Note: This material is related to a section in *AP42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

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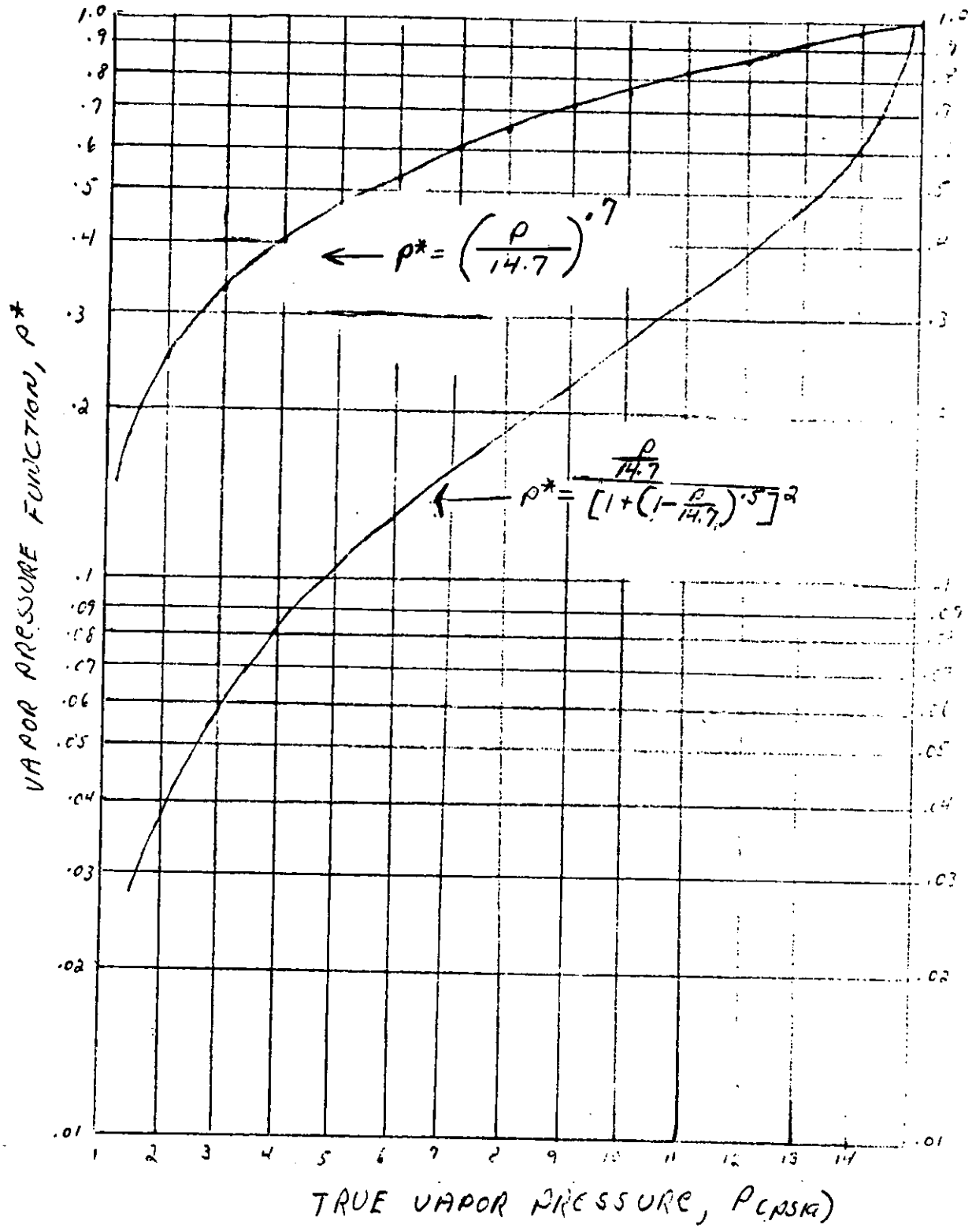
AP42 Section:	7.1
Related	3
Title:	Vapor Pressure Function Analysis Warren Hicks (?) No date

Warren - Hicks
Vapor Pressure Function
analysis



VAPOR PRESSURE FUNCTION ANALYSIS

Step (1) As a function of VP; normalize emissions from tests conducted at low vapor pressures to emissions from comparable tests conducted at high vapor pressures.

Stp (2) Calculate the difference between the normalized emissions and the emissions from tests conducted at high vapor pressures.

Low VP tests		High VP tests		Normalized emissions minus Emissions from high VP tests	
Test #	Product	Test #	Product	Function 1(1)	Function 2(2)
A. ncIFR Tanks (Phase I and IR)					
API 27A	C3/nC8	API 22A	C3/nC8	.0182	.1345
API 27B	C3/nC8	API 22B	C3/nC8	-.0284	.0587
API 27C	C3/nC8	API 22C	C3/nC8	-.0203	.0904
API 28	C3/nC8	API 21B	C3/nC8	.0223	.0623
API 29R	nC8	API 22B	C3/nC8	.1436	.5495
API 30R	nC8	API 21B	C3/nC8	.0438	.1428
API 32	nC6	API 21B	C3/nC8	-.0204	-.0177
API 33	nC6	API 22B	C3/nC8	-.0942	-.0862
API 33A	nC6	API 22C	C3/nC8	-.1130	-.1015
			Subtotal	-.0484	.8328
			Average	-.0054	.0925
B. Welded cIFR Tanks (Phase 2 and 2R)					
API 72	C3/nC8	API 71	C3/nC8	-.0035	.0132
API 67	nC8	API 71	C3/nC8	-.0055	.0486
API 68	nC6	API 71	C3/nC8	-.0121	-.0033
			Subtotal	-.0211	.0585
			Average	-.0070	.0195
C. Bolted cIFR Tanks (Phase 3 and 3R)					
API 63	C3/nC8	API 60	C3/nC8	.0071	.0593
API 62	C3/nC8	API 60	C3/nC8	-.0409	-.0395
API 64	nC8	API 60	C3/nC8	-.0043	.0491
API 64	nC8	API 62	C3/nC8	-.0042	.0197
API 65	nC6	API 60	C3/nC8	-.0046	.0031
API 65	nC6	API 62	C3/nC8	-.0044	-.0061
			Subtotal	-.0507	.0856
			Average	-.0085	.0143
Overall Total				-.1206	.9774
Overall Average				-.0067	.0543

