PlasTEP

plasma for environment protection

Concept of optimisation of modules

OP6-4.2

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Introduction

The aim of this report is to give a more detailed concept of a prototype of mobile device for destruction of oil and oil-type leakages in ports of the Baltic Sea. Since the existing setup already matches the requirements, the task is to improve the practicability and give, when possible, first parameters regarding dimensions, flow rate and power. The concept is based on the joint test results carried out in August 8-9, 2011, and described in the previous report OP6-4.1.

Concept

Power supply module

According to WP6 project flow and planned milestones the ZUT project team is responsible for improvements list resulting from the joint test results. Proposed floating vessel should imply improved components. The following improvements are proposed:

- photovoltaic panel charger/load controller: control system improvements, final circuit preparation (ordered printed circuits), waterproof casing,
- microwave plasma supply: control system improvements, system integration, new high voltage transformer prepared for 24V DC supply, load controller, battery state of charge controller, battery charger, final circuit preparation, waterproof casings,
- DBD reactor supply: high voltage transformer design for 30V DC supply (Li-ion battery pack), new power electronic module, new control system, final circuit preparation and system integration, waterproof casing and high voltage terminals,
- Auxiliary loads: low load choppers (fan, oil separator motor), new pump exhaust unit (DC supplied), unit operation signal, overall control unit, final circuit preparation and waterproof casing.

Proposed improvements are based on current experiences and results of measurements. Based on given vessel construction component placement will follow together with battery mounting systems. All components will require professional printed circuit preparation, final soldering, mounting, and waterproof casing. As discussed during project meeting in Uppsala, in October 5, 2011, final components will be placed in the vessel prototype and will be displayed during the Achema fair in 2012.

Microwave plasma module

IMP as being responsible for building the microwave plasma module proposes after joint tests the following improvements:

- shorter waveguide line without circulator and shorter fixed plunger instead of movable one (Fig. 1),
- plasma igniter installed on the top of gas inlet unit as presented in Fig. 1 (it will be a movable wire used only for manual inception of plasma),
- new material for the drum of oil-water separator in order to increase efficiency of oil separation,
- new hood with extended walls in which a shaft of separator drum will be placed.

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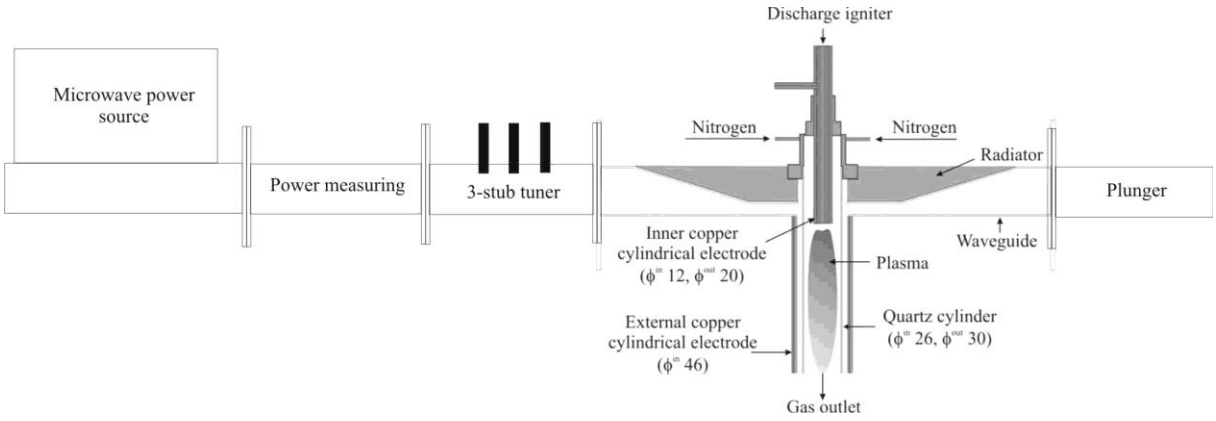


Fig. 1. Microwave plasma module for the mobile device. Total length: 115 cm.

Dielectric barrier discharge module

Approach of INP, which is responsible for the DBD module, is to built a reactor based on the same principle and with the same properties as the one used in the joint test. The electrical as well as spatial properties will stay similar. The supplied power should be set to 25 W plasma power, while the spatial dimensions are shown in Fig. 2.

