4.1.1 Sustainable products and services

Brazed Plate Heat Exchangers

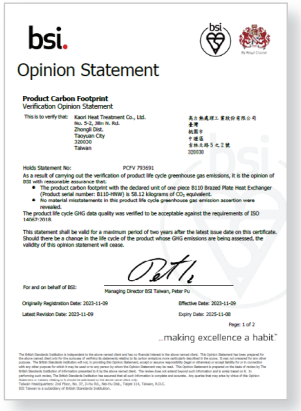
Featuring wave patterns stamped on 304 or 316 stainless steel materials, Kaori's brazed plate heat exchangers are made through multi-point brazing of stainless steel with copper or nickel in a vacuum furnace, thereby allowing them to operate under extreme pressure in a very small chassis while making them especially suitable for refrigeration and air conditioning systems. Meanwhile, the wave patterns stack on top of each other to form conduits that create a turbulent flow of the coolant even at low flow speeds. This enables the heat exchangers to achieve high thermal conduction efficiency in a small heat transfer area. In systems that require high efficiency, the use of brazed plate heat exchangers may further increase the coefficient of performance (COP) and reduce the overall space needed to install the modules, which in turn lessens the need for fluorinated greenhouse gases (F-GHG) and is a more efficient and environment-friendly design.

Industry Applications

•Air conditioning •Semiconductors and electronics •Refrigeration •Energy and utilities •Machinery •Transportation •Medical equipment •Data centers

Sustainable Development Highlights

- The first heat exchanger manufacturer in Taiwan to pass ISO 14067 carbon footprint third-party inspection.
  (The certificate is shown on the right)
- Digitalization of product manuals.
- Continue to develop low-carbon stainless steel in a diversified manner, which can reduce carbon emissions by 95%.
- Assist overseas customers in obtaining local quality certification.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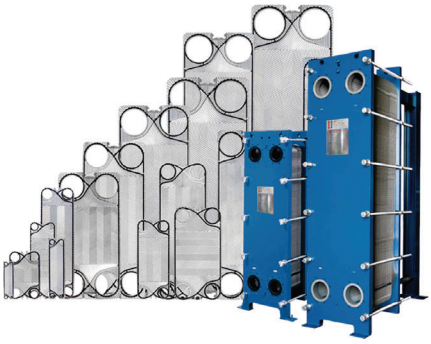
Opinion Statement

Product Carbon Footprint
Verification Opinion Statement

...making excellence a habit.



Gasket Plate Heat Exchangers

Offers better heat conduction in a smaller size compared to spiral type or shell and tube type heat exchangers. With proper design, gasket plate heat exchangers can be more efficient at transferring heat and easier to clean, maintain, disassemble, and install while retaining the potential for capacity expansion.

Industry Applications

•Petrochemical plants •Oil refineries •Steel •Power generation •Freight •Semiconductors •Metal processing •Food •Refrigeration

Sustainable Development Highlights

- Energy efficiency and conservation:

  The special pattern design enables a high level of turbulent flow even at low flow speeds, therefore delivering a number of advantages including efficient heat transfer, reusability, and a longer lifespan of at least 10 years.

- Heat recycling:

  Data centers, for example, may use a combination of immersion liquid cooling and gasket plate heat exchangers to recycle heat and increase overall energy efficiency by more than 40%.

Critical SOFC Components
High-efficiency Fuel Cell Recuperators

Heat-resistant nickel-base superalloys are assembled using Kaori's proprietary brazing technology in conjunction with advanced TIG welding to allow heat transfer under high temperatures. The material achieves a thermal cycle efficiency of 60%. This demonstration of exceptional brazing and TIG welding techniques has gained recognition from green manufacturers worldwide and made Kaori a long-term strategic partner.

Industry Applications

A solid oxide fuel cell (SOFC) is a form of distributed energy system which involves generating and supplying power directly to local users based on their requirements. Kaori's solutions offer a high degree of versatility that make them suitable for medium- and small-size energy conversion systems of various purposes. Ships, for example, may install fuel cell power systems to replace diesel power.

Sustainable Development Highlights

- Advantages such as high performance, stability, low emissions, zero pollution, waterless, and long lifespan have been validated through commercial operation by reputable customers for more than 10 years.
- Thermal reactors for high capacity SOFCs increase power generation efficiency to 65% from the previous generation.
- Thermal reactors have been developed for hydrogen generation and energy storage.
- Application in vessels helps the shipping industry achieve energy and carbon reduction goals.

Reformed methanol/hydrogen PSA system

The hydrogen generator takes in a methanol solution and applies a process called pressure swing absorption (PSA) to purify and generate high-purity hydrogen (99.999%). It is widely used in industrial processes that make use of the gases generated, such as hydrogen reduction furnaces, heat treatment furnaces, semiconductors, and optoelectronics.

