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Energy Conservation Measures due to Industrial Gas Supply Business Model Innovation

Air Water Inc.
Industry Business Division Industry Business Department

◎ **Keywords**: **Others (Liquid oxygen and nitrogen, tanker lorry transportation, and business model innovation, using state-of-the-art compact cryogenic air separation technology)**

◎ Outline of Theme

Oxygen and nitrogen gases manufactured using cryogenic air separation are generally called “industrial gas”, and are supplied for various industrial applications (including medical applications) such as the iron and steel production and the semiconductor production. In recent years, following the regional dispersion of industrial gas demand and the increase in the consumption amounts, energy efficiency has once again become a problem with relation to the previous industrial gas business model that was based on centralized mass production. The major issue is the increase in transportation distance driven by the tanker lorries. In order to resolve this problem, Air Water Inc. has developed high efficiency compact liquid oxygen and nitrogen manufacturing equipment that exceeds previous accepted practice, together with improving the innovative energy efficiency of the manufacturing and transporting processes by locating them in the demand areas.

◎ Implementation Period for the Said Example

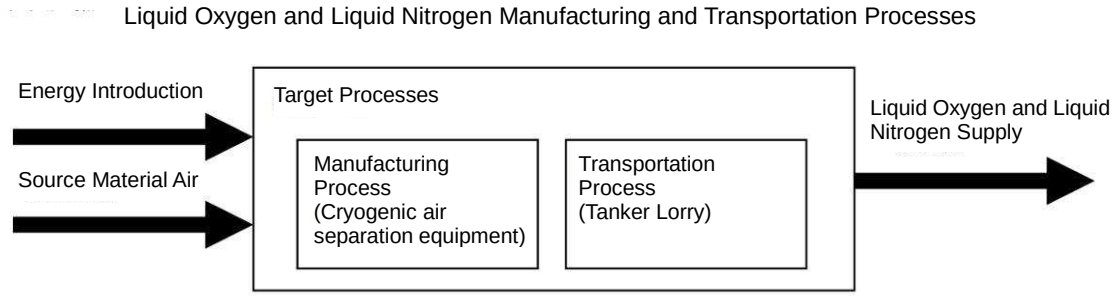
- Project Planning Period April 2000 – February 2001 Total of 11 months
- Measures Implementation Period March 2001 – September 2003 Total of 28 months
- Measures Effect Confirmation Period October 2003 – March 2011 Total of 90 months

◎ Outline of the Business Establishment

	Niigata Ekisan Co., Ltd.	NSCC Air Water Inc. Kumamoto Plant	Mikuni Ekisan Co., Ltd.	Tokai Ekisan Co., Ltd.	Fukushima Ekisan Co., Ltd.	Sagamihara Ekisan Co., Ltd.	Matsuyama Oxygen Co., Ltd.
Operations	Oct. 2003	May 2005	April 2006	April 2007	April 2008	April 2008	May 2008
Items Produced	Liquid Oxygen and Liquid Nitrogen						
No. of Employees	6 persons	6 persons	6 persons	7 persons	6 persons	7 persons	6 persons
Energy Management Designation	Type 1	Type 1	Type 1	Type 1	Type 1 (Next Fiscal Year)	Type 1 (Next Fiscal Year)	Type 1 (Next Fiscal Year)
Energy Usage Amount (Crude Oil Conversion kL/year)	4,347 kL	4,508 kL	4,356 kL	4,698 kL	4,250 kL (Expected Values)	4,550 kL (Expected Values)	5,770 kL (Expected Values)
Energy Usage Amount (GJ year)	168,472 GJ	174,711 GJ	168,842 GJ	182,098 GJ	164,700 GJ (Expected Values)	176,300 GJ (Expected Values)	223,700 GJ (Expected Values)

