

Marine crude oil transport – 2006 analysis shows fall in voyage losses

This article by Paul Harrison – Consultant to the Energy Institute's HMC-4(A) Marine Oil Transportation Database Committee – presents findings from analysis of the 2006 data, updating the 2005 analysis which was reported in the October 2006 issue of Petroleum Review.

The Marine Oil Transportation Database Committee was formed in 1986 and is now the Energy Institute HMC-4A (Hydrocarbon Management Committee 4A). The Committee collects and analyses worldwide oil shipping data with the general aim of improving loss control through a better understanding of loss patterns and trends. The 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.

The Committee has established a website for the publication of the information presented here, together with additional data concerning crude oil marine transportation. This can be found at www.oil-transport.info or via the EI website at www.energyinst.org.uk

Committee members submit their company data for analysis and an annual report is issued individually to all members. This report includes a confidential analysis of the individual company data together with a general global analysis of the entire annual data set. Reports are normally issued in electronic format, although hard copies are provided to members on request.

The following companies submitted data for 2006: BP Oil International, CEPESA, Chevron, Chinese Petroleum Corporation (CPC), ConocoPhillips, Eni, ErgMed, ExxonMobil, Marathon Petroleum, Petrobras, Petrogal (GALP Energia), PMI Pemex, Repsol-YPF, Saras, PREEM Petroleum, Shell, Statoil, Sunoco and Total.

The Committee welcomes new members and membership is open to all

oil companies with data to contribute. The Committee meets twice a year and meetings are held in conjunction with those of the sister Committee, HMC-4B – The Oil Transportation Measurement Committee. The next meetings will be held in New Orleans on 27–29 November 2007 and will be hosted by Marathon. Companies interested in joining the Committees may be invited to attend as guests and should contact the Energy Institute on t: +44 (0)207 4677131.

Database growth

For the first time since 2000 there was a fall in the size of the database compared with the previous year. The total number of voyages reported fell to just under 10,300, down from over 11,000, and included 6.39bn barrels of crude at bill of lading (BOL) compared

with 6.96bn barrels in 2005. The total volume for voyages with complete load and discharge data – plotted in **Figure 1** – was 5.8bn barrels, a decrease of around 4% compared to the 2005 volume.

The latest *BP Statistical Review of World Energy* gives global crude trade for 2006 as 14.2bn barrels. The database therefore includes 45% of the global volume at BOL and contains complete load and discharge data for 40% of global volume. The database therefore remains sufficiently large to represent the global situation.

Global mean loss

The mean net standard volume (NSV) loss from the database from 1990 to 2006 is plotted in **Figure 1**. An overall improvement from 1990 to 1995 is clear and global loss then showed no major change between 1995 and 2000. A significant increase in mean NSV loss occurred between 2000 and 2001. However, losses have been falling consistently since 2001 and were at another all-time low in 2006, with a mean NSV loss of -0.177% (by convention losses are given as negative).

