2004 Prize of Director General of Agency for Natural Resources and Energy

Challenge of Reducing Specific Energy Consumption by Half at the Brewery

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Engineering Department

◎ **Keywords: Rationalization of fuel combustion**

◎ Outline of Theme

Asahi Breweries has the goal of reducing carbon dioxide emissions by 10% of the fiscal year 1990 level by 2008. To attain this goal, it is necessary to reduce specific energy consumption significantly in the whole company. To this end, this manufacturing site strove to reduce specific energy consumption by suppressing the use of fuel and power through effective use of heat and was able reduce specific energy consumption significantly.

◎ Implementation Period of the Said Example

September 2001 ongoing

- Planning period: September 2001 ongoing (Total of 36 months)
- Measure implementation period: November 2001 ongoing (Total of 34 months)
- Measure effect confirmation period: January 2004 to March 2004 (Total of 6 months)

◎ Outline of the Business Establishment

- Production item: Beer and low-malt beer
- Employees: 206
- Annual energy consumption (achievement for FY2003)
  - Heavy oil: 12,529 kL
  - Electric power: 52,382 MWh

◎ Process Flow of Target Facility

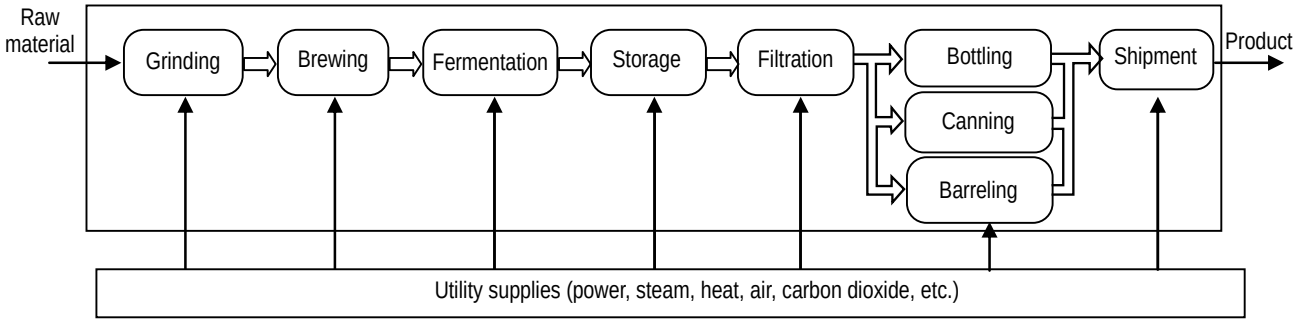

Fig. 1 Process flow of target facility

1. Reason for Theme Selection

In December 1997, the 3rd Conference of the Parties to the United Nations Framework Convention on Climate Change (COP3) was held, where Japan promised to reduce total CO_2 emissions between 2008 and 2012 by an average of 6% of 1990 level. To keep this promise, we have had the goal of reducing total CO_2 emissions at all nine breweries by 10% of the fiscal year 1990 level by 2008. Since our production volume in 2003 significantly increased by 61% compared to the fiscal year 1990 level, it means that the specific CO_2 emission (emission per kiloliter of beer and low-malt beer manufactured) is reduced to 41% of the fiscal year 1990 level in 2006 and to 47% in 2008. To attain this goal, it is necessary to reduce specific energy consumption significantly in the whole company. To this end, we have set this manufacturing site as a model brewery to make efforts to conduct energy conservation activities with the aim of reducing energy specific energy consumption by half.

2. Understanding and Analysis of Current Situation

(1) Changes in Carbon Dioxide Emissions and Production Volume

Fig. 2 shows the changes in production volume and carbon dioxide emissions at all of our breweries. In 2003, the production volume increased by 61% compared to the fiscal year 1990 level. Since CO_2 emissions increase proportionately with an increase in production volume, a 10% reduction in CO_2 emissions of the fiscal year 1990 level requires a substantial 47% reduction in CO_2 emissions.

