

# Refrigerante 134a Sistema Internacional

740

TERMODINÁMICA

TABLA A.11

Refrigerante 134a saturado – Tabla de temperatura

| Temp.,<br>T °C | Presión,<br>P <sub>sat</sub><br>MPa | Volumen específico,<br>m <sup>3</sup> /kg |                                 | Energía<br>interna, kJ/kg        |                                 | Entalpía,<br>kJ/kg               |                                 | Entropía,<br>kJ/kg · K           |                                 |        |
|----------------|-------------------------------------|---|---------------------------------|----------------------------------|---------------------------------|----------------------------------|---------------------------------|----------------------------------|---------------------------------|--------|
|                |                                     | Líqu.<br>sat.,<br>v <sub>f</sub>          | Vap.<br>sat.,<br>v <sub>g</sub> | Líqu.<br>sat.,<br>u <sub>f</sub> | Vap.<br>sat.,<br>u <sub>g</sub> | Líqu.<br>sat.,<br>h <sub>f</sub> | Vap.<br>sat.,<br>h <sub>g</sub> | Líqu.<br>sat.,<br>s <sub>f</sub> | Vap.<br>sat.,<br>s <sub>g</sub> |        |
| -40            | 0.05164                             | 0.0007055                                 | 0.3569                          | -0.04                            | 204.45                          | 0.00                             | 222.88                          | 222.88                           | 0.0000                          | 0.9560 |
| -36            | 0.06332                             | 0.0007113                                 | 0.2947                          | 4.68                             | 206.73                          | 4.73                             | 220.67                          | 225.40                           | 0.0201                          | 0.9506 |
| -32            | 0.07704                             | 0.0007172                                 | 0.2451                          | 9.47                             | 209.01                          | 9.52                             | 218.37                          | 227.90                           | 0.0401                          | 0.9456 |
| -28            | 0.09305                             | 0.0007233                                 | 0.2052                          | 14.31                            | 211.29                          | 14.37                            | 216.01                          | 230.38                           | 0.0600                          | 0.9411 |
| -26            | 0.10199                             | 0.0007265                                 | 0.1882                          | 16.75                            | 212.43                          | 16.82                            | 214.80                          | 231.62                           | 0.0699                          | 0.9390 |
| -24            | 0.11160                             | 0.0007296                                 | 0.1728                          | 19.21                            | 213.57                          | 19.29                            | 213.57                          | 232.85                           | 0.0798                          | 0.9370 |
| -22            | 0.12192                             | 0.0007328                                 | 0.1590                          | 21.68                            | 214.70                          | 21.77                            | 212.32                          | 234.08                           | 0.0897                          | 0.9351 |
| -20            | 0.13299                             | 0.0007361                                 | 0.1464                          | 24.17                            | 215.84                          | 24.26                            | 211.05                          | 235.31                           | 0.0996                          | 0.9332 |
| -18            | 0.14483                             | 0.0007395                                 | 0.1350                          | 26.67                            | 216.97                          | 26.77                            | 209.76                          | 236.53                           | 0.1094                          | 0.9315 |
| -16            | 0.15748                             | 0.0007428                                 | 0.1247                          | 29.18                            | 218.10                          | 29.30                            | 208.45                          | 237.74                           | 0.1192                          | 0.9298 |
| -12            | 0.18540                             | 0.0007498                                 | 0.1068                          | 34.25                            | 220.36                          | 34.39                            | 205.77                          | 240.15                           | 0.1388                          | 0.9267 |
| -8             | 0.21704                             | 0.0007569                                 | 0.0919                          | 39.38                            | 222.60                          | 39.54                            | 203.00                          | 242.54                           | 0.1583                          | 0.9239 |
| -4             | 0.25274                             | 0.0007644                                 | 0.0794                          | 44.56                            | 224.84                          | 44.75                            | 200.15                          | 244.90                           | 0.1777                          | 0.9213 |
| 0              | 0.29282                             | 0.0007721                                 | 0.0689                          | 49.79                            | 227.06                          | 50.02                            | 197.21                          | 247.23                           | 0.1970                          | 0.9190 |
| 4              | 0.33765                             | 0.0007801                                 | 0.0600                          | 55.08                            | 229.27                          | 55.35                            | 194.19                          | 249.53                           | 0.2162                          | 0.9169 |
| 8              | 0.38756                             | 0.0007884                                 | 0.0525                          | 60.43                            | 231.46                          | 60.73                            | 191.07                          | 251.80                           | 0.2354                          | 0.9150 |
| 12             | 0.44294                             | 0.0007971                                 | 0.0460                          | 65.83                            | 233.63                          | 66.18                            | 187.85                          | 254.03                           | 0.2545                          | 0.9132 |
