HYDROCARBON MANAGEMENT

Benchmarking marine product losses

Paul Harrison – Consultant to the EI HMC-4A and B Marine Oil Transportation Database Committees – presents findings from an analysis of products shipment data, from which benchmarks have been established.

The Energy Institute HMC-4A Oil Transportation Database Committee has been collecting and analysing worldwide crude oil shipping data for over 25 years, and publishes annual summary reports in *Petroleum Review*. In 2004 a second sub-committee (HMC-4B) began to investigate product shipping losses with a view to gaining a better understanding of losses and establishing benchmark information as had been done for crude oil.

Data collection was stopped in 2015 following several years with no apparent movement in the results. However, the group is considering collecting data again in 2018 to determine if there have been any significant changes. This article considers results from data collected since the beginning of the work, but focuses on the most recent years of the study.

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. Shore-to-shore losses will also include differences due to unmeasured product remaining on board and in transfer lines.

The following companies have contributed data: BP Oil International, Chevron, ConocoPhillips, Eni, ExxonMobil, Phillips 66, Saras and Shell.

Database development

Data has been collected globally and includes sea voyages by ship and US inland barge movements.

There are a large number of product grades with many variations in grade names between companies and locations. To overcome the problems in handling large numbers of similar but differently named products, nine key product types have been identified and used for the analysis. Product types and typical grades which are included in each type are shown in **Table 1**.

Data collection also proved to be an issue as product tends to be shipped in much smaller quantities than crude, with a large number of small parcels involved. This has made data collection difficult in the past. However, with the spread of computerised data collection most companies now have centralised access to significant amounts of product shipment data. In 2004 less than 300 voyages with load and discharge data were submitted, but numbers rose gradually and, as can be seen from **Table 2**, in 2013 8,686 voyages with load and discharge figures were submitted, while in 2014, a total of 7,154 voyages were made available.

In order to carry out a detailed study of measurement differences it is necessary to have data from the four main points of measurement in the voyage – shore measurement at loading (bill of lading; BOL), ship measurement after loading (and any onboard quanity; OBQ), ship before discharge (and any remaining onboard; ROB), shore quantity received (outturn). Unfortunately, due to the nature of many product shipments these measurements are rarely available. Work has therefore focused on shore-to-shore losses.

Due to the wide variation in parcel size and the large number of small parcels involved, any small 'fixed' volume differences which occur lead to large variations in percentage losses for small parcels. This gives large standard deviations associated with mean percentage loss figures and makes identification of significant differences difficult. Parcels of less than 1,000m^3 have been excluded from the statistical calculations to reduce this problem.

Global losses

Data was limited during the initial years of the work, as a result mean

Product Type	Grade
Chemical	Benzene
	Toluene
	Xylene
Component	Alkylate
	Blendstock
	Condensate
	Isomerate
	Naphtha
	Pygas
	Raffinate
	Reformate
LPG	LPG
Distillate	Avtur
	EN590
	FOD
	G101
	G102
	Gasoil
	GHO
	Kero
	ULSD
Gasoline	91 UL
	92 UL
	95 UL
	98 UL
	PU 50
Heavy Oil	CVR
	LSFO
	PCGO
	Slurry Oil
	SRAR
	LCO
	VGO
FAME	FAME
Ethanol	Ethanol
Lube Oil	Lube Oil

Table 1: Products types and typical grades *Source: Energy Institute*

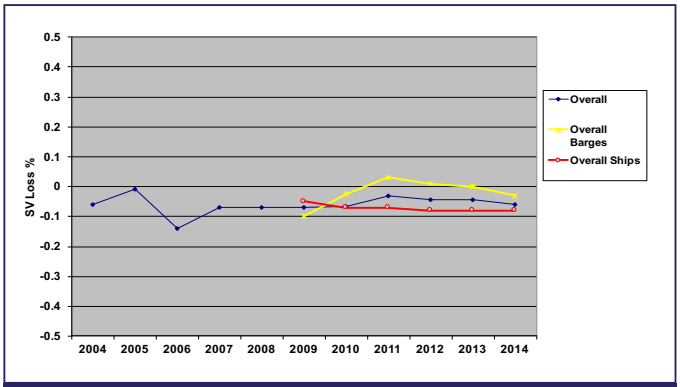

Figure 1: Product losses in 2004–2014 by mean parcel standard volume (SV) loss
Source: Energy Institute

