2008 Prize of the Chairman of ECCJ

Energy Conservation by Installing Hydrogen Fired Boiler for Electrolysis Equipment

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◎ **Keywords: Rationalization of fuel combustion**
Waste heat recovery and usage

◎ Outline of Theme

In order to balance the amount of hydrogen generated by salt electrolysis equipment with the amount of hydrogen used by customers (Users), a hydrogen fired boiler with a high turndown ratio was installed. A hydrogen holder was also installed to improve utilization of hydrogen by way of adjusting fluctuated pressure in the system, using the pressure of the holder, so that the amount of hydrogen to be released into the air for regular pressure regulation is reduced to zero.

◎ Implementation Period for the Said Example

October 2005 – July 2008

- Project Planning Period October 2005 – January 2007 Total of 16 months
- Measures Implementation Period February 2007 – July 2007 Total of 6 months
- Measures Effect Verification Period August 2007 – July 2008 Total of 12 months

◎ Outline of the Business Establishment

- Items Produced Chemical products including caustic soda, fine sodium bicarbon, propylene oxide, and fluororesin
  Flat glasses for buildings including insulating glass, mirror, double glazing glass, tempered glass, and laminated glass
- No. of Employees 426
- Type1 designated energy management factory

◎ Process Flow of Target Facility

Outline of Salt Electrolysis Equipment

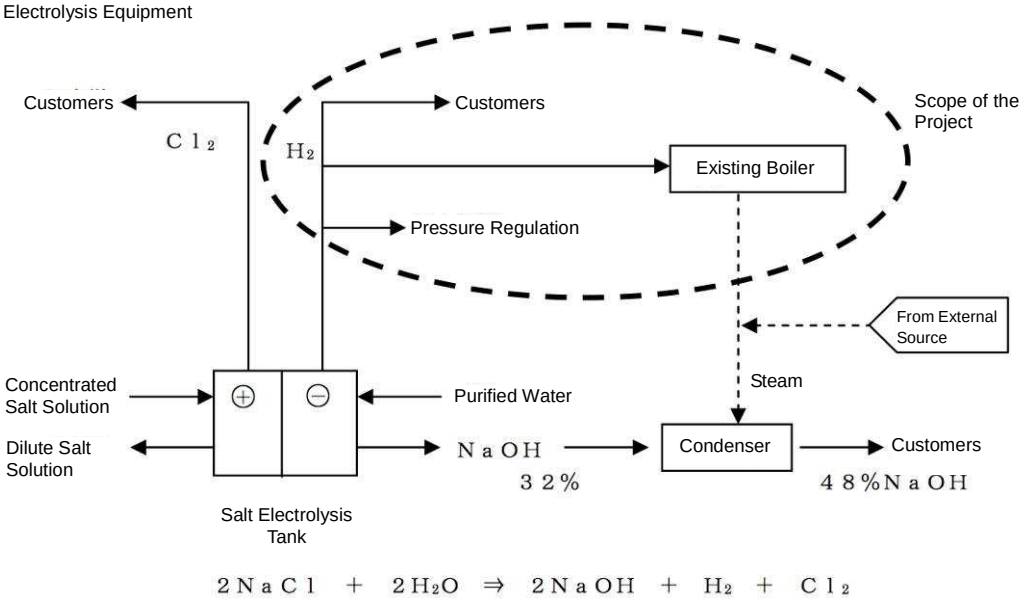

Fig. 1 Outline of Process Chart of the Facility

1. Reasons for Theme Selection

- Salt electrolysis equipment is a series of devices designed to generate chlorine, caustic soda, and hydrogen by electrolysis of salt solution. In order to take the most advantage of electricity during night hours, where electricity price is lower than daytime, more amount of work is done during night hours than daytime (Load-shifting operations). Due to this operation cycle, the amount of hydrogen used by customers does not balance with the amount generated, and therefore, some of the hydrogen was wasted.
- In order to regulate fluctuated pressure of hydrogen generated by the salt electrolysis equipment, a part of generated hydrogen was released into the air in order to keep constant pressure, resulting in another waste of the gas.
- We were seeking for sustainable energy-conservation measures in accordance with the Law concerning the Rational Use of Energy (Energy Conservation Law) and ISO 14001.
- The salt electrolysis equipment our company uses is one of the most energy-consuming equipment in the plant, and energy-conserving and cost-saving effect achieved through implementing some measures is expected.