| 16             | 0.50416                             | 0.0008062                                 | 0.0405                          | 71.29                            | 235.78                          | 71.69                            | 184.52                          | 256.22                           | 0.2735                          | 0.9116 |
| 20             | 0.57160                             | 0.0008157                                 | 0.0358                          | 76.80                            | 237.91                          | 77.26                            | 181.09                          | 258.35                           | 0.2924                          | 0.9102 |
| 24             | 0.64566                             | 0.0008257                                 | 0.0317                          | 82.37                            | 240.01                          | 82.90                            | 177.55                          | 260.45                           | 0.3113                          | 0.9089 |
| 26             | 0.68530                             | 0.0008309                                 | 0.0298                          | 85.18                            | 241.05                          | 85.75                            | 175.73                          | 261.48                           | 0.3208                          | 0.9082 |
| 28             | 0.72675                             | 0.0008362                                 | 0.0281                          | 88.00                            | 242.08                          | 88.61                            | 173.89                          | 262.50                           | 0.3302                          | 0.9076 |
| 30             | 0.77006                             | 0.0008417                                 | 0.0265                          | 90.84                            | 243.10                          | 91.49                            | 172.00                          | 263.50                           | 0.3396                          | 0.9070 |
| 32             | 0.81528                             | 0.0008473                                 | 0.0250                          | 93.70                            | 244.12                          | 94.39                            | 170.09                          | 264.48                           | 0.3490                          | 0.9064 |
| 34             | 0.86247                             | 0.0008530                                 | 0.0236                          | 96.58                            | 245.12                          | 97.31                            | 168.14                          | 265.45                           | 0.3584                          | 0.9058 |
| 36             | 0.91168                             | 0.0008590                                 | 0.0223                          | 99.47                            | 246.11                          | 100.25                           | 166.15                          | 266.40                           | 0.3678                          | 0.9053 |
| 38             | 0.96298                             | 0.0008651                                 | 0.0210                          | 102.38                           | 247.09                          | 103.21                           | 164.12                          | 267.33                           | 0.3772                          | 0.9047 |
| 40             | 1.0164                              | 0.0008714                                 | 0.0199                          | 105.30                           | 248.06                          | 106.19                           | 162.05                          | 268.24                           | 0.3866                          | 0.9041 |
| 42             | 1.0720                              | 0.0008780                                 | 0.0188                          | 108.25                           | 249.02                          | 109.19                           | 159.94                          | 269.14                           | 0.3960                          | 0.9035 |
| 44             | 1.1299                              | 0.0008847                                 | 0.0177                          | 111.22                           | 249.96                          | 112.22                           | 157.79                          | 270.01                           | 0.4054                          | 0.9030 |
| 48             | 1.2526                              | 0.0008989                                 | 0.0159                          | 117.22                           | 251.79                          | 118.35                           | 153.33                          | 271.68                           | 0.4243                          | 0.9017 |
| 52             | 1.3851                              | 0.0009142                                 | 0.0142                          | 123.31                           | 253.55                          | 124.58                           | 148.66                          | 273.24                           | 0.4432                          | 0.9004 |
| 56             | 1.5278                              | 0.0009308                                 | 0.0127                          | 129.51                           | 255.23                          | 130.93                           | 143.75                          | 274.68                           | 0.4622                          | 0.8990 |
| 60             | 1.6813                              | 0.0009488                                 | 0.0114                          | 135.82                           | 256.81                          | 137.42                           | 138.57                          | 275.99                           | 0.4814                          | 0.8973 |
| 70             | 2.1162                              | 0.0010027                                 | 0.0086                          | 152.22                           | 260.15                          | 154.34                           | 124.08                          | 278.43                           | 0.5302                          | 0.8918 |
| 80             | 2.6324                              | 0.0010766                                 | 0.0064                          | 169.88                           | 262.14                          | 172.71                           | 106.41                          | 279.12                           | 0.5814                          | 0.8827 |
| 90             | 3.2435                              | 0.0011949                                 | 0.0046                          | 189.82                           | 261.34                          | 193.69                           | 82.63                           | 276.32                           | 0.6380                          | 0.8655 |
| 100            | 3.9742                              | 0.0015443                                 | 0.0027                          | 218.60                           | 248.49                          | 224.74                           | 34.40                           | 259.13                           | 0.7196                          | 0.8117 |

