

# PRODUCTION OF HYDROGEN VIA METHANE CONVERSION USING ATMOSPHERIC PRESSURE MICROWAVE PLASMA SOURCE WITH CH<sub>4</sub> SWIRL

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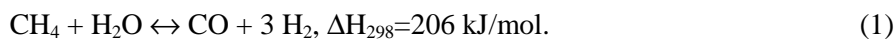
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**Abstract.** In this paper, results of hydrogen production via methane pyrolysis in the atmospheric pressure microwave plasma with CH<sub>4</sub> swirl are presented. A waveguide-based nozzleless cylinder-type microwave plasma source (MPS) was used to convert methane into hydrogen. The plasma generation was stabilized by a CH<sub>4</sub> swirl having a flow rate of 87.5 l min<sup>-1</sup>. The absorbed microwave power was 1.5-5 kW. The hydrogen mass yield rate and the corresponding energetic hydrogen mass yield were 866 g[H<sub>2</sub>] h<sup>-1</sup> and 577 g [H<sub>2</sub>] per kWh of microwave energy absorbed by the plasma, respectively. These parameters are better than our previous results when nitrogen was used as a swirl gas and much better than those typical for other plasma methods of hydrogen production (electron beam, gliding arc, plasmatron).

## 1. INTRODUCTION

Methane or natural gas reforming is widely used in industry to obtain hydrogen or synthesis gas (H<sub>2</sub>+CO), which are utilized in industry, for example as source materials for the production of raw chemicals (e.g. methanol and ammonia), as well as hydrogenation agents in oil refinery and reducing gases in steel industry. Recently hydrogen gains in importance as fuel in fuel cell applications, combustion engines or gas turbines with the goal to achieve more efficient exploitation of energy sources and to reduce noxious emissions [1].

Usual reforming of methane is carried out thermally with steam and oxygen where oxidation of methane takes place to provide reaction heat because the methane reforming reaction using steam is endothermic. The main reaction in the steam reforming of methane is the oxidation with steam, yielding a mixture of hydrogen and carbon monoxide:



Since that process is highly endothermic, to decrease activation energy, it requires catalyst, which is usually Ni/Al<sub>2</sub>O<sub>3</sub> working at temperature 1100-1150 K. Hence the reforming system is sensible to impurities in substrates which deactivates catalysts.

Conventional technologies of hydrogen production, i.e. coal gasification, hydrocarbon reforming and water electrolysis, are too expensive or not applicable for specific applications (e.g. for fuel cells) due to technical reasons. Thus, new methods are under development, like water photolysis, biological and plasma methods.

One of attracting methods for reforming hydrocarbons to produce hydrogen is the use of plasmas [1-19]. The plasma contains reactive radicals, ions and high-energetic electrons. High reactivity shown by these species enhances the chemical reaction rates whereby expensive and impurity vulnerable catalysts can be avoided. These advantages as well as its high energy density ensure the compactness of the plasma reformer. Besides, the plasma system can be adapted for reforming various hydrocarbons, like natural gas, gasoline, heavy oils and biofuels. Fast response time can be also

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