DEPARTMENT OF SYSTEMS AND CONTROL

E-2

The department is engaged in the analysis, control and optimization of systems and processes. The activities of the department are focused on the research of new methods and algorithms for automatic control, the development of procedures and tools to support the design of control systems, the development of specific measurement and control modules, and the development and construction of complete systems for the control and supervision of machines, devices and industrial processes.

Head:
Dr. Vladimir Jovan

Basic and applied research in 2017 was devoted to three sub-areas: methodologies for analysis and control systems design; tools and building blocks for implementation; and applied research in the priority problem domains.

The first topic addressed the *modelling and identification of nonlinear and complex dynamical systems*. The research on methods for the dynamical systems' modelling was pursued in the direction of the development of Gaussian-process models and their use in environmental systems. Online as well as offline methods for system identification based on Gaussian processes were investigated.

The second topic was *advanced control.* We have continued the research and development of model predictive control (MPC) methods by using fast online first-order quadratic programming optimization techniques. We have been developing fast implementations of the advanced MPC controller for the outer loop of plasma current and shape control for the Iter tokamak plasma magnetic control, based on the dual fast-gradient method. These methods would allow the use of such control also on dynamically faster medium-sized tokamaks and for other fast processes, where advanced handling of the constraints on process signals is important. We have also developed an MPC controller for the stabilization of the unstable resistive wall modes in Iter, which appear in certain advanced tokamak operation modes. In this case, the primal fast-gradient method was used due to the much faster system dynamics.

Within the framework of *prognostics and health management*, a novel algorithm for state-of-health estimation and remaining useful life (RUL) prediction, dedicated to solid-oxide fuel cells (SOFCs), was developed. Combining the 1st principle models and measurements on a SOFC system, the algorithm is capable of reconstructing the area-specific resistance (ASR) of the stack, which proves to be an efficient indicator of the system's health, regardless of the operating conditions. Later on, a degradation model, identified from semi-past data, serves for RUL predictions. The estimation of corresponding variables is achieved via non-linear filtering techniques (Figure 1).

In the area **tools and building blocks for implementation** we continued the design of a tool for the analysis and optimization of production performance. We have realized and laboratory tested the architectural design of a system for an on-line analysis of the discrete event data flow. Together with that, an environment for the analysis of the production data through web-services was designed. It integrates various analytical tools like big data platforms, Python libraries, Matlab algorithms, etc.

In collaboration with the University of Arkansas, Fayetteville, the modelling of landscape evolution was conducted. The modelling showed that steady-state topography cannot exist when rock layers are close to the horizontal. The resulting landscape may differ strongly from expectations coming from a landscape equilibrium perspective. For example, stream channels can be steeper in weaker rock layers than in harder rock layers. The finding has been presented in an article in *Earth surface dynamics* and at the GSA Annual Meeting.

In the course of a 3-year programme "Gostop-Building Blocks, tools and systems for factories of the future" we performed activities both on programme management as well as within the framework of R&D projects. We participated in three areas of R&D content. The first area relates to the development of a module to provide 100% quality in a series of finished products using the example of an electric-motors production line. In this regard, trends within the Industry 4.0 concept were taken into account as an important guideline. The second area represents the
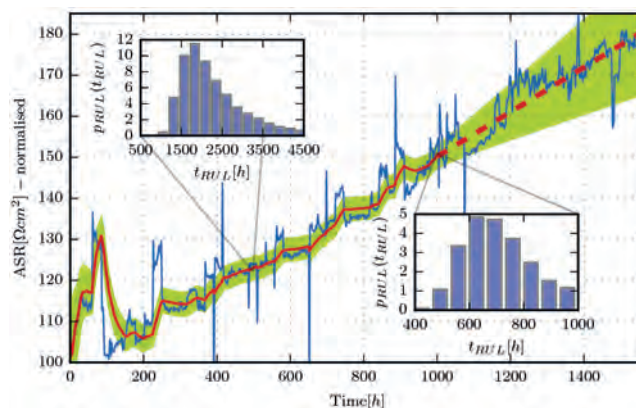
Figure 1: The estimated ASR (blue), its filtered value (red), and a prediction of the future evolution of ASR (dashed red). Due to the stochastic setup, the RUL predictions (purple) come in the form of probability density functions.