Fig. 1 List of Places of Business

◎ Process Flow of Target Facility



1. Reasons for Theme Selection

The energy consumption in the said industry arises from a process to separate the air, a main source material into its constituents, oxygen and nitrogen, and a transportation process using tanker lorries. In order to improve the energy environmental problem caused by the increase in tanker lorry transportation distances in recent years, it has become necessary to reduce the transportation distances through the regional dispersion of compact

cryogenic air and nitrogen manufacturing equipment. However, in conventional compact equipment the energy efficiency is poor and there was a problem of the increase in energy required for the manufacturing. In 1984, Air Water Inc. independently developed its V1 compact high purity nitrogen gas generating equipment. By installing this equipment on the premises of demand plants, the company began its on-site gas supply business, and currently 100 on-site plant units are in operation*. From the accumulation of cryogenic air separation technology since the development of the V1, Air Water Inc. succeeded in developing its VSU in 2003 as the industry's first high efficiency compact liquid oxygen and nitrogen manufacturing equipment. The company is currently installing this equipment in VSU regional bases to develop a regional dispersion type industrial gas supply business model. We report here the results of the activities implemented until now that have realized a large reduction in the distances transported by the tanker lorries, in addition to achieving energy conservation and CO_2 emission reductions.

* The large reduction in tanker lorry transportation distances which the on-site business contributed to realizing has led to the case study this time.

2. Progress of Activities

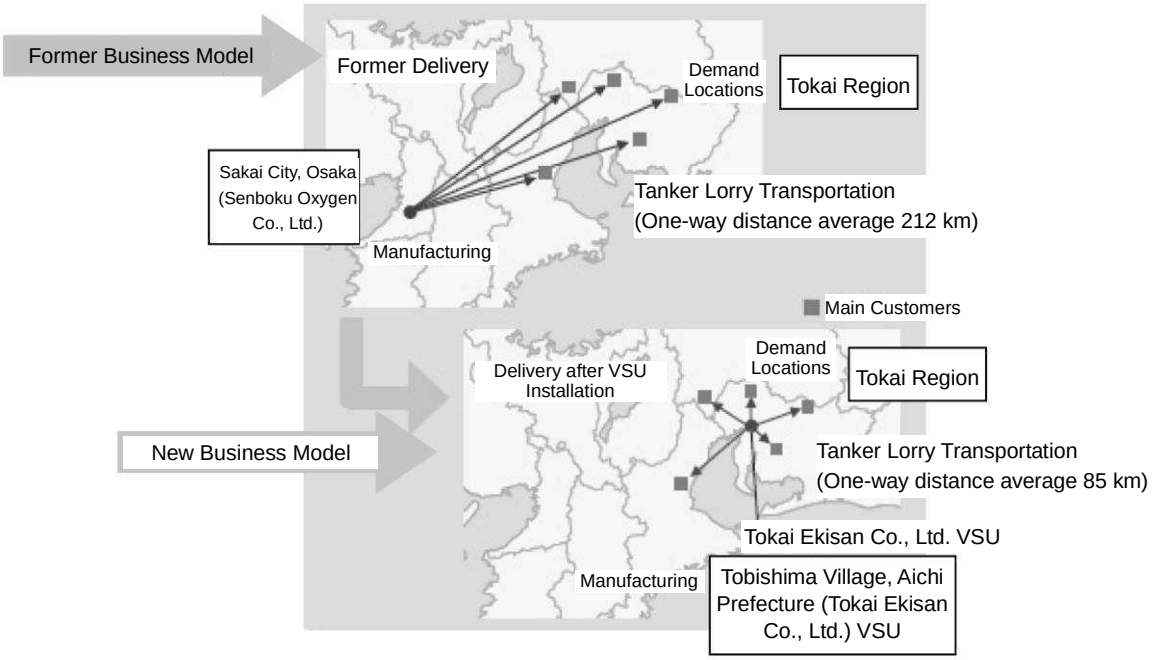
(1) Implementation Structure

Concerning the energy conservation aspect, as shown in the table below the work was integrated as shared work between each related department centered on the Industry Business Department.

