Univerza v Mariboru

FRAMEWORK PROGRAMME OF EARLY STAGE RESEARCHER TRAINING[1]

1. BASIC DATA

Mentor's name and surname	**Luka Lešnik**	Mentor's register number at ARIS (SICRIS):	**33258**
Mentor's e-mail:	luka.lesnik@um.si	Mentor's tel. no.:	02 220 7734
Research programme (RP) leader's name and surname:	Matjaž Hriberšek	RP leader's register number at ARIS (SICRIS):	11167
Title of research programme:	Research in Power, Process, and Environmental Engineering	RP's Register number at ARIS (SICRIS):	P2-0196
Research organisation (RO) of University of Maribor, where training shall be conducted:	UM FME	RO Register number at ARIS (SICRIS):	0795
Research field according to ARIS classification:	2.13 Procesno strojništvo	Research field according to Ortelius classification (EURAXESS)	15.22 Process engineering

2. DEFINITION OF RESEARCH PROBLEM AND GOALS OF DOCTORAL RESEARCH[2]

Starting point of research task of the early stage researcher and its position in the research programme, where the mentor is included, work hypothesis, research goals and foreseen result with emphasis on an original contribution to science:

The starting point of the young researcher's research task and its placement in the research program or in a research project in which the mentor is involved:
The whole world is facing the problem of the energy consumption growth, which is increasing by 1% on average per year in all sectors of energy consumption (industry, households and transport). In 2022 81.8% of global energy was still obtained from fossil fuels, from which the largest share was obtained from oil (31.6%), followed by coal (26.7%) and natural gas (23.5%). Another big problem

[1] *Term early stage researcher (ESR) is written in male form and used as neutral for women and men.*

[2] *Research and study programme of training have to harmonise with contents of the research programme, where the mentor is a member.*

facing the whole world is the issue of waste, especially waste plastic. Waste and waste plastics have high energy potential that can be used to obtain raw materials that have the potential to partially replace fossil fuels. The obtained raw materials can be in liquid, gaseous or solid form. They are often called synthetic fuels. Liquid synthetic fuels have the greatest potential for use in existing heat engines. The physical-chemical compositions of synthetic fuels are often affected by inhomogeneity in the composition of raw materials for their production, various additives (stabilizers, flame retardants, dyes, etc.) and their production processes. Therefore, it is necessary to check their properties (compositions) and the influence on the processes inside the heat engines before their usage in heat engines (internal combustion engines, gas power-plants and gas turbines, boiler burners, etc.), These can be verified experimentally and/or numerically using appropriate computational models (numerical methods).

Working hypothesis and work methods:

In the course of the proposed research, we will follow the working hypothesis that waste represents a great energy potential, which can be used for the production of synthetic fuels by choosing appropriate processes. With the appropriate upgrade of some heat engines components, synthetic fuels can be used to power heat engines. The research work will be divided into an experimental and a numerical part. Each part will consist of several steps. Experimental work in the field of fuels will be divided into determining the energy potential of waste, obtaining synthetic fuels from waste using thermal and catalytic pyrolysis processes, and characterizing the obtained synthetic fuels. In the second part of experimental work measurements on selected components of heat engines (e.g., fuel injection nozzles) will be performed, followed by measurements on real heat engines or their models. These results will give us an insight on the influence of the properties of synthetic fuels on fuel injection process, fuels combustion process in heat engines and influence on the environmental impact of their use compared to fossil fuels. Numerical modelling of individual processes within heat engines and their components is planned simultaneously with the experimental work.

Simulations enable us to do numerical experiments that can contribute to faster and more affordable virtual optimization of heat engine components for operation with synthetic fuels. The numerical experiment also allows us to obtain information (e.g., velocity fields and temperature fields) inside the components of heat engine in non-invasive way.

Research objectives and expected results with an emphasis on original contribution to science:

The goal of the research work is to investigate the energy potential of plastic and other waste with the aim of obtaining liquid synthetic fuels for use in heat engines. The aim of the research is then extended to study the potential use of synthetic fuels in heat engines (like gas turbines) and the study of the environmental impacts of the use of synthetic fuels and their comparison with fossil fuels.

The study will also give us an insight into the reduction of the environmental impact due to secondary use of waste (combustion in heat engines with the aim of obtaining nett work or heat) compared to traditional methods of waste treatment (landfilling, co-incineration, incineration, etc.).

Together with the first two goals, the study will offer Slovenian companies for waste treatment (Snaga, Cerop, ...) alternative options for waste treatment and acquisition of secondary raw materials with application for their use.

3. STUDY PROGRAMME

Foreseen study programme, to which early stage researcher shall be enrolled in academic year 2024/2025:

The doctoral school study programme,3. cycle,Doctoral School of the Faculty of Mechanical Engine ering.
Year 2024/2025: 1.year; Individual research work 1 and 2
Year 2025/2026: 2.year; Individual research work 3 and 4
Year 2026/2027: 3. year; Individual research work 5 and 6;
Doctoral dissertation; Defense of doctoral dissertation.

4. DESCRIPTION OF WORK AND TASKS

Implementing projects of scientific research.
Taking part in the design of research programmes.
Cooperating with research sponsors.
Drawing up research and other reports.
Monitoring and coordinating research work according to the grant agreement.
Ensuring safety and health at work.
Organising and instructing employees and students on using personal safety equipment and other safety measures.
Performing other tasks at the behest of the superiors.
Participating in ad-hoc and permanent committees of university or faculty bodies.
Acting on behalf of colleagues and superiors during their absence (upon authorisation).
Participating in annual and other inventories.
Performing other related tasks delegated by superiors.

5. REQUESTED LEVEL OF EDUCATION

VII/2. tariff group

6. REQUESTED FIELD OF EDUCATION

Technical, Natural sciences

7. KLASIUS SRV

Seventh level: Second cycle of higher and similar education/Second cycle of higher and similar education

8. KLASIUS P

145 – Education of teachers of individual subjects
4 - Natural science, mathematics and computing
5 - Engineering, manufacturing and construction

9. REQUESTED KNOWLEDGE

Computer skills: MS Windows, Word, Excel, Internet, e-mail, e-commerce

10. REQUESTED SPECIAL REQUIREMENTS

/

11. REQUESTED LANGUAGES

Active knowledge of one world language

12. REQUESTED WORK EXPERIENCE

/

13. FORESEEN POSTDOCTORAL TRAINING

Kliknite ali tapnite tukaj, če želite vnesti besedilo.

Mentor's signature:

Research programme leader's signature:

Name and surname of Dean or authorised person[3]:
red. prof. dr. Matej Vesenjak

Signature of dean or authorised person:

Place and date:

Maribor, 23.02.2024

Kliknite ali tapnite tukaj, če želite vnesti datum.

Stamp:

[3] The training program is signed by the dean of the member where the ESR's employment and training will take place.