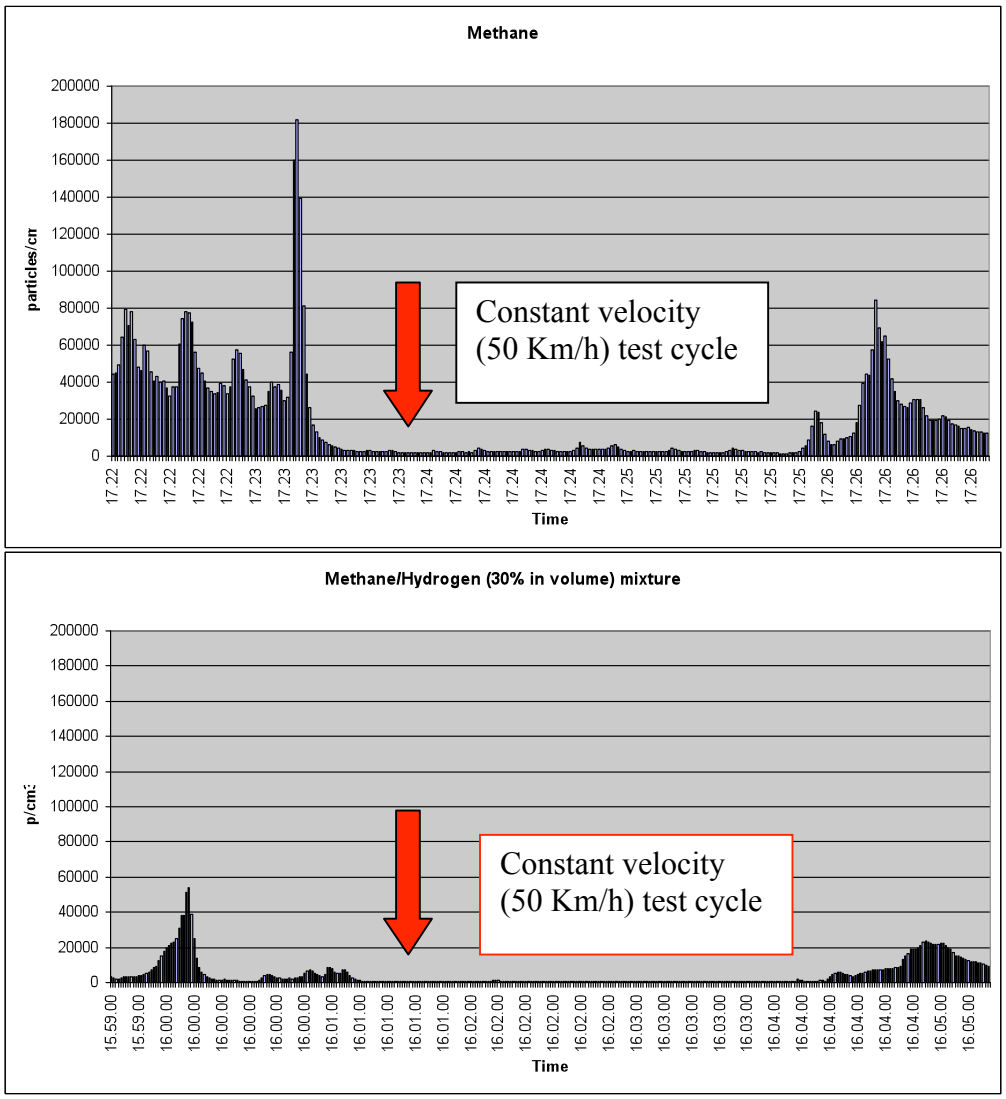
The use of methane-hydrogen mixtures in buses

W. Tirler [1], G. Voto [1], M. Donegà [1], K. Mair [1], M. Gallmetzer [2], T. Klauser [2], W. Huber [2],G. De Sangro [3], M. Capoccia [3], F. Rampelotto [4], C. Fazzari [4], Luana Grimolizzi [5].

