Cost-effectiveness of marine vapour emissions control

CONCAWE updates its figures in the light of European and US experience.

BACKGROUND

The European Directive (94/63/EC) on the 'control of volatile organic compound (VOC) emissions resulting from the storage of petrol and its distribution from terminals to service stations', the so-called Stage-1 Directive, does not currently address controls of vapour emissions from ships. Stipulation of such controls was delayed, pending discussions within the International Maritime Organization (IMO) concerning international standardization and safety during the loading of ships. Article 9 of the Directive invites the Commission to come forward with proposals, where appropriate, for amendment of the Directive, including in particular the extension of the scope to include vapour control and recovery systems for loading installations and ships. The proposals for amendments are to coincide with the Commission's first report on the implementation of the Directive.

CONCAWE Report 92/52 reviewed costs and cost-effectiveness of installing vapour emission controls (VECs) for loading of gasoline into ships and barges. In that study the data were primarily based on project studies as only 2 barge loading VECs had been installed. CONCAWE has undertaken an update of the cost data taking account of both the experience gained with installed systems in the USA and Europe and new project studies. The study results are reported here.

SHORE-SIDE COSTS

Figure 1 shows the reported capital expenditure (Capex) for vapour emission control systems plotted against design capacity for 20 facilities.

The plot shows that costs vary widely for systems with similar design capacities—the costs of vapour emission control systems are very dependent on site-specific issues including:

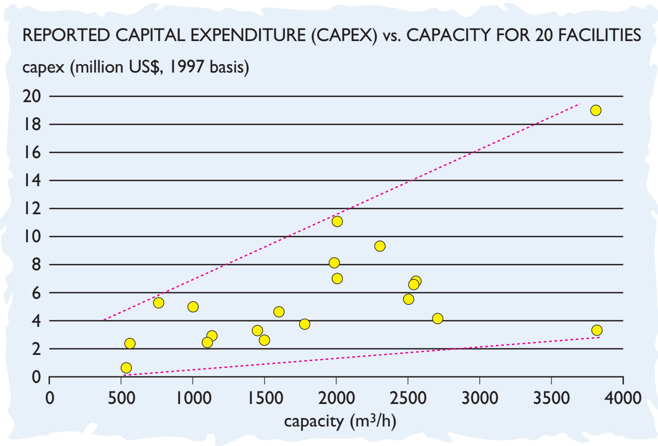

Figure 1
The costs to install vapour emission control systems vary widely, and are dependent on a variety of site-specific issues.

- the number of loading berths connected to the system;
- the distances between the berths and the shore line;
- the length of vapour line to the location of the emissions control facility;
- the need for blowers to assist vapour flows over long distances;
- the number and level of redundancy of measurement, alarm and safety systems; and
- whether additional gas is added to the vapour to reduce the risk of ignition propagation along the vapour collection lines.

SHIP-BOARD COSTS

In order for vapours to be collected and passed to a shore-side emission control system, sea-going vessels will need to have vapour collection pipework on board. The costs to fit this depends on tankers being equipped with closed loading and/or inert gas systems. The latter, for example, could be used as the vapour collection system during loading.

As identified in the aforementioned CONCAWE Report, the costs of modifying sea-going vessels vary considerably. Reported costs from both actual retrofits and project estimates compare well with the costs identified previously adjusted for inflation. These are:

- for a vessel without inert gas: US$275 000
- for a vessel with inert gas: US$130 000

From an analysis of the tanker data in the Lloyds Register, it is estimated that gasoline is transported in about 600 sea-going vessels of less than 40 000 tonnes dead weight in European waters. Of these, about 100 are assumed to have inert gas systems already fitted. Thus the total cost to retrofit these vessels will be of the order of US$151 million.

COST-EFFECTIVENESS

Cost-effectiveness is defined as the annual cost in US dollars required to achieve the annual reduction in emissions in tonnes. The overall cost-effectiveness of marine loading vapour emission controls is the sum of the cost-effectiveness of the investments for both the shore-side and on-board vessel equipment.

