{-6}$$

$$\Delta X_{C_4H_6} = 1.0 \times 10^{-6} \quad \text{即} \quad X_{C_4H_6} = 98.1 \times 10^{-6} \pm 1.0 \times 10^{-6}$$

$$\Delta X_{C_4H_8} = 1.0 \times 10^{-6} \quad \text{即} \quad X_{C_4H_8} = 97.6 \times 10^{-6} \pm 1.0 \times 10^{-6}$$

对于氮中 n-C<sub>5</sub>H<sub>12</sub>, I-C<sub>5</sub>H<sub>12</sub> 混合标准气体

由表 1-1 配制记录表可计算出二次稀释后各组份气的摩尔浓度

已知:

$$M_{i-C_5H_{12}} = M_{n-C_5H_{12}} = 72.150 \text{ g/mol} \quad M_{N_2} = 28.0134 \text{ g/mol}$$

$$n_{n-C_5H_{12}} = 5.531 \times 4.8521 / [(5.531 + 103.301) \times 72.150] = 0.00330 \text{ molL}$$

$$n_{N_2}^1 = 103.301 \times 4.851 / [(5.531 + 103.301) \times 28.0134] = 0.1647 \text{ molL}$$

$$n_{i-C_5H_{12}} = 5.340 \times 4.792 / [(5.340 + 102.902) \times 72.150] = 0.00327 \text{ molL}$$

$$n_{N_2}^2 = 102.902 \times 4.792 / [(5.340 + 102.902) \times 28.0134] = 0.1626 \text{ molL}$$

$$n_{N_2}^3 = 453.116 / 28.0134 = 16.175 \text{ molL} \quad n = \sum n_i = 16.5088 \text{ molL}$$

则:

$$X_{n-C_5H_{12}} = 0.00330 / 16.5088 = 199.9 \times 10^{-6}$$

$$X_{i-C_5H_{12}} = 0.00332 / 16.5088 = 198.1 \times 10^{-6}$$

称量不确定度的计算:

$$\text{由于: } \Delta X_{2i} / X_{2i} \leq \Delta \mu_1 / \mu_1 (1 - n \cdot \mu_1 / N_{S_2} \cdot m) / \mu_1$$

$$+ \Delta \mu_{d_1} \cdot N_{d_1} / \mu_{d_1} \cdot N_{S_2} \quad (7)$$

$$+ \Delta m_i \cdot [1 - m_i / m - (X_i - m_i / m) \cdot n \cdot \mu_1 / N_{S_2} \cdot m] / m_i$$

$$+ \sum \Delta m_j \cdot [m_j / m + (X_j - m_j / m) \cdot n \cdot \mu_1 / N_{S_2} \cdot m] / m_j$$

$$m = m_i + \sum m_j$$

$$n = n_i + \sum n_j$$

$N_{S_2}$  为所得混合气的总摩尔数

$$\text{由 } \Delta \mu_1 = \Delta m_1 = 0.031 \text{g}; \quad \Delta \mu_{d_1} = \Delta m_2 = 0.0712 \text{g}$$

$$\text{推出: } \Delta \mu_1 / \mu_1 = 0.031 / 4.851 = 6.390 \times 10^{-3}$$

$$\Delta \mu_{d_1} / \mu_{d_1} = 0.0712 / 453.116 = 1.571 \times 10^{-4}$$

$$\text{已知: } N_{2i} = 0.0033$$

$$N_{d_1} = 16.175$$

$$N_{S_2} = 16.5088$$

$$m_1/m=5.331/(5.331+103.301)=0.04907$$

$$m_2/m=103.301/(5.331+103.301)=0.9509$$

$$n \cdot \mu_1/N_{S_2} \cdot m=9.983 \times 10^{-3}$$

$$N_{d1}/N_{S_2}=0.97978$$

$$X_1 - m_1/m = -0.02943$$

$$X_2 - m_2/m = 0.02943$$

代入(7)式计算  $X_{n-C_5H_{12}}$  的相对不确定度

$$\Delta X_{n-C_5H_{12}}/X_{n-C_5H_{12}} \leq 0.951 \times 10^{-2}$$

$$\text{则 } \Delta X_{n-C_5H_{12}} \leq 0.95 \times 10^{-2} \times 199.9 \times 10^{-6} \leq 1.9 \times 10^{-6}$$

$$\text{即 } X_{n-C_5H_{12}} = 199.9 \times 10^{-6} \pm 1.9 \times 10^{-6}$$

同理可推出其他组份的不确定度

$$\Delta X_{i-C_5H_{12}}/X_{i-C_5H_{12}} = 0.945$$

$$\Delta X_{i-C_5H_{12}} = 1.9 \times 10^{-6} \quad \text{即 } X_{i-C_5H_{12}} = 198.1 \times 10^{-6} \pm 1.9 \times 10^{-6}$$