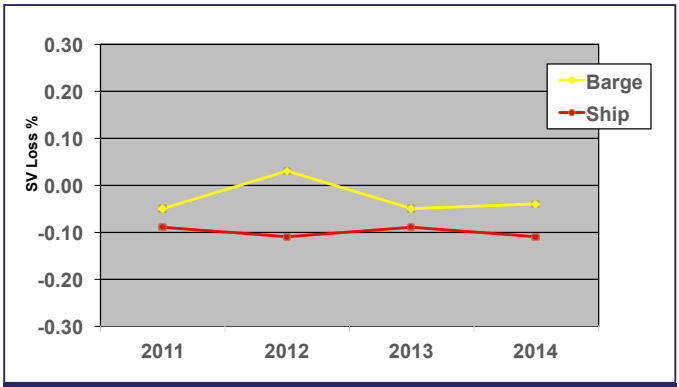

Figure 2: Gasoline – barge vs ship losses, 2011–2014
Source: Energy Institute

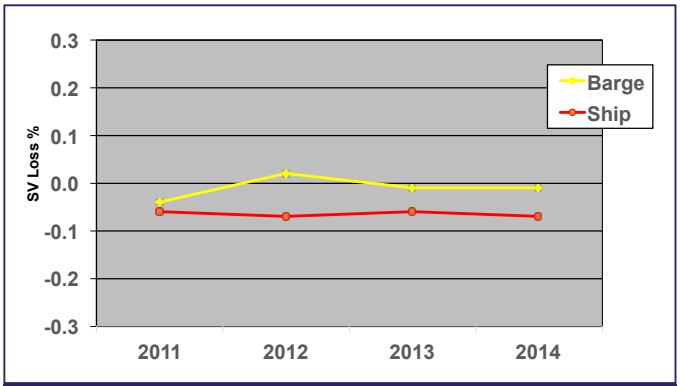

Figure 3: Distillate – barge vs ship losses, 2011–2014
Source: Energy Institute

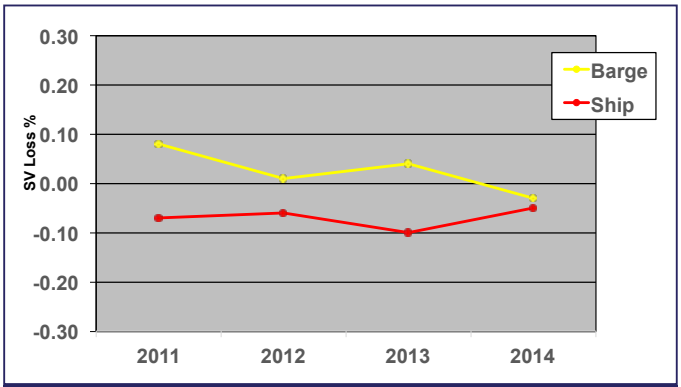

Figure 4: Heavy oil – barge vs ship losses, 2011–2014
Source: Energy Institute

losses for individual product groups were very variable. Work therefore concentrated on overall, combined shore-to-shore losses (standard volume loss; or SV loss). Mean overall SV losses are shown in **Figure 1**.

Following initial years, the mean SV Loss across all product groups has remained between –0.03% and –0.07%. This is significantly lower than the mean loss for crude oil (TCV Loss) which is around –0.17%. This is perhaps to be expected as crude oil still contains light hydrocarbons which can be 'lost', particularly during load and discharge. This is not the case for products, except for liquefied gasses which are carried under 'sealed' conditions; pressurised and/or refrigerated.

