Our Mission

To provide the next generation of combustion researchers, engineers and technologists with a comprehensive fundamental knowledge of the fluid mechanics and chemical kinetics of reacting flows, for application in issues related to energy and the environment.

The 2023 Session

The 2023 session will offer the following six courses:

- Combustion Chemistry
- Theoretical and Numerical Combustion
- Plasma Aided Combustion and Manufacturing
- Fundamentals of Detonations in Gases
- Mitigating the Carbon Footprint of Combustion through CO_2 Capture and Storage
- Formation of Polycyclic Aromatic Hydrocarbons and Soot through the Eyes of a Chemist

Due to the uncertainty in the development of the pandemic during planning of the Summer School, a hybrid format has evolved. Specifically, lectures will be remotely delivered by the lecturers, while on-campus attendance of the telecommunicated lectures and participation of additional academic and networking activities are arranged and required to maximize the learning experience.

Intended Participants

Graduate students, postdocs and faculty members in universities; combustion professionals in research organizations; R & D engineers in industries.

Program Dates

Classes and enrichment activities will be held from Monday, July 10 to Friday, July 14, 2023.

Application

Application is to be made online at http://www.cce.tsinghua.edu.cn/en/Outreach/Combustion_Summer_School/Overview.htm starting from Friday, April 7, 2023 to Saturday, April 29, 2023. Admission decisions will be sent by Monday, May 22, 2023. Admitted applicants will be notified of the date by which the registration fee is due to complete the registration. Late applications may be considered depending on space availability.

Expenses

Registration: 1200 RMB for students and 1500 RMB for all other participants.

Note on Course Selection

The courses on **Fundamentals of Flames** and **Combustion Chemistry and Kinetic Mechanism Development** are the foundational combustion courses, suggested to be taken by first-timers especially first-year students. The others are advanced, enrichment courses.

Further Inquiries

For inquiries on the academic program or the logistics of participation, please contact the program administrator, Ms. Hong Tian, (86)10-62796768, ccess@tsinghua.edu.cn, or the program co-organizer, Prof. Yu Cheng Liu, ycliu7@mail.tsinghua.edu.cn

Course Descriptions (All times are Beijing times)

Combustion Chemistry (July 10~14)

Lecturer: Michael J. Pilling, University of Leeds, UK

Course Content: Chemical mechanisms play a central role in combustion. Rate coefficients and products of key elementary reactions are important in those mechanisms. We shall examine how they are determined by experiment and by theory, and how they are incorporated in the chemical mechanisms used in combustion models. The course will cover aspects of experimental techniques, thermodynamics, statistical mechanics and theories of kinetics, including transition state and RRKM theories and master equation models. Approaches to constructing and assessing reaction mechanisms will be discussed.

Theoretical and Numerical Combustion (July 10~14)

Lecturer: Thierry Poinsot, Institut de Mécanique des Fluides de Toulouse, CNRS, France

Course Content: Theory and numerical simulations are essential elements of modern combustion science. This course describes the fundamental theories needed to understand combustion before presenting numerical tools to compute flames, from laminar cases to turbulent burners. RANS, LES, and DNS modeling are discussed as well as numerical methods adapted to these models. The course includes the theoretical basis of turbulent combustion models and explores multiple examples of applications: steady turbulent combustion, ignition, quenching, flame-wall interactions, pollutant formation and combustion instabilities in real combustors (gas turbines, rocket engines, piston engines).

Plasma Aided Combustion and Manufacturing (July 10~11)

Lecturer: Yiguang Ju, Princeton University, USA

Course Content: Green fuels for transportation and electrified chemicals and materials manufacturing provide great opportunities to enable net zero carbon emissions. Non-equilibrium plasma provides a promising opportunity to create new reaction pathways and enhance combustion and chemical conversion. This short course will provide an overview of the fundamentals and research frontiers of non-equilibrium plasma assisted combustion and chemical/materials manufacturing. The course will discuss the physics of non-equilibrium plasma discharges, plasma chemistry, plasma dynamics and instability, plasma enhancement of ignition, flame propagation, and cool flames, plasma diagnostics and modeling, and plasma aided chemical synthesis (ammonia), chemical looping, and materials manufacturing.

Fundamentals of Detonations in Gases (July 12~14)

Lecturer: Hoi Dick Ng, Concordia University, Canada

Course Content: Detonation phenomenon is a violent mode of combustion – a supersonic, compression wave sustained by rapid energy release from chemical reactions that causes a significant pressure and temperature increase in an explosive medium. The objective of this course is to help students understand the fundamental theories and basic dynamics of gaseous detonation waves. It provides the background knowledge to conduct specific research on the detonation phenomenon, including its application to explosion safety and propulsion. The course will include a review of the Rankine-Hugoniot analysis and Chapman-Jouguet theory, a description of detonation structure, instability and propagation mechanisms, the classical dynamic parameters of gaseous detonation, and an introduction to deflagration-to-detonation transition. Recent advances in the field of detonation and its application will be discussed.

Mitigating the Carbon Footprint of Combustion through CO_2 Capture and Storage (July 10~11)

Lecturer: Howard J. Herzog, Massachusetts Institute of Technology, USA

Course Content: The combustion of fossil fuels with its release of CO_2 to the atmosphere is the number one contributor to climate change. Through carbon capture technologies, it is possible to capture the CO_2 produced by combustion and prevent it from being emitted to the atmosphere. This course will cover the following topics: climate change fundamentals and the role of CO_2; approaches to carbon capture, including post-combustion, oxy-combustion, and pre-combustion; novel combustion processes aimed at facilitating CO_2 capture; what to do with the captured CO_2 (CO_2 storage and utilization); and carbon removal (creating offsets by removing CO_2 from the atmosphere).

Formation of Polycyclic Aromatic Hydrocarbons and Soot through the Eyes of a Chemist (July 12~14)

Lecturer: Nils Hansen, Sandia National Laboratories, USA

Course Content: In this course, we will cover fundamental chemical kinetics aspects of the formation of polycyclic aromatic hydrocarbons and soot in combustion environments. Experimental, theoretical, and modeling aspects will be covered. Starting from the formation of the first aromatic ring, we will introduce basic concepts of individual radical-radical and radical-molecule reactions that govern molecular-weight growth. We will summarize basic mechanisms and modeling approaches, e.g., HACA (H-abstraction-carbon-addition) and CHRCR (clustering of hydrocarbons via radical chain reactions). The course will also summarize the various hypothesis on soot particle nucleation.