New correlations for prediction of high-pressure phase equilibria of n-alkane mixtures with the RKPR EoS: Back from the use of $l_{ij}$ (repulsive) interaction parameters

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Section A. Tables containing selected data for objective functions

Table S1. Experimental liquid-vapor critical pressures ($P_c$) and critical compositions [$z_c$ ($\text{CH}_4$)] at given temperatures, for some $\text{CH}_4$ (1) + n-alkane (2) systems, selected for the objective function. Compound 2 is indicated by its Carbon Number (CN).

| CN  | Temperature (K) | $P_c$ (bar) | $z_c$ ($\text{CH}_4$) | Reference               |
|-----|-----------------|-------------|-----------------------|-------------------------|
| 2   | 230.0           | 65.0        | 0.765                 | Wei et al. (1995) ¹     |
|     | 270.0           | 66.5        | 0.438                 | Raabe et al. (2001) ²   |
| 3   | 241.5           | 94.4        | 0.835                 | Akers et al. (1954) ³   |
|     | 319.5           | 89.1        | 0.5                   | Sage et al. (1934) ⁴    |
| 4   | 233.18          | 93.495      | 0.9097                | Elliot et al. (1974) ⁵  |
|     | 377.6           | 104.8       | 0.4722                | Sage et al. (1940) ⁶    |
| 5   | 273.16          | 151.19      | 0.9086                | Chu et al. (1976) ⁷     |
|     | 310.9           | 169.3       | 0.8236                | Sage et al. (1942) ⁸    |
| 6   | 273.16          | 184.3075    | 0.929                 | Chen et al. (1976) ⁹    |
|     | 323             | 201.6       | 0.81                  | Marteau et al. (1997) ¹⁰|
| 10  | 277.6           | 361.3       | 0.905                 | Wiese et al. (1970) ¹¹  |
|     | 444.3           | 287.0       | 0.833                 | Reamer et al. (1969) ¹² |
| 14  | 320.74          | 540         | 0.89                  | de Leeuw et al. (1992) ¹³|
|     | 431             | 430         | 0.89                  |                         |
| 16  | 293.15          | 695.5       | 0.94                  | Rijkers et al. (1993) ¹⁴|
|     | 350.0           | 593.2       | 0.93                  | Glaser et al. (1985) ¹⁵|
| 20  | 307.37          | 890.0       | 0.951                 | van der Kooi et al. (1995) ¹⁶|
|     | 353.15          | 754.0       | 0.951                 |                         |
Table S1 (Continued).

| CN | Temperature (K) | $P_c$ (bar) | $z_c$ (CH$_4$) | Reference |
|----|----------------|-------------|----------------|-----------|
| 24 | 322.6          | 1047        | 0.9590         | Floter et al. (1997) $^{17}$ |
|    | 442.62         | 710.2       | 0.957          |           |
| 30 | 359.46         | 1142        | 0.97           | Machado & de Loos (2004) $^{18}$ |
|    | 470.68         | 799.0       | 0.97           |           |
| 36 | 373.0          | 1274.0      | 0.972          | Marteau et al. (1998) $^{19}$ |
|    | 453.0          | 945.0       | 0.965          |           |

Table S2. Experimental liquid-vapor critical pressures ($P_c$) and critical compositions [$z_c$ (C$_2$H$_6$)] at given temperatures, for some C$_2$H$_6$ + n-alkane systems, selected for the objective function. Compound 2 is indicated by its Carbon Number (CN).

| CN | Temperature (K) | $P_c$ (bar) | $z_c$ (C$_2$H$_6$) | Reference |
|----|----------------|-------------|-------------------|-----------|
| 4  | 324.39         | 54.13       | 0.9095            | Horstmann et al. (2001) $^{20}$ |
|    | 352.55         | 58.13       | 0.7407            |           |
| 5  | 324.50         | 58.50       | 0.9480            | Singh et al. (2000) $^{21}$ |
|    | 377.59         | 68.26       | 0.7189            | Reamer et al. (1960) $^{22}$ |
| 10 | 344.26         | 81.64       | 0.964             | Reamer & Sage (1962) $^{23}$ |
|    | 444.26         | 118.25      | 0.835             |           |
| 16 | 322.90         | 66.80       | 0.980             | du Rand & Nieuwoudt (2001) $^{24}$ |
|    | 352.70         | 105.40      | 0.960             |           |
| 20 | 310.66         | 56.701      | 0.977             | Kohn et al. (1966) $^{25}$ |
|    | 370.00         | 145.00      | 0.960             | Peters et al. (1987) $^{26}$ |
Table S2 (continued).

| CN | Temperature (K) | $P_c$ (bar) | $z_c$ (C$_3$H$_8$) | Reference                  |
|----|-----------------|-------------|-------------------|---------------------------|
| 24 | 332.80          | 113.40      | 0.970             | du Rand & Nieuwoudt (2001) |
|    | 352.70          | 144.00      | 0.960             |                           |
| 28 | 337.80          | 142.20      | 0.965             | du Rand & Nieuwoudt (2001) |
|    | 352.60          | 164.80      | 0.955             |                           |
| 36 | 350.00          | 200.00      | 0.975             | Schwarz et al. (2008)     |
|    | 366.00          | 224.00      | 0.975             |                           |

Table S3. Experimental liquid-vapor critical pressures ($P_c$) and critical compositions [$z_c$ (C$_3$H$_8$)] at given temperatures, for some \( C_3H_8 \) (1) + n-alkane (2) systems, selected for the objective function. Compound 2 is indicated by its Carbon Number (CN).

| CN | Temperature (K) | $P_c$ (bar) | $z_c$ (C$_3$H$_8$) | Reference |
|----|-----------------|-------------|-------------------|-----------|
| 4  | 390.65          | 43.96       | 0.695             | Nysewander et al. (1940) |
|    | 410.85          | 40.70       | 0.309             | Kay (1970) |
| 6  | 411.45          | 49.50       | 0.813             | Kay (1971) |
|    | 422.15          | 49.90       | 0.76              |           |
| 8  | 455.75          | 59.60       | 0.775             | Kay et al. (1974) |
|    | 499.25          | 53.60       | 0.573             |           |
| 10 | 426.76          | 64.256      | 0.90              | Reamer & Sage (1966)     |
|    | 477.32          | 70.878      | 0.80              |           |
| 14 | 378             | 50.0        | 0.99              | (pseudocritical)         |
|    | 408             | 65.0        | 0.94              | Schwarz et al. (2008)    |
| 32 | 378.2           | 57.7        | 0.978             | (pseudocritical)         |
|    | 408.2           | 92.3        | 0.978             | Schwarz & Nieuwoudt (2003) |
| 34 | 388.76          | 67.0        | 0.984             | (pseudocritical)         |
|    | 427.85          | 110.0       | 0.984             | Peters et al. (1992)     |
### Table S3 (continued).

| CN | Temperature (K) | $P_c$ (bar) | $z_c$ ($\text{C}_3\text{H}_8$) | Reference                |
|----|-----------------|-------------|--------------------------|--------------------------|
| 36 | 378.15          | 61.8        | 0.9865                   | (pseudocritical)         |
|    | 408.15          | 100.5       | 0.9805                   | Schwarz & Nieuwoudt (2003) |
| 40 | 378.15          | 69.5        | 0.979                    | (pseudocritical)         |
|    | 408.15          | 109.35      | 0.985                    | Schwarz & Nieuwoudt (2003) |
| 46 | 378.15          | 76.15       | 0.981                    | (pseudocritical)         |
|    | 408.15          | 115.75      | 0.981                    | Schwarz & Nieuwoudt (2003) |
| 54 | 378.15          | 93.15       | 0.985                    | (pseudocritical)         |
|    | 408.15          | 134.65      | 0.990                    | Schwarz & Nieuwoudt (2003) |
| 60 | 378.15          | 99.45       | 0.982                    | (pseudocritical)         |
|    | 408.15          | 141.75      | 0.984                    | Schwarz & Nieuwoudt (2003) |

