



UNIVERSITY of MISKOLC
Faculty of Materials Science and Engineering
Antal Kerpely Doctoral School of Materials
Science & Technology



Hot forming

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COURSE DESCRIPTION

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Lecturer

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Recommendation

The lecture is proposed for all students of the Kerpely doctoral school, especially in the field of metal forming, physical metallurgy, heat treatment and casting.

Language

Hungarian or English.

Scope

The objective of the course is to teach the processes of hot forming of metals, considering the changes in material structure during the forming. Presentation of hot rolling, extrusion and forging. continuum mechanical basis of metal forming processes. To show the process planning of hot working.

Methodology

For larger student numbers, the course is held in contact lectures. The time of contact courses is based on agreements with the students. In case of 1-2 students, keywords are given of the corresponding block. Four blocks in total cover the whole course. Basic questions are also given for the blocks. 3 meetings are held during which answers for the basic questions, the students' questions and fundamentals are discussed.

Topics

1. Topic

High temperature deformation of crystalline materials: Structural and mechanical basis.

Basic mechanisms of plastic deformation. Hardening and softening during the forming. The phenomenon of superplasticity. Types of recrystallization. Textural development in plastic deformation. Changing the material properties under the conditions of hot forming. Damage, deformability in hot forming. Physical simulation of the hot deformation processes

Basic questions:

1. Determination of elementary processes of hot deformation.
2. Describe the hardening and softening processes of deformation.
3. What is the difference between the cold and hot deformation ?
4. What does it mean static and dynamic recrystallization, what factors influence the processes involved.

5. Describe the effects of inhomogeneous deformation and alloy distribution on recrystallisation.
6. What are the typical parameters for the hot-forming of metals? Which test methods can be used to determine the hot-workability?
7. How define the flow stress under hot forming conditions. Describe the measurement procedures and the evaluation methods.
8. Determine the concept of equivalent stress, equivalent deformation, and the total plastic deformation.
9. Describe the basic mechanical equations for determining the stress and strain state of 3D problem.
10. Describe the Gleeble Physical Simulator principle and the experiments that can be performed.

2. Topic

Hot rolling processes.

Analysis of stress and strain state of sheet rolling. Control of material structure and properties for hot rolling. Rolling equipment's. The main steps of technology planning. The methods of rolling for various materials. Interaction between the equipment, the rolls and the product. Accuracy of production

Basic questions:

1. Summarise the basic concepts of rolling.
2. Calculate the speed distribution of sheet during rolling. Describe the methods for the calculation of rolling force, torque and slip.
3. Describe the whole technological process of hot rolling, including the function of each equipment. What is the difference between the cold and hot deformation?
4. What are the main steps for rough rolling?
5. Describe the structure and classification of roll system.
6. Summarize the elastic deformation of the rolling, taking into account the influence of the part of the rolling mills.
7. Describe the method of roll pass design for products with different cross sections.
8. Defects in roll plates and sheets.
9. Shape rolling operations.
10. Characteristics of steel rolling.
11. Main features of aluminum rolling.
12. Modeling a property change during hot rolling. Physical and mathematical simulation.

3. Topic

Forging

Basic forging processes: open die forging, closed die forging. Tools and equipment's. Materials and loading of dies. Damage of dies. Thermo-mechanical analysis of forging. Factors determining the precision of the forged piece.

Basic questions:

1. The main steps and equipment's of open die forging. Typical products.
2. Technological steps of closed die forging. Methods for design of round and long parts.
3. The role of the cross rolling in the process of technological design.
4. Change of material structure during the closed die forging. The role of material fiber structure.
5. Determination of forging stress and strain. The cavity filling process, the shaping force and work. The roll of the flash.
6. Methodology of die design.
7. Die materials and lubrication.
8. Forgeability. Different tests

9. Forging machines.
10. Load and lifetime of forging dies.

4.Topic

Extrusion

Material flow in the narrowing channel. Mechanical basic equations of molding. Direct and indirect extrusion. Extrusion of circular and general cross section solid and hollow product .Design of extrusion technology Methods for planning of die and determining of the load.

Basic questions:

1. Determine the basic equation for extrusion in the conical channel using the energetical method.
2. How can you determine dead zone ?
3. Compare the loading force in case of direct and indirect extrusion
4. Describe the tool design for direct and indirect extrusion.
5. Design of extrusion of complex cross-sectional products.
6. Possible defects in extrusion and the ways of eliminating them.
7. Characteristics of extrusion of various metallic materials.
8. Load bearing capacity and lifetime of dies.
9. The use of flow functions for the design of tools.
10. Changing the material properties during extrusion.

References

1. T.Altan, S.OH, H.Gegel: Metal Forming Fundamentals and Applications,ASM 1983
2. K: Lange : Handbook of Metal Forming, McGraw Hill 1985
3. J.G. Lenard, M. Pietrzyk, L. Cser :Metal Forming: Mathematical and Physical Simulation of the Properties of Hot Rolled Products, Elsevier , 1999
4. E.M.Mielnik: Metalworking Science and Engineering, McGraw Hill 1991

Exam

Oral exam if basic questions are answered correctly.

Complex exam questions

1. How to determine the flow stress of the metall under the hot forming conditions. ?
2. Describe the hot rolling process of the thick plate, specifying the function of each unit.
3. The main technological steps of closed die forging, methods of force and power determination for each operation.
4. Comparison of direct and indirect extrusion, methods of designing on the processes.
5. What material laws can be used to design the hot forming processes?