(1) $\left(\frac{P}{14.7}\right)^{.7}$

(2) $$\frac{\frac{P}{14.7}}{\left[1 + \left(1 - \frac{P}{14.7}\right)^{.5}\right]^2}$$

VAPOR PRESSURE FUNCTION ANALYSIS

Goal: Statistical Comparison of the following vapor pressure functions.

1) $\left(\frac{P}{14.7}\right)^{.7}$

2) $$\frac{\frac{P}{14.7}}{\left[1 + \left(1 - \frac{P}{14.7}\right)^{.5}\right]^2}$$

Steps:

I. For each function, scale emissions from tests conducted at low vapor pressures to comparable tests conducted at high vapor pressures. Calculate the difference between observed and expected emissions.

II. Using a t-test, compare the mean differences of each function.

Step I. COMPARABLE TESTS FOR TANKS STORING C3/nC8, nC8 and nC6
(all emissions in lb mole/day)

Low VP tests				High VP tests				Observed emissions		Observed-expected	
Test #	VP	Product	Emissions	Test #	VP	Product	Emissions	Function 1	Function 2	Function 1	Function 2
A. ncIFR Tanks (Phase I and IR)											
API 27A	.72	C3/nC8	.0415	API 22A	3.85	C3/nC8	.1160	.1342	.2505	.0182	.1345
API 27B	.72	C3/nC8	.0311	API 22B	3.85	C3/nC8	.1290	.1006	.1877	-.0284	.0587
API 27C	.72	C3/nC8	.0395	API 22C	3.85	C3/nC8	.1480	.1277	.2384	-.0203	.0904
API 28	.71	C3/nC8	.0258	API 21B	2.70	C3/nC8	.0434	.0657	.1057	.0223	.0623
API 29R	.29	nC8	.0446	API 22B	3.85	C3/nC8	.1290	.2726	.6785	.1436	.5495
API 30R	.29	nC8	.0183	API 21B	2.70	C3/nC8	.0434	.0872	.1862	.0438	.1428
API 32	2.05	nC6	.0190	API 21B	2.70	C3/nC8	.0434	.0230	.0257	-.0204	-.0177
API 33	2.35	nC6	.0246	API 22B	3.85	C3/nC8	.1290	.0348	.0428	-.0942	-.0862
API 33A	2.35	nC6	.0267	API 22C	3.85	C3/nC8	.1480	.0377	.0465	-.1130	-.1015
B. Welded cIFR Tanks (Phase 2 and 2R)											
API 72	2.4	C3/nC8	.0150	API 71	6.20	C3/nC8	.0326	.0291	.0458	-.0035	.0132
API 67	.36	nC8	.0037	API 71	6.20	C3/nC8	.0326	.0271	.0812	-.0055	.0486
API 68	3.05	nC6	.0125	API 71	6.20	C3/nC8	.0326	.0205	.0293	-.0121	-.0033
C. Bolted cIFR Tanks (Phase 3 and 3R)											
API 63	.88	C3/nC8	.0163	API 60	4.85	C3/nC8	.0461	.0538	.1054	.0077	.0593
API 62	2.95	C3/nC8	.0037	API 60	4.85	C3/nC8	.0461	.0052	.0066	-.0409	-.0395
API 64	.55	nC8	.0091	API 60	4.85	C3/nC8	.0461	.0418	.0952	-.0043	.0491
API 64	.55	nC8	.0091	API 62	2.95	C3/nC8	.0337	.0295	.0534	-.0042	.0197
API 65	3.4	nC6	.0324	API 60	4.85	C3/nC8	.0461	.0415	.0492	-.0046	.0031
API 65	3.4	nC6	.0324	API 62	2.95	C3/nC8	.0337	.0293	.0276	-.0044	-.0061

Step II. STATISTICAL COMPARISON OF THE MEAN DIFFERENCES OF EACH FUNCTION

	Function 1	Function 2
N	18	18
$\bar{X}$	-.0067	.0543
ΣX^2	.0486	.3844
$(\Sigma X)^2/N$	.0008	.0530
$\Sigma(X-\bar{X})^2$	.0478	.3314

$$\text{pooled } S^2 = \frac{\Sigma(X_1-\bar{X}_1)^2 + \Sigma(X_2-\bar{X}_2)^2}{2(N-1)} = .0112$$

$$S_{\bar{x}_1-x_2} = \sqrt{\frac{2S^2}{N}} = .0353$$

$$t = \bar{X}_1-\bar{X}_2/S_{\bar{x}_1-\bar{x}_2} = 1.73$$

Conclusion:

1) At 34 d.f., $p < .06$; therefore, the two functions predict significantly different emissions.

2) Function 2 has an average deviation approximately 8 times larger than Function 1.