

HYDROCARBON MANAGEMENT

Global crude oil voyage losses show small decrease in 2017

Paul Harrison – Consultant to the HMC-4A Marine Oil Transportation Database Committee – presents findings from analysis of the 2017 data on global marine crude oil voyage losses.

The Energy Institute's (EI) HMC-4A Marine Oil Transportation Database Committee has been collecting and analysing worldwide oil shipping data for over 25 years and meets twice a year. The 2017 autumn meeting was held in Singapore in November, arranged by Melverley Consultants, with the spring 2018 meeting held in London hosted by Total.

Committee members submit their voyage measurement data annually and receive a global analysis and confidential individual company reports.

The following member companies submitted data for 2017: Bazan, BP Oil International, CEPESA, Chevron, Chinese Petroleum Corporation, Eni, Essar Oil UK, ExxonMobil, Marathon Petroleum, Monroe Energy, Petrobras, Petrogal (GALP Energia), PetroIneos, Phillips 66, PMI Pemex, PREEM, Repsol, Saras, Shell, Statoil (now Equinor) and Total. Additional members are always welcome – see the end of this article for more information on how to become involved.

The main findings from the global analysis are presented below. US inland barge movements are analysed separately and are not included in the global figures.

Database development

The total number of ship voyages reported for 2017 increased to over 9,300, while the number of reported ship voyages with both bill of lading (BOL) and outturn data increased by 12% to almost 7,200. The reported BOL volume totalled 6.44bn barrels and the volume of crude with complete data increased to 4.86bn barrels, as shown in Figure 1.

Comparison with the BP Statistical Review of World Energy indicates that the database

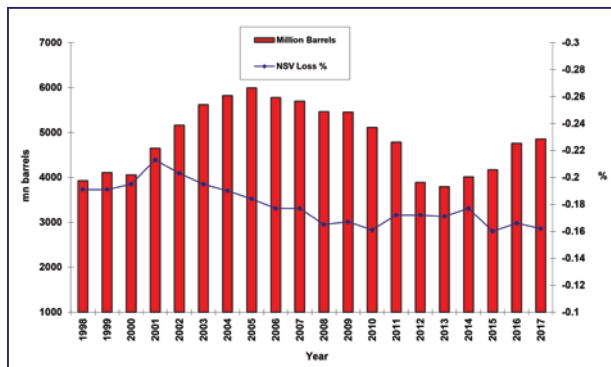


Figure 1: Database volume and average recorded net loss of crude oil, 1998–2017 Source: HMC-4A

includes approximately 44% of the global shipped volume at BOL, and contains complete load and discharge data for over 33% of estimated global seaborne movements.

Global losses

Losses fell steadily after 2001 to a 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%, with losses remaining fairly steady until 2015,

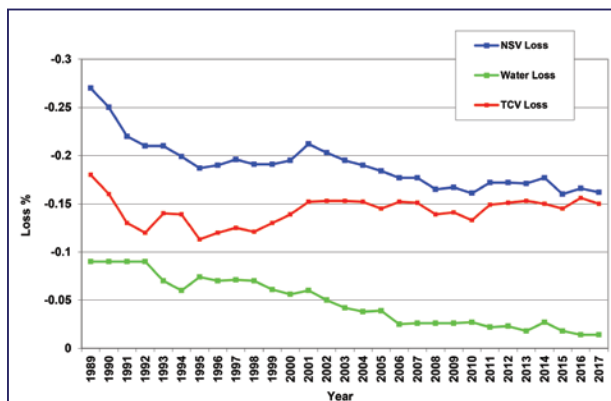


Figure 2: NSV, water and TCV losses, 1989–2017 Source: HMC-4A

which saw a significant fall to -0.160% – a record low level. This was partly reversed in 2016 with a mean NSV loss of -0.166%, but fell back to -0.162% in 2017. However, these recent changes are not statistically significant.

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. The increase in NSV loss in 2014 was the result of a significant increase in water loss, while TCV loss actually fell slightly. The fall in 2015 was due to the water loss falling back to the 2013 level, coupled with a further fall in TCV loss. A partial reversal of the TCV loss resulted in the NSV loss increase in 2016, with water loss falling to -0.014%. The reduced water loss was maintained in 2017, with the fall in TCV loss leading to the fall in NSV loss. 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 for individual crude oils

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 2017 and 2016.

