HYDROCARBON MANAGEMENT

Global crude oil voyage losses fall in 2015

Paul Harrison, Consultant to the HMC-4A Marine Oil Transportation Database Committee, presents findings from analysis of the 2015 data on global marine crude oil voyage losses.

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 2015 autumn meeting was held in Houston in November, hosted by ExxonMobil, and the spring 2016 meeting was held in London, UK, hosted by Melverley Consultants.

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 2015: Bazan, BP Oil International, CEPSA, Chevron, Chinese Petroleum Corporation, Eni, ExxonMobil, Marathon, Petrobras, Petrogal (GALP Energia), PetroIneos, Phillips 66, PMI Pemex, Repsol, Saras SpA, Shell, Statoil and Total.

The main findings from the global analysis are presented below. US inland barge movements are analysed separately and are not included. However, domestic grades carried by barge are included in **Table 1**.

Database development

The total number of ship voyages reported for 2015 fell slightly to just over 8,200. However, the number of reported ship voyages with both bill of lading (BOL) and outturn data increased slightly to almost 6,400. The reported BOL volume totalled 5.34bn barrels and the volume of crude with complete data increased to 4.17bn barrels, as shown in **Figure 1**.

The *BP Statistical Review of World Energy* gives global crude seaborne trade for 2015 around 14.52bn barrels, an increase of approximately 5% compared with 2014. The database, therefore, includes approximately 37% of the global volume at BOL and contains complete load and discharge data for just under 29% of estimated global movements.

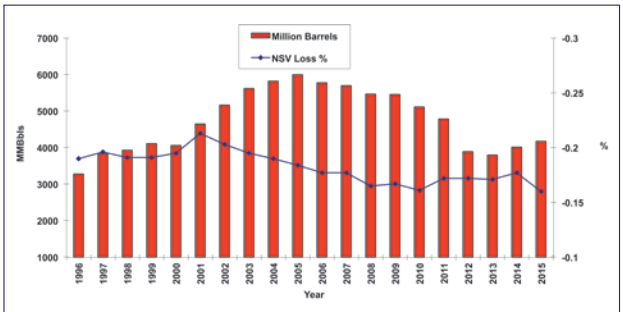

Figure 1: Growth in volume of database and average net loss of crude oil 1996–2015 *Source: HMC-4A*

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%, repeated in 2012 and 2013. In 2014 mean NSV loss increased to –0.177%. However, 2015 saw a significant fall to –0.160%, a record low level.

It must 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. 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. The fall in 2015 was due to the water loss falling back to the 2013 level coupled with a further fall in TCV loss, as shown in **Figure 2.**

TCV loss comprises any real losses 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 the 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 2015 and 2014.

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 2015 with those for 2014.

Key comparisons used in the analysis are as follows:

- 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.