Framework	Shared Work	Department in Charge
Plan Establishment	Energy Conservation Plan	Industry Business Department
	Plant Development	Integrated Research Laboratory
	Plant Design and Manufacturing	Engineering Business Department
Measure Implementation	Liquid Oxygen and Nitrogen Manufacturing	On-site Business Department
	Liquid Oxygen and Nitrogen Conveying	Logistics Business Department
	Sales	Regional Business Companies
Measure Confirmation	Energy Conservation Integration	Industry Business Department

(2) Understanding of Current Situation

Below, the manufacture and transportation in the Tokai region (Tokai Ekisan Co., Ltd.) centered on Nagoya is taken as a representative case to allow understanding of the difference between the previous business model and the new business model.



(3) Analysis of Current Situation

The above case study energy efficiency improvement degree was quantitatively analyzed.

Business Model	Manufacturing Electric Power Intensities	Demand Location	Tanker Lorry Transportation Distance
Previous: Senboku Industrial Complex Area, Sakai District Large-sized Plant	1.05 kWh/m ^{3}	Tokai Region (Nagoya)	123,000 km/month
New: Regionally Distributed Plants (VSU)	0.85 kWh/m ^{3}	Tokai Region (Nagoya)	36,000 km/month

(4) Target Settings

Compact liquid oxygen and nitrogen manufacturing equipment (VSU), which has a high energy efficiency, was installed in bases nationwide, and a regionally distributed type industrial and medical gas supply network was built up around these bases. In this new

business model, seven bases had been established nationwide by July 2008, and this was to be expanded further to 10 nationwide bases by March 2010. With this increase in bases, a large reduction in the tanker lorry transportation distance and improvement in the electric power intensities was achieved compared to the previous model.

(5) Problem Points and Their Investigation

In order to realize the regionally distributed type business model, the following issues and resolution policies were investigated.

1) Development of high efficiency compact liquid oxygen and nitrogen manufacturing equipment (VSU)
2) Reduction of tanker lorry transportation distances
3) VSU planned installation location investigation

Regarding these, details are described in the following items.

