Green cyber-production of semiconductor electronic

A V Shukalov¹, I O Zharinov¹ and O O Zharinov²
¹ Faculty of Information Security and Computer Technologies, ITMO University, 49, Kronverksky Av., Saint Petersburg, 197101, Russia
² Department of Problem-Oriented Computing Complexes, Saint Petersburg State University of Aerospace Instrumentation, 67, Bolshaya Morskaia str., Saint Petersburg, 190000, Russia

E-mail: mpbva@mail.ru

Abstract. To clean the industrial company air substances of the semiconductor electronics production is a necessary procedure to lower the atmosphere technical load. The hazardous substances of soldering and montage works are some metal oxides and aerosol substances, which simultaneously circulate in a production in its vapor and gas forms. To evacuate those hazardous substances from the production equipment is done through the tide and extraction ventilation channels, which transport the contaminations into the center filtering system. There is a scheme how to collect the hazardous production substances in an electronics production. The center filtering system contains some engineer cyber-systems (ECS) to neutralize the contaminations with absorbing and adsorbing ecological means and also with catalyst methods. There is a scheme of center filtering aggregates to neutralize the contaminations using ECS. The production and ECS synchronous interaction must be provided with the intellectual environment resources to support the nature safety technologies to minimize the technical influence on the environment.

1. Introduction
The rational nature consumption and ecology attention in metropolises created in the Industry 4.0 as some basic human values may significantly influence the technological development strategies of the semiconductor electronics production sector [1, 2]. The electronic devices are widely being used today as a part of household and medical aggregates, the mobile connection system and other [3, 4].

The semiconductor electronics production is a mass one and uses some physical and mechanical means in its technological processes where the air contaminations may appear and spread. The contamination sources could be the production cyber-systems (CS) of soldering and montage works with semiconductor components [5, 6].

To mount the semiconductor includes the concentrated gaseous substances and low-dispersing aerosols with metal oxides vapors, oils, formaldehydes and other toxins hazardous for the environment [7, 8]. Into the living nature the contaminants are transported through the air, which channels must be technologically filtered [9].

To neutralize vapors and gases exhausts from the electronics production it must be done to its harmless state with engineer cyber-systems (ECS) to unite them in a company as an air cleaning complex [10, 11]. The ECS provides the air tides technological processing with ecological methods to minimize the contamination penetration into the atmosphere [12, 13].

The electronics production ecological safety are additionally actual when the companies are placed
into densely populated areas which landscape and wind climate conditions may form some still air masses, which are suspended over the living edifices [14]. In such nature area the population technological load is exorbitant and this is the reason why the new effective technological solutions must be found to provide the quality atmosphere industrial exhausts cleaning [15, 16].

2. The technology how to collect the vapor and gases air substances in the electronics cyber-production

The air cleaning complex in an electronics production is a combination of ECS united with air pipelines. The air masses circulation in a production is done with compressor pumps of inlet and extracting tides. The inlet tide is done after some atmospheric air suction or after a secondary time when the air cleaned from contaminations before is used again. The extracting tide is done after the forced air ventilation from the contamination sources and which are to be cleaned with ECS.

Each production CS to mount the electronics in the elements soldering or the units cleaning the flying fractions are formed, which are to be neutralized. The hazardous substances evacuation from the production CS is done directly from the soldering point with integrated smoke receptors. To unite the smoke receptors tides inside a production CS is done with integrated into the industrial machine an air masses extraction channel containing a large variety of technical contaminants.

The air additional substances, which toxicity is formed with reaction agents extractors of the electronics units cleaning (washing) means is for the production CS integrated smoke catchers, which is a one big channel of gas extraction. The washing CS hazardous substances are inside the organic dissolvers vapors and based on oil products liquids, which are used to take away from the electronics units all types of contaminators.

The extraction channels integrated into production CS are formed with sub-systems of local air cleaning to prevent the air masses formation in weighted particles of explosion danger concentration. The local air cleaning is important in soldering works where the smoke extraction is generated and in washing works where the gas extracting is generated, which are equally dangerous for the environment.

