The dual-chamber process gas boiler

Cost performance optimization in hydrogen plants

Steam generation in hydrogen production

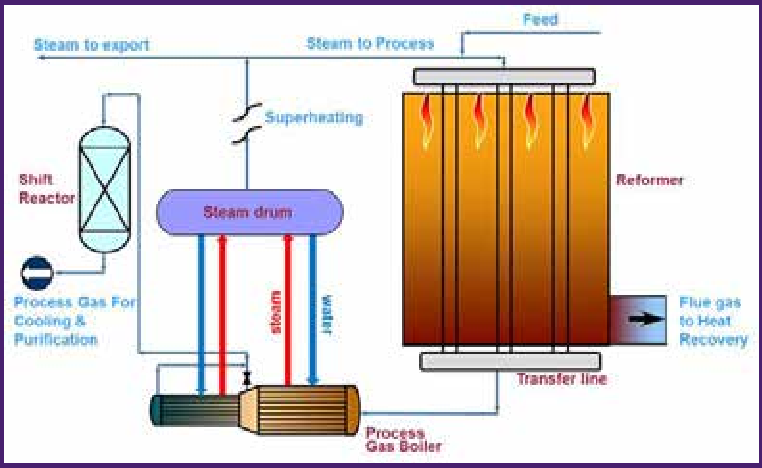
TechnipFMC's state-of-the-art steam reforming technology has been employed in more than 270 hydrogen plants worldwide, capitalizing on know-how and experience to deliver effective, tailored solutions to our clients. Consistently, TechnipFMC has adapted process solutions to implement cutting-edge technology in new and revamped hydrogen plant design.

Steam reforming is the predominant technology for hydrogen production, widely adopted for its flexibility, simplicity and high efficiency. High energy efficiency is obtained by case-specific optimization of heat recovery design. TechnipFMC has developed and patented the dual-chamber process gas boiler for offering cost-effective heat recovery in steam reforming plants with high operational flexibility and low maintenance costs.

Steam reforming and heat recovery

Hydrocarbon steam reforming is an endothermic process driven by energy supplied to the reforming catalyst by the combustion of fuel gas in the reformer box. The combustion heat is transferred from the hot flue gas in the firebox to the catalyst and the process gas through the walls of the catalyst tubes. The converted feedstock or process gas leaves the fired section at temperatures typically between 800° and 950°C. The process gas is then cooled in a process gas boiler to the temperature required for entering the downstream water-gas shift section that allows for additional hydrogen production by carbon monoxide (CO) conversion. The heat of the process gas is transferred to boiling water and recovered as valuable high-pressure steam, which may be superheated and used partially as process steam with the balance monetized as steam export.

