

Cold-start emissions and excess fuel consumption in low ambient temperatures – Assessment of EU2, EU3 and EU4 passenger car performances

Juhani Laurikko, VTT Technical Research Centre of Finland, Finland

Continuous development of engines and emission control devices in passenger cars to bring them in compliance with the progressive amendments of the European Directives for exhaust emissions has apparently improved also their performance with regard to cold-start related emissions in low ambient temperatures. This has happened, even if the targeted test procedure to specifically measure and control these emissions was included in the type approval requirements as late as year 2002.

VTT has evaluated the cold-start emissions performance of new cars since 1993. Each year a batch of some 10 to 20 cars representing that particular model year has been tested. The objective of this work has been to make an assessment, how the cold-start performance is developing, and to provide first-hand results of current cars for the motoring magazines in their evaluation tests. The selection of each annual fleet has mostly favoured cars of high sales volumes in Finland, but the eventual choice has been made by the magazines that initiated the testing. Most of the tested cars were fairly new, with odometer readings below 5,000 km.

As the test results presented in this paper demonstrate, cold-start performance has been gradually improved, and emission rates measured at low ambient temperatures (-7 °C) have declined. The average cold-start CO emission result has fallen over 50 % between EU2 and EU4 cars. However, HC emissions have not improved with the same magnitude, but only by some 30%. Extremely high values have been cut down, though, especially with the introduction of the latest EU4 cars.

Although cold-start excess emissions are primarily associated with petrol-fuelled cars, we have also tested diesel passenger cars, because emission inventories do need cold-start data also for diesel cars. According the results, elevated emission levels at cold-start are indeed mostly associated with petrol-fuelled cars, and much lower levels were recorded for those with diesel engines. Overall, the difference is almost of an order of magnitude. However, the worst performing diesel cars are close to the best-performing petrol cars.

Even if the CO and HC emissions performance has been improved quite substantially, excess fuel consumption due to a cold start has not been lowered at all in practice. The test data shows that even in latest EU3 and EU4 compliant petrol cars, about 36 % extra fuel consumption was recorded between a cold-started ECE15 cycle and when running the same cycle with warm engine restart. As typical passenger car trips in most European countries are rather short, this excess cold-start consumption has a distinct impact of overall fuel economy of the passenger car fleet.

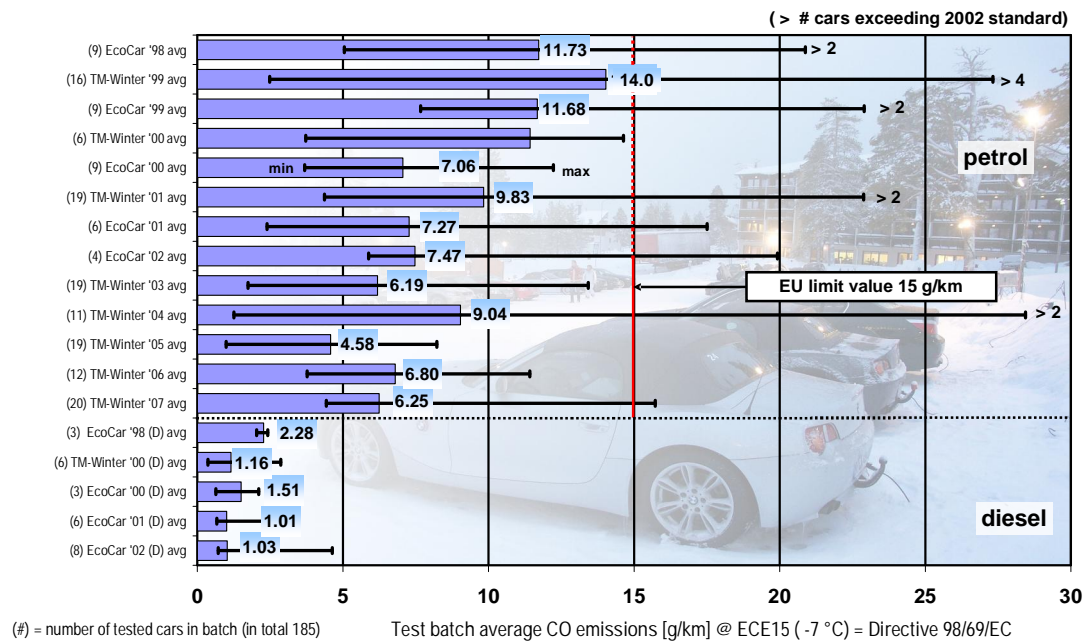


Fig 1. Average cold-start CO emissions of different annual fleet batches measured according to 98/69/EC cold-start procedure.