1 Eco-Research – Bolzano, Italy
2 IIT – Bolzano, Italy
3 Ener.Go – Bolzano, Italy
4 SASA – Bolzano, Italy
5 Sapio - Monza, Italy

The use of pure hydrogen produced from renewable resources as fuel for automotive purposes results in multiple environmental benefits. Neither carbon dioxide nor unburned hydrocarbons (beside traces from lube-oil) are emitted by the engines.
Unfortunately a series of safety issues, like the wide range of explosion limits, the scarce visibility of the hydrogen flame and the lack of odor of spill outs, limits its use. In contrast by using Hydrogen in a mixture with methane a series of advantages are obtained without the stated safety issues. In Italy a methane mixture of up to 30% in hydrogen by volume is not subject to the special safety restrictions applied for hydrogen. Methane has a slow flame speed, also compared to gasoline. By adding hydrogen it is fastened resulting in a better ignition behavior of the mixture.
To quantify the prospected environmental benefits we did tests on a methane-bus normally used in the city of Bolzano for public transportation. The aim of the study was to verify if environmental benefits can be realized easily by a simple change of the combustible on buses already in use.
Before performing tests on the bus the test set-up was optimized using a scooter that could also be run by methane. The small engine permitted faster set-ups and a considerable lower fuel consumption during the tests. The test equipment for the emissions for particle determination after a hot dilution with purified dry air was a scanning mobility particle sizer (SMPS) and a condensation particle counter (CPC). A on-line mass spectrometer was used to determine the gaseous components .
The tests on the bus were performed on a test bench resembling cycles of normal engine load in daily operation. Under this conditions and after adjustments to the motor management (ignition, valve set-up) we obtained a substantial reduction on certain pollutants:
Using the methane/hydrogen mixture (30% in volume) nitrogen oxides emissions were 60% lower and particle emission, measured on the basis of particle number from 5 nm to 20 µm (CPC measurement) was 70% lower.

Figure 1 : comparative results by using methane and the mixture methane/hydrogen (30% v/v)



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Introduction

The use of pure hydrogen produced from renewable resources as fuel for automotive purposes results in multiple environmental benefits. No carbon dioxide and no unburned hydrocarbons (beside traces from lube-oil) are emitted by the engines.

Unfortunately a series of safety issues, like the wide range of explosion limits, the scarce visibility of the hydrogen flame and the lack of odour of spill outs, limits its use. In contrast by using Hydrogen in a mixture with methane a series of advantages are obtained without the stated safety issues. In Italy a methane mixture until 30% in hydrogen by volume is not subject to the special safety restrictions applied for hydrogen. Methane has a slow flame speed, also compared to gasoline. By adding hydrogen it is fastened resulting in a better ignition behavior of the mixture.

Experimental

To quantify the prospected environmental benefits we did tests on a methane-bus normally used in the city of Bolzano for public transportation. The aim of the study was to verify if environmental benefits can be realized easily by a simple change of the combustible on buses already in use. Before performing tests on the bus the test set-up was optimized using a scooter that could also be run by methane. The small engine permitted faster set-ups and a considerable lower fuel consumption during the tests. The test equipment for the emissions for particle determination after a hot dilution with purified dry air was a scanning mobility particle sizer (SMPS) and a condensation particle counter (CPC). To determine the gaseous components an on-line mass spectrometer was used.

The tests on the bus were performed on a test bench resembling cycles of normal engine load in daily operation. Under this conditions and after adjustments to the motor management (ignition, valve set-up) we obtained a substantial reduction on certain pollutants:

Results

Using the methane/hydrogen mixture (30% in volume) nitrogen oxides emissions resulted 60% lower. Particle emission, measured on the basis of particle number/cm^3 from 5 nm to 20 µm (CPC measurement) was 70% lower