development of a system for adaptive production control, also on an example of an electric-motors production line. In this context, the definition of the infrastructure for capturing and storing data from different production steps was performed. The third area covers the development of agents for the synthesis of models from production data and for supporting decision-making based on these models. This activity will be carried out on a sample line for the production of plastomagnetic rotors. A study of current trends and guidelines in the field of technologies relevant to this field was performed. Furthermore, a structural analysis of the production process and the associated information ecosystem was carried out. Two agents are being developed, i.e., a prototype agent for monitoring the state of production equipment, where the functional design of the sensor for the jet tool was performed, and the prototype agent for the real-time monitoring, prediction and improvement of production processes. In the past year, the functions of the MES/MOM system were defined and its architectural design was defined. For this purpose, a platform for production data analysis through pre-prepared web services and a system for online data analysis are under development and laboratory testing.

Figure 2: Project DIAMOND - Experimental validation of the supervisory optimizer

Applied research in the priority problem domains was the third sub-area of our interest. For the Slovenian Research Agency project Method for the forecasting of local radiological pollution of atmosphere using Gaussian process models we have started with the evaluation of meteorological forecasts and the identification of key deficiencies in pollution dispersion modelling and with the evaluation of different Gaussian-process-based modelling methods for the identification of models useful for forecasting the variables under consideration.
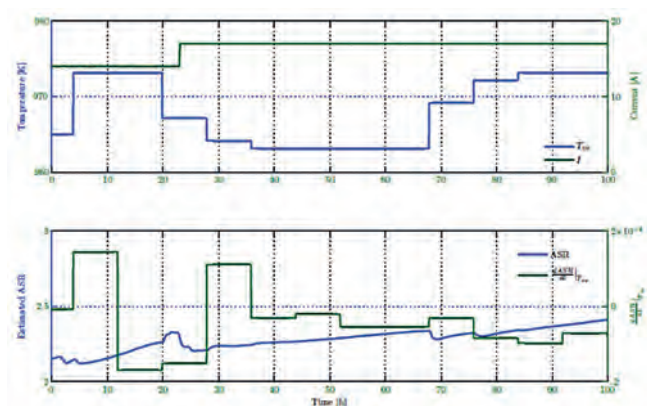

Figure 3: Diagnostic system on ML-14 assembly line at Domel d.o.o.

In the area of *condition monitoring, prognostics and health management* (CM&PHM) of the rotational machines the foundations of an embedded system for on-line monitoring of the vital components of mechanical drives have been laid down. The concept builds on local signal processing for feature extraction and then fusion of the features for the sake of final diagnosis and prognosis of the remaining useful life. Together with the team from the company Domel, the partner in this development project, we completed a novel test rig for bearings lifelong tests and executed a series of experiments on 12 bearings.

Within the "State-of-health estimation of electrochemical energy systems", funded by the Slovenian Research Agency, activities can be divided into two segments: performing long-term experiments and the development of models for an estimation of the remaining useful life. In 2017 we successfully performed initial experiments on the test bed developed within the project. Additionally, in cooperation with the Technical University of Graz, we have performed experiments on SOFCs too. Activities on the segment of model development were focused on the implementation of numerical tools for the simulation and parameter identification of fractional order models. These models are applicable for describing diffusion processes that are the governing processes for fuel cells. For that purpose we have started an active collaboration with a research group from Johannes Kepler University from Linz, Austria.