### Table S4.
Experimental liquid-vapor critical pressures ($P_c$) and critical compositions [$z_c$ ($\text{C}_4\text{H}_{10}$)] at given temperatures, for some $\text{C}_4\text{H}_{10}$ (1) + n-alkane (2) systems, selected for the objective function. Compound 2 is indicated by its Carbon Number (CN).

| CN | Temperature (K) | $P_c$ (bar) | $z_c$ ($\text{C}_4\text{H}_{10}$) | Reference                |
|----|-----------------|-------------|----------------------------------|--------------------------|
| 10 | 465.65          | 46.4707     | 0.90                             | Reamer & Sage (1964)     |
|    | 518.87          | 49.00793    | 0.70                             |                          |
| 60 | 433.15          | 66.0        | 0.98414                          | (pseudocritical)         |
|    | 453.15          | 87.2        | 0.98689                          | Nieuwoudt (1996)         |

### Table S5.
Experimental fluid phase compositions under two-phase equilibrium conditions, at specified T and P, for some $\text{CH}_4$ (1) + n-alkane (2) systems, considered in the objective function.

| CN | T (K) | P (bar) | $x_1$ | $y_1$ | Reference                |
|----|-------|--------|-------|-------|--------------------------|
| 2  | 210.000 | 16.100 | 0.2263 | 0.7782 | Wei et al. (1995)         |
|    | 230.000 | 27.560 | 0.2573 | 0.7100 |                          |
|    | 240.001 | 44.221 | 0.3684 | 0.7248 | Raabe et al. (2001)      |
|    | 250.000 | 55.930 | 0.4260 | 0.6730 | Davalos et al. (1976)    |
|    | 269.835 | 60.136 | 0.3276 | 0.4917 | Raabe et al. (2001)      |
| CN  |  τ   |  x   |  y   | Reference            |
|-----|------|------|------|----------------------|
| 3   | 187.54 | 6.90 | 0.1506 | 0.9839 | Wichterle & Kobayashi (1972) |
| 230.00 | 39.71 | 0.4126 | 0.9556 | Webster et al. (2001) |
| 270.00 | 84.13 | 0.5642 | 0.8356 | Reamer et al. (1950) |
| 294.26 | 41.40 | 0.1987 | 0.7038 | Roy Price & Kobayashi (1959) |
| 255.37 | 82.80 | 0.6370 | 0.8730 | Reamer et al. (1950) |
| 327.59 | 75.90 | 0.3361 | 0.5546 | |
| 344.26 | 65.50 | 0.2375 | 0.3678 | |
| 344.26 | 34.50 | 0.0433 | 0.1550 | |
| 4   | 277.59 | 103.5 | 0.539 | 0.92621 | Wiese et al. (1970) |
| 310.95 | 126.2 | 0.6111 | 0.8232 | Gozalpour et al. (2005) |
| 377.59 | 69.0 | 0.2361 | 0.563 | Wiese et al. (1970) |
| 410.93 | 46.161 | 0.087 | 0.202 | Roberts et al. (1962) |
| 6   | 273.15 | 61.1 | 0.315 | 0.9958 | Kandil et al. (2011) |
| 273.15 | 142.3 | 0.61 | 0.973 | |
| 373.15 | 59.8 | 0.2199 | 0.9158 | Marteau et al. (1997) |
| 373.15 | 177.0 | 0.6178 | 0.8176 | |
| 423.0 | 30.0 | 0.0826 | 0.6695 | Shim et al. (1962) |
| 423.0 | 90.0 | 0.304 | 0.76 | |
| 10  | 423.15 | 70.7 | 0.2309 | 0.9819 | Lin et al. (1979) |
| 510.95 | 120.291 | 0.3855 | 0.8911 | |
| 563.25 | 75.6288 | 0.2744 | 0.7118 | |
| 20  | 573.2 | 20.089 | 0.0869 | 0.9772 | Huang et al. (1988) |
| 573.2 | 50.237 | 0.2030 | 0.9876 | |
| 36  | 373.0 | 906.0 | 0.89956 | 0.99699 | Marteau et al. (1998) |
| 423.0 | 803.0 | 0.90334 | 0.9973 | |
| 453.0 | 399.0 | 0.77685 | 0.99977 | |

CN: Carbon number of the n-alkane. \( x_1 \) and \( y_1 \) are mole fractions of CH\(_4\) in the heavy and light phases respectively.
Table S6. Experimental fluid phase compositions under two-phase equilibrium conditions, at specified T and P, for some C$_2$H$_6$ (1) + n-alkane (2) systems, considered in the objective function. Compound 2 is indicated by its Carbon Number (CN).

| CN | T (K) | P (bar) | $x_1$ | $y_1$ | Reference |
|----|-------|---------|-------|-------|-----------|
|    | 338.7 | 48.33   | 0.653 | 0.833 | Mehra & Thodos (1965) | 50 |
|    | 366.48| 47.64   | 0.437 | 0.650 |           | |
| 4  | 394.26| 43.02   | 0.230 | 0.377 |           | |
|    | 303.15| 33.13   | 0.791 | 0.944 | Lhotak & Wichterle (1981) | 51 |
|    | 323.15| 28.31   | 0.486 | 0.830 |           | |
|    | 343.17| 36.54   | 0.477 | 0.747 |           | |
|    | 363.40| 30.78   | 0.261 | 0.529 |           | |
| 5  | 277.6 | 10.34   | 0.4316| 0.9659|           | |
|    | 310.93| 20.69   | 0.4474| 0.9389|           | |
|    | 344.26| 27.58   | 0.3991| 0.8722| Reamer et al. (1960) | 22 |
|    | 377.6 | 34.48   | 0.3430| 0.7661|           | |
|    | 410.93| 48.27   | 0.3426| 0.6107|           | |
|    | 444.26| 41.37   | 0.1606| 0.3299|           | |
| 10 | 410.93| 6.9     | 0.0675| 0.945 |           | |
|    | 444.26| 13.79   | 0.1107| 0.9306|           | |
|    | 477.6 | 20.69   | 0.1383| 0.8845| Reamer & Sage (1962) | 23 |
|    | 510.93| 27.58   | 0.1588| 0.784 |           | |
|    | 444.26| 103.43  | 0.6849| 0.939 |           | |
|    | 510.93| 89.64   | 0.5448| 0.8139|           | |
| 28 | 337.8 | 117.7   | 0.9041| 0.9955| du Rand & Nieuwoudt (2001) | 24 |

CN: Carbon number of the n-alkane. $x_1$ and $y_1$ are mole fractions of C$_2$H$_6$ in the heavy and light phases respectively.

Table S7. Experimental fluid phase compositions under two-phase equilibrium conditions, at specified T and P, for some C$_3$H$_8$ (1) + n-alkane (2) systems, considered in the objective function. Compound 2 is indicated by its Carbon Number (CN).

| CN | T (K) | P (bar) | $x_1$ | $y_1$ | Reference |
|----|-------|---------|-------|-------|-----------|
|    | 273.15| 1.44    | 0.113 | 0.3   |           | |
|    | 313   | 9.88    | 0.64  | 0.819 | Seong et al (2008) | 52 |
| 4  | 323   | 16.02   | 0.922 | 0.964 |           | |
|    | 280   | 1.979   | 0.1734| 0.4585| Kayukawa et al (2005) | 55 |
|    | 300   | 5.328   | 0.3878| 0.6703|           | |
| 10 | 376.95| 32.41   | 0.796 | 0.9931| Jennings & Schucker (1966) | 54 |
CN: Carbon number of the n-alkane. $x_i$ and $y_i$ are mole fractions of $C_{4}H_{10}$ in the heavy and light phases respectively.

