THE REDUCTION OF GHG EMISSIONS FROM SHIPPING - A KEY CHALLENGE FOR THE INDUSTRY

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The paper outlines current thinking on policy, technological and operational measures to control GHG emissions from ships. These initiatives are likely to go some way towards stabilising CO_2 emissions from the industry, however, significant challenges remain if the industry is to deliver deep cuts in CO_2 emissions. Further developments will be required including the use of alternative propulsion technologies, different fuels and innovative measures to enhance energy efficiency.

KEY WORDS

Greenhouse gas; CO_2; shipping; IMO; energy efficiency index; regulatory control

INTRODUCTION

Reducing climate change resulting from anthropogenic greenhouse gas (GHG) emissions is a high priority internationally. The 4th Intergovernmental Panel on Climate Change (IPCC) report estimates that a CO_2 concentration below 450 ppm is necessary to limit the average global temperature increase to 2°C (IPCC, 2007). To achieve this, it is estimated that a 50-85% reduction in GHG emissions as compared to today's levels needs to have been achieved by 2050.

Shipping is key to the world economy and the future population and economic growth projected by the IPCC. Nevertheless shipping is expected to bear its share of the burden and contribute to overall GHG emission reduction. This concept may not be palatable to many but it is something the industry needs to be aware of and prepare for. The shipping industry, like all industries, faces the challenge of what to do and how to ensure any solution is effective whilst allowing maritime trade to flourish.

Looking at the 'basket of six' GHG covered by the Kyoto Protocol, carbon dioxide (CO_2) is the most significant GHG emission from shipping. However, leakages of various refrigerant gases and methane, both of which have appreciable global warming potential, will also be of significance.

Recent estimates indicate that shipping emitted around 1,120 million tonnes CO_2 in 2007, equivalent to around 4% global anthropogenic CO_2 emissions. These emissions are projected to rise to 1,475 million tones by 2020 (IMO, 2008a).

Stabilisation and subsequent reduction of CO_2 emissions whilst allowing maritime trade to thrive, is currently one of the greatest challenges currently facing the industry.

Approaches to the Control of CO_2 Emissions

There are two distinct approaches to controlling CO_2 emissions:

(i) The technical & operational measures to reduce emissions from individual ships

(ii) Regulatory measures to control total emissions from the industry.

TECHNICAL AND OPERATIONAL MEASURES TO REDUCE CO_2 EMISSIONS

Carbon dioxide is formed from the oxidation of carbon in hydrocarbon fuels. Therefore to reduce CO_2 emissions, either less fuel must be burnt or the carbon content of the fuel burnt must be reduced or eliminated. These approaches essentially translate to either the implementation of energy efficiency measures, both technical and operational, or the use of alternative low or zero carbon fuels – or preferably a combination of both.

Energy Efficiency Measures

The potential for technical measures to improve energy efficiency and therefore reduce fuel consumption and CO_2 emissions have been estimated at up to 30% in new ships and up to 20% in existing ships or ships constructed using present technology (IMO 2008b).

Technologies which are available to improve fuel efficiency in the short to medium term include:

- Improved engine energy efficiency, hull form optimisation, propeller design, high efficiency rudders, stern flaps, improved steering configurations
- New antifouling materials to reduce hull friction
- Waste heat recovery from engines
- Zero or minimum ballast configurations by design
- Improved efficiency of minor energy consumers such as lighting and air conditioning

- Use of lighter materials.

The potential savings from operational improvements are also significant. Operational measures to reduce the fuel consumption and CO_2 emissions include:

- Fleet optimisation - better planning, large-scale improvements in vessel utilisation
- Enhanced weather routing, optimised trim and ballasting, hull and propeller cleaning, better main and auxiliary engine maintenance and tuning, slower steaming
- Optimisation of logistic chains - fewer ballast legs, larger cargo batches, optimised arrival times
- Reduction in port congestion and other limitations on quick port turn-around.