Austria –
30,000 Nm^3/h Hydrogen



Role of process gas boiler in a hydrogen plant

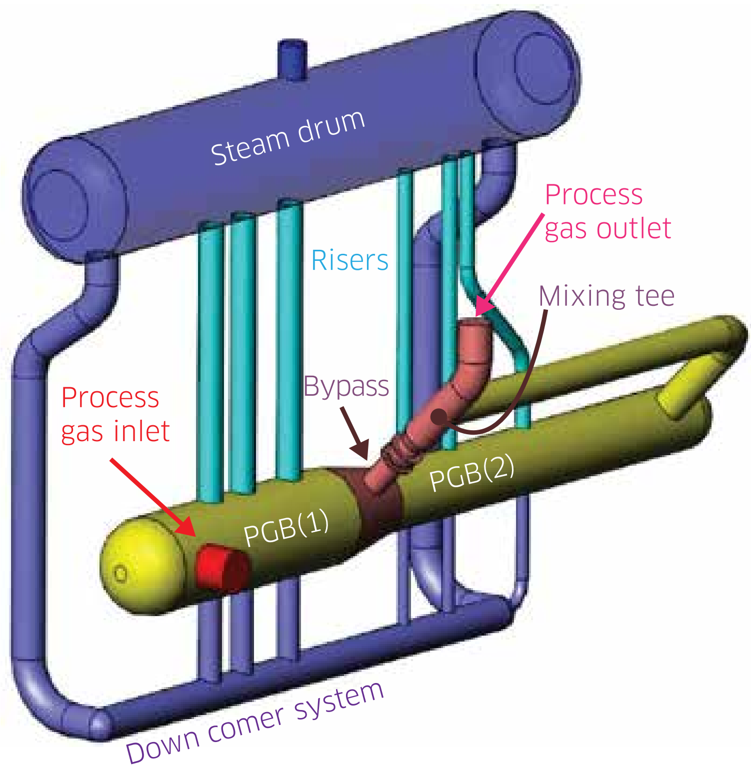
Effective heat transfer

The dual-chamber process gas boiler provides a cost-effective method to recover process gas heat exiting hot reformer tubes.

The heat exchange surface is divided into two chambers separated by an intermediate channel equipped with an external bypass system controlling the heat duty of the second chamber. The independent design of the two compartments allows for greater flexibility for the selection of tube diameter and length, saving money. The bypass valve provides accurate control of the outlet temperature for clean and fouled conditions to obtain the desired temperature upstream of the shift section. The design complies with the typical operating window for the process gas boiler and achieves the target outlet temperature for design parameters of plant turndown and fouling factors by a thorough understanding of the internal flow regimes.

The process gas boiler can be installed as a single system or complemented by the steam drum designed by TechnipFMC.

Typical arrangement of the dual chamber process gas boiler with the steam drum

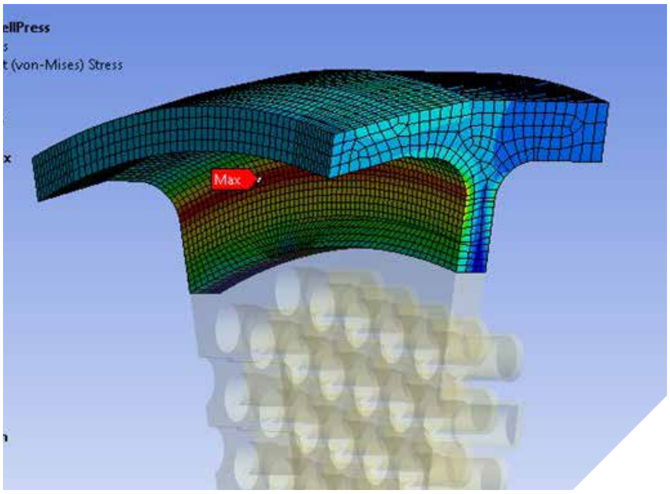


Rigorous process and mechanical design

The process and mechanical design is performed by in-house experts in compliance with international standards. The synergy between the Computational Fluid Dynamics (CFD) and the Finite Element Analysis (FEA) has resulted in a robust, cost-effective mechanical design.

TechnipFMC's vast experience in CFD supports the determination of temperature profile and heat flows in the equipment while ensuring a uniform flow distribution in the tubes. The FEA calculation on the critical parts of the heat exchanger is applied to ensure that mechanical and thermal stresses are safely below the allowable limits. All potential load combinations, as well as extreme climate conditions, are considered during the FEA calculation.

The resulting design enables the heat exchange area to be optimized while avoiding excessive stress caused by the differential expansion between the shell and the tubes. The dual-chamber process gas boiler design offers high levels of operational safety and flexibility.



Mechanical stress profile from FEA

Dual-chamber advantages

A significant reduction of material costs associated with heat transfer surface is achieved by optimization of the heat transfer area in each compartment.

A reduction of the differential growth between shell and tubes supports significantly larger units without excessive stress on critical components of the process gas boiler.

The external bypass system operates under less severe temperatures, minimizing the risk to metal dusting and other mechanical failures while allowing easier valve inspection and maintenance.

Bulgaria –
83,400 Nm^3/h Hydrogen

Transportation of a process gas boiler to the plant site

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