2. Progress of Activities

(1) Implementation Structure

The program was carried out as a NEDO's grant-aided project for fiscal year 2006 under the structure shown below.

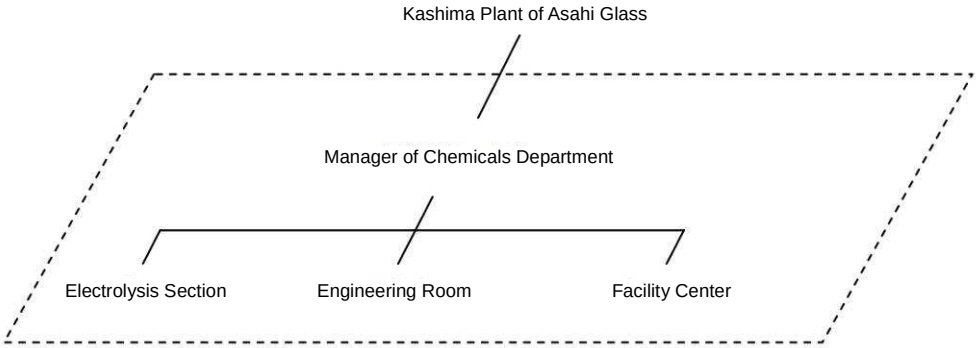

Fig. 2 Implementation Structure

(2) Understanding of Current Situation

The hydrogen generated in a salt electrolysis tank is pressured up by a roots blower to be sent to customers, as well as be used as fuel source for a hydrogen boiler. Unbalanced amounts of the generated and used hydrogen are adjusted by releasing a part of the gas into the air (See Fig. 3). The gap between generated and used hydrogen is larger during night, where electricity price is lower. Even during daytime, where its generation and use are almost equal in amount, some of the hydrogen is released into the air for pressure regulation to maintain constant pressure.

