



CCQTA June 2008: Crude Grades and Grade Management Policies/Procedures



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Enbridge Commodity Types (Enbridge.com & crudemonitor.ca)



	Density	wt% S	MCR	TAN
Heavy	910+ (23.9+)	2.6-4.5	8.5-11.3	0.5-1.05
Heavy Hi Tan	910+ (23.9+)	3.0-4.5	7.5-10	1.4-3.5
Heavy Lo Resid	933 (20.0)	3.0	<1.0	3.5
Medium	850-875 (30-35)	2.5	6.0	0.2
Sour	850-875 (30-35)	1.1-1.8	4.0-6.0	0.3
Sweet	825 (40)	<0.5	2.0	0.2
Lt Sweet Synthetic	850-875 (30-35)	0.1-0.25	<0.5	0.1
Condensate	739 (60)	0.2	-	-
Olefinic	933 (20.0)	3.0-3.5	<1.0	<1.0

Quality Management of Commodities in Enbridge Batched Pipeline

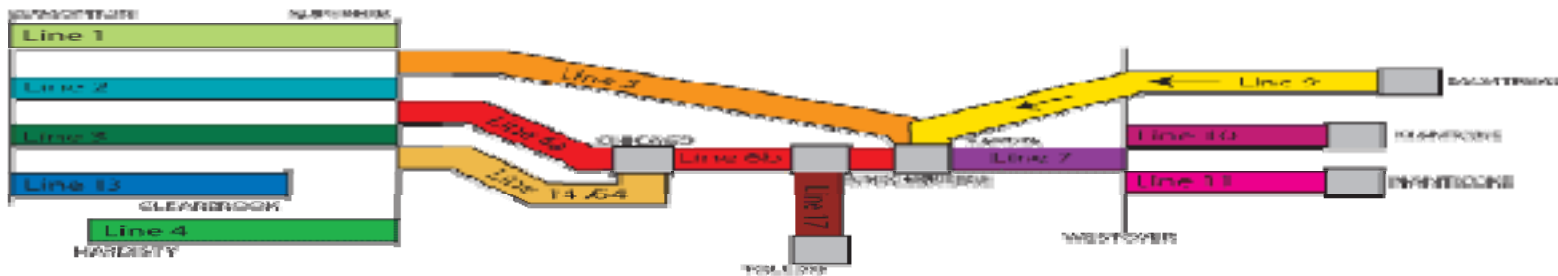


- **Enbridge controls quality of delivered crude in the following ways.**
 - **In the Pipe: Manage Interface - number, type, size, cut**
 - Line Splits: Like commodities in segregated lines
 - Line Rates: Turbulent flow to minimize interface sizes
 - Batch Sizes: Minimum 60KB, Multiples batch trains
 - Batch Sequence; Based on least contamination risk
 - Batch Cuts (Interfaces): Mid point
 - **In the Tank**
 - Tank Bottoms Crossing
 - Tank Selection/Terminal Piping/Service Change

Core Liquid Pipelines Number & Type



Pipeline System Configuration Quarter 1, 2008



- Line 1**
37,000 m³/d
NPS 18/20 1797 km
NGL
Refined Products
Synthetics
- Line 2a**
23,000 m³/d
NPS 24 1638 km
- Line 2b**
22,000 m³/d
NPS 24/20 808 km
Condensates
Synthetics
Light Crudes
Medium Crudes
- Line 3**
20,000 m³/d
NPS 24 1787 km
Light Crudes
Medium Crudes
Heavy Crudes
- Line 4**
120,000 m³/d¹
NPS 36/48 1592 km
Heavy Crudes

- Line 5**
75,100 m³/d
NPS 20 1028 km
NGL
Condensates
Synthetics
Light Crudes
- Line 6a**
100,000 m³/d
NPS 24 752 km
- Line 6b**
45,000 m³/d
NPS 20 572 km
Light Crudes
Synthetics
Medium Crudes
Heavy Crudes
- Line 7**
25,000 m³/d
NPS 20 248 km
Condensates
Synthetics
Light Crudes
Medium Crudes
Heavy Crudes

- Line 9**
25,200 m³/d
NPS 24 842 km
Condensates
Light Crudes
- Line 10**
11,000 m³/d
NPS 12/20 342 km
Condensates
Synthetics
Light Crudes
Medium Crudes
Heavy Crudes
- Line 11**
15,000 m³/d
NPS 16/20 70 km
Condensates
Synthetics
Light Crudes
Medium Crudes
Heavy Crudes
- Line 13**
27,200 m³/d
NPS 18/18/20 1403 km
Synthetics
Light Crudes
Medium Crudes

- Line 14/64**
29,500 m³/d
NPS 24 752 km
Condensates
Synthetics
Light Crudes
Medium Crudes
Heavy Crudes
- Line 14/61/64**
70,500 m³/d¹
NPS 24/24 751 km
Condensates
Synthetics
Light Crudes
Medium Crudes
Heavy Crudes
- Line 17**
15,500 m³/d
NPS 18 142 km
Heavy Crudes

NOTES:
 1. Includes CIP 2008
 2. Capacity includes and exceeds capacities
 3. Updated January 2008

The Quality Matrix – Number & Type



CRUDE TYPE MATRIX - THE QUALITY PROCESS							
	Heavy -TAN	Heavy	Medium	Sour	Sweet	Synthetic	Condensate
Heavy -TAN	1	2	3	4	5	6	7
Heavy	2	1	3	4	5	6	7
Medium	7	6	1	2	3	4	5
Sour	7	6	2	1	3	4	5
Sweet	7	6	5	4	1	2	3
Synthetic	7	6	5	4	3	1	2
Condensate	7	6	5	4	3	2	1

The above numbers rank the order (as a guideline) that should be followed when changing from crude types.

