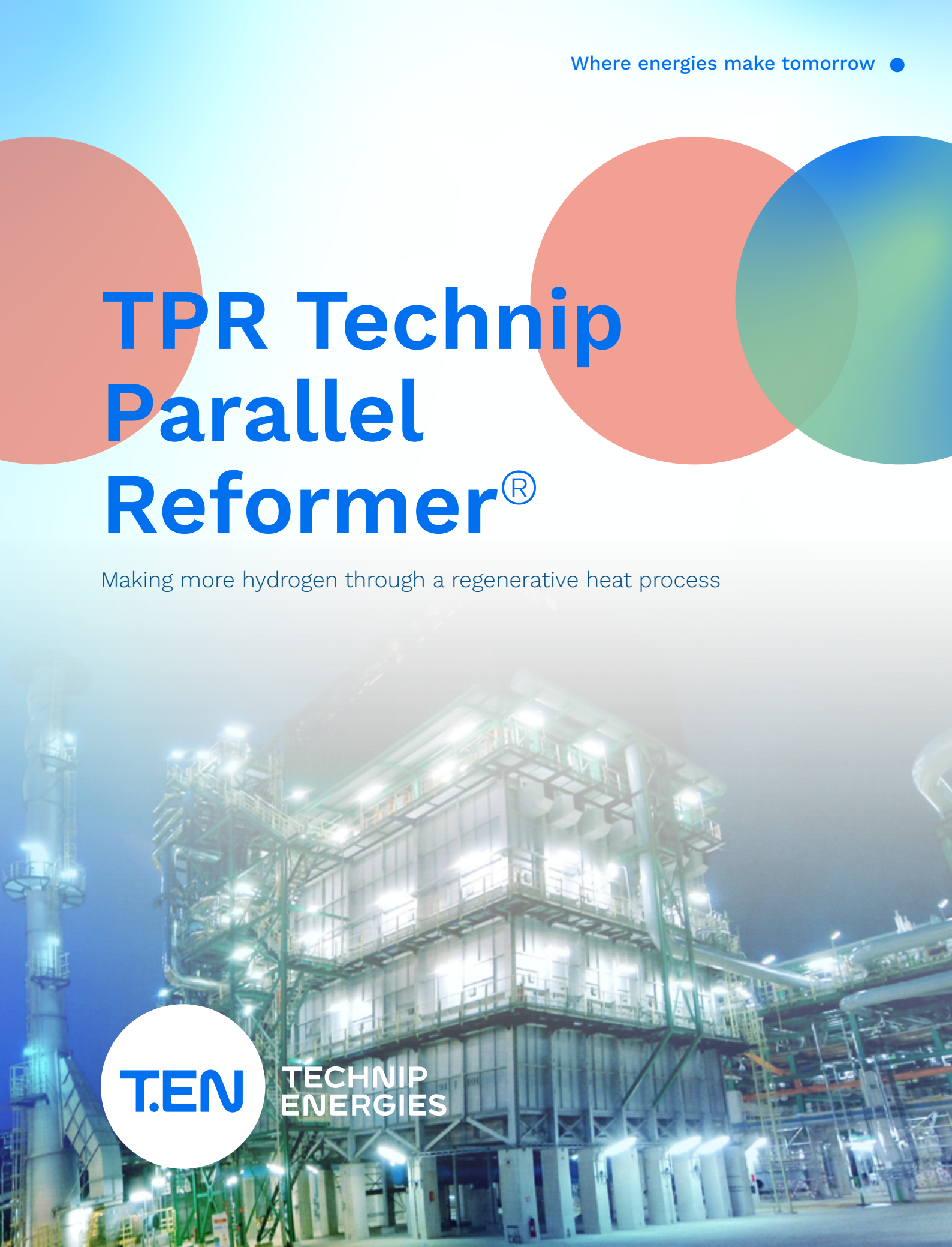
Where energies make tomorrow

TPR Technip Parallel Reformer®

Making more hydrogen through a regenerative heat process



T.EN TECHNIP ENERGIES

Steam reforming with TPR for additional hydrogen production

Today's preferred technology for hydrogen production is steam reforming of hydrocarbons. The process has been widely adopted for its cost performance, flexibility, simplicity and high efficiency.

