2006 Prize of the Chairman of ECCJ

2005 Energy Conservation Activities of Akita Orient

Akita Orient Precision Instruments Co. Ltd.
Administration and Management Department
Plant Management Group

◎ **Keywords: Rationalization of conversion to electricity motive power, heat, etc. (Electric power application equipment, electric heating equipment, etc.)**

◎ Outline of Theme

Akita Orient Precision Instruments is a manufacturing plant and works on its production holding up a company policy to “aim for the ultimate *monozukuri* (manufacturing) group”. Energy conservation activities are very effective measures to drive efficient manufacturing of products. Being a type1 designated energy management factory (electricity), we are required to make continuous efforts for further energy conservation. The energy conservation project described in this report was driven by entire company based on collaborative efforts by our Facility Management Division, production floors, Technical Division, and affiliate companies. Through the project, 5% improvement in intensity was achieved by way of energy conservation measures for air-conditioning equipment, compressors, pumps, and production machinery, which produced a large power saving effect of 1,583 MWh/year.

◎ Implementation Period for the Said Example

February 2005 – March 2006

● Project Planning Period	February 2005 – January 2006	Total 12 months
● Measures Implementation Period	June 2005 – March 2006	Total 10 months
● Measures Effect Verification Period	July 2005 – March 2006	Total 9 months

◎ Outline of the Business Establishment

- Items Produced: Manufacturing of printer heads and quartz crystals
- No. of Employees: 928 (as of April 1, 2006)
- Annual Energy Usage Amount (Actual results for fiscal year 2005)

Type A heavy oil	316 kL
Kerosene	408 kL
Electricity	19,348 MWh

◎ Process Flow of Target Facility

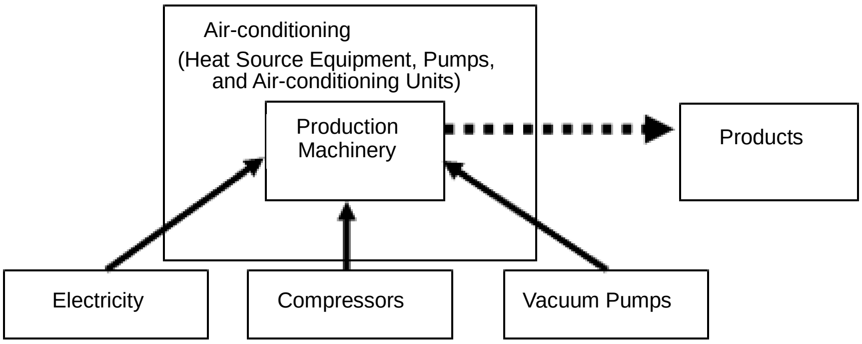

Fig. 1 Process Flow

1. Reasons for Theme Selection

Being a manufacturing plant, Akita Orient must contribute to society and make profits by "*monozukuri*" as well as be an energy-conserving and environmentally conscious plant. Recently, companies are required to perform their business activities satisfying the both aspects. Since overseas productions have become a mainstream in manufacturing industry in recent years, we have been working on our manufacturing business aiming for becoming "the ultimate *monozukuri* group" in order to survive the "intensified cost competitions" as a domestic manufacturing base. Energy conservation activities are effective for the corporate activities to achieve the goal, in terms of possible cost reductions through effective manufacturing of products using less energy.

After being designated as a type1 designated energy management factory (electricity) in 1999, the plant has continued its energy conservation activities based on the efforts toward making "a large effect using our wisdom and innovative ideas without spending much money". Due to additional installation of production machinery, it was expected that the plant's electric consumption would be increased in FY2005, leading to "worse intensity". Considering the above, we reached a decision that "further enhanced activities tackled by the entire company as a team" through "collaboration by various divisions" is rather required than previous activities which were mainly led by each division. We determined to develop a new structure to implement the activities.

