Zero Emission Hydrocarbon-Fuelled Vehicle Transportation With Fuel Re-synthesis From On-board Sequestrated $CO_2$

Keywords: $CO_2$ hydrogenation, re-syn fuel refinery, Off-shore wind energy

A combination of the Zero Emission Petrol Vehicle (ZEPV) concept, catalytic hydrogenation of $CO_2$ and the methanol to gasoline process has been analysed to examine gasoline re-synthesis from recycled $CO_2$. $CO_2$ from closed-cycle gasoline combustion in a modified conventional IC engine can be readily liquefied and stored on-board. This liquid $CO_2$ is available to be converted back to gasoline via methanol. Four possible chemical pathways for this re-synthesis are direct $CO_2$ hydrogenation, the Camere process, methanation process and the $H_2O$-$CO_2$ electrolysis. The "ideal" and "practical" energy recycle penalty ($\eta$), which are obtained from material and energy balances for around 30 million vehicles in UK, are used to analyse these chemical pathways. Carrying out this recycling in a set of geographically distributed "re-syn fuel" refineries using offshore wind energy has no further cost for exploration and production of crude oil, no limitation of raw material and furthermore no cost penalty for the emitted carbon value. By predicting that the wind energy cost will be reduced as low at 2.5 p per kWh in the future (2020), it is estimated that the total production costs for this futuristic sustainable re-synthesis refinery would be decreased to 16 p per litre of gasoline. This cost is cheaper than for current conventional oil refineries (18.3 p per litre) and still less than the total cost for a "re-syn fuel" refinery powered by indigenous (non-sustainable) coal (21.8 p per litre). Based on the initial economic analysis, gasoline re-synthesis from recycled $CO_2$ (to produce re-syn fuel) using offshore wind energy, is both perfectly sustainable and almost competitive for today and will be cheaper than petrol from crude oil in the future. Although this analysis is based on gasoline, the concept is straight forwardly extended to diesel. In this way, the present 25% of total UK $CO_2$ emissions from road transport could be reduced to virtually zero.