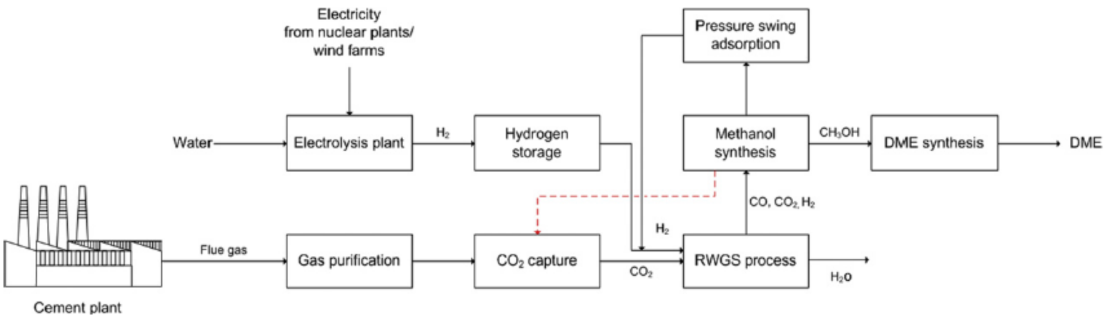
IEAGHG Information Paper; 2013-IP9: Cement Plant CO_2 to DME

Background: **Paper in International Journal of Hydrogen Energy (2013) Vibhatavata P, et al., Chemical recycling of carbon dioxide emissions from a cement plant into dimethyl ether - A case study of an integrated process in France using a Reverse Water Gas Shift (RWGS) step**

A process is proposed for the synthesis of dimethylether (DME) as a road transport fuel from CO_2 and hydrogen. The process uses conventional process steps, with the exception of a novel exothermic Reverse Water Gas Shift step, providing low grade heat for the CO_2 capture step. This process is proposed for French situation where cement production is one of the largest potential point sources of CO_2, non-fossil base-load electricity is available at low cost and there is a net import of hydrocarbon transport fuels. Hence the proposed process may be viable in the French context.



CO2 to DME simplified process schematic

The paper presents detailed mass and energy balance data for the process and reports that the estimated overall energy conversion efficiency from electricity to DME is 53% (LHV). To be economic the process requires cheap off-peak electricity that is available from the base load nuclear power stations in France. This necessitates the daily storage of large volumes of hydrogen to enable the CO_2 capture and DME synthesis processes to operate continuously.

Since the DME product is destined to be used as transport fuel, with consequent dispersed release of the carbon as CO_2, this process does not eliminate CO_2 emissions from cement manufacture, but only delays those emissions reaching the atmosphere. Since the DME product is an oxygenated fuel with a lower energy density than petroleum-based hydrocarbon fuel, it is limited to road transport use and is not well suited to use as an aviation fuel.

From an overall energy perspective, including DME use in a diesel engine, the process would convert electricity into motive power. If the average fuel to shaft power efficiency of an automotive diesel engine on DME is 25% (LHV) then the overall electricity to motive power efficiency would be about 13%. In contrast an electric motor might have electricity to motive power efficiency of 90%. If 15% of the electricity is lost in a Li-ion battery storage stage of electric vehicle use then an electric vehicle would still use 5-6 times less electricity than a diesel vehicle using DME made via the proposed process. Also electric vehicles can potentially address the loading issue by charging with cheap off-peak electricity.

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