International R&D projects

In 2017 we successfully concluded the development within the 3-year EU FW7 project "Diamond - Diagnosis-aided control for SOFC power systems". The supervisory optimizer was implemented on a programmable logic controller and tested on a 5-kW SOFC power system. The optimizer was in charge of solving a constrained optimisation problem where various instances of the criterion function included electrical efficiency and/or degradation rate. In the experiment carried out on site, the objective of the optimizer was to minimise the degradation rate of the cells by manipulating the stack temperature. In spite of the short duration of the experiment, caused by a too rapid deterioration of the stack, the proposed optimizer returned promising initial results (Figure 2).

In the framework of the 3-year project "Fast Model Predictive Control for Magnetic Plasma Control - FMPCFMPC", "Enabling Research" activity of the EUROfusion Work Programme 2015 (part of Horizon 2020 / Euratom), we have been collaborating with the consortium ENEA/CREATE from Naples, Italy. The aim of the project is to apply novel,

fast MPC approaches to plasma magnetic control for the Iter tokamak, where MPC is currently not applicable due to the large-scale multivariable nature of the problem and a sub-second sampling rates. In the final project year, the emphasis was on the stabilization of resistive wall modes.

The scope of an international project H2020 "Memphys - MEMbrane based Purification of HYdrogen System" is the development of an electro-chemical system for hydrogen compression and cleaning using membranes, similar to the ones, used in PEM fuel cells. The electrochemical compression has no moving parts, it is driven by electricity and it has higher energy efficiency than mechanical compressors. The task of the Department of Systems and Control is the design of the hardware and the software for the control and diagnostic system, which will estimate the process condition by the system identification methods. The activities of the last year were focused on the preparation of the experimental setup.

A new H2020 project INSIGHT has been started in cooperation with the leading academic and industrial players in the domain of SOFCs. The project is aimed to develop the efficient tools for on-line health monitoring of a SOFC stack, detection and isolation of the evolving degradation mechanisms and design of the accommodation actions. The IJS team contributes an innovative approach to the characterisation of SOFCs based on dynamic response to the persistently excited stack and the identified mathematical model in terms of the lumped fractional order differential equations.

Research in the domain of degradation monitoring of solid-oxide electrolysis cells is conducted in cooperation with CEA, Grenoble. To better understand anode delamination, numerical modelling of a single, electrolyte supported, solid oxide electrolysis cell (SOEC) was performed in the COMSOL Multiphysics environment. The proposed model is an efficient tool to analyse the hot spots of current density, where a high pressure of oxygen possibly appears and hence accelerates the degradation rate. The simulation results show that increasing the area of the delaminated anode increases the operating voltage and decreases the conversion efficiency of the SOEC.

Based on the existing references, a contract for the development of the control system for the 100-kW natural-gas fuel-cell cogeneration unit (CHP) was signed with the *Institute Fraunhofer ICT IMM* (Institut Mikromechanic Mainz). Our task is the definition of the control system specification, the development of the control system software and the support during commissioning and optimization of the system. The project will result in fully functional demonstration system with an emphasis on the high efficiency, which will be achieved by thermal integration and optimal control.

Figure 4: Matching of the SBR model with the measurements

Applied work

In the course of our long-term partnership with Danfoss Trata d.o.o in 2017 we continued to develop hardware and software for three families of valve drives. The smart drives will be able to reduce the oscillations in the system by reducing the operating pressure. They will also have other functionalities, including a communication interface that will be used in both HVAC systems and in district heating systems.

A diagnostic system for the assembly line ML13 of the DOMEL Company was upgraded with new functionalities, dedicated to new types of motors. Namely, the production range of the line was upgraded by small suction units, used by the Wagner GmBH for paint sprayers. The upgrade required the design of smaller velocity sensors, adaptation of the velocity controllers, addition of special supervision algorithm and expansion of diagnostic features. The second functionality – classification of the produced units into quality classes required development of new modules for information-communications system.