2. Understanding and Analysis of Current Situation

(1) Understanding of Current Situation

In order to understanding current situation, it is necessary to make measurement and records as described in "Evaluation Criteria of the Law concerning the Rational Use of Energy (Energy Conservation Law)". When the company received an on-site inspection by Bureau of Economy, Trade and Industry in 2004, information for electric consumption by individual equipment needed for preparing a summary report and micro data was found unclear, and that made us recognize a strong need for measuring equipment. Since "understanding of current situation" was necessary as a first step of our new energy conservation activities, a "power monitoring system" was installed following the inspection and it was connected to our internal LAN with a real-time access to current power consumptions. The "visualization" established by the new system made it possible for us to view current electric consumption and effects achieved by placing improvement measures.

(2) Analysis of Current Situation

Fig. 2 shows a breakdown of electric consumption in FY2004.
Electricity consumed by compressors accounts for 22%, the largest proportion as single equipment. Basic facilities account for 44%, of which 38% is for air-conditioning equipment including air-conditioning units, chilled/hot water generator, and pumps. The next 28% is consumed by production machinery which includes various types of machines and equipment, which require individual measures. Electric lights such as ceiling lamps and desk equipment account for 6%.

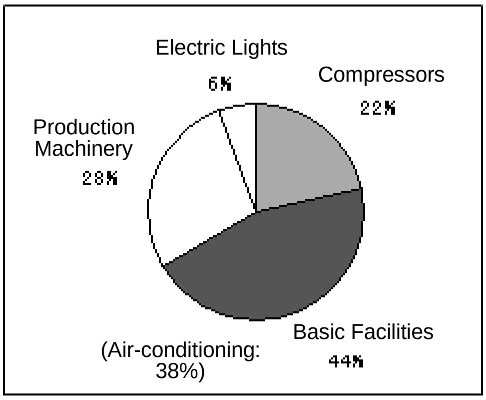

Fig. 2 Breakdown of Electric Consumption in FY2004

3. Progress of Activities

(1) Implementation Structure

The previous structure for promoting energy-conservation activities was vertically divided into business divisions focusing on divisional activities, and resulted in poor communication and cooperation among the divisions. Since "further enhanced activities are needed" for the new program, a structure with close connections among the divisions was developed this time. Persons in charge of project were selected from each division and they were in charge of compressor system (compressed air system), basic facilities, and production machinery to establish a driving structure through "collaboration by various divisions". A secretariat (Facility Management Division) was engaged in to supplement the approach.

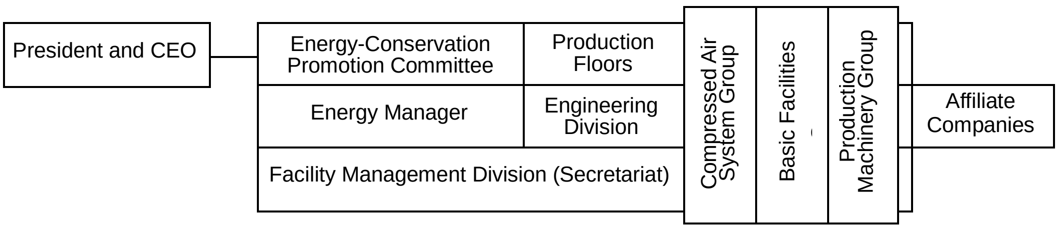

Fig. 3 Program Structure Chart

(2) Target Settings

We sets out an environmental objective/target of ISO1401 by 7% reduction compared to previous year by CO_2 equivalent and to achieve the target a total CO_2 reduction of 831 (t-CO_2) is required. We developed and implemented measures for this achievement.

(3) Problem Points and Their Investigation

In order to meet the very challenging target, “development of cooperative framework to obtain cooperation by each division” was required. Since we must improve product quality and productivity as a manufacturing plant, we determined to work on expanding the activities to production floors, which had been unwilling to accept such measures due to some concerns over “impact on product quality”, as “activities driven by collaboration by various divisions”. Having “promotion of energy conservation activities while maintaining and even improving product quality” as a keyword, we drove the project forward.
Since many ideas were needed for the measures, we started seeking what could be targeted for the energy conservation project by reviewing general energy conservation cases and through affiliate companies’ efforts in looking around shop floors. We visited to see the floors and put ideas out for the energy saving measures, based on the *sangen shugi*, or “ the three actual philosophy”, which means you need to go to actual site, observe actual part/product, and face the actual situation to understand what is going on. We also asked all employees for 1,000 ideas to be submitted as an activity in the “Energy-conserving Ideas Month” which we had developed as a part of the company’s proposal system for improvement. The approach created an opportunity for every employee to think about energy conservation and raise his/her awareness on the topic.

