ORC AND STEAM EXPANDERS

POWER RECOVERY AND POWER GENERATION THROUGH HEAT AND PRESSURE

- Capacities from 50kW to Multi-Megawatts
- Oil free screw expanders for steam or gases expansion
- Lubricated screw expander for Kaishan ORC
- Pressure regulation in steam or gas pipelines
- Flash steam and brine from geothermal wells can be accepted
- Wasted heat recovery systems for any kind of hot fluid
- Wasted pressure recovery systems in steam pipelines
- Low cost investment, easy to install and maintain

RENEWABLE ENERGY TECHNOLOGIES
ABOUT US

Over the last sixty years, the Kaishan Group has steadily grown to become a significant, diversified engineering company developing high value machinery for industry worldwide.

With modern specialized manufacturing facilities positioned in seven strategic locations, Kaishan is the world’s third largest manufacturer of compressed air mining and drilling equipment. Today we produce over 60,000 rotary screw and 250,000 reciprocating compressors annually. Supporting these production facilities, Kaishan Group, including thirty-two subsidiary companies, supplies compressed air and mining equipment to over sixty countries and regions including the USA, Australia, Germany, Japan, Korea, Russia, Africa and throughout Latin America.

Research and development for all new compressor products is done in Seattle, WA, USA. Combining highly skilled engineering with low cost manufacturing allows us to provide performance-proven, reliable equipment of optimum value to our customers. Kaishan’s manufacturing processes are 85% vertically integrated insuring full control of the material supply chain, component cost and quality.

This unique control of the material supply chain affords Kaishan the ability to respond rapidly to changing market demands. Integral in the design and manufacture of our products is outstanding energy efficiency and field-proven reliability. Kaishan’s fundamental belief in environmental sustainability drives our focus on producing products that maximize energy efficiency, meeting the needs of industry now and into the future and helping to preserve our precious energy resources. Single- and two-stage compressors that produce more compressed air per unit of power input as well as expanders that utilize waste heat to produce electricity are just two of the fundamental products in our sustainable approach.

Throughout our manufacturing processes, unused waste materials are rigorously recycled at every stage to maximize the use of our raw materials. The positive impact for our customers is that of outstanding engineering with a pioneering spirit and a focus on continuous improvement. Kaishan will continue to develop more technologies and unique manufacturing techniques providing industry with machinery of exceptional value—now and well into the future.
This is the most innovative product to generate clean energy through expanding steam or gases. Our expander can accept saturated, dry or overheated steam as well any kind of gas with the exception of O$_2$ and H$_2$. During the condensation, the steam or gas can be discharged at any desired pressure—even at vacuum. While the expansion process is made, the system will generate power that will be transferred and regulated by the electrical control.

**DIRECT EXPANSION APPLICATIONS**

- Drop and control the pressure in steam and gas pipelines.
- Steam thermal plants burning any kind of fuel.
- Flash steam expansion from geothermal wells.
- Expansion and/or condensation of wasted steam to recirculate hot water to a boiler.
- Take advantage of any differential pressure in steam pipelines.

**DIRECT STEAM OR GAS EXPANSION POWER PLANT USING KAISHAN OIL FREE SCREW EXPANDER**

Kaishan has developed and patented the innovative screw expander that can be used to replace the conventional turbines improving the isentropic efficiency up to almost 90%. Through this innovation Kaishan is the leader in waste heat recovery systems and waste pressure recovery systems at low temperatures and pressure. Using our technology Kaishan is recovering near to 100MW around the world with short payback and reducing CO2 emissions and heat to the atmosphere. The use of Kaishan screw expander systems can be grouped with other renewable energies such as co-generation, waste heat recovery and waste pressure recovery. The Kaishan screw expanders and ORCs are versatile, easy to install and provide low maintenance costs.

