

A MAGIC CARPET RIDE FOR CRUISE SHIPS:

Air Lubrication Reduces Fuel Consumption, Stack Emissions

Beginning with *Quantum of the Seas*, which joined Royal Caribbean International's fleet in November 2014, all new Royal Caribbean ships sail the seas on a curtain of bubbles.

The air-bubble lubrication system introduced on *Quantum* is one of the means by which Royal Caribbean steadily improves fuel efficiency on each new ship launched. *Quantum*, for example, is 20 percent more fuel efficient per available passenger day than her predecessors. And *Harmony of the Seas*, another Oasis class vessel, is more than 20 percent more fuel efficient than sister ships *Oasis* and *Allure*, thanks to a number of design improvements, including addition of the air-lubrication technology.



The system works by coating a ship's bottom, from stem to stern, with a curtain of uniformly sized and evenly distributed micro air bubbles. The bubbles reduce resistance between the ship's hull and seawater. Bubble size is important. A large quantity of tiny bubbles yields more drag-reducing surface area than a smaller quantity of large bubbles.

The lessened drag means less fuel consumed at cruising speed. Net of the fuel required to power the system, the air-lubrication system is estimated to reduce fuel consumption by up to 8 percent. Less fuel consumed results not only in significant cost savings – fuel is second only to payroll as the company's largest cost – but also means lower stack emissions, an environmental benefit.

Royal has also discovered that the air-lubrication system reduces propeller noise, adding a guest benefit to those the technology already delivers for fuel efficiency and environmental stewardship.



IMPROVE
FUEL EFFICIENCY



REDUCE FUEL CONSUMPTION
BY 8 PERCENT



LESS FUEL ALSO
MEANS LOWER
STACK EMISSIONS