

**Tikrit University**

**The College of Petroleum Processes Engineering**

**Petroleum Systems Control Engineering**

**Department**

**Properties of Petroleum & Natural Gas**

**Third Class**

**Lecture 14**

**By**

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## Conversion ASTM D1160 to TBP, EFV, or ASTM D86 distillation curves

- Equations (1 and 2) only convert distillation curves from one pressure to another within the same type of distillation.
- It should be noted that when ASTM D1160 distillation curve is converted to or reported at atmospheric pressure (760 mm Hg) it is not equivalent to or the same as ASTM D86 distillation data.

### To convert ASTM D 1160 to TBP at atmospheric pressure

- Convert D 1160 at any pressure to D 1160 at 10 mmHg
- Convert D 1160 at 10 mmHg to TBP at 10 mmHg.
- Convert TBP at 10 mmHg to TBP at 760 mmHg

This means if ASTM D 1160 at 1 mm Hg is available, it must be first converted to D 1160 at 760 mmHg, then to D 1160 at 10 mm Hg followed by conversion to TBP at 10 mmHg and finally to TBP at 760 mmHg.

Edmister-Okamoto method is used to *Convert of ASTM D 1160 at 10 mmHg to TBP Distillation Curve at 10 mmHg.*

$$TBP(100\%) = ASTM\ D1160\ (100)$$

$$TBP(90\%) = ASTM\ D1160\ (90)$$

$$TBP(70\%) = ASTM\ D1160\ (70)$$

$$TBP(50\%) = ASTM\ D1160\ (50)$$

$$TBP(30\%) = ASTM\ D1160\ (50) - F_1$$

$$TBP(10\%) = ASTM\ D1160\ (30) - F_2$$

$$TBP(0\%) = ASTM\ D1160\ (10) - F_3$$

Where functions  $F_1$ ,  $F_2$ , and  $F_3$  are given in terms of temperature difference in the ASTM D 1160:

$$F_1 = 0.3 + 1.2775(\Delta T_1) - 5.539 \times 10^{-3}(\Delta T_1)^2 + 2.7486 \times 10^{-5}(\Delta T_1)^3$$

$$F_2 = 0.3 + 1.2775(\Delta T_2) - 5.539 \times 10^{-3}(\Delta T_2)^2 + 2.7486 \times 10^{-5}(\Delta T_2)^3$$

$$F_3 = 2.2566(\Delta T_3) - 266.2 \times 10^{-4}(\Delta T_3)^2 + 1.4093 \times 10^{-4}(\Delta T_3)^3$$

$$\Delta T_1 = \text{ASTM D 1160}(50\%) - \text{ASTM D 1160}(30\%)$$

$$\Delta T_2 = \text{ASTM D 1160}(30\%) - \text{ASTM D 1160}(10\%)$$

$$\Delta T_3 = \text{ASTM D 1160}(10\%) - \text{ASTM D 1160}(0\%)$$

**In the above relations all temperatures are either in °C or in kelvin.**

**Example1:** for a given petroleum fraction, convert ASTM D1160 performed at (1 mmHg) to TBP and ASTM D86 both at 760 mmHg.