Fuente: Tablas A.11 a A.13: M. J. Moran y H. N. Shapiro, *Fundamentals of Engineering Thermodynamics*, 2a. ed. (Nueva York: John Wiley & Sons, 1992), pp. 710-715. Basadas originalmente en las ecuaciones de D. P. Wilson y R. S. Basu, "Thermodynamic Properties of a New Stratospherically Safe Working Fluid—Refrigerant-134a", *ASHRAE Trans.* 94, Pt. 2 (1988), pp. 2095-2118. Empleadas con permiso.

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TABLA A.12

Refrigerante 134a saturado – Tabla de presión

| Presión,<br>$P$ MPa | Temp.,<br>$T_{\text{sat}}$ °C | Volumen específico,<br>$\text{m}^3/\text{kg}$ |                        | Energía<br>interna, $\text{kJ}/\text{kg}$ |                        | Entalpía,<br>$\text{kJ}/\text{kg}$ |                    |                        | Entropía,<br>$\text{kJ}/\text{kg} \cdot \text{K}$ |                        |
|---------------------|-------------------------------|---|------------------------|---|------------------------|------------------------------------|--------------------|------------------------|---|------------------------|
|                     |                               | Líqu.<br>sat.,<br>$v_f$                       | Vap.<br>sat.,<br>$v_g$ | Líqu.<br>sat.,<br>$u_f$                   | Vap.<br>sat.,<br>$u_g$ | Líqu.<br>sat.,<br>$h_f$            | Evap.,<br>$h_{fg}$ | Vap.<br>sat.,<br>$h_g$ | Líqu.<br>sat.,<br>$s_f$                           | Vap.<br>sat.,<br>$s_g$ |
| 0.06                | -37.07                        | 0.0007097                                     | 0.3100                 | 3.41                                      | 206.12                 | 3.46                               | 221.27             | 224.72                 | 0.0147  | 0.9520                 |
| 0.08                | -31.21                        | 0.0007184                                     | 0.2366                 | 10.41                                     | 209.46                 | 10.47                              | 217.92             | 228.39                 | 0.0440  | 0.9447                 |
| 0.10                | -26.43                        | 0.0007258                                     | 0.1917                 | 16.22                                     | 212.18                 | 16.29                              | 215.06             | 231.35                 | 0.0678  | 0.9395                 |
| 0.12                | -22.36                        | 0.0007323                                     | 0.1614                 | 21.23                                     | 214.50                 | 21.32                              | 212.54             | 233.86                 | 0.0879  | 0.9354                 |
| 0.14                | -18.80                        | 0.0007381                                     | 0.1395                 | 25.66                                     | 216.52                 | 25.77                              | 210.27             | 236.04                 | 0.1055  | 0.9322                 |
| 0.16                | -15.62                        | 0.0007435                                     | 0.1229                 | 29.66                                     | 218.32                 | 29.78                              | 208.18             | 237.97                 | 0.1211  | 0.9295                 |
| 0.18                | -12.73                        | 0.0007485                                     | 0.1098                 | 33.31                                     | 219.94                 | 33.45                              | 206.26             | 239.71                 | 0.1352  | 0.9273                 |
| 0.20                | -10.09                        | 0.0007532                                     | 0.0993                 | 36.69                                     | 221.43                 | 36.84                              | 204.46             | 241.30                 | 0.1481  | 0.9253                 |
| 0.24                | -5.37                         | 0.0007618                                     | 0.0834                 | 42.77                                     | 224.07                 | 42.95                              | 201.14             | 244.09                 | 0.1710  | 0.9222                 |
| 0.28                | -1.23                         | 0.0007697                                     | 0.0719                 | 48.18                                     | 226.38                 | 48.39                              | 198.13             | 246.52                 | 0.1911  | 0.9197                 |
| 0.32                | 2.48                          | 0.0007770                                     | 0.0632                 | 53.06                                     | 228.43                 | 53.31                              | 195.35             | 248.66                 | 0.2089  | 0.9177                 |
| 0.36                | 5.84                          | 0.0007839                                     | 0.0564                 | 57.54                                     | 230.28                 | 57.82                              | 192.76             | 250.58                 | 0.2251  | 0.9160                 |
| 0.4                 | 8.93                          | 0.0007904                                     | 0.0509                 | 61.69                                     | 231.97                 | 62.00                              | 190.32             | 252.32                 | 0.2399  | 0.9145                 |
| 0.5                 | 15.74                         | 0.0008056                                     | 0.0409                 | 70.93                                     | 235.64                 | 71.33                              | 184.74             | 256.07                 | 0.2723  | 0.9117                 |
| 0.6                 | 21.58                         | 0.0008196                                     | 0.0341                 | 78.99                                     | 238.74                 | 79.48                              | 179.71             | 259.19                 | 0.2999  | 0.9097                 |
| 0.7                 | 26.72                         | 0.0008328                                     | 0.0292                 | 86.19                                     | 241.42                 | 86.78                              | 175.07             | 261.85                 | 0.3242  | 0.9080                 |
| 0.8                 | 31.33                         | 0.0008454                                     | 0.0255                 | 92.75                                     | 243.78                 | 93.42                              | 170.73             | 264.15                 | 0.3459  | 0.9066                 |
| 0.9                 | 35.53                         | 0.0008576                                     | 0.0226                 | 98.79                                     | 245.88                 | 99.56                              | 166.62             | 266.18                 | 0.3656  | 0.9054                 |
| 1.0                 | 39.39                         | 0.0008695                                     | 0.0202                 | 104.42                                    | 247.77                 | 105.29                             | 162.68             | 267.97                 | 0.3838  | 0.9043                 |
| 1.2                 | 46.32                         | 0.0008928                                     | 0.0166                 | 114.69                                    | 251.03                 | 115.76                             | 155.23             | 270.99                 | 0.4164  | 0.9023                 |
| 1.4                 | 52.43                         | 0.0009159                                     | 0.0140                 | 123.98                                    | 253.74                 | 125.26                             | 148.14             | 273.40                 | 0.4453  | 0.9003                 |
| 1.6                 | 57.92                         | 0.0009392                                     | 0.0121                 | 132.52                                    | 256.00                 | 134.02                             | 141.31             | 275.33                 | 0.4714  | 0.8982                 |
| 1.8                 | 62.91                         | 0.0009631                                     | 0.0105                 | 140.49                                    | 257.88                 | 142.22                             | 134.60             | 276.83                 | 0.4954  | 0.8959                 |
| 2.0                 | 67.49                         | 0.0009878                                     | 0.0093                 | 148.02                                    | 259.41                 | 149.99                             | 127.95             | 277.94                 | 0.5178  | 0.8934                 |
| 2.5                 | 77.59                         | 0.0010562                                     | 0.0069                 | 165.48                                    | 261.84                 | 168.12                             | 111.06             | 279.17                 | 0.5687  | 0.8854                 |
| 3.0                 | 86.22                         | 0.0011416                                     | 0.0053                 | 181.88                                    | 262.16                 | 185.30                             | 92.71              | 278.01                 | 0.6156  | 0.8735                 |