Crude type	API gravity	Overall volumes (NSV)			Calculation by voyage					
					2015 NSV loss %			2014 NSV loss %		
		Total barrels	Barrels loss	Barrels loss %	Mean	St. dev.	No.	Mean	St. dev.	No.
Agbami	48.3	57,291,529	−115,946	−0.20	−0.20	0.21	60	−0.21	0.22	54
Akpo	46.1	34,320,662	−72,486	−0.21	−0.21	0.17	34	−0.12	0.17	37
Al Shaheen	30.2	14,775,736	−49,835	−0.34	−0.31	0.23	23	−0.29	0.13	30
Alaskan North Slope	32.2	76,686,659	−43,380	−0.06	−0.05	0.15	88	−0.03	0.16	95
Alvheim	34.4	29,415,031	−25,783	−0.09	−0.08	0.15	38	−0.13	0.15	38
Arabian Extra Light	39.2	66,959,652	−166,158	−0.25	−0.31	0.63	119	−0.27	0.49	151
Arabian Heavy	27.1	18,648,205	−39,572	−0.21	−0.16	0.40	42	−0.27	0.26	63
Arabian Light	33.2	346,243,285	−519,082	−0.15	−0.16	0.27	355	−0.14	0.29	417
Arabian Medium	30.8	65,894,386	−89,953	−0.14	−0.15	0.35	89	−0.22	0.31	84
Asgard	51.0	32,060,184	−59,364	−0.19	−0.18	0.19	39	−0.13	0.23	40
Azeri Light	37.2	140,726,200	−248,591	−0.18	−0.17	0.19	207	−0.17	0.16	205
Bakken	42.7	5,575,310	−2,444	−0.04	−0.03	0.17	44	−0.04	0.20	161
Basrah Heavy	24.1	24,974,229	−298	0.00	−0.03	0.50	29	-	-	-
Basrah Light	28.4	149,557,640	−352,429	−0.24	−0.21	0.28	130	−0.27	0.25	126
Bonga	29.0	29,977,776	−49,310	−0.16	−0.16	0.16	35	−0.20	0.30	34
Bonny Light	34.6	33,878,779	−83,751	−0.25	−0.27	0.41	37	−0.32	0.23	28
Boscan	10.5	9,609,786	6,346	0.07	0.03	0.49	32	−0.09	0.36	26
Brent Blend	37.7	21,152,407	−33,876	−0.16	−0.16	0.27	35	−0.16	0.21	23
Castilla Blend	18.9	52,772,612	−38,760	−0.07	−0.07	0.18	77	−0.11	0.20	72
Clov	32.9	46,560,994	−87,164	−0.19	−0.18	0.18	48	-	-	-
Cpc Blend	46.3	209,940,904	−563,105	−0.27	−0.26	0.16	254	−0.28	0.16	223
Dalia	23.2	33,288,879	−27,125	−0.08	−0.08	0.27	36	−0.13	0.24	37
Das Blend	39.5	27,746,040	−65,002	−0.23	−0.22	0.20	40	-	-	-
Eagle Ford	46.4	92,905,694	−104,777	−0.11	−0.11	0.29	372	−0.11	0.34	376
Ekofisk	39.1	51,489,841	−25,766	−0.05	−0.05	0.13	83	−0.07	0.11	73
Escravos	32.5	31,518,863	−40,876	−0.13	−0.13	0.14	35	−0.41	0.43	40
Espo	35.6	20,802,315	−25,614	−0.12	−0.11	0.24	35	−0.04	0.12	35
Flotta Gold	36.7	17,919,097	−57,881	−0.32	−0.32	0.12	28	-	-	-
Forcados Blend	33.8	33,664,216	−40,505	−0.12	−0.11	0.24	38	−0.14	0.41	28
Forties Blend	38.2	32,934,061	−35,431	−0.11	−0.12	0.24	50	−0.20	0.21	75
Grane	20.4	29,371,521	6,366	0.02	0.03	0.17	48	0.05	0.20	53
Gudrun Blend	50.0	16,829,238	−33,552	−0.20	−0.20	0.20	26	-	-	-
Gullfaks	39.2	51,498,026	−83,822	−0.16	−0.16	0.16	68	−0.22	0.19	79
Hamaca Blend	19.6	24,627,861	−66,295	−0.27	−0.27	0.40	41	−0.28	0.50	33
Heidrun	24.7	22,987,447	−2,310	−0.01	−0.01	0.30	35	−0.08	0.19	31
Hibernia	35.3	19,899,584	−9,478	−0.05	−0.04	0.16	30	−0.11	0.42	35
Isthmus	33.1	15,873,519	−32,749	−0.21	−0.21	0.45	41	−0.19	0.24	31