Technip Energies is a global leader in hydrogen technology and plant supply with more than 35 percent of the market share. Our proprietary state-of-the-art steam reforming technology has been employed successfully in more than 270 plants worldwide. While striving to deliver the most effective and optimized solutions to our clients, we adapt our designs with cutting-edge technologies for both new and revamped hydrogen plants. Our innovative designs are tailored to meet project-specific needs and satisfy our clients' business objectives.

Steam hydrocarbon reforming is an endothermic catalytic process where the heat of reaction is typically supplied in a furnace containing multiple tubes filled with catalyst. The combustion heat is transferred from the hot flue gas to the tubes mainly through radiative heat transfer.

In advancing the application of steam reforming technology beyond the conventional fired reformer, we developed the TPR Technip Parallel Reformer® as a convective–regenerative heat exchange reformer that:

- optimizes the high-grade heat recycle, and
- increases reforming capacity without additional firing.

TPR can be applied effectively in new plants or as a retrofit for existing plants. For retrofits, the technology offers an unmatched solution for operators looking to increase hydrogen capacity by providing additional reformed gas with minimal or no modifications to the existing reformer, including the steam system. The solution requires less plot area, a shorter execution time and lower investment compared to building a new plant.

USA, 30% capacity increase by TPR

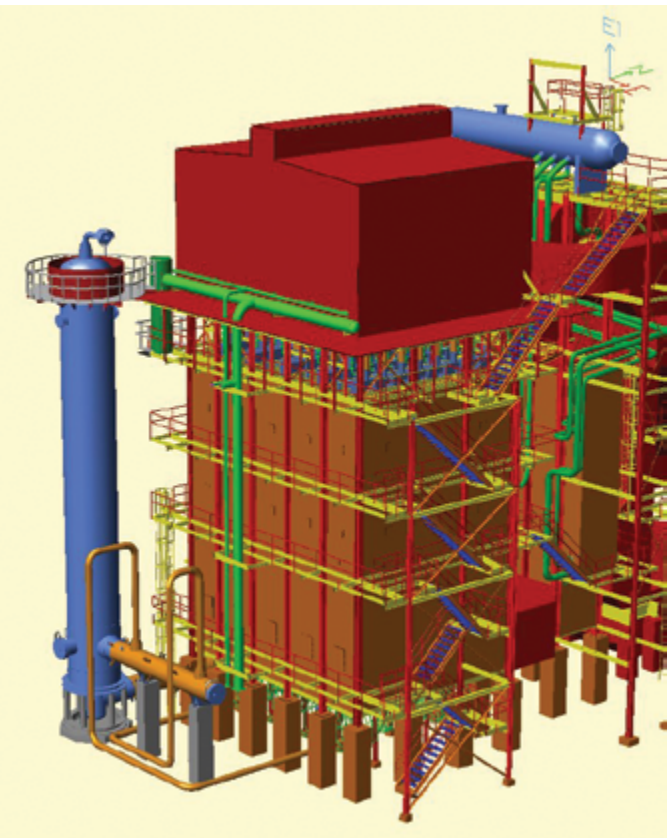
Boosting hydrogen with the same fuel firing

The TPR is a compact heat exchanger reactor for steam reforming. Other than in the fired reformer, the heat for the TPR is supplied by hot process gas rather than by hot flue gas.

Up to 30 percent additional feed can be reformed using the TPR in parallel to the fired reformer.

Since the steam reformer effluent is used to meet the heat duty of the TPR, the steam production in the downstream process gas boiler is reduced significantly. The design is optimized considering both hydrogen and steam requirements.

The design, metallurgy and fabrication of TPR involves advanced engineering know-how to ensure mechanical integrity and operational reliability. Feedback from our operating reference units supports our ongoing improvement efforts.