Vol % distilled	10	30	50	70	90
ASTM D1160 °C	104	143	174	202	244

### Solution

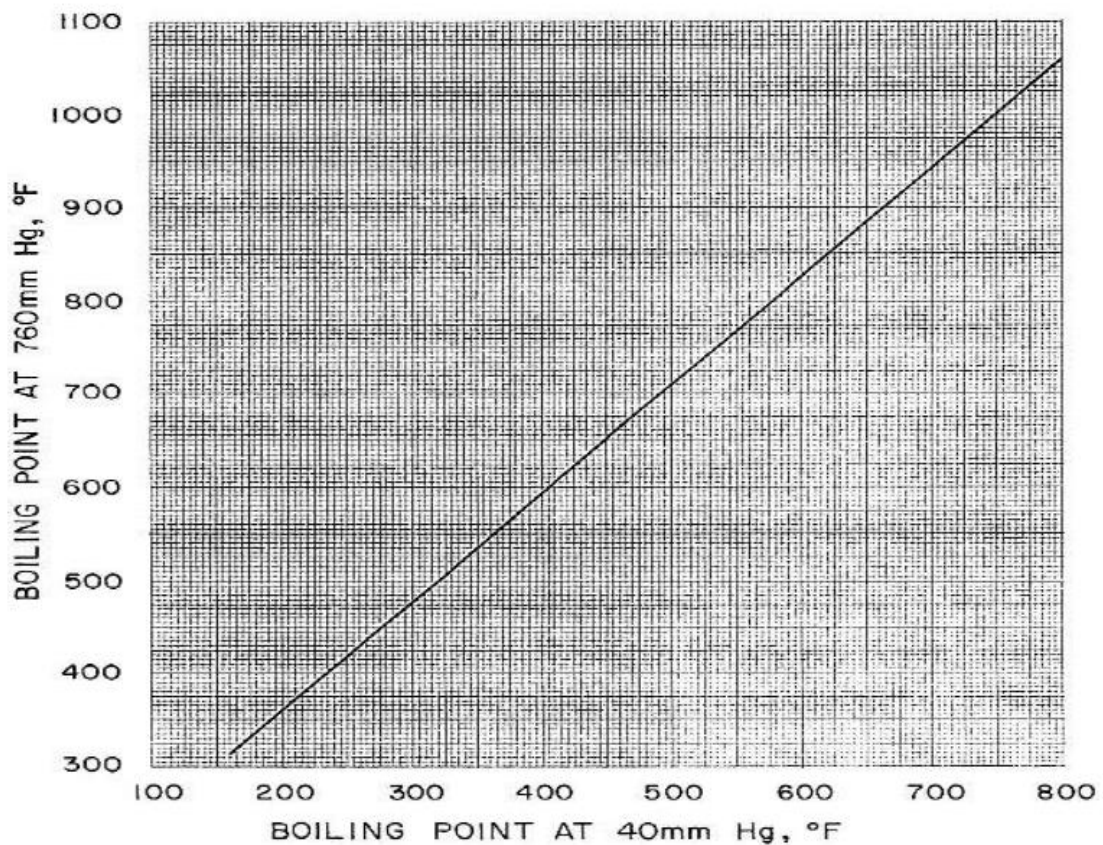
- Convert D1160 at 1 mmHg to D1160 at 760 mmHg using eq.1
- Convert D1160 at 760 mmHg to D1160 at 10 mmHg using eq. 2
- Convert D1160 at 10 mmHg to TBP at 10 mmHg using [Edmister-Okamoto method](#)
- [Convert TBP at 10 mmHg to TBP at 760 mmHg using eq.1](#)
- [Finally, convert TBP at 760 mmHg to ASTM D86](#)

vol %	T at 1 mmHg	Q	Tb at 760 mmHg	Tb at 10 mmHg	TBP at 10 mmHg	TBP at 760 mmHg	
10	377	0.002253	560.7084207	421.8443299	417.6348705	555.6236513	
30	416	0.002253	611.2676534	464.1039682	459.6904419	606.0328376	
50	447	0.002253	650.596001	497.5167125	497.5167125	650.5985795	
70	475	0.002253	685.4832894	527.5612713	527.5612713	685.4859649	
90	517	0.002253	736.7181342	572.3902252	572.3902252	736.7209445	
		$\Delta T_1$	$\Delta T_2$	$\Delta T_3$	F1	F2	F3
		33.41274	42.25963831		37.82627067	46.4691	