[1] Compressor system

Our analysis on current situation found that 22% of total electricity was consumed by the compressor system, making up the largest proportion as single equipment. The compressor system of the plant consists of 13 oil-free compressors; two 22 kW units, eight 55 kW units, and three 100 kW units. Since all but the 100 kW units are single-stage compressors which are less efficient than two-stage compressors, only the necessary number of units is operated under the control by an Operating Units Control System. Electric consumption required by an unloading operation of a 55 kW compressor is 26 kW and, according to the measured and recorded data, the unloading time was found to be very long, reaching annual power consumption to 187k kWh. Taking account of the findings, we determined to focus on “reduction of the unloading time”. Since it was proven by previous case study that installation of an efficient compressor would be effective for energy saving, cost for installing a new highly-efficient compressor was prepared in budget.

[2] Basic facilities

Several measures, including a proposal based on the findings through affiliate companies' efforts in looking around shop floors and a draft measure for enhancing control of air-conditioning units, were reviewed to narrow down to several themes for measures to be taken by the collaboration of various divisions.

1) Energy conservation of vacuum pumps

Regarding the two units of water-seal 22 kW vacuum pumps constantly operated, we made an investigation on a necessary degree of vacuum and made some experiments, trying to see if we could make the operation by only 1 unit.

2) Energy conservation of chilled/hot water pumps

It was found through the affiliate companies' efforts in looking around the floors that opening of the valves of chilled/hot water pumps for air-conditioning heat source was fixed to 30%, resulting in inefficient operations. We found that this was the process where we could gain large energy-saving effect by placing appropriate measures. (The air-conditioning system was using a chilled/hot water generator as its heat source and chilled/hot water pumps to circulate the water in constant flow rate.)

3) Energy conservation of air-conditioning

Since the plant takes a shift work system, air-conditioning for 24 hours a day is required, resulting in large consumption of electricity. We were considering how we could improve the electricity consumption.

Although there were temperature and humidity control values as quality requirements to be observed by shop floors workers, actual conditions were not clear and it was difficult to place any measures in the area. Considering the above, we developed a plan to firstly select a sample shop floor to carry out activities for energy conservation of the air-conditioning system through collaboration by various divisions, and then extend the measures to other floors [3] Production machinery

Since there were various types of production machinery, we worked on investigating the shop floors based on the *sangen shugi,* understanding the current situation, exchanging ideas, and making discussions on investment recovery effect. As we look around the floors (looking for what could be targeted in the energy saving project), we saw some machines with their power on while they were not producing any products. Following measurement of electricity consumption by such machines, it was confirmed that “the machines not running for production use sand-by power equals to 70% of the power consumed by running time”. As we examined if we could reduce the stand-by power, we learned that there would be several problems when we put the power off the machines (complete shutoff of a breaker of the machines).

4. Details of Measures

[1] Compressor system

In the past, we implemented several measures, including installation of an Operating Units Control System and highly-efficient compressor, check and repair of air-leakage, lowered dew-point temperature, lowered supply pressure, enlarged pip diameter and looped the piping system, review of compressor layout, and additional installation of air tanks, etc. This report describes the details of our continuous approach mentioned above.

1) Reduction of unloading time

Loading, unloading, and shutdown were controlled by the Operating Units Control System. Through our study based on *sangen shugi* trying to understand current situation of the machine operations, it was found that unnecessary unloading operations were made because the control system had poor traceability to load changes. Further a long time is used when the machine stops the operation after the unloading operation.