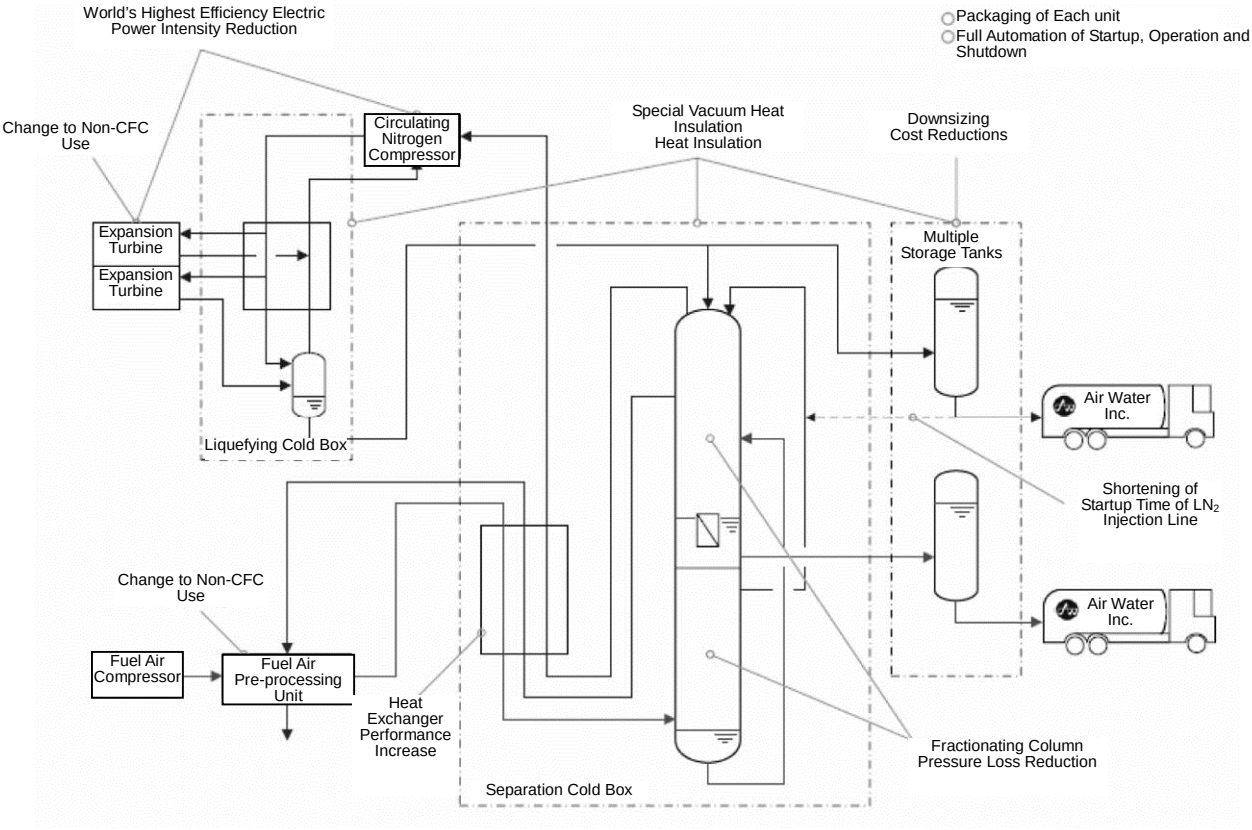
(6) Details of Measures

1) VSU development

The motivation for developing the compact and highly efficient liquid oxygen and nitrogen manufacturing equipment was that a new business model consisting of a regionally distributed industrial gas supply could not be realized without it. That is to say, to support the changes in the demand structure for industrial gases, the enabling of manufacture and supply at locations closer to the demand locations was set as an objective from the start of the equipment development. Accordingly, a thorough improvement of the insulation efficiency and minimizing of the electric power intensities was required as shown in the figure.

(VSU Equipment Schematic Diagram)

The characteristics of the VSU include the items that the basic equipment unit incorporates a large-sized vacuum thermal insulation container to improve the vacuum thermal insulation performance, a change to a non-CFC refrigerator is realized, and a 2-turbine system is used to improve the cooling cycle performance.



