

A Sustainable Future for Aviation

The Importance of Scientific Support



Aalto University
School of Engineering

Professor Martti Larmi

May 9, 2019

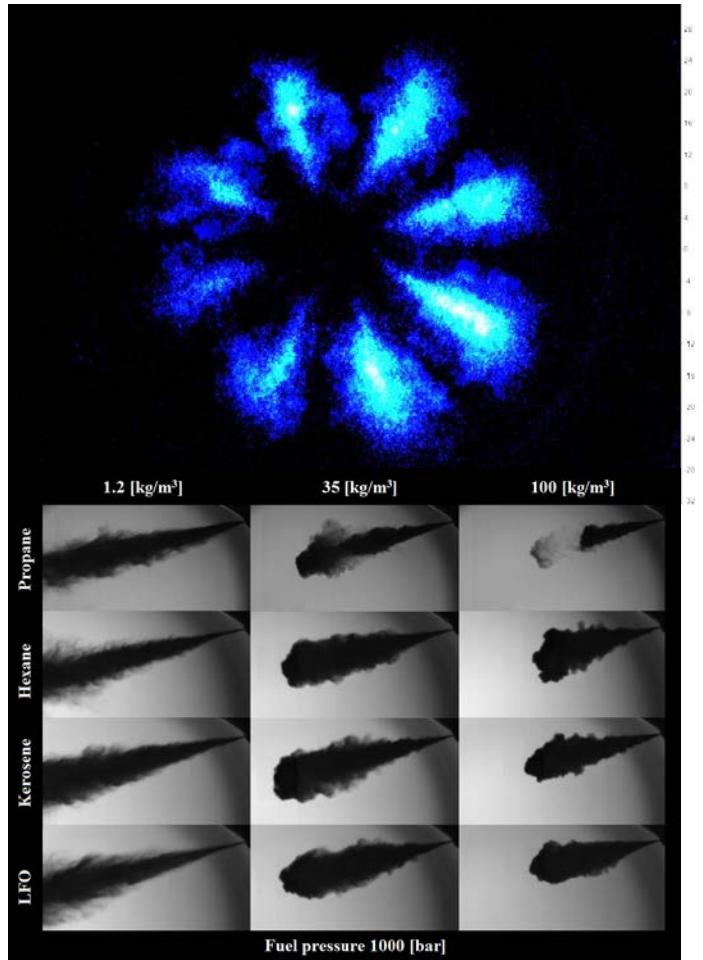
Combustion research

Fuels and combustion
research in Aalto has
focused on alternative
fuels more than 10 years.

A?

Aalto University
School of Engineering

Ethanol
Methanol
FAME
HVO
Kerosene
Propane
Hexane
LFO
Methane
Hydrogen
Etc...



Science and renewable fuels

Journal article
with 268 citations

**Hydrotreated Vegetable Oil (HVO) as a
Renewable Diesel Fuel: Trade-off
between NO_x, Particulate Emission, and
Fuel Consumption of a Heavy Duty
Engine**

**Hannu Aatola, Martti Larmi, Teemu
Sarjovaara and Seppo Mikkonen**

SAE International Journal of Engines

Vol. 1, No. 1 (2009), pp. 1251-1262

ADVANCEFUEL

- ❑ Part of EU Horizon 2020
- ❑ Coordination and Support Action of EU Commission
- ❑ Facilitating market roll-out of advanced liquid biofuels in transportation sector between 2020 and 2030 and beyond

Partners:



FNR – Fachagentur
Nachwachsende Rohstoffe
(Co-ordinator)
Germany



ECN – Energy Research
Centre of the Netherlands
The Netherlands



Universiteit Utrecht
Utrecht University
The Netherlands

Imperial College
London

Imperial College London
United Kingdom



Chalmers
University of
Technology
Sweden



Greenovate! Europe
Belgium



ATB - Leibniz Institute
for Agricultural Engineering
and Bioeconomy
Germany



Aalto University
Finland



NESTE OIL



AVL

Stakeholders:



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N.º 764799.

TOPIC : Development of next generation biofuel and alternative renewable fuel technologies for aviation and shipping

Topic identifier: LC-SC3-RES-23-2019

Publication date: 27 October 2017

Focus area: [Building a low-carbon, climate resilient future \(LC\)](#)

Types of action: RIA Research and Innovation action

DeadlineModel: single-stage

Planned opening date: 07 May 2019

Deadline: 27 August 2019 17:00:00

Time Zone : (Brussels time)

Specific Challenge:

Decarbonising the aviation and shipping transport sectors, which are expanding fast and increasing the overall fossil fuel consumption, relies on biofuel and renewable fuels. The specific challenge is to increase the competitiveness of next generation biofuel and renewable fuel technologies in aviation and shipping, compared to fossil fuel alternatives.

