

## HYDROCARBON MANAGEMENT

# Marine crude oil transport – global voyage losses

**Paul Harrison, Consultant to the HMC-4A Marine Oil Transportation Database Committee, presents findings from analysis of the 2014 data on marine crude oil transport.**

The Energy Institute (EI) HMC-4A Marine Oil Transportation Database Committee has been collecting and analysing worldwide oil shipping data for over 20 years and meets twice a year. The 2014 autumn meeting was held in Singapore last November, hosted by Eni, and the spring 2014 meeting was held in London, hosted by Phillips 66. The next meeting will be held in Houston this November.

Committee members submit their voyage measurement data annually. They receive a global analysis and confidential individual company reports. The following member companies submitted data for 2014 – Bazan, BP Oil International, CEPESA, Chevron, Chinese Petroleum Corporation, Eni, ExxonMobil, Koch, Marathon Petroleum, Petrobras, Petrogal (GALP Energia), Petrolneos, Phillips 66, PMI Pemex, Repsol, Saras, Shell, Statoil and Total. The main findings from the global analysis follow.

#### Database development

Over 2,000 inland US barge movements were reported

for 2014. These are analysed separately and have not been included in the analysis presented below. The total number of ship voyages reported for 2014 rose to just over 8,700. The number of reported ship voyages with both bill of lading (BOL) and outturn data also increased to over 6,300. The reported BOL volume totalled 5.27bn barrels. The volume of crude with complete data increased to 4bn barrels, as shown in **Figure 1**.

The *BP Statistical Review of World Energy* gives global crude seaborne trade for 2014 as 13.75bn barrels, down very slightly (about 0.1%) compared with 2013. The database, therefore, includes approximately 38% of the global volume at BOL, and contains complete load and discharge data for just under 29% of estimated global shipped volume.

#### Global losses

Losses fell steadily after 2001 to a record low net standard volume (NSV) loss of  $-0.161\%$  in 2010 (by convention losses are given as negative). The 2011 figures showed an increased loss of  $-0.172\%$ , repeated in 2012 and 2013. In

2014 mean NSV loss increased to  $-0.177\%$ . This figure is not significantly different from the previous year statistically, but may indicate the start of an upward trend.

It should be noted that losses include apparent as well as physical losses. Apparent losses result from the combination of fixed and random errors in the measurement systems used at load and discharge.

Gross or total calculated volume (TCV) loss stayed fairly constant between 2000 and 2007, while water losses fell, reducing NSV loss. Changes in TCV loss have driven NSV losses since 2006. However, the increase in NSV loss in 2014 was the result of a significant increase in water loss (from  $-0.018$  to  $-0.027$ ) while TCV loss actually fell slightly. See **Figure 2**.

TCV loss comprises any real losses due to evaporation plus any apparent losses due to systematic measurement differences. Water loss represents any additional water reported at discharge compared with that reported at load; ie an accounting loss in terms of oil quantity but not a real loss of either oil or water.

#### Loss comparison

**Table 1** gives mean NSV loss and standard deviation for shipments of the most popular crudes in the database (20 or more voyages with full data). The mean of the reported API gravity is also given, together with the overall percentage loss based on reported total barrels shipped. For comparison, figures for NSV loss calculated by voyage are given for 2014 and 2013.

#### Detailed loss analysis

In addition to NSV loss, the database contains details of all measurements made through each voyage. This enables more detailed analysis to determine where losses are occurring and sets realistic performance limits for each stage in the measurement process.

Overall results for each of the main measurement differences are shown in **Table 2**, comparing