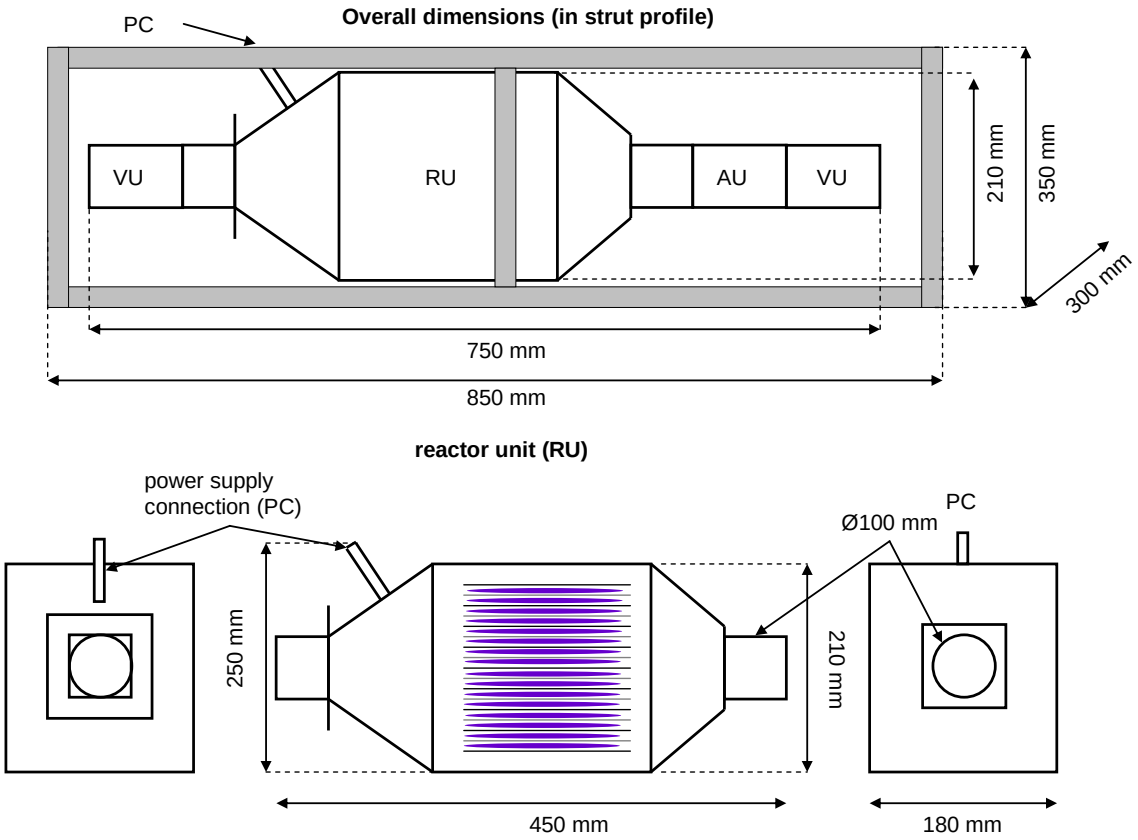
The principle of the stack reactor is a combination of 40 electrodes, which are arranged between a mica composite dielectric. Each second electrode is fed with high voltage while the others are grounded. A basic scheme of the electrode arrangement as well as the burning plasma in the reactor chamber can be seen in Fig. 2.

Nevertheless, certain adaptations need to be considered. A major change is the application of a larger gas connection. We propose a tube diameter of 100 mm in order to reduce the back pressure.

The adsorber will be placed in a tube of the same diameter. To reach the same retention time of the gas in the adsorber unit, the volume of used adsorber will be extended from 225 ccm^3 to a value of approx. 800 cm^3. Therefore, the adsorber unit will have a length of 10 cm. As previous test already showed, the most fitting adsorber for this task is siliporite.

Since the back pressure is relatively high, we propose two adjustable fans that assure a constant gas flow. One of these fans will be placed before the reactor. The second one will be located behind the adsorber unit. These fans provide a flow rate of 600-900 l/h. It should be mentioned that the each fan is about 10 cm in length and will be included in a pipe in the final setup. Additionally it needs a power that still needs to be determined.

The whole setup will be installed in a strut profile (30 mm) of Bosch/Rexroth. The outer dimensions of the final setup should not exceed 850 mm x 300 mm x 350 mm.