**TABLA A.13**

Refrigerante 134a sobrecalentado

| $T$<br>°C | $v$<br>m <sup>3</sup> /kg                                       | $u$<br>kJ/kg | $h$<br>kJ/kg | $s$<br>kJ/kg · K | $v$<br>m <sup>3</sup> /kg                                       | $u$<br>kJ/kg | $h$<br>kJ/kg | $s$<br>kJ/kg · K | $v$<br>m <sup>3</sup> /kg                                       | $u$<br>kJ/kg | $h$<br>kJ/kg | $s$<br>kJ/kg · K |
|-----------|---|--------------|--------------|------------------|---|--------------|--------------|------------------|---|--------------|--------------|------------------|
|           | $P = 0.06 \text{ MPa } (T_{\text{sat}} = -37.07^\circ\text{C})$ |              |              |                  | $P = 0.10 \text{ MPa } (T_{\text{sat}} = -26.43^\circ\text{C})$ |              |              |                  | $P = 0.14 \text{ MPa } (T_{\text{sat}} = -18.80^\circ\text{C})$ |              |              |                  |
| Sat.      | 0.31003   | 206.12       | 224.72       | 0.9520           | 0.19170   | 212.18       | 231.35       | 0.9395           | 0.13945   | 216.52       | 236.04       | 0.9322           |
| -20       | 0.33536   | 217.86       | 237.98       | 1.0062           | 0.19770   | 216.77       | 236.54       | 0.9602           |   |              |              |                  |
| -10       | 0.34992   | 224.97       | 245.96       | 1.0371           | 0.20686   | 224.01       | 244.70       | 0.9918           | 0.14549   | 223.03       | 243.40       | 0.9606           |
| 0         | 0.36433   | 232.24       | 254.10       | 1.0675           | 0.21587   | 231.41       | 252.99       | 1.0227           | 0.15219   | 230.55       | 251.86       | 0.9922           |
| 10        | 0.37861   | 239.69       | 262.41       | 1.0973           | 0.22473   | 238.96       | 261.43       | 1.0531           | 0.15875   | 238.21       | 260.43       | 1.0230           |
| 20        | 0.39279   | 247.32       | 270.89       | 1.1267           | 0.23349   | 246.67       | 270.02       | 1.0829           | 0.16520   | 246.01       | 269.13       | 1.0532           |
| 30        | 0.40688   | 255.12       | 279.53       | 1.1557           | 0.24216   | 254.54       | 278.76       | 1.1122           | 0.17155   | 253.96       | 277.97       | 1.0828           |
| 40        | 0.42091   | 263.10       | 288.35       | 1.1844           | 0.25076   | 262.58       | 287.66       | 1.1411           | 0.17783   | 262.06       | 286.96       | 1.1120           |
| 50        | 0.43487   | 271.25       | 297.34       | 1.2126           | 0.25930   | 270.79       | 296.72       | 1.1696           | 0.18404   | 270.32       | 296.09       | 1.1407           |
| 60        | 0.44879   | 279.58       | 306.51       | 1.2405           | 0.26779   | 279.16       | 305.94       | 1.1977           | 0.19020   | 278.74       | 305.37       | 1.1690           |
| 70        | 0.46266   | 288.08       | 315.84       | 1.2681           | 0.27623   | 287.70       | 315.32       | 1.2254           | 0.19633   | 287.32       | 314.80       | 1.1969           |
| 80        | 0.47650   | 296.75       | 325.34       | 1.2954           | 0.28464   | 296.40       | 324.87       | 1.2528           | 0.20241   | 296.06       | 324.39       | 1.2244           |
| 90        | 0.49031   | 305.58       | 335.00       | 1.3224           | 0.29302   | 305.27       | 334.57       | 1.2799           | 0.20846   | 304.95       | 334.14       | 1.2516           |
| 100       |   |              |              |                  |   |              |              |                  | 0.21449   | 314.01       | 344.04       | 1.2785           |
|           | $P = 0.18 \text{ MPa } (T_{\text{sat}} = -12.73^\circ\text{C})$ |              |              |                  | $P = 0.20 \text{ MPa } (T_{\text{sat}} = -10.09^\circ\text{C})$ |              |              |                  | $P = 0.24 \text{ MPa } (T_{\text{sat}} = -5.37^\circ\text{C})$  |              |              |                  |
| Sat.      | 0.10983   | 219.94       | 239.71       | 0.9273           | 0.09933   | 221.43       | 241.30       | 0.9253           | 0.08343   | 224.07       | 244.09       | 0.9222           |
| -10       | 0.11135   | 222.02       | 242.06       | 0.9362           | 0.09938   | 221.50       | 241.38       | 0.9256           |   |              |              |                  |
| 0         | 0.11678   | 229.67       | 250.69       | 0.9684           | 0.10438   | 229.23       | 250.10       | 0.9582           | 0.08574   | 228.31       | 248.89       | 0.9399           |
| 10        | 0.12207   | 237.44       | 259.41       | 0.9998           | 0.10922   | 237.05       | 258.89       | 0.9898           | 0.08993   | 236.26       | 257.84       | 0.9721           |
| 20        | 0.12723   | 245.33       | 268.23       | 1.0304           | 0.11394   | 244.99       | 267.78       | 1.0206           | 0.09339   | 244.30       | 266.85       | 1.0034           |