The potential for up to a 30% saving in fuel has been associated with the implementation of operational measures in the short to medium term (IMO, 2008b). However, for these reductions to materialise, a concerted effort is needed from all parties of the ship transportation value chain, including yards, technology suppliers, owners, operators, cargo owners and charterers. New ways of collaborating in the operational and commercial phase have to be developed with clear incentives for all parties to improve operations to achieve overall emission reduction.

The projected timescale for the full realisation of both technical and operational measures is shown in Table 1.

Table 1. Timescale for realisation of energy efficiency measures

	% reduction in CO_2 emissions/tonne-mile with respect to 2008 baseline				
	2010	2015	2020	2030	2050
Operational measures*	10	25	30	30	30
Technical measures# (excluding fuels)	-	5	10	20	30

Source: abstracted from IMO 2008b
* new & existing ships # newbuildings

Alternative fuels

At present, there is no viable large scale low carbon or carbon free fuels which could significantly reduce or eliminate CO_2 emissions. Electrification is not viable for shipping.

Existing propulsion systems with carbon based fuels are likely to be the only realistic large volume fuel for shipping over the next 20 years and probably longer. Natural gas is currently the front runner in terms of a lower carbon fuel for the short-medium term either as liquefied natural gas (LNG) or compressed natural gas (CNG). With currently available propulsion machinery, use of natural gas could achieve around 20% reduction in CO_2 emissions compared to residual or diesel oil fuels.

In the longer term, hydrogen for use in conjunction with fuel cells could emerge as a viable solution. Sustainable biofuel may also have a role to play if sufficient fuel could be made available to shipping. Alternatively, radically new fuels and/or technologies may emerge to play an important role.

Wind and solar energy could also contribute to reduced CO_2 emissions, but as a supplementary source of energy rather a total provider. Various sail arrangements and kites have been tested on merchant vessels and their usage may increase. Nuclear propulsion has been successfully used in naval vessels. However, nuclear propulsion requires a special infrastructure and emergency response capabilities. Added to the general societal anxiety related to nuclear power, it appears unlikely that nuclear propulsion will play a significant role in merchant ships in the foreseeable future.

Although shipping is able to reduce CO_2 emissions considerably on a per tonne-mile basis, existing measures and more extensive use of lower carbon content fuel are unlikely to ensure emission reduction in absolute terms compared to present levels. This is because such reductions are likely to be offset by increased emissions associated with growth in the world fleet. In order to realise absolute reductions in CO_2, implementation of currently available measures must be accompanied by the development of new technologies and solutions.

It is difficult to forsee what radically new fuels and technologies could emerge, but development of low or zero carbon fuels and power systems are likely to be an important area. The timing of the availability of such fuels and power systems is likely to be the main factor determining the rapidity and extent to which shipping is able to achieve a wholescale reduction in its CO_2 emissions.

REGULATORY CONTROL MEASURES

The International Maritime Organization (IMO) has been considering and developing measures to control greenhouse gas (primarily CO_2) emissions from ships for the past decade. The on-going development activities have tended to focus on technical and operational measures and include:

- Development of guidance on Best Practice for Fuel-Efficient Operation of Ships. This guidance will contain information on many of the technical and operational measures discussed earlier in the paper and is due to be finalised by MEPC 59 in July 2009. This best practice document is complemented by a model Ship Energy Efficiency Management Plan for use by existing ships being developed by the International Chamber of Shipping.

- Interim guidelines for calculating an individual ship's Operational Energy Efficiency Index in terms of CO_2

emitted per unit of freight carried per unit distance have been available for some time in the IMO Circular MEPC/Circ.471 'Interim Guidelines for voluntary CO_2 emission indexing for use in trials'. The calculation of Operational Energy Efficiency Indices is not likely to become a mandatory requirement. The Index is proposed as a management tool which could be used for tracking the CO_2 emissions per unit of cargo carried per unit distance for an individual ship.

