



Acronym:

FluidExAp

Titlul proiectului:

NOI FLUIDE DE TRANSFER TERMIC ÎN OPERAȚII DE SCHIMB DE CĂLDURĂ

Contract nr. 18 PCE / 08.01.2025

**Proiect finanțat de Ministerul Cercetării, Inovării și digitalizării,
CNCS - UEFISCDI, în cadrul PNCDI IV**

Data de începere a proiectului: 8 ianuarie 2025

Durata proiectului: 36 luni

Livrabil Nr. 1.4

RAPORT CĂTRE AUTORITATEA CONTRACTANTĂ

Data	31/12/2025	
Autor livrabil	Alina Adriana MINEA	
Status	Draft/Final	
Nivel de diseminare	PU / CO	
Aprobat	30/09/2025	30/09/2025

1. Raport la finalul Activității 1

1.1. Cerințe din cererea de finanțare

Cererea de finanțare prevede 4 livrabile cu efect în a produce fluidele de transfer termic, și anume :

Deliverables:

- D1.1 Report on new NFs,
- D1.2. Report on sonication/stability experiments,
- D1.3. Dissemination plan deliver,
- D1.4. Reports to funding organization;

Key milestones:

- M1.1. Stable fluids

A1. Manufacturing the nanofluids (extras din cererea de finanțare)

Tasks: A1.1. Acquisition of base fluids and nanoparticles, conceiving the new fluids by calculating the suspensions and sonication time; A1.2. Manufacturing of the new NF

This activity implies the acquisition of nanoparticles and base fluids. The envisaged nanoparticles are: alumina, CNT, Cu, Ag and the base fluids are polyethylene glycol (i.e. PEG 400) and different thermal oils (Therminol-55, Therminol 67, Dowtherm A and Therminol VP-1 will be the first choice – see the review performed by the PI in 2022) are water mixtures, if possible (this alternative will be studied punctually in order to decrease the viscosity without affecting operating temperature or samples properties). Using water mixtures was proved extremely beneficial in the ionic liquids preparation (see previously published papers). The volume fractions are in the range: 0.01-3% (i.e. low volume nanoparticles concentrations are envisaged, in order to control the viscosity increase).

This can go to at least 7 types of new fluids and about 35 samples. Both the mixtures and new fluids will be calculated based on chemical and mixing formulas based on mole fraction (for the mixtures) and mass fractions (for the suspensions), as we also described in our recently published papers. Firstly, we will buy little quantities of nanoparticles and base fluids in order to obtain 15 ml for each new fluid, quantity needed for testing the properties. Further on, when we will be able to decide which NF can give better thermophysical properties improvement and stability, we will purchase a larger quantity (i.e. **feedback loop with A2**) needed for the experimental set-up from A4. The phases of obtaining the new fluids are: calculating the dilutions, obtaining the mixtures and suspensions, establishing the

volume fractions, calculating the sonication time and perform sonication. Also, a study on surfactants (SDS/SDBS or ionic liquids as these were lately identified in the literature as the best surfactants) will be considered, depending on NF stability.

1.1.2. Realizări în cadrul proiectului

Încă de la debutul proiectului au fost demarate achizițiile de materiale și echipamente, astfel că nu au fost întârzieri.

În tabel este prezentată o analiză comparativă aceea ce a fost scris în cererea de finanțare și ceea ce a fost realizat în cadrul proiectului. În coloana observații sunt trecute justificări în cazul în care au fost abateri.

