ETN DRAFT OUTLINE AMMONIA

Application and advantages of ammonia use

Ammonia is a zero-carbon chemical energy storage. It has been identified as a sustainable fuel for remote applications due to its high hydrogen content. Therefore it is important to realise that developments of use of hydrogen and ammonia go hand in hand since ammonia needs hydrogen as a source. It can be obtained from fossil fuels or most renewable sources (wind, biomass, photovoltaics, marine) where excess energy may be converted to chemicals via hydrogen. Ammonia characteristics that can support the "hydrogen transition" are

1) low storage costs 0.54 $/kg-H2 – vs 14.95 $/kg-H2 of pure hydrogen – (over 182 days);
2) high volumetric energy density (7.1 – 2.9 MJ/L) ;
3) energy density of 22.5 MJ/kg, comparable to other fossil fuels;
4) easy liquefaction and handling;
5) existing proven & reliable infrastructure.

Moreover, ammonia can transport much more hydrogen (kg-H2/L) than liquid hydrogen itself. For that reason, the International Energy Agency has recognised the role of ammonia as an energy vector that can contribute with the decarbonisation of the planet. Although, ammonia will not solve all problems to power our society, it can be a solution that coupled with hydrogen can resolve powering issues for long distance distribution (i.e. marine vessels), heavy duty transportation (i.e. large trucks and trains) and large-scale power for sessional backup (i.e. summer excess renewable energy to usage in winter).

State of the art of ammonia fueled gas turbines (AGTs)

AGTs are able to produce large-scale power generation with excess energy and support the transition to more stable, easy to handle highly hydrogenated gas turbine systems. Developers, manufacturers and users are focusing on the use of hydrogen to regain their leading position in the energy field. Although gas turbines running on hydrogen-based fuels can become high-efficiency candidates for generation of electricity, pure hydrogen units suffer considerable instabilities. Therefore, ammonia can support the hydrogen transition by distributing larger hydrogen quantities while achieving reliable clean combustion, as the ammonia is cracked into water and nitrogen. Although the process generates high NOx, it also produces unburned hydrogen (according to the latest studies). The latter can be used in secondary stages of the combustion system to boost energy production, literally enabling the use of hydrogen in combustion chambers. Thus, ammonia can act as a direct precursor of hydrogen via combustion. Finally, all studies have demonstrated that NOx emissions are considerably decreased (few orders of magnitude) with increasing operating pressures. Thus, the potential of AGTs to unlock the potential of hydrogen and reduction of NOx in industrial systems is evident.

Japan works insatiably and has enormous efforts demonstrating the concept. From hydrogen, transported from Australia to Japan as ammonia, Japanese plan to have the first 100MW AGT with NOx emissions below 50ppm by 2030. Europe should start considering this development as well.

Objectives and activities of the Working Group

We need to know the key enablers for the introduction of ammonia in gas turbines, searching for novel implementation opportunities. Topics that require consideration for the progression of the technology are the understanding and development/improvement of:

- Impacts of hot ammonia/alkaline-acid streams to materials and lubricant/oils
- Fundamental combustion issues: radicals formation/control, stability, NOx, designs
- Compressor, turbines and pumps performance under new cycle, industrial conditions
- Dissemination of NH_3 as hydrogen vector. It is not a hydrogen "competitor" but "enabler".

ETN a.i.s.b.l.
Chaussée de Charleroi 146/20, 1060, Brussels, Belgium
Tel: +32 (0)2 646 15 77 www.etn.global info@etn.global