- A Design Energy Efficiency Index for application to new ships is also under development. It is likely that assignment of the Design Index becomes a mandatory requirement. The Design Energy Efficiency Index is a separate concept from the operational index and it is likely to have a different numerical value to the Operational Index, although the units will be similar (CO_2 emitted per unit of freight carried per unit distance).

  Mandatory performance standards may also be linked to the Design Index. Due to significant differences between ship types in terms of the level of emissions generated and cargoes carried, a range of performance standards would probably need to be developed for different categories of ships.

Whilst these initiatives may assist owners and operators wanting to realise energy efficiency savings in their fleet and provide a basic energy efficiency indication or standard for new ships, these mainly voluntary measures are unlikely to be able to reduce the overall contribution of shipping to anthropogenic CO_2 emissions. Regulatory pressure and a cap on the overall level of emissions allowable is likely to be required to drive the innovation necessary to stabilise and subsequently substantially reduce CO_2 emissions from the world fleet.

The IMO is currently examining the options for regulatory control. These include:

A marine fuel levy or tax. This has the advantage of being easy to implement, but taxes are traditionally not very effective in reducing CO_2 emissions and without introducing a cap on marine fuel sales, there is no mechanism for reducing overall CO_2 emissions. Additionally who would impose the charge and who would benefit? Would a tax on bunker fuel be levied by the country where the fuel originates or by the country where the fuel is sold? Would the money raised be recycled back into climate change improvement?

The other main option is currently an emissions trading scheme where ship operators are required to obtain allowances for GHG emissions which would be capped at a finite emission level, although there would be potential for buying allowances from other sectors. Such a scheme would have the benefit of consistency with measures in other sectors and could be combined with existing credit systems such as Clean Development Mechanism or Joint Implementation projects. It would also enable a cap to be set on CO_2 emissions from ships and could lead to significant GHG reductions, but consideration would have to be given as to how to deal with new ships within the concept of a finite amount of credits for CO_2 emissions. There is also concern regarding the level of bureaucracy, cost of trading and a potential lack of availability of allowances.

A legally-binding mechanism to improve fuel efficiency across the maritime fleet has also been proposed. New ships would be required to meet a specific efficiency standard based on the new ship design index currently under development. This standard could then be further improved in second and third tier standards in later years. For existing ships, a ship-specific energy efficiency management plan is proposed potentially coupled with mandatory efficiency improvements at a later date.

The IMO is striving to reach agreement on regulatory control measures by July 2009. Should agreement not be achieved by this time, it is almost certain that national and regional schemes for controlling CO_2 from shipping will begin to emerge. This is unlikely to be to the benefit of the shipping industry or the environment.

CONCLUSIONS

Technical and operational measures are likely to enable shipping to reduce CO_2 emissions per tonne-mile substantially for ships being delivered in 2030 and beyond compared to current levels.

For the reductions discussed to materialise, a concerted effort is needed from all parties of the ship transportation value chain, including yards, technology suppliers, owners, operators, cargo owners and charterers. New ways of collaborating in the operational and commercial phase have to be developed with clear incentives for all parties to improve operations to achieve overall emission reduction.

With the anticipated growth in seaborne trade, reductions in per tonne-mile emissions may be outweighed by emissions associated with increased shipping activity. The logical conclusion therefore is that regulatory pressure is likely to be required to drive the innovation necessary to stimulate the development of low or zero carbon fuels and power systems in order to decouple increased CO_2 emissions from increased shipping activity.

Shipping is a global industry and regulations to control GHG emissions need to be global if they are to be effective. The IMO is striving to obtain agreement on mechanisms to control CO_2 emissions from shipping and should be supported in this undertaking. Failure to reach agreement within the IMO is almost certain to lead to the introduction of national and regional measures for controlling CO_2 emissions from shipping.

This is unlikely to be to the benefit of the shipping industry or the environment.

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