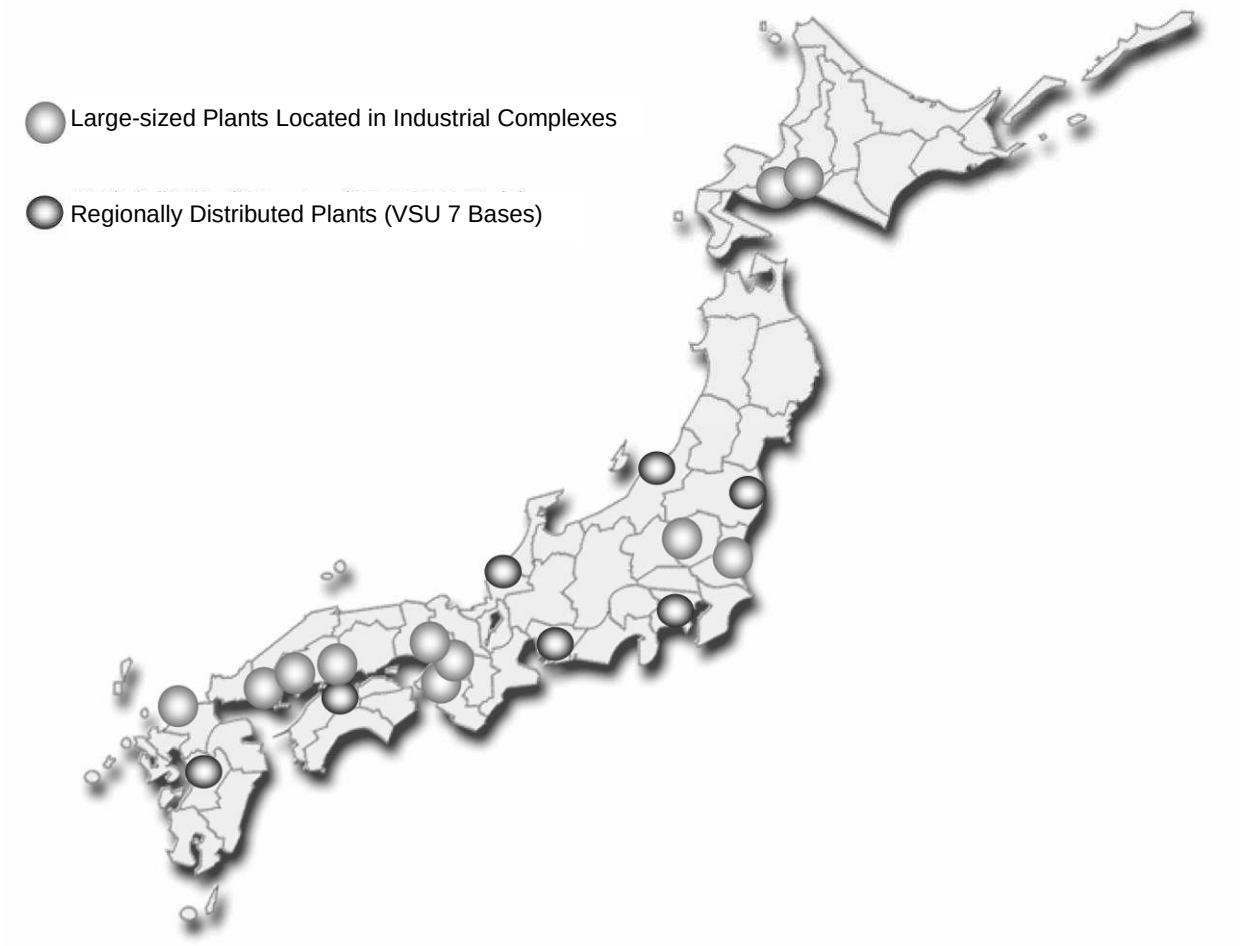
2) Reduction of tanker lorry transportation distances

As shown by the Tokai Ekisan Co., Ltd. case, it was verified that by locating the manufacturing plants in the demand locations, the tanker lorry transportation distances could be greatly reduced.

3) VSU planned installation location investigation

Air Water Inc. selected the plant establishment locations according to the industrial gas demand and supply predictions, and had established VSUs in seven locations nationwide by July 2008. While the company is still developing its regionally distributed industrial gas supply business, it is planned to further increase the number of nationwide bases to 10 by March 2010. By doing so, it is anticipated that the company will achieve a large energy conservation effect.

Large-sized Plants and VSU Installation Bases



(7) Effects Achieved after Implementing Measures

The energy conservation effect of the seven nationwide bases established up to July 2008 can be summarized as shown below. It can be said theoretically that the total amount of energy conservation effects due to the tanker lorry transportation distance reduction and the energy conservation effect of the liquid oxygen and nitrogen manufacturing plant efficiency improvement will be a reduction of 183,938 GJ/year using calorie basis (12.7% reduction compared to the previous model), which converts to a 10,657 t-CO_2/year reduction in CO_2 emissions (13.1% reduction compared to the previous model). However, the “previous model” in this case is not a comparison with the nationwide total amounts manufactured in this company’s large-sized plants and transported by tanker lorry, but considers as its subject the 7-base portion of the total amount that was replaced by the regionally distributed model.