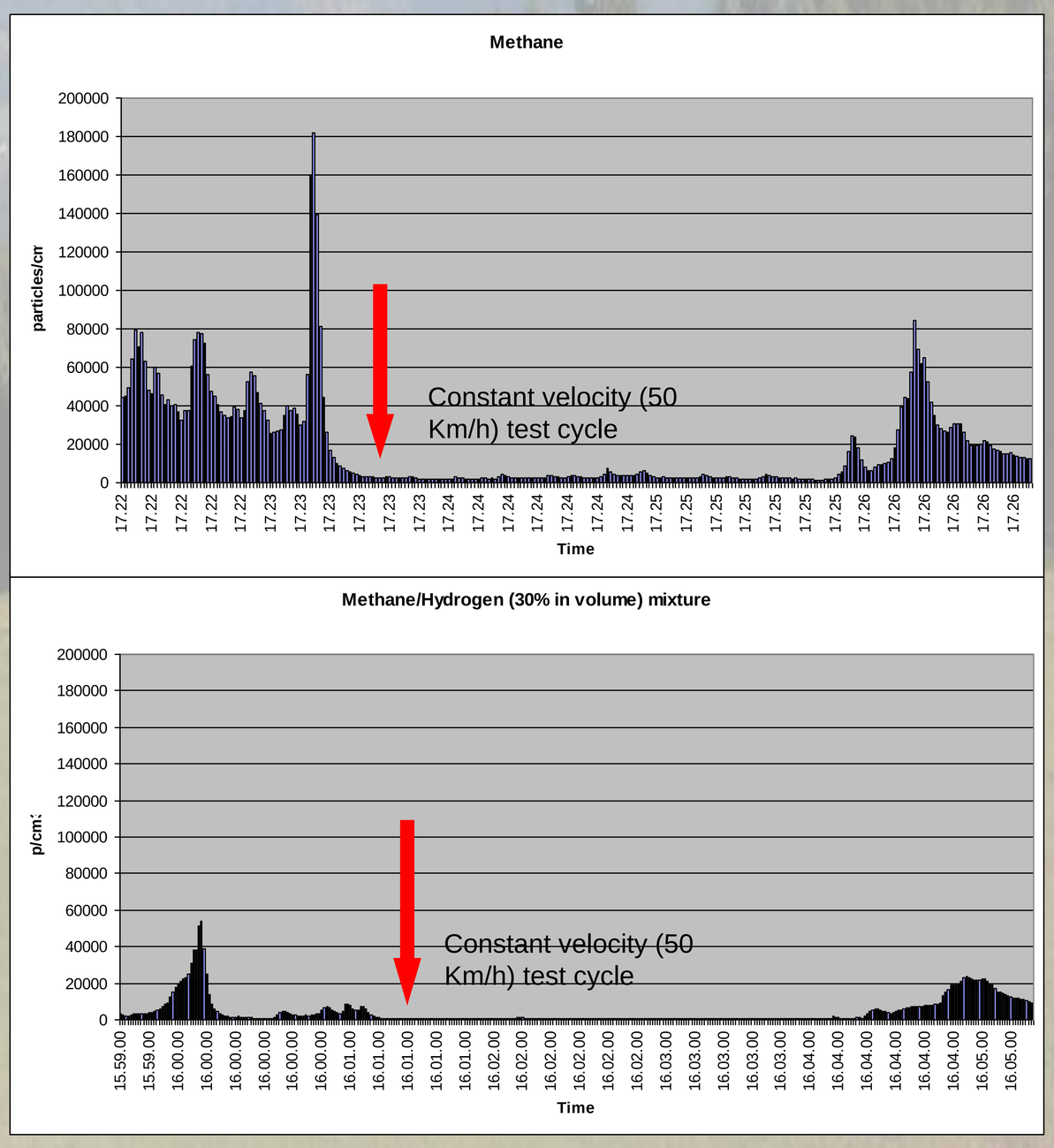

Figure 3 : comparative results by using methane and the mixture methane/hydrogen

Figure1 : test set-up optimization with a four stroke scooter

Figure 2 : measurements on the bus on a test bench

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