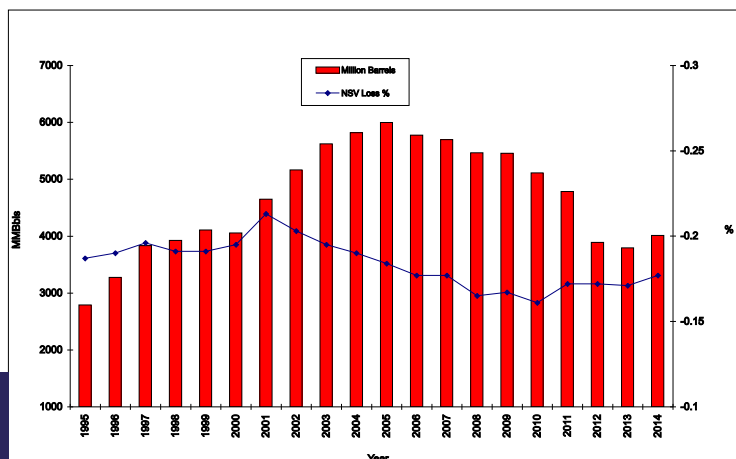


Figure 1: Growth in volume of database and average net loss of crude oil

Crude type	API gravity	Overall volumes (NSV)			Calculation by voyage					
		Total barrels	Barrels loss	Barrels loss %	2014			2013		
					NSV loss %	Mean	St. dev.	No.	NSV loss %	Mean
Agbami	48.4	51,591,247	-105,787	-0.21	-0.21	0.22	54	-0.34	0.39	60
Akpo	46.2	35,283,029	-41,930	-0.12	-0.12	0.17	37	-0.15	0.31	41
Al Shaheen	30.1	20,235,235	-57,360	-0.28	-0.29	0.13	30	-0.34	0.17	22
Alaskan North Slope	31.7	78,487,609	-8,329	-0.01	-0.03	0.16	95	0.00	0.16	97
Alvheim	34.9	30,676,557	-40,027	-0.13	-0.13	0.15	38	-0.14	0.24	41
Arabian Extra Light	39.5	81,235,780	-191,838	-0.24	-0.27	0.49	151	-0.20	0.25	74
Arabian Heavy	27.0	27,345,148	-73,034	-0.27	-0.27	0.26	63	-0.26	0.24	78
Arabian Light	33.2	394,435,927	-678,096	-0.17	-0.14	0.29	417	-0.19	0.24	323
Arabian Medium	30.7	46,416,490	-102,889	-0.22	-0.22	0.31	84	-0.25	0.35	94
Asgard	49.3	31,631,878	-36,945	-0.12	-0.13	0.23	40	-0.24	0.27	58
Azeri Light	37.2	133,665,782	-235,326	-0.18	-0.17	0.16	205	-0.15	0.16	189
Bakken	42.9	18,850,728	-8,722	-0.05	-0.04	0.20	161	0.02	0.15	195
Basrah Light	28.9	150,701,747	-459,500	-0.30	-0.27	0.25	126	-0.20	0.28	90
Bonga	30.7	28,381,096	-55,629	-0.20	-0.20	0.30	34	-0.14	0.20	26
Bonny Light	34.5	25,445,743	-85,529	-0.34	-0.32	0.23	28	-0.53	0.35	21
Boscan	10.5	9,135,010	-4,261	-0.05	-0.09	0.36	26	-	-	-
Brent Blend	37.3	13,408,329	-23,060	-0.17	-0.16	0.21	23	-0.20	0.18	36
Castilla Blend	19.2	48,181,651	-42,775	-0.09	-0.11	0.20	72	-0.11	0.16	47
CPC Blend	46.0	180,464,093	-498,954	-0.28	-0.28	0.16	223	-0.25	0.22	174
Dalia	23.4	28,517,402	-27,837	-0.10	-0.13	0.24	37	-0.01	0.23	43
Eagle Ford	46.6	82,172,089	-73,292	-0.09	-0.11	0.34	376	-0.11	0.34	206
Ekofisk	39.5	45,447,760	-32,833	-0.07	-0.07	0.11	73	-0.08	0.16	81
El Sharara	42.8	13,867,161	-15,568	-0.11	-0.13	0.27	21	-0.09	0.15	48
Escravos	32.9	37,857,817	-155,592	-0.41	-0.41	0.43	40	-0.19	0.19	23
Espo	35.4	24,604,041	-11,377	-0.05	-0.04	0.12	35	-0.03	0.19	51
Forcados Blend	32.3	25,571,960	-39,914	-0.16	-0.14	0.41	28	-0.22	0.26	34
Forties Blend	37.6	47,260,870	-95,901	-0.20	-0.20	0.21	75	-0.26	0.16	67
Grane	20.1	33,406,598	17,470	0.05	0.05	0.20	53	0.03	0.14	46
Gullfaks	38.8	61,171,857	-135,312	-0.22	-0.22	0.19	79	-0.13	0.30	60
Hamaca Blend	19.8	19,804,941	-54,917	-0.28	-0.28	0.50	33	-0.09	0.63	22
Heidrun	25.4	20,125,909	-17,166	-0.09	-0.08	0.19	31	0.05	0.16	28
Hibernia	34.8	22,144,842	-26,946	-0.12	-0.11	0.42	35	-0.05	0.16	28
Isthmus	32.8	16,426,507	-31,342	-0.19	-0.19	0.24	31	-0.27	0.21	25
