

Carbon 2 Chem®

# L-VIII | Methanol, the "ICE Green Maker"

TU Dresden, Professur für Verbrennungsmotoren und Antriebssysteme (Prof. Frank Atzler)

George-Bähr Straße 1b, 01069 Dresden, Germany

Maximilian Dobberkau, +49 351 463-39804, maximilian.dobberkau@tu-dresden.de

Dr. Ronny Werner, +49 351 463-34352, ronny.werner@tu-dresden.de

Prof. Dr.-Ing. Frank Atzler, +49 351 463-37618, frank.atzler@tu-dresden.de

Lehrstuhl  
**VERBRENNUNGSMOTOREN**  
und Antriebssysteme

Green methanol is a renewable fuel with great advantages when used in an gasoline combustion process. MeOH has a comparatively high enthalpy of vaporization, leading to low combustion temperatures and, hence, low wall heat losses as well as a reduced tendency to pre-ignition. Therefore, an brake effective efficiency of more than 40 % (this is comparable to diesel engines!) and minimal emissions (even in cold start) are possible.

## Efficiency improvement

Test engine:

- 2-cylinder Zero Vibration Generator (Obrist GmbH)
- natural aspirated, 1,000 cm<sup>3</sup>, two valve gasoline engine
- serial connection to an electrical generator
- maximum power output 42,5 kW
- compression ratio 16:1

The thermodynamics allow an even higher compression ratio, because of the **high enthalpy of vaporization** of methanol → low tendency to pre-ignition

- high cylinder pressure gradients → high noise emissions → acoustic investigation required
- methanol has a **tendency to glow ignitions** → platinum catalyzes methanol decomposition → platinum electrodes lead to glow ignitions
- improved mixture formation through optimized port injectors and injection timing → see engine maps below → **efficiency increase 3,5 % !** (best point) → larger areas of efficiencies above 40 %

## Cold start/Cold run

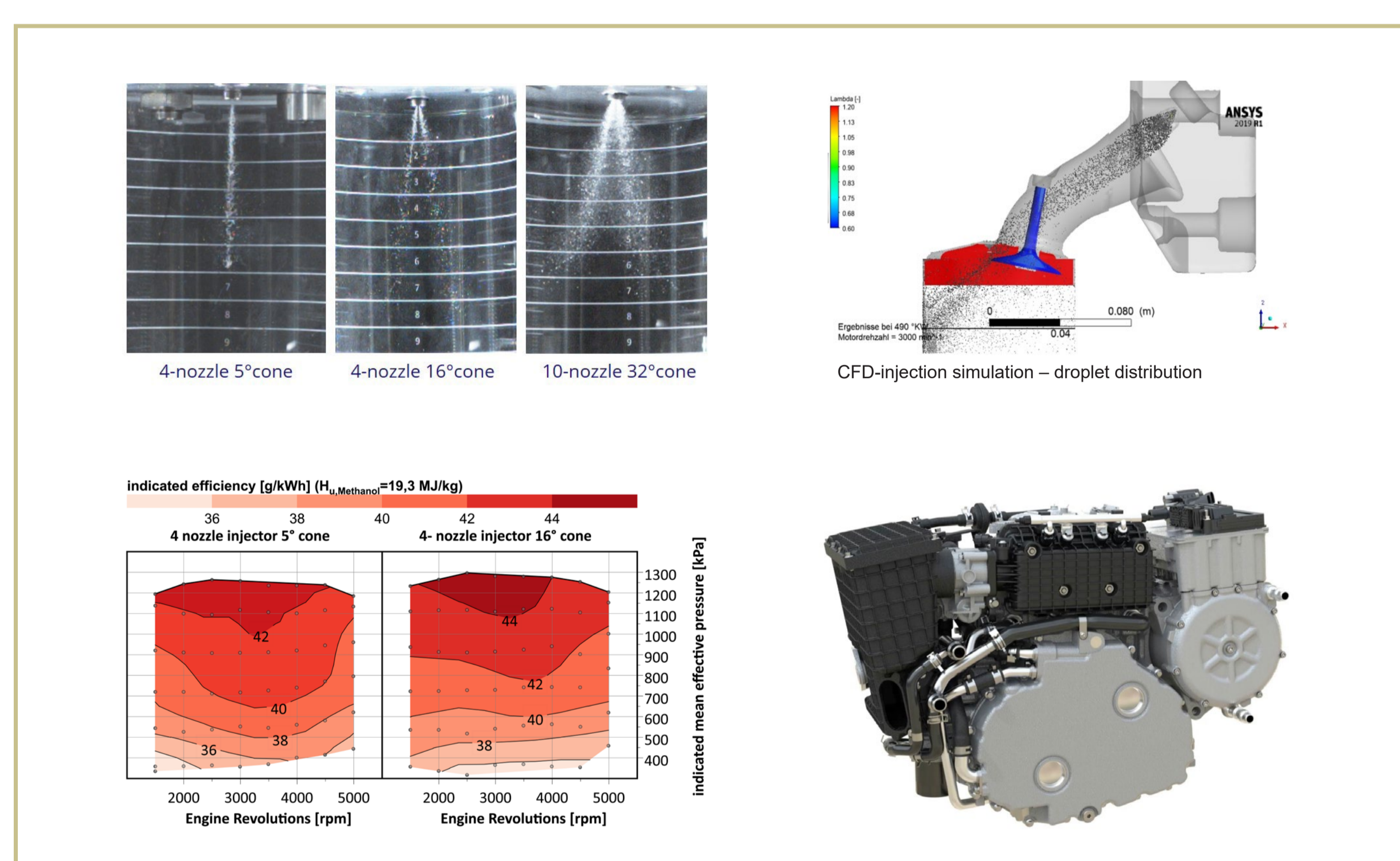
Increased corrosion from methanol:

- injector endurance investigations (500 h) → see below
- changes in injector spray quality? (high speed camera)
- cavitation damage? (x-ray tomography)

High enthalpy of vaporization → challenges for **cold start** → **testing down to -25 °C**

- mixture enrichment increases the cooling effect
- heating of fuel and/or the intake air
- CFD simulation detailed understanding of the mixture formation

To **minimize the cold start emissions** the catalyst is preheated + **motoring of the engine before start up** → airflow through the catalyst → the catalyst reaches light off conditions before engine start



Injection jets (top left), CFD injection simulation (top right)  
indicated efficiency (bottom left), Zero Vibration Generator (bottom right)



Engine test bed:

- **closed climate box** conditioned down to -25 °C, including air path, fuel, oil, coolant
- **mechanical connection** of crank to brake for the measurement of **effective efficiency**
- **exhaust gas analysis**
  - HC, CO, NO<sub>x</sub>, soot
  - particle emissions (number and size)
  - non-regulated emissions (FTIR) → e.g. formaldehyde, methanol slip, ammonia

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