

Development of an Integrated Mechanism for the Elimination of Sulfur and Nitrogen Oxides Emitted by Ship Engines

The NEMO research project team started work on January of 2009 on the project, which is partially funded by the Cyprus Research Promotion Foundation, within the framework for the promotion of sustainable economic development and the improvement of the standards of living in Cyprus through significant innovations.

The project's main objective is to develop and test an **integrated technology for the destruction of the gaseous pollutants sulfur (SO_2) and nitrogen (NO_x) oxides emitted by ships** by using the H_2 Lean De- NO_x technology, **oxidation of solid particulate matter (PM)** by using an oxidation catalyst and the **absorption of SO_2** by using the Sea Water Absorption (SWA) technology on a ship in operation.

To achieve the above objective, the following entities were involved as project partners:

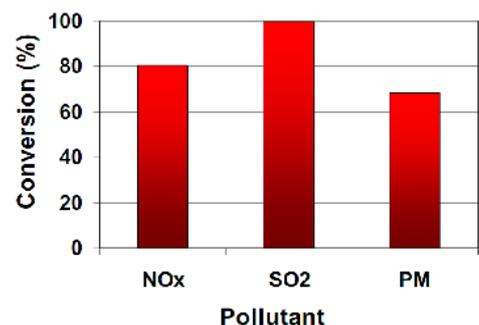
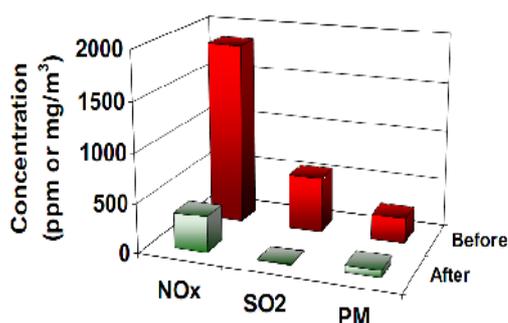
- Cyprus University of Technology – CUT (project leader);
- University of Cyprus (UCY);
- eMedi8 Digital Solutions Ltd.;
- Proplan Industrial Engineering Consultants Ltd.;
- S.M.E.C. Marine & Engineering Co. Ltd.

For the purpose of testing the effectiveness of this technology, a pilot plant was designed and built consisting of three independent parts connected serially between them in the following order:

- Exhaust scrubber for the removal of SO_x ;
- Oxidation catalyst for the removal of PM; and
- Catalytic system for the removal of NO_x .

The pilot unit described above, was installed in a suitable location on M.V. Sapphire, and it was monitored / controlled via an analyzer and computer systems, during the ship's voyages in the Mediterranean Sea.

The measurement results exceeded the project team expectations, as it was observed that the proposed integrated technology has achieved a massive reduction of the three major pollutants contained in the exhaust gases of the ship, namely NO_x , SO_2 and PM. More specifically, a conversion of 80% for oxides of nitrogen (NO_x), removal of over 99% for sulfur dioxide (SO_2) and removal of 70% of solid particulate matter (PM) was achieved, as seen in the following two graphs of the NEMO project's pilot unit test results.

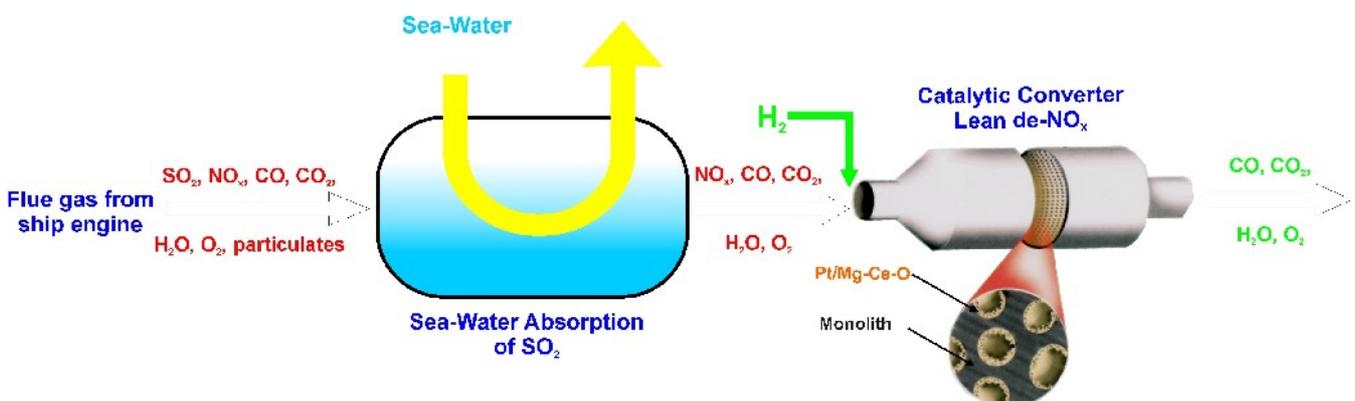


The gathered test results, confirm that:

1. The *Sea Water Absorption (SWA)* method can lead to a very high level of removal of sulfur dioxide (SO_2). Based on the test results of this project, an almost complete (above 99%) removal of SO_2 has been achieved, in compliance with current and future IMO control limits for SO_x emissions.
2. A significant level of removal of solid particulate matter (PM) can be achieved, using an oxidizing catalytic converter. The first tests carried out under this project have recorded removal levels of 70% of PM. It should be noted that this efficiency percentage may be increased further by using a different oxidizing catalyst or by changing operating parameters. Such a study is not within the NEMO project's objectives.
3. The Selective Catalytic Reduction (SCR) of NO with the use of hydrogen (H_2) and a suitable catalyst can result in the removal of significant levels of NO. Specifically, under this project with the use of latest technology, the test results present a removal rate of over 80% of NO, compliant with IMO Tier III controls for NO_x emissions.
4. The results obtained through the testing of the proposed integrated technology, present very encouraging conclusions and indicate that this technology could lead to the complete de-pollution of a ship's exhaust gases.

It is widely accepted that shipping, although it is an environmentally friendly transport mode, it is still a major polluter of the earth's atmosphere. The NEMO research project, is able to offer the technology that will provide the solution to the problem of the air pollutants, especially sulfur oxides (SO_x) and nitrogen (NO_x), emitted by ships. The next goal of the NEMO research team is to create a full-scale functional unit, which can be installed in all types of ships, aiming for large-scale benefits for both the environment and human health, particularly for people living in port cities and coastal communities.

A second pilot unit testing is presently under way, integrating the project NEMO technology with a new and improved catalyst offering a system that would require no hydrogen to be carried onboard.



About the NEMO Research Project Partners

The NEMO research project team members are:

- The **Laboratory of “Wastes Treatment and Disposal” of the Cyprus University of Technology (CUT)**, coordinated the performance of the activities required for the successful implementation of the NEMO project. The research laboratory of CUT is fully equipped with advanced scientific instrumentation which was used for the implementation of the experimental work within NEMO project (at a laboratory scale). The research team of CUT has a large and proven experience in the management and implementation of large research projects (European, National and Private Funding), in the fields of Air Pollution and De-pollution Technologies, Wastes Management and the development of novel Computer Assisted Processes.
- The **Laboratory of “Heterogeneous Catalysis” of the University of Cyprus (UCY)** possesses a large experience in the fields of heterogeneous catalysis and materials technology, at an international level.
- **eMedi8 digital solutions Ltd (eMedi8)** is a research-oriented SME based in Cyprus. The company is active in the field of Information Technology (IT) services and in particular in the development, provision and support of web-based services and advanced, novel informational systems, such as the novel informational system for the on-board and remote monitoring and recording of pollutant emissions from ships, designed and developed within the NEMO project.
- **Proplan Industrial Engineering Consultants Ltd (Proplan)** is a research-oriented SME based in Cyprus. Proplan is active in the field of industrial engineering and specializes in the provision of consulting services in technical, financial and managerial issues of the field, as well as in the design and installation of novel industrial technologies. The work of Proplan within the NEMO project mainly focused on the realization of the design and implementation of the pilot unit.
- **SMEC Marine & Engineering Co. Ltd (SMEC)** specializes in the provision of consulting services in the field of marine technologies (naval architecture and marine engineering). SMEC's activities focus in the implementation of international standard protocols, laws and directives, inspections and maintenance of ships, designs and technical studies and further development or optimization of security and quality management systems. SMEC's participation in the NEMO project was a prerequisite for the study of techno-economic and feasibility parameters and also for the successful implementation of the pilot unit installation.

FOR MORE INFORMATION PLEASE CONTACT THE NEMO PROJECT TEAM

P.O. Box 50329, 3603 Lemesos, Cyprus
Tel.: +357 25 002 515, +357 99 696 512 - Fax: +357 25 002 656 - E-mail: projectnemo@emedi8.com



eMedi8 **PROPLAN Ltd**
digital solutions Industrial Engineering Consultants