The reduction in NSV losses in earlier years was related almost entirely to

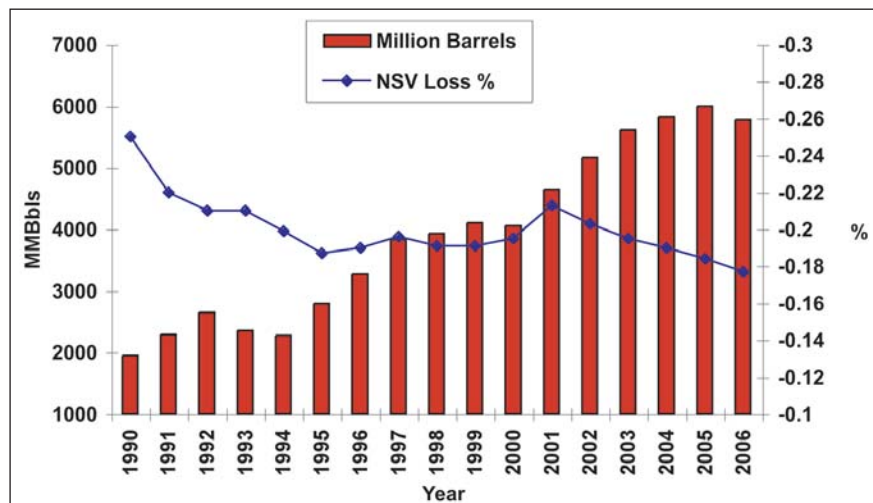


Figure 1: Growth in volume of database and average net loss of crude oil

Crude type	API gravity	Overall volumes (NSV)			Calculation by voyage							
		Total barrels	Barrels loss	Barrels loss %	2006			2005				
					NSV loss %	Mean	Std dev	No.	NSV loss %	Mean	Std dev	No.
Al Shaheen	27.7	41,445,628	-47,538	-0.11	-0.09	0.29	63	-0.25	0.24	46		
Alaskan North Slope	32.6	139,102,925	-91,548	-0.07	-0.06	0.20	158	-0.05	0.21	336		
Alba	19.4	11,073,677	10,127	0.09	0.08	0.51	22	-	-	-		
Amenam Blend	39.8	42,317,459	-44,301	-0.10	-0.11	0.26	45	-0.15	0.17	52		
Amna	37.8	51,770,163	-148,409	-0.29	-0.28	0.15	104	-0.27	0.16	91		
Arabian Extra Light	39.9	39,107,764	-80,446	-0.21	-0.23	0.23	73	-0.25	0.21	99		
Arabian Heavy	27.8	110,064,803	-351,092	-0.32	-0.28	0.28	184	-0.30	0.34	209		
Arabian Light	33.3	403,627,260	-1,182,550	-0.29	-0.25	0.32	423	-0.21	0.40	410		
Arabian Light Berri	39.0	25,541,625	-95,321	-0.37	-0.39	0.48	44	-0.36	0.48	48		
Arabian Medium	30.8	101,592,045	-285,777	-0.28	-0.23	0.46	152	-0.20	0.42	189		
Asgard	48.5	30,886,300	-77,888	-0.25	-0.25	0.15	37	-0.23	0.16	31		
Azeri Light	35.2	75,810,834	-140,782	-0.19	-0.19	0.22	123	-0.33	0.26	43		
Bach Ho	40.5	49,184,850	-125,701	-0.26	-0.21	0.32	120	-0.20	0.34	129		
Basrah Light	30.2	252,223,846	-237,658	-0.09	-0.11	0.20	285	-0.13	0.21	228		
Belayim	25.1	13,133,507	-37,886	-0.29	-0.29	0.22	25	-	-	-		
Benchamas	42.0	12,542,523	-75,330	-0.60	-0.52	0.54	37	-	-	-		
Bonga	29.5	46,387,291	-53,633	-0.12	-0.09	0.23	69	-	-	-		
Bonny Light	33.6	41,075,021	-13,969	-0.03	-0.03	0.36	44	-0.23	0.32	54		
Brass	35.1	45,422,333	-72,613	-0.16	-0.14	0.43	56	-0.01	0.28	37		
Brega	42.6	19,676,102	-48,548	-0.25	-0.26	0.17	30	-	-	-		
Brent Blend	37.9	51,349,419	-83,876	-0.16	-0.17	0.13	84	-0.14	0.15	77		
Bunga Kekwa	36.2	8,104,676	-14,364	-0.18	-0.18	0.23	25	-0.25	0.25	36		
Cañadon Seco	24.6	26,099,693	-33,965	-0.13	-0.12	0.12	62	-0.18	0.14	75		
Captain	20.0	14,971,641	-3,407	-0.02	-0.02	0.34	31	0.14	0.72	27		
Cerro Negro SCO	15.6	27,564,129	-75,265	-0.27	-0.25	0.31	51	0.04	0.28	44		
Cossack	47.3	12,152,125	-25,972	-0.21	-0.19	0.61	22	-	-	-		
CPC Blend	43.8	149,418,637	-403,820	-0.27	-0.27	0.17	181	-0.28	0.19	221		
Danish	33.9	52,133,735	-71,956	-0.14	-0.14	0.16	83	-0.14	0.25	108		