The adsorber unit (AU) and the ventilation units (VU) are tubes of length and diameter 100 mm

Fig. 2. Spatial dimensions of the used reactor including the adsorption unit.

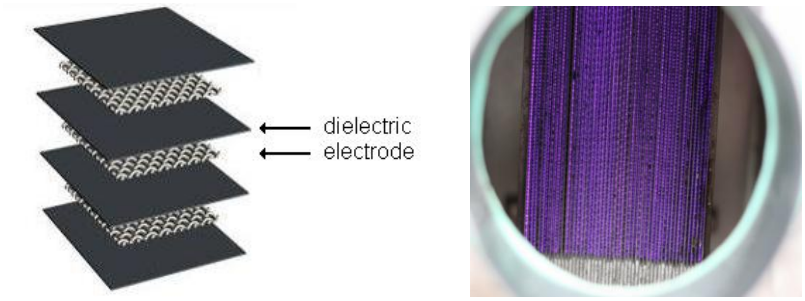


Fig. 3. Basic scheme of the electrode arrangement and the burning plasma in the reactor chamber.

Floating platform

Since dimensions of all modules are more or less known at this point it is possible to re-design the platform on which all part will be fixed (Fig. 4). The platform will be made of light metal commonly used for boats construction. Floats will be attached to edges whereas below the platform, in the free space from the sea surface, oil-water separator will be partially immersed together with jaws directing an oil slick towards the separator during the move of the platform. The outer dimensions of the platform (excluding floats) should not exceed 170 cm x 85 cm.

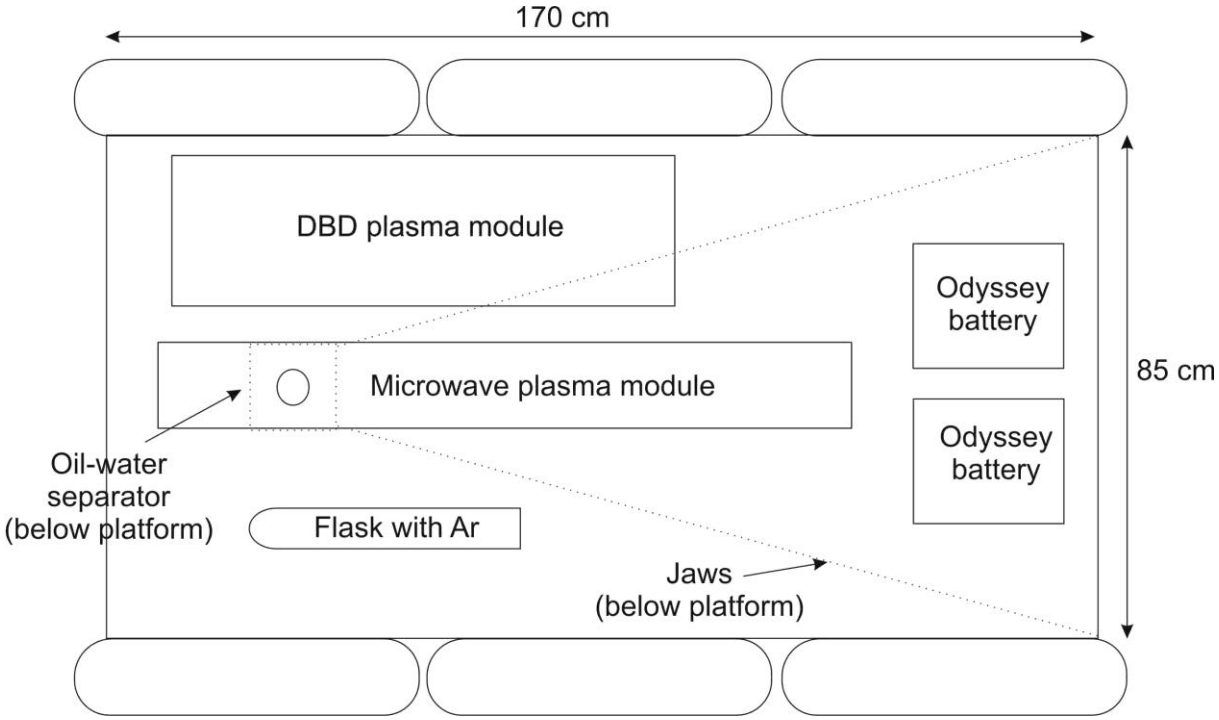


Fig. 4. Scheme of the floating platform with fixed modules.