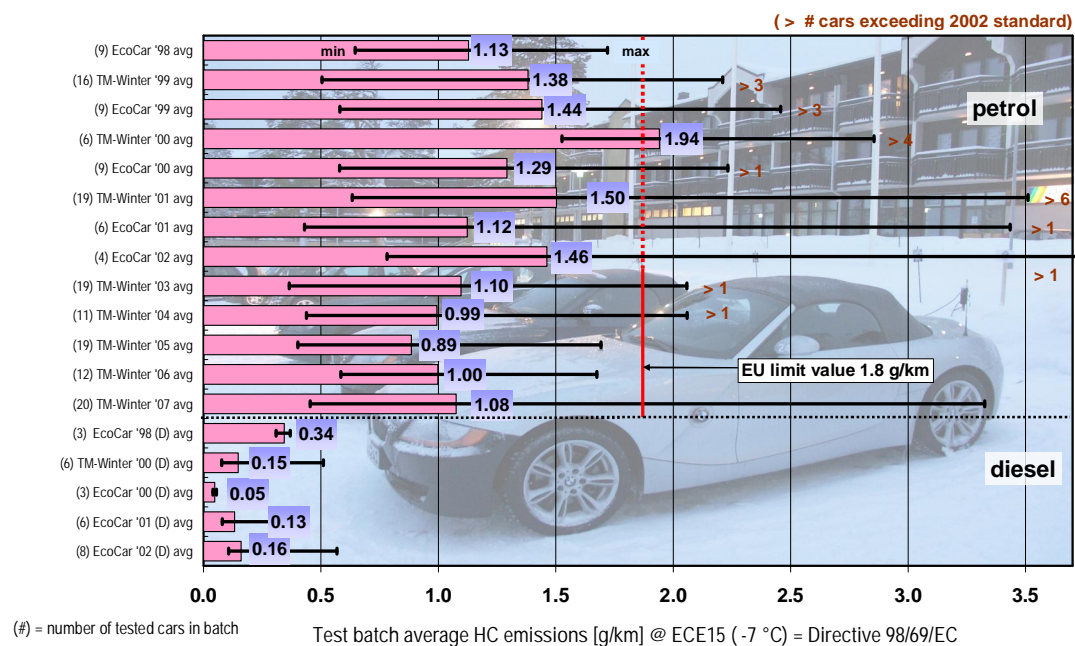


Fig 2. Average cold-start HC emissions of different annual fleet batches measured according to 98/69/EC cold-start procedure.

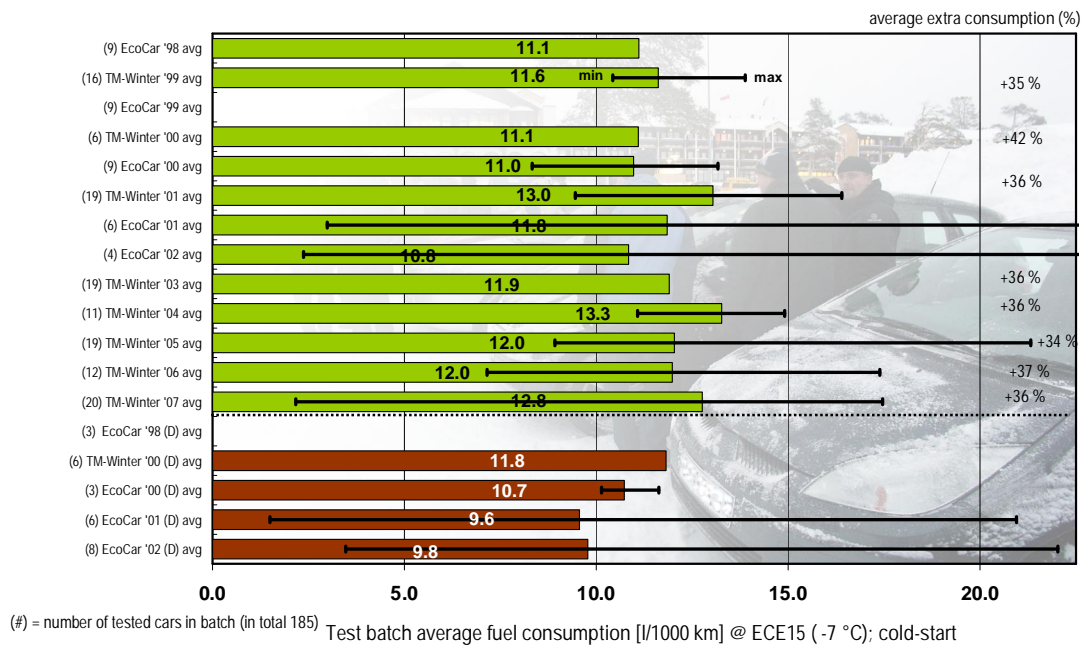


Fig 3. Average cold-start fuel consumption of different annual fleet batches measured at -7 C.