Optimizing rudders to minimize fuel consumption

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More than half of all transportation of goods is done by ship. The reason being this way of transportation is much more cost effective and less polluting than other means of long distance transportation. Even so great focus should be taken on minimizing the effect this form of shipping has on the environment. As a minimal reduction in emissions will result in a great relative reduction. Many measures of minimizing fuel consumption have already been taken, but many have yet to be explored.

The goal of this project has been to minimize the force affecting rudders by optimizing rudder specifications. More specifically by altering three main variables of the rudder, as the general profile of rudders have been greatly optimized by the flight industry. This was to be done so the ships maneuverability still meets the requirements presented by the UN organization IMO.

The project has been carried out in collaboration with FORCE Technology.

The manoeuvring and calculation of the force acting on the rudder has been done by simulations using the DENMark1 model, a simulation program developed by FORCE Technology. For the means of optimization the force has been calculated at maximum velocity only. An optimization method has been utilized to find the specifications of the rudder resulting in minimal force. Further analysis of the results have then been made to conclude in which extend these specifications may be altered, still giving a near minimal force acting on the rudder.

The tests have been done on two different kinds of rudders, one conventional type and one flap rudder. From their original specifications the force acting on the rudders could be minimized by approximately 40% for the conventional type rudder and approximately 55% for the flap rudder. The further analysis of the rudders with optimal specifications has shown that two out of three specifications may be altered together within certain bounds without significantly increasing the force acting on the rudder.

In conclusion there is with certainty room for optimization, but further research should be done in a greater variety of sailing conditions to obtain a larger perspective on exactly how much the force acting on the rudder can be minimized. The final program is though tuned to be able to find the optimal rudder specifications given other sailing conditions.

Pneumatic Regenerative Braking System for Vehicle

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ABSTRACT

Throughout the later years there has been an increasing focus on the development of technologies which can reduce the need for fossil fuel without limiting the yielding capacity. Cars have a great deal of the focus about the use of oil. With 10% of the world’s populations owning a car and expectation of the world car park tripled in 2050 it is crucial to limit the use of fuel for vehicles. The efficiency improvement of vehicles is how to limit the losing of energy (e.g. braking, idle and external energy demanding utilisation) and especially the loss of energy while braking and idling is staked to 40% of the total energy use. Several of these hybrid techniques are continuously under development and they “competes” against each other with the purpose of limiting the need of fossil fuel and to run a vehicle with best overall efficiency. Equal for all hybrid technologies are that they avoid the loss of energy.

Pneumatic hybrid vehicle (PHV) is a technique that could work without adding advanced and expensive materials or components – thereby it would be simpler and cheaper. The option to use air as thrust giving fuel has no pollution and letting a compressor inverting brake energy into compressed air stored in air tank - it would be free to run. With automakers downsizing their engines to reduce engine friction, the kinetic regenerated compressed air has better circumstances as thrust giving fuel. To store compressed air and use it in e.g. four-stroked ICE, it won’t have any combustion gasses while running on compressed air. Therefore, to achieve higher efficiency the engine would have to run as two-stroke. To control this, the valve control is a complex matter [4] due to the shift from combustion and pneumatic mode. Research by L. Guzzella et al.² has shown fuel improvements up to 35% on gasoline engine approximately the same efficiency as electric hybrid but by far less cost and less complex technique. By implementing the pneumatic technique in the ICE the interaction would be smooth and less complex and costly as with flywheel, electric and fuel cell - thereby improves the driveability for the hybrid vehicle.

Downsizing improves fuel consumption 12-17%³ and lowers emissions by basically fitting a smaller engine with a turbocharger. A side effect from turbocharged downsized ICE’s is turbo lag at lower revs. With storage of compressed air, turbo lag can be minimized thus, downsizing and pneumatic hybrid shows promising.

The result of pneumatic hybrid is: No external implementation except pressure tank, made by easy recyclable materials as: cast iron and aluminium, low costs.

¹ Development of a 4-Cylinder Gasoline Engine with a Variable Flow Turbo-charger SAE TECHNICAL PAPER SERIES 2007-01-0263 Nobuhiro Ito, Tohru Ohta, Ryuji Kono, Satoshi Arikawa and Takaki Matsumoto