**Table S8.** Experimental fluid phase compositions under two-phase equilibrium conditions, at specified $T$ and $P$, for some $C_{4}H_{10}$ (1) + n-alkane (2) systems, considered in the objective function. Compound 2 is indicated by its Carbon Number (CN).

| CN | $T$ (K) | $P$ (bar) | $x_i$ | $y_i$ | Reference |
|----|---------|-----------|-------|-------|-----------|
| 10 | 410.93  | 13.78951  | 0.5553| 0.9749| Reamer & Sage (1964) 36 |
|    | 444.26  | 31.02641  | 0.7630| 0.9677|           |
|    | 477.59  | 24.13165  | 0.4658| 0.8899|           |
|    | 510.93  | 31.02641  | 0.4552| 0.8209| Nieuwoudt (1996) 37 |
| 60 | 453.15  | 74.00     | 0.9476| 0.9981|           |
|    | 453.15  | 81.90     | 0.9631| 0.9954|           |
|    | 433.15  | 58.00     | 0.9558| 0.9985|           |
|    | 433.15  | 59.80     | 0.9615| 0.9981|           |

CN: Carbon number of the n-alkane. $x_i$ and $y_i$ are mole fractions of $C_{4}H_{10}$ in the heavy and light phases respectively.

**Table S9.** Experimental bubble pressures at given temperature and liquid phase composition for some $CH_{4}$ (1) + n-alkane (2) systems, considered in the objective function. Compound 2 is indicated by its Carbon Number (CN).

| CN | $T$ (K) | $P$ (Bar) | $x_i$ | Reference |
|----|---------|-----------|-------|-----------|
| 3  | 144.26  | 5.106     | 0.5258| Wichterle & Kobayashi (1972) 39 |
|    | 158.15  | 12.903    | 0.8738|           |
|    | 310.93  | 34.500    | 0.1235| Wiese et al. (1970) 43 |
| 4  | 244.26  | 89.355    | 0.58  | Roberts et al. (1962) 45 |
|    | 273.16  | 96.516    | 0.4480|           |
|    | 248.34  | 82.727    | 0.4965|           |
| 5  | 223.92  | 55.152    | 0.4737| Chu et al. (1976) 7 |
|    | 194.17  | 41.364    | 0.6226|           |
|    | 176.21  | 20.696    | 0.4819|           |
| CN | T (K) | P (Bar) | x₁ | Reference |
|----|-------|---------|----|-----------|
| 6  | 198.05| 27.579  | 0.3412 | Lin et al. (1977)  |
|    | 198.05| 72.739  | 0.8932 | Kandil et al. (2011)  |
|    | 273.15| 61.1    | 0.315  | Rijkers et al. (1992)  |
| 10 | 326.30| 84.65   | 0.3050 | Lin et al. (1979)  |
|    | 336.13| 319.05  | 0.7493 | Nourozieh et al. (2012)  |
|    | 583.05| 30.5424 | 0.0857 | de Leeuw et al. (1992)  |
| 14 | 294.0 | 65.0    | 0.282  | Glaser et al. (1985)  |
|    | 324.0 | 20.7    | 0.100  | van der Kooi et al. (1995)  |
|    | 348.7 | 135     | 0.396  | Darwish et al. (1993)  |
|    | 400.02| 265     | 0.593  |             |
|    | 429.6 | 349.1   | 0.771  |             |
| 16 | 361.36| 515.6   | 0.824  |             |
|    | 292.72| 369.4   | 0.703  |             |
|    | 361.44| 361.8   | 0.703  |             |
|    | 293.22| 156.9   | 0.497  |             |
|    | 347.37| 179.4   | 0.497  |             |
|    | 323.12| 45.33   | 0.184  |             |
| 20 | 305.8 | 659.4   | 0.823  |             |
|    | 323.2 | 466.0   | 0.748  |             |
|    | 423.2 | 38.5    | 0.1560 |             |
|    | 423.2 | 106.9   | 0.3500 |             |

CN: Carbon number of the n-alkane. x₁ is the mole fraction of CH₄ in the liquid phase.

**Table S9. (Continued).** Experimental bubble pressures at given temperature and liquid phase composition for some CH₄ (1) + n-alkane (2) systems, considered in the objective function. Compound 2 is indicated by its Carbon Number (CN).
| CN | T (K)  | P (bar) | x<sub>1</sub>  | Reference                        |
|----|--------|---------|---------------|----------------------------------|
| 30 | 341.22 | 224     | 0.598         | Machado & de Loos (2004)          |
|    | 349.65 | 955.0   | 0.897         |                                  |
|    | 352.01 | 66.0    | 0.299         |                                  |
|    | 384.51 | 537     | 0.798         |                                  |
| 30 | 425.97 | 232     | 0.598         |                                  |
|    | 440.78 | 502     | 0.798         |                                  |
|    | 452.38 | 737.0   | 0.897         |                                  |
|    | 472.5  | 74.8    | 0.299         |                                  |
| 36 | 373.0  | 40.06   | 0.230         |                                  |
|    | 473.0  | 20.02   | 0.118         | Tsai et al. (1987)               |
|    | 573.0  | 20.12   | 0.114         |                                  |
|    | 573.0  | 50.05   | 0.250         |                                  |
| 36 | 373.0  | 906.0   | 0.89956       |                                  |
|    | 398.0  | 146.0   | 0.51294       | Marteau et al. (1998)            |
|    | 423.0  | 803.0   | 0.90334       |                                  |
|    | 453.0  | 399.0   | 0.77685       |                                  |
|    | 423.2  | 48.9    | 0.2478        | Darwish et al. (1993)            |

CN: Carbon number of the n-alkane. x<sub>1</sub> is the mole fraction of CH<sub>4</sub> in the liquid phase.

Table S10. Experimental bubble pressures at given temperature and liquid phase composition for some C<sub>2</sub>H<sub>6</sub> (1) + n-alkane (2) systems, considered in the objective function. Compound 2 is indicated by its Carbon Number (CN).
Table S10. (Continued). Experimental bubble pressures at given temperature and liquid phase composition for some C\textsubscript{2}H\textsubscript{6} (1) + n-alkane (2) systems, considered in the objective function. Compound 2 is indicated by its Carbon Number (CN).

| CN | T (K) | P(bar) | x\textsubscript{1} | Reference |
|----|-------|--------|------------------|-----------|
| 28 | 352.6 | 141.7  | 0.9041           | du Rand & Nieuwoudt (2001) \textsuperscript{24} |
|    | 348.2 | 31.3   | 0.52             | Gasem et al. (1989) \textsuperscript{65} |
|    | 373.2 | 17.55  | 0.30             |           |