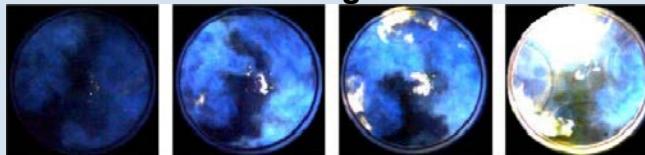
Experimental Combustion Research in the academic team of Professor Martti Larmi



High Efficiency Combustion in Dual-Fuel Engines



Optical Engine



Gas Combustion Variations in Optical Engine

Alternative Fuels and Spray Diagnostics



Spray Chamber Measurements

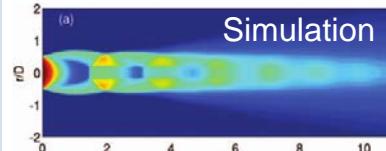


Alternative Fuels and Mixing Differences

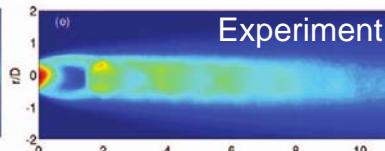
Optical Measurements on High Pressure Fuel Injection and



Int.J. Heat and Fluid Flow (2013)



Simulation



Experiment

Direct Gas Injection (Phys.Fluids 2014)

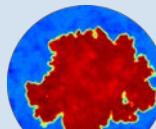
Advanced Computational Energy Research in the Team of Prof. Ville Vuorinen



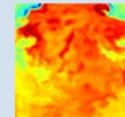
Ignition and Combustion Control in Gas and Dual-Fuel Combustion



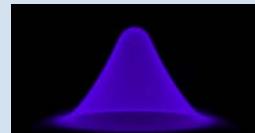
Dual Fuel Spray Ignition (submitted)



Cycle-to-Cycle Combustion Variations in Engines (submitted)



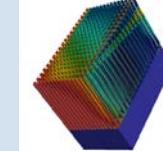
CFD of Chemically Reacting Flows and Heat Transfer



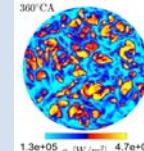
Detailed chemistry simulations



Low NOx spray combustion (Comb.&Flame 2016)

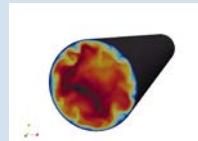


Wall heat transfer (Int.J.H.M.(2017))



300° CA
1.3e+05 q_w [W/m²] 4.7e+05

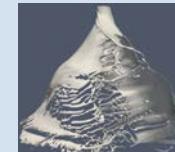
Computational Fluid Dynamics Fundamentals



Basic flows (Adv.Eng.(2014))



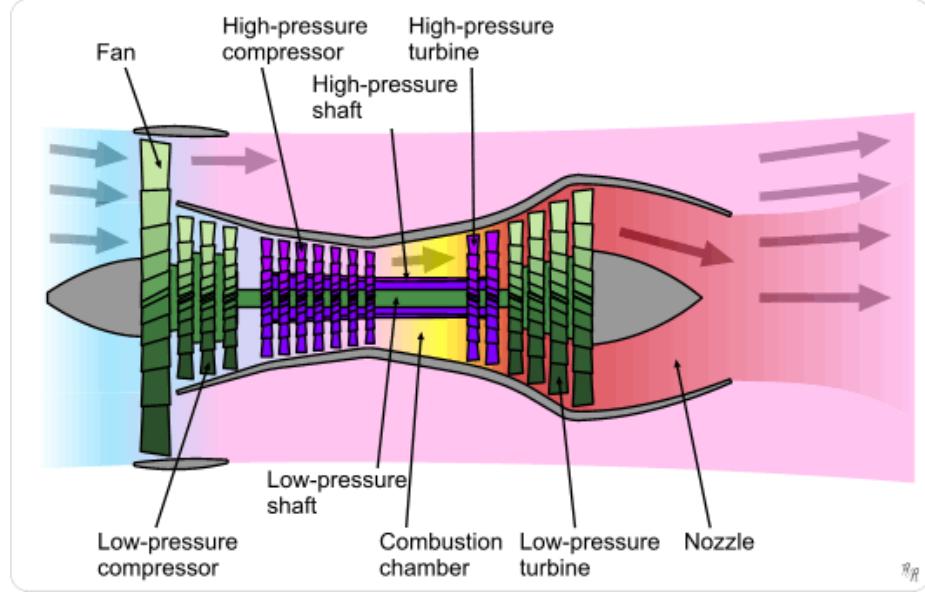
High speed fuel injection (Phys.Fluids 2014)



Biofuel spray atomization

Aviation power generation

Mixing controlled diffusion combustion



Drop in fuels

Alternative drop in fuels should be very close to existing jet fuel

Compatibility and safety

- Aircraft systems with extreme cold properties + fuel infrastructure and delivery system
- Gas turbine combustion

Fuel properties

- Energy content (LHV), density, reactivity, viscosity, stability, lubricity, volatility, non-corrosivity, purity etc...
- Paraffinic hydrocarbons

New non-drop in fuels

New air craft & new fuel infra

Hydrogen or other gases?
Methanol or higher alcohols?
Synthetic hydrocarbons?

...

Energy content, emissions, costs and safety will be important!



**Thank you
for your
attention**

**Research Group of
Energy Conversion,
Department of Mechanical
Engineering**

<https://youtu.be/mK41f24IX1k>