A fully automatic diagnostic system for electronically commutated (EC) motors was designed and put into operation on the assembly line ML14. The main customers of this production line are the VTS Group and Gorenje. The main R&D efforts were dedicated to a diagnosis of the interplay between the electromechanical part and the electronic part of the product under test. The diagnostic system (Figure 3) together with other manipulation systems that were appointed to us to develop are tightly coupled with many of the Domel's ICT systems. As such this work is seen as the corner stone of the future Domel's smart factory.

A new diagnostic system on the assembly line ML15 was designed and put into the operation. It supports the quality assessment of high-performance and low-power suction units for vacuum cleaners of the Kaercher Company. Our R&D work supports the pioneering role of DOMEL in the manufacturing of highly efficient electronically com-
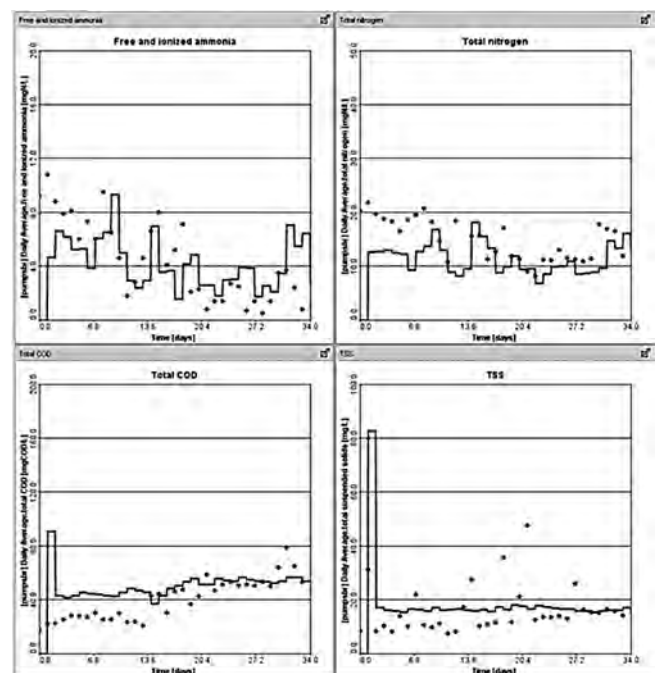
Figure 5: Ceremony of awarding Puh's acknowledgments for the most important development achievements in 2017

mutated motors in this field of application. Here, basic R&D efforts were given into the diagnostics of the interplay of the electromechanical and the electronic part of the product.

Another project in Domel d.o.o was installed in their unit PE ECS. During 2017 we have performed a major upgrade on the line for end-quality control. The line was upgraded from the initial hand manipulated one into a semi-automatic version. Additionally, we have upgraded the measurement loops as well as the algorithms for fault detection. Furthermore, we performed upgrades on the system for production tracking. The upgraded version of the system allows the aggregation of quality data from various measurement points along the production line into one overall assessment of the products quality. For the complete systems we were awarded the Puch Award for 2017.

The mathematical model of the sequential batch reactor (SBR) technology of the Domžale-Kamnik wastewater treatment plant (WWTP) was developed in GPS-X software. It is a technology with four batch reactors that alternately operate in 3-hour cycles. The model shows a relatively good agreement with the measurements (Figure xxxx). Simulation analyses indicate that the SBR is very sensitive to aeration of the reactors and waste sludge removal, low organic carbon load deteriorates denitrification process and operation with only three reactors deteriorates nitrification process.

Educational and training activities

Some members of the department are giving lectures and practical courses at different faculties and universities: the Faculty of Electrical Engineering, University of Ljubljana, the Faculty of Logistics, University of Maribor, the University of Nova Gorica and the "Jožef Stefan" International Postgraduate School. They also act as the supervisors of four Ph.D. students.