| 30        | 0.13230   | 253.36       | 277.17       | 1.0604           | 0.11856   | 253.06       | 276.77       | 1.0508           | 0.09794   | 252.45       | 275.95       | 1.0339           |
| 40        | 0.13730   | 261.53       | 286.24       | 1.0898           | 0.12311   | 261.25       | 285.88       | 1.0804           | 0.10181   | 260.72       | 285.16       | 1.0637           |
| 50        | 0.14222   | 269.85       | 295.45       | 1.1187           | 0.12758   | 269.61       | 295.12       | 1.1094           | 0.10562   | 269.12       | 294.47       | 1.0930           |
| 60        | 0.14710   | 278.31       | 304.79       | 1.1472           | 0.13201   | 278.10       | 304.50       | 1.1380           | 0.10937   | 277.67       | 303.91       | 1.1218           |
| 70        | 0.15193   | 286.93       | 314.28       | 1.1753           | 0.13639   | 286.74       | 314.02       | 1.1661           | 0.11307   | 286.35       | 313.49       | 1.1501           |
| 80        | 0.15672   | 295.71       | 323.92       | 1.2030           | 0.14073   | 295.53       | 323.68       | 1.1939           | 0.11674   | 295.18       | 323.19       | 1.1780           |
| 90        | 0.16148   | 304.63       | 333.70       | 1.2303           | 0.14504   | 304.47       | 333.48       | 1.2212           | 0.12037   | 304.15       | 333.04       | 1.2055           |
| 100       | 0.16622   | 313.72       | 343.63       | 1.2573           | 0.14932   | 313.57       | 343.43       | 1.2483           | 0.12398   | 313.27       | 343.03       | 1.2326           |
|           | $P = 0.28 \text{ MPa } (T_{\text{sat}} = -1.23^\circ\text{C})$  |              |              |                  | $P = 0.32 \text{ MPa } (T_{\text{sat}} = 2.48^\circ\text{C})$   |              |              |                  | $P = 0.40 \text{ MPa } (T_{\text{sat}} = 8.93^\circ\text{C})$   |              |              |                  |
| Sat.      | 0.07193   | 226.38       | 246.52       | 0.9197           | 0.06322   | 228.43       | 248.66       | 0.9177           | 0.05089   | 231.97       | 252.32       | 0.9145           |
| 0         | 0.07240   | 227.37       | 247.64       | 0.9238           |   |              |              |                  |   |              |              |                  |
| 10        | 0.07613   | 235.44       | 256.76       | 0.9566           | 0.06576   | 234.61       | 255.65       | 0.9427           | 0.05119   | 232.87       | 253.35       | 0.9182           |
| 20        | 0.07972   | 243.59       | 265.91       | 0.9883           | 0.06901   | 242.87       | 264.95       | 0.9749           | 0.05397   | 241.37       | 262.96       | 0.9515           |
| 30        | 0.08320   | 251.83       | 275.12       | 1.0192           | 0.07214   | 251.19       | 274.28       | 1.0062           | 0.05662   | 249.89       | 272.54       | 0.9837           |
| 40        | 0.08660   | 260.17       | 284.42       | 1.0494           | 0.07518   | 259.61       | 283.67       | 1.0367           | 0.05917   | 258.47       | 282.14       | 1.0148           |
| 50        | 0.08992   | 268.64       | 293.81       | 1.0789           | 0.07815   | 268.14       | 293.15       | 1.0665           | 0.06164   | 267.13       | 291.79       | 1.0452           |
| 60        | 0.09319   | 277.23       | 303.32       | 1.1079           | 0.08106   | 276.79       | 302.72       | 1.0957           | 0.06405   | 275.89       | 301.51       | 1.0748           |
| 70        | 0.09641   | 285.96       | 312.95       | 1.1364           | 0.08392   | 285.56       | 312.41       | 1.1243           | 0.06641   | 284.75       | 311.32       | 1.1038           |
| 80        | 0.09960   | 294.82       | 322.71       | 1.1644           | 0.08674   | 294.46       | 322.22       | 1.1525           | 0.06873   | 293.73       | 321.23       | 1.1322           |
| 90        | 0.10275   | 303.83       | 332.60       | 1.1920           | 0.08953   | 303.50       | 332.15       | 1.1802           | 0.07102   | 302.84       | 331.25       | 1.1602           |
| 100       | 0.10587   | 312.98       | 342.62       | 1.2193           | 0.09229   | 312.68       | 342.21       | 1.1076           | 0.07327   | 312.07       | 341.38       | 1.1878           |
| 110       | 0.10897   | 322.27       | 352.78       | 1.2461           | 0.09503   | 322.00       | 352.40       | 1.2345           | 0.07550   | 321.44       | 351.64       | 1.2149           |
| 120       | 0.11205   | 331.71       | 363.08       | 1.2727           | 0.09774   | 331.45       | 362.73       | 1.2611           | 0.07771   | 330.94       | 362.03       | 1.2417           |
| 130       |   |              |              |                  |   |              |              |                  | 0.07991   | 340.58       | 372.54       | 1.2681           |
| 140       |   |              |              |                  |   |              |              |                  | 0.08208   | 350.35       | 383.18       | 1.2941           |