**KAISHAN INNOVATION:**

Kaishan has developed and patented the innovative screw expander that can be used to replace the conventional turbines improving the isentropic efficiency up to almost 90%. Through this innovation Kaishan is the leader in waste heat recovery systems and waste pressure recovery systems at low temperatures and pressure. Using our technology Kaishan is recovering near to 100MW around the world with short payback and reducing CO2 emissions and heat to the atmosphere. The use of Kaishan screw expander systems can be grouped with other renewable energies such as co-generation, waste heat recovery and waste pressure recovery. The Kaishan screw expanders and ORCs are versatile, easy to install and provide low maintenance costs.
Using this table, it is easy to estimate the net power generated in kW per ton/h of saturated steam:

In the first row, find the steam inlet pressure, in the first column find the desired outlet pressure, look for the intersection at the table and get the net power generated in kW for every ton of steam per hour, multiply the value of the intersection per ton/h mass flow and get the estimate of net power to generate. The values are for reference only.

### POWER GENERATION FROM DIRECT STEAM EXPANSION

#### POWER GENERATION FROM PROCESSES OR WASTED HEAT

The ORC is used for the transformation of heat into clean electricity. Your power supply is the heat from hot fluids like liquid or gaseous fluids that can be driven to an evaporator. There the refrigerant will evaporate and will raise your pressure. Once this gas expands into the lubricated screw expander it will generate movement and at the same time electricity. Then the refrigerant is condensed and through a fluid pump, it will return to the evaporator to continue absorbing heat and continuously generate electricity.

#### ORC APPLICATIONS

Power generation applications from hot fluids, liquids or gases:

- Water used for engine cooling circuits, or any machine or process that raises to 80°C and above.
- Geothermal hot water (brine).
- Processes hot fluids: ethanol, gasoline, water, low pressure to condensate steam, thermal oil, chemicals, etc.
- Hot exhaust gases from combustion in gas turbines or internal combustion engines burning gas or diesel.
- Hot gases from kilns and furnaces in industries like cement, glass, steel, etc.
- Solar thermal energy generated by hot water or steam.
- Any application where heat can be transferred to a fluid and taken to the ORC.
In a power generating plant, the hot gases of combustion and heat from the engine cooling water circulate to produce clean electricity. The heat is taken to the ORC through a water circuit which first exchanges heat with the cooling water and then with hot combustion gases. Finally this hot water reaches the evaporator of the ORC where it evaporates the refrigerant gas which then expands in the Kaishan Screw Expander.

SUCCESS CASE: WASTE HEAT RECOVERY IN INTERNAL COMBUSTION ENGINE

In a power generating plant, the hot gases of combustion and heat from the engine cooling water circulate to produce clean electricity. The heat is taken to the ORC through a water circuit which first exchanges heat with the cooling water and then with hot combustion gases. Finally this hot water reaches the evaporator of the ORC where it evaporates the refrigerant gas which then expands in the Kaishan Screw Expander.

SUCCESS CASE: TWO STAGE HYBRID SYSTEM

In a steel mill, 9.5 ton/hour of steam was used and steam pressure was reduced in the first stage from 4.19 barg (62 psig) down to 0.43 barg (6.2 psig) while generating a net of 470 kW; then an ORC was used for the condensation of the steam (at 110°C) to obtain hot water at 50°C and generate an additional 673 kW. The total amount of clean energy generated is a net 1143 kW. Currently the steel mill has three equal systems that allows them to retrieve nearly 3.5 MW and has the additional benefit of reducing CO₂ emissions to 23,072 ton/year and recover up to 219,400 ton/year of water.

ORC AND EXPANDERS TECHNICAL SPECIFICATIONS

- Generation capacity from 50kW to Multi-Megawatts.
- Kaishan oil free/lubricated screw expanders with high isentropic efficiency.
- Efficient performance for unsteady flow conditions without losing efficiency.
- Intake of any kind of steam—dry, saturated, superheated or flash for direct expansion.
- Admission of all kinds of gases except H₂ and O₂ for direct expansion.
- Three different options for condensers: evaporative, air cooled or water cooled heat exchanger.
- Expanders with SKF bearings for 100,000 hours of duty and John Crane seals.
- Heat exchangers are built to ASME standards.
- Induction or synchronous generator for any voltage and frequency.
- Control with Siemens PLC for controlling and remote monitoring.
- High efficiency and reliability.
- Environmentally friendly refrigerant.
- Zero emissions, without byproducts.
- Easy and inexpensive installation.