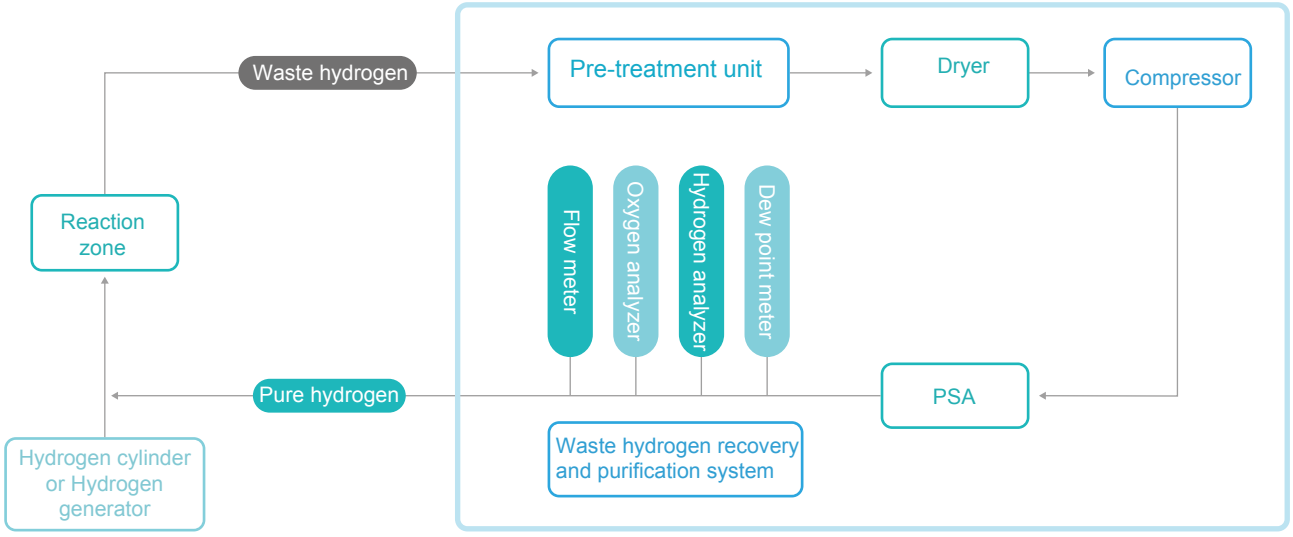
- 30-4.5 m^3/hour
- Generates hydrogen at low pressure (<5 kg/cm^2) with rigorous safety protection
- Uses methanol (<59%) as the raw material; the hydrogen produced can be used immediately and does not require a hydrogen storage tank
- Replaces pressurized hydrogen canisters; equipment investments can be recovered in as little as six months

Reformed Methanol/Proton Exchange Membrane (PEM) Fuel Cell System/Ammonia Fuel Cell (AFC) System

- System size is 30-50% smaller compared to products of equivalent grade
- Energy consumption ≤ 0.5 kW and noise ≤ 65 dB (at 5 kW output)
- CO emission ≤ 20 ppm (low exhaust; no NOx and SOx)
- Safe and stable: Overall power and thermal efficiency >85%; continuous operation for >72hr
- Applications: Backup power for remote areas or disaster sites; reserve power for critical facilities

Industrial Waste Hydrogen Purification/Recycling System

- Recycling and reuse: Eliminates the need to remove hydrogen or transport hydrogen in pressurized form; approximately 70% is recycled, which lowers carbon emissions
- Greatly reduces the need to supply hydrogen through tankers/canisters; can be replaced with Kaori's methanol hydrogen generators
- Recovery period of equipment investment is about 2.5 years



Organic Solvent Hydrocracking System

By treating organic solvent waste, hydrogen can be recycled and reused to generate base load power. Waste silicon from semiconductors and solar panels can be processed to produce hydrogen at 99.9% purity; using Kaori's purification system, the level of purity can be increased to 99.999%, which makes the hydrogen usable for industrial and power generation applications.

Industry Applications

- Supports hydrogen-based production procedures or by-product hydrogen: For example, hydrogen reduction furnaces, heat treatment furnaces, semiconductors, optoelectronics, powder metallurgy, metal wires, and steel industries.
- Organic solvent waste fluids of the electronics industry (semiconductors, circuitry, LCD panel, etc.) can be pre-processed and cracked at high temperature to separate hydrogen for power or heat.

Sustainable Development Highlights

Ammonia cracking and hydro power: Clean energy research involving the use of ammonia as hydrogen fuel carrier has gained popularity around the world in recent years due to the ease of storage, ease of transportation, and better economic viability of ammonia compared to hydrogen.

Liquid Cooling System

The Thermal Energy Business Unit focuses on AI data centers and has introduced a new generation of server liquid cooling products targeting “server thermal management”. These solutions align with current trends in AI development and provide more sustainable cooling solutions for data centers and high-performance computing.

Industry Applications

Cloud services/5G communication, Edge computing, Data centers, Semiconductor EDA, Artificial intelligence, Blockchain, Cryptocurrency (mining), Electric vehicle battery cooling

Sustainable Development Highlights

- Power usage effectiveness (PUE) is an internationally accepted metric for measuring the power efficiency of data centers. PUE is calculated by dividing the total data center power draw by the total IT equipment power draw. A low PUE indicates that the data center requires less power for cooling, which suggests lower power consumption and greater environmental friendliness.
- China's first data center with 5A green rating uses single-phase immersion cooling technology with insulated coolant to achieve high-efficiency cooling without the need for fans, air conditioners, or chillers. The solution reduces power used in cooling by 70% and lowers the PUE to 1.09.