**How Heat Integrated Units become a Safely Integrated Plant**

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**Highlights**

* Development of improved relief scenarios for fully integrated Aromatics complex
* Simulation of vapor flow rates from columns with fired heater reboilers
* Mitigated relief loads resulting in considerably smaller flare header

**1. Introduction**

The design of Aromatic complexes has become increasingly more integrated over the years. The first process integration was achieved by removal of intermediate storage followed by feed-effluent heat integration. In recent years, a large degree of heat exchange between units has been applied. Together with the use of co-produced desorbent and a large amount of dividing wall columns, these developments have resulted in fully integrated aromatics complexes.

When developing relief scenarios for such an integrated complex, one should therefore look beyond the single-equipment envelop. In this paper, an example will be provided how power-failure scenarios were established and optimized for an integrated Aromatics plant.

**2. Methods**

The design of a 60” flare header resulting from large vapor flow rates in the Aromatics plant under relieving conditions triggered Fluor to establish a baseline relief load. Estimates from a simple black-box assessment, coupling the plant inventory to the residual heat, provided significantly lower relief loads for the governing relief scenarios. Therefore, Fluor assessed these scenarios in the various units of the complex heat-integrated Aromatics plant and established the basis for the combined relief load by development of a fully integrated plant scenario. The design data from the distillation columns, fired heaters and hydraulic circuits were used to simulate the vapor flow rates contributing to the combined relief load. By applying high integrity pressure protection systems (HIPPS) on the fired heater reboiled columns, an improved general power failure scenario provided the governing relief load and a new basis for the hydraulic calculations to perform flare header sizing.

**3. Results and discussion**

The basis for the general power failure scenario is a typical steady-state total unmitigated relief load resulting from the residual heat input of the fired heater reboilers into the isolated process at normal operating conditions with full loss of cooling capacity (**Figure 1**). Therefore, the relief loads are result of the duty of the fired heaters and the available column inventory. As sizing of the individual relief valves serves the primary purpose of column protection, interaction between columns in the heat-integrated plant is not taken into account. This approach results in an overly conservative and often, cost prohibitive design of the flare header. Considering that there is a fixed amount of residual fired heater duty, the proper identification of heat integration and application of HIPPS provides an improved relief scenario and mitigated relief loads. The overall result is a more balanced design and a considerably smaller flare header of 32”.



**Figure 1.** Sketch of the relief load resulting from the residual fired heater duty into the isolated process.

**4. Conclusions**

Column overpressure safety systems for completely heat-integrated plants should be carefully designed by looking beyond the single-equipment envelope. Only with a fully integrated plant scenario a proper assessment can be made for both column safety and the impact on the combined relief load for the governing relief scenario. In addition, mitigation of the combined relief load will lead to a substantial cost benefit in the design.

**References**

1. API Standard 520 Part I, *Sizing, Selection and Installation of Pressure-relieving Devices, Part I – Sizing and Selection*, Ninth Edition, January 2014.
2. API Standard 521, *Pressure-Relieving and Depressurizing Systems*, Sixth Edition, January 2014.