

Table 32 .... Refrigerant 600 (n-Butane) Properties of Liquid and Saturated Vapor

| Temp<br>F | Pressure* |       | Volume<br>cu<br>ft/lb   | Density<br>lb/cu<br>ft   | Enthalpy**<br>Btu/lb    | Entropy**<br>Btu/lb (°R) | Temp<br>F | Pressure* |       | Volume<br>cu<br>ft/lb   | Density<br>lb/cu<br>ft   | Enthalpy**<br>Btu/lb    | Entropy**<br>Btu/lb (°R) |
|-----------|-----------|-------|-------------------------|--------------------------|-------------------------|--------------------------|-----------|-----------|-------|-------------------------|--------------------------|-------------------------|--------------------------|
|           | psia      | psig  | Vapor<br>v <sub>g</sub> | Liquid<br>l <sub>f</sub> | Vapor<br>h <sub>g</sub> | Liquid<br>h <sub>f</sub> |           | psia      | psig  | Vapor<br>v <sub>g</sub> | Liquid<br>l <sub>f</sub> | Vapor<br>h <sub>g</sub> | Liquid<br>h <sub>f</sub> |
| 0         | 7.5       | 15.0* | 11.1                    | 38.59                    | 103.8                   | 0.228                    | 95        | 48.2      | 33.5  | 1.96                    | 35.04                    | 153.1                   | 0.332                    |
| 5         | 8.2       | 15.9* | 9.98                    | 38.41                    | 106.2                   | 0.231                    | 100       | 52.2      | 37.5  | 1.81                    | 34.84                    | 156.2                   | 0.340                    |
| 10        | 9.2       | 17.1* | 8.95                    | 38.24                    | 108.8                   | 0.235                    | 105       | 56.4      | 41.7  | 1.70                    | 34.62                    | 159.1                   | 0.346                    |
| 15        | 10.4      | 18.8* | 8.05                    | 38.07                    | 111.5                   | 0.239                    | 110       | 60.8      | 46.1  | 1.59                    | 34.41                    | 161.9                   | 0.352                    |
| 20        | 11.6      | 20.3* | 7.22                    | 37.89                    | 114.0                   | 0.243                    | 115       | 65.6      | 50.9  | 1.48                    | 34.19                    | 165.0                   | 0.357                    |
| 25        | 13.0      | 22.0* | 6.55                    | 37.72                    | 116.7                   | 0.248                    | 120       | 70.8      | 56.1  | 1.37                    | 33.96                    | 167.8                   | 0.362                    |
| 30        | 14.4      | 23.9* | 5.90                    | 37.54                    | 119.2                   | 0.254                    | 125       | 76.0      | 61.3  | 1.25                    | 33.76                    | 171.0                   | 0.367                    |
| 35        | 16.0      | 25.9* | 5.27                    | 37.37                    | 121.8                   | 0.260                    | 130       | 81.4      | 66.7  | 1.15                    | 33.56                    | 174.0                   | 0.372                    |
| 40        | 17.7      | 28.0* | 4.67                    | 37.19                    | 124.2                   | 0.267                    | 135       | 87.0      | 72.3  | 1.11                    | 33.34                    | 177.1                   | 0.377                    |
| 45        | 19.6      | 29.9* | 4.07                    | 37.00                    | 126.8                   | 0.274                    | 140       | 92.5      | 77.9  | 1.04                    | 33.14                    | 179.9                   | 0.382                    |
| 50        | 21.6      | 31.9* | 3.73                    | 36.82                    | 129.6                   | 0.282                    | 145       | 100.0     | 85.3  | 0.966                   | 32.92                    | 183.1                   | 0.388                    |
| 55        | 23.8      | 34.1* | 3.37                    | 36.63                    | 132.1                   | 0.290                    | 150       | 108.0     | 93.7  | 0.897                   | 32.70                    | 186.3                   | 0.394                    |
| 60        | 26.3      | 36.6* | 3.00                    | 36.45                    | 134.8                   | 0.297                    | 155       | 115.0     | 100.3 | 0.840                   | 32.43                    | 189.3                   | 0.399                    |
| 65        | 28.9      | 39.2* | 2.75                    | 36.24                    | 137.2                   | 0.305                    | 160       | 122.0     | 107.2 | 0.785                   | 32.15                    | 192.2                   | 0.404                    |
| 70        | 31.6      | 41.9* | 2.58                    | 36.06                    | 140.1                   | 0.313                    | 165       | 130.0     | 115.3 | 0.731                   | 31.90                    | 195.0                   | 0.409                    |
| 75        | 34.5      | 44.8* | 2.45                    | 35.86                    | 142.5                   | 0.320                    | 170       | 140.0     | 125.3 | 0.687                   | 31.68                    | 199.2                   | 0.415                    |
| 80        | 37.5      | 47.8* | 2.28                    | 35.65                    | 145.0                   | 0.328                    | 175       | 150.0     | 135.3 | 0.643                   | 31.36                    | 202.1                   | 0.420                    |
| 85        | 40.9      | 51.2* | 2.10                    | 35.45                    | 147.8                   | 0.335                    | 180       | 160.0     | 145.3 | 0.602                   | 31.10                    | 205.0                   | 0.425                    |
| 90        | 44.5      | 54.8* | 1.92                    | 35.24                    | 150.5                   | 0.342                    |           |           |       |                         |                          |                         |                          |