Since detailed setting of the Operating Units Control System was as it was when the machine had been installed, we checked its setting to see if it was appropriate. Then, it was confirmed that “the unloading time could be shortened by modifying the initial setting”. To be more precise, we found a couple issues concerning the setting as shown below:

a) Due to poor traceability to load changes, the 2nd unit starts running soon after load up because the system still thinks only the 1st unit cannot cover required load. Therefore, we made an adjustment on the latency effects for the starting time of the 2nd unit.

b) Based on specifications of the compressor, certain period of time not allowing a shutdown operation (cooling time) is set. The setting makes the system keep running for at least 20 minutes once it starts operating, regardless of loading or unloading operations.

Furthermore, an “unloading operation time” until the system shuts down after unloading is ordered was also set. By adjusting the default time setting, the unloading time was successfully reduced.

2) Installing additional highly-efficient compressor

Since it was proven by previous case study that installation of a highly-efficient compressor was effective, 1 unit of such compressor was additionally installed. We changed the operational structure to have the new efficient compressor constantly operated as a main unit, supplemented by operation of certain number of single-stage compressors when additional load requires them. An inverter-controlled freezing dryer was installed for an air drying purpose.

[2] Basic facilities

The measures we have implemented include: displaying a manager of air-conditioning units and clarifying their settings (display); scheduled operation of air-conditioning units; installing an ice storage unit; enhancing thermal insulation by spraying urethane material; installing double sash windows; applying (heat insulating) film on windows; installing window shades; setting light thinning and attaching individual switches to lights; turning off lights during lunch break; using Hf lights, sensor-controlled lights, timer-controlled lights, and dummy light tubes; installing photovoltaic unit; miniaturization and inverter of pumps; installing highly efficient motors; and adding a capacitor for power factor improvement.

1) Energy conservation of vacuum pump

The two water-seal 22 kW vacuum pumps currently operated. As we investigated and understand current situation of production floors, we learned that high degree of vacuum was required by a small number of production machinery. Taking the fact into consideration, we determined to attach a small vacuum pump (in-stock item) to the production machinery so that operation of one water-seal pump on the supply side could be stopped. Based on the experimental operations which were found successful, we completed the improvement in suspending one of the 22 kW vacuum pumps.

2) Energy conservation of chilled/hot water pumps

The opening of the valves of chilled/hot water pumps used for air-conditioning heat source was set to nearly 30%, leading to inefficient operations. In order to solve the issue, some measures such as installation of smaller pumps and cutting impellers were proposed, however, a shift to inverter control was determined to be the best way to meet our requirement for controlling the flow to minimized level and making it adjustable depending on load changes.

3) Energy conservation of air-conditioning

We made an investigation to understand current situation based on the *sangen shugi*. Through installing a temperature/humidity data logger to the sample shop floor to understand current conditions in comparison with required temperature/humidity control values, and to check and validate their variations. (The air-conditioning system was running through air-handling units to control overall air-conditioning and 5 backup units to supplement additionally required loads.) As a result of the investigation, it was found that temperature near windows was higher due to “sun light through the windows” and to mitigate the temperature rise, some window shades were attached. It was also found that there were some areas which were cooled excessively. Focusing on the fact that air-conditioning units for backup were constantly operated, we carried out some experiments for verifying that there was no relationship between temperature and product quality, and therefore, the backup units could be stopped. Since operation of the backup units was controlled by a manually adjustable dial in 1 to 5 levels, the original sensor was detached and replaced with an external sensor which could accept temperature setting in order to make proper temperature control. Operation and air blowing of the air-conditioning units were controlled by their sensor and the fans were also constantly running.

Taking account of the above facts, we placed measures to improve the control system so that fans would stop running while the air-conditioning units themselves were not in operation.

[3] Production machinery

In order to reduce stand-by power of the machines not running for production, we formed a new working group involving some persons with expertise. Starting with identifying problems, we learned some reasons why “the machine power cannot be turned off”, such as loss of program, a long time required for restarting the machines, and difficulties to secure product quality after restarting. As we worked on understanding the current situation, analysis, and verification, we found the fact that backup batteries for maintaining the program memory were not regularly replaced with new ones. The bad practice caused some machines to lose their data when it stops the operation and not to recover it after restarting. To solve the problem, we replaced batteries of 144 relevant machines, made experimental “power-off” operations, and confirmed that their “restarting time” and “quality after restarting the system” were both good enough. (Regular replacement of backup batteries was incorporated into standard procedures). After that, a new operational structure was established to implement a rule to “power off production machinery while they are not running for production”, which resulted in successful reduction of the stand-by power.

