Pillow Plate Heat Exchanger

Product Coding
PXXXXXXXXX

Introduction

Pillow plate is a bonded double plate in which the thin face sheets are laser/weld sealed at a pattern and pressurized to form “pillow” chambers; the welded pairs form a corrugated fluid channel. Pillow plate assemblies (also called thermoplates) are used as compact, robust heat transfer surfaces and can be fabricated into flat panels, curved shells, or complex shapes for direct integration into vessels or reactor jackets. They are used for cooling/heating liquids and gases and can be configured as reactor internals.

Recent technical work explores using pillow-plate reactors (i.e., catalyst packed around or between pillow plate channels) for methanol synthesis as an alternative to conventional multi-tubular reactors, the literature shows promise for small scale or intensified units where compactness and heat removal are critical.

Features

- **High surface area per footprint:** Can provide a compact heat removal surface for exothermic reactors.
- **Good mechanical robustness:** Welded plate construction tolerates pressure and thermal cycling.
- **Flexible geometries:** Panels can be formed to fit cylindrical reactors or trays, enabling direct heat extraction close to catalyst beds.
- **Contaminant tolerance:** Suitable for some dirty/particulate or two phase media where small tubes might foul.
- **Compactness:** High area density for limited reactor diameter/length.
- **Mechanical simplicity:** Fewer penetrations and no small tubes to plug; easier cleaning access in some designs.
- **Manufacturability:** Modular panels can be prefabricated and installed on site.
- **High local heat transfer:** Flattened pillows create turbulence in adjacent coolant channels and good conduction through thin plate walls.
- **Good fatigue and pressure resistance:** Welded pockets resist bursting and can be designed for moderate pressures.

Tel.: +98 21 88686942-3
Fax: +98 21 88686168
Sales@euroslot-pars.com

www.euroslot-pars.com
Linkedin.com/company/euroslotpars
Youtube.com/@Euroslot-pars

Office: No. 2, Unit 2, East 32nd (East Qeysari) St., South Allameh Ave., Sa'adat Abad Area, Tehran, Iran

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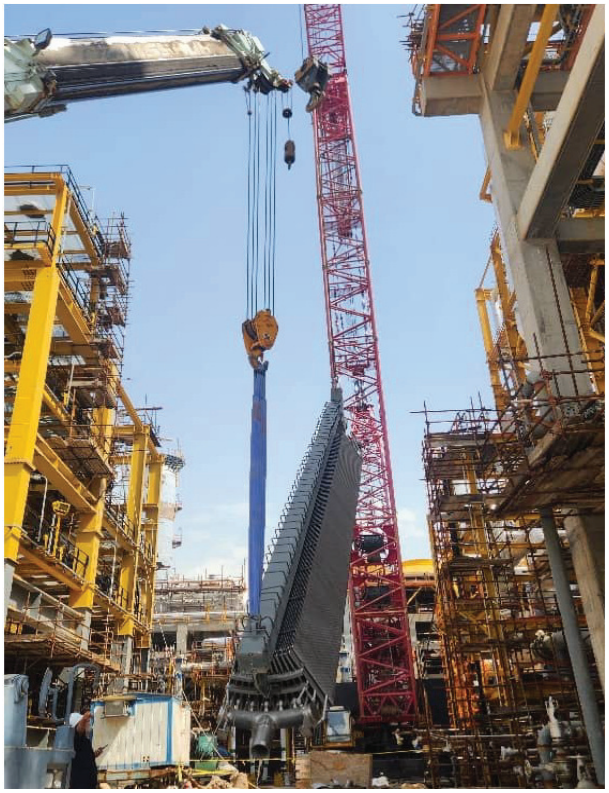
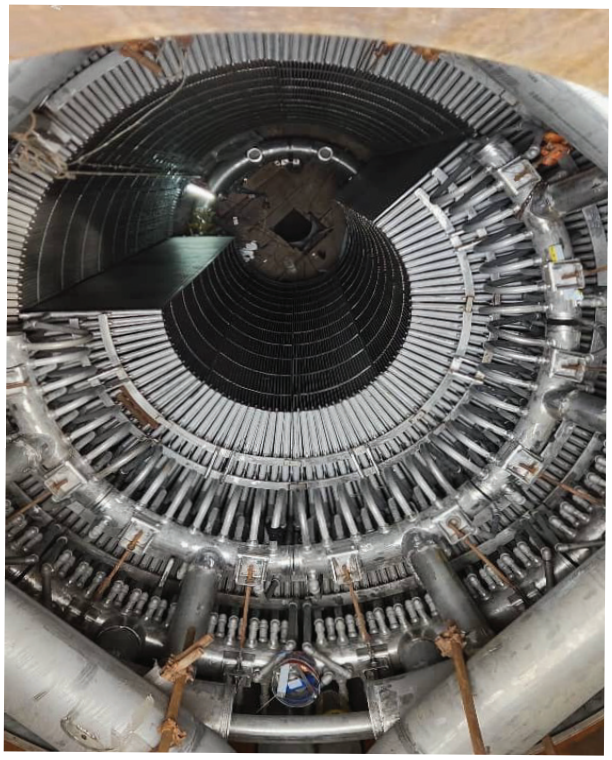
Applications

