HAZOP STUDY OF A WATER ELECTROLYSIS PLANT USED IN GREEN HYDROGEN PRODUCTION

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ABSTRACT

To boost green hydrogen economy, the water electrolysis plant needs to have high reliability and safety. In this work, reliability study of such a plant used for green hydrogen production is conducted. In this context, Hazard and operability (HAZOP) method is adopted to determine the probable deviation of the plant from its intended operation as well as their causes and consequences. Though it's a risk assessment tool, HAZOP can identify operational failures which prevent smooth operation by using logical sequences of cause-deviation-consequence of different process parameters. It is essential to begin with a full understanding of the system which involves component working conditions, input and output content, design intent etc. (Rausand & Haugen, 2020). The schematic of a water electrolysis plant for producing green hydrogen is presented in Figure 1. Water is the only physical input to the electrolyzer which is split into hydrogen and oxygen using electricity generated by renewable sources. However, the water must meet a specific purity level before entering the electrolyzer. When the hydrogen is produced, it flows into a separator and a deoxidizer and dryer system to remove moisture and impurity. Finally, it's stored as a compressed gas for future usage.

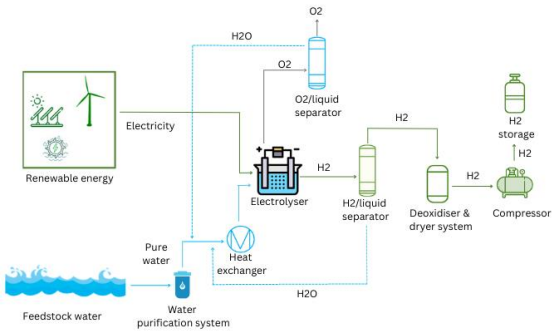

Figure 1: Schematic of a water electrolysis plant used for green hydrogen production

HAZOP study is carried out to identify the causes that can prevent operation of a water electrolysis plant or the deviations resulting in equipment failure, accident or reduced production. In order to do that, guide words such as, more, less, are used to study the deviation of the process parameters. The water electrolysis plant is divided into several sub-systems to perform HAZOP study (See Figure 2). Process parameters for each sub-system is selected based on the optimum operational

conditions, characteristics of input and output content. Guideword is assigned to each parameter to generate a deviation. For this purpose, guide words such as, more, less are selected from the standard set of guidewords for process plant (Crawley & Tyler, 2015). The causes and consequences of each deviation is recorded in the HAZOP table by reviewing relevant literatures. Since, HAZOP study is typically carried out by a multidisciplinary team, the prepared HAZOP table is sent to expert personnel for quality check. Based on their feedback, the HAZOP table is modified to capture all the deviations that might occur during the operation of a water electrolysis plant. This will not only help to enhance the reliability of the operating procedure but also assisting in maintenance activities.

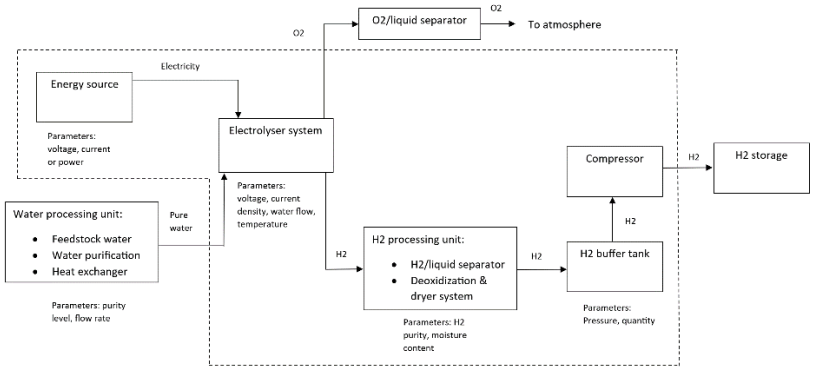

Figure 2: Sub-system of a water electrolysis plant for HAZOP study

Tentative results

By performing the HAZOP study, the deviations in the process parameters are identified which indicates under what conditions hydrogen production is reduced and even stopped. The causes behind each deviation and their consequences are also recorded in the HAZOP table. This will help in preventing failures of components by studying the parameters and their deviation from normal operating conditions. By receiving feedback from expert personnel, the credibility of the HAZOP table is verified. Moreover, this work can be valuable for forecasting failure of components and performing maintenance activities to prevent failure, accident or to restore desired hydrogen production rate.

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