\* Based on material from Dana, Jenkins, Burdick and Timm, published originally in *Refrigerating Engineering*, June 1926, vol. 12, no. 12, page 402.

\*\* Inches of mercury below one standard atmosphere.

\* From Pressure-Enthalpy Diagram (Fig. 20). Based on 0 for the saturated liquid at -50 F.

Table 33 .... Refrigerant 601 (Isobutane) Properties of Liquid and Saturated Vapor

| Temp<br>F | Pressure* |       | Volume<br>cu<br>ft/lb   | Density<br>lb/cu<br>ft   | Enthalpy**<br>Btu/lb    | Entropy**<br>Btu/lb (°R) | Temp<br>F | Pressure* |       | Volume<br>cu<br>ft/lb   | Density<br>lb/cu<br>ft   | Enthalpy**<br>Btu/lb    | Entropy**<br>Btu/lb (°R) |
|-----------|-----------|-------|-------------------------|--------------------------|-------------------------|--------------------------|-----------|-----------|-------|-------------------------|--------------------------|-------------------------|--------------------------|
|           | psia      | psig  | Vapor<br>v <sub>g</sub> | Liquid<br>l <sub>f</sub> | Vapor<br>h <sub>g</sub> | Liquid<br>h <sub>f</sub> |           | psia      | psig  | Vapor<br>v <sub>g</sub> | Liquid<br>l <sub>f</sub> | Vapor<br>h <sub>g</sub> | Liquid<br>h <sub>f</sub> |
| -20       | 7.50      | 14.5* | 11.0                    | 38.35                    | -9.0                    | 0.256                    | 85        | 58.6      | 43.9  | 1.54                    | 34.10                    | 50.0                    | 0.098                    |
| -15       | 8.30      | 15.3* | 9.90                    | 38.15                    | -7.0                    | 0.258                    | 90        | 63.3      | 48.6  | 1.42                    | 33.90                    | 53.5                    | 0.105                    |
| -10       | 9.28      | 16.3* | 8.91                    | 37.95                    | -4.5                    | 0.260                    | 95        | 68.4      | 53.7  | 1.32                    | 33.70                    | 57.5                    | 0.112                    |
| -5        | 10.4      | 17.4* | 7.99                    | 37.70                    | -2.5                    | 0.262                    | 100       | 73.7      | 59.0  | 1.23                    | 33.45                    | 61.0                    | 0.118                    |
| 0         | 11.6      | 18.6* | 7.17                    | 37.60                    | 0.0                     | 0.264                    | 105       | 79.3      | 64.6  | 1.14                    | 33.25                    | 65.0                    | 0.125                    |
| +5        | 13.1      | 20.1* | 6.41                    | 37.40                    | +2.5                    | 0.266                    | 110       | 85.1      | 70.4  | 1.07                    | 33.00                    | 69.0                    | 0.132                    |
| 10        | 14.6      | 21.6* | 5.75                    | 37.20                    | 5.0                     | 0.268                    | 115       | 91.4      | 76.7  | 0.990                   | 32.80                    | 73.0                    | 0.139                    |
| 15        | 16.3      | 23.3* | 5.18                    | 37.00                    | 7.5                     | 0.270                    | 120       | 98.0      | 83.3  | 0.928                   | 32.50                    | 77.0                    | 0.147                    |
| 20        | 18.2      | 25.2* | 4.68                    | 36.80                    | 10.0                    | 0.272                    | 125       | 104.8     | 90.1  | 0.867                   | 32.20                    | 81.5                    | 0.154                    |
| 25        | 20.2      | 27.2* | 4.24                    | 36.60                    | 12.5                    | 0.274                    | 130       | 112.0     | 97.3  | 0.811                   | 32.00                    | 86.0                    | 0.161                    |
| 30        | 22.3      | 29.3* | 3.86                    | 36.40                    | 15.0                    | 0.276                    | 135       | 119.8     | 104.6 | 0.760                   | 31.80                    | 90.5                    | 0.169                    |
| 35        | 24.6      | 31.6* | 3.52                    | 36.20                    | 17.5                    | 0.278                    | 140       | 128.0     | 112.1 | 0.710                   | 31.50                    | 95.0                    | 0.176                    |
| 40        | 26.9      | 33.9* | 3.22                    | 36.00                    | 20.0                    | 0.280                    | 145       | 136.0     | 120.3 | 0.662                   | 31.20                    | 99.5                    | 0.183                    |
| 45        | 29.5      | 36.5* | 2.96                    | 35.80                    | 22.5                    | 0.282                    | 150       | 145.0     | 129.3 | 0.620                   | 31.03                    | 104.5                   | 0.190                    |
| 50        | 32.5      | 39.5* | 2.71                    | 35.60                    | 25.0                    | 0.284                    | 155       | 155.0     | 140.3 | 0.580                   | 30.73                    | 109.3                   | 0.197                    |
| 55        | 35.5      | 42.5* | 2.49                    | 35.40                    | 27.5                    | 0.286                    | 160       | 165.0     | 150.3 | 0.542                   | 30.43                    | 114.2                   | 0.204                    |
| 60        | 38.7      | 45.7* | 2.28                    | 35.20                    | 30.0                    | 0.288                    | 165       | 175.0     | 160.3 | 0.505                   | 30.14                    | 119.3                   | 0.211                    |
| 65        | 42.2      | 49.2* | 2.10                    | 35.00                    | 32.5                    | 0.290                    | 170       | 186.0     | 171.3 | 0.475                   | 29.85                    | 124.7                   | 0.219                    |
| 70        | 45.8      | 52.8* | 1.94                    | 34.80                    | 35.0                    | 0.292                    | 175       | 198.0     | 183.3 | 0.448                   | 29.54                    | 129.9                   | 0.226                    |
| 75        | 49.7      | 56.7* | 1.79                    | 34.60                    | 37.5                    | 0.294                    | 180       | 210.0     | 195.3 | 0.420                   | 29.23                    | 135.0                   | 0.233                    |
| 80        | 53.9      | 60.9* | 1.66                    | 34.35                    | 40.0                    | 0.296                    |           |           |       |                         |                          |                         |                          |

