Marine water cleaning system

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Introduction of the global sulphur cap

The global marine sulphur emissions were decreased from 3.5% to 0.5% from January 1st 2020 by the International Maritime Organization (Fig. 1). To comply with the new legislation, ship owners can switch to a compliant fuel or install an exhaust gas cleaning system, such as a scrubber, to continue operating with heavy fuel oil (HFO). The scrubber cleans the flue gas for sulphur, soot and particulate matter (PM) by 'washing' the flue gas with water. The pollutants are transferred from the flue gas to the water. The polluted water needs to be cleaned before the washwater can be discharged back into the ocean. It is expected that more strict legislation is to be introduced in a near future and an efficient water cleaning system is therefore needed.

Next generation water cleaning system

The continued use of scrubbers relies on an efficient water cleaning system, when more strict legislation is to be introduced. Alfa Laval has a patented water cleaning unit utilising a high-speed centrifugal separator, separating the particulate matter from the water. This project will simulate the physics of the water cleaning system, including agglomeration of small particulate matter using chemical coagulant and flocculant and separation in a high-speed centrifugal separator.

Allowable SO_2 Emissions

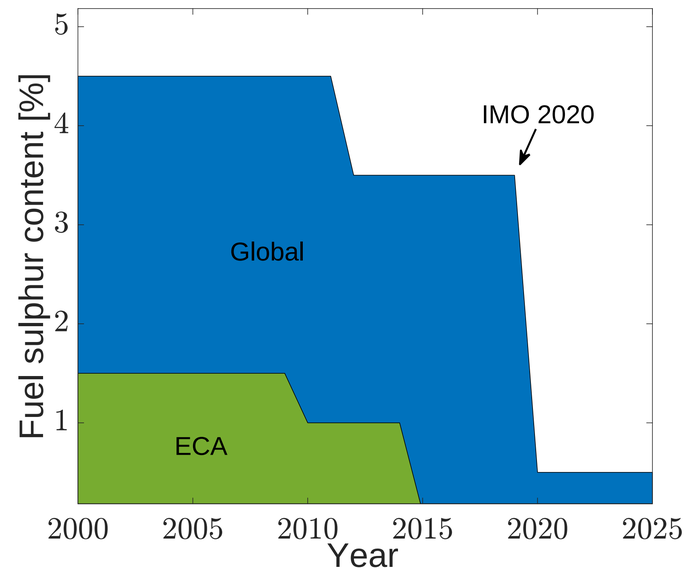

Fig. 1: Global sulphur cap January 2020

About Alfa Laval

Alfa Laval is an international company specialising in separation, heat transfer and fluid handling. The department in Aalborg specialises in Marine boilers and exhaust gas systems. Alfa Laval's unique marine test centre is located in Aalborg, where waste heat recovery systems and exhaust gas cleaning systems are installed. The exhaust gas is delivered by a 2 MW 4-stroke marine engine.

Aalborg University - Energy Technology

The department of energy technology at Aalborg University focuses on energy systems and especially the technical development of systems and components. This project is part of the section for thermo-fluids which specialises in multi-phase flow, reacting flow and model development and validation. One of the key issues for the section is to develop and validate models for fluid-particle flows using Computational Fluid Dynamics (CFD).

Agglomeration of particulate matter and efficient separation

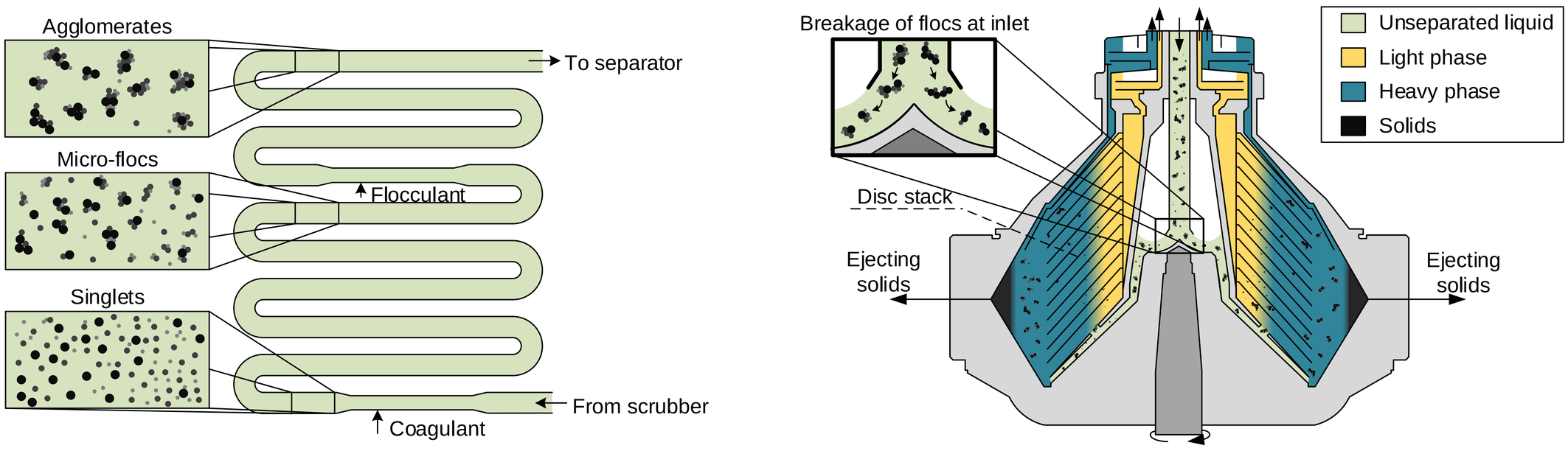

Fig. 2: The individual particles are destabilised using chemical coagulant and agglomerated in the static flocculator (left). The agglomerated particle flocs are effectively separated using the high-speed separator (right).

Commercial potential

Alfa Laval is expecting more strict legislation concerning discharge of scrubber washwater and the continued use of scrubber therefore heavily rely on efficient water cleaning. Currently the pay-back time of a scrubber is less than a year and in the nearest future, each scrubber sold needs a water cleaning system to continue operating with HFO. Currently, the retrofit market potential is 3.000 vessels resulting in a potential of €600 million. The International Energy Agency expects the new-built market to be 300 vessels/year, resulting in a potential of €60 million/year.

Research goals

The particulate matter needs to be agglomerated to be effectively separated from the liquid phase, since larger particles settle faster than smaller particles. Developing a mathematical model expressing the agglomeration of particulate matter is of great interest, since the particles needs to be chemically destabilised before agglomeration. Developing and validating a multi-phase coupled CFD-DEM model allows for predicting the agglomeration and break-up of particles, thereby optimising the feed to the high-speed separator, to achieve a high separation efficiency.

Description of water cleaning system