Some outstanding publications in the past year

1. Pregelj, Boštjan, Debenjak, Andrej, Dolanc, Gregor, Petrovčič, Janko. A diesel-powered fuel cell APU: reliability issues and mitigation approaches. *IEEE transactions on industrial electronics*, ISSN 0278-0046. [Print ed.], 2017, vol. 64, no. 8, pp. 6660-6670

2. Dolanc, Gregor, Pregelj, Boštjan, Petrovčič, Janko, Samsun, Remzi Can. Control of an afterburner in a diesel fuel cell power unit under variable load. *Journal of power sources*, ISSN 0378-7753, 2017, vol. 338, pp. 117-128

3. Dolenc, Boštjan, Vrečko, Darko, Juričić, Đani, Pohjoranta, Antti, Pianese, Cesare. Online gas composition estimation in solid oxide fuel cell systems with anode off-gas recycle configuration. *Journal of power sources*, ISSN 0378-7753, 2017, vol. 343, pp. 246-253

4. Dolenc, Boštjan, Boškoski, Pavle, Stepančič, Martin, Pohjoranta, Antti, Juričić, Đani. State of health estimation and remaining useful life prediction of solid oxide fuel cell stack. *Energy conversion and management*, ISSN 0196-8904. [Print ed.], 2017, vol. 148, pp. 993-1002

5. Boškoski, Pavle, Debenjak, Andrej, Mileva-Boshkoska, Biljana. Rayleigh copula for describing impedance data - with application to condition monitoring of proton exchange membrane fuel cells. *European journal of operational research*, ISSN 0377-2217

Some outstanding achievements in the past year

1. The Puh award 2017 for development achievements was awarded to our Department members Dr. Pavle Boškoski, Dr. Bojan Musizza and Dr. Andrej Debenjak, and our partners from Domel company (Figure 5)

2. The book entitled "*Fast electrochemical impedance spectroscopy as a statistical condition monitoring tool*", authored by Pavle Boškoski and Andrej Debenjak (our Department members) and Biljana Mileva Boshkovska, has appeared in the Springer series „ Springer Briefs in Applied Sciences and Technology „

3. The department member Tomaž Kos was awarded with the PCT technology network award (Process Control Technology) for his Master's thesis entitled „Measurement system for automated low-frequency and high-temperature characterization of dielectric materials"

4. Two new projects in the field of the development of hydrogen technologies (Memphys, Insight) have started in 2017 within the scope of Horizon 2020 programme (Fuel Cells and Hydrogen Joint Undertaking)

Awards and appointments

1. Pavle Boškoski, Bojan Musizza, Andrej Debenjak and DOMEL company (Damjan Demšar, Jernej Tomažin, Janez Urh, Miha Kržišnik in Marjan Kavčič): received the Puh award for 2017. This is the highest state award for development achievements issued by the Ministry of Education, Science and Sport within the Zois awards - the state highest awards for scientific and research achievements. The award was bestowed for an adaptive system for the quality control of blowers and production tracking.

2. Tomaž Kos: was awarded with the PCT technology network award (Process Control Technology) for his Master's thesis entitled "Measurement system for automated low-frequency and high-temperature characterization of dielectric materials".

INTERNATIONAL PROJECTS

1. 7FP - FLUMABACK; Fluid Management Component Improvement for Back up Fuel Cell Systems
Dr. Pavle Boškoski
European Commission
2. 7FP - DIAMOND; Diagnosis-aided Control for SOFC Power System
Prof. Đani Juričić
European Commission
3. 7FP - FCGEN; Fuel Cell Based On-board Power Generation
Dr. Boštjan Pregelj
European Commission
4. H2020 - MEMPHYS; Membrane based Purification of Hydrogen System
Dr. Gregor Dolanc
European Commission
5. H2020 - INSIGHT; Implementation in Real SOFC Systems of Monitoring and Diagnostic Tools Using Signal Analysis to Increase their Lifetime
Prof. Đani Juričić
European Commission
6. H2020 EUROfusion - Fast Model Predictive Control for Magnetic Plasma Control - FMPCFMPC, ER-3-FU
Dr. Samo Gerkšič
European Commission
7. Non-invasive Condition Monitoring of High Temperature Steam Electrolyser
Prof. Đani Juričić
Slovenian Research Agency