Jubilee	37.2	19,749,138	-23,514	-0.12	-0.10	0.17	22	-	-	-
Kaliningrad	40.5	5,285,543	-10,903	-0.21	-0.21	0.24	42	-0.19	0.34	36
Karachaganak	48.1	2,892,710	-10,642	-0.37	-0.37	0.19	22	-0.23	0.23	31
Kikeh	36.9	8,606,971	-25,580	-0.30	-0.30	0.36	26	-0.28	0.30	37
Kuwait Export	30.5	50,066,612	-131,348	-0.26	-0.30	0.24	54	-0.18	0.21	54
Louisiana Light Sweet	38.3	5,248,603	-555	-0.01	-0.09	0.34	28	-	-	-
Lower Zakum	39.5	21,353,146	-64,086	-0.30	-0.26	0.29	34	-0.25	0.31	34
Maya	20.9	194,808,573	-319,843	-0.16	-0.17	0.22	324	-0.21	0.23	306
Mellitah	43.2	16,448,890	-14,609	-0.09	-0.10	0.49	28	-	-	-
Merey 16	16.3	52,267,895	23,017	0.04	0.04	0.29	96	0.14	0.22	82
Miri Light	30.0	7,678,361	-15,732	-0.20	-0.22	0.19	26	-	-	-
Morichal 16	16.5	23,259,922	-25,959	-0.11	-0.13	0.35	42	-0.24	0.31	29
Murban	40.3	59,070,901	-148,518	-0.25	-0.23	0.26	97	-0.32	0.32	107
Norne	29.8	23,535,593	-71,426	-0.30	-0.30	0.29	39	-0.19	0.21	30
Olmecca	38.9	17,832,379	-47,322	-0.27	-0.26	0.32	34	-0.29	0.21	33
Oriente	25.0	16,783,276	-9,149	-0.05	-0.03	0.28	40	-0.07	0.28	27
Oseberg	37.9	22,737,917	-37,071	-0.16	-0.17	0.13	36	-0.24	0.13	38
Ostra	19.3	19,862,568	-9,292	-0.05	-0.02	0.28	25	-	-	-
Pazflor	25.3	28,213,577	-32,492	-0.12	-0.12	0.15	30	-0.06	0.18	40
Peregrino	13.7	10,656,745	5,552	0.05	0.04	0.39	26	0.04	0.30	37
Plutonio	33.2	16,699,255	-40,128	-0.24	-0.20	0.20	21	-	-	-
Qatar Marine	32.3	13,025,093	-23,298	-0.18	-0.21	0.28	22	-	-	-
Qua Iboe	36.5	31,864,024	-59,661	-0.19	-0.18	0.39	42	-0.19	0.26	41
Roncador Heavy	18.9	35,559,133	-89,991	-0.25	-0.24	0.25	33	-0.28	0.28	23
Saharan Blend	44.5	88,653,548	-110,803	-0.12	-0.14	0.17	122	-0.13	0.18	126
Skarv	38.1	22,506,072	-123,819	-0.55	-0.55	0.28	37	-	-	-
South Texas Sweet	44.6	11,601,093	-24,807	-0.21	-0.23	0.33	77	-0.13	0.25	38
Statfjord	39.7	56,196,700	-115,314	-0.21	-0.20	0.17	74	-0.24	0.19	64
Terra Nova	33.8	12,838,611	-3,782	-0.03	-0.03	0.06	21	-	-	-
Troll	35.2	32,833,470	-59,226	-0.18	-0.19	0.13	54	-0.14	0.14	46
Upper Zakum	34.1	30,977,509	-97,876	-0.32	-0.38	0.31	38	-0.30	0.20	41
Urals (Baltic)	30.9	104,356,730	-165,962	-0.16	-0.16	0.14	145	-0.15	0.13	310
Urals (Black Sea)	30.9	40,768,198	-52,311	-0.13	0.13	0.16	54	-0.09	0.20	74
Usan	30.8	31,136,372	-99,967	-0.32	-0.32	0.24	32	-0.10	0.19	23
Varandey	37.0	20,422,102	-38,961	-0.19	-0.18	0.29	29	-0.12	0.15	29
Vasconia	26.5	37,974,626	-22,308	-0.06	-0.09	0.29	79	-0.07	0.37	74
Western Desert	41.1	13,949,062	-23,879	-0.17	-0.17	0.29	42	-0.16	0.23	25
Zafiro	30.1	21,208,168	-43,761	-0.21	-0.21	0.19	21	-	-	-
Zuata Medium	18.4	14,192,880	-14,984	-0.11	-0.10	0.35	26	0.10	0.36	31