CN: Carbon number of the n-alkane. x\textsubscript{1} is the mole fraction of C\textsubscript{2}H\textsubscript{6} in the liquid phase.
| CN | Temperature (K) | Pressure (bar) | Mole Fraction of Compound 2 (x₂) | Reference |
|----|----------------|----------------|-----------------------------------|-----------|
| 4  | 378.25         | 31             | 0.5211                            | Kay (1970) |
|    | 383.45         | 10.3           | 0.2198                            |           |
| 6  | 390.35         | 31             | 0.6487                            | Kay (1971) |
|    | 414.05         | 48.2           | 0.7599                            |           |
| 8  | 359.85         | 27.6           | 0.864                             | Kay et al. (1974) |
|    | 402.65         | 37.9           | 0.7175                            |           |
| 10 | 323.35         | 14.69          | 0.891                             |           |
|    | 344.15         | 19.99          | 0.794                             | Jennings & Schucker (1996) |
|    | 377.95         | 23.3           | 0.603                             |           |
| 14 | 378.0          | 33.6           | 0.7888                            | Schwarz et al. (2008) |
|    | 393.0          | 45.0           | 0.8495                            |           |
| 20 | 358.06         | 5.6            | 0.254                             |           |
|    | 309.11         | 5.2            | 0.4509                            |           |
|    | 315.12         | 7.44           | 0.5681                            |           |
|    | 328.09         | 11.42          | 0.6555                            | Gregorowicz et al. (1992) |
|    | 338.08         | 16.72          | 0.7552                            |           |
|    | 346.09         | 22.98          | 0.8597                            |           |
|    | 358.56         | 32.47          | 0.9497                            |           |
| 32 | 378.2          | 48.8           | 0.90727                           |           |
|    | 393.2          | 70.6           | 0.94322                           | Schwarz & Nieuwoudt (2003) |
|    | 408.2          | 90.7           | 0.95677                           |           |
| 34 | 336.67         | 10.49          | 0.6031                            | Peters et al. (1992) |

CN: Carbon number of the n-alkane. x₁ is the mole fraction of C₃H₈ in the liquid phase.

**Table S11.** Experimental bubble pressures at given temperature and liquid phase composition for some C₃H₈ (1) + n-alkane (2) systems, considered in the objective function. Compound 2 is indicated by its Carbon Number (CN).
Table S11. (Continued). Experimental bubble pressures at given temperature and liquid phase composition for some C\textsubscript{3}H\textsubscript{8} (1) + n-alkane (2) systems, considered in the objective function. Compound 2 is indicated by its Carbon Number (CN).

| CN | T (K) | P (bar) | x\textsubscript{1} | Reference               |
|----|-------|---------|-----------------|------------------------|
| 36 | 378.15| 50.7    | 0.9278          | Schwarz & Nieuwoudt (2003)  
|    | 393.15| 67.5    | 0.9278          |                        |
|    | 408.15| 96      | 0.9498          |                        |
| 40 | 378.15| 51.8    | 0.91232         | Schwarz & Nieuwoudt (2003)  
|    | 393.15| 82.5    | 0.95493         |                        |
| 46 | 378.15| 64.1    | 0.9484          | Schwarz & Nieuwoudt (2003)  
|    | 408.15*| 117.8   | 0.95412         |                        |
| 54 | 393.99| 18.35   | 0.6098          |                        |
|    | 419.15| 42.01   | 0.7595          |                        |
|    | 421.29| 57.91   | 0.8284          | Peters et al. (1993)  
|    | 428.97| 78.81   | 0.8682          |                        |
|    | 402.51| 91      | 0.9296          |                        |

CN: Carbon number of the n-alkane. x\textsubscript{1} is the mole fraction of C\textsubscript{3}H\textsubscript{8} in the liquid phase.

* This experimental point only could be adjusted with RKPR EoS since there is no solution for the PR EoS.

Table S12. Experimental bubble pressures at given temperature and liquid phase composition for some C\textsubscript{4}H\textsubscript{10} (1) + n-alkane (2) systems, considered in the objective function. Compound 2 is indicated by its Carbon Number (CN).

| CN | T (K) | P (bar) | x\textsubscript{1} | Reference               |
|----|-------|---------|-----------------|------------------------|
| 10 | 377.59| 10.34214| 0.68            | Reamer & Sage (1964)  
|    | 453   | 44.03   | 0.9074          |                        |
| 14 |       |         |                 | De Leeuw et al. (1992)  
|    |       |         |                 |                        |

CN: Carbon number of the n-alkane. x\textsubscript{1} is the mole fraction of C\textsubscript{3}H\textsubscript{8} in the liquid phase.
CN: Carbon number of the n-alkane. \( x_1 \) is the mole fraction of \( \text{C}_4\text{H}_{10} \) in the liquid phase.

### Table S13

Experimental dew pressures at given temperature and vapor phase composition for some \( \text{CH}_4 \, (1) + \text{n-alkane} \, (2) \) systems, considered in the objective function. Compound 2 is indicated by its Carbon Number (CN).

| CN | \( T \) (K) | \( P \) (bar) | \( x_1 \) | Reference |
|----|-------------|---------------|----------|-----------|
| 277.59 | 38.0 | 0.7966 | Reamer et al. (1950) |
| 344.26 | 48.3 | 0.2983 | Wichterle & Kobayashi (1972) |
| 195.2 | 2.1045 | 0.9244 | |
| 222.07 | 6.9138 | 0.9840 | Chen et al. (1974) |
| 277.59 | 20.7276 | 0.9176 | |
| 344.26 | 34.5 | 0.6769 | Wiese et al. (1970) |
| 273.16 | 137.88 | 0.945 | Chu et al. (1976) |
| 350.33 | 267.45 | 0.9753 | Rijkers et al. (1992) |
| 510.95 | 27.2 | 0.8029 | Lin et al. (1979) |
| 367.81 | 464.8 | 0.961 | de Leeuw et al. (1992) |
| 313.15 | 150.0 | 0.9999 | Rijkers et al. (1993) |
| CN  | T (K)       | P (bar) | y₁    | Reference                  |
|-----|-------------|---------|-------|----------------------------|
| 20  | 326.95      | 582.0   | 0.9770| Glaser et al. (1985)       |
|     | 324.37      | 659.0   | 0.992 | van der Kooi et al. (1995) |
| 24  | 328.78      | 848.0   | 0.992 | Floter et al. (1997)       |
|     | 450.45      | 554.8   | 0.992 |                            |

CN: Carbon number of the n-alkane. y₁ is the mole fraction of CH₄ in the vapour phase.

Table S14. Experimental dew pressures at given temperature and vapor phase composition for some C₂H₆ (1) + n-alkane (2) systems, considered in the objective function. Compound 2 is indicated by its Carbon Number (CN).
CN: Carbon number of the n-alkane. $y_1$ is the mole fraction of C$_2$H$_6$ in the vapour phase.

Table S15. Experimental dew pressures at given temperature and vapor phase composition for some C$_3$H$_8$ (1) + n-alkane (2) systems, considered in the objective function. Compound 2 is indicated by its Carbon Number (CN).

| CN | $T$ (K) | $P$ (bar) | $y_1$ | Reference |
|----|---------|-----------|-------|-----------|
| 6  | 383.15  | 17.085    | 0.8201| Chun et al. (1993)  |
|    | 496.7   | 33.196    | 0.1435|           |
| 8  | 524.15  | 24.10     | 0.3306| Kay et al. (1974)  |
|    | 505.15  | 31.00     | 0.5729|           |
| 32 | 393.2   | 67.10     | 0.99713| Schwarz & Nieuwoudt (2003)  |
|    | 408.2   | 84.70     | 0.99565|           |
| 36 | 378.15  | 57.40     | 0.9941|           |
|    | 393.15  | 69.10     | 0.9977| Schwarz & Nieuwoudt (2003)  |
|    | 408.15  | 81.90     | 0.9987|           |
| 40 | 431.05  | 116.70    | 0.9936| Luszczyk and Radosz (2003)  |
|    | 408.15  | 96.20     | 0.99515| Schwarz & Nieuwoudt (2003)  |
|    | 363.00  | 37.80     | 0.9974| Aalto and Liukkonen (1996)  |
| 46 | 378.15* | 63.1      | 0.9972| Schwarz & Nieuwoudt (2003)  |
| 60 | 408.15  | 121.3     | 0.99778| Schwarz & Nieuwoudt (2003)  |

CN: Carbon number of the n-alkane. $y_1$ is the mole fraction of C$_3$H$_8$ in the vapour phase.