Kaliningrad	40.5	4,233,620	−10,513	−0.25	−0.25	0.22	34	−0.21	0.24	42
Kimanis	38.8	15,156,632	−34,652	−0.23	−0.22	0.31	34	-	-	-
Kirkuk	34.7	21,803,212	−42,541	−0.20	−0.15	0.31	34	-	-	-
Kuwait Export	30.6	80,862,688	−201,848	−0.25	−0.28	0.20	78	−0.30	0.24	54
Louisiana Light Sweet	39.3	11,873,102	−3,871	−0.03	−0.02	0.14	48	−0.09	0.34	28
Lula	30.0	37,157,406	−79,203	−0.21	−0.21	0.21	36	-	-	-
Marlim	19.7	22,590,898	−15,992	−0.07	−0.04	0.26	28	-	-	-
Maya	20.8	157,699,179	−317,655	−0.20	−0.20	0.22	287	−0.17	0.22	324
Merey 16	16.0	45,239,033	27,986	0.06	0.06	0.29	83	0.04	0.29	96
Miri Light	29.7	7,865,447	−13,660	−0.17	−0.18	0.17	24	−0.22	0.19	26
Morichal 16	15.9	21,373,840	−37,599	−0.18	−0.18	0.28	38	−0.13	0.35	42
Murban	40.3	47,600,582	−118,458	−0.25	−0.24	0.35	71	−0.23	0.26	97
Norne	29.8	12,513,267	−23,481	−0.19	−0.17	0.28	23	−0.30	0.29	39
Olmeca	38.7	20,862,006	−75,413	−0.36	−0.36	0.25	40	−0.26	0.32	34
Oriente	25.1	17,659,173	−3,278	−0.02	−0.01	0.25	40	−0.03	0.28	40
Oseberg	38.3	28,467,628	−65,957	−0.23	−0.23	0.14	47	−0.17	0.13	36
Ostra	18.5	22,055,910	−24,441	−0.11	−0.10	0.45	34	−0.02	0.28	25
Pazflor	25.4	21,901,851	−37,570	−0.17	−0.18	0.20	25	−0.12	0.15	30
Peregrino	13.8	13,819,395	15,114	0.11	0.07	0.33	31	0.04	0.39	26
Qatar Marine	32.2	14,152,898	−30,193	−0.21	−0.22	0.17	24	−0.21	0.28	22
Qua Iboe	37.0	26,387,437	−71,997	−0.27	−0.27	0.49	28	−0.18	0.39	42
Roncador Heavy	19.9	49,243,314	−124,040	−0.25	−0.20	0.27	45	−0.24	0.25	33
Saharan Blend	44.7	91,834,951	−133,212	−0.15	−0.13	0.15	125	−0.14	0.17	122
Sarir	38.0	14,469,802	−31,450	−0.22	−0.23	0.24	24	-	-	-
Siberian Light	35.5	13,525,604	−9,747	−0.07	−0.07	0.13	22	-	-	-
Skarv	39.9	19,738,937	−83,159	−0.42	−0.42	0.14	31	−0.55	0.28	37
Statfjord	39.8	76,804,600	−96,682	−0.13	−0.12	0.21	99	−0.20	0.17	74
Su Tu Den	40.9	10,568,228	−22,179	−0.21	−0.24	0.30	29	-	-	-
Sumatran Light	34.0	14,238,394	28,747	0.20	0.22	0.47	26	-	-	-
Talam	16.0	12,013,607	−9,054	−0.08	−0.11	0.25	31	-	-	-
Troll	35.7	16,571,769	−19,717	−0.12	−0.13	0.18	26	−0.19	0.13	54
Upper Zakum	33.9	38,437,303	−129,282	−0.34	−0.34	0.19	44	−0.38	0.31	38
Urals (Baltic)	30.8	117,228,593	−163,144	−0.14	−0.14	0.13	167	−0.16	0.14	145
Urals (Black Sea)	31.6	31,455,194	−20,156	−0.06	−0.05	0.31	43	−0.13	0.16	54
Usan	29.7	21,133,450	−45,814	−0.22	−0.22	0.13	21	−0.32	0.24	32
Varandey	37.4	24,482,155	−60,132	−0.25	−0.25	0.16	31	−0.18	0.29	29
Vasconia	25.6	76,321,361	−34,263	−0.04	−0.06	0.33	136	−0.09	0.29	79
West Texas Inter	41.5	16,240,150	−19,398	−0.12	−0.12	0.21	36	-	-	-
Western Desert	41.1	21,130,248	−38,981	−0.18	−0.17	0.33	46	−0.17	0.29	42
Zuata 300 Vr 20	19.5	16,015,900	−29,511	−0.18	−0.16	0.39	36	−0.10	0.35	26

