

ECOROBOT for total cleaning & destruction of microorganisms on air-obstructed HVAC'S internal surfaces



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The microorganisms may enter the HVAC systems from outdoor or indoor environment. These microorganisms can survive in various HVAC components: air ducts, filters, heat exchangers and fan coils, and could be transmitted and spread to indoor in the form of bio-aerosols or accumulated dust with supply airflow. At the start of COVID-19 pandemic, in order to prevent the airborne spreading of SARS-COV-2, a lot of the HVAC systems in buildings were not in operation. Ten years ago has been invented device so called ECOROBOT which can help us to destroy microorganisms from HVAC systems and breathe “healthy” air.

Keywords: ECOROBOT, HVAC system, microorganisms, remote controlling, quality air

Comfortable environmental conditions (temperature and humidity) and clean air in indoor settings such as buildings and vehicles are provided by heating, ventilation and air-conditioning (HVAC) systems. Depending on the application and the functions of the building, HVAC systems can be configured in a variety of ways. Increased transmission of respiratory infections is associated with poor ventilation in indoor spaces. There have been numerous

COVID-19 transmission events associated with closed spaces, including some from pre-symptomatic cases [1]. When it's not possible to clean and disinfect channels regularly, the air can become contaminated, which can significantly endanger people's health. Ventilation and air in HVAC systems conditioning channels are very susceptible to microorganisms growth. The channels have not enough light. They are damp and there are enough particles to grow a base. Air distribution

channel become an incubator for the growth of bacteria, viruses and fungi which reach to human working and living environment and via respiratory organs, hands, food and water they finally reach into the very human organism. It is very serious problem for humans.

Cleaning and disinfecting ventilating and air distribution channels needs

Within central system for air distribution structure, it is already included filter section on air conditioning chamber that prevents transit of dirt. However, filters let fine particles small enough to be measured in nm to pass through them, and they halt on the ventilating channel walls and create lamination of dirt. Exploring and sampling of lamination from the ventilating channel walls for air distribution show presence of viruses and bacteria in lamination. Ventilating channel is suitable habitation for viruses and bacteria because of its huge moisture and no light. Viruses and bacteria get to the respiratory human organs via grid for air distribution.

Based on many years of research it was created a device so called ECOROBOT for destroying viruses and bacteria in air conditioning channels ([2], [3]), ECOROBOT (Figure 1) device is used for destroying viruses and bacteria in airing channels, in order to provide clean and quality air to the indoor environment. It is used in buildings with forced ventilating and air conditioning, in business and residential buildings, hospitals, banks, cinemas, theaters, restaurants, hotels, airports, sport and production halls [4]. Its functions are: cleaning lamination, suction of lamination, disinfection of channels, drying of channels. After functions performed, all lamination is eliminated. The lamination is packed and sterilized properly and handed over to ravage procedure. Viruses and bacteria are destroyed and clean and quality air is provided to the space.

The device performs four operations within a defined work area. Destroying viruses, bacteria and other micro-

organisms can not be infiltrated into working space through flowing vents. An intake manifold prevents this from happening and rear rotation creates an air bag thus preventing microorganisms to infiltrate into cleaned zone. After viruses and other microorganisms destroying process performed, the device disinfects and dries the channels. The channel positioned after the device remains completely protected from eventually harmful microorganisms. Ravaging agents for viruses and other microorganisms are biodegradable and leave no consequences on human health.

ECOROBOT performs cleaning and disinfection of all types of channels (horizontal, vertical, flexible, rectangular, round) from \varnothing 100 to \varnothing 2,000 mm.

In Republic Serbia there is legal regulation for maintenance of channel airing systems. Legal regulation comprises of The Law for occupational safety and health as well as of The Rules for preventive actions for safe and healthy work on work place. Based on above mentioned law, employer has an obligation to provide maintenance of working tools (air conditioning installation) on the work place. Figure 2 shows ECOROBOT operating in a rectangular channel.

Basic parts of ecorobot and its operation principles:

1. Front rotational nozzle is used for taking off the lamination deposited on channel walls with adjusted speed. An intake manifold prevents the lamination from infiltrating into the front section, thus preventing it from protrusion through flowing vents and entering of virus particles into a working space.
2. Rear rotational turbo nozzle can change number of rotations in order to achieve appropriate speed and create an „air bag“ which stops protrusion of viral and bacterial particles into cleaned space.

