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## **Renewable Energy for Nitric Acid Production with Atmospheric Microwave Plasma**

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Since electricity from renewable sources of energy is subject to fluctuations, energy consumption on demand plays a crucial role to create a reliable grid system.

The annual nitric acid production is around 150 million tons worldwide. It is typically produced using the Ostwald process through the catalytic oxidation of ammonia from the Haber-Bosch process. An undesirable by-product is emitted during the production of nitric acid: Nitrous oxide (N<sub>2</sub>O) is a greenhouse gas that is 265 times more harmful to the climate than carbon dioxide.

In 1903 the Birkeland-Eyde process was invented using an arc for the production of nitrogen monoxide NO. NO is then oxidized to nitrogen dioxide NO<sub>2</sub> which reacts with water to form nitric acid HNO<sub>3</sub>. But this type of production is only profitable when electricity prices are low.

A process for producing nitrogen dioxide from nitric acid for the production of nitric acid using atmospheric pressure microwave plasma process is presented. On the basis of technological requirements for a microwave plasma unit for NO<sub>2</sub> production a modular plasma torch, which enables a "self-ignition" and stable operation of an air plasma over a wide range of parameters, has been constructed. Due to the flexible operating mode, excess capacities of photovoltaics and wind can be used on demand. The air plasma has been investigated via optical emission spectroscopy and FT-IR absorption spectroscopy in order to determine the plasma parameters as well as the energy and conversion efficiency.

### **Keywords**

atmospheric pressure microwave plasma  
renewable energy  
nitric acid production  
climate protection