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The Development of Energy Sharing in Industrial Areas of Japan with Pinch Technology

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In fiscal 2000, we started a three years research project which is the first study applying "area-wide Pinch Technology analysis" supported by the New Energy and Industrial Technology Development Organization (NEDO), an affiliated organization of Japan's Ministry of Economy, Trade and Industry, and have found a large number of energy saving potential by the energy sharing between sites in one of the major industrial area which is a heavy chemical industry field. We could establish the method of application of area-wide Pinch Technology analysis and develop the energy sharing project between two sites in the industrial area.

1. Introduction

In recent years, it is a common understanding in Japan that there is little room for further energy reduction in the major industrial sites such as oil refining and petrochemicals.
We thought that there should be a new possibility for further energy reduction if we combine some sites so that the waste heat of one site may be still useful for another site.
NEDO accepted this idea and supported our research "The Development of Energy Sharing in Industrial Areas of Japan with Pinch Technology" for three years from fiscal 2000 to 2002.

2. "Industrial area version" Pinch Technology

We have applied Pinch Technology to analyze the energy system in a single site until now. In the research project we have studied the possibility of the expansion application of Pinch Technology to cover an industrial area, which means that we applied Pinch Technology for the energy-sharing analysis between two or more sites in industrial area because the energy system is absolutely required and useful for all the sites. That is, we have done the research and development for the "industrial area version" Pinch Technology.

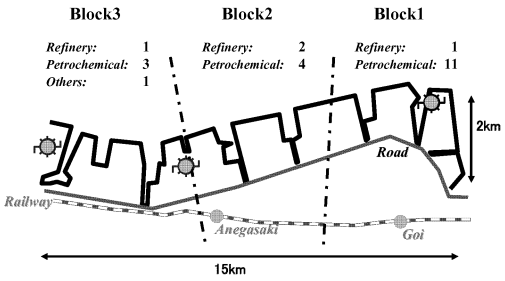

Fig.1 Chiba Industrial Area (23 stites)

3. Large theoretical energy saving room

In the research, we selected "Chiba industrial area" and obtained cooperation of a total of 20 companies (23 sites) shown in Fig.1, which is closed to Tokyo and one of the major industrial areas in Japan. We divided the industrial area into three blocks due to the long distance of 15 kilometers.

3.1 R-curve analysis

In order to optimize the total enegy systems including heat and eleectricity, we applied two analysis techniques of Pinch Technology, which are R-curve analysis and Site soruce Sink Profile (SSSP) analysis. R-curve analysis shows the theoretical limit lines for two energy systems. One is “Gas turbine combined system” and the other is “Boiler and turbine conventional system”. Fig. 2 shows the result of R-curve analysis for a seleced block of Chiba industrial area. Introducing the ideal “Gas turbine combined system” could lead to increase the energy efficiency from 73.4% to 86.3%, which means there is an energy saving potential by that increment.

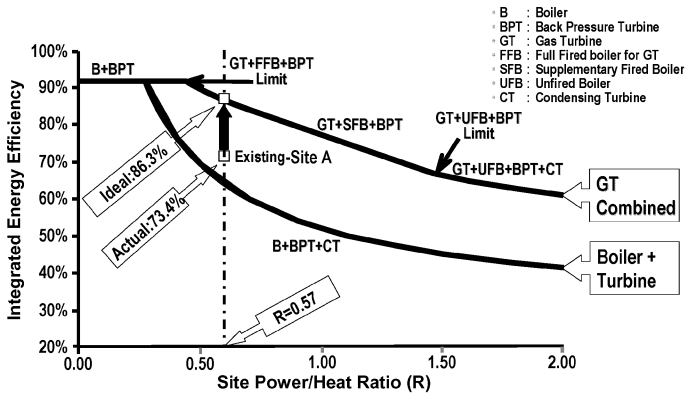

Fig.2 R-Curve Analysis for a Selected Block

3.2 SSSP analysis

Site Source Sink Profile (SSSP) analysis integrates the information of the heat supply and demand based on the heat exchangers data. Fig.3 shows the result of SSSP analysis for a selected block, same of Fig.2. According to the result, the following information is recognized. (a)Heating demand of 168GJ/h (40 million kcal/h) exists in the region less than 100 deg.C and almost all of the heating demand is heated by low pressure (0.3MpaG) steam. (b)Unutilized exhaust heat of 419GJ/h (100 million kcal/h) exists in the region from 100 deg.C to 140 deg.C.

The energy saving potentials are three items; (1)Very low pressure steam and hot water recovered. (2)Excess hot water recovered which is beyond the hot water

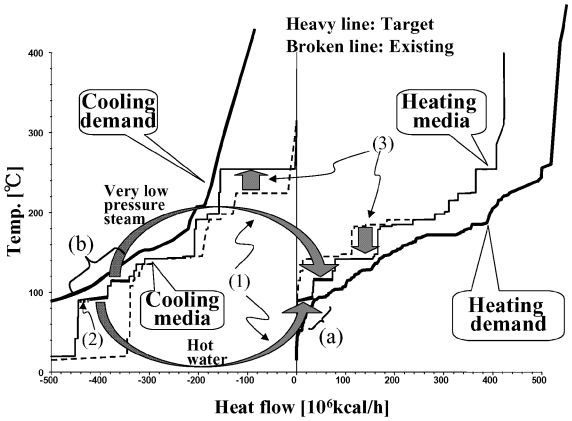

Fig. 3 SSSP Analysis for a Selected Block

demand. (3)Power generation increased by heigtening the generated steam pressure and lowering the consumed steam pressure.