对于乙烯中  $CO, CO_2, C_2H_2, CH_3OH$  标准气体

由表 1-2 配制记录表可计算出二次稀释后各组份气的摩尔浓度

已知:

$$M_{CO} = 28.010 \text{ g/mol}$$

$$M_{CO_2} = 44.010 \text{ g/mol}$$

$$M_{C_2H_2} = 26.038 \text{ g/mol}$$

$$M_{CH_3OH} = 32.040 \text{ g/mol}$$

$$M_{C_2H_4} = 29.054 \text{ g/mol}$$

$$n_{CO} = 2.561 \times 2.319 / [(2.561 + 103.601) \times 28.010] = 0.001998 \text{ mol/L}$$

$$n^1_{C_2H_4} = 103.601 \times 2.319 / [(2.561 + 103.601) \times 28.054] = 0.080670197 \text{ molL}$$

$$n_{CO_2} = 4.321 \times 2.201 / [(4.321 + 103.902) \times 44.010] = 0.001997 \text{ molL}$$

$$n^2_{C_2H_4} = 103.902 \times 2.201 / [(4.321 + 103.902) \times 28.054] = 0.07532 \text{ molL}$$

$$n_{C_2H_2} = 2.210 \times 2.422 / [(2.210 + 100.602) \times 26.038] = 0.001999 \text{ molL}$$

$$n^3_{C_2H_4} = 100.602 \times 2.422 / [(2.210 + 100.602) \times 28.054] = 0.08448 \text{ molL}$$

$$n_{CH_3OH} = 1.620 \times 4.031 / [(1.620 + 100.401) \times 32.040] = 0.001998 \text{ molL}$$

$$n^4_{C_2H_4} = 269.418 / 28.054 = 9.6036 \text{ molL} \quad n = \sum n_i = 9.9935 \text{ molL}$$

则:  $X_{CO} = 0.001998 / 9.9935 = 199.9 \times 10^{-6}$

$$X_{CO_2} = 0.001997 / 9.9935 = 199.8 \times 10^{-6}$$

$$X_{C_2H_2} = 0.001999 / 9.9935 = 200.1 \times 10^{-6}$$

$$X_{CH_3OH} = 0.001998 / 9.9935 = 199.9 \times 10^{-6}$$

称量不确定度的计算

同理根据(7)式可推出各组份的不确定度

$$\Delta X_{CO} / X_{CO} = 0.935$$

$$\Delta X_{CO_2} / X_{CO_2} = 0.960$$

$$\Delta X_{C_2H_2} / X_{C_2H_2} = 0.930$$

$$\Delta X_{CH_3OH} / X_{CH_3OH} = 0.970$$

$$\Delta X_{CO} = 1.87 \times 10^{-6} \quad \text{即} \quad X_{CO} = 199.9 \times 10^{-6} \pm 1.9 \times 10^{-6}$$

$$\Delta X_{CO_2} = 1.9 \times 10^{-6} \quad \text{即} \quad X_{CO_2} = 199.8 \times 10^{-6} \pm 1.9 \times 10^{-6}$$

$$\Delta X_{C_2H_2} = 1.86 \times 10^{-6} \quad \text{即} \quad X_{C_2H_2} = 200.1 \times 10^{-6} \pm 1.9 \times 10^{-6}$$

$$\Delta X_{CH_3OH} = 1.94 \times 10^{-6} \quad \text{即} \quad X_{CH_3OH} = 199.9 \times 10^{-6} \pm 1.9 \times 10^{-6}$$