TPR adjacent to steam reformer

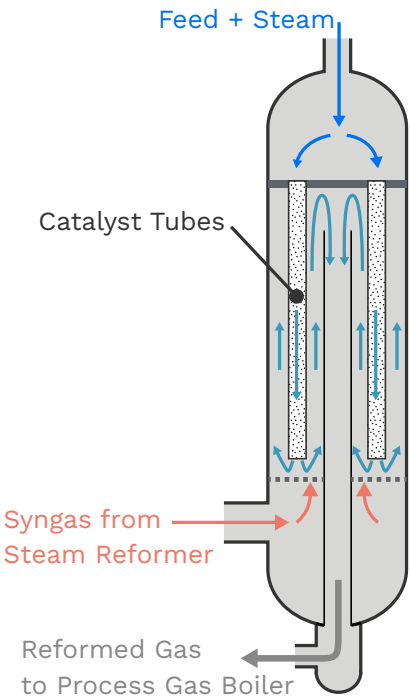
Main features

The catalyst tube bundle is embedded in the refractory-lined shell of the TPR vessel.

Pre-heated feed gas (natural gas with steam or pre-reformed feed) flows from the top of the unit through the tubes. The feed is steam reformed to an equilibrium mixture of hydrogen, carbon monoxide, carbon dioxide, methane and water, analogous to the reactions in the main steam reformer. The process gas exiting the tubes is mixed with the incoming hot steam reformer effluent at the bottom. The mixture then flows upward through the shell side, supplying the necessary reaction heat to the catalyst tubes.

As part of the proprietary design, a central collector pipe in the middle of the reactor directs the mixed reformed gas to leave the TPR at the bottom, avoiding an external transfer line to the downstream process gas boiler.

The size, configuration and mechanical design of TPR, especially in terms of tube sheet, tube geometry and layout, and material selection is the result of multi-disciplinary know-how and expertise. The fabrication involves several features and engineering details that follow international standards to ensure long-term integrity and reliability.



TPR internal flow configuration

France –97,000 Nm^3/h Hydrogen

Advantages of TPR

- Increases reforming capacity in a compact unfired unit parallel to steam reformer.
- Adds up to 30 percent additional hydrogen in capacity revamps of existing plants without additional firing demand or major modifications to the existing reformer.
- Substantially lowers cost per unit of additional hydrogen compared to other options such as adding a reformer or building a full plant to achieve the capacity increase.
- Minimizes export steam, especially when steam revenues are not favorable. The technology further allows zero export steam enabling stand-alone plants that do not need to be connected to an external steam network.
- Lowers CO_2 footprint per unit of hydrogen compared to a stand-alone steam reformer of equal capacity.
- Requires minimum plot area.
- Offers ease of operational control and is inherently safe on upset modes.
- Provides proven, reliable technology with several world-scale hydrogen plants reporting capacity increases of 20 to 30 percent.
- Fits in a typical project execution schedule within the turnaround schedule of the plant

TPR has been successfully employed in various hydrogen plants for capacity revamps. For more than 50 years, we have provided cost-effective solutions to our customers.

TPR references

Location	Start-up year	Feedstock	Pre-reformer	Add-on capacity (kNm3/h)	Capacity increase (%)
Spain	2003	NG/Nap	Yes	3.4	25
Spain	2009	Nat. Gas	Yes	9	26
USA	2010	Nat. Gas	No	5	30
USA	2011	Nat. Gas	No	9	24
France	2012	Nat. Gas	Yes	21	22
India	2017*	Naphtha	Yes	20.5	20
India	2017*	Naphtha	Yes	7	20
India	2017*	NG/Nap	Yes	2.8	20
India	2018	LPG/Nap	Yes	24.7	23
India	2018*	NG/Nap	Yes	2x30**	24

*Year of award
**Grass-root unit

Trial fit of the TPR tube bundle at the fabrication shop


HANYŠ
www.hanys.cz
LIEBHERR

The Netherlands

Zain Abdin
+31 79 3293 625
zainul.abdin@technipenergies.com

USA

Vinay Khurana
+1 909 447 3683
vinay.khurana@technipenergies.com

Where energies make tomorrow. **technipenergies.com**