

From: Toms Torims
Sent: 07 July 2017 17:35
To: Maurizio Vretenar

From my visit to INCT in Warsaw, I would like to retort the following:

1. I was very warmly and professionally received by Prof. Chmielewski and relevant staff of INCT. Over two days I was able to learn about work of the institute and in particular about environmental applications of the accelerators. \
2. After discussing scientific and technological aspects of the accelerator application for the marine diesel engine exhaust fumes treatment and visiting relevant labs, **I conclude that there is great potential for the application of this technology in (and by) the maritime industry. I recommend that CERN pays particular attention to this application due to its large impact to the environment and maritime business. If technology is proven, it could be a game changer with enormous economic and societal impact.** I suggest that we see how CERN could engage in the development of this technology and participate in the activities led by INCT.
3. **Advantages of the technology:**
 1. - is it is only one which deals with SO₂ and NO_x simultaneously;
- has high efficiency;
- for NO_x treatment, which is more challenging than SO₂, there is hybrid technology encompassed
- irradiation by electron beam and subsequent treatment by proven seawater scrubber system. Results are promising.
- size and complexity of the systems and control is compatible with the medium-large size vessel engine room environment. Funnel could be considered as an appropriate space for the installation of the system.
- this system could be cheaper and more efficient than other currently commercially available
- energy needed for the accelerator in question is (DC) of magnitude of 300-max500 KeV - these components are accessible on the market.
- INCT is holding patent application for this technology, as from Apr 2017.

Despite of obvious advantages, there is number of **questions and challenges to be answered**. I am looking here only from the side of maritime engineering and leave accelerator related part for the experts.

1. Q- what will be losses of energy?
2. Q- despite low energy on board of the ship particular attention will be given to the safety, so shelter vs local shielding should be evaluated.
3. Q- what will be energy consumption and how it is compatible with the onboard el energy supply and management systems. power is not an issue, more it is how to manage it (DC) in the ship environment.
4. Q- what will be the beam power applied?
5. Q- what will be the "window" material?
6. Q- this process and its control on board of the ship has to be reliable and fully automated, independent from other systems.

7. Q- usually variation of fuels is used on medium-large size two-stroke engines. So, this technology has to be efficient from low, up to IFO 380 heavy fuels.
8. Q- cost benefit and risk assessment of this technology has to be done before proposing it to the ship-owners
9. Q- ship is moving environment. Inclinations up to 30 degrees and constant instability along with high vibrations in the engine room have to be taken into account.
10. Q- electron accelerator- to buy off shelf components or to build prototype in the lab? Pros and cons of both options have to be evaluated. What kind and type of accelerator to use?
11. Q- scientific base of the process and technology has to be described in simple manner, to illustrate this to the ship owners and relevant stake holder. It is clear for scientist but not for maritime engineer.
12. Q- what are limitations of technology? Why it is not yet implemented? What is difference with the power-plants? E.g. This is hybrid technology.

In conclusion, I would like to inform you that INCT has Polish government grant for 3y of amount some 250K euro, to engage shipping industry and to make proof of concept and feasibility study.

The gas turbine industry also has expressed serious interest in the technology, yet NOx concentrations and margins are of magnitude less.

Taking into account the above mentioned, I suggest that we try to see how to develop a Pilot Project to make the prototype device, involving: ship owners, ship repair companies, Class Societies, Accelerator producers, research institutes.

If you agree I will discuss the matter also with my contacts in European Commission DG MOVE, EMSA and IMO.

Kind regards,

Toms