We have decided to set this manufacturing site as a model brewery to take measures to conduct energy conservation activities with the aim of reducing specific energy consumption at all breweries through the top runner program in which successful measures are taken at all breweries as necessary.

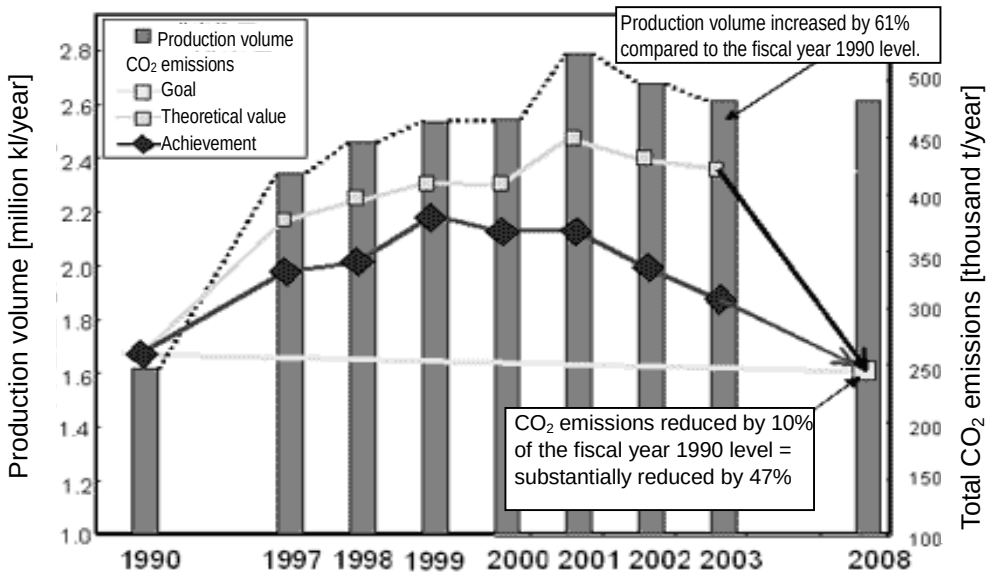

Fig. 2 Changes in production volume and carbon dioxide emissions at all of our breweries

(2) Investigation of Energy Consumption Ratio

In considering energy conservation measures, we investigated the energy consumption ratio at the entire brewery (see Fig. 3). As shown in the figure, the result clearly indicates that the energy used for heating and refrigerating accounts for 42% and 30%of energy consumption at the entire brewery, respectively. If refrigerator power is subdivided, the energy used for air conditioning accounts for 51% and the energy used for beer cooling accounts for 40%. In other words, the high performance of heat exchange systems and air-conditioning systems is the point of energy conservation technology at the brewery. We started the effective use of heat and reconstruction of the heat exchange system with the aim of significantly reducing specific fuel and power consumption.

