

APPENDIX A

Petrol liquid/vapour volume equivalence

According to the ideal gas law, 1 kg of hydrocarbon (VOC) vapour at atmospheric pressure and a temperature of 15° C (European conditions) occupy a volume as shown in Equation A1.

$$\text{Volume of vapour}(V) = 22,4 \times \frac{288}{273} \times \frac{1}{M} = \frac{23,6}{M} \text{ m}^3 \quad [A1]$$

where M = mean molecular weight of the hydrocarbon (VOC) vapours and the 22,4 term is in m³/kmol at standard conditions (0 °C and 101,325 kPa), according to Avogadro's law.

Also, according to Hadley *et al.* (1978), 1kg of the same vapour in liquid form occupies the volume shown in Equation A2.

$$\text{Volume of liquid}(L) = \frac{1}{d} \text{ m}^3 \quad [A2]$$

where d = liquid density of the hydrocarbon (VOC) vapours in kg/m³.

Therefore, by combining Equations A1 with A2, the vapour/liquid volume ratio (V/L) at atmospheric pressure and 15°C, is:

$$\frac{V}{L} = \frac{23,6 \times d}{M} \quad [A3]$$

According to Hadley *et al.* (1978) the typical mean molecular weight for hydrocarbon (VOC) vapour at European conditions is 64 g/gmol and the condensed vapour density is approximately 600 kg/m³ at 15°C and 101,325 kPa. By substituting these values into Equation A3, $V/L = 220 \text{ m}^3$. The inverse, $L/V = 0,0045$ or 0,45%; is known as the liquid to vapour equivalence factor (f), used in calculating the volume liquid equivalent contained in a given volume of petrol vapour (Hadley *et al.*, 1978).



Figure B.1 Nomogram for the determination of true vapour pressure (TVP) from RVP and temperature (Hadley *et al.*, 1978).

APPENDIX B

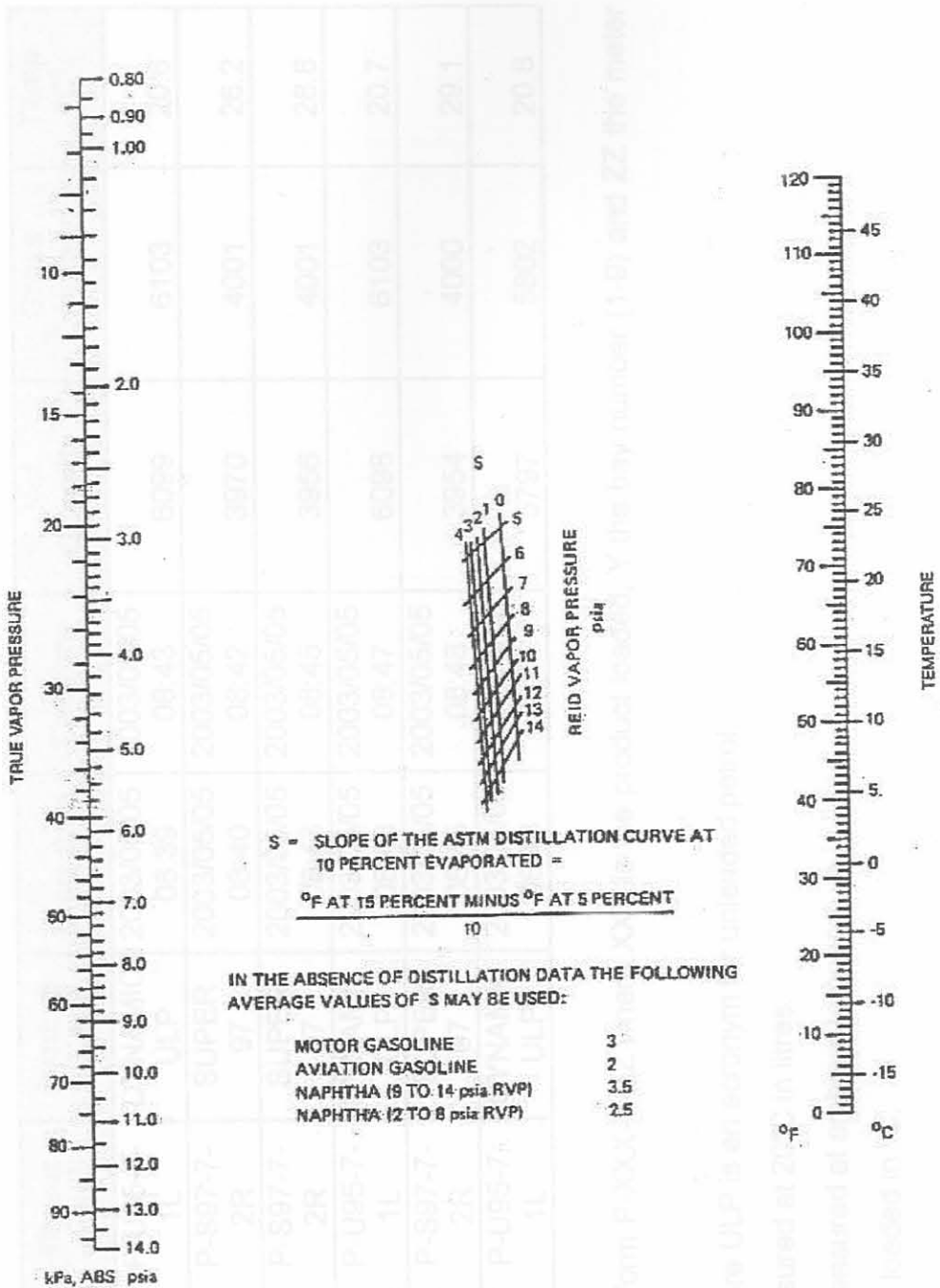


Figure B.1 Nomogram for the determination of true vapour pressure (TVP) from RVP and temperature (Hadley *et al.*, 1978).

