

## Hydrogen-fueled internal combustion engines (H<sub>2</sub>ICEs)

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### Abstract

The threat posed by climate change and the striving for security of energy supply are issues high on the political agenda these days. Governments are putting strategic plans in motion to decrease primary energy use, take carbon out of fuels and facilitate modal shifts.

Taking a prominent place in these strategic plans is hydrogen as a future energy carrier. A number of manufacturers are now leasing demonstration vehicles to consumers using hydrogen-fueled internal combustion engines (H<sub>2</sub>ICEs) as well as fuel cell vehicles. Developing countries in particular are pushing for H<sub>2</sub>ICEs (powering two- and three-wheelers as well as passenger cars and buses) to decrease local pollution at an affordable cost.

This article offers a comprehensive overview of H<sub>2</sub>ICEs. Topics that are discussed include fundamentals of the combustion of hydrogen, details on the different mixture formation strategies and their emissions characteristics, measures to convert existing vehicles, dedicated hydrogen engine features, a state of the art on increasing power output and efficiency while controlling emissions and modeling.

**Keywords:** Hydrogen; Internal combustion engine; NO<sub>x</sub> emissions; Direct injection; Port-fuel injection; Abnormal combustion

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