Table 1: Analysis by crude oil type 2015, 2014

Source: HMC-4A

- 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 the BOL and outturn water and sediment.

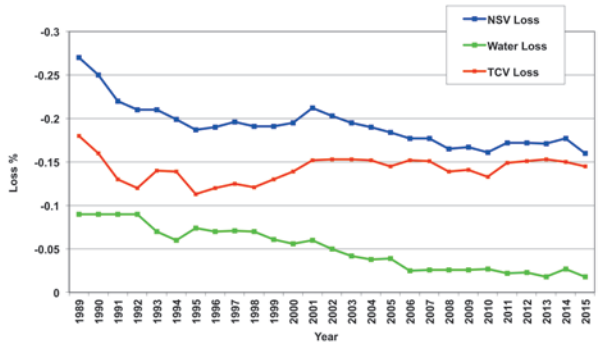

Figure 2: NSV, water and TCV losses 1989–2015 *Source: HMC-4A*

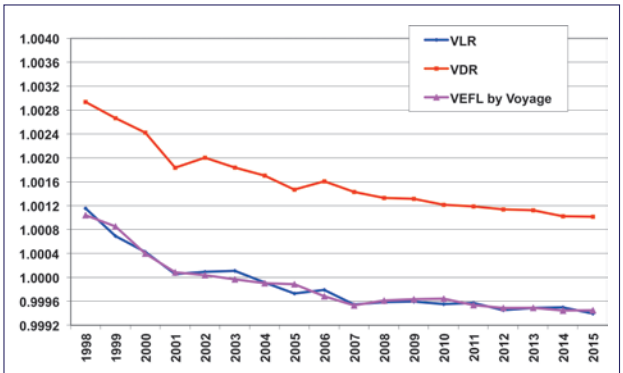

Figure 3: VEF trend 1998–2015 *Source: HMC-4A*

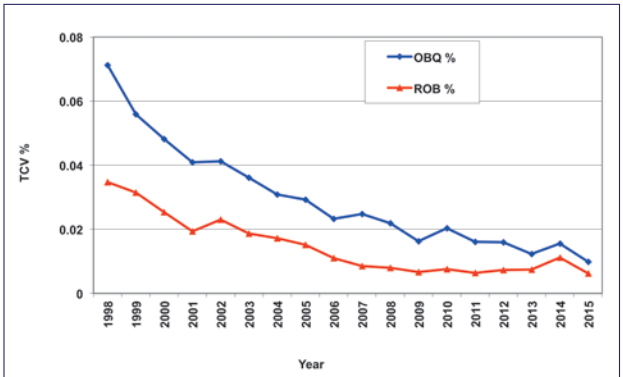

Figure 4: OBQ–ROB differences 1998–2015 *Source: HMC-4A*

	2015 Mean	St Dev	2014 Mean	St Dev
NSV Loss %	–0.16 (–0.160)	0.33	–0.18 (–0.177)	0.32
TCV Loss %	–0.15	0.30	–0.15	0.30
Load Loss %	–0.07	0.29	–0.05	0.28
Ship Loss %	0.01	0.22	0.01	0.22
Discharge Loss %	–0.10	0.30	–0.10	0.29
Water Loss %	–0.02	0.21	–0.03	0.20
OBQ–ROB Difference %	0.00	0.10	0.01	0.08

Table 2: Global loss analysis *Source: HMC – 4A*

- 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

VEFs are used to to predict shore quantities. VEFs are not applied to vessel measurements used for the above analysis, but 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.

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 2015 the mean VEF by voyage was 0.99945. 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 mean vessel load ratio (VLR) is also shown in **Figure 3** and is essentially the same as the mean VEF load.

The average vessel discharge ratio (VDR) was 1.00102 for 2015. Unfortunately very little vessel experience factor discharge (VEFD) data is collected. However, as with VEFL, 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 have been falling together with onboard quantity (OBQ) which is found on board before loading. The difference between these two quantities represents clingage – cargo which is not measured after discharge as it remains on the tank walls. OBQ–ROB differences have been falling steadily and in 2015 were 0.004%. (See **Figure 4**.)

Conclusion

Mean NSV Loss for 2015 was –0.160%, compared with –0.177% for 2014. 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 the small decrease in TCV loss coupled with a reverse of the water loss increase seen in 2014 which led to the NSV loss fall in 2015. 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 (apparent losses).

The number of voyages with complete data increased in 2015. Volume also increased but so did the global total, such that the BOL volume in the database represents 37% of the estimated global seaborne crude trade, a 1% fall compared with 2014.

The 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 and any companies with data to submit should contact Kerry Sinclair at the Energy Institute at e: **ksinclair@energyinst.org**