

TITLE : Development of the compact size steam-electric generator, using the load change of steam flow and a small amount of steam

## 1.ABSTRACT

Kobe Steel developed the compact size steam-electric generator, named "STEAM STAR", which make the energy-saving come true in the minor scale steam processes. In the past, the power generation by using the load change of steam flow and a small amount of steam has been a low efficiency. Conventional steam process is shown in FIG. 1. The steam obtained from the boiler in many factories, is regulated by pressure reducing valve to control the temperature of the steam, and is used for the desiccation and the heating process.

STEAM STAR has a screw expander and a power generator. The screw expander convert energy of steam into torque in the process of reducing the pressure of steam, and the power generator convert torque into the electricity.

As indicated above, STEAM STAR enables to recover the unutilized energy from steam in a process of reducing the pressure. And STEAM STAR generates 100kW of electricity from approximately 3.0t/h steam, and can be applied by the user, who has small type once-through boiler widespread with about 250,000 units in JAPAN.

## 2. DESCRIPTION

Configuration of STEAM STAR is shown in FIG. 2. The steam obtained from boiler is led to a drain separator, and the drain is removed from the steam by a drain separator. The steam go through a flow control valve double as a emergency shutoff valve, and expand through a screw expander with isentropic expansion.

The screw expander is powered by the steam, and the power of screw expander is transmitted to the generator. At the same time, the pressure of the process steam is controlled by the screw rotation speed.

The feature of STEAM STAR is to be composed of the screw expander, and STEAM STAR have high-efficiency power generation enabled under lower steam flow condition, which going up and down the steam flow or the steam pressure.

The power generation output of STEAM STAR is shown in FIG. 3. The horizontal axis presents the steam flow and the vertical axis presents the output of power generation. The upper characteristics curve is STEAM STAR, and the lower characteristics curve is an axial expander in this chart. Seeing that this device is equipped with a screw expander, the screw rotation speed control with the inverter has power generation enabled under lower steam flow condition. The advantage of the screw expander over the axial and radial expander, is that the power can be generated under lower steam flow condition. When the turbine efficiency compared with the

axial turbine and screw expander for medium pressure, STEAM STAR has high efficient, 65% under lower steam flow condition.

The pressure controllability of STEAM STAR is shown in FIG. 4. The horizontal axis presents the time and the vertical axis presents the pressure of process steam. It shows the changing pressure of the process steam, which the supply pressure is twitched up and down from 0.8MPaG to 0.4MPaG for 300 second. In spite of the pressure drop of 50 second duration and the pressure rise of 300 second duration, the pressure change of process steam is kept in  $\pm 0.01$ MPa.

### 3.CONCLUSIONS

In June 2007, this compact size steam-electric generator, named "STEAM STAR", is developed and started selling. At present there are 17 units generating electricity.

In conclusion, the following is the feature of STEAM STAR.

- 1) This device gets to the energy-saving in the minor scale steam processes, which has the cleaning process and the heating process.
- 2) This device gets to generate the electricity of vital use to industrials like a conventional process, in which is reduced the pressure of the steam.
- 3) This device gets to the high-efficiency power generation in 100kW class power generator.
- 4) This device gets to reducing greenhouse gas emissions by approximately 440ton in a year.