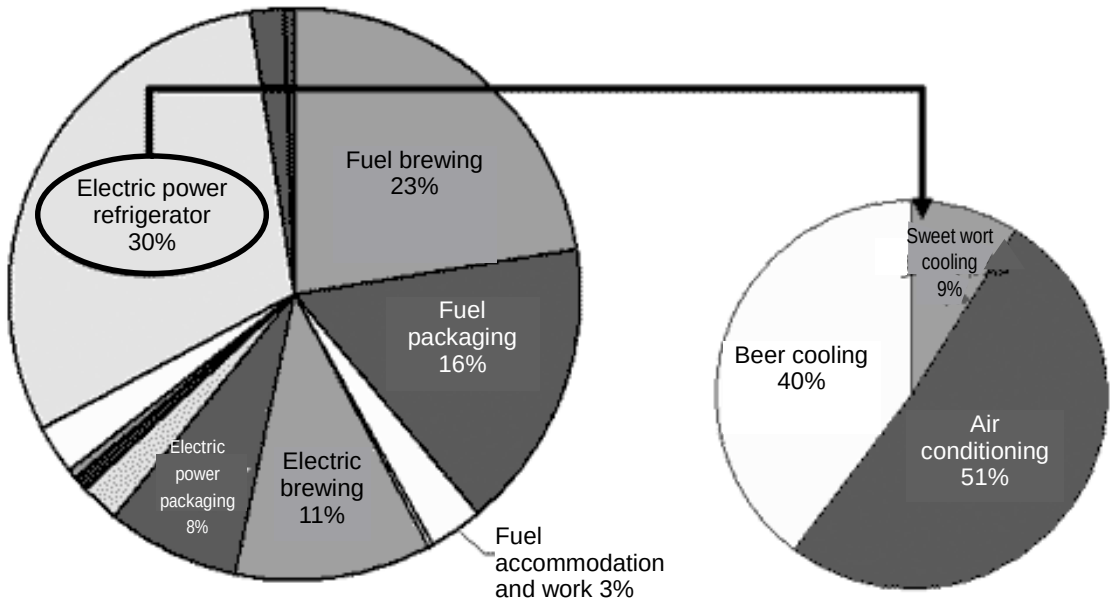

Fig. 3 Energy consumption ratio at the brewery (before energy conservation measures are taken)

3. Progress of Activities

(1) Implementation Structure

In proceeding with the activity, the Energy Conservation Committee centered on the Engineering Department was established. In this committee in which all departments and sections participated, problems with energy used in the divisions were extracted and improvement measures were considered. The brewery made concerted efforts together to promote energy conservation activities (see Fig. 4).

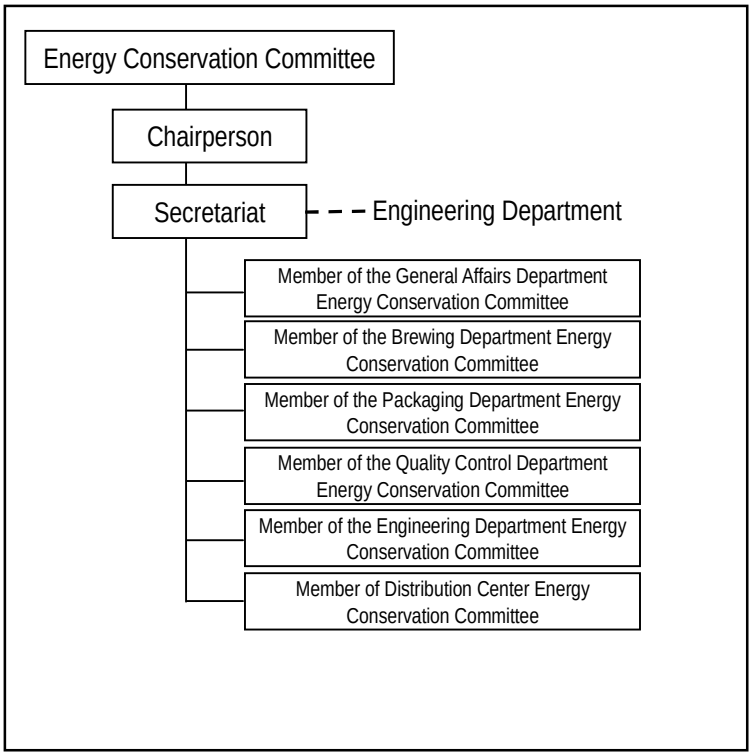

Fig. 4 Organization chart for the Energy Conservation Committee

(2) Targets Setting

Fig. 5 shows changes in specific energy consumption between 1999 and 2006. The goal of specific energy consumption in fiscal year 2006 was set to 159 MJ/HL, which is a 47% reduction from the fiscal year 1999 level.

As evaluation indicators, the following formula (specific fuel consumption + specific power consumption) was used.

