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What plasma could achieve for disaster relief using a new technology

Decontamination with DBD plasma | The partners involved in the Moplasdekon joint project have developed a mobile plasma disinfectant which can be used to disinfect ambulances, for example. The technology differs from industrial processes as well as from approaches based on plasma sterilization.



Photo: Plasmatreat

The mobile plasma decontamination system can disinfect the interior of the entire ambulance during emergency situations. This is done without using chemicals.

YOUR KEYWORDS

- Plasma for mobile decontamination
- Dielectric barrier discharge to generate the plasma
- Proven efficacy
- Suitable for different surfaces

Atmospheric plasma systems for industrial applications are generally permanently integrated into their production line. The type of low-pressure plasma units that have been developed for sterilizing products are normally large and heavy because they require a vacuum chamber. Both these systems operate under boundary conditions that have been adapted to an industrial environment. So the idea of making plasma available as a surface treatment for mobile applications was not an obvious one. But that is precisely what the partners in the Moplasdekon joint project have succeeded in doing: The technology they

have developed makes it possible to decontaminate contaminated surfaces using plasma without having to use chemicals that are harmful to health and the environment.

Since this approach is of interest to disaster relief organizations, the project has been funded for three years – until the middle of this year – by the German Federal Ministry of Education and Research (BMBF) as part of its “Research for Civil Security” program. During this time the partners have not only developed the innovative mobile plasma system, but tested its effectiveness and practical applications on diverse surfaces as well. For instance,

protective suits worn by emergency personnel that may be contaminated with dangerous bacteria can be decontaminated just as rapidly and effectively as the interior of ambulances.

As joint project partners Plasmatrete GmbH from Steinhagen, the Fraunhofer Institute for Process Engineering and Packaging IVV in Freising and M-U-T GmbH, a manufacturer of measuring instruments for use in medical and environmental engineering from Wedel have collaborated on this project. The job of developing and designing the plasma unit itself fell to Plasmatrete, a company that specializes in atmospheric plasma surface technology. Experts at Plasmatrete built the power generator which is required to generate the plasma, as well as the plasma nozzle and other parts for the demonstration model.

Plasma gas concentration is measured inside the vehicle

The demonstration model is currently in Freising, where the system is undergoing microbiological evaluation at the Fraunhofer IVV. The researchers there have used bacteria, fungi and viruses to test whether the plasma effectively decontaminates and disinfects the surfaces of different materials. M-U-T in turn has developed special gas analyzers which send data directly to the mobile power generator of the plasma system. One of these instruments measures the plasma at the nozzle outlet at the start of the decontamination phase. The other is located inside the area to be decontaminated – for example, in the ambulance – and signals to the generator when the concentration of plasma gas inside is sufficient.

The Moplasdekon demonstration model uses plasma gas generated under normal pressure. However, unlike Openair-Plasma used in industry to clean and activate material surfaces, this plasma is not generated using an arc-like discharge. Instead, the newly developed CD-40 sterilization nozzle generates the plasma by means of dielectric barrier discharge, or DBD as it is known for short.

Support from experienced rescue workers

For general questions on disaster management, the organizations involved in the joint project consulted four associated partners:

The Analytical Task Force (ATF) of the Essen Fire Service that specializes in biological threats, the rescue and disaster management specialists at the Bavarian Red Cross (BRK) and the supplier of specialist tents and equipment Thorsten Schöppner Inhag Zelte und Zubehör, based in Hesse. The fourth practical advisor was the German government's center for the monitoring and prevention of diseases – the Robert Koch Institute (RKI) in Berlin, which itself operates a task force for biological threats.

“In contrast to conventional atmospheric pressure plasma, this technology produces a reactive plasma gas with a long life which is suitable for disinfecting and even sterilizing larger areas up to five cubic meters in volume“, explains Dr. Alexander Knospe, director of Innovation Management at Plasmatrete and coordinator of the joint project. “This corresponds approximately to the volume of an ambulance vehicle, which can be decontaminated using the DBD process in around one to two hours without the need for chemicals.”

No difference in performance on glass, plastic, or metal surfaces

The plasma process is monitored spectroscopically to ensure continuous and reproducible operation. When asked which materials had so far been treated during testing, Prof. Dr. Thomas Schmitt-John, director of the systems engineer's Plasma Life Science department replies: “We have tested it on glass, plastic and metal surfaces and so far found no difference in disinfection performance.“ Since the DBD plasma gas is relatively cold and the distance between the nozzle and the substrate is already large, it would also be possible to decontaminate heat-sensitive plastics.

The CD-40 nozzle achieved a 6-log microbial reduction rate. This equates to a reduction in the bacterial load by a factor of one million, which meets the requirements for sterilization. The decontami-

nation test thus demonstrated the bactericidal and fungicidal effect as well as the antiviral and sporicidal effect of the technology.

One thing that makes the new system particularly interesting is that unlike conventional decontamination processes which rely on chemical active substances such as peracetic acid (PAA) or hydrogen peroxide, it requires only electrical energy and air as the process gas. The chemicals are not only dangerous to the health of emergency workers, they are also harmful to the environment. As a result, delivery to the contaminated areas, storage and eventual disposal involves significant effort.

If there is no mains power supply available at the point of use, rescue services have emergency power generators which can be used to operate the plasma unit. If these also fail, the system has a built-in lithium-ion battery to fall back on. If necessary, this can even be recharged using the vehicle's battery.

The declared technical goal of the research project was that the plasma disinfectant should be compact and relatively light so that one person could carry it. No such device currently exists. The future Moplasdekon product will weigh 25 kg and be rapidly deployable and even more user-friendly than the demonstrator model. ■

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