The air tides locally cleaned into production CS are united through the air extracting ventilation outputs into mobile air cleaning units to provide the contaminants extraction formed in a technological section. The section has an air extraction case, which has flexible air pipelines and apertures of wide opening are connected with integral vapor and gas tide containing some hazardous substances.

The air extraction case is a low dimensions element of the electronics production ventilation system, which neutralizes the vapor and gases exhausts containing technical contaminators. The air cleaning step by step technology is necessary to prevent the tides penetration to the company center filtering and ventilation system with some gaseous components which are significantly higher in concentration over the permitted. One time and excessively high contaminators concentration has a crippling effect to clean up the ECS, which can break down the filtering aggregates.

The air extraction case provides the unnecessary substances filtering from the air being ventilated. To localize the cleaning systems and hazardous substances extraction in the technological section level guarantees the production room cleaning level, which is necessary to complete soldering and montage works of semiconductor electronics with required quality. The semiconductor electronics production is sensitive to the technological processes completion conditions and adds some additional requirements for the room cleanliness.

A case of air extraction through an air pipeline, shafts and ventilation chambers are united in a direct tide channel of the general exchange air cleaning facility made with center filtering and ventilation aggregate. The central aggregate is built with reserved engineer cyber systems to make the technological air final cleaning before it will be exhausted into the atmosphere. The scheme how to collect vapor and gaseous substances in the electronic household devices manufacturing company is given in figure 1.
**3. The aerial contamination technological neutralization**

Filtering and ventilation aggregate to provide the clean atmospheric air inlet into a production CS and worked out aerial tides cleaning containing significant concentrations of hazardous substances. To clean up the exhausts with a multi-step filters range, which are a part of ECS. The technological air cleaning degree is defined with technical rules, which prohibit the atmospheric output of all contaminants types.

The ECS filters range selects physical and chemical reactions where the hazardous substances partially or fully neutralized. The cleaning technologies apply toxic components adsorbing and absorbing catalyst methods with some microscopic structure. To filter the aerial and gaseous substances they apply the recuperation cleaning means and some absorbents to provide the electronic devices production ecological safety.

An ECS supports the low-wastes production principle and constructively designed as a complex of fast changing filters with a calculator and a mobile connection sub-system. The controller controls the aerial tide intensiveness and cleaning quality including a mobile interface to support exchange with the company intellectual environment.

The intellectual environment remotely monitors the production and ECS technical characteristics, which correspondently extract and neutralize the hazardous substances. The control indicators are: filters condition, the production being generated contamination level and air quality which is let out to the atmosphere. The increased contaminants indicators in the company exiting tide is a base to block some ECS because they are faulty or the neutralizing filters technological resources use is exaggerated.

The ECS restoration maintenance works are done automatically by changing the worked out filters for new ones. The consumable components operative change provides with the intellectual environment commands to collect the production diagnostics information. The change tool is a manipulator, which makes orienting or forward and returning filter transportation. The ECS blocking for the maintenance period is changed for a duplicator from the reserve fund.

The organic and non-organic production wastes neutralization products (used absorbents and other) including the worked out filters are to be technologically processed in a recycling factory to make the technical contaminants utilization final stage. The electronics production company central cleaning system filtering aggregates are the most important components to provide the environment safety from the industrial toxins.
The resource preserving production technologies use the returning mechanisms of previously cleaned technological air into the company engineer infrastructure. The air cleaning quality requirements in this case could be particularly omitted for additional mixing of the technological air with the atmospheric one, which is provided with inlet ventilation system. The electronics production company air cleaning filter and ventilation aggregate scheme equipped with ECS is given in figure 2.

**Figure 2.** The electronics production company air cleaning filter and ventilation aggregate scheme equipped with ECS.

### 4. Conclusion

The electronics production company projection includes the effective air cleaning system designing task to metal oxides and alloys neutralization and also low-dispersed inclusions created after the soldering and montage works technological processes. The semiconductor components montage processes today are formalized and used for generally spread technological operations. To count up the industrial CS which have the most part of contaminants and form the known toxins nomenclature is the most important stage to create a new production.