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 figures for 2017 with those for 2016. It appears that the reduction

Crude type	API gravity	Overall volumes (NSV)			Calculation by voyage					
		Total barrels	Barrels loss	Barrels loss %	Mean	2017 NSV loss % St. dev.	No.	Mean	2016 NSV loss % St. dev.	No.
Agbami	47.9	40,209,035	-152,106	-0.38	-0.37	0.27	41	-0.24	0.23	33
Al Shaheen	30.0	36,051,385	-80,291	-0.22	-0.23	0.23	57	-0.26	0.14	35
Alaskan North Slope	32.8	97,908,381	-60,769	-0.06	-0.04	0.30	132	-0.09	0.19	180
Alvheim	34.4	19,500,940	-31,679	-0.16	-0.16	0.19	24	-0.11	0.30	43
Amna	37.7	15,426,030	-41,679	-0.27	-0.27	0.17	25	-	-	-
Arabian Extra Light	39.4	93,139,399	-203,022	-0.22	-0.27	0.44	177	-0.36	0.46	130
Arabian Heavy	27.4	12,905,037	-30,587	-0.24	-0.18	0.49	32	-0.25	0.24	34
Arabian Light	33.1	338,388,575	-543,127	-0.16	-0.16	0.25	348	-0.16	0.23	352
Arabian Medium	31.0	42,047,312	-43,359	-0.10	-0.08	0.34	77	-0.17	0.22	110
Arctic Oil	23.8	17,583,273	-19,108	-0.11	-0.11	0.16	25	-0.12	0.19	21
Asgard	54.1	35,436,935	-65,695	-0.19	-0.18	0.19	42	-0.19	0.18	47
Azeri Light	36.7	145,751,607	-185,580	-0.13	-0.12	0.12	193	-0.14	0.23	203
Bakken	43.0	10,520,726	-20,421	-0.19	-0.18	0.14	25	-	-	-
Basrah Heavy	24.1	72,141,901	-123,247	-0.17	-0.13	0.34	96	-0.20	0.33	105
Basrah Light	29.5	123,033,527	-300,961	-0.24	-0.25	0.32	113	-0.22	0.26	173
Bonga	28.1	40,869,342	-39,905	-0.10	-0.13	0.62	45	-0.17	0.28	39
Bonny Light	34.1	20,794,149	-47,145	-0.23	-0.24	0.40	24	-0.24	0.35	30
Brass	38.7	19,230,376	-36,273	-0.19	-0.20	0.24	25	-	-	-
Brent Blend	39.5	13,969,760	4,983	0.04	0.03	0.22	23	-0.07	0.47	51
Castilla Blend	18.2	54,848,299	-17,895	-0.03	-0.04	0.25	90	-0.03	0.27	109
Clov	32.7	21,599,386	-34,513	-0.16	-0.15	0.18	25	-0.22	0.21	29
CPC Blend	46.2	251,354,646	-528,597	-0.21	-0.20	0.16	318	-0.24	0.18	255
Danish	34.2	17,749,392	-22,570	-0.13	-0.12	0.34	32	-0.10	0.26	23
Das Blend	39.1	31,796,670	-111,165	-0.35	-0.33	0.31	47	-0.23	0.22	57
Dfc Condensate	57.7	14,395,383	-9,890	-0.07	-0.06	0.37	27	-	-	-
Eagle Ford	47.1	21,009,157	-20,274	-0.10	-0.03	0.29	59	-0.10	0.39	188
Ekofisk	39.0	45,734,145	-11,521	-0.03	-0.03	0.18	72	-0.04	0.12	59
El Sharara	42.9	27,365,570	4,569	0.02	0.02	0.18	44	-	-	-
Es Sider	36.3	27,476,871	-75,508	-0.27	-0.29	0.33	44	-	-	-
Escravos	31.5	44,190,844	-58,692	-0.13	-0.13	0.13	48	-0.10	0.14	27
Espo	35.7	18,211,346	-29,788	-0.16	-0.14	0.26	28	-0.08	0.15	30
Export Blend	31.7	43,046,516	-63,851	-0.15	-0.16	0.26	54	-0.09	0.35	56
Flotta Gold	36.8	26,513,215	-81,541	-0.31	-0.31	0.15	41	-0.30	0.16	43
Forcados Blend	32.7	30,908,410	-37,189	-0.12	-0.11	0.17	37	-	-	-
Forties Blend	39.6	32,415,492	-101,767	-0.31	-0.30	0.47	41	-0.22	0.29	63
Grane	27.9	67,022,905	-48,487	-0.07	-0.07	0.14	102	-0.11	0.22	87
Gudrun Blend	50.1	27,641,248	-20,803	-0.08	-0.08	0.18	44	-0.19	0.16	42