APPENDIX C

Table C.1 Product loading data from Fuel Facts[®] system.

Tanker name	Number	Preset code ¹	Product loaded ²	Start time	End time	Net Quantity ³	Gross Quantity ⁴	Temp °C ⁵
Engen transport	92062	P-U95-7-1L	DYNAMIC ULP	2003/05/05 08:39	2003/05/05 08:43	6099	6103	20.6
Engen transport	92062	P-S97-7-2R	SUPER 97	2003/05/05 08:40	2003/05/05 08:42	3970	4001	26.2
Engen transport	92062	P-S97-7-2R	SUPER 97	2003/05/05 08:43	2003/05/05 08:45	3956	4001	28.8
Engen transport	92062	P-U95-7-1L	DYNAMIC ULP	2003/05/05 08:43	2003/05/05 08:47	6098	6103	20.7
Engen transport	92062	P-S97-7-2R	SUPER 97	2003/05/05 08:45	2003/05/05 08:48	3954	4000	29.1
Engen transport	92062	P-U95-7-1L	DYNAMIC ULP	2003/05/05 08:48	2003/05/05 08:51	5797	5802	20.8

- 1 Preset code in the form P-XXX-Y-ZZ where XXX is the product loaded, Y the bay number (1-9) and ZZ the meter position.
- 2 Product loaded where ULP is an acronym for unleaded petrol.
- 3 Net quantity is measured at 20°C in litres.
- 4 Gross quantity is measured at ambient temperature in litres.
- 5 Temperature of fuel loaded in °C.

APPENDIX D

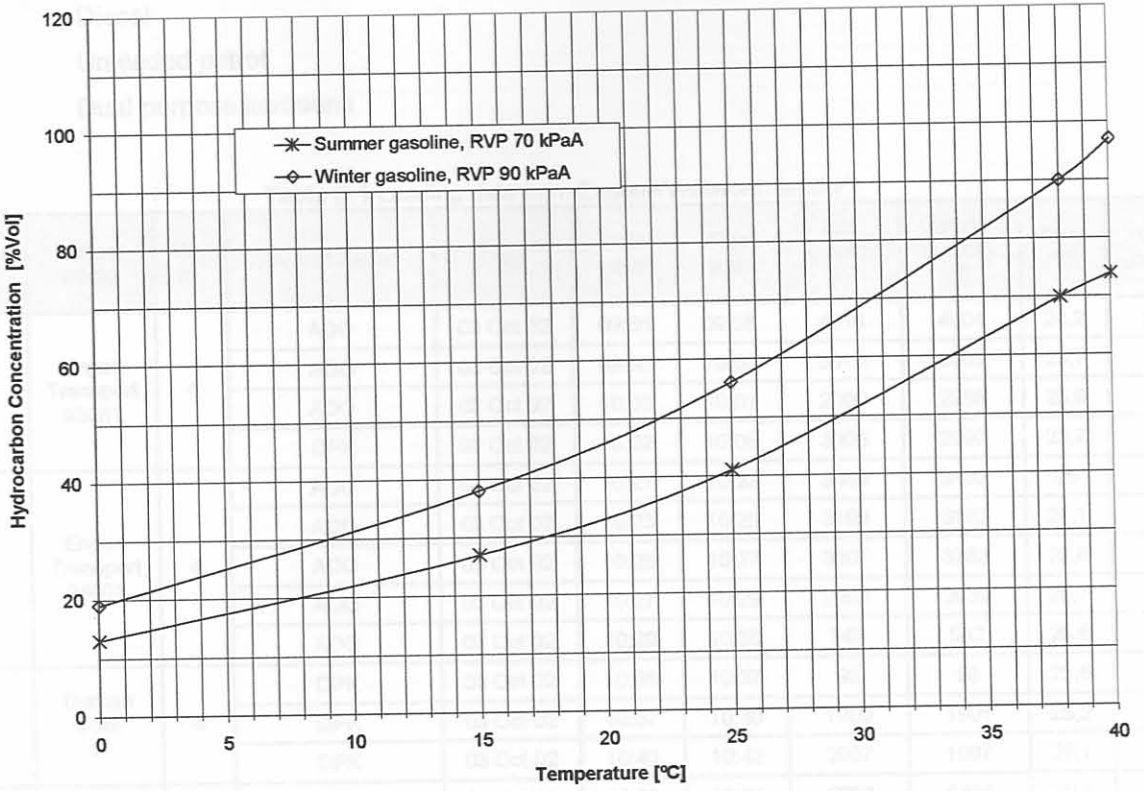


Figure D.1 Hydrocarbon (VOC) concentration (vol%) as a function of temperature for petrol with RVP values of 70 kPa and 90 kPa, respectively (Cool Sorption, 2001).