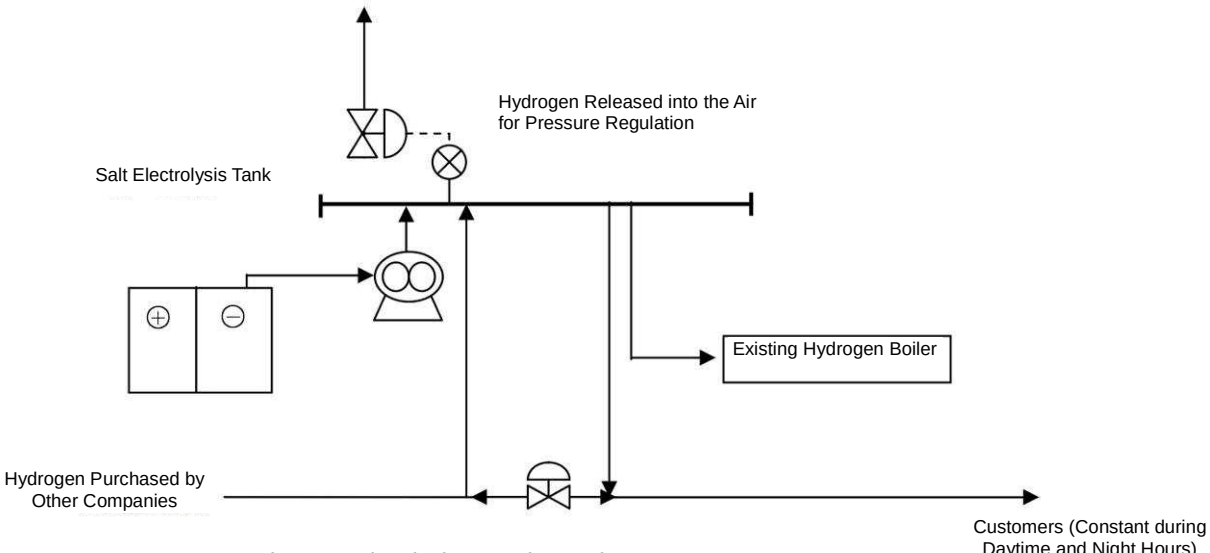

Fig. 3 H_2 Flow before Implementing Improvement Measures

(3) Analysis of Current Situation

The balance of hydrogen consumption during daytime and night hours before implementing improvement measures is shown below.

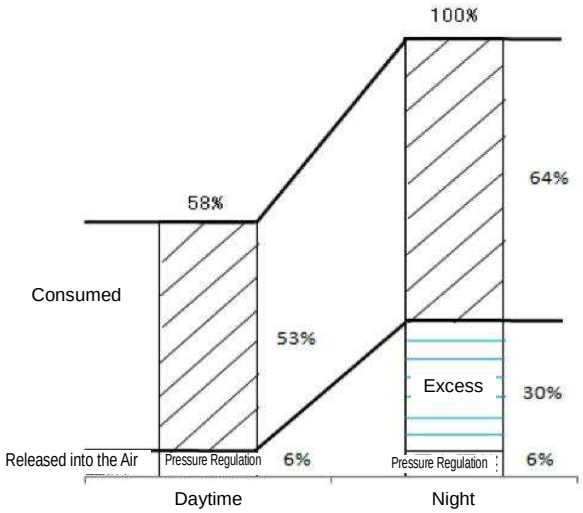

Table 1 Balance of Hydrogen before Implementing Measures

(4) Target Settings

① We aim to effectively utilize the excess hydrogen, which is caused by an unbalance between generation and consumption of the gas, as boiler fuel.

② We aim to effectively utilize the hydrogen released into the air for pressure regulation as boiler fuel.

(5) Problem Points and Their Investigation

The table below shows what to be investigated to achieve the targets.

Target	Measures	What to be Discussed/Investigated
Generation - Solve the unbalanced consumption of hydrogen	By installing a new boiler, effectively utilize the excess hydrogen caused by the unbalanced consumption.	* Selection of boiler with a high turndown ratio * Measures to reduce NO_x generation * Stabilization measures at emergency stop * Automated operation to change loads to electrolysis tank
Zero hydrogen released into the air for pressure regulation	By installing a hydrogen holder, adjust the fluctuated pressure.	* Determination of holder capacity and pressure regulation

Table 2 Targets and Investigations

(6) Details of Measures

1) Boiler selection

A boiler with turndown ratio of 1:8, where the fluctuation can be covered, was selected.