Gulfaks	39.8	69,395,902	-130,055	-0.19	-0.19	0.20	87	-0.09	0.18	103
Hamaca Blend	17.5	11,887,868	-37,587	-0.32	-0.31	0.58	23	-0.33	0.83	36
Heidrun	24.5	23,498,350	25,491	0.11	0.11	0.18	38	0.14	0.21	48
Hibernia	33.8	21,263,729	-12,914	-0.06	-0.04	0.17	41	-0.01	0.14	78
Hibernia (Offshore)	33.6	15,337,172	-28,413	-0.19	-0.20	0.19	21	-	-	-
Iracema	32.1	76,596,190	-151,105	-0.20	-0.19	0.26	80	-0.24	0.23	59
Iranian Heavy	29.3	58,263,790	-140,034	-0.24	-0.21	0.25	60	-0.25	0.35	31
Iranian Light	33.0	39,840,230	-67,509	-0.17	-0.15	0.19	39	-0.32	0.23	36
Kaliningrad	40.4	4,768,957	-14,294	-0.30	-0.31	0.22	27	-0.25	0.30	42
Kimanis	37.3	25,676,723	-17,076	-0.07	-0.06	0.21	50	-0.17	0.16	38
Knarr Blend	45.4	13,874,005	-30,073	-0.22	-0.22	0.16	23	-0.18	0.28	28
Kutubu	51.9	13,198,358	-41,166	-0.31	-0.31	0.17	23	-0.38	0.14	23
Kuwait Export	30.4	131,821,865	-325,198	-0.25	-0.24	0.25	138	-0.23	0.26	103
Louisiana Light Sweet	39.1	13,294,229	55	0.00	0.00	0.12	95	0.04	0.20	121
Lula	29.9	130,618,110	-231,570	-0.18	-0.19	0.37	143	-0.20	0.26	100
Marlim	20.1	24,572,888	54,074	0.22	0.21	0.43	31	0.01	0.22	23
Maya	21.6	193,582,347	-330,599	-0.17	-0.18	0.27	342	-0.21	0.25	330
Merrey 16	16.2	20,386,076	11,233	0.06	0.06	0.35	39	-0.01	0.39	100
Murban	40.4	75,199,967	-186,557	-0.25	-0.26	0.22	116	-0.27	0.19	57
Novy Port	34.5	24,927,454	-43,364	-0.17	-0.17	0.11	33	-	-	-
Oriente	24.3	14,692,665	-14,040	-0.10	-0.10	0.29	32	-0.07	0.34	24
Oseberg	39.4	13,793,785	-22,235	-0.16	-0.16	0.20	23	-0.15	0.18	47
Patos Marinza	9.9	2,603,563	-1,943	-0.07	-0.08	0.18	21	-0.08	0.26	25
Peregrino	13.8	20,321,531	-34,630	-0.17	-0.18	0.21	38	-0.20	0.26	30
Qua Iboe	37.6	34,312,406	-60,031	-0.17	-0.17	0.24	38	-	-	-
Roncador	28.5	31,519,706	-58,368	-0.19	-0.17	0.26	35	-	-	-
Roncador Heavy	19.5	34,320,836	-51,979	-0.15	-0.12	0.32	42	-0.18	0.31	45
Russian Export Blend	30.6	310,584,925	-540,684	-0.17	-0.18	0.16	431	-	-	-
Saharan Blend	44.6	86,905,754	-88,013	-0.10	-0.09	0.19	133	-0.10	0.16	115
Sapinhoa	30.0	41,992,332	-105,663	-0.25	-0.25	0.44	48	-0.16	0.38	36
Siberian Light	34.4	20,839,293	-45,057	-0.22	-0.21	0.14	36	-0.20	0.13	27
Skarv	45.0	13,937,898	-31,064	-0.22	-0.22	0.13	21	-0.32	0.23	25
Sokol	35.8	22,995,006	-13,069	-0.06	-0.07	0.19	36	-	-	-
Statfjord	39.5	69,251,917	-100,082	-0.14	-0.15	0.24	89	-0.19	0.15	99
Stones	28.4	6,993,053	-13,088	-0.19	-0.18	0.26	24	-	-	-
Troll	35.1	19,298,254	-11,844	-0.06	-0.06	0.06	27	-0.09	0.12	34
Upper Zakum	34.0	63,264,254	-187,741	-0.30	-0.29	0.27	73	-0.28	0.23	84
Varandey	37.8	42,391,573	-173,175	-0.41	-0.41	0.14	56	-0.36	0.21	45
Vasconia	25.4	69,374,947	-33,433	-0.05	-0.07	0.24	125	-0.05	0.24	124
West Texas Intermediate	42.2	57,678,414	-61,373	-0.11	-0.09	0.17	111	-0.20	0.32	54
Western Desert	41.3	33,344,087	-110,051	-0.33	-0.33	0.27	66	-0.15	0.27	62
Zuata 300 Vr 20	20.0	20,367,272	-20,694	-0.10	-0.08	0.61	38	-0.19	0.36	38