* This experimental point only could be adjusted with RKPR EoS since there is no solution for the PR EoS.
Section B. Complementary figures

This section contains complementary figures that, for reasons of space, were not included in the main body of the manuscript.

Figure S1. Critical lines for some methane + n-alkane binary systems. Calculations with the PR EoS (dashed lines) and RKPR EoS (solid line) correspond to quadratic mixing rules with parameters from Table 5. The sources of experimental critical information can be found in Table S1 of this section.
Figure S2. Prediction of isopleths for different C₁ + C₁₆ mixtures with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data are from Glaser et al. ¹⁵.
Figure S3. Prediction of isopleths for different $C_1 + C_{17}$ mixtures with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data are from Pauly et al. 73.
Figure S4. Prediction of isopleths for different C$_1$ + C$_{24}$ mixtures with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data are from Floter et al.\textsuperscript{17}.
Figure S5. Prediction of isothermal Pxy diagrams for the system C₁ + C₆ with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data are from Marteau et al. ¹⁰, Shim et al. ⁴⁷ and Chylinski et al. ⁷⁴.
Figure S6. Prediction of isothermal Pxy diagrams for the system \( C_1 + C_{20} \) with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data are from van der Kooi et al.\textsuperscript{16} and Darwish et al.\textsuperscript{58}.
Figure S7. Prediction of isothermal Pxy diagrams for the system $\text{C}_2 + \text{C}_4$ with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data are from Lhotak & Wichterle $^{51}$ and Mehra & Thodos $^{50}$. 
Figure S8. Prediction of isothermal Pxy diagrams for the system $\text{C}_2 + \text{C}_8$ with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data is from Weng & Lee.75
Figure S9. Prediction of isothermal Pxy diagrams for the system C₂ + C₁₀ with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data is from Reamer et al. 23.
Figure S10. Prediction of isopleths for different $\text{C}_2 + \text{C}_{10}$ mixtures with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data is from Zamudio et al. 76.
Figure S11. Prediction of isothermal Pxy diagrams for the system C2 + C24 with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data is from Peters et al. 62.
Figure S12. Prediction of isothermal Pxy diagrams for the system C$_2$ + C$_{36}$ with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data is from 59.
Figure S13. Critical lines for some propane + n-alkane binary systems. Calculations with the PR EoS (dashed lines) and RKPR EoS (solid line) correspond to quadratic mixing rules with parameters from Table 5. The sources of experimental critical information can be found in Table S3 of this Section.
Figure S14. Prediction of isopleths for different C$_3$ + C$_4$ mixtures with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data is from Kay et al. 29.
Figure S15. Prediction of isopleths for different C₃ + C₅ mixtures with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data is from Kay et al. 29.
Figure S16. Prediction of isopleths for different C₃ + C₆ mixtures with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data is from Chun et al. 77.
Figure S17. Prediction of isopleths for different C$_3$ + C$_6$ mixtures with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data is from Kay et al. 30
Figure S18. Prediction of isopleths for different C₃ + C₇ mixtures with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data is from Kay et al. 30.
Figure S19. Prediction of isothermal Pxy diagrams for the system C$_3$ + C$_{10}$ with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data is from Reamer & Sage $^{32}$. 
Figure S20. Prediction of isothermal Pxy diagrams for the system C$_3$ + C$_{14}$ with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data is from Schwarz et al. 78.
Figure S21. Prediction of isothermal Pxy diagrams for the system $C_3 + C_{32}$ with the RKPR EoS (solid line) and PR EoS (dashed line) and correlations developed in this work. The experimental data is from Schwarz & Nieuwoudt. 

$C_3 + C_{32}$

- $T = 378.2$ K
- $T = 393.2$ K
- $T = 408.2$ K

Pressure (MPa) vs. Propane mol fraction
Section C. Additional volume shift results

To illustrate the performance of the proposed volume translations, in addition to the predictions already included in the results and discussion section, we present in this section the predicted volumes for pure methane, pure propane and pure n-decane (Figs. S22, S23 and S24 respectively), and for the binary mixtures of methane + n-decane (Fig. S25) and ethane + n-decane (Fig. S26).

Both models successfully predict the volume of pure methane when compared with the data of Span and Wagner 79 in the whole pressure range of Fig. S22. In the case of pure propane, the performance of RKPR EoS is superior to that of the PR EoS, but some discrepancies are observed. For pure n-decane, the performance of RKPR is better than that of the PR at lower pressures and the opposite is observed at the higher-pressure range. Figures S23 and S24 seem to indicate the need of a temperature dependent volume shift, increasing as the temperature drops. This is independent of the equation used since the behavior is similar in both cases.

![METHANE](image)

Figure S22. Pressure vs translated volume projection for pure methane. The predicted volumes correspond to the PR EoS (dashed lines) and RKPR EoS (solid line) models considering the parameters of Table 5 and the volume translations performed according to Pedersen et al. 80 and to Eq. S1 (for RKPR EoS). Symbols: data obtained with the multiparametric equations of Span y Wagner 79.
Figure S23. Pressure vs translated volume projection for pure propane. The predicted volumes correspond to the PR EoS (dashed lines) and RKPR EoS (solid line) models considering the parameters of Table 5 and the volume translations performed according to Pedersen et al.\textsuperscript{80} (for PR EoS) and to Eq. S1 (for RKPR EoS). Symbols: experimental data obtained with the multiparametric equations of Span y Wagner\textsuperscript{79}.

Figure S24. Pressure vs translated volume projection for pure n-decane. The predicted volumes correspond to the PR EoS (dashed lines) and RKPR EoS (solid line) models considering the parameters of Table 5 and the volume translations performed according to Eq. S3 (for PR EoS) and to Eq. S2 (for RKPR EoS). Symbols: experimental data obtained with the multiparametric equations of Span y Wagner\textsuperscript{79}. 
Figure S25 shows the predicted volumes for the mixture of methane (1) + n-decane (2) at 353.15 K. For this system and at the considered conditions, the predictions of both models are similar and satisfactory when compared with the data of 81, with a slight superiority of the PR EoS for the lower methane concentrations.

Figures S26 and S27 show the predicted volumes for the ethane (1) + n-decane (2) system at two different compositions, with a methane mole fraction of $z_1 = 0.4$ and $z_1 = 0.6$ respectively, and for four isotherms. In both cases the superiority of RKPR to predict the volumes is encountered. Nonetheless, as it was anticipated for pure n-alkanes, it is also observed the necessity of temperature dependent volume translations, so that the translation is greater as the temperature decreases. Frey et al. 82–84 present different proposals where the performance of temperature independent volume shifts are compared with parameters dependent on temperature and density. The comparison is performed for volatile n-alkanes (as n-C8 among other pure compounds), as well as for binary and multicomponent mixtures. The results show the improvement with respect to non-dependent parameters. Another recent study related to this subject is the one by Young et al. 85, where parameters were estimated for different volume translation functions applied to the PR EoS, and also they identified different tendencies regarding the volume translation functions format. In this context, the present work introduces reference values and general trends for the volume shift parameters, providing some very good results as illustrative cases and as a proof of concept showing a qualitative evolution with respect to the RKPR2015 correlations for prediction of volumetric properties. Nevertheless, in order to successfully cover wider ranges of temperatures for different mixtures, some dependence, like the ones explored in the articles cited above, should be adopted.
Figure S25. Pressure vs translated volume projection for the system methane (1) + n-decane (2) at 353.15 K. The predicted volumes correspond to the PR EoS (dashed lines) and RKPR EoS (solid line) models considering the parameters of Table 5 and the volume translations performed according to Eq. S4. Symbols: experimental data from ref. 79.