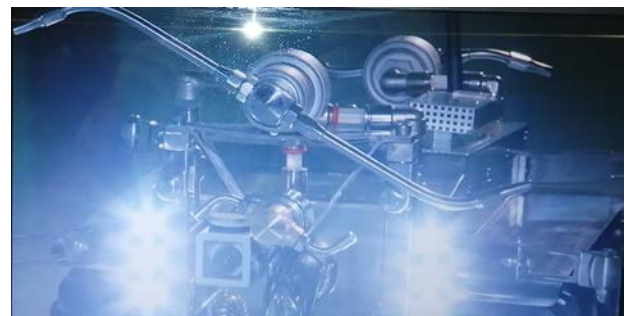
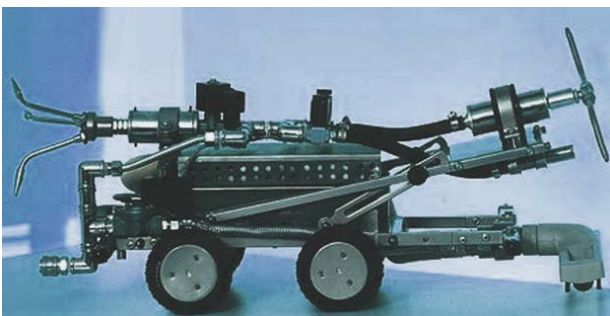


Figure 1. Two views on the ECOROBOT.

3. The intake manifold has capacity to suck everything which is taken off the channel walls, it is provided by appropriate speed of turbo rotational nozzle. The nozzle can operate with adjustable speed, it is adjusted in accordance with quantity of material in the intake manifold.
4. After gathering of viruses, bacteria, fungi and other lamination performed, ecorobot packs them into a reservoir and later sends them to an autoclave machine
5. Front turbo rotational nozzle has smaller dimensions from the nozzle for taking off the lamination. The nozzle has a function of disinfection and ravaging of remaining viral particles and other microorganisms on the film wall. This function is provided by reverse action, when turbo nozzle is protecting the film in order not to plant and fertilize microorganisms and viral particle again and not to produce eventual mutant of unknown origin. The mutant can damage human organism in significant extent, and quality treatment is performed only after its origin is defined.
6. In the next step it is provided simultaneous functioning of the front and rear turbo rotational nozzle, which perform thrust of biocide agents for ravaging

of viruses and drying of channel walls. New technologies at the entry of air conditioning chamber use filters capable to eliminate particles measured in μm . Viral particles have dimensions in nm and that is the reason why great number of viruses can be found on channel walls. These invisible viruses and microorganisms can be cleaned equally effective with a wireless robot.

The most common technique is impression of microorganisms because of its reliability. It is easy to perform, it's economic and reliable. Author's idea was to make a functional device of perfect function which will move freely through ventilating channel. The device has to work within working area.

Cleaning of rectangular channels is solved by stable self-propelled robot adaptable to different dimensions and the same principle can be applied in round channels. One of the problems was cleaning of vertical channels. For these purposes it was made turborotational self-propelled nozzle device which uses its own drive by a reactive spray and which uses turborotational circular spray for keeping the device within the axle of channels with smaller diameters. In this way it is provided quality