3.3 Result of Energy saving room

We applied the above two analysis techniques of Pinch Technology to three blocks of Chiba industrial area and concluded that optimizing energy use for entire area would theoretically yield energy savings -- crude-oil conversion -- about 641,000 kL(s)/a year. Reference is shown in Table 1. This is equivalent to the one day on amount of crude-oil consumption in Japan.

Table 1 Result of Energy Saving Studies

{Annual crude oil equivalent}

Theoretical energy saving	Block1	Block2	Block3	Total
By R-curve analysis	170,000	170,000	168,000	508,000
By SSSP analysis	40,000	57,000	36,000	133,000
Total	210,000	227,000	204,000	641,000

4. Development of Energy sharing project

Development of an energy-sharing project proposal was performed based on a little more than 1200 sets of the heat exchanger data offered from all the sites, the discussion with the sites was repeated to narrow down the available heat exchangers for the feasible proposals, and eventually eight project proposals constituted of a little more than 30 sets of heat exchangers were devised. The resulting energy saving rate of the eight projects was 90,000 kL(s).

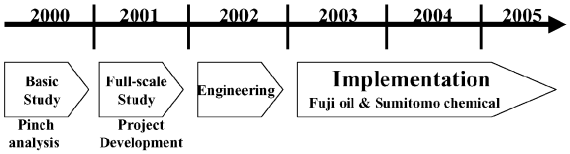

Fig. 4 Overall Schedule

Furthermore, adding the evaluation of economical efficiency with cooperation of the corresponding sites, it was narrowed down to the leading project proposal, consequently amount of energy saving rate little mote than 10,000kL was obtained as an energy-sharing proposal for two sites, Fuji Oil Company and Sumitomo Chemical Company.

5. Implementation of Energy sharing project

We developed a three-year business plan of the above-mentioned energy sharing project involving Fuji Oil Company and Sumitomo Chemical Company. With NEDO providing some support, the energy sharing project was started from the second half in fiscal 2003 and completed in summer of fiscal 2005. Now the project has achieved the target value of energy savings and was awarded a

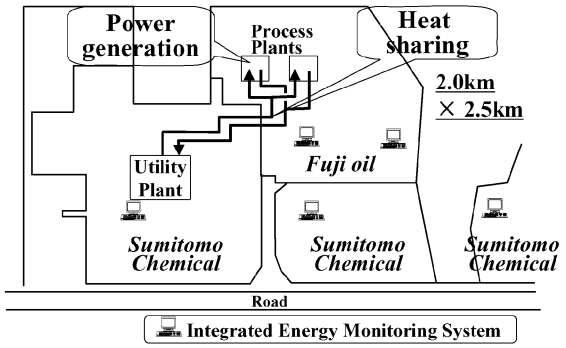

Fig.5 Implementation of Energy sharing project

prize of Director-General of the Agency of Natural Resources and Energy at the 27th Energy Conserving Machinery Awards in January 2007. This energy sharing project consists of two energy saving systems, which are “Heat sharing system” and “Power Generation system with Lower Heat”. (1)”Heat sharing system” collects the exhaust heat from the cooling water coolers in Fuji Oil Company and supplies the heat to Sumitomo Chemical Company to reduce the fuel of the boilers. This system is equipped with the Integrated Energy Monitoring System which shows the optimized operation condition for the sites. This achieves energy savings of 4,900kL/yr. (2)”Power Generation system with Lower Heat” collects the lower heat in the air fin cooler at the overhead vapor from the distillation tower in Fuji Oil and vaporizes the ammonia gas at high pressure to generate the electricity. This achieves energy savings of 5,600kL/yr. With the two systems, energy savings of 10,500kL/yr has been achieved. This is equivalent to CO2 reduction rate of 28,000tons per year.

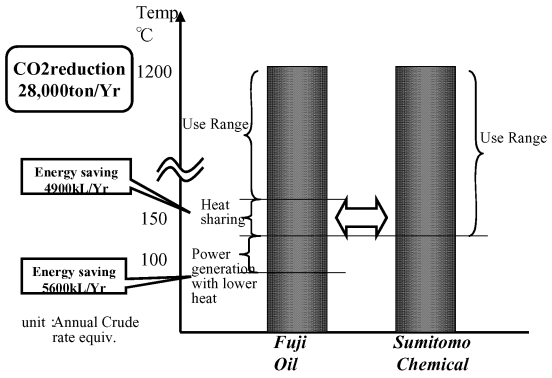

Fig.6 Heat Map in Two Sites

6. A future view

It is almost time to renew the plants and equipments at domestic large-sized sites in Japan because those become over thirty years old after construction. This is in the situation of discussion about the countermeasures against the updating time of the aging equipments in domestic industrial area. It is necessary to show a drastic policy of grand design as early as possible. However, it is not easy for one company to decide on a new investment independently in the present economic situation. We believe that one of the most powerful proposals for such subjects is “Energy-sharing project”. Energy-sharing project in the industrial areas could lead to a significant effect on promoting environmental preservation, lowering production costs and strengthening the international competitiveness of Japan’s industrial areas. And Pinch Technology would be helpful and useful to provide the optimal system of energy-sharing project.

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