Doba Blend	21.6	29,085,949	103,109	0.35	0.32	0.52	36	0.23	0.38	39		
Draugen	40.3	25,748,481	-84,235	-0.33	-0.34	0.17	34	-0.32	0.11	34		
Ekofisk	37.7	123,135,178	-72,459	-0.06	-0.06	0.13	189	-0.04	0.14	186		
El Sharara	42.3	26,920,734	-48,643	-0.18	-0.17	0.16	40	-0.10	0.19	26		
Eocene	18.4	16,421,093	-17,405	-0.11	-0.09	0.38	34	-0.12	0.44	38		
Erha	32.7	33,955,626	-59,830	-0.18	-0.16	0.27	42	-	-	-		
Es Sider	37.0	34,433,871	-122,169	-0.35	-0.35	0.29	56	-0.34	0.16	56		
Escravos	33.9	57,583,180	-75,781	-0.13	-0.13	0.20	60	-0.46	0.38	63		
Forozan	29.7	21,518,109	-44,746	-0.21	-0.16	0.33	28	-0.18	0.17	24		
Forties Blend	44.2	92,923,023	-228,129	-0.25	-0.24	0.27	151	-0.20	0.19	160		
Galeota	40.2	14,946,953	-43,118	-0.29	-0.29	0.37	41	-	-	-		
Gippsland	51.2	11,432,146	19,691	0.17	0.15	0.57	21	0.11	0.41	24		
Girassol	32.2	30,265,156	-31,109	-0.10	-0.10	0.23	35	-0.26	0.21	41		
Gltne	33.1	3,924,154	-6,741	-0.17	-0.17	0.35	22	-	-	-		
Grane	19.1	30,294,997	28,996	0.10	0.10	0.25	51	-0.04	0.13	41		
Gulfaks	36.5	93,061,175	-234,564	-0.25	-0.25	0.19	113	-0.21	0.23	134		
Hamaca Blend	25.4	15,134,870	-71,256	-0.47	-0.46	0.28	29	-	-	-		
Hanze	38.9	3,134,028	19,875	0.63	0.62	0.51	24	0.81	0.36	27		
Hibernia	35.3	46,063,945	-15,073	-0.03	-0.03	0.19	69	-0.05	0.15	92		
Hungo Blend	29.1	34,873,548	-65,598	-0.19	-0.17	0.23	34	-0.18	0.20	33		
Iranian Heavy	29.8	74,086,081	-217,298	-0.29	-0.30	0.31	111	-0.21	0.33	135		
Iranian Light	33.4	79,591,498	-129,064	-0.16	-0.18	0.28	114	-0.15	0.36	80		
Isthmus	32.7	8,202,864	-16,989	-0.21	-0.23	0.21	22	-0.11	0.24	32		
Jotun	41.0	11,761,362	-38,118	-0.32	-0.32	0.18	21	-0.47	0.19	24		
Kaliningrad	40.2	9,246,737	-15,626	-0.17	-0.17	0.35	30	-0.38	0.44	68		
Karachaganak	47.1	3,761,534	-8,081	-0.21	-0.22	0.34	31	-	-	-		
Kissanje	30.5	27,752,218	-41,123	-0.15	-0.13	0.28	29	-	-	-		
Kole Marine Blend	32.0	18,172,498	-23,031	-0.13	-0.13	0.13	23	-0.05	0.13	21		
Kutubu	44.2	12,705,542	3,574	0.03	0.04	0.25	22	-	-	-		
Kuwait Export	30.6	117,030,067	-419,397	-0.36	-0.35	0.21	79	-0.27	0.21	74		
Lower Zakum	39.9	16,252,300	-40,316	-0.25	-0.25	0.14	23	-	-	-		
Maya	21.6	342,080,468	-751,888	-0.22	-0.23	0.24	604	-0.27	0.22	636		
Mellitah	43.2	16,453,052	-6,152	-0.04	-0.04	0.20	27	-	-	-		
Merrey 16	16.0	58,137,069	66,917	0.12	0.12	0.20	111	0.13	0.21	112		
Mesa 30	30.3	22,701,268	-4,092	-0.02	-0.04	0.24	30	-0.01	0.25	53		
Murban	39.6	89,752,737	-237,343	-0.26	-0.26	0.24	119	-0.36	0.20	55		
