INTRODUCTION

Plate-fin heat exchangers (PFHE) are key components in many cryogenic processing plants. They have compact dimensions, are cost efficient and offer high heat integration as well as excellent operating performance. However, using them incorrectly can reduce the lifetime and result in repair costs and plant downtime.

As a technology, engineering, procurement and construction (EPC) company, Linde has developed many innovative processes, manufactures proprietary key components like PFHEs and also has comprehensive experience in operating process plants. Consequently, Linde is able to optimize the application (i.e. process topology, control concepts) of PFHEs and provide individual safeguards, guidelines and smart alarming concepts to ensure decades of trouble-free service.

LIFETIME OPTIMISATION

For each new Linde plant, an internal quality assurance program is performed to ensure reliable long-term operation of PFHEs. For this lifetime optimization, special attention has to be paid to potential sources of thermal stresses. If the typical PFHE service and operation guidelines (clean service, no corrosive fluids, no violation of design pressures and temperatures) are adhered to, thermal stress is the main source of potential fatigue.

An interdisciplinary team of specialists (operations, process, equipment, structural mechanics, safety) is involved in the hazard analysis (HAZAN) study of potentially harmful process upsets and the definition of countermeasures. PFHE design optimizations is a major part of this process. Further measures may include process optimization such as choosing the right control concepts and topology, as well as alarms and operator instructions.

For potentially critical process upsets, rigorous fluid-dynamic simulation models can be applied. The results of these simulations are then channelled into finite element models (FEM) to investigate the impact on the expected lifetime in detail.

For customers with plants in operation, Linde offers lifetime screening as a service. To support the operator in avoiding potentially harmful conditions, a report with critical thermal stress scenarios is provided. If required, a lifetime estimation with rigorous simulations can be performed for specific scenarios.

RESEARCH AND DEVELOPMENT

Air separation plants can be used to capitalize on the highly volatile electricity prices characteristic of liberalized energy markets. In this context, several thousand cycles of plant restarts from cold, warm or intermediate conditions might be required within the designed plant lifetime.

To investigate the impact of frequent restarts on the main heat exchanger (which is at the heart of an air separation plant), Linde initiated a research project in cooperation with the Technical University of Munich (TUM). The project is embedded into the Kopernikus Synergie project founded by the German Federal Ministry of Education and Research.

A large-scale test rig consisting of two heat exchangers, each comprising two modules, has been developed. The heat exchangers are periodically exposed to fast and wide temperature changes simulating rapid start-ups of an air separation plant. The overarching development aim is focused on longer lifetimes. The final results can also be applied to LNG PFHEs to prolong typical lifetime expectations and to extend the scope of application for PFHEs.

REFERENCES

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