- Bulk methanol production for chemical, petrochemical, and energy industries.
- Feedstock for downstream chemicals, including formaldehyde, acetic acid, dimethyl ether, methanol-to-olefins, and gasoline blending components.
- Hydrogen storage and carrier systems, where methanol serves as a compact liquid hydrogen carrier.
- Solvent and process chemical for pharmaceuticals, resins, coatings, adhesives, and plastics.
- Intermediate for clean fuels, e.g., biodiesel transesterification and syngas conditioning.
- Base chemical supply for integrated complexes, feeding refineries, polymer plants, and chemical parks.





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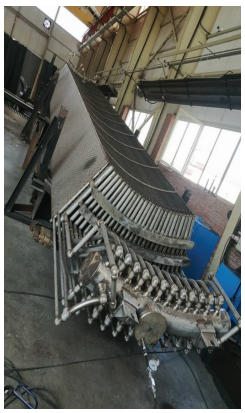
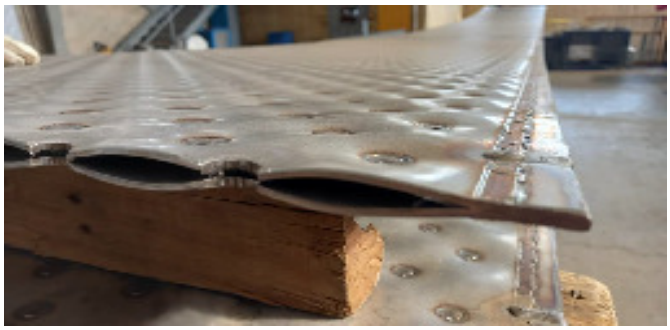
Engineering Challenges

- **Catalyst contact and packing:** Pillow plates are essentially flat panels, achieving uniformly packed catalyst with good gas/solid contact and pressure drop comparable to multi tube bundles is non-trivial; channeling or poor axial mixing can reduce conversion.
- **Hydraulics/pressure drop:** For a given throughput, pillow-plate reactor passages may yield different velocity profiles and pressure drops than tube bundles; detailed hydraulic design and sometimes CFD are required.
- **Two phase flows and condensate:** Methanol synthesis involves gas phase reaction with condensation; pillow plates must be designed to handle vapor/liquid behavior and possible fouling or liquid hold-up.
- **Temperature uniformity:** Mixing trays and staged quench systems (or distributed pillow plates) help prevent hotspots, combine with quench piping and mixing trays where needed. (Quench systems are commonly used in Topsoe designs.)
- **Scale and modular limits:** While excellent for compact units and pilot/intensified reactors, pillow plate reactors are less proven at the largest world scale single trains compared with multi tubular reactors used by licensors in commercial projects. Topsoe and others typically use proven multi tubular fixed bed reactors for large plants.
- **Heat removal rate:** Design to keep catalyst within allowable temperature window (methanol synthesis is exothermic and high local temperatures reduce catalyst life and selectivity). Use kinetic data and catalyst apparent heat release to size pillow plate area.
- **Leak detection:** Incorporate interstitial leak detection or pressure testing methods, patch repairs are more difficult than tube replacement in shell-and-tube.
- **Fouling and cleaning:** Plan for blowdown, chemical cleaning, and potential mechanical cleaning of pillow channels if condensate or solids accumulate.
- **Access strategy:** Design pillow plate panels as removable modules or provide manway access for catalyst handling.





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