Table 1: Analysis by crude oil type

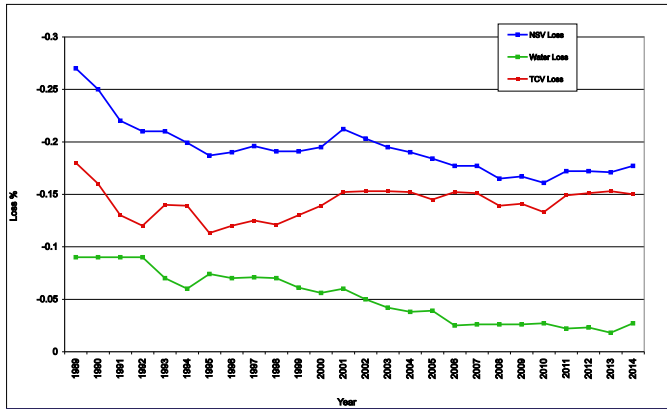


Figure 2: NSV, water and TCV losses

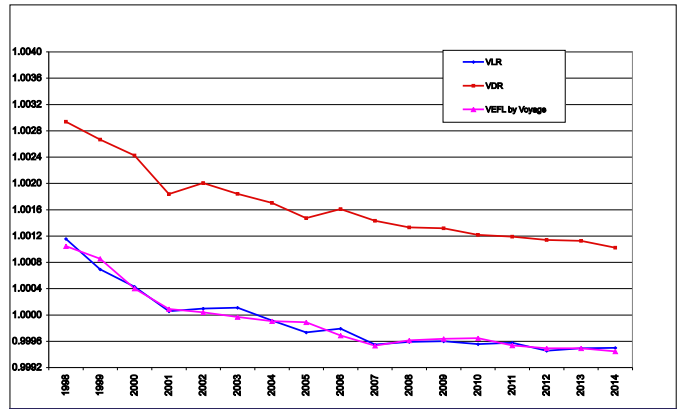


Figure 3: VEF trend

figures for 2014 with those for 2013.

Key comparisons used in the analysis are as follows:

- NSV and TCV losses are simple comparisons between BOL and outturn figures.
- NSV is the standard volume of crude with sediment and water quantities (free and dissolved) deducted. TCV is the NSV plus sediment and free and dissolved water.
- Load loss is the TCV difference between the received volume measured on the ship (allowing for onboard quality (OBQ)) and the shore delivered volume.
- Discharge loss is the TCV difference between the discharged volume measured on the ship (allowing for remaining onboard (ROB)) and the shore received volume.
- Ship loss or ‘transit difference’ is the difference between ship TCV measurements at the load port before sailing and at the discharge port on arrival.
- Water loss is the difference between BOL and outturn water and sediment.
- OBQ–ROB difference is the difference between the TCV measured on the ship prior to loading (OBQ) and that

remaining after discharge (ROB).

**Vessel experience factor**

Vessel experience factor load (VEFL) values fell fairly consistently over the 10 years from 2006, as shown in Figure 3. The trend has tailed off with only small changes now apparent. In 2014 the mean VEFL by voyage was 0.99944 compared with the 2013 figure of 0.99949. Both values are below 1.0000 and it would seem that this figure may be close to the real loss at loading. A value of 0.9995 would be equivalent to a –0.05% evaporative loss. However, systematic shore/ship measurement differences will contribute to this figure. The mean vessel load ratio (VLR) is also shown in Figure 3 and it is clear that this is essentially the same as the mean VEFL.

The average vessel discharge ratio (VDR) was 1.00102 for 2014. Committee members began collecting vessel experience factor discharge (VEFD) data in 2012 and hope to publish information on this factor in the future. However, as with VEFL, on a global basis this is not expected to differ significantly from the average of the VDR.

**Conclusion**

Mean NSV loss for 2014 was –0.177%, compared with –0.171% for 2013. Losses have followed

a downward trend since 2001, levelling off in recent years and it remains to be seen if this small increase is a sign of this trend reversing. The majority of the net shore-to-shore difference is related to TCV loss and not water loss. It must be remembered that the loss figures include not only any real losses between load and discharge port but also any systematic differences between load and discharge measurements.

The number of voyages with complete data increased in 2014 and, although volume fell, the BOL volume in the database still represents 38% of the estimated global seaborne crude trade. The Committee is working on analysis of the significant US crude oil barge movements in addition to development of product loss benchmarks. New members are always welcome to join and expand the database and any companies with data to submit should contact Kerry Sinclair at the Energy Institute on t: +44 (0)207 467 7127. ●

	2014 Mean	St Dev	2013 Mean	St Dev
NSV loss %	-0.18 (-0.177)	0.32	-0.17 (-0.171)	0.31
TCV loss %	-0.15	-0.30	0.15	0.30
Load loss %	-0.05	0.28	-0.05	0.27
Ship loss %	0.01	0.22	0.01	0.19
Discharge loss %	-0.10	0.29	-0.11	0.29
Water loss %	-0.03	0.20	-0.02	0.19
OBQ–ROB difference %	0.01	0.08	0.00	0.08

Table 2: Global loss analysis

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