UNIVERSITÄT
DUISBURG
ESSEN

Prof. T. Kasper
Fachbereich Ingenieurwissenschaften
Institut für Verbrennung und Gasdynamik
Thermodynamik
Massenspektrometrie in reaktiven Strömungsprozessen (*MRS*)

2 weeks course of lectures for students

„COMBUSTION: FROM BASICS TO RESEARCH"

presented by Dr. D. Knyazkov
(Voevodsky Institute of Chemical Kinetics and Combustion,
Novosibirsk State University, Russia)

Credits: 4; Exam: April 25-27, 2018
Exam form: talk by the student on one topic of the lecture and subsequent QnA
Target audience: ISE and Maschinenbau, Master level
First lecture: April 9, 11 am in MB445 a

Content:

1. **Fundamentals and mathematical description of combustion theory.** Nonstationary heat-conduction equation in a medium with continuously distributed heat sources. Similarity of concentration and temperature fields. The method of exponent expansion. Self-ignition and ignition. Semenov and Frank-Kamenetsky theory of the thermal explosion. Stationary and nonstationary thermal explosion theories. Chain explosion. Critical phenomena in branched-chain reactions. Ignition peninsula.
2. **Theory of laminar premixed flame propagation.** Thermal theories proposed by Mallard and Le Chatelier, by Zeldovich and Frank-Kamenetsky. Zeldovich's theory of the flame propagation with chain-branching reactions. Limits of flame propagation. Spark ignition.
3. **Laminar diffusion flames.** Burke-Schumann problem. Counterflow flames. Flame balls.
4. **Numerical modeling of combustion processes.** Numerical methods for modeling of reactive multi-component gas flows using detailed chemical kinetic mechanisms to describe the propagation velocity and structure of laminar flames. Thermodynamic databases. Boundary conditions. Analysis of reaction mechanisms, reaction pathways, sensitivity. Mathematical simulation of counterflow flames.
5. **Experimental methods for studying the combustion of gaseous flames.** Types of burners and flames. (Bunsen, Mache-Hebra , flat flame, spherical , opposed-jet , "cup")
6. **Measurement of the normal burning velocity.** Total flame area method. Schlieren method. Particle image velocimetry (PIV). Methods of a constant volume bomb, Heat-flux Counterflow-burner.
7. **Flame temperature measurements.** Thermocouples: The problem of heat exchange in the gas phase. Uncertainties. Pneumatic probe method. Optical methods for measuring flame temperature. Laser-induced fluorescence. CARS spectroscopy.
8. **Measurements of species concentrations in flames.** Molecular beam mass spectrometry. Sampling probe perturbations. Application of photoionization mass spectrometry for the flame studies. Chromatography, chromatomass spectrometry.
9. **Inhibition and promotion of combustion.** Flame retardants. Mechanism of flame inhibition. Organophosphorus inhibitors.
10. **Formation of hazardous substances in combustion, methods to reduce their emissions.** Formation of NO during combustion. Thermal and prompt mechanisms, mechanisms of NO production from N_2O and fuel nitrogen. Mechanisms and methods for reducing NO in combustion products: reburning technology, ammonia injection. Formation of soot in flames. Destruction of toxic waste by incineration.