

Closure process design for conversion of green electricity to product of nitric acid

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WFEO

Nitric acid (HNO_3 , NC) is one of the important massive chemical products, with a 50 million ton's market capacity globally, which has been affecting human civilization in agriculture, industry and military especially for over 100 years. Traditionally it is manufactured from catalytic oxidation of ammonia, catalogued under typical fossil fuel based product with a consumption of carbon 470 kg/t-NC. Meanwhile the manufacture process system is air opened with an emission of waste gas 3400 m³/t-NC containing toxic NO_x 300~500 mg/m³. Obviously sustainable adaptation is needed for it both in resource and environment. To take this task in engineering field, the first important step is to find out a pathway friendly to the nature and economic to the industry. For this goal a closure process system (CPS) was proposed for NC production by green electricity conversion^[1]. The innovative CPS techniques include coupling of synthesizing and oxidation of ammonia with precisely supplying of H_2 , N_2 and O_2 according to stoichiometric ratio, thus ideally avoiding the waste gas emission. As an alternative source of H_2 supply for 2050^[2], the proton exchange membrane (PEM) water electrolysis, of which the thermodynamic efficiency has been made over 75%^[3], is introduced together with cryogenic air separation to feed CPS in the way of zero carbon by green electricity from renewables. Even more importantly, the chemical reaction heat released from synthesizing and oxidation of ammonia in CPS is converted directly into power output by supercritical pressure cycle, which produces a 225 kW.h/t-NC net increase of power output compared with existing technology. As the result of analysis in the paper, CPS techniques will bring a future of nitric acid production with zero pollution and zero carbon emission in a competitive cost when the price of green electricity is reasonably set to 30% lower than the carbon based power supply.

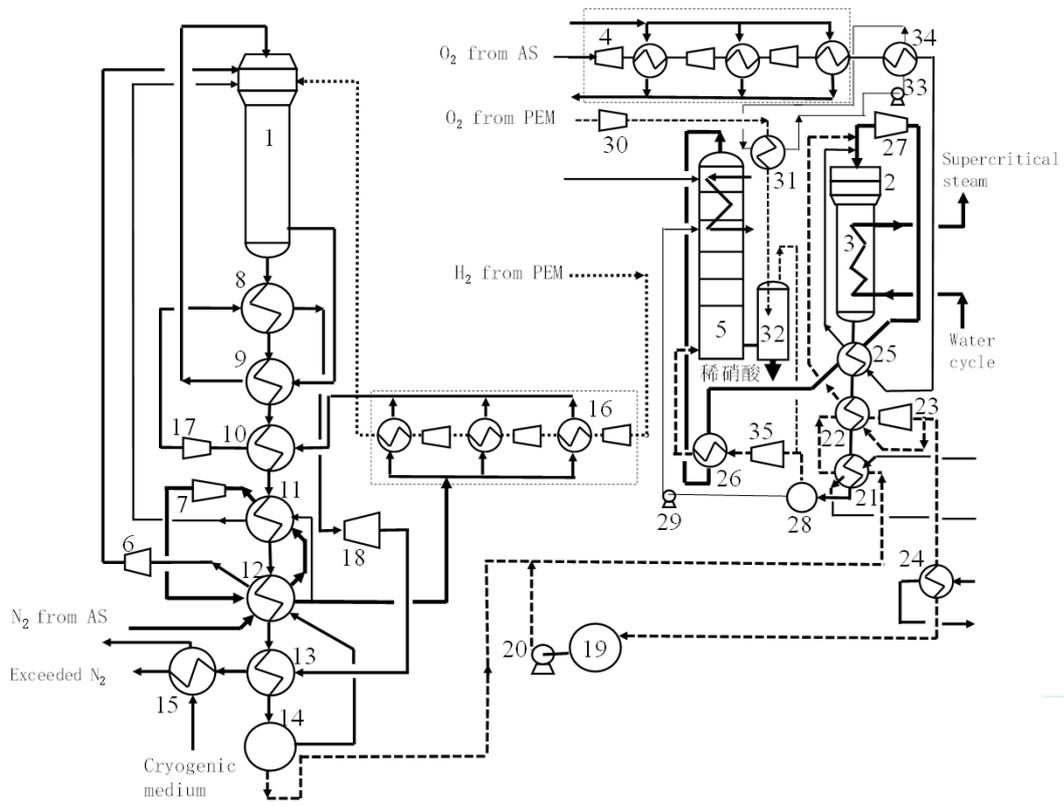


Fig.1 Schematic diagram of CPS for green electricity conversion to nitric acid production