Green Hydrogen Inherent Safety Practices on large industrial scale

Publieke samenvatting / Public summary

The need to ensure process safety of large-scale green hydrogen production

Green hydrogen production is expected to scale up at an unparalleled pace in the coming years. In the Netherlands, 500 **MW** of large-scale green hydrogen plants are scheduled for completion in 2025, producing nearly 0.5 milliontonnes of hydrogen per year. The REPowerEU Plan reveals that the EU aims to produce 10 million tonnes of domesticrenewable hydrogen, in addition to 10 million tonnes of imported renewable hydrogen, by 2030.

This ambitious production ramp-up poses an important challenge to the industry. Large-scale industrial water electrolysisplants typically use hydrogen and oxygen inside the same equipment, separated by a membrane/diaphragm. Safeguardingprocess safety in the design, implementation and operation phases is a complex task. While experience with operationsand maintenance is available for small plants, it is lacking for large-scale production.

The lack of historica! data and validated models of failure frequencies and consequences means that electrolyser systemssuppliers, asset owners and authorities have only limited data and knowledge on specific fire and explosion hazardscenarios. Due to the lack of a common understanding and standardised risk and design approach, different stakeholdersmay make different choices. This

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may then lead to delays in design and authorisation processes. lt could potentially also lead to underestimation of the risks involved. The exchange of information on technica! safety practices between all stakeholders will therefore be a cornerstonefor enabling the hydrogen economy.

This public report aims to stimulate awareness about required safety levels regarding large-scale green hydrogenproduction. A special focus is placed on fire and explosion risks associated with the combination of oxygen and hydrogen inequipment and buildings. This project is a first step towards achieving a uniform and consistent risk assessmentmethodology for large-scale green hydrogen plants. In this way, we want to help the industry and stakeholders understand explosion risks and enable them to create safe designs for large-scale water electrolysis systems.

The report summarises the results of a year-long project involving extensive cooperation with safety experts from HyCC,0rsted, Shell, Yara, DNV, Royal HaskoningDHV and TNO. This process was managed by the lnstitute for Sustainable ProcessTechnology (ISPT). Interviews were held with electrolyser suppliers so that their input and feedback could be included in theproject results.

Two top events that lead to explosions

Two typical scenarios were identified for events that might lead to an explosion or fire:

o in-equipment mixing of hydrogen and oxygen (in an electrolyser stack, pipe or separator);

o mixing of hydrogen and oxygen (from the air) as a result of loss of containment inside an electrolyser building.

Potential causes, consequences, safeguards and opportunities for inherently safe design were identified for bath scenarios.

Main conclusion

The process/chemical industry has well-established tools to assess the safety of processes involving hydrogen, includingGW-scale electrolyser plants. However, there is a lack of historica! and validated data on failure frequencies, probability of failure on demand and probability of ignition

at GW scale. In addition, data and corresponding models on deflagration and detonation are not as well developed forhydrogen as they are for hydrocarbon systems. This will require a conservative approach in assumptions and models forthe design and operation of upcoming large-scale deployments.

De data in deze applicatie is afkomstig van de Rijksdienst voor Ondernemend Nederland (RVO) en wordt in samenwerking met de Topsector Energie ontsloten.
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