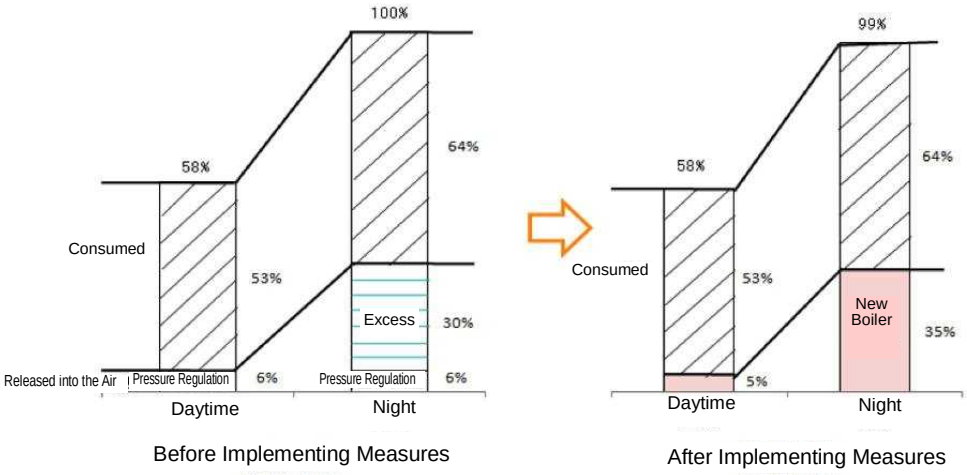

Table 3 Balance of Hydrogen after Implementing Measures

Boiler Specifications

Manufacturer of the Boiler	Kawasaki Thermal Engineering Co., Ltd.
Manufacturer of the Burner	Nippon Furnace Co., Ltd.
Maximum Evaporation	19.5 T/H
Maximum Operation Pressure	1.96 MPaG
Heat Transfer Area	353 m^2
Guaranteed Boiler Efficiency	92%
Guaranteed NO_x Concentration	130 ppm or less (When converted to 5% O_2)

Table 4 Boiler Specifications

Structure of the Burner

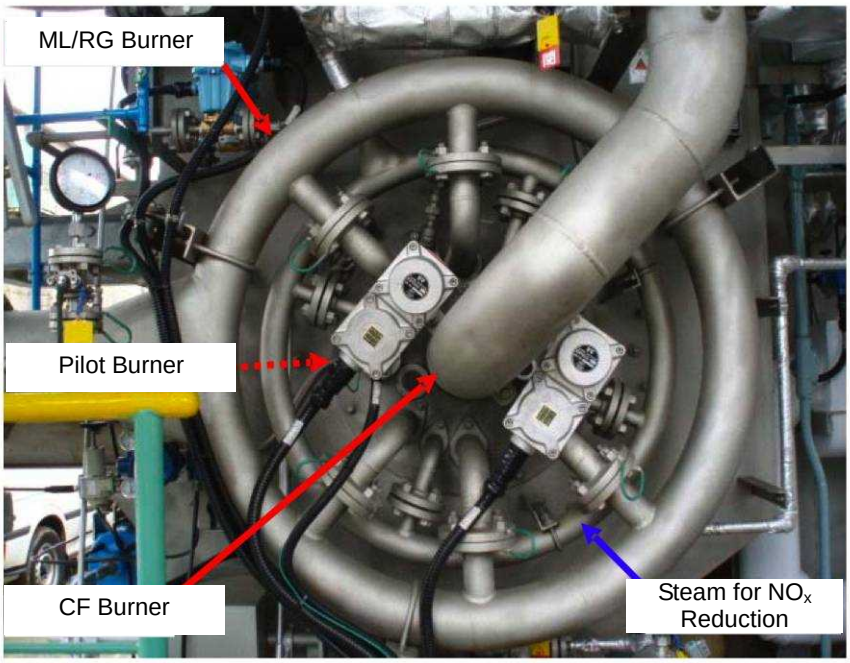

Fig. 4 Structure of the Burner

Tree types of burners are used depending on required load.
(The CF burner is used in full-time operation and ML/RG burner is used when the equipment is heavily-loaded. They automatically launch and shut down.)
A steam nozzle was installed in order to reduce NO_x generation.

2) Stabilization measures at emergency stop

When the new boiler stops for an emergency, a maximum load of hydrogen is shut down instantly, resulting in possible large impact on upper stream. Therefore, we determined to take a measure by releasing the amount of hydrogen equal to the combusted amount into the air when the system stops, so that such impact on the upper stream can be prevented.