Napo	19.1	10,730,353	10,949	0.10	0.10	0.19	31	0.15	0.46	44		
Nemba	40.4	48,950,754	-86,032	-0.18	-0.15	0.25	56	-0.25	0.26	34		
N'kossa	39.3	19,023,657	-66,551	-0.35	-0.33	0.20	21	-	-	-		
Norne	31.2	32,706,367	-40,302	-0.12	-0.12	0.13	39	-0.03	0.20	31		
Olmeca	38.5	69,249,958	-178,165	-0.26	-0.26	0.26	129	-0.26	0.21	119		
Oman Export	32.8	44,040,197	-80,564	-0.18	-0.19	0.47	66	-0.21	0.30	47		
Oriente	23.6	10,092,687	32,074	0.32	0.35	0.44	22	0.38	0.44	25		
Oseberg	37.9	59,444,486	-155,188	-0.26	-0.26	0.18	93	-0.24	0.18	130		
Qua Iboe	35.5	93,550,226	-127,641	-0.14	-0.12	0.20	102	-0.11	0.37	86		
Rang Dong	40.5	8,588,742	-22,637	-0.26	-0.23	0.39	26	-0.48	0.44	24		
Ras Gas Condensate		10,765,789	-22,073	-0.21	-0.20	0.25	23	-	-	-		
Ratawi	24.0	14,623,351	-24,446	-0.17	-0.16	0.25	33	-0.22	0.28	40		
Saharan Blend	45.2	153,521,703	-161,827	-0.11	-0.09	0.18	224	-0.09	0.24	210		
Santa Barbara	39.9	17,138,852	-31,102	-0.18	-0.22	0.35	30	-0.30	0.26	25		
Sarir	37.6	16,157,781	-26,206	-0.16	-0.16	0.26	26	-0.15	0.26	29		
Schiehallion	28.8	21,930,763	3,809	0.02	0.00	0.25	32	0.06	0.16	23		
Seria Light	36.2	11,092,301	3,543	0.03	0.04	0.32	38	0.02	0.33	27		
Siberian Light	35.6	24,543,307	-88,913	-0.36	-0.35	0.27	52	-0.30	0.31	36		
Sirtica	40.3	26,970,959	-30,930	-0.11	-0.12	0.17	44	-0.18	0.24	31		
Souedie	24.0	17,204,091	-56,865	-0.33	-0.32	0.37	38	-0.22	0.31	42		
South Pars Condensate	58.4	16,580,057	-40,213	-0.24	-0.21	0.19	27	-	-	-		
Statfjord	39.4	97,212,269	-181,338	-0.19	-0.19	0.20	121	-0.16	0.20	117		
Su Tu Den	36.2	8,857,345	-27,467	-0.31	-0.26	0.42	25	-0.18	0.58	31		
Syrian Light	38.2	20,649,371	-66,239	-0.32	-0.32	0.28	40	-0.35	0.38	51		
Triton	37.4	12,165,800	-65,660	-0.54	-0.54	0.22	24	-0.69	0.40	30		
Troll	30.6	23,946,014	-13,887	-0.06	-0.04	0.17	39	-0.07	0.18	59		
Upper Zakum	34.2	29,764,464	-94,622	-0.32	-0.35	0.43	34	-0.22	0.16	21		
Urals (Baltic)	31.7	223,893,174	-284,326	-0.13	-0.12	0.15	316	-0.15	0.15	494		
Urals (Black Sea)	31.0	122,635,788	-318,613	-0.26	-0.27	0.22	179	-0.29	0.23	219		
Val d'Agri	37.9	5,377,831	-19,225	-0.36	-0.36	0.30	25	-0.49	0.56	23		
Yoho	39.1	26,654,617	-97,853	-0.37	-0.42	0.51	31	-0.29	0.37	35		
Zafiro	29.6	36,989,849	-43,650	-0.12	-0.11	0.20	37	-0.28	0.26	43		
Zarzaïtine	43.1	15,119,072	-38,541	-0.25	-0.26	0.17	25	-0.33	0.17	23		
Zuata Sweet	30.5	14,949,726	-27,743	-0.19	-0.18	0.34	27	-0.13	0.20	30		