**TABLA A.13**

Refrigerante 134a sobrecalentado (Conclusión)

| T<br>°C                                   | v<br>m³/kg | u<br>kJ/kg | h<br>kJ/kg | s<br>kJ/kg · K                            | v<br>m³/kg | u<br>kJ/kg | h<br>kJ/kg | s<br>kJ/kg · K                            | v<br>m³/kg | u<br>kJ/kg | h<br>kJ/kg | s<br>kJ/kg · K |
|---|------------|------------|------------|---|------------|------------|------------|---|------------|------------|------------|----------------|
| P = 0.50 MPa (T <sub>sat</sub> = 15.74°C) |            |            |            | P = 0.60 MPa (T <sub>sat</sub> = 21.58°C) |            |            |            | P = 0.70 MPa (T <sub>sat</sub> = 26.72°C) |            |            |            |                |
| Sat.                                      | 0.04086    | 253.64     | 256.07     | 0.9117                                    | 0.03408    | 238.74     | 259.19     | 0.9097                                    | 0.02918    | 241.42     | 261.85     | 0.9080         |
| 20  | 0.04188    | 239.40     | 260.34     | 0.9264                                    |            |            |            |   |            |            |            |                |
| 30  | 0.04416    | 248.20     | 270.28     | 0.9597                                    | 0.03581    | 246.41     | 267.89     | 0.9388                                    | 0.02979    | 244.51     | 265.37     | 0.9197         |
| 40  | 0.04633    | 256.99     | 280.16     | 0.9918                                    | 0.03774    | 255.45     | 278.09     | 0.9719                                    | 0.03157    | 253.83     | 275.93     | 0.9539         |
| 50  | 0.04842    | 265.83     | 290.04     | 1.0229                                    | 0.03958    | 264.48     | 288.23     | 1.0037                                    | 0.03324    | 263.08     | 286.35     | 0.9867         |
| 60  | 0.05043    | 274.73     | 299.95     | 1.0531                                    | 0.04134    | 273.54     | 298.35     | 1.0346                                    | 0.03482    | 272.31     | 296.69     | 1.0182         |
| 70  | 0.05240    | 283.72     | 309.92     | 1.0825                                    | 0.04304    | 282.66     | 308.48     | 1.0645                                    | 0.03634    | 281.57     | 307.01     | 1.0487         |
| 80  | 0.05432    | 292.80     | 319.96     | 1.1114                                    | 0.04469    | 291.86     | 318.67     | 1.0938                                    | 0.03781    | 290.88     | 317.35     | 1.0784         |
| 90  | 0.05620    | 302.00     | 330.10     | 1.1397                                    | 0.04631    | 301.14     | 328.93     | 1.1225                                    | 0.03924    | 300.27     | 327.74     | 1.1074         |
| 100                                       | 0.05805    | 311.31     | 340.33     | 1.1675                                    | 0.04790    | 310.53     | 339.27     | 1.1505                                    | 0.04064    | 309.74     | 338.19     | 1.1358         |
| 110                                       | 0.05988    | 320.74     | 350.68     | 1.1949                                    | 0.04946    | 320.03     | 349.70     | 1.1781                                    | 0.04201    | 319.31     | 348.71     | 1.1637         |
| 120                                       | 0.06168    | 330.30     | 361.14     | 1.2218                                    | 0.05099    | 329.64     | 360.24     | 1.2053                                    | 0.04335    | 328.98     | 359.33     | 1.1910         |
| 130                                       | 0.06347    | 339.98     | 371.72     | 1.2484                                    | 0.05251    | 339.38     | 370.88     | 1.2320                                    | 0.04468    | 338.76     | 370.04     | 1.2179         |
| 140                                       | 0.06524    | 349.79     | 382.42     | 1.2746                                    | 0.05402    | 349.23     | 381.64     | 1.2584                                    | 0.04599    | 348.66     | 380.86     | 1.2444         |
| 150                                       |            |            |            |   | 0.05550    | 359.21     | 392.52     | 1.2844                                    | 0.04729    | 358.68     | 391.79     | 1.2706         |
| 160                                       |            |            |            |   | 0.05698    | 369.32     | 403.51     | 1.3100                                    | 0.04857    | 368.82     | 402.82     | 1.2963         |