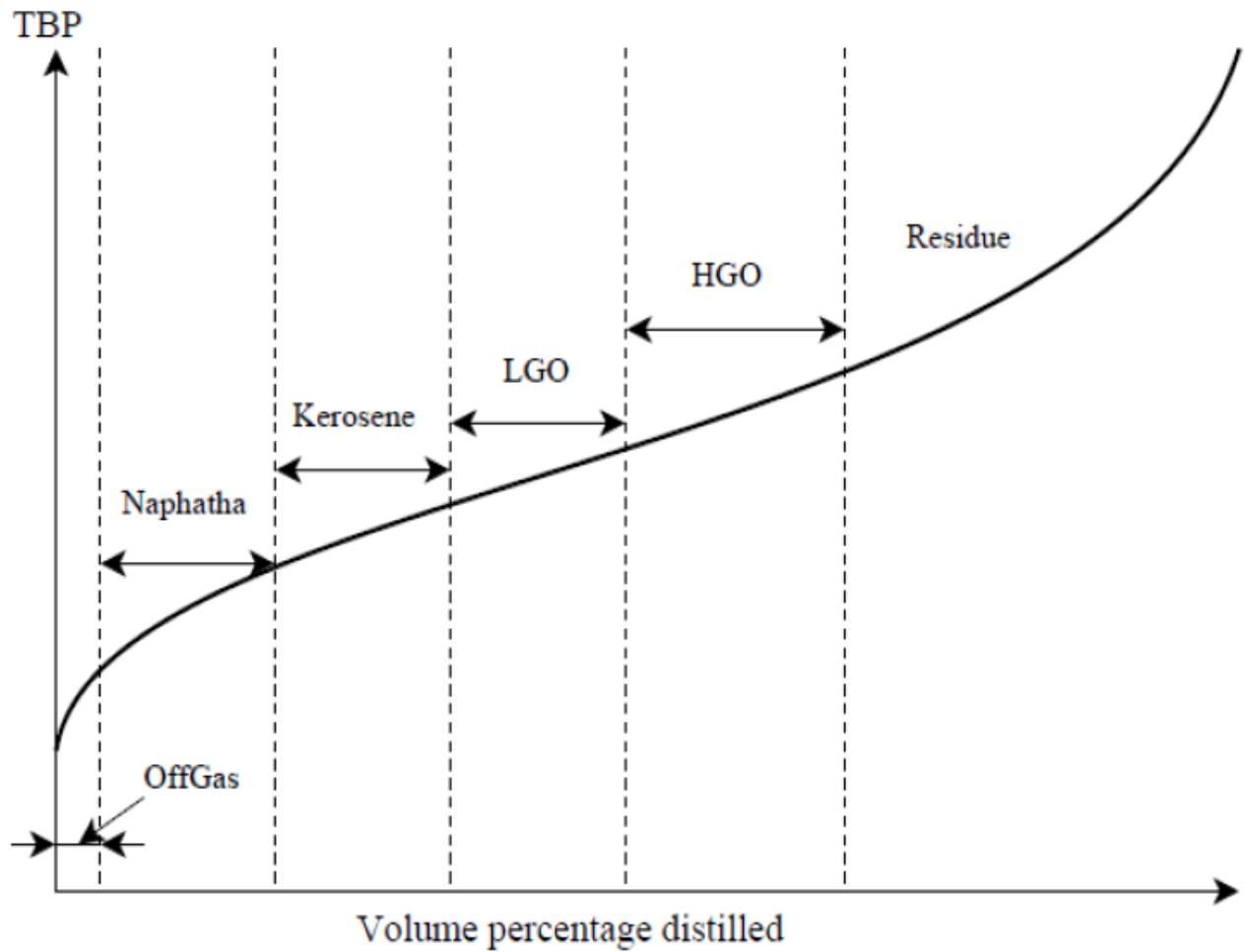
$$\text{ASTM D86} = \left(\frac{1}{a}\right)^{1/b} \text{TBP}^{1/b}$$

a	b	1/a	1/b	ASTMD86
0.9167	1.0019	1.090869	0.998104	
0.5277	1.09	1.895016	0.917431	592.7045
0.7429	1.0425	1.346076	0.959233	620.6816
0.892	1.0176	1.121076	0.982704	650.7765
0.8705	1.0226	1.148765	0.977899	679.5503
0.949	1.011	1.053741	0.98912	722.0916
0.8177	1.0355	1.222942	0.965717	

Any temperature at 40 mm Hg corrected to 760 mm Hg pressure using charts developed by Esso Research and Engineering Company (Figure below).



**Figure:** Boiling point at 760 mmHg versus boiling point at 40 mmHg.



**A typical true boiling point curve of crude**