World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:18, No:09, 2024

Additive Manufacturing – Application to Next Generation Structured Packing (SpiroPak)

Authors : Biao Sun, Tejas Bhatelia, Vishnu Pareek, Ranjeet Utikar and Moses Tadé

Abstract : Additive manufacturing (AM), commonly known as 3D printing, with the continuing advances in parallel processing and computational modeling, has created a paradigm shift (with significant radical thinking) in the design and operation of chemical processing plants, especially LNG plants. With the rising energy demands, environmental pressures, and economic challenges, there is a continuing industrial need for disruptive technologies such as AM, which possess capabilities that can drastically reduce the cost of manufacturing and operations of chemical processing plants in the future. However, the continuing challenge for 3D printing is its lack of adaptability in re-designing the process plant equipment coupled with the non-existent theory or models that could assist in selecting the optimal candidates out of the countless potential fabrications that are possible using AM. One of the most common packings used in the LNG process is structured packing in the packed column (which is a unit operation) in the process. In this work, we present an example of an optimum strategy for the application of AM to this important unit operation. Packed columns use a packing material through which the gas phase passes and comes into contact with the liquid phase flowing over the packing, typically performing the necessary mass transfer to enrich the products, etc. Structured packing consists of stacks of corrugated sheets, typically inclined between 40-70° from the plane. Computational Fluid Dynamics (CFD) was used to test and model various geometries to study the governing hydrodynamic characteristics. The results demonstrate that the costly iterative experimental process can be minimized. Furthermore, they also improve the understanding of the fundamental physics of the system at the multiscale level. SpiroPak, patented by Curtin University, represents an innovative structured packing solution currently at a technology readiness level (TRL) of 5~6. This packing exhibits remarkable characteristics, offering a substantial increase in surface area while significantly enhancing hydrodynamic and mass transfer performance. Recent studies have revealed that SpiroPak can reduce pressure drop by 50~70% compared to commonly used commercial packings, and it can achieve 20~50% greater mass transfer efficiency (particularly in CO2 absorption applications). The implementation of SpiroPak has the potential to reduce the overall size of columns and decrease power consumption, resulting in cost savings for both capital expenditure (CAPEX) and operational expenditure (OPEX) when applied to retrofitting existing systems or incorporated into new processes. Furthermore, pilot to large-scale tests is currently underway to further advance and refine this technology.

Keywords : Additive Manufacturing (AM), 3D printing, Computational Fluid Dynamics (CFD, structured packing (SpiroPak)
Conference Title : ICACCE 2024 : International Conference on Applied Chemistry and Chemical Engineering
Conference Location : Vancouver, Canada
Conference Dates : September 26-27, 2024