Prevăzut în cererea de finanțare	Realizat	Observații
This activity implies the acquisition of nanoparticles and base fluids. The envisaged nanoparticles are: alumina, CNT, Cu, Ag and the base fluids are polyethylene glycol (i.e. PEG 400) and different thermal oils (Therminol-55, Therminol 67, Dowtherm A and Therminol VP-1 will be the first choice – see the review performed by the PI in 2022)	S-au achiziționat nanoparticule de Mg, MWCNT, TiO ₂ , Cu, Ag, Al ₂ O ₃ , MgO. Si fluidele PEG 200 și PEG 400. Au fost achiziționați și un număr de 5 tipuri de surfactanți : SDS, SDBS, PVP, PSS, CTAB.	Nu a fost posibilă achiziționarea de uleiuri termice, deoarece cantitatea minimă cerută de distribuitor era 20 litri. Au fost scrise mesaje către producători, dar nu s-a primit răspuns.
Water mixtures, if possible (this alternative will be studied punctually in order to decrease the viscosity without affecting operating temperature or samples properties). Using water mixtures was proved extremely beneficial in the ionic liquids preparation (see previously published papers).	S-au realizat fluide de tip mixtură, fiind implicată și apa în suspensii. S-au preparat probe cu apă și TiO ₂ .	Mixturile PEG 200 + apă au dovedit rezultate mai slabe decât cele dintre PEG 200 + PEG 400.
The volume fractions are in the range: 0.01-3% (i.e. low volume nanoparticles	Suspensiile au fost calculate în procente de masă.	

<p>concentrations are envisaged, in order to control the viscosity increase).</p>	<p>Suspensiile au fost până în 2.5 %wt, fiind realizate și două suspensii mai concentrate : F3 + 5%wt MgO și 7.5 %wt. MgO pentru a putea observa diferențele.</p>	
<p>This can go to at least 7 types of new fluids and about 35 samples.</p>	<p>Au fost realizate următoarele tipuri de suspensii :</p> <ul style="list-style-type: none"> - pilon PEG : 6 clase de fluide (PEG 200, F3 și F4 cu MgO sau MWCNT). Total 28 probe - pilon surfactanți : o probă martor și probe cu 8 surfactanți în câte 3 concentrații (printre care și PEG sau lichid ionic). Total : 25 probe 	<p>7 tipuri de noi fluide 53 probe testate</p>
<p>Both the mixtures and new fluids will be calculated based on chemical and mixing formulas based on mole fraction (for the mixtures) and mass fractions (for the suspensions), as we also described in our recently published papers. Firstly, we will buy little quantities of nanoparticles and base fluids in order to obtain 15 ml for each new fluid, quantity needed for testing the properties. Further on, when we will be able to decide which NF can give better thermophysical properties improvement and stability, we will purchase a larger quantity (i.e. feedback loop with A2) needed for the experimental set-up from A4. The phases of obtaining the new fluids are: calculating the dilutions, obtaining the mixtures and suspensions, establishing the volume fractions, calculating the sonication time and perform sonication. Also, a study on surfactants (SDS/SDBS or ionic liquids as these were lately identified in the literature</p>	<p>Realizat, conform protocoalelor elaborate și rezultatele incluse în livrabilele anterioare.</p>	<p>S-au realizat probe de minimum 30 ml, pentru a fi destulă cantitate pentru efectuarea testelor.</p>

as the best surfactants) will be considered, depending on NF stability.		
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Rezultatele experimentale au fost prezentate la conferințe și publicate în reviste de prestigiu.

Conferințe (8)

- **Discussion on polyethylene glycols mixtures and PEG + MWCNT nanocolloids behaviour in thermal applications**
 A A Minea, E I Cherecheș, C A Țugui, G C Tofan
 Computational Civil Engineering 2025, 7-9 May 2025, Iași, România
<https://www.cce.ci.tuiasi.ro/>
- **Nanocolloids Based on Polyethylene Glycol Mixtures for Heat Transfer Applications: a Combined Experimental and Numerical Study**
 N. Cojocariu, C.A. Tugui, E.I. Cherecheș, D. Bejan, B. Pricop, A.A. Minea
 HPC 2025 – 11th Heat Powered Cycles Conference, 25-28 May 2025, Lisbon, Portugal
<https://hpc2025.tecnico.ulisboa.pt/>
- **An experimental study on the influence of different new surfactants on nanocolloids properties**
 G. Tofan, C.A. Tugui, E.I. Cherecheș, D. Bejan, B. Pricop, A.A. Minea
 Emerging Materials Global Network (EMGN) 2025, 1-3 September 2025, Istanbul, Turkey
<https://2025.emgn-meeting.org/>
- **PEG based nanocolloids for heat transfer applications: a study on heat transfer enhancement in laminar flow**
 G. C. Tofan, N. Cojocariu, C. A.Tugui, B. Pricop, M. N. Lohan, E. I. Chereches, D. Bejan, A. A. Minea
 4th Journal of Thermal Analysis and Calorimetry Conference and 10th V4 Thermoanalytical Conference, 24-27 June 2025, Budapest, Hungary
<https://akcongress.com/jtacc/>
- **Surfactant influence on high loaded nanofluids: a study on thermal effusivity**
 G. C. Tofan, C. A. Tugui, N. Cojocariu, E. I. Cherecheș, D. Bejan, B. Pricop, A. A. Minea
 International Conference on Applied Sciences, ICAS 2025, 29.05. – 31.05.2025, Hunedoara – Romania
<https://icas.fih.upt.ro/>
- **Low molecular mass polyethylene glycol mixtures for heat transfer applications**
 N. Cojocariu, PhD supervisor: A. A. Minea

