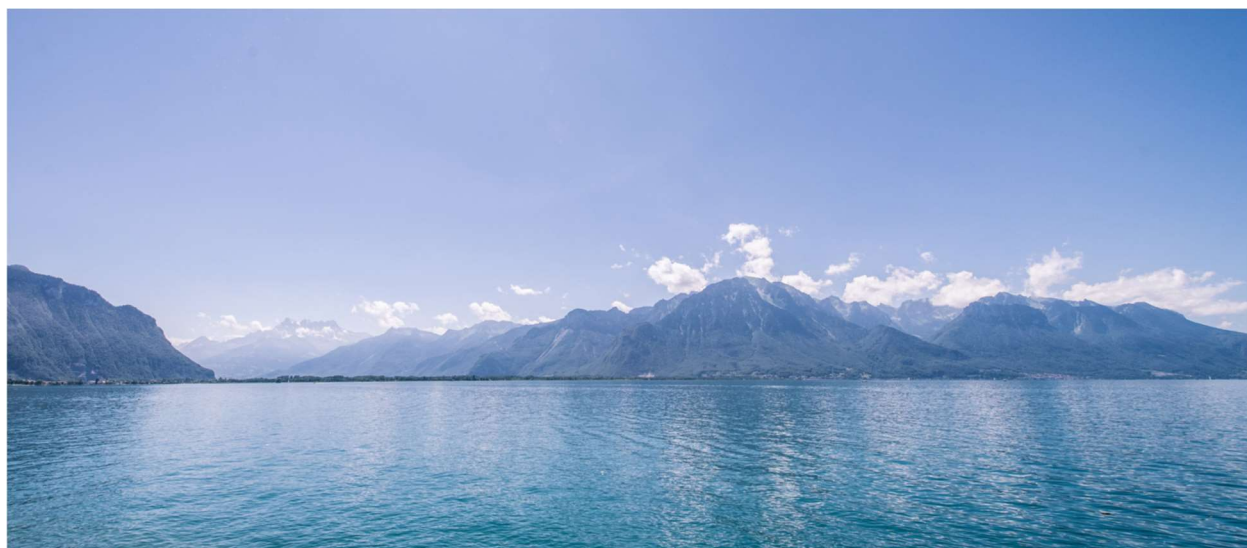


Joint Workshop of the IEA Technology Collaboration Programmes

Clean & Efficient Combustion with Advanced Motor Fuels (AMF)

November 6, 2019

Montreux, Switzerland



The TCP on **Clean and Efficient Combustion** was created in 1977 to accelerate the development and deployment of combustion technologies with reduced fuel consumption and lower pollutant emissions. Today, our collaborative tasks address specific research questions from combustion fundamentals to technical applications in internal combustion engines, furnaces & gas turbines, thus enabling efficiency gains and emission reductions in the industry, buildings, transportation and power generation sectors.

www.ieacombustion.com



The TCP on **Advanced Motor Fuels** provides an international platform for co-operation to promote cleaner and more energy efficient fuels and vehicle technologies. The activities of AMF relate to R&D, deployment and dissemination of advanced motor fuels. AMF looks upon transport fuel issues in a systemic way, taking into account production, distribution and end-use related aspects. As fuels, engines and exhaust after-treatment systems have to be considered as interactive systems, the scope of AMF also covers propulsion systems (vehicles) using advanced motor fuels.

<https://iea-amf.org>



IEA Combustion & AMF Workshop, November 6, 2019 / Organized by Swiss Federal Office of Energy /cma/hea/SR

Clean & Efficient Combustion with Advanced Motor Fuels (AMF)

The joint workshop shall be a platform to discuss challenges, opportunities and requirements of future combustion systems and appropriate fuels.

- What role will low emission ICE propulsion system play in the future transport system?
- How can the ICE complement the electrification trend?
- Which are the most promising ICE technologies and fuels?

The target is to identify key research questions and to discuss ideas and novel concepts for clean and efficient combustion systems using advanced fuels for road transport, shipping, aviation, off road machinery and power generation.

In a first session, **low emission propulsion systems** with conventional and drop-in fuels will be discussed. The scope are combustion systems (ICE, Gas Turbine) fueled with commercially available fuels, i.e. fossil fuels (gasoline, diesel), blended fuels (E xx or D xx) or Ethanol, BioDiesel etc. This includes multifuel systems such as Dual Fuel combustion with gaseous and liquid fuels. A key question is whether combustion systems fueled with conventional or drop-in fuels can fulfil future low-emission standards (NO_x, HC, CO, Soot, Aerosols) and reduced CO₂-emission requirements. Which fuels hold the greatest promise? Do we need dedicated fuels for dedicated engines? What do future combustion based - propulsion systems look like? Single fuel ICE, multifuel ICE or hybrid systems?

The second session addresses **novel fuels for advanced engine concepts**. Novel fuels are expected to decarbonize the energy system. A wide range of novel fuels is in discussion. Several of them are based on hydrogen (H₂), which can be generated with electricity from renewable sources (electro fuels). In different steps hydrogen can be transformed to methane, methanol, DME or OME. It is even possible to generate higher alcohols (Ethanol) or higher hydrocarbons (gasoline, diesel). Novel fuels can be generated from different sources of biomass or waste, too. To use novel fuels in a clean and efficient way, combustion systems have to be adapted and developed further. Key questions concern the fuel requirements of internal combustion engines and vice versa, which fuels can be adapted to the combustion process and produced as efficiently as possible? How can the internal combustion engine support the use of a variety of advanced fuels? The target is to identify novel highly efficient and nearly zero emission engine concepts and the suitable fuels for these applications, and vice versa.