Specific energy consumption (MJ/HL) = specific fuel consumption (MJ/HL) + specific power consumption (MJ/HL)

Specific fuel consumption (MJ/HL) = amount of heavy oil used (HL) × high calorifict value (MJ/KL)/production volume (HL)

Specific power consumption (MJ/HL) = power consumption (KWH) × 10.24 (MJ/KWH)/production volume (HL)

*1 HL = 100 L

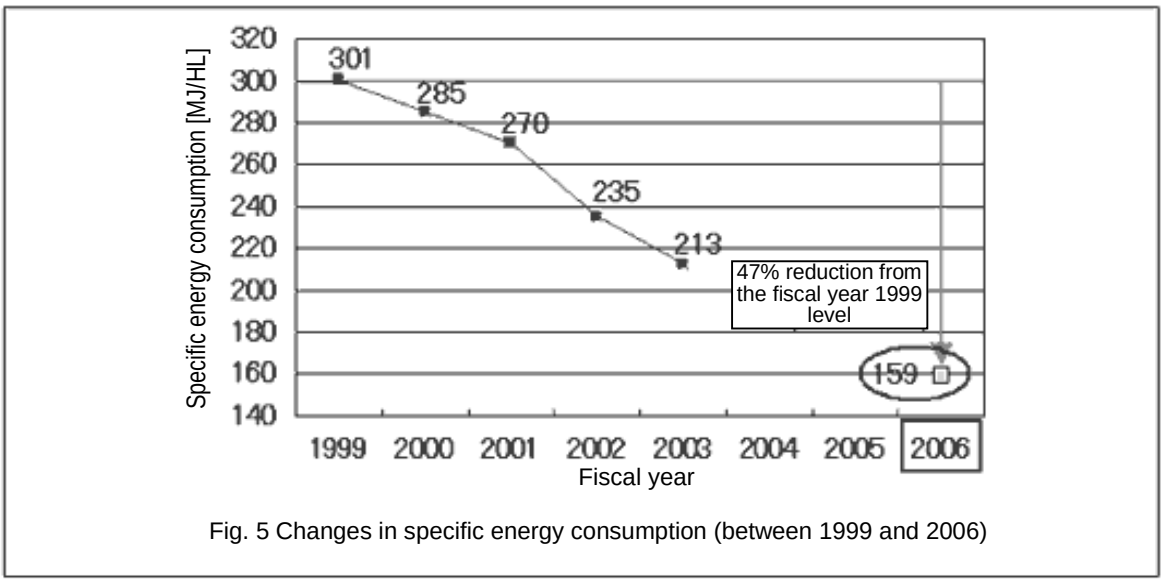

Fig. 5 Changes in specific energy consumption (between 1999 and 2006)

4. Details of Measures

The energy conservation measures listed in Table 1 were taken with the aim of reducing specific energy consumption significantly. Among them, we report the measures [1] intake and control of outside air into the filler room and [2] use of low temperature heat from the carbon dioxide vaporizer. Because these measures help obtain a great effect of reducing energy consumption.

Table 1 Energy conservation measures

Energy conservation measure	Reduced amount MJ/HL
Intake and control of outside air into the filler room	3.1
冷凍熱システムの運転方法見直し	2.2
ボイラー軟化器の高温化対応	
仕込原料液の移替ライン新設	2.1
HBSの有効利用	1.7
クリーンルーム温湿度条件の変更	1.3
仕込麦冷却槽のシステム見直し	1.1
樽フィラー室温湿度条件の変更	0.8
蒸気タービン効率化	0.8
通過通過貯酒タンク室の空調負荷低減	0.5
麦汁CIPポンプ更新	0.4
仕込装置凍結度の変更(50%→10%開閉)	0.4
ボイラー燃焼空気比の見直し	0.4
原酒醗酵容器タンクレベル制御の見直し	0.3
ボイラー連続ブロー量の見直し	0.3
用水処理ポンプ周波数設定最適化	0.3
COP算定計算整備→冷凍機の効率運転	0.3
樽フィラー室空調負荷低減工事	0.2
炭酸回収ガスの回収率アップ	0.2
コンプレッサー運転台数の制御見直し	0.2
HBS冷凍機プレートへのデスケ設置工事	0.2