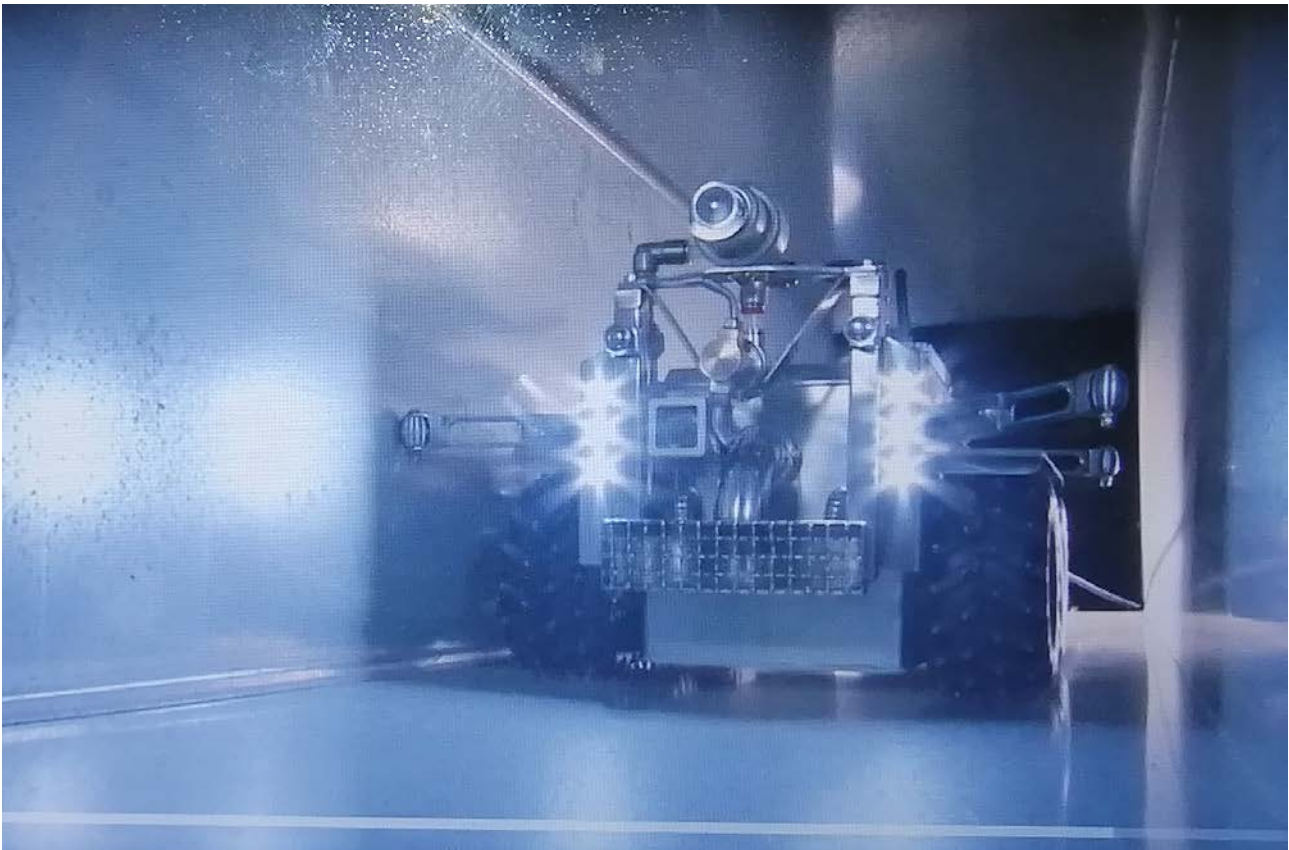
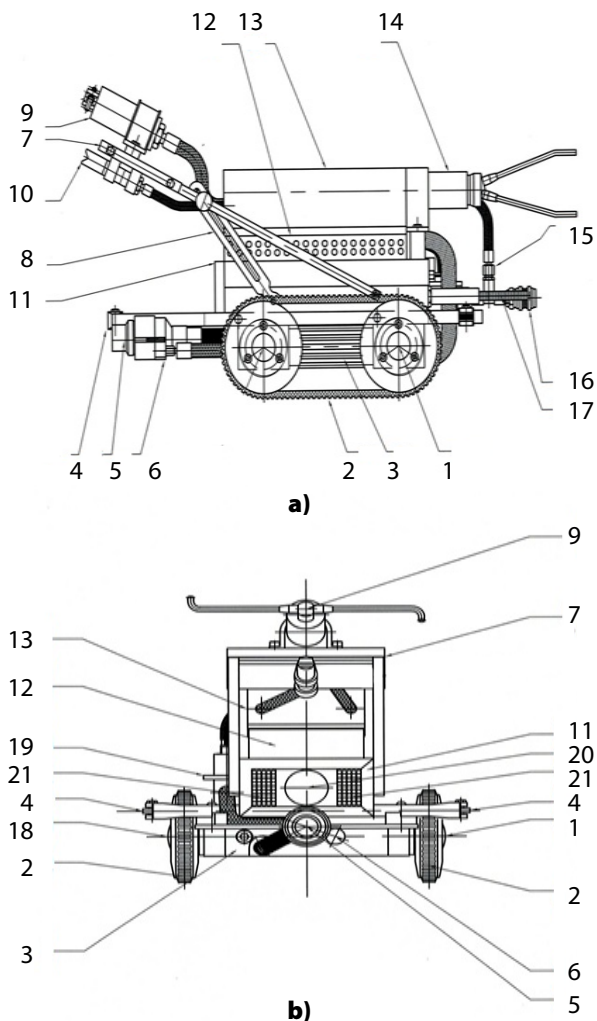


Figure 2. ECOROBOT operating in a rectangular channel.



Pos.	Name	Figure	
1	Right drive	a)	b)
2	Timing belt	a)	b)
3	Base	a)	b)
4	Suction buffer	a)	b)
5	Suction throat	a)	b)
6	Suction nozzle	a)	b)
7	Rotational platform of the front nozzles	a)	b)
8	Base for rotational platform		b)
9	Front rotational nozzle	a)	b)
10	Front rinsing nozzle	a)	b)
11	Housing with front and rear camera with a light	a)	b)
12	Basket with a suction bag	a)	b)
13	Housing with electromagnetic valves	a)	b)
14	Rear rotational nozzle		b)
15	Intake of compressed air for electromagnetic valves in the housing		b)
16	Connection for intake of compressed air from the compressor		b)
17	Supply electric cable from control panel		b)
18	Left drive	a)	
19	Electromagnetic valve for intake of compressed air into suction nozzle	a)	
20	Front camera	a)	
21	Front light	a)	

Figure 3. ECOROBOT (Self-propelled device for cleaning and disinfection of ventilating channels) with marked components.

cleaning and ravaging of viruses and bacteria in vertical and horizontal channels of smaller diameters. Figure 3 shows ECOROBOT components.

Conclusions

ECOROBOT is much more than ordinary technical invention. Strategic aim is to make ECOROBOT known through its mass acting in every building with forced ventilation and air conditioning, enable its presence in all kind of buildings and to make it accessible to all of us. ECOROBOT is one of the inventions keeping our hope in better, nicer, healthier and safer future world. Its multifunctional technical/biophysical features and performance should be further measured and investigated and based on the existing laboratory level constructed devices should be developed industrial level devices production tracing worldwide

encouragement and vision of the roadmap of resilience and salvation. ■

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