Figure S26. Pressure vs translated volume projection for the system ethane (1) + n-decane (2) with ethane mole fraction $z_1 = 0.4$. The predicted volumes correspond to the PR EoS (dashed lines) and RKPR EoS (solid line) models considering the parameters of Table 5 and the volume translations performed according to Eq. S4. Symbols: experimental data from ref. 23.
Figure S27. Pressure vs translated volume projection for the system ethane (1) + n-decane (2) with ethane mole fraction $x_1 = 0.6$. The predicted volumes correspond to the PR EoS (dashed lines) and RKPR EoS (solid line) models considering the parameters of Table 5 and the volume translations performed according to Eq. S4. Symbols: experimental data from ref. 23.
References

(1) Wei, M. S. W.; Brown, T. S.; Kidnay, A. J.; Sloan, E. D. Vapor + Liquid Equilibria for the Ternary System Methane + Ethane + Carbon Dioxide at 230 K and Its Constituent Binaries at Temperatures from 207 to 270 K. *J. Chem. Eng. Data* **1995**, *40* (4), 726–731.

(2) Raabe, G.; Janisch, J.; Koehler, J. Experimental Studies of Phase Equilibria in Mixtures Relevant for the Description of Natural Gases. *Fluid Phase Equilib.* **2001**, *185* (1–2), 199–208.

(3) Akers, W. W.; Burns, J. F.; Fairchild, W. R. Low-Temperature Phase Equilibria: Methane-Propane System. *Ind. Eng. Chem.* **1954**, *46* (12), 2531–2534.

(4) Sage, B. H.; Reamer, H. H.; Schaafsma, J. G. Phase Equilibria in Hydrocarbon Systems. II Methane-Propane System. *Ind. Eng. Chem.* **1934**, *26* (2), 214–217.

(5) Elliot, D. G.; Chen, R. J. J.; Chappelear, P. S.; Kobayashi, R. Vapor-Liquid Equilibrium of Methane-n-Butane System at Low Temperatures and High Pressures. *J. Chem. Eng. Data* **1974**, *19* (1), 71–77.

(6) Sage, B. H.; Budenholzer, R. A.; Lacey, W. N. Phase Equilibria in Hydrocarbon Systems: Methane-n-Butane System in the Gaseous and Liquid Regions. *Ind. Eng. Chem.* **1940**, *32* (9), 1262–1277.

(7) Chu, T.-C.; Chen, R. J. J.; Chappelear, P. S.; Kobayashi, R. Vapor-Liquid Equilibrium of Methane-n-Pentane System at Low Temperatures and High Pressures. *J. Chem. Eng. Data* **1976**, *21* (1), 41–44.

(8) Sage, B. H.; Reamer, H. H.; Olds, R. H.; Lacey, W. N. Phase Equilibria in Hydrocarbon Systems. Volumetric and Phase Behavior of Methane-n-Pentane System. *Ind. Eng. Chem.* **1942**, *34* (9), 1108–1117.

(9) Chen, R. J. J.; Chappelear, P. S.; Kobayashi, R. Dew-Point Loci for Methane–n-Hexane and Methane–n-Heptane Binary Systems. *J. Chem. Eng. Data* **1976**, *21* (2), 213–219.

(10) Marteau, P.; Obriot, J.; Barreau, A.; Ruffier-Meray, V.; Behar, E. Experimental Determination of the Phase Behavior of Binary Mixtures: Methane - Hexane and Methane - Benzene. *Fluid Phase Equilib.* **1997**, *129*, 285–305.

(11) Wiese, H. C.; Reamer, H. H.; Sage, B. H. Phase Equilibria in Hydrocarbon Systems. Phase
Behavior in the Methane-Propane-n-Decane System. J. Chem. Eng. Data 1970, 15 (1), 75–82.

(12) Reamer, H. H.; Berry, V. M.; Sage, B. H. Phase Equilibria in Hydrocarbon Systems. Volumetric Behavior in the Methane + Propane + n-Decane System. J. Chem. Eng. Data 1969, 14 (4), 447–454.

(13) de Leeuw, V. V.; de Loos, T. W.; Kooijman, H. A.; de Swaan Arons, J. The Experimental Determination and Modelling of VLE for Binary Subsystems of the Quaternary System N2+ CH4+ C4H10+ C14H30 up to 1000 Bar and 440 K. Fluid Phase Equilib. 1992, 73 (3), 285–321.

(14) Rijkers, M. P. W. M.; Peters, C. J.; de Swaan Arons, J. Measurements on the Phase Behavior of Binary Mixtures for Modeling the Condensation Behavior of Natural Gas. Part III. The System Methane + Hexadecane. Fluid Phase Equilib. 1993, 85 (C), 335–345.

(15) Glaser, M.; Peters, C. J.; Van Der Kooi, H. J.; Lichtenthaler, R. N. Phase Equilibria of (Methane + n-Hexadecane) and (p, Vm, T) of n-Hexadecane. J. Chem. Thermodyn. 1985, 17, 803–815.

(16) van der Kooi, H. J.; Flöter, E.; de Loos, T. W. High-Pressure Phase Equilibria of (1-x)CH4 + XCH3(CH2)18CH3. J. Chem. Thermodyn. 1995, 27 (4), 847–861.

(17) Flöter, E.; de Loos, T. W.; de Swaan Arons, J. High Pressure Solid-Fluid and Vapour-Liquid Equilibria in the System (Methane + Tetracosane). Fluid Phase Equilib. 1997, 127, 129–146.

(18) Machado, J. J. B.; de Loos, T. W. Liquid-Vapour and Solid-Fluid Equilibria for the System Methane + Triacontane at High Temperature and High Pressure. Fluid Phase Equilib. 2004, 222–223, 261–267.

(19) Marteau, P.; Tobaly, P.; Ruffier-Meray, V.; de Hemptinne, J. C. High-Pressure Phase Diagrams of Methane + Squalane and Methane + Hexatriacontane Mixtures. J. Chem. Eng. Data 1998, 43 (3), 362–366.

(20) Horstmann, S.; Fischer, K.; Gmehling, J. Experimental Determination of Critical Data of Mixtures and Their Relevance for the Development of Thermodynamic Models. Chem. Eng. Sci. 2001, 56 (24), 6905–6913.

(21) Singh, H.; Lucien, F. P.; Foster, N. R. Critical Properties for Binary Mixtures of Ethane Containing Low Concentrations of N-Alkane. J. Chem. Eng. Data 2000, 45 (1), 131–135.

(22) Reamer, H. H.; Sage, B. H.; Lacey, W. N. Phase Equilibria in Hydrocarbon Systems
Volumetric and Phase Behavior of Ethane-n-Pentane System. *J. Chem. Eng. Data* **1960**, *5* (1), 44–50.

(23) Reamer, N. H.; Sage, N. H. Phase Equilibria in Hydrocarbon Systems. Volumetric and Phase Behavior of the Ethane-n-Decane System. *J. Chem. Eng. Data* **1962**, *7* (2), 161–168.

(24) du Rand, M.; Nieuwoudt, I. Measurement of Phase Equilibria of Supercritical Carbon Dioxide and Paraffins. *J. Supercrit. Fluids* **2001**, *21*, 181–193.

(25) Kohn, J. P.; Kim, Y. J.; Pan, Y. C. Partial Miscibility Phenomena in Binary Hydrocarbon Systems Involving Ethane. *J. Chem. Eng. Data* **1966**, *11* (3), 333–335.