Energy conservation measure	Reduced amount MJ/HL
Use of low temperature heat from the carbon dioxide vaporizer	1.8
脱気水2次注入ラインへの改造(0→7℃)	
貯酒タンク温度変更(0℃→2℃)	1.7
冬季、排水酸生成槽温度設定変更	1.6
仕込管廻CIPのすすぎ湯の水化	1.3
特高変電所自動カットアウト切替装置改造工事	1.1
脱気水温度変更(0℃→18℃)	0.9
排水処理設備醗気フロア制御見直し	0.5
脱気水温度変更(0℃→24℃)	0.5
アイスバンク見学者空調分離化工事	0.5
夜間のボイラー1台運転	0.5
麦汁原料水/過ポンプ適正化	0.4
蒸気トレン回収ラインの改造工事	0.3
日中のボイラー1台運転	0.3
老朽化スチームトラップの更新	0.2
脱気水使用量の削減	0.2
醗酵容器タンクレベル制御の再見直し	0.1
脱気水製造装置の制御変更工事	0.1
冷圧用ロアーのINV化	0.1
壁面からの冷却のPG化工事	0.1
仕込み原料麦コンプレッサー休日運転停止	0.1

Energy conservation measure	Reduced amount MJ/HL
省エネライト設置(SHV、パレタイザエリア)	0.6
逆電電圧低下時間延長	0.7
醗酵CIP洗浄タンクオーバーフロー対策	0.6
発酵・貯酒タンク洗浄り工程の見直し	0.5
発酵・貯酒タンク洗浄り工程の見直し	0.2
洗びん機停止	0.1
中央コントロール室照明INV化	0.1

(1) Intake of Outside Air into the Filler Room in Winter

We tailor the filler room where the container is filled with beer to the clean room specifications and maintain the temperature, humidity and positive pressure constant in the room. As shown in Fig. 3, enormous amounts of energy are required for refrigerator power for air conditioning. In addition, as shown in Fig. 6, since an air intake duct for the air conditioner had been set inside the building, hot and humid air in the building was cooled.
For this reason, a measure was taken to take outside air into the filler room in winter with the aim of reducing cooling energy consumption. As shown in Fig. 6, outside air was taken as intake air to stop the use of cooling water used for cooling, and air-conditioning power consumption was reduced.
As a result, the energy required for cooling changed from 4112 MJ/day to 2108 MJ/day, and about a 49% reduction in energy consumption was achieved.