One being first choice. **Seven** being the last choice.

When making sequence decisions between crudes of the same type(Heavy-Heavy), reference the crude prices for best choice.

Reynolds No. - Laminar vs. Turbulent



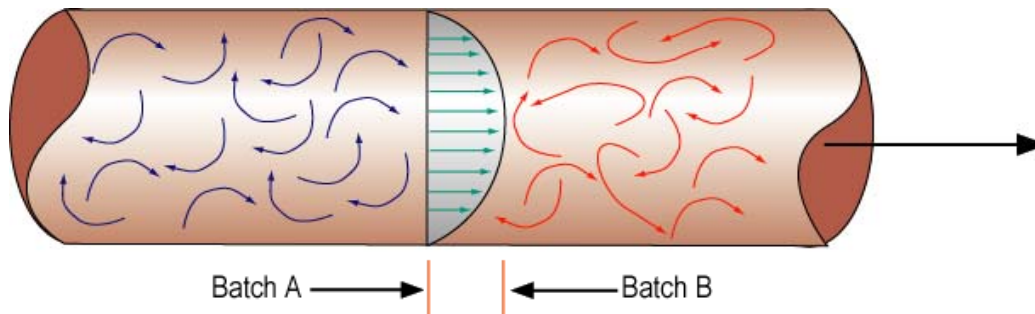
$Re = \frac{D \cdot v}{\nu}$	$v = \frac{4Q}{\pi \cdot D^2}$	$v = \frac{\mu}{\rho}$	Re = Reyn. no: D = Pipe ID v = Velocity Q = Flow Rate ρ = Density ν = Viscosity(kin) μ = Viscosity(abs)
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- Definition - a dimensionless number characteristic of the flow of a fluid in a pipe or past an obstruction
- Laminar - <3000
- Turbulent - >3000

Line Rates at Turbulent flow – interface size

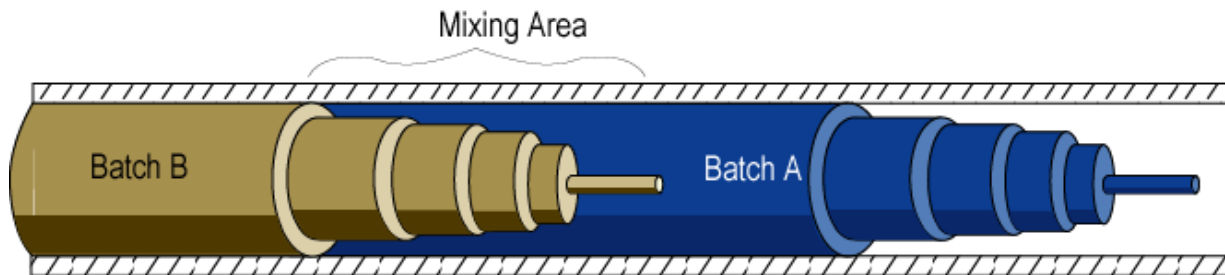


Turbulent Flow



Notice the increased size of the mixing area from the Turbulent to Laminar flow

Laminar Flow



In The Tank



- **Tank Selection** - Determines the amount of contamination within station piping. This may increase or decrease depending on the location of the tank and the amount of common piping. Most sensitive crude types closest to manifold.
- **Tank Bottoms Crossing** - The procedure is located in the Service Levels (Table 5). Outlines how each commodity is treated through tankage at every location from receipt through delivery.
- **Tank Service Change** - Follows a rigid procedure to minimize contamination.
- **Tank Cleaning** – Potential for products to be delivered with high S&W, which can cause refinery problems. Procedure in place to monitor and restrict high S&W

Special Procedures



- **High TAN (Total Acid Number >1.0) commodities have dedicated tanks or flush batch (destined to same facility) is required if routed through a regular heavy tank.**
- **“Cracked” products contain olefins desired by very few refineries. Cracked products require both front and back buffers that are sized to contain the cracked crude interfaces. The whole train (buffers and crude) moves into the same refinery.**

ITS Quality Metrics



- **Reward/penalty based on meeting or exceeding targets set over 5 years (2005-2009). Targets negotiated based on baseline data on main lines only – to Sarnia & Chicago**
- **Targets set on formula which includes**
 - Absolute change + (constant x std dev at delivery)
- **Quality metrics parameters – receipt to delivery**
 - Heavy: sulphur, MCR, TAN
 - Light Synthetic: sulphur, density
 - Refined products: diesel flash, ULSD sulphur pick-up
- **Light Targets tighten by 50% and Heavy targets tighten by 30%**
- **Performance has been excellent – 23 out of 28 targets in 2007 were in bonus situation indicating gains in crude quality on delivery**
- **Connecting pipelines benefiting**

Summary



- **Many different crudes of wide variety (9 classes)**
- **7 basic strategies to manage commodities through the system (5 in line, 2 in tankage)**
- **Special procedures required to manage downstream facility sensitivities (cracked, high TAN)**
- **ITS Quality metrics program to measure and improve quality during transport (benefiting connecting pipelines/facilities)**