\* Based on material from Dana, Jenkins, Burdick and Timm, published originally in *Refrigerating Engineering*, June 1926, vol. 12, no. 12, page 402.\*\* Specific volume and density beyond 135 F. B. H. Sage and W. N. Lacey, *Industrial and Engineering Chemistry*, June 1938.

\* Inches of mercury below one standard atmosphere.

\* Based on 0 for the saturated liquid at 0 F.

Table 34 .... Refrigerant 744A (Nitrous Oxide) Properties of Liquid and Saturated Vapor

| Temp<br>F | Pressure* |       | Volume<br>cu<br>ft/lb   | Density<br>lb/cu<br>ft   | Enthalpy**<br>Btu/lb    | Entropy**<br>Btu/lb (°R) | Temp<br>F | Pressure* |        | Volume<br>cu<br>ft/lb   | Density<br>lb/cu<br>ft   | Enthalpy**<br>Btu/lb    | Entropy**<br>Btu/lb (°R) |
|-----------|-----------|-------|-------------------------|--------------------------|-------------------------|--------------------------|-----------|-----------|--------|-------------------------|--------------------------|-------------------------|--------------------------|
|           | psia      | psig  | Vapor<br>v <sub>g</sub> | Liquid<br>l <sub>f</sub> | Vapor<br>h <sub>g</sub> | Liquid<br>h <sub>f</sub> |           | psia      | psig   | Vapor<br>v <sub>g</sub> | Liquid<br>l <sub>f</sub> | Vapor<br>h <sub>g</sub> | Liquid<br>h <sub>f</sub> |
| -127      | 14.7      | 0.0   | 5.5                     | 80.0                     | -98.5                   | 0.33                     | -10       | 240.0     | 225.3  | 0.384                   | 64.7                     | -64.3                   | 1.2455                   |
| -120      | 20.0      | 4.3   | 4.2                     | 79.5                     | -95.5                   | 0.33                     | 0         | 255.0     | 240.3  | 0.39                    | 63.0                     | -63.4                   | 1.2585                   |
| -110      | 26.0      | 11.3  | 3.18                    | 77.5                     | -93.8                   | 0.33                     | 10        | 335.0     | 320.3  | 0.42                    | 61.2                     | -61.8                   | 1.2700                   |