| P = 0.80 MPa (T <sub>sat</sub> = 31.33°C) |            |            |            | P = 0.90 MPa (T <sub>sat</sub> = 35.53°C) |            |            |            | P = 1.00 MPa (T <sub>sat</sub> = 39.39°C) |            |            |            |                |
| Sat.                                      | 0.02547    | 243.78     | 264.15     | 0.9066                                    | 0.02255    | 245.88     | 266.18     | 0.9054                                    | 0.02020    | 247.77     | 267.97     | 0.9043         |
| 40  | 0.02691    | 252.13     | 273.66     | 0.9374                                    | 0.02325    | 250.32     | 271.25     | 0.9217                                    | 0.02029    | 248.39     | 268.68     | 0.9066         |
| 50  | 0.02846    | 261.62     | 284.39     | 0.9711                                    | 0.02472    | 260.09     | 282.34     | 0.9566                                    | 0.02171    | 258.48     | 280.19     | 0.9428         |
| 60  | 0.02992    | 271.04     | 294.98     | 1.0034                                    | 0.02609    | 269.72     | 293.21     | 0.9897                                    | 0.02301    | 268.35     | 291.36     | 0.9768         |
| 70  | 0.03131    | 280.45     | 305.50     | 1.0345                                    | 0.02738    | 279.30     | 303.94     | 1.0214                                    | 0.02423    | 278.11     | 302.34     | 1.0093         |
| 80  | 0.03264    | 289.89     | 316.00     | 1.0647                                    | 0.02861    | 288.87     | 314.62     | 1.0521                                    | 0.02538    | 287.82     | 313.20     | 1.0405         |
| 90  | 0.03393    | 299.37     | 326.52     | 1.0940                                    | 0.02980    | 298.46     | 325.28     | 1.0819                                    | 0.02649    | 297.53     | 324.01     | 1.0707         |
| 100                                       | 0.03519    | 308.93     | 337.08     | 1.1227                                    | 0.03095    | 308.11     | 335.96     | 1.1109                                    | 0.02755    | 307.27     | 334.82     | 1.1000         |
| 110                                       | 0.03642    | 318.57     | 347.71     | 1.1508                                    | 0.03207    | 317.82     | 346.68     | 1.1392                                    | 0.02858    | 317.06     | 345.65     | 1.1286         |
| 120                                       | 0.03762    | 328.31     | 358.40     | 1.1784                                    | 0.03316    | 327.62     | 357.47     | 1.1670                                    | 0.02959    | 326.93     | 356.52     | 1.1567         |
| 130                                       | 0.03881    | 338.14     | 369.19     | 1.2055                                    | 0.03423    | 337.52     | 368.33     | 1.1943                                    | 0.03058    | 336.88     | 367.46     | 1.1841         |
| 140                                       | 0.03997    | 348.09     | 380.07     | 1.2321                                    | 0.03529    | 347.51     | 379.27     | 1.2211                                    | 0.03154    | 346.92     | 378.46     | 1.2111         |
| 150                                       | 0.04113    | 358.15     | 391.05     | 1.2584                                    | 0.03633    | 357.61     | 390.31     | 1.2475                                    | 0.03250    | 357.06     | 389.56     | 1.2376         |
| 160                                       | 0.04227    | 368.32     | 402.14     | 1.2843                                    | 0.03736    | 367.82     | 401.44     | 1.2735                                    | 0.03344    | 367.31     | 400.74     | 1.2638         |
| 170                                       | 0.04340    | 378.61     | 413.33     | 1.3098                                    | 0.03838    | 378.14     | 412.68     | 1.2992                                    | 0.03436    | 377.66     | 412.02     | 1.2895         |
| 180                                       | 0.04452    | 389.02     | 424.63     | 1.3351                                    | 0.03939    | 388.57     | 424.02     | 1.3245                                    | 0.03528    | 388.12     | 423.40     | 1.3149         |