SHORE-SIDE INVESTMENT

The cost-effectiveness of a shore-side facility can be calculated from the emission reduction achievable, the annualized cost of the capital investment, and operating and maintenance costs. An annual capital charge (ACC) of 15 per cent has been used[1]. The operating and maintenance costs have been taken to be 5 per cent and 2 per cent of capital respectively. No allowance has been made for either tax incentives or for the untaxed benefit associated with the recovered vapours, because the majority of gasoline loaded into ships is duty free and the untaxed value of the recovered vapours is low.

[1] *Rather than the conventional annual capital charge (ACC) of 25% used by CONCAWE, an ACC of 15% has been used. This allows a comparison with Auto/Oil 1 costs since it is based on the AOP I net present value for a 7% discount rate. A standard Discounted Cash Flow calculation over a 10-year plant lifetime is linked to a construction phasing of 2 years, 15% in the first year and 85% in the second year.*

The uncontrolled emissions during loading have been calculated using an emission factor of 0.034 per cent by volume (derived from API Publication 2514A, 1987).

Figure 2 plots the cost of abatement (US$ per tonne) for the 20 reported shore-side facilities.

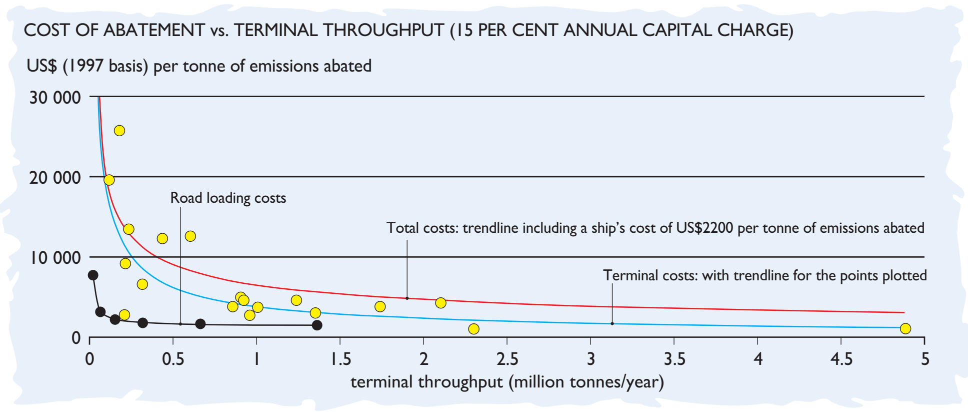

Figure 2
Cost of abatement vs. terminal throughput for 20 reported shoreside facilities (15 per cent ACC)

ON-BOARD VESSEL INVESTMENT

The overall cost-effectiveness of the total vessel on-board investments can be calculated from the total emission reduction achievable if all ships and terminals were equipped for vapour emission controls and the total vessel retrofit costs.

An annual capital charge of 15 per cent has been used. It has been assumed that there will be no additional on-board operating and maintenance costs.

Within Europe about 38 Mt/year gasoline is loaded onto sea-going vessels. Using the emission factor of 0.034 per cent vol. and a total ship retrofit cost of US$151 million gives a cost-effectiveness of the vessel on-board equipment of 2200 US$/tonne emissions abated.

TOTAL INVESTMENT

The cost-effectiveness of the total investment has been determined by summing the cost-effectiveness figure for the vessel on-board costs with that for the on-shore facility costs. Figure 2 shows the trend-line of the total costs of abatement plotted against terminal throughput.

For comparison, the average cost-effectiveness for Stage I vapour recovery on road loading and deliveries, including the cost of modifying the road tanker fleet, was determined in CONCAWE Report 90/52 to range from 1200 to 8200 US$/tonne with an average of 2400 US$/tonne (adjusted for inflation). The average cost data are included in Figure 2.

CONCLUSIONS

The costs of installing a vapour emissions control system for loading gasoline onto sea-going vessels vary significantly at sites with similar product loading rates because of site specific issues. Reported costs for sites with loading rates typical of a large refinery, range from 4 to 20 million US$.

It is estimated that about 600 sea-going vessels of less than 40 000 tonnes dead weight will require vapour emission collection systems installed to permit trading to terminals fitted with vapour emission control systems. The total retrofit cost is estimated at US$151 million.

The overall cost-effectiveness of vapour emission controls for the largest facility would be of the order of 3200 US$/tonne emissions abated and could exceed 25 000 US$/tonne as terminal throughput decreases. This compares with a range from 1200 to 8200 US$/tonne for road loading.