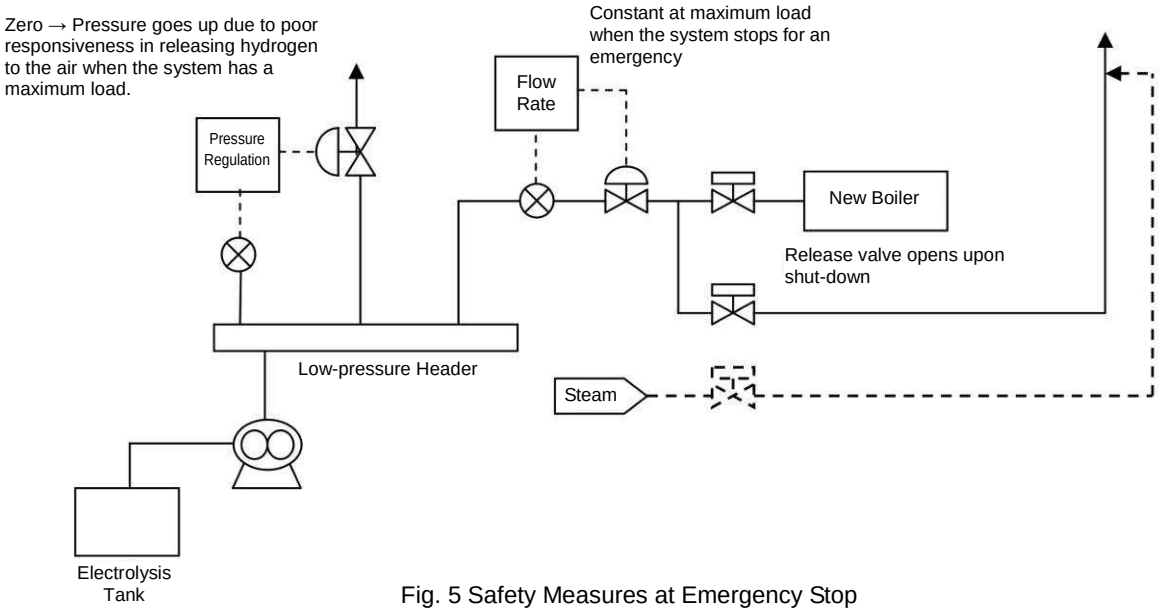

Fig. 5 Safety Measures at Emergency Stop

3) Automated operation to change loads to electrolysis tank

By designing and utilizing a sequence for automatic changes in load to the new boiler, operators' work load while they are on load shifting operations has been significantly reduced.

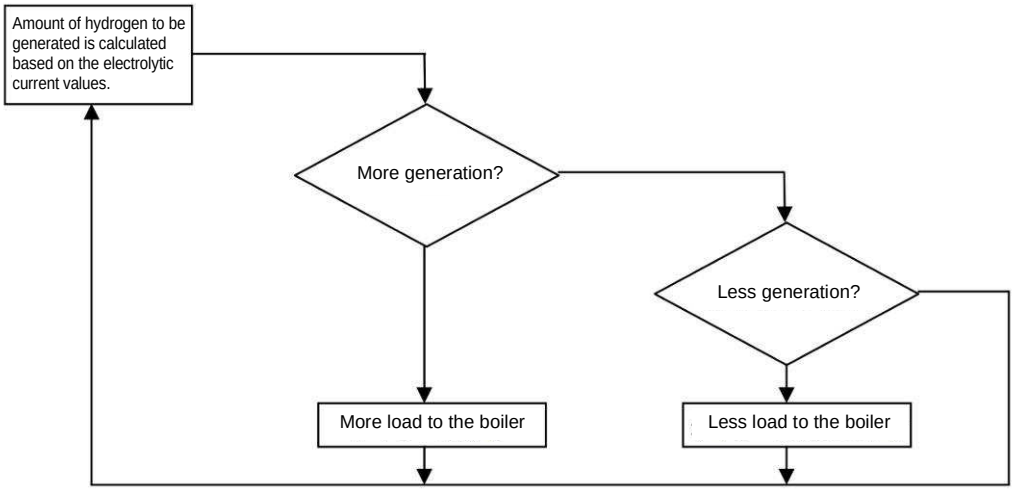

Fig. 6 Sequence to Change Boiler Loads

5) Pressure regulation by installing a hydrogen holder

As shown in the figure below, we changed our pressure regulation method from a control by releasing the gas to the air to a control using a hydrogen holder as a buffering tank. A necessary capacity of the hydrogen holder was determined based on our analysis on

current variation factors and varied amounts during the operations. The hydrogen holder we used had been an unutilized item in the plant.