对于氮中  $\text{SO}_2, \text{H}_2\text{S}, \text{COS}$  混合标准气体

由表 1-1 配制记录表可计算出二次稀释后各组份气的摩尔浓度

已知:  $M_{\text{H}_2\text{S}} = 34.080 \text{ g/mol}$      $M_{\text{COS}} = 60.070 \text{ g/mol}$

$M_{\text{SO}_2} = 64.063 \text{ g/mol}$      $M_{\text{N}_2} = 28.0134 \text{ g/mol}$

$$n_{\text{SO}_2} = 5.531 \times 21.8621 / [(5.531 + 108.610) \times 64.063] = 0.01654 \text{ mol}$$

$$n_{\text{N}_2}^1 = 108.601 \times 21.862 / [(5.531 + 108.610) \times 28.0134] = 0.7426 \text{ mol}$$

$$n_{\text{H}_2\text{S}} = 4.862 \times 13.011 / [(4.862 + 106.704) \times 34.080] = 0.01664 \text{ mol}$$

$$n_{N_2}^2 = 106.704 \times 13.011 / [(4.862 + 106.704) \times 28.0134] = 0.4442 \text{ molL}$$

$$n_{COS} = 5.462 \times 20.742 / [(5.462 + 108.304) \times 60.070] = 0.01658 \text{ molL}$$

$$n_{N_2}^3 = 108.304 \times 20.742 / [(5.462 + 108.304) \times 28.0134] = 0.7049 \text{ molL}$$

$$n_{N_2}^4 = 862.720 / 28.0134 = 30.797 \text{ molL} \quad n = \sum n_i = 32.7382 \text{ molL}$$

则:

$$X_{SO_2} = 505.2 \times 10^{-6}$$

$$X_{H_2S} = 508.3 \times 10^{-6}$$

$$X_{COS} = 506.4 \times 10^{-6}$$

称量不确定度的计算:

由于:  $\Delta X_{2i} / X_{2i} \leq \Delta \mu_1 (1 - n \cdot \mu_1 / N_{S_2} \cdot m) / \mu_1$

$$+ \Delta \mu_{d_1} \cdot N_{d_1} / \mu_{d_1} \cdot N_{S_2} \quad (7)$$

$$+ \Delta m_i \cdot [1 - m_i / m - (X_i - m_i / m) \cdot n \cdot \mu_1 / N_{S_2} \cdot m] / m_i$$

$$+ \sum \Delta m_j \cdot [m_j / m + (X_j - m_j / m) \cdot n \cdot \mu_1 / N_{S_2} \cdot m] / m_j$$

$$m = m_i + \sum m_j \quad n = n_i + \sum n_j$$

$N_{S_2}$  为所得混合气的总摩尔数

由  $\Delta \mu_1 = \Delta m_1 = 0.040g$ ;  $\Delta \mu_{d_1} = \Delta m_2 = 0.0709g$

推出:  $\Delta \mu_1 / \mu_1 = 0.040 / 21.862 = 1.83 \times 10^{-3}$

$$\Delta \mu_{d_1} / \mu_{d_1} = 0.0709 / 862.720 = 8.218 \times 10^{-5}$$

已知:  $N_{2i} = 0.01654$

$$N_{d_1} = 30.797$$

$$N_{S_2} = 32.7382$$

$$m_1 / m = 0.04846$$

$$m_2/m=0.9515$$

$$n \cdot \mu_1/N_{S_2} \cdot m=0.1807$$

$$N_{d1}/N_{S_2}=0.9407$$

$$X_1 - m_1/m = -0.02666$$

$$X_2 - m_2/m = 0.02666$$

代入(7)式计算  $X_{SO_2}$  的相对不确定度

$$\Delta X_{SO_2}/X_{SO_2} \leq 8.57 \times 10^{-3}$$

$$\text{则 } \Delta X_{SO_2} \leq 8.57 \times 10^{-3} \times 505.2 \times 10^{-6} \leq 4.329 \times 10^{-6}$$

$$\text{即 } X_{SO_2} = 505.2 \times 10^{-6} \pm 4.5 \times 10^{-6}$$

同理可推出其他组份的不确定度

$$\Delta X_{H_2S}/X_{H_2S} = 8.54 \times 10^{-3}$$

$$\Delta X_{COS}/X_{COS} = 8.56 \times 10^{-3}$$

$$\Delta X_{H_2S} = 4.5 \times 10^{-6} \quad \text{即 } X_{H_2S} = 508.3 \times 10^{-6} \pm 4.5 \times 10^{-6}$$

$$\Delta X_{COS} = 4.5 \times 10^{-6} \quad \text{即 } X_{COS} = 506.4 \times 10^{-6} \pm 4.5 \times 10^{-6}$$