5. Effects after Implementing Measures

[1] Compressor system

1) Reduction of unloading time

By changing the setting of “unloading operation time” between starting time of unloading ordered on the Operating Units Control System and actual shutdown time of the compressor, the unloading time of the compressor unit was successfully reduced. Compared to average unloading rate of 34% in FY2004, the rate after implementing the improvement measures was 14%, improved by 20%. Operation time was also reduced through our reviews on the traceability of the control system.

- Annual power reduction: considerable reduction amount 155,000 kWh/year (only through changes in machine setting, with no investment cost)
  (conversion to operation time in FY2005)

2) Installing additional highly-efficient compressor

Since one unit of two-stage 100 kW compressor is capable of supplying the amount of air which would require 2.7 units of single-stage 55 kW compressors, the installation of the two-stage compressor generated reduction effect for 51 kW. The installed inverter-controlled freezing air-dryer, making it possible to control rotation speed depending on loading level, generated additional 2.5 kW reduction compared to conventional type. After all, the compressor intensity was successfully reduced (Table 1).

- Annual power reduction: considerable reduction amount 461,000 kWh/year (investment recovery 2.5 years)

Table 1 Changes in Compressor Intensity (kWh/m^3)

	FY1999	FY2002	FY2005
Compressor Intensity	0.1708	0.1403	0.1149
Difference	-	Improvement by 22%	Improvement by 22%

[2] Basic facilities

1) Energy conservation of vacuum pump

We succeeded in reducing number of operating water-seal 22 kW vacuum pumps to one unit, stop the operation of other one. Two units of 1.5 kW cooling water pumps and cooling tower were also stopped. These measures generated a 25 kW reduction.

- Annual power reduction: considerable reduction amount 219,000 kWh/year (No new investment was required due to use of stock)

2) Energy conservation of chilled/hot water pumps

An inverter unit was attached to 45 kW chilled/hot water pump and its valve was opened to full extent. The inverter control was adjusted, making sure that the flow would be in a minimum necessary level required by the load side. Through this measure, the power consumption was improved to 11 kW, with a reduction of 34 kW.

- Annual power reduction: considerable reduction amount 298,000 kWh/year (Investment recovery 0.7 year)

3) Energy conservation of air-conditioning

Improvement of backup air-conditioning units

- The original sensor of the unit was detached and replaced with an external sensor which allows temperature setting in order to make proper temperature control.
- Control of the fans was improved so that the they would be stopped while the air-conditioning units themselves were not running. The measure reduced power consumption by nearly 20%, compared to our previous electricity monitoring results.
- Annual power reduction: considerable reduction amount 159,000 kWh/year (Investment recovery 0.2 year)

[3] Production machinery

Regarding the rule to “power off production machinery while they are not running for production”, we developed an operating structure following a rule to “power off the machines if they are to be idle for more than 8 hours”. With the new structure, it is now ensured that the rule is also implemented on Saturdays, Sundays and during night shifts when no production is running. At a certain production process, for example, about 50% power reduction was achieved by turning the power off during night shifts.

- Annual power reduction: considerable reduction amount 291,000 kWh/year (Investment: several tens of thousands yen for new batteries only)

* Total reduction effect: 1,583 MWh/year of annual power reduction and 21,370,000 yen/year of saving in yen. (The program was implemented assuming its investment recovery period would be within 3 years.)

6. Summary

The case studies of the improvement activities described in this report are just major ones, and many others including small measures were also implemented. As a result of the activities, we could achieve a result of 1,162 (t-CO_2), compared to the targeted 831 (t-CO_2), and get 140% of achievement ratio, largely exceeding the target.