Table 1: Analysis by crude oil type 2006

Crude type	Mean NSV loss %		Table difference
	Original	Corrected	
Abu Safah	-0.18	0.03	0.21
Arabian Extra Light	-0.24	-0.09	0.15
Arabian Heavy	-0.31	-0.23	0.08
Arabian Light	-0.34	-0.17	0.16
Arabian Light Berri	-0.39	-0.24	0.15
Arabian Medium	-0.26	-0.16	0.10
Banoco Arab Medium	-0.17	-0.12	0.05
Belida	-0.31	-0.20	0.11
Bunga Kekwa	-0.19	-0.09	0.10
Champion	0.21	0.21	0.00
Dulang	0.02	0.06	0.04
Eocene	0.04	0.04	0.00
Handil	-0.01	0.00	0.01
Kaji Semoga	-0.06	-0.05	0.01
Labuan	-0.45	-0.39	0.07
Lower Zakum	-0.23	-0.12	0.10
Murban	-0.27	-0.12	0.14
Oman Export	-0.18	-0.09	0.10
Qatar Land	0.13	0.20	0.07
Ratawi	-0.04	-0.02	0.03
Saharan Blend	-0.05	0.01	0.06
Senipah Condensate	-0.09	-0.08	0.01
Seria Light	0.06	0.06	0.00
Souedie	-0.40	-0.38	0.02
Syrian Light	-0.33	-0.32	0.01
Tapis Blend	-0.03	0.12	0.15
Umm Shaif	-0.27	-0.20	0.06
Upper Zakum	-0.27	-0.15	0.11
Zarzaitine	-0.23	-0.23	0.00
Mean difference			0.07

Table 2: Effect of table corrections on net standard volume loss figures for individual crude oils

water measurement as shown in Figure 2. Gross or total calculated volume (TCV) loss also fell between 1990 and 1994, but has risen again in recent years as water losses have continued to fall. It was noted last year that with TCV loss now responsible for around 80% of the NSV loss it is this figure which must be the target for further significant reductions in NSV loss. However, contrary to this observation, it was a significant reduction in water loss (from -0.040% to -0.025%) which resulted in the NSV loss reduction between 2005 and 2006, partly offset by a small increase in the TCV loss, back to the 2004 level of -0.15%.

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 2006 and 2005.

	2006		2005	
	Mean	St dev	Mean	St dev
NSV loss %	-0.18 (-0.177)	0.31	-0.18 (-0.184)	0.35
TCV loss %	-0.15	0.30	-0.14	0.33
Load loss %	-0.01	0.24	-0.01	0.24
Ship loss %	0.02	0.21	0.02	0.21
Discharge loss %	-0.18	0.27	-0.17	0.30
Water loss %	0.03	0.16	-0.04	0.18
OBQ-ROB difference %	0.01	0.09	0.01	0.10

Table 3: Global loss analysis

Note that the data in Table 1 is not 'table corrected' but based on original BOL figures. Where possible, for load ports using 'old' (1956) Table 6 or Table 54, corrected BOL figures are calculated using 'new' (1980 or 2004) tables for comparison with outturns at discharge ports which also use the 'new' tables. The effect of using table corrected BOL data for specific crudes is shown in Table 2.