对于氮中  $CO, CO_2, CH_4$  标准气体

由表 1-2 配制记录表可计算出二次稀释后各组份气的摩尔浓度

已知:

$$M_{CO} = 28.010 \text{g/mol}$$

$$M_{CO_2} = 44.010 \text{g/mol}$$

$$M_{CH_4} = 16.043 \text{g/mol}$$

$$M_{N_2} = 28.0134 \text{g/mol}$$

$$n_{CO} = 2.601 \times 3.852 / [(2.601 + 105.603) \times 28.010] = 0.00331 \text{ molL}$$

$$n_{N_2}^1 = 105.603 \times 3.852 / [(2.601 + 105.603) \times 28.0134] = 0.1334 \text{ molL}$$

$$n_{CO_2} = 4.291 \times 3.641 / [(4.291 + 103.101) \times 44.010] = 0.00331 \text{ molL}$$

$$n_{N_2}^2 = 103.101 \times 3.641 / [(4.291 + 103.101) \times 28.0134] = 0.1248 \text{ molL}$$

$$n_{CH_4} = 2.130 \times 2.690 / [(2.130 + 106.302) \times 16.043] = 0.00330 \text{ molL}$$

$$n^3_{N_2} = 106.302 \times 2.690 / [(2.130 + 106.302) \times 28.0134] = 0.09414 \text{ molL}$$

$$n^4_{N_2} = 905.426 / 28.0134 = 32.3212 \text{ molL} \quad n = \sum n_i = 32.6834 \text{ molL}$$

则:  $X_{CO} = 101.3 \times 10^{-6}$

$$X_{CO_2} = 101.3 \times 10^{-6}$$

$$X_{CH_4} = 101.0 \times 10^{-6}$$

称量不确定度的计算

同理根据(7)式可推出各组份的不确定度

$$\Delta X_{CO} / X_{CO} = 9.87 \times 10^{-3}$$

$$\Delta X_{CO_2} / X_{CO_2} = 9.82 \times 10^{-3}$$

$$\Delta X_{CH_4} / X_{CH_4} = 9.90 \times 10^{-3}$$

$$\Delta X_{CO} = 1.0 \times 10^{-6} \quad \text{即} \quad X_{CO} = 101.3 \times 10^{-6} \pm 1.0 \times 10^{-6}$$

$$\Delta X_{CO_2} = 1.0 \times 10^{-6} \quad \text{即} \quad X_{CO_2} = 101.3 \times 10^{-6} \pm 1.0 \times 10^{-6}$$

$$\Delta X_{CH_4} = 1.0 \times 10^{-6} \quad \text{即} \quad X_{CH_4} = 101.0 \times 10^{-6} \pm 1.0 \times 10^{-6}$$

## 5. 定值与不确定度的计算

### 5.1 误差来源

标准气体组份含量的不确定度来源于原料气体纯度的不确定度(组份气体纯度的不确定度以及稀释气中 I 组份含量及其测定的不确定度)和配制称量过程的不确定度以及混合气体在瓶内的稳定性,均匀性引起的不确定度.

#### 5.1.1 原料气纯度的不确定度(B类不确定度)

#### 5.1.2 抽空充气过程引入的误差(B类不确定度)

#### 5.1.3 称量的不确定度(A类不确定度)

##### 1) 天平称量的不确定度

TG320B 型机械天平称量不确定度为 3mg

- 2) 砝码值的不确定度 (B 类不确定度)
- 3) 浮力影响 的不确定度 (B 类不确定度)
- 4) 分子量测量的不确定度 (B 类不确定度)

分子量测量的不确定度一般为  $10^{-5}$ - $10^{-6}$ , 可以忽略.

- 5) 气瓶与充气装置连接拆装机机械磨损的不确定度 (B 类不确定度)

根据 GB5274-85 称量法配制标准气摩尔浓度和相对不确定度的计算可参照 3.2.2.1 式和 3.2.2.2(7) 式