1) Effect of transportation distance reduction = 58% reduction compared with previous model

Amount	Previous Model (Usage and Emission Amounts)	Regional Distribution Model (7 Bases)	Reduction Effect After Measures Introduction (7 Bases)
Transportation Distance	5,592,000 km/year (466,000 km/month)	2,364,000 km/year (197,000 km/month)	3,228,000 km/year (269,000 km/month
Fuel (Diesel)	1,469 kL/year	621 kL/year	848 kL/year
Crude Oil Equivalent	1,448 kL/year	612 kL/year	836 kL/year
Calorie Basis	56,116 GJ/year	23,722 GJ/year	32,394 GJ/year
CO_2 Emissions	3,848 t-CO /year	1,627 t-CO /year	2,221 t-CO /year

2) Effect of electric power intensities reduction = 10.9% reduction compared to previous model

Amount	Previous Model (Usage and Emission Amounts)	Regional Distribution Model (7 Bases)	Reduction Effect After Measures Introduction (7 Bases)
Manufacturing Electric Power	139,709,000 kWh/year	124,509,000 kWh/year	15,200,000 kWh/year
Crude Oil Equivalent	35,905 kL/year	31,999 kL/year	3,906 kL/year
Calorie Basis (Daytime)	1,392,899 GJ/year	1,241,355 GJ/year	151,544 GJ/year
CO_2 Emissions	77,538 t-CO /year	69,102 t-CO /year	8,436 t-CO /year

Total（**1)**＋**2)**）

Amount	Previous Model (Usage and Emission Amounts)	Regional Distribution Model (7 Bases)	Reduction Effect After Measures Introduction (7 Bases)	Reduction Rate
Crude Oil Equivalent	37,353 kL/year	32,611 kL/year	4,742 kL/year	12.70%
Calorie Basis	1,449,015 GJ/year	1,265,077 GJ/year	183,938 GJ/year	12.70%
CO_2 Emissions	81,386 t-CO /year	70,729 t-CO /year	10,657 t-CO /year	13.10%

3. Summary

The energy usage amount (calorie basis) following the manufacture and transportation under the previous model before the introduction of the VSU introduction (fiscal year 2002)

was 1,449,015 GJ/year. In contrast, the annual average energy reduction amount (calorie basis) of 183,938 GJ/year due to the VSU introduction corresponds to an approximate energy conservation of around 12.7%. In addition, this enables an annual 13.1% reduction in CO_2 emissions.

Further, at the point of time that the seven bases were installed, 30 tanker lorries were retired. When the 10 bases are established, a further 12 tanker lorries will be eliminated, resulting in a total reduction of 42 lorries and making a large energy conservation effect due to the facilities reduction.

We would also like to point out that an effect of this business model innovation will be that the regionally distributed industrial and medical gas supply network will also help to bring about regional economic activation and create sources of new business.

4. Future Plans

Air Water Inc. plans to expand the regionally distributed model to 10 bases by March 2011. At this time, the energy conservation effect is estimated to be as shown in the following table. Due to this, in comparison with the previous model an annual 19.3% energy conservation effect is expected. In addition, the CO_2 emissions amount will be reduced 20% compared with the previous model.

	Current Situation (7 Bases)	3 Base Addition	Planned (10 Bases)
Fuel Reduction Amount (Diesel)	848 kL/year	+ 353 kL/year	1201 kL/year
Manufacturing Electric Power Reduction Amount	15,200,000 kWh/year	8,534,000 kWh/year	23,734,000 kWh/year
Total Crude Oil Equivalent Reduction Amount	4,742 kL/year	2,541 kL/year	7,283 kL/year
Total Calorie Basis Reduction	183,938 GJ/year	98,569 GJ/year	282,507 GJ/year
CO_2 Emissions Reduction Amount	10,657 t-CO₂/year	5,661 t-CO₂/year	16,318 t-CO₂/year