(26) Peters, C. J.; De Roo, J. L.; Lichtenthaler, R. N. Measurements and Calculations of Phase Equilibria of Binary Mixtures of Ethane + Eicosane. Part I: Vapour + Liquid Equilibria. *Fluid Phase Equilib.* **1987**, *34* (2–3), 287–308.

(27) Schwarz, C. E.; Nieuwoudt, I.; Knoetze, J. H. Phase Equilibria of Long Chain N-Alkanes in Supercritical Ethane: Review, Measurements and Prediction. *J. Supercrit. Fluids* **2008**, *46* (3), 226–232.

(28) Nysewander, C. N.; Sage, B. H.; Lacey, W. N. Phase Equilibria in Hydrocarbon Systems: The Propane-n-Butane System in the Critical Region. *Ind. Eng. Chem.* **1940**, *32* (1), 118–123.

(29) Kay, W. B. Vapor-Liquid Equilibrium Relations of Binary Systems. The Propane-n-Alkane Systems. n-Butane and n-Pentane. *J. Chem. Eng. Data* **1970**, *15* (1), 46–52.

(30) Kay, W. B. Vapor-Liquid Equilibrium Relationships of Binary Systems. Propane-n-Alkane Systems, n-Hexane and n-Heptane. *J. Chem. Eng. Data* **1971**, *16* (2), 137–140.

(31) Kay, W. B.; Genco, J.; Fichtner, D. A. Vapor-Liquid Equilibrium Relations of Binary Systems Propane-n-Octane and Butane-n-Octane. *J. Chem. Eng. Data* **1974**, *19* (3), 275–280.

(32) Reamer, H. H.; Sage, B. H. Phase Equilibria in Hydrocarbon Systems Volumetric and Phase Behavior of the Propane—n-Decane System. *J. Chem. Eng. Data* **1966**, *11* (1), 17–24.

(33) Schwarz, C. E.; Nieuwoudt, I. Phase Equilibrium of Propane and Alkanes. Part I. Experimental Procedures, Dotriacontane Equilibrium and EOS Modelling. *J. Supercrit. Fluids* **2003**, *27*, 133–144.

(34) Peters, C. J.; de Roo, J. L.; de Swaan Arons, J. Measurements and Calculations of Phase Equilibria in Binary Mixtures of Propane + Tetratriacontane. *Fluid Phase Equilib.* **1992**, *72*, 251–266.
(35) Schwarz, C. E.; Nieuwoudt, I. Phase Equilibrium of Propane and Alkanes Part II: Hexatriacontane through Hexacontane. *J. Supercrit. Fluids* 2003, 27, 145–156.

(36) Reamer, H. H.; Sage, B. H. Phase Equilibria in Hydrocarbon Systems. Phase Behavior in the n-Butane-n-Decane System. *J. Chem. Eng. Data* 1964, 9 (1), 24–28.

(37) Nieuwoudt, I. Vapor - Liquid Equilibria and Densities for the System Butane + Hexacontane. *J. Chem. Eng. Data* 1996, 41, 1024–1027.

(38) Davalos, J.; Anderson, W. R.; Phelps, R. E.; Kidnay, A. J. Liquid-Vapor Equilibria at 250 K for Systems Containing Methane, Ethane, and Carbon Dioxide. *J. Chem. Eng. Data* 1976, 21 (1), 81–84.

(39) Wichterle, I.; Kobayashi, R. Vapor-Liquid Equilibrium of Methane-Propane System at Low Temperatures and High Pressures. *J. Chem. Eng. Data* 1972, 17 (1), 4–9.

(40) Webster, L. A.; Kidnay, A. J. Vapor-Liquid Equilibria for the Methane-Propane-Carbon Dioxide Systems at 230 K and 270 K. *J. Chem. Eng. Data* 2001, 46 (3), 759–764.

(41) Reamer, H. H.; Sage, B. H.; Lacey, W. N. Phase Equilibria in Hydrocarbon Systems. Volumetric and Phase Behavior of the Methane-Propane System. *Ind. Eng. Chem.* 1950, 42 (3), 534–539.

(42) Price, A. R.; Kobayashi, R. Low Temperature Vapor-Liquid Equilibrium in Light Hydrocarbon Mixtures: Methane-Ethane-Propane System. *J. Chem. Eng. Data* 1959, 4 (1), 40–52.

(43) Wiese, H. C.; Jacobs, J.; Sage, B. H. Phase Equilibriums in the Hydrocarbon Systems. Phase Behavior in the Methane-Propane-n-Butane System. *J. Chem. Eng. Data* 1970, 15 (1), 82–91.

(44) Gozalpour, F.; Danesh, A.; Todd, A. C.; Tohidi, B. Viscosity, Density, Interfacial Tension and Compositional Data for near Critical Mixtures of Methane + Butane and Methane + Decane Systems at 310.95 K. *Fluid Phase Equilib.* 2005, 233 (2), 144–150.

(45) Roberts, L. R.; Wang, R. H.; Azarnoosh, A.; Mcketta, J. J. Methane-n-Butane System in the Two-Phase Region. *J. Chem. Eng. Data* 1962, 7 (4), 484–485.

(46) Kandil, M. E.; Thoma, M. J.; Syed, T.; Guo, J.; Graham, B. F.; Marsh, K. N.; Huang, S. H.; May, E. F. Vapor-Liquid Equilibria Measurements of the Methane + Pentane and Methane + Hexane Systems at Temperatures from (173 to 330) K and Pressures to 14 MPa. *J. Chem. Eng. Data* 2011, 56 (12), 4301–4309.
(47) Shim, J.; Kohn, J. P. Multiphase and Volumetric Equilibria of Methane-n-Hexane Binary System at Temperatures between -110°C and 150°C. *J. Chem. Eng. Data* **1962**, 7 (1), 3–8.

(48) Lin, H. M.; Sebastian, H. M.; Simnick, J. J.; Chao, K. C. Gas-Liquid Equilibrium in Binary Mixtures of Methane with n-Decane, Benzene, and Toluene. *J. Chem. Eng. Data* **1979**, 24 (2), 146–149.

(49) Huang, S. H.; Lin, H.-M.; Chao, K.-C. Solubility of Carbon Dioxide, Methane and Ethane in n-Eicosane. *J. Chem. Eng. Data* **1988**, 33 (2), 145–147.

(50) Mehra, V. S.; Thodos, G. Vapor-Liquid Equilibrium in Ethane n-Butane System. *J. Chem. Eng. Data* **1965**, 10 (4), 307–309.

(51) Lhotak, V.; Wichterle, I. Vapor-Liquid Equilibria in the Ethane n-Butane System at High Pressures. *Fluid Phase Equilib.* **1981**, 6 (3–4), 229–235.

(52) Seong, G.; Yoo, K.; Lim, J. S. Vapor-Liquid Equilibria for Propane (R290) + n-Butane (R600) at Various Temperatures. *J. Chem. Eng. Data* **2008**, 53, 2783–2786.

(53) Kayukawa, Y.; Hasumoto, M.; Kano, Y.; Watanabe, K. Liquid-Phase Thermodynamic Properties for Propane (1), n-Butane (2), and Isobutane (3). *J. Chem. Eng. Data* **2005**, 50 (2), 556–564.

(54) Jennings, D. W.; Schucker, R. C. Comparison of High-Pressure Vapor - Liquid Equilibria of Mixtures of CO2 or Propane with Nonane and C9 Alkylbenzenes. *J. Chem. Eng. Data* **1996**, 41 (4), 831–838.

(55) Lin, Y. N.; Chen, R. J. J.; Chappelear, P. S.; Kobayashi, R. Vapor-Liquid Equilibrium of the Methane-n-Hexane System at Low Temperature. *J. Chem. Eng. Data* **1977**, 22 (4), 402–408.