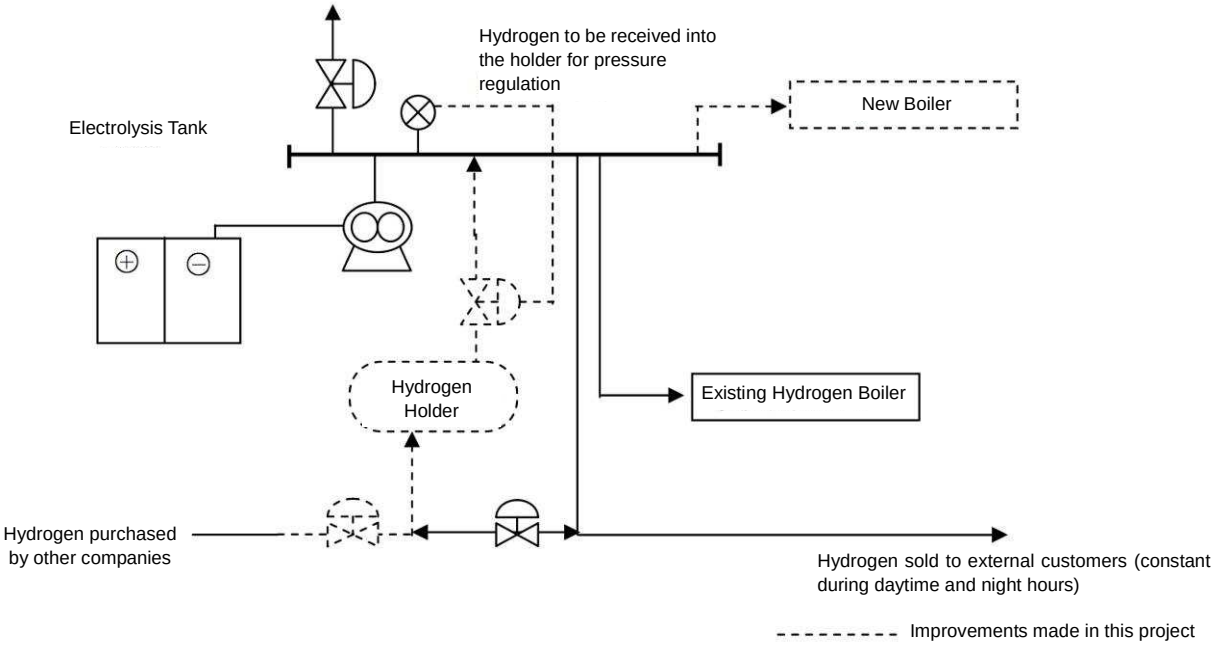

Fig. 7 Hydrogen Holder

(7) Effects Achieved after Implementing Measures

The following results were obtained from the operations between August 2007 and July 2008.

① Steam reductions 89,540 t/year
(Crude oil conversion of 6,552 kl/year)

② Proportion of hydrogen released into the air (amount released/generated)
Before implementing measures 28.1%
After implementing measures 3.3%
The small percentage of hydrogen still released is due to irregular operations such as a launch and suspension of a plant.

3. Summary

Through this project, a heavy oil reduction effect for 6,552 kl/year has been achieved by installing a boiler running on the hydrogen which had been wasted. The amount of saved oil accounts for as much as 8% of total fuels consumed in the plant.

4. Future Plans

Following this project where steam was generated by combusting the hydrogen not effectively utilized before, we plan to work on steam reduction measures for caustic condensation equipment which uses a large amount of steam.