Internationally recognized experts from both TCPs will attend the meeting. In addition, management and R&D representatives from leading Swiss engine and gas turbine companies will participate and share their industry perspective. This workshop provides a unique opportunity to identify areas of possible **collaborations** between experts of both TCPs and industry.

| Introduction | | |
|---|--|---|
| 08:30 | Opening remarks | St. Renz |
| 08:40 | Keynote | K. Boulouchos |
| Session 1: | | |
| Low emission combustion systems with conventional fuels (road transport, shipping, aviation, off-road machinery, power generation) | | |
| In Session 1 the scope are combustion systems (ICE, Gas Turbine) fueled with conventional and drop-in fuels such as fossil fuels (gasoline, diesel), blended fuels (E xx or D xx) or Ethanol, BioDiesel etc. | | |
| In IEA Combustion TCP contributing tasks include: | | |
| <ul style="list-style-type: none"> • Sprays in Combustion • Low Temperature Combustion • Soot | | |
| In IEA AMF TCP different Annexes deal with this topic: | | |
| <ul style="list-style-type: none"> • Annex 55: Real Driving Emissions and Fuel Consumption • Annex 54: GDI Engines and Alcohol Fuels • Annex 51: Methane Emission Control • Annex 48: Value Proposition Study on Natural Gas Pathways for Road Vehicles | | |
| 09:20 | Point of view of the IEA Combustion TCP | Combustion P. Miles |
| 09:40 | Point of view of the IEA Advanced Motor Fuels TCP | AMF M. Lindgren, N.-O. Nylund |
| 10:00 | Introduction to the breakout groups | C. Alles |
| 10:05 | <i>Coffee break</i> | <i>All</i> |
| 10:30 | <p>Discussion of topic 1 in breakout groups</p> <p>Guiding questions:</p> <ol style="list-style-type: none"> 1. Which combustion and propulsion concepts are best suited to achieve high efficiency and minimized pollutant emissions with conventional fuels? 2. Can combustion systems fueled with conventional and drop-in fuels fulfil future low-emission standards (NO_x, HC, CO, soot, aerosols as well as CO₂)? 3. What do future low emission – combustion based - propulsion systems look like? 4. Do we need dedicated fuels for dedicated engines? 5. Which fuels are best suited to reach emission targets in these novel propulsion systems? 6. Identify areas for collaboration between experts from the AMF and Combustion TCPs to improve combustion systems using conventional and drop-in fuels. <p>Please consider all modes of transport; i.e. road, rail, sea, air and machinery.</p> | All participants, in 7 groups, with facilitators & rapporteurs |
| 11:30 | Sharing of session 1 discussion highlights from the groups | Rapporteurs + Facilitators |
| | Open discussion | All |
| 12:45 | <i>Networking Lunch</i> | <i>All</i> |

Session 2: Novel fuels for advanced engine concepts

Session 2 covers novel fuels and advanced combustion engine concepts to use these fuels in a clean and efficient way. Novel fuels can be produced from different sources (e.g. electricity, biomass or waste), but are not yet available at commercial scale. The target is to develop engines that use such fuels at high efficiency with nearly zero emissions of air pollutants, or to develop the fuel in a way that significantly reduces CO₂ and other combustion related emissions.

In IEA AMF TCP different Annexes deal with this topic:

- Annex 57: Heavy Duty Vehicle Evaluation
- Annex 56: Methanol as Motor Fuel
- Annex 52: Fuels for Efficiency
- Annex 50: Fuel and Technology Alternatives for Non-Road Engines
- Annex 49: COMVEC – Fuels and Technology Alternatives for Commercial Vehicles
- Annex 47: Reconsideration of DME Fuel Specifications for Vehicles

In IEA Combustion TCP the following tasks can contribute:

- Combustion Chemistry
- Sprays in Combustion
- Low Temperature Combustion
- Gas Engines
- Gas Turbines

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|-------|--|---|
| 13:45 | Welcome back / Introduction to the afternoon | S. Hermle |
| 13:50 | Point of view of the IEA Advanced Motor Fuels TCP | AMF K. Winter |
| 14:10 | Point of view of the IEA Combustion TCP | Combustion P. Miles |
| 14:30 | <p>Discussion of topic 2 in breakout groups</p> <p>Guiding questions:</p> <ol style="list-style-type: none"> 1. What are the most promising novel fuels with regards to their well-to-wheel GHG-emissions, availability, technical readiness, costs, time to market, etc.? 2. What positive or negative impacts do advanced fuels have on the overall performance of combustion systems (emissions, efficiency, power-to-weight, noise, overall cost,)? 3. How can novel combustion concepts take advantage of the unique properties of a variety of advanced fuels? 4. What is the better solution - drop-in fuels or dedicated fuels for dedicated engines? 5. Identify areas for collaboration between experts from the AMF and Combustion TCPs to develop combustion system for novel fuels. <p>Please consider all modes of transport; i.e. road, rail, sea, air and machinery.</p> | All participants, in 7 groups, with facilitators & rapporteurs |
| 15:30 | <i>Coffee break</i> | <i>All</i> |
| 15:45 | Sharing of discussion highlights from the groups | Rapporteurs + Facilitators |
| | Open discussion | All |
| 17:00 | Closing remarks | Chairs C. Alles, M. Lindgren |
| 17:10 | <i>Meeting adjourns / Transfer to Chateau Chillon</i> | |