International Conference of the Doctoral School, 14-16 May 2025, Iași, România

<https://conferinta-csd.tuiasi.ro/>

- **Surfactants employed for nanofluids stabilization: recent research and trends**

G. C. Tofan, PhD supervisor: A. A. Minea

International Conference of the Doctoral School, 14-16 May 2025, Iași, România

<https://conferinta-csd.tuiasi.ro/>

- **Surfactants for stable nanocolloids: an experimental approach**

G. Tofan, C.A. Tugui, E.I. Cherecheș, D. Bejan, B. Pricop, and A.A. Minea

Conferința Internațională EmergeMAT Ediția a 8-a, Tehnologii emergente în ingineria materialelor 6-7 octombrie 2025

<https://imnr.ro/wp/conferinta-internationala-emergemat-editia-a-8-a/>

Articole în reviste (4, din care 2 Q1 și 2 Q2)

- **Studies on several mixtures of PEG based phase change materials for heat transfer**

Applications: An experimental approach

D. Bejan, N. Cojocariu, E.I. Cherecheș, A.A. Minea

Journal of Molecular Liquids 429 (2025) 127652

doi: <https://doi.org/10.1016/j.molliq.2025.127652>

- **Nanocolloids Based on PEG Mixtures with Several Nanoparticles: Experimental Study on Viscosity, Thermal Conductivity, Density and Isobaric Heat Capacity**

N Cojocariu, CA Tugui, EI Cherecheș, AA Minea

International Journal of Thermophysics 46 (10) (2025), 1-21

doi: <https://doi.org/10.1007/s10765-025-03621-6>

- **Surfactants for heat exchange nanocolloids: Review of advantages, drawbacks, quantitative information and recommendations**

AA Minea

Thermal Science and Engineering Progress 65 (2025) 103983

<https://doi.org/10.1016/j.tsep.2025.103983>

- **Discussion on polyethylene glycols mixtures and PEG + MWCNT nanocolloids behaviour in thermal applications**

A A Minea, EI Chereches, CA Tugui, GC Tofan

Applied Sciences 15 (18) (2025) 9898

doi: <https://doi.org/10.3390/app15189898>

Articole under review (4):

- **Experimental studies on developing novel nanocolloids based on PEG mixtures and different nanoparticles: insights into thermal conductivity and effusivity**
Nicoleta COJOCARIU, Elena Ionela CHERECHEȘ, Dana BEJAN, Bogdan Pricop, Alina Adriana MINEA
Case Studies in Thermal Engineering
- **PEG 200/400 mixture and Metallic/Oxide Nanoparticles Nanocolloids: Experimental Evaluation of Thermophysical Properties**
Nicoleta Cojocariu, Cătălin Andrei Țugui, Elena Ionela Cherecheș, Alina Adriana Minea
Journal of Energy Storage
- **PEG based nanocolloids for heat transfer applications: a study on heat transfer enhancement in laminar flow**
George Catalin Tofan, Nicoleta Cojocariu, Catalin Andrei Tugui, Bogdan Pricop, Monica Nicoleta Lohan Elena Ionela Chereches, Dana Bejan, Alina Adriana Minea
Journal of Thermal Analysis and Calorimetry
- **A complex investigation of electrical conductivity and pH of polyethylene glycol nanocolloids**
Nicoleta Cojocariu, Elena Ionela Chereches, Dana Bejan, Alina Adriana Minea
Journal of Molecular Liquids