| -100      | 35.0      | 20.3  | 2.28                    | 75.5                     | -90.7                   | 0.33                     | 20        | 387.0     | 372.3  | 0.45                    | 59.5                     | -59.8                   | 1.2800                   |
| -90       | 48.0      | 33.3  | 1.62                    | 73.0                     | -87.8                   | 0.33                     | 30        | 490.0     | 467.3  | 0.48                    | 57.0                     | -57.3                   | 1.2900                   |
| -80       | 65.0      | 50.3  | 1.13                    | 74.0                     | -83.7                   | 0.33                     | 40        | 620.0     | 605.3  | 0.50                    | 54.7                     | -55.2                   | 1.2985                   |
| -70       | 88.0      | 73.3  | 0.82                    | 72.5                     | -79.8                   | 0.33                     | 50        | 790.0     | 775.3  | 0.53                    | 52.3                     | -52.8                   | 1.3065                   |
| -60       | 112.0     | 97.3  | 0.58                    | 70.5                     | -75.8                   | 0.33                     | 60        | 1000.0    | 985.3  | 0.56                    | 49.8                     | -50.3                   | 1.3140                   |
| -50       | 137.0     | 122.3 | 0.41                    | 68.0                     | -71.8                   | 0.33                     | 70        | 1250.0    | 1235.3 | 0.59                    | 47.3                     | -47.8                   | 1.3210                   |
| -40       | 167.0     | 152.3 | 0.31                    | 67.0                     | -67.2                   | 0.33                     | 80        | 1550.0    | 1535.3 | 0.62                    | 44.8                     | -45.3                   | 1.3275                   |
| -30       | 203.0     | 188.3 | 0.23                    | 65.5                     | -62.7                   | 0.33                     | 90        | 1900.0    | 1885.3 | 0.65                    | 42.3                     | -42.8                   | 1.3335                   |

\* Based on 0 for the saturated liquid at 80 F.

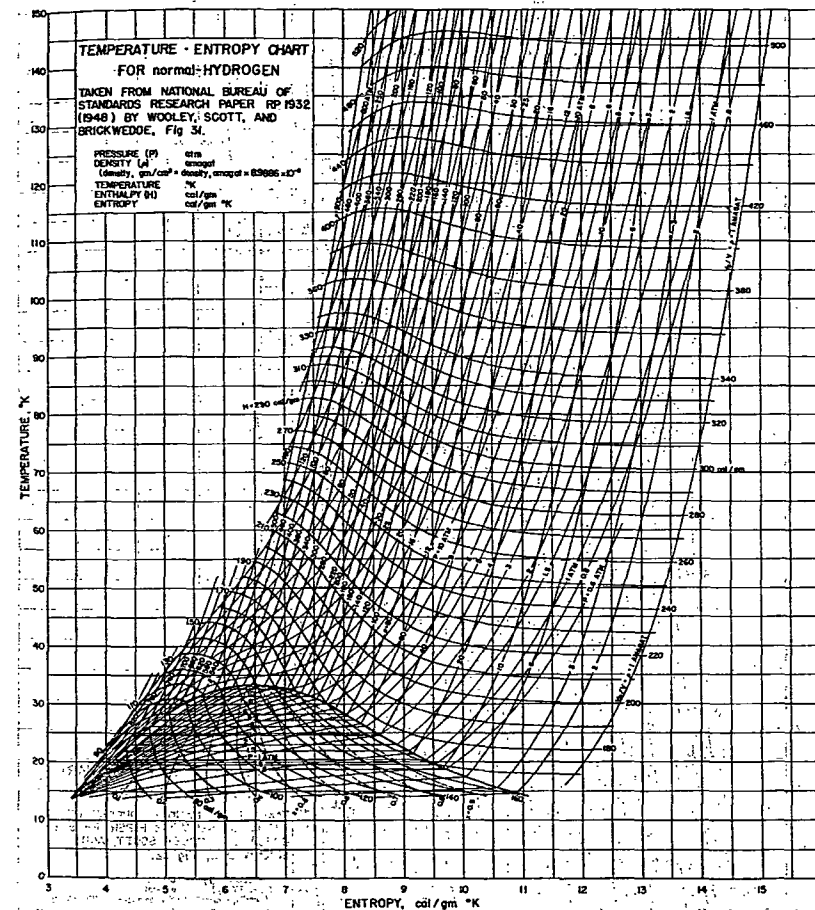


Fig. 22 .... Temperature-Entropy Diagram for Refrigerant 702 (Normal Hydrogen)