Integrating Baffles in Electrolyzer Systems to avoid FRT-induced Trips due to Pressure Fluctuations

The field of hydrogen production through electrolysis has seen significant advancements over the years. However, there remains a critical challenge that has yet to be fully addressed.

This issue arises from a fault scenario in the electrical grid, which causes voltage fluctuations at the connection point of the electrolysis plant. These fluctuations can cause the grid voltage to drop to zero for a few hundred milliseconds, resulting in an interruption of hydrogen production. After the grid fault is cleared, grid operators require units to resume to pre-fault power consumption to ensure grid stability. This requirement, referred to as Fault-Ride Through (FRT), is expected to be included in upcoming grid code requirements. While the electrolyzer cells can handle such events, the process side, specifically gas management, is not yet compliant.

The industry's current solution to this problem is lacking. As the electrolyzer cells are presently in a ramp-up phase, no effective solution has been implemented thus far. The abrupt cessation of hydrogen production during an FRT event, coupled with the simultaneous stoppage of the compressor, leads to a pressure fluctuation between the electrolyzer and the buffer tank. This fluctuation results from a wave in the pressure distribution, which presents a serious problem. Safety regulations require a pressure measurement between the electrolyzer and the buffer tank, which triggers a trip when the pressure reaches a low or high limit. Therefore, it is imperative to prevent this trip when an FRT occurs.

The proposed solution to this problem involves the introduction of artificial turbulence in the product piping between the electrolyzer and the buffer tank. This turbulence can be generated using segmented baffles, some examples can be observed in Figure 1 below.

By doing so, the percentage difference between the normal pressure and the fluctuation-induced higher pressure can be reduced. Consequently, the effects of an FRT are lower in percentage terms and can be considered in the pressure control. This prevents the trip and still complies with safety guidelines.

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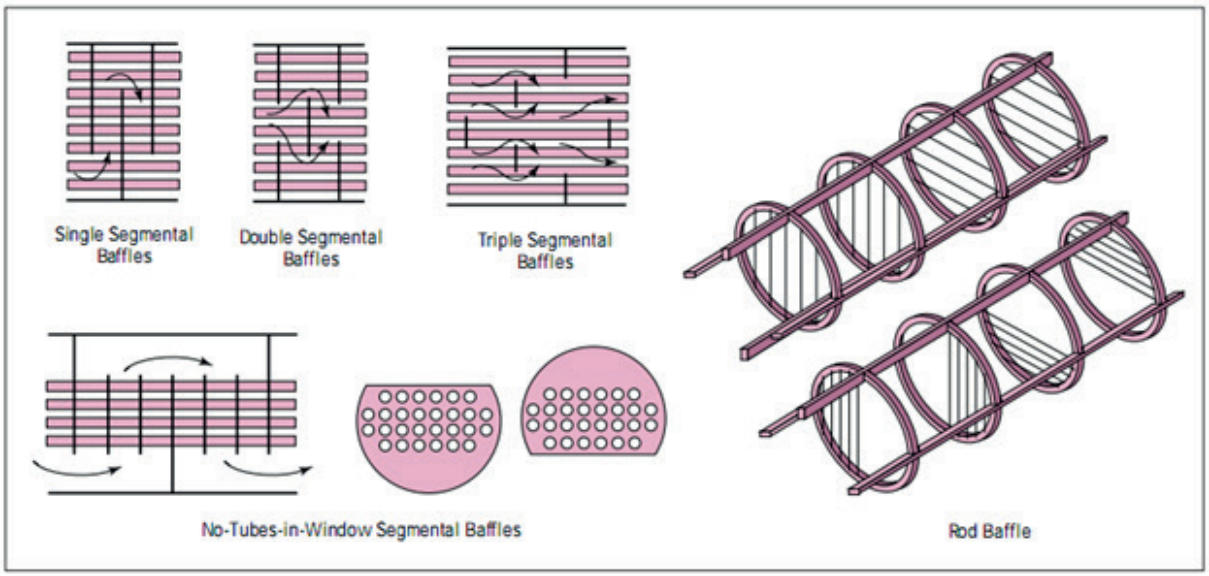

Figure 1. Different generic baffles

(Source: http://chemical-eng-world.blogspot.com/2013/05/baffles.html)

This innovative approach differs significantly from known solutions and products in the field. As grid operators have not yet considered electrolysis plants as significant loads on the grid, electrolyzer OEMs have not considered solutions to ride through FRT. Hence, current solutions do not address this problem.

The advantages of the proposed method are manifold. Firstly, it effectively mitigates the negative effects of an FRT on the hydrogen production process. Secondly, it ensures compliance with safety guidelines even during an FRT event. Finally, it aids in maintaining grid stability by allowing the electrolysis plant to swiftly resume pre-fault power consumption after a grid fault is cleared.

In conclusion, the invention provides a novel and effective solution to the problem of voltage fluctuations at the connection point of electrolysis plants. By introducing artificial turbulence in the product piping, it addresses the issues caused by an FRT event, thus ensuring the smooth and uninterrupted production of hydrogen. This method holds the potential to significantly improve the reliability and efficiency of hydrogen production through electrolysis.