| P = 1.20 MPa (T <sub>sat</sub> = 46.32°C) |            |            |            | P = 1.40 MPa (T <sub>sat</sub> = 52.43°C) |            |            |            | P = 1.60 MPa (T <sub>sat</sub> = 57.92°C) |            |            |            |                |
| Sat.                                      | 0.01663    | 251.03     | 270.99     | 0.9023                                    | 0.01405    | 253.74     | 273.40     | 0.9003                                    | 0.01208    | 256.00     | 275.33     | 0.8982         |
| 50  | 0.01712    | 254.98     | 275.52     | 0.9164                                    |            |            |            |   |            |            |            |                |
| 60  | 0.01835    | 265.42     | 287.44     | 0.9527                                    | 0.01495    | 262.17     | 283.10     | 0.9297                                    | 0.01233    | 258.48     | 278.20     | 0.9069         |
| 70  | 0.01947    | 275.59     | 298.96     | 0.9868                                    | 0.01603    | 272.87     | 295.31     | 0.9658                                    | 0.01340    | 269.89     | 291.33     | 0.9457         |
| 80  | 0.02051    | 285.62     | 310.24     | 1.0192                                    | 0.01701    | 283.29     | 307.10     | 0.9997                                    | 0.01435    | 280.78     | 303.74     | 0.9813         |
| 90  | 0.02150    | 295.59     | 321.39     | 1.0503                                    | 0.01792    | 293.55     | 318.63     | 1.0319                                    | 0.01521    | 291.39     | 315.72     | 1.0148         |
| 100                                       | 0.02244    | 305.54     | 332.47     | 1.0804                                    | 0.01878    | 303.73     | 330.02     | 1.0628                                    | 0.01601    | 301.84     | 327.46     | 1.0467         |
| 110                                       | 0.02335    | 315.50     | 343.52     | 1.1096                                    | 0.01960    | 313.88     | 341.32     | 1.0927                                    | 0.01677    | 312.20     | 339.04     | 1.0773         |
| 120                                       | 0.02423    | 325.51     | 354.58     | 1.1381                                    | 0.02039    | 324.05     | 352.59     | 1.1218                                    | 0.01750    | 322.53     | 350.53     | 1.1069         |
| 130                                       | 0.02508    | 335.58     | 365.68     | 1.1660                                    | 0.02115    | 334.25     | 363.86     | 1.1501                                    | 0.01820    | 332.87     | 361.99     | 1.1357         |
| 140                                       | 0.02592    | 345.73     | 376.83     | 1.1933                                    | 0.02189    | 344.50     | 375.15     | 1.1777                                    | 0.01887    | 343.24     | 373.44     | 1.1638         |
| 150                                       | 0.02674    | 355.95     | 388.04     | 1.2201                                    | 0.02262    | 354.82     | 386.49     | 1.2048                                    | 0.01953    | 353.66     | 384.91     | 1.1912         |
| 160                                       | 0.02754    | 366.27     | 399.33     | 1.2465                                    | 0.02333    | 365.22     | 397.89     | 1.2315                                    | 0.02017    | 364.15     | 396.43     | 1.2181         |
| 170                                       | 0.02834    | 376.69     | 410.70     | 1.2724                                    | 0.02403    | 375.71     | 409.36     | 1.2576                                    | 0.02080    | 374.71     | 407.99     | 1.2445         |
| 180                                       | 0.02912    | 387.21     | 422.16     | 1.2980                                    | 0.02472    | 386.29     | 420.90     | 1.2834                                    | 0.02142    | 385.35     | 419.62     | 1.2704         |
| 190                                       |            |            |            |   | 0.02541    | 396.96     | 432.53     | 1.3088                                    | 0.02203    | 396.08     | 431.33     | 1.2960         |
| 200                                       |            |            |            |   | 0.02608    | 407.73     | 444.24     | 1.3338                                    | 0.02263    | 406.90     | 443.11     | 1.3212         |

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