To apply the ECS to neutralize the wastes is a technological novation, which requires to design some new models and methods to calculate the exhausts made by a production company into the atmosphere. United filtering cleaning aggregates integrates the technological tides air masses to be neutralized. So it is necessary to design a more efficient cleaning CS adapted for the exhausts intensiveness preventive or reduction technologies of vapor and gaseous substances containing hazardous materials concentrated sums.

The ECS air technological cleaning has a limited potential of its capabilities and is a passive form how to protect the environment from aggressive components of a technical nature. To design some active methods how to protect the ecology includes the maximum implementation of resource preserving technologies and non-waste production technologies into industrial technical processes. So it minimizes the production generated hazardous materials total number.

The production exhausts level higher than the norm is the most important anthropogenic factor defines the humanity negative influence on the living nature. In most cases the generated industrial contaminations levels are significantly higher the ecosystem capability of its natural self-restoration. Alternative methods how to clean the air contaminations are being designed today to prevent the hazardous substances formation and is of in priority to be implemented in an Industry 4.0 production.

The most perspective thing to be implemented into the production filtering aggregates are ECS integrated into the existing (being modernized) industrial company infrastructure. The application
mobility and modular construction of rapidly changing filters is the engineer equipment property of some competitive nature to arrange an innovative production. Like any other equipment to provide the production ecological safety the ECS must be periodically verified to guarantee the air masses cleaning quality preservation into the exploitation.

References
[1] Mascarenhas J, Chowdhury H, Thirugnanasambandam M, Chowdhury T and Saidur R 2019 *Journal of cleaner production* **231** 183-95
[2] Wang B, Hong G, Qin T, Fan W-R and Yuan X-C 2019 *Journal of cleaner production* **235** 1304-14
[3] Kabugo J, Jamsa-Jounela S-L, Schiemann R and Binder C 2020 *International journal of electrical power & energy systems* **115** 105508
[4] Moktadir Md A, Ali S M, Kusi-Sarpong S and Shaikh Md A 2018 *Process safety and environmental protection* **117** 730-41
[5] Aheleroff S, Xu X, Lu Y, Aristizabal M, Velasquez J P, Joa B and Valencia Y 2020 *Advanced engineering informatics* **43** 101043
[6] Lin R-B, Xiang S, Xing H, Zhou W and Chen B 2019 *Coordination chemistry reviews* **378** 87-103
[7] Taylor M P, Boxall P, Chen J J, Xu X, Liew A and Adeniji A 2020 *Computers & industrial engineering* **139** 105486
[8] Boyjoo Y, Sun H, Liu J, Pareek V K and Wang S 2017 *Chemical engineering journal* **310(2)** 537-59
[9] Ojstrsek A, Fakin D, Hribernik S, Fakin T, Bracic M and Kurecic M 2020 *Carbohydrate polymers* **236** 116071
[10] Das A, Ruksana, Chatterjee P 2019 *Encyclopedia of renewable and sustainable materials* **3** 501-12
[11] Kerdlap P, Low J S, Ramakrishna S 2019 *Resources, conservation and recycling* **151** 104438
[12] Sanchis R, Dejoz A, Vázquez I, Vilarrasa-Garcia E, Jimenez-Jimenez J, Rodriguez-Castellon E, Nieto J M and Solsona B 2019 *Chemosphere* **219** 286-95
[13] Yu B, Hou J, He W, Liu S, Hu Z, Ji J, Chen H and Xu G 2018 *Applied energy* **226** 365-80
[14] Seck M, Mohammadian N, Diallo A K, Faraji S, Erouel M, Bouguila N, Ndiaye D, Khirouni K and Majewski L A 2020 *Organic electronics* **83** 105735
[15] Yu B, Zhong D, Liu J and Niu X 2020 *Energy conversion and management* **210** 112697
[16] Vesely P, Busek D, Krammer O and Dusek K 2020 *Journal of materials processing technology* **275** 116289