It should be noted that as the information in Table 2 is derived from a smaller set of voyages than those used for Table 1 (ie those with both corrected and uncorrected BOL figures) the actual mean losses will therefore differ. Table 1 should be used as a guide for typical measurement differences and Table 2 gives an indication as to likely table difference. The above figures are based on a minimum of five voyages per grade.

Detailed loss analysis

In addition to NSV loss figures 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 3, comparing figures for 2006 with those for 2005.

Key comparisons used in the analysis are as follows:

- NSV (net standard volume) and TCV (total calculated volume) losses are simple comparisons between bill of lading (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 (load difference) is the TCV difference between the received volume measured on the ship (corrected for OBQ (preload onboard quantity) and VEF (vessel experience factor)) and the shore delivered volume.
- Discharge loss is the TCV difference between the discharged volume measured on the ship (corrected for ROB (remaining onboard) and VEF) 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.

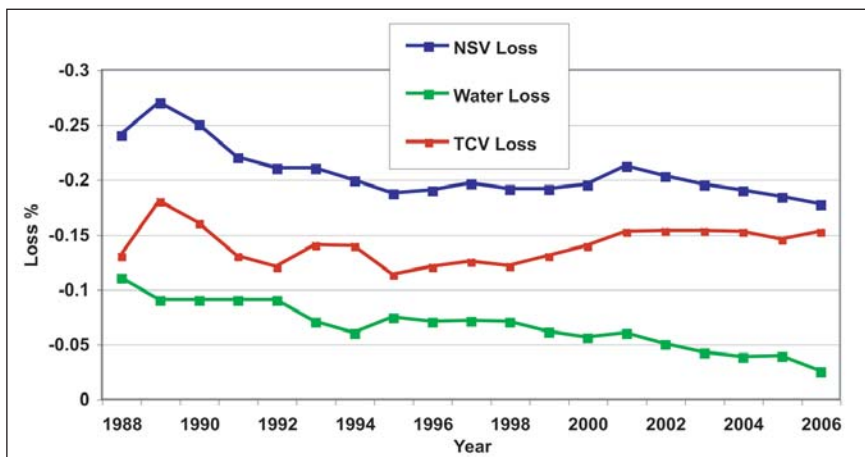


Figure 2: Overall loss trend

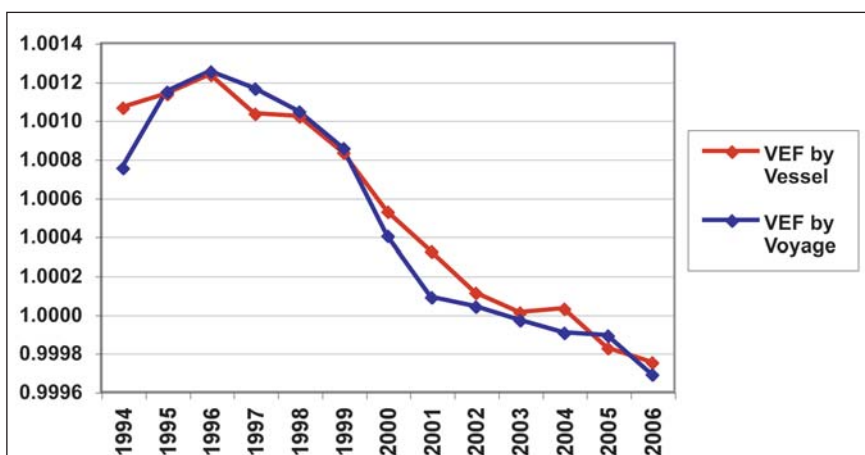


Figure 3: VEF trend

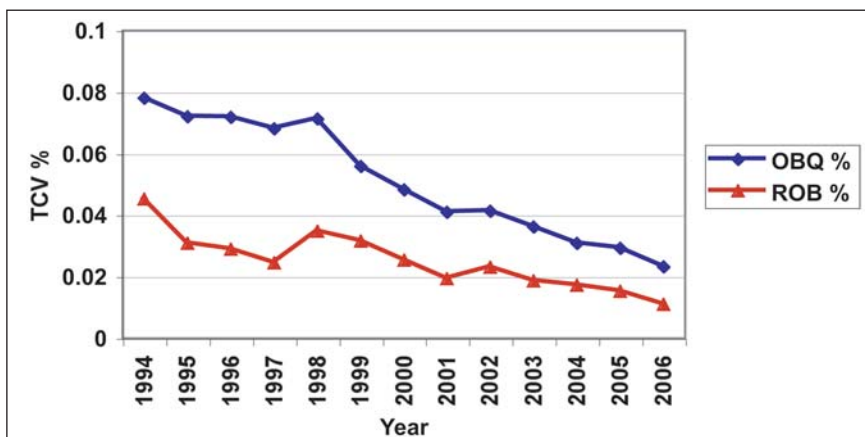


Figure 4: OBQ and ROB trend

• OBQ-ROB difference is the difference between the TCV measured on the ship prior to loading (OBQ) and that remaining after discharge (ROB). Load loss in 2005 was -0.011%, higher than in 2004 but still very close to zero. This should be the case as application of the load VEF will generally take account of ship/shore differences, including calibration differences, vapour losses and systematic measurement differences.

Ship loss shows a small gain, which is unexpected but has been consistent over many years. Recent studies indicate that average venting losses during voyages are very low, probably in the region of -0.004%. More study work is in hand regarding venting losses, but clearly if the actual figure is this small then a very small systematic difference in measurements at load and discharge (eg ship trim differences) can lead to

the small apparent gain which the data shows.