(56) Rijkers, M. P. W. M.; Malais, M.; Peters, C. J.; de Swaan Arons, J. Measurements on the Phase Behavior of Binary Hydrocarbon Mixtures for Modelling the Condensation Behavior of Natural Gas. Part I. The System Methane + Decane. *Fluid Phase Equilib.* **1992**, 71 (1–2), 143–168.

(57) Nourozieh, H.; Kariznovi, M.; Abedi, J. Vapor-Liquid Equilibrium Measurement and Thermodynamic Modeling of Binary Systems (Methane+n-Tetradecane). *Fluid Phase Equilib.* **2012**, 318, 96–101.

(58) Darwish, N. A.; Fathikalajahi, J.; Gasem, K. A. M.; Robinson, R. L. Solubility of Methane in Heavy Normal Paraffins at Temperatures from 323 to 423 K and Pressures to 10.7 MPa. *J.
Chem. Eng. Data 1993, 38 (10), 44–48.

(59) Tsai, F.; Huang, S. H.; Lin, H.-M.; Chao, K.-C. Solubility of Methane, Ethane and Carbon Dioxide in n-Hexatriacontane. J. Chem. Eng. Data 1987, 32, 467–469.

(60) De Goede, R.; Peters, C. J.; van der Kooi, H. J.; Lichtenthaler, R. N. Phase Equilibria in Binary Mixtures of Ethane and Hexadecane. Fluid Phase Equilib. 1989, 50, 305–314.

(61) Peters, C. J.; Spiegelaar, J.; De Swaan Arons, J. Phase Equilibria in Binary Mixtures of Ethane + Docosane and Molar Volumes of Liquid Docosane. Fluid Phase Equilib. 1988, 41 (3), 245–256.

(62) Peters, C. J.; Van Der Kooi, H. J.; De Swaan Arons, J. Measurements and Calculations of Phase Equilibria for (Ethane + Tetracosane) and (p, Vm*, T) of Liquid Tetracosane. J. Chem. Thermodyn. 1987, 19 (4), 395–405.

(63) Gasem, K. A. M.; Bufkin, B. A.; Raff, A. M.; Robinson Jr., R. L. Solubilities of Ethane in Heavy Normal Paraffins at Pressures to 7.8 MPa and Temperatures from 348 to 423 K. J. Chem. Eng. Data 1989, 34 (2), 187–191.

(64) Gregorowicz, J.; De Loos, T. W.; De Swaan Arons, J. The System Propane + Eicosane: P, T, and x Measurements in the Temperature Range 288-358 K. J. Chem. Eng. Data 1992, 37 (3), 356–358.

(65) Peters, C. J.; de Roo, J. L.; de Swaan Arons, J. Phase Equilibria Hexacontane in Binary Mixtures of Propane and Hexacontane. Fluid Phase Equilib. 1993, 85, 301–312.

(66) Wichterle, I.; Kobayashi, R. Vapor-Liquid Equilibrium of Methane-Ethane System at Low Temperatures and High Pressures. J. Chem. Eng. Data 1972, 17 (1), 9–12.

(67) Chen, R. J. J.; Chappelear, P. S.; Kobayashi, R. Dew-Point Loci for Methane-n-Butane Binary System. J. Chem. Eng. Data 1974, 19 (1), 53–58.

(68) Gregorowicz, J. Solubility of Eicosane in Supercritical Ethane and Ethylene. J. Supercrit. Fluids 2003, 26, 95–113.

(69) Gregorowicz, J. Solubility of Tetracosane in Supercritical Ethane and Ethylene. J. Supercrit. Fluids 2003, 27, 13–23.

(70) Chun, S. W.; Kay, W. B.; Rainwater, J. C. Vapor-Equilibria of Mixtures of Propane and Isomeric Hexanes. J. Chem. Eng. Data 1993, 38, 494–501.

(71) Luszczyk, M.; Radosz, M. Temperature and Pressure Induced Crystallization and Melting of
Tetracontane in Propane: Evidence of Retrograde Crystallization. *J. Chem. Eng. Data* **2003**, *48*, 226–230.

(72) Aalto, M.; Liukkonen, S. Bubble Point Pressures and Densities for the Binary Systems of Propane with Triacontane, Hexatriacontane, Tetracontane, Pentacontane, and Squalane at 353-373 K and 4.00-7.00 MPa. *J. Chem. Eng. Data* **1996**, *41*, 79–83.

(73) Pauly, J.; Coutinho, J. A. P.; Daridon, J.-L. High Pressure Phase Equilibria in Methane + Waxy Systems. 1. Methane + Heptadecane. *Fluid Phase Equilib.* **2007**, *255* (2), 193–199.

(74) Chylinski, K.; Cebola, M. J.; Meredith, A.; Saville, G.; Wakeham, W. A. Apparatus for Phase Equilibrium Measurements at High Temperatures and Pressures. *J. Chem. Thermodyn.* **2002**, *34*, 1703–1728.

(75) Weng, W. L.; Lee, M. J. Vapor-Liquid Equilibrium of the Octane/Carbon Dioxide, Octane/Ethane, and Octane/Ethylene Systems. *J. Chem. Eng. Data* **1992**, *37*, 213–215.

(76) Zamudio, M.; Schwarz, C. E.; Knoetze, J. H. Phase Equilibria of Branched Isomers of C10-Alcohols and C10-Alkanes in Supercritical Ethane. *J. Supercrit. Fluids* **2011**, *58* (3), 330–342.

(77) Chun, S. W.; Kay, W. B.; Rainwater, J. C. Vapor-Liquid Equilibria of Mixtures of Propane and Isomeric Hexanes. *J. Chem. Eng. Data* **1993**, *38*, 494–501.

(78) Schwarz, C. E.; Bonthuys, G. J. K.; Knoetze, J. H.; Burger, A. J. The Influence of Functional End Groups on the High-Pressure Phase Equilibria of Long Chain Molecules in Supercritical Propane. *J. Supercrit. Fluids* **2008**, *46*, 233–237.

(79) Span, R.; Wagner, W. Equations of State for Technical Applications. II. Results for Nonpolar Fluids. *Int. J. Thermophys.* **2003**, *24* (1), 41–109.

(80) Pedersen, K. S.; Christensen, P. L.; Shaikh, J. A. *Phase Behaviour of Petroleum Reservoir Fluids*; Taylor & Francis Group, LLC., 2015; Vol. 2.

(81) Audonnet, F.; Pádua, A. A. H. Viscosity and Density of Mixtures of Methane and N-Decane from 298 to 393 K and up to 75 MPa. *Fluid Phase Equilib.* **2004**, *216*, 235–244.

(82) Frey, K.; Augustine, C.; Ciccolini, R. P.; Paap, S.; Modell, M.; Tester, J. Volume Translation in Equations of State as a Means of Accurate Property Estimation. *Fluid Phase Equilib.* **2007**, *260*, 316–325.

(83) Frey, K.; Modell, M.; Tester, J. Density-and-Temperature-Dependent Volume Translation for
the SRK EOS: 1. Pure Fluids. *Fluid Phase Equilib.* **2009**, *279*, 56–63.

(84) Frey, K.; Modell, M.; Tester, J. W. Density-and-Temperature-Dependent Volume Translation for the SRK EOS: 2. Mixtures. *Fluid Phase Equilib.* **2013**, *343*, 13–23.

(85) Young, F.; Pessoa, F. L. P.; Ahon, V. R. R. Comparison of Volume Translation and Co-Volume Functions Applied in the Peng-Robinson EoS for Volumetric Corrections. *Fluid Phase Equilib.* **2017**, *435*, 73–87.