RESEARCH PROGRAM

1. Program systems and control
Prof. Đani Juričić

R & D GRANTS AND CONTRACTS

1. State-of-health prognostics of electrochemical energy systems
Dr. Pavle Boškoski
2. E-maintenance of electro-mechanical drives: prognostics and health management solutions under non-stationary operating conditions
Prof. Đani Juričić
3. Method for the forecasting of local radiological pollution of atmosphere using Gaussian process models
Prof. Juš Kocijan
4. Building blocks, tools and systems for the Factories of the Future – GOSTOP
Dr. Vladimir Jovan
Ministry of Education, Science and Sport
5. Strategic Research & Innovation Partnership Factories of the Future (SRIP FoF)
Dr. Vladimir Jovan
Ministry of Education, Science and Sport
6. Development of the Control System for the Gas Fuel Processor / Fuel Cell System (Phase 1)
Dr. Gregor Dolanc
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung

NEW CONTRACTS

1. Design and assembly of diagnostic system for quality assessment of the 771 family of brushless motors
Dr. Janko Petrovčič
Domel, d. o. o.
2. Upgrade of DSML13 Diagnostic System
Dr. Andrej Debenjak
Domel, d. o. o.
3. Diagnostic line for the end-quality control of electronically commutated blowers
Dr. Pavle Boškoski
Domel, d. o. o.
4. Simulation study of the operation of the sequencing batch reactors at the Domžale-Kamnik wastewater treatment plant
Dr. Darko Vrečko
JP Cčn Domžale-Kamnik d. o. o.
5. Upgrade of Communication Capabilities on the Assembly Line Ml-13
Dr. Andrej Debenjak
Domel, d. o. o.
6. Modification of the iSET Functionality
Asst. Prof. Damir Vrančić
Danfoss Trata, d. o. o.
7. Design and Assembly of the Electrical and Control Cabinet for the Diagnostic System on line ML-15
Dr. Janko Petrovčič
Domel, d. o. o.
8. Upgrade of Diagnostic System on the Assembly line ML-13 - Electrical and Control Part
Dr. Janko Petrovčič
Domel, d. o. o.
9. Upgrade of Diagnostic System on the Assembly line ML-14 - Electrical and Control Part
Dr. Janko Petrovčič
Domel, d. o. o.
10. Development and Manufacture of the USB-AKO Communication Converter
Dr. Andrej Debenjak
Domel , d. o. o.
11. Functional upgrades on existing diagnostics systems for on-line analysis of operating characteristics and vibration measurement of motors
Dr. Janko Petrovčič
Domel, d. o. o.
12. Development of the new family of dpMA and MD valve actuators
Asst. Prof. Damir Vrančić
Danfoss Trata, d. o. o.
13. Co-financing project: Method for the forecasting of local radiological pollution of atmosphere using Gaussian process models
Prof. Juš Kocijan
Reodom d. o. o.
14. Contract for the program „GOSTOP: Building Blocks, Tools and Systems for Factories of the Future"
Dr. Dejan Gradišar
TECOS
15. Contract for the program „GOSTOP: Building Blocks, Tools and Systems for Factories of the Future"
Dr. Pavle Boškoski
LPKF Laser & Electronics d.o.o.
16. Contract for the program „GOSTOP: Building Blocks, Tools and Systems for Factories of the Future"
Dr. Pavle Boškoski
Špica International d.o.o.
17. Contract for the program „GOSTOP: Building Blocks, Tools and Systems for Factories of the Future"
Dr. Giovanni Godena
Yaskawa Slovenija d.o.o.
18. Contract for the program „GOSTOP: Building Blocks, Tools and Systems for Factories of the Future"
Dr. Bojan Musizza
Optotek d.o.o.
19. Contract for the program „GOSTOP: Building Blocks, Tools and Systems for Factories of the Future"
Dr. Bojan Musizza
L-TEK d.o.o.
20. Contract for the program „GOSTOP: Building Blocks, Tools and Systems for Factories of the Future"

Dr. Vladimir Jovan
Fotona d.o.o.

