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New application of IR spectroscopy in catalyst evaluation for dry reforming of methane

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Dry reforming of methane converts two greenhouse gases to syngas (H_2 + CO) and Ni catalysts are commonly used for this reaction. Gas chromatography (GC) is almost exclusively used to evaluate catalyst's performance. The performance is derived from the measurements of molar fractions of the gases in the effluent including unreacted CH_4 and CO_2 and the reaction products, H_2 and CO. Since this reaction leads to an increase in the total number of moles of the system, an inert gas is usually required to be fed into the system as an internal standard to correctly perform the evaluation. This increases the complexity of the experiments and may arguably change the reaction kinetics. Recently, we developed a novel IR spectroscopy-based method to achieve the same technical goal. IR is used to measure the molar fractions of unreacted CH_4 and CO_2, a reaction product *i.e.* CO and a reaction byproduct *i.e.* H_2O, in the effluent from the reactor. By applying general mass balance principle and the relevant reaction stoichiometry, the flow rates of all gases in the effluent including H_2 are calculated as functions of these IR-measured molar fractions. These flow rates are essential in evaluating catalyst performance and they are what the adding of an internal standard in the GC measurements is aimed to achieve. This IR spectroscopy-based method will render IR an independent technique for catalyst evaluation for dry reforming but without having to use an internal standard. The measurements are more accurate than GC with more than 100 times higher time resolution. This technique will provide a powerful tool for catalytic performance evaluation and make it possible to experimentally measure fast reaction kinetics that is usually not measurable by GC.

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