Load VEF values have fallen fairly consistently over the past 10 years, as shown in Figure 3. This fall is apparent from the average by voyage values and also from the average by vessel values. The 2006 average by vessel is 0.99975 and the average by voyage is 0.99970; both below 1. With modern, accurately calibrated vessels this figure will represent the real loss at loading. A value of 0.9998 would be equivalent to a -0.02% evaporative loss.

OBQ and ROB (expressed as percentages of BOL and outturn TCVs respectively) also continue to fall, as shown by Figure 4. The difference between OBQ and ROB has also been declining, indicating that ROB clingage volume has reduced. Mean OBQ for 2006 was 0.023% and mean ROB 0.011%.

Conclusion

Mean NSV loss for 2006 was -0.177%, the lowest level recorded since the database was begun. The majority of this shore difference is now related to TCV loss and not water loss. However, although the TCV loss figure fell in 2005 for the first time in almost 10 years, this fall was reversed in 2006 and the reduced NSV loss was due to a further reduction in water loss. It is hoped that the efforts being made to reduce real losses at load, on voyage and at discharge will lead to improvements in TCV loss in the near future. It must be remembered that the TCV loss figure includes not only any real losses between load and discharge port but also any systematic differences between load and discharge measurements.

The changes in global loss patterns seen over recent years in relation to ship/shore comparisons at load and at discharge continue with OBQ-ROB difference at its lowest ever value of 0.012%. Average OBQs, ROBs and load VEFs all continue to fall.

The number of voyages and database volume fell slightly in 2006. However, the Committee remains committed to its next target of collecting full load and discharge data for 50% of the crude oil transported by ship, not just keeping pace but growing faster than the world volumes. In addition to improving data gathering by existing members, the Committee is also keen to increase the membership and prospective new members are encouraged to contact the EI for further details, t: +44 (0)207 467 7131.

Work is progressing with a products database and it is hoped that some information can be published in 2008. ●

Disclaimer

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