SUCCESS CASE: TWO STAGE HYBRID SYSTEM

- Features Caterpillar G3516
- Engine capacity: 1000kW
- Cooling type: water
- Fuel: Biogas

Characteristics of the installed ORC
- Additional net power generated: 120kW
- Engine increased efficiency: 12%
- Reduction in CO₂ emissions: 865 ton/year
- Savings equivalent in tons of coal per year: 365 ton/year
STEAM THERMAL PLANTS
Energy generation using steam from a boiler burning fuels like: coal, gas, diesel, biomass, etc. Boilers or heat exchangers that use the heat from recovery systems in hot exhaust gases or any source that generate steam in the required conditions.

SUCCESS CASE: WATER COOLING IN REFINERY
- Fluid: Water
- Flow capacity: 200t/h
- Water inlet temperature: 118°C
- Water outlet temperature: 70°C
- Net power output at the annual average ambient temperature 25°C: 907 kW
- Net power output at the hottest monthly average ambient temperature 34°C: 789 kW

SUCCESS CASE: GASOLINE COOLING IN SINOPEC REFINERY
- Fluid: Gasoline
- Fuel flow capacity: 125 t/h
- Gasoline Inlet temperature: 135°C
- Gasoline outlet temperature: 70°C
- Special specification: Explosion proof system
- Net power output: 546kW

SUCCESS CASE: TEAM DIRECT EXPANSION
- Decompressing low pressure steam generated in cooling process in a steel factory
- Inlet steam pressure: 4.19barg (62psig)
- Outlet steam pressure: 0.43barg (6.2psig)
- Steam flow rate: 9.5 Ton/hour
SUCCESS CASE: GEOTHERMAL POWER PLANT, UNITED STATES

In the case of geothermal energy from hot water (brine) in Lightning Dock, New Mexico, 4 plants of 1 MW were installed. 2400 gallons per minute of water at 149°C pass through the system, then fresh water is reinjected into the soil.

SUCCESS CASES IN ASIA AND UNITED STATES

KAISHAN has installed ORC, Steam Expanders (SE)) and HYBRIDS (SE+ORC) in Asia and the United States, in steel mills, refineries, chemical plants, oil palm processing plants, low enthalpy geothermal energy sites, and facilities burning solid waste, among others. The total of the net power currently generated is more 100MW including recent projects—power previously wasted into the atmosphere. Kaishan is a leader worldwide in waste heat recovery and waste pressure recovery systems utilizing its screw expanders technology.

<table>
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<tr>
<th>CUSTOMER</th>
<th>PLANT</th>
<th>PLANT TOTAL POWER (KW)</th>
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<td>JIANSHU CHENXING PHOSPHATING PLANT</td>
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<td>QINGHAI GEOTHERMAL</td>
<td>ORC</td>
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<tr>
<td>DELI XICHANGJIANG ENVIRONMENTAL COMPANY</td>
<td>ORC</td>
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## KAISHAN COMPRESSOR—THE WORLD'S THIRD LARGEST COMPRESSOR MANUFACTURER

### MODEL | COMPRESSOR TYPE | FEATURES
---|---|---
KRSP2 | Two Stage | Global leader in air compressor efficiency
KRSP | Single Stage | Patented “SKY” air end, triple SKF bearings
KRSD | Single Stage | Direct drive, TEFC motor, low sound enclosure
KRSB | Single Stage | Belt drive, economical to own and operate
KRSH | Two Stage High Pressure | Pressure to 580 PSI
KRL | Single Stage Low Pressure | Pressure as low as 15 PSI
KRSV | Rotary Screw Vacuum Pump | World class vacuum efficiency

### OTHER KAISHAN PRODUCTS

- Filtration
- Air Treatment
- Portable Compressors
- Gas Compressors
- Pressure Vessels
- Steam Expanders
- ORC Expanders

### CONTACT US OR YOUR LOCAL AUTHORIZED DISTRIBUTOR:

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