21. Contract for the program „GOSTOP: Building Blocks, Tools and Systems for Factories of the Future"
Prof. Đani Juričić
University of Maribor

22. Contract for the program „GOSTOP: Building Blocks, Tools and Systems for Factories of the Future"
Dr. Pavle Boškoski
Kolektor Group d.o.o.

23. Contract for the program „GOSTOP: Building Blocks, Tools and Systems for Factories of the Future"
Prof. Đani Juričić
Inea d.o.o.

24. Contract for the program „GOSTOP: Building Blocks, Tools and Systems for Factories

of the Future"
Dr. Pavle Boškoski
Cosylab, d.d.

25. Contract for the program „GOSTOP: Building Blocks, Tools and Systems for Factories of the Future"
Dr. Pavle Boškoski
NELA razvojni center d.o.o.

26. Contract for the program „GOSTOP: Building Blocks, Tools and Systems for Factories of the Future"
Dr. Bojan Musizza
Podkrižnik d.o.o.

27. Development of Programme Modules for „Podkrižnik" Company
Dr. Bojan Musizza
Podkrižnik d.o.o.

VISITOR FROM ABROAD

1. Armando Salvati, University of Salerno, Fisciano (SA), Italy, 1 January to 28 February 2017
2. Ilaria La Rocca, University of Salerno, Fisciano (SA), Italy, 6 February to 6 June 2017
3. Ornella Cannavacciuolo, University of Salerno, Fisciano (SA), Italy, 6 February to 6 June 2017
4. Vanja Subotić, Technische Universität Graz, Graz, Austria, 18 October 2017
5. Dr Nicole Gehring, Johannes Kepler University, Linz, Austria, 21–30 October 2017

STAFF

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1. Dr. Pavle Boškoski
2. Dr. Gregor Dolanc
3. Dr. Samo Gerkšič
4. Dr. Giovanni Godena
5. Dr. Dejan Gradišar
6. Dr. Nadja Hvala
7. **Dr. Vladimir Jovan, Head**
8. Prof. Đani Juričić
9. Prof. Juš Kocijan
10. Dr. Bojan Musizza
11. Dr. Marko Nerat
12. Dr. Matija Perne
13. Dr. Janko Petrovčič
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24. Stanislav Černe, B. Sc.
25. Primož Fajdiga, B. Sc.

Technical and administrative staff
26. Maja Janežič, B. Sc.
27. Miroslav Štrubelj