Table 1: Analysis by crude oil type, 2017 and 2016

Source: HMC-4A

in TCV loss is due to a reduction in the load loss figure.

Key comparisons used in the analysis are as follow:

- NSV and TCV losses are simple comparisons between BOL and outturn figures.
- NSV is the volume of crude corrected to 60°F 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 quantity, 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 measured after discharge (ROB).

Vessel experience factors

Vessel experience factors (VEFs) are used to predict shore quantities for loss control comparisons or in cases where direct shore measurements are not available, eg when metering systems fail or if shore tanks are being filled or emptied from shoreside at the same time as a ship is loading or discharging, making measurement impossible.

Historical ship/shore ratios are used to correct ships' figures, thereby allowing for evaporative losses, clingage at discharge and any ship calibration offsets.

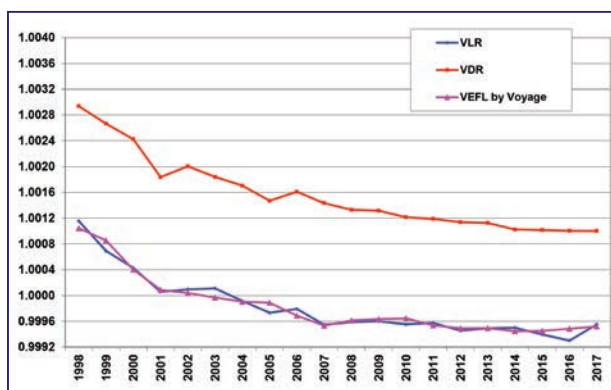


Figure 3: VEF trend, 1998–2017

Source: HMC-4A

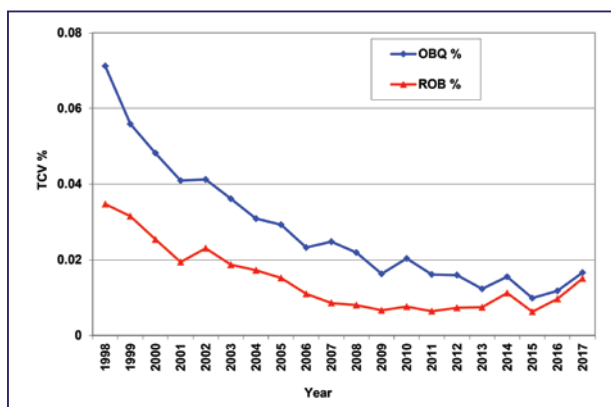


Figure 4: OBQ-ROB difference, 1998–2017

Source: HMC-4A

VEFs are normally calculated onboard using load or discharge figures from the most recent voyages and, where available, are reported for inclusion in the database.

VEF load values have fallen consistently over the years, as shown in Figure 3. The trend has tailed off with only small changes now apparent. In 2016 the mean reported VEF by voyage was 0.99952, a slight increase over 2015. The mean load ratio (VLR) as calculated from database vessel and shore quantities increased to almost match the VEF again at 0.99955. Values have been below 1.0000 for some years and it would seem that this figure may now represent 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 average vessel discharge ratio (VDR) remained at its lowest level of 1.00100 for 2017.

Unfortunately, very little vessel experience factor discharge (VEFD) data is collected. However, on a global basis this is not expected to differ significantly from the average of the VDRs.

OBQ and ROB

With improved design of ships' tanks, quantities of cargo remaining onboard (ROB) after discharge fell steadily up to 2009. Onboard quantity (OBQ), which is found onboard before loading, also followed a general downward trend over this period. However, both quantities have risen slightly over the last two years. The difference between these two quantities represents clingage – cargo which is not measured after discharge as it remains on the tank walls but then drains down to be measured before the next load. This has continued to fall and in 2017 was at its lowest recorded level of 0.0015%. See Figure 4.

Conclusion

Mean NSV loss for 2017 was -0.162%, compared with -0.166% for 2016. Losses followed a downward trend from 2001 to 2008, but now seem fairly flat with only minor annual fluctuations. The majority of the net shore-to-shore difference is related to TCV loss and not water loss, and it was small decrease in TCV loss which led to the NSV loss falling in 2017. 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 again in 2017, such that the BOL volume in the database represents some 44% of the estimated global seaborne crude trade.

The HMC-4 Committee also analyses US crude oil barge movements in addition to developing product loss benchmarks. New members are always welcome to join and expand the database. Any companies with data to submit should contact Kishan Kansara at the Energy Institute, kkansara@energyinst.org

	2017 Mean	St dev	2016 Mean	St dev
NSV loss %	-0.16 (-0.162)	0.31	-0.17 (-0.166)	0.30
TCV loss %	-0.15	0.29	-0.16	0.30
Load loss %	-0.04	0.25	-0.07	0.28
Ship loss %	0.00	0.20	0.01	0.22
Discharge loss %	-0.10	0.25	-0.10	0.27
Water loss %	-0.01	0.21	-0.01	0.21
OBQ-ROB difference %	0.00	0.08	0.00	0.08

Table 2: Global loss analysis

Source: HMC-4A

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