TOPICS RELATED TO SULFUR VAPOUR PRESSURE

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1. What was wrong the accepted vapour pressure of elemental sulfur?

2. Do new data and an updated correlation really affect dew-point calculations at near-ambient pressures (recovery conditions)?

3. Is there a difference in sulfur vapour pick-up using N₂ versus CO₂ purge?

THE DIFFERENCES BETWEEN REPORTED VAPOUR PRESSURES OF ELEMENTAL SULFUR AND THOSE ESTIMATED USING MARRIOTT AND WAN (2011)

- ●, experimental data of Baker [21]; ○, experimental data of Rau et al. [20]; ◊, experimental data of West and Menzies [3]; ———, calculated using the Wagner equation of Ferreira and Lobo [1]; ———, calculated from the equation of Rau et al. [20]; ———, calculated using the equations of Shuai and Meison [6].
RECOMMENDED THERMODYNAMIC CONDITIONS FOR THE PHASE DIAGRAM OF ELEMENTAL SULFUR

<table>
<thead>
<tr>
<th>Condition</th>
<th>$T / K$</th>
<th>$T / ^\circ C$</th>
<th>$T / ^\circ F$</th>
<th>$p / \text{Pa}$</th>
<th>$p / \text{psia}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triple point ($\alpha$-$\beta$-$g$)</td>
<td>368.39</td>
<td>95.24</td>
<td>203.43</td>
<td>0.4868</td>
<td>0.00007060</td>
</tr>
<tr>
<td>Triple point ($\alpha$-$\beta$-l)</td>
<td>419.06</td>
<td>145.91</td>
<td>294.64</td>
<td>124,360,000</td>
<td>18,036</td>
</tr>
<tr>
<td>Triple point ($\beta$-l-$g$)</td>
<td>388.326</td>
<td>115.176</td>
<td>239.317</td>
<td>2.4437</td>
<td>0.00035443</td>
</tr>
<tr>
<td>Natural melt ($\beta$-l)</td>
<td>388.348</td>
<td>115.198</td>
<td>239.356</td>
<td>101,325</td>
<td>14.696</td>
</tr>
</tbody>
</table>

Note that the ‘observed’ melting point is normally $T = 393.5 \pm 0.5 \text{ K (120.0} \pm 0.5 \text{ }^\circ \text{C or 248.1} \pm 0.9 \text{ }^\circ \text{F)}$.

This new model uses the pure vapour pressure for $\alpha$-sulfur and liquid sulfur and the enthalpy of the $\alpha \rightarrow \beta$ transition. Volumetric data come from literature and the vapour pressure is forced to align with the natural fusion line.


NEW VAPOUR PRESSURE MEASUREMENTS

Pirani gauge (1.0•10^-4 to 1000)Torr
Digital display
Pt/Ir sensor

Vacuum 2.3 mTorr
Flask with sulfur
Oil bath
RELATIVE DIFFERENCES IN VAPOUR PRESSURE MEASUREMENTS FOR ELEMENTAL SULFUR

New model based on all available data
(updated with ASRL data from January 2012)

THE VAPOUR PRESSURE OF PURE ELEMENTAL SULFUR

Would this new information really change dew-point calculations at low pressures?

The calculated dew point temperature changes by $\delta T < 0.75^\circ$C for $p^p > 0.1$ kPa
SULFUR SATURATORS USED TO MEASURE VAPOUR PICK-UP USING DIFFERENT PURGE GASES

Configuration A
Surface area unknown

Configuration B
$A = 8.5 \text{ cm}^2$

N$_2$ or CO$_2$ In
Gas Out
To Mass Spectrometer

A) SWEEPING SULFUR VAPOUR USING N$_2$ OR CO$_2$ GAS

Vapour pressure extrapolations

CO$_2$ gas sweep

N$_2$ gas sweep
CONCLUSIONS

1. New vapour pressure measurements have been completed and used to optimise a reference correlation (now self-consistent with the melting point).

2. Low pressure dew-point predictions do not change significantly with the new data (but Dr. Gibbs will be satisfied).

3. No significant difference in sulfur vapour pick-up was detected when comparing N$_2$ versus CO$_2$ as a purge gas.

4. The rate of sulfur volatilization at $T = 125^\circ$C (257°F; 3°Bs) was found to be $\sim$0.002 kg hr$^{-1}$ m$^{-2}$.

Are there any reasons why CO$_2$ would not be an acceptable purge gas for a controlled shut-down?
Thank you

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