

**Blending to Maximize Crude Oil
Revenue
&
Reid Vapor Pressure:
“The Most Misunderstood Measurement”**

Reid vapor pressure (RVP) is a common measure of the volatility of gasoline. It is defined as the absolute vapor pressure exerted by a liquid at 100 °F (37.8 °C) as determined by the test method ASTM-D-323.

1st Animation

Reid Vapor Pressure

Reid vapor pressure (RVP) is a common measure of the volatility of gasoline. It is defined as the absolute vapor pressure exerted by a liquid at 100 °F (37.8 °C) as determined by the test method ASTM-D-323. The test method applies to vapor pressure of gasoline, volatile crude oil, and other volatile petroleum products, except liquefied petroleum gases. RVP is stated in units of psi but would be more correct to be stated as psig as ASTM-D-323 is measuring the gauge pressure of the sample in a non-evacuated chamber.

Reid Vapor Pressure

- Invented in 1927 because true vapor pressure could not be measured in the field
- ASTM D-323 issued in 1930
- Intended to be used as standard, applicable anywhere regardless of ambient conditions or altitude
- RVP is read directly off of pressure gauge.
- Any RVP that is less than 1 atmosphere is simply stated as “zero”

Correspondence between Dr. Kevin Bly, ExxonMobil and chairman of ASTM D-323 committee, Dr. Rey Montemayor, committee member, and Dr. M. Hlavinka from Bryan Research

“We frequently have to clarify this issue with customers who only read Note 1...or who see the unspecific psi or kPa reporting of the RVP and assume it is an absolute pressure...

Once they understand the procedure they usually realize that the value is actually a gauge pressure.”

“I feel if the standard were revised with more specific wording, we would not be required to waste time so frequently with this clarification”

“I believe that the phrase “absolute pressure” is an attempt to indicate that the VP measured by D-323 is ‘absolute’ i.e. not relative to anything, rather than defining that the measured VP is the absolute pressure (psia).”

From Dr. Montemayor, D323 committee:

“...when we speak of D323 RVP, we are not talking about in the engineering sense but in the analytical (measurement) sense. When we measure RVP...using D323, we are measuring the VP of the petroleum product, and the measurement method uses a gauge to read the pressure... Hence, if one uses D323 to measure the VP of a material that has no VP, the gauge will read zero and the RVP will be reported as zero... a material that has a VP of 100 psi, the gauge will read 100 and the RVP will be reported as 100 psi” (excerpt)

Reid Vapor Pressure of Common Hydrocarbons

- Propane: 175 psi
- n-Butane: 37 psi
- n-Pentane: 1 psi
- Hexane+: 0 psi

- Like Things are soluble in Like Things
- Polar Compounds Dissolve Polar Compounds
 - Water, Sugar, Salt, Alcohol, Acids, Bases
- Non Polar Dissolves Non Polar
 - Fat, Oil, Gasoline, Solvents, LPG, (even CO₂)
- Blending is a strong function of Solubility

Now for an extreme case where solubility is controlling over equilibrium.

2nd Animation

USDA Table of Nutrient Retention Factors

Release 6

Prepared by the

Nutrient Data Laboratory
Beltsville Human Nutrition Research Center (BHNRC)
Agricultural Research Service (ARS)
U.S. Department of Agriculture (USDA)

- Alcohol added to boiling liquid and removed from heat: 85% alcohol retained
- Alcohol flamed: 75% alcohol retained
- No heat, stored overnight: 70% alcohol retained
- Baked, 25 minutes, alcohol not stirred into mixture: 45% alcohol retained

- FYI – Your Oil already contains C1, C2, and C3
- You need to know your product Specs
- RVP is usually a hard Specification
- API Gravity is usually a soft Specification
- YOUR OIL WILL BE BLENDED TO THE LIMITS

- Oil is always worth more than C4's and usually worth more than C5+
- Butanes historically sell for about 65% of Crude
- C5+ historically sells for about 92% of Crude

Blending Example

- Oil Characteristics
 - Volume = 3000 BBL/Day
 - 45 API, 3.25 RVP
- C4+ Characteristics (47% C4's, 53% C5+)
 - Volume = 650 BBL/day
 - 99 API, 21 RVP
- Blend
 - Volume = 3650 BBL/day (22% increase)
 - 52 API, 8.3 RVP

Blending Example

- Value of selling all products as OIL at \$55 WTI
 - Volume = 3650 BBL/day
 - Value = \$200,750
- Value of selling different products
 - Oil Revenue = \$165,000
 - C5+ Revenue = \$17,430
 - C4 Revenue = \$10,920
 - Total = \$193,350
- Difference = \$7,400/Day or about \$2.6MM/year

- Rules to ensure a good mix
 - At least 60 diameters (Exxon Prudhoe Bay)
 - Static Mixer
 - Pump
- Best to keep a few psi on the C4+ stream
- Can you store the mix in a tank – YES!
 - Vapors off at the same rate as same RVP oil
 - Cenovus doing this since 2013 without issues

Thank You
(now please spread the word)