COURSE DESCRIPTION CARD - SYLLABUS

Course name
Technical rheology [S1IChiP1>RT]

Course

Field of study
Chemical and Process Engineering

Year/Semester
3/5

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
30

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

5,00

Coordinators

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Lecturers

Prerequisites

Students starting this subject should have basic knowledge in mathematics, physics, chemistry, statistics, engineering graphics, fluid mechanics and materials technology. They should also have the ability to use spreadsheets, performing statistical analysis of measurement results and be ready to work in a team.

Course objective

1. Getting students with the basic knowledge of technical rheology, in particular with properties of non-Newtonian fluids and their microstructure, rheometry and methods of calculation of pressure loss. 2. Development of ability of perform rheological study and practical use of the results obtained from experiment.

Course-related learning outcomes

Knowledge:
1. the student knows the basic concepts of rheology: dynamic, kinematic and extensional viscosity, flow

and viscosity curves, deborah number, classification of fluids - [k_w11]
2. the student knows the basic rheological properties of time-independent and time dependent fluids, viscoelastic fluids, magneto- and electrorheological fluids and methods of their mathematical description - [k_w11]
3. the student knows the theoretical basis of capillary and rotational rheometry, measurement methods of viscoelastic properties of fluid and extensional viscosity, advantages and disadvantages of the different measurement methods and principles of their selection - [k_w11]
4. the student knows the basic rheological properties of polymeric fluids, two-phase systems, and biomaterials used in the chemical industry - [k_w09]
5. the student knows the methods of calculating the pressure loss for different classes of non-newtonian fluids in pipelines - [k_w11], [k_w15]

Skills:
1. the student is able to select an appropriate measurement method for determining the rheological properties of the various fluids - [k_u08], [k_u18]
2. the student can perform rheological measurements using different methods - [k_u08], [k_u12]
3. the student is able to distinguish, based on the experimental studies, the rheological properties of various non-newtonian fluids and to use appropriate mathematical rheological models to describe the flow curves - [k_u08]
4. the student is able to find relation between rheological properties of fluid and their application - [k_u07]

Social competences:
1. the student understands the need to broaden their knowledge and skills due to the rapid advances in the chemical industry. he is aware that continuous training is a way to remain competitive in the labor market - [k_k01]
2. the student can independently and as a team perform various tasks. he is aware of the responsibility for their implementation within the team - [k_k04]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Knowledge acquired during the lecture is verified during the exam. The exam consists of 5 open questions for the same number of points and about 30 closed test questions. Minimum threshold: 50% points. Exam issues, on the basis of which questions are formed, will be sent to students by e-mail using the university e-mail system. The online exam will be conducted only in the form of a test via the eKursy platform.
Skills and knowledge acquired as part of the laboratory are verified on a daily basis based on oral answers and 2 final tests. To pass the laboratory you must:
1. Provide an oral answer from the material contained in the exercises and from the given issues (each failing grade must be corrected to a positive).
2. Perform all laboratory exercises provided in the study program
3. Get passes for reports on the exercises performed.
4. Pass two tests: 1 - test (about 15 closed questions); 2 - three open-ended questions (passing threshold: 51% of points)
5. The final grade will be issued on the basis of:
a) the arithmetic mean of all grades obtained from oral responses,
b) the arithmetic mean of all the grades obtained in the tests.
The arithmetic means calculated in this way will be divided by two and the final grade will be issued according to a scale: up to 2.74 - unsatisfactory; from 2.75 to 3.24 - sufficient; from 3.25 to 3.74 - a sufficient plus; from 3.75 to 4.24 - good; from 4.25 to 4.74 - a good plus; from 4.75 - very good)
Passing the laboratory will be in an online form, carried out on the same terms via the eMeeting platform or another platform recommended by the Poznań University of Technology.

Programme content

The course covers the following topics:
1. The elastic, viscous and viscoelastic response
2. Time as an additional parameter in characterizing material response

3. Simple shear of solids and fluids
4. Kinematic viscosity and dynamic viscosity
5. Influence of temperature and pressure on the rheological properties of fluids
6. Non-Newtonian fluids: definition, the concept of a generalized Newtonian fluids, classification
7. Mathematical descriptions of flow curves of time-independent fluids
8. The interpretation of the phenomena of shear thickening and shear thinning
9. Yield stress fluids (microstructure and methods of determining yield stress)
10. Time-dependent fluids (thixotropy and anti-thixotropy)
11. First normal stress differences
12. Normal stress effects (Weissenberg effect, Barus effect)
13. Mechanical models of viscoelastic liquids (Maxwell, Kelvin, Burgers)
14. Magnetorheological and electrorheological fluids
15. Viscometric flows
16. Characteristics of viscometers (gravitational capillary viscometers, orifice viscometers, falling ball viscometers)
17. Single particle settling (falling velocity, the drag force on a spherical and non-spherical particle, Schiller-Naumann model, Kozioł model).
18. Capillary rheometry - basic equations.
19. Rotational rheometry - basic equations.
20. Measurement methods of viscoelastic fluid properties
21. Advantages and disadvantages of rheometers: capillary rheometers, concentric cylinders rheometers, cone-and-plate rheometers
22. Extensional viscosity – definition and measurement methods
23. Calculation of pressure drop of non-Newtonian fluid flow in channels
24. Drag reduction phenomenon
25. Rheological properties of polymeric fluids
26. Rheological properties of dispersed two-phase systems
27. Methods of estimating a shear rate

Course topics

none

Teaching methods

1. Lecture: multimedia presentation, illustrated with examples on the board.
2. Laboratory exercises: performing rheological measurements using viscometers and rheometers.

Bibliography

Basic
1. M. Dziubiński, T. Kiljański, J. Sęk, Podstawy teoretyczne i metody pomiarowe reologii, Wydawnictwo Politechniki Łódzkiej, Łódź 2014.
2. M. Dziubiński, Kiljański T., Sęk J.: Podstawy reologii i reometrii płynów, Wydawnictwo Politechniki Łódzkiej, Łódź 2009.
3. T. Kiljański, M. Dziubiński, J. Sęk, K. Antosik: Wykorzystanie właściwości reologicznych płynów w praktyce inżynierskiej, Wydawca EKMA Krzysztof Antosik, Warszawa 2009.
4. K. Wilczyński: Reologia w przetwórstwie tworzyw sztucznych, Wydawnictwo Naukowo-Techniczne, Warszawa 2001.
Additional
1. J. Ferguson, Z. Kembłowski: Reologia stosowana płynów, Wydawnictwo Marcus s.c., Łódź 1995.
2. Z. Kembłowski, T. Kiljański: Ćwiczenia laboratoryjne z reometrii technicznej, Wydawnictwo Politechniki Łódzkiej, Seria: Skrypty, Łódź 1993.
3. Z. Orzechowski, J. Prywer, R. Zarzycki: Mechanika płynów w inżynierii środowiska, WNT, Warszawa 1997.

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,00
Classes requiring direct contact with the teacher	75	3,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	50	2,00