

**Application form for research topics in the field of engineering and
technology for candidates to the Doctoral School
in the academic year 2025/2026**

Proposed subject matter of a doctorate
Study of the phenomenon of condensation of pro-environmental refrigerant mixtures in compact heat exchangers fabricated by 3D printing from metal powders
Scientific discipline
MECHANICAL ENGINEERING
Proposed doctoral thesis supervisor
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Brief description of the research topics with an indication of the scientific issues (max. 350 words)
The study of the phenomenon of liquefaction of new pro-ecological mixtures of refrigerants in compact heat exchangers produced by the method of 3D printing from metal powders includes in its scope the execution of the design of the exchanger and carrying out the indicated tests in it. In the research it is planned to use mixtures from the following groups: R404A, R407C, R407F, R419A, R448A, R449A, R452A, R455A, R422D. The indicated refrigerants are considered as replacements for chemical compounds that are being phased out or have already been phased out due to their negative environmental impact. It is therefore important to carry out studies to identify characteristic quantities concerning the condensation process of these types of thermodynamic agents in mini heat exchanger systems.
Justification of the purposefulness of taking up the research topics (max. 150 words)
Current regulations are forcing the use of new environmentally neutral working factors in left-handed thermodynamic systems (refrigeration equipment, air conditioning, heat pumps). In most cases, the working factors used are in the form of mixtures, which can cause uneven evaporation or condensation (temperature slippage). Currently, there is a lack of studies on this issue and, in particular, when these processes occur in channels with hydraulic diameters not exceeding 6 mm.
Proposed topics of doctoral theses within the proposed research subject matter (up to 3 topics)
1. Study of the phenomenon of condensation of pro-environmental refrigerant mixtures in compact heat exchangers fabricated by 3D printing from metal powders
The sources of financing of the research topics (the subject matter of currently implemented research grants financed from external sources or as part of subsidies)
Own funds of the Department of Energy and planned application to NCN within the Opus and Prelude competition

Confirmation of the possibility of ensuring access to scientific apparatus and software necessary for the realization of the proposed research topics

FULLY

If the answer is PARTIALLY or NONE please indicate a type of missing scientific apparatus and/or software and the sources of financing an access to them

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List of the supervisor's scientific achievements in the field of indicated scientific problems

A list of up to 5 major supervisor's publications related to the proposed research topics, published in journals indexed in the Web of Science or Scopus for the period of the last 3 years (taking into account the IF Impact Factor and the MNiSW score)

1. Kuczyński W., Chliszcz, K.: *Experimental investigations into the condensation process of new environmentally friendly f-gas substitutes in mini-channels*. **Energy** Volume 295, 15 May 2024, 130883. (MEiN – 200 pkt.)
2. Kuczyński W.: *Modeling the phenomena accompanying the condensation of environmentally friendly refrigerants in mini-channels*. **Archives of Thermodynamics** Volume 44, No. 1 pp. 121 – 137, 2023. DOI:10.24425/ather.2023.145880 (MEiN – 140 pkt.)
3. Kuczyński W., Kruzel M., Chliszcz K.: *Regression Model of Dynamic Pulse Instabilities during Condensation of Zeotropic and Azeotropic Refrigerant Mixtures R404A, R448A and R507A in Minichannels*. **Energies** Vol. 15, No. 5 2022, 1789. (MEiN – 140 pkt.)
4. Kuczyński W., Kruzel M., Chliszcz K.: *A Regressive Model for Periodic Dynamic Instabilities during Condensation of R1234yf and R1234ze Refrigerants*. **Energies** Vol. 15, No. 6 2022, 2117. (MEiN – 140 pkt.)
5. Kruzel M., Bohdal T., Dutkowski K., Kuczynski W., Chliszcz K.: *Current Research Trends in the Process of Condensation of Cooling Zeotropic Mixtures in Compact Condensers*. **Energies** Vol. 15, No. 6 2022, 2241. (MEiN – 140 pkt.)
6. Kuczyński, W., Charun, H., Piątkowski, P., Bałasz, B., Chliszcz, K.: *A regressive model for dynamic impulsive instabilities during the condensation of R134a, R1234ze(E) and R1234yf refrigerants*. *International Journal of Heat and Mass Transfer* Volume 169, April 2021, 120963. (MEiN – 200 pkt.)

A list of research grants financed by the National Science Centre, the National Centre of Research and Development and the European Research Council for the period of the last 5 years

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A list of research services provided for industry related to the proposed research topics for the period of the last 5 years

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