[1] Reduction of fixed energy consumption

The energy used by compressors, air-conditioning equipment, vacuum pumps, chilled/hot water pumps and stand-by power for production machinery are constantly consumed regardless of production volumes. Our successful reductions while “maintaining product quality” largely contributed to an improvement of the intensity. Implementation of the various measures also helped reducing power demand, contributing to a large cost-saving due to contract modification of power. These could never been achieved without understanding and cooperation by production floors and Technological Division. We believe that the measures can be effectively and extensively implemented by other companies.

[2] Changes in intensity

It was expected that our company would have “worse intensity” due to planned installation of additional production machinery. However, we succeeded in reducing power consumption while production volume was growing, and finally improved the intensity by 5% compared to previous year.

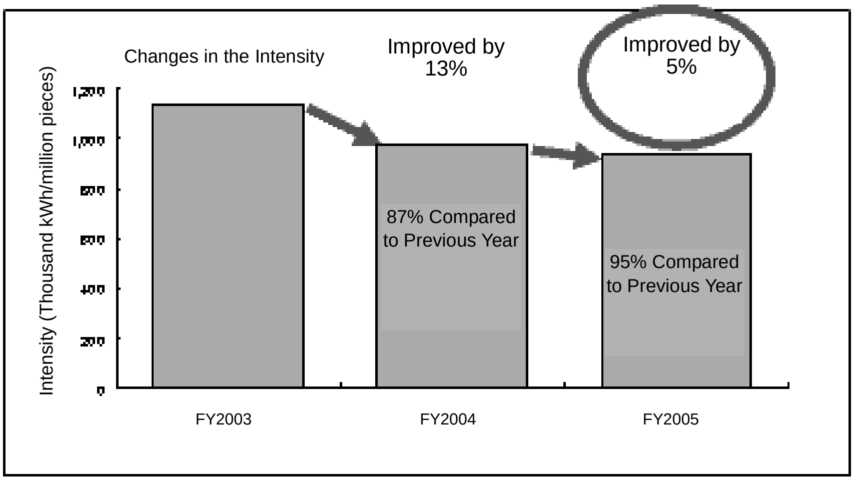

Fig. 4 Changes in the Intensity

[3] Visualization

We held a briefing session every time a measure was implemented and delivered a result. The progress and effects of our activities were “visualized” through publication on our LAN and notices on bulletin boards, so that anyone could see and understand them.

[4] On-site inspection, management manual, evaluation criteria

As we accepted an on-site inspection, it was necessary for us to fully understand and follow the ”Evaluation Criteria” in order to develop and review our management manual. The criteria contained very useful information such as data collection and analysis by “measurements and recording” and “power-off of machines while they are not in operation” which was used in this project. The experience of receiving an on-site inspection made us more conscious about the “Energy Conservation Law”, making it possible for us to develop and complete the activities.

[5] Enhancement of driving structure

Throughout the program, our energy-saving activities were successfully carried out by “the entire company as a team”, through “collaboration by various divisions” joined by Facility Management Division, production floors, and Technological Division. We succeeded in implementing measures for air-conditioning equipment and production machinery, which had been difficult to penetrate due to some concerns over “impact on product quality”, based on refreshed understanding and cooperation by the relevant divisions toward the “promotion of energy conservation activities while maintaining and even improving product quality”, and the project was driven under mutual understanding among related parties. The fact that “we all worked together toward one target, overcame the challenges, and achieved a significant effect” throughout the activities brought us a great sense of accomplishment. Another significant achievement we gained from the project was that human circle was enlarged in the works through the activities involving a large number of people and this gain will give larger and stronger effects on future activities.

Since the company policy of aiming for “ultimate *monozukuri* group” and “improvement of efficiency and cost reductions through energy conservation activities” shared the same goal, we could convince the management team of the company that “energy conservation activities are very effective for improving business activities” and successfully obtained “understanding and cooperation by the management”. We believe it was the most significant achievement we attained.

7. Future Plans

- Expand and improve the activities in this project further to continuously drive our energy conservation activities.
- Inform and expand the activities to other shop floors and other equipment users.
- Based on the revisions on the Energy Conservation Law, take account of "heat" issues and make active efforts for further measures, such as exhaust heat recovery.

At last, we sincerely hope that this report of our efforts and case studies will be useful for other companies in driving their energy conservation activities.