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ORIGINAL ARTICLE

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2. Marija Božnar, Boštjan Grašič, Primož Mlakar, Dejan Gradišar, Juš Kocijan, "Nonlinear data assimilation for the regional modeling of maximum ozone values", *Environ. sci. pollut. res. int.*, **24**, 31, 24666-24680, 2017.
3. Marija Božnar, Boštjan Grašič, Primož Mlakar, Dejan Gradišar, Juš Kocijan, "The use of a new diagram for the analysis of the daily cycles in the air-pollution data", *Int. j. environ. pollut.*, **62**, 2/4, 385-394, 2017.
4. Gregor Dolanc, Boštjan Pregelj, Janko Petrovčič, Remzi Can Samsun, "Control of an afterburner in a diesel fuel cell power unit under variable load", *J. power sources*, **338**, 117-128, 2017.
5. Boštjan Dolenc, Pavle Boškoski, Martin Stepančič, Antti Pohjoranta, Đani Juričić, "State of health estimation and remaining useful life prediction of solid oxide fuel cell stack", *Energy convers. manage.*, **148**, 993-1002, 2017.
6. Boštjan Dolenc, Darko Vrečko, Đani Juričić, Antti Pohjoranta, Cesare Pianese, "Online gas composition estimation in solid oxide fuel cell systems with anode off-gas recycle configuration", *J. power sources*, **343**, 246-253, 2017.
7. Nadja Hvala, Darko Vrečko, Meta Levstek, Cirila Bordon, "The use of dynamic mathematical models for improving the designs of upgraded wastewater treatment plants", *J. sustain. dev. energy water environ. syst.*, **5**, 1, 15-31, 2017.
8. Danjela Kuščer, Tadej Rojac, Darko Belavič, Marina Santo-Zarnik, Andraž Bradeško, Tomaž Kos, Barbara Malič, Marcel Boerrigter, Diego Morrilo Martin, Mirko Faccini, "Integrated piezoelectric vibration system for fouling mitigation in ceramic filtration membranes", *J. membr. sci.*, **540**, 277-284, 2017.
9. Primož Mlakar, Dragana Kokal, Boštjan Grašič, Marija Božnar, Dejan Gradišar, Juš Kocijan, "Validation of meteorological forecasts in fine spatial and temporal resolution produced as an input for dispersion models", *Int. j. environ. pollut.*, **62**, 2/4, 236-246, 2017.
10. Marko Nerat, "Modeling and analysis of short-period transient response of a single, planar, anode supported, solid oxide fuel cell during load variations", *Energy (Oxford)*, **138**, 728-738, 2017.
11. Matija Perne, Matt Covington, Evan Thaler, Joseph M. Myre, "Steady state, erosional continuity, and the topography of landscapes developed in layered rocks", *Earth surface dynamics*, **5**, 85-100, 2017.
12. Boštjan Pregelj, Andrej Debenjak, Gregor Dolanc, Janko Petrovčič, "A diesel-powered fuel cell APU: reliability issues and mitigation approaches", *IEEE trans. ind. electron.*, **64**, 8, 6660-6670, 2017.
13. Gregor Primc, Alenka Vesel, Gregor Dolanc, Damir Vrančić, Miran Mozetič, "Recombination of oxygen atoms along a glass tube loaded with a copper sample", *Vacuum*, **138**, 224-229, 2017.

PUBLISHED CONFERENCE CONTRIBUTION

1. Darko Belavič, Katarina Vojisavljević, Danjela Kuščer, Tanja Pečnik, Jerzy Zając, Adrian Anghelescu, George Muscalu, Marjan Hodnik, Tomaž Kos, Silvo Drnovšek, Barbara Malič, "Ceramic packaging of PiezoMEMS

devices", In: *European Microelectronics Packaging Conference, EMPC 2017, 10-13 September 2017, Warsaw, Poland.*

2. Pavle Boškoski, Boštjan Dolenc, Bojan Musizza, Đani Juričić, "Model-based prediction of the remaining useful life of the machines", In: *Proceedings of the 20th IFAC World Congress, 9-14 July 2017, Toulouse, France,* (IFAC papersOnline, **50**), New York, International Federation of Automatic Control = IFAC, 2017, **50**, 1, 12803-12808.

3. Boštjan Dolenc, Pavle Boškoski, Antti Pohjoranta, Matti Noponen, Đani Juričić, "Hybrid approach to remaining useful life prediction of solid oxide fuel cell stack", In: *SOFC-XV, 15th International Symposium on Solid Oxide Fuel Cells, July 23, 2017 - July 28, 2017, Hollywood, FL,* Subhash C.Singhal, ed., T. Kawada, ed., *ECS transactions*, **78**, 1, 2251-2264, 2017.

4. Nadja Hvala, Darko Vrečko, Cirila Bordon, "Assessment of upgraded full-scale wastewater treatment plant performance through a plant-wide modelling approach", In: *Proceedings*, fFrontiers International Conference on Wastewater Treatment (FICWTM), May 21-24, 2017, Palermo, Italy, Giorgio Mannina, ed., [S. l.], IWA = International Water Association, 2017, 896-902.

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MENTORING

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