US barges vs ships

With increased amounts of data over recent years it is now clear that mean losses for US inland barges are significantly lower than those for ships. Also, the standard deviation (scatter) for barge loss is higher than that for ships. See **Table 2** for the last four years' figures.

Individual product losses

Having noted the systematic difference between barge and ship losses it is necessary to separate barge and ship data when considering losses for individual product groups. Unfortunately this reduces the number of individual cargoes available in each category, but useful comparisons can be made for the main cargo types for the final years of the study. These are shown in **Table 3** and **Figures 2, 3 and 4**.

In line with the overall data, US inland barges show a lower loss than ships across all main product types. Also, it is apparent from the graphs of the more consistent ship data that gasoline suffers slightly higher losses than distillates or heavy oil. This is statistically significant (95% level) for gasoline versus distillate in 2013 and 2014, and for gasoline versus heavy oil in 2012 and 2014. It appears that barge data also shows a systematic difference between distillate and gasoline losses, but this is not significant at the 95% level.

Other product types show more scattered results, even when considering total annual volumes rather than the mean losses of individual parcels. This is partly due to the relatively small number of cargoes and also, for chemicals and components, because the product type covers a more diverse range of products.

Conclusion

The analysis work to date has shown that overall product losses

	2011			2012			2013			2014		
	Mean SV loss%	Standard deviation %	No	Mean SV loss%	Standard deviation %	No	Mean SV loss%	Standard deviation %	No	Mean SV loss%	Standard deviation %	No
Overall	–0.03	0.48	8,112	–0.04	0.39	5,386	–0.04	0.45	8,686	–0.06	0.44	7,154
Barges	0.03	0.59	3,800	0.01	0.47	2,405	0.00	0.54	3,613	–0.03	0.51	2,678
Ships	–0.07	0.34	4,312	–0.08	0.31	2,981	–0.08	0.37	5,073	–0.08	0.39	4,476

Table 2: Load and discharge data, 2013 and 2014
Source: Energy Institute

	2011 Standard volume loss %			2012 Standard volume loss %			2013 Standard volume loss %			2014 Standard volume loss %		
Barge	**Mean**	**St. Dev**	**Count**	**Mean**	**St. Dev**	**Count**	**Mean**	**St. Dev**	**Count**	**Mean**	**St. Dev**	**Count**
Distillate	–0.04	0.34	442	0.02	0.36	336	–0.01	0.35	697	–0.01	0.38	500
Gasoline	–0.05	0.50	818	0.03	0.50	552	–0.05	0.48	876	–0.04	0.29	547
Heavy oil	0.08	0.65	1,316	0.01	0.54	855	0.04	0.62	1,111	–0.03	0.64	713
Ship	**Mean**	**St. Dev**	**Count**	**Mean**	**St. Dev**	**Count**	**Mean**	**St. Dev**	**Count**	**Mean**	**St. Dev**	**Count**
Distillate	–0.06	0.28	1,836	–0.07	0.31	1,251	–0.06	0.30	1,966	–0.07	0.36	1,389
Gasoline	–0.09	0.38	905	–0.11	0.36	588	–0.09	0.37	1,191	–0.11	0.42	1,268
Heavy oil	–0.07	0.42	919	–0.06	0.30	516	–0.10	0.44	1,079	–0.05	0.32	892

Table 3: Individual product losses, 2011–2014 *Source: Energy Institute*

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are less than those for crude oil and also that the US barges show lower losses than ships. Reasons for this are unclear at present. Any meaningful analysis must, therefore, separate barge data from that for ships.

Grouping the large number of individual products into product groups has allowed meaningful benchmark information to be produced for the main product types – gasoline, distillate and heavy oil.

The Committee is currently considering collecting 2018 data for analysis and is also looking to collect and pool information regarding product quality issues. New members are always welcome to join and expand the database and any companies with an interest and data to submit should contact Kerry Sinclair at the Energy Institute on t:+44 (0)207 467 7127.