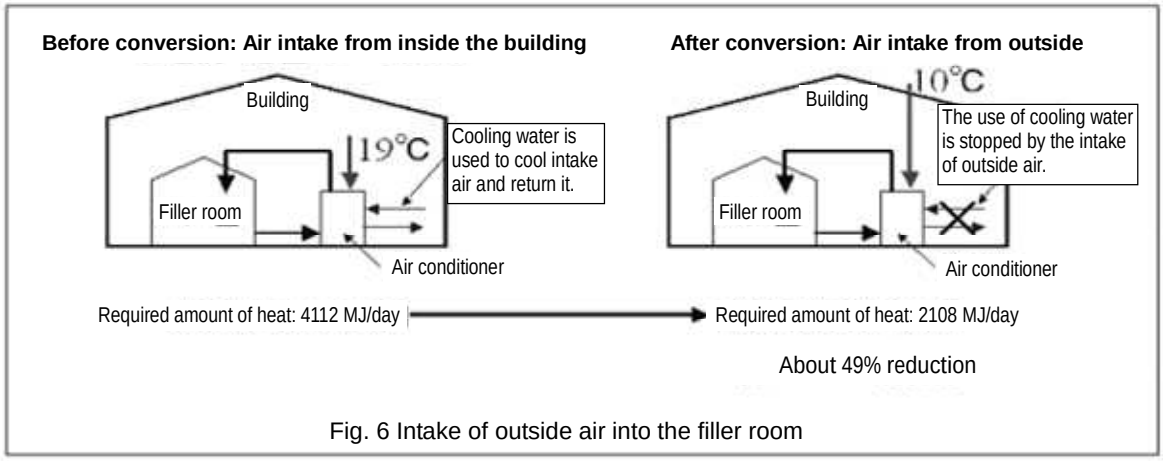

Fig. 6 Intake of outside air into the filler room

Energy consumption could be further reduced by 24%, which is a total of 73% reduction by changing the method of controlling the atmosphere in the filler room from relative humidity control to absolute humidity control.
The effect of energy conservation by this measure is 3.1 MJ/HL in terms of specific energy consumption.

(2) Use of Low Temperature Heat from the Carbon Dioxide Vaporizer

The carbon dioxide used in the beer-manufacturing process is stored in a liquid state at a temperature of -25^{o}C and at a pressure of 1.7 MPa in the tank. When it is actually used, it is vaporized using hot water whose temperature is raised to about 50^{o}C by steam (see Fig. 7). At this manufacturing site, 14,000 tons of carbon dioxide is used annually, and fuel of about 8.4 million MJ is used accordingly.

Before this carbon dioxide vaporizer, the shell and tube heat exchanger was installed to exchange heat between liquid carbon dioxide and coolant for cooling beer (propylene glycol, hereinafter abbreviated to PG) for low temperature heat recovery (see Fig. 8).

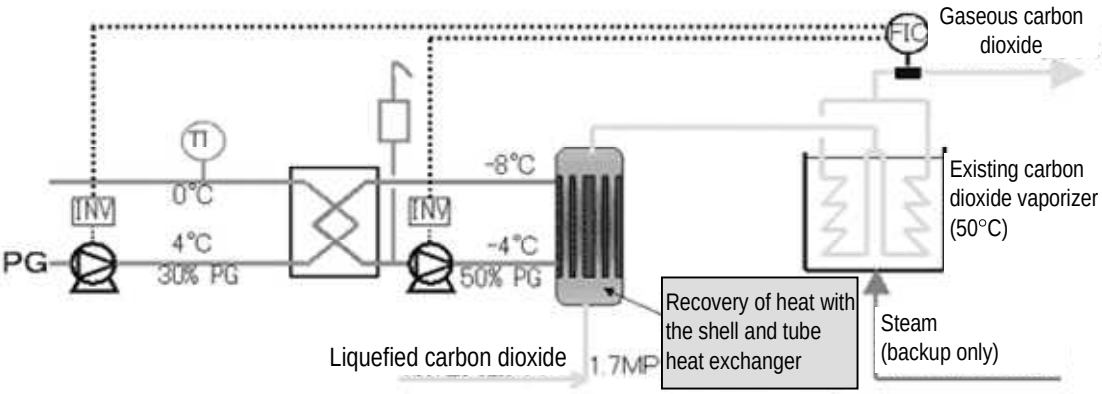

Fig. 8 Flow of carbon dioxide vaporizer after conversion

As shown in Fig. 9, the PG system in this brewery is divided into two systems (0oC system and -3oC system) according to the feed temperature. The above heat exchanger was installed at the return piping of the 0oC system to reduce beer-cooling refrigerator power. The liquid carbon dioxide temperature was also raised to reduce amount of steam for retaining the carbon dioxide vaporizer temperature. The effect of reducing energy consumption is as follows.

Effect of reducing energy consumption	
Vaporizer steam	1.0 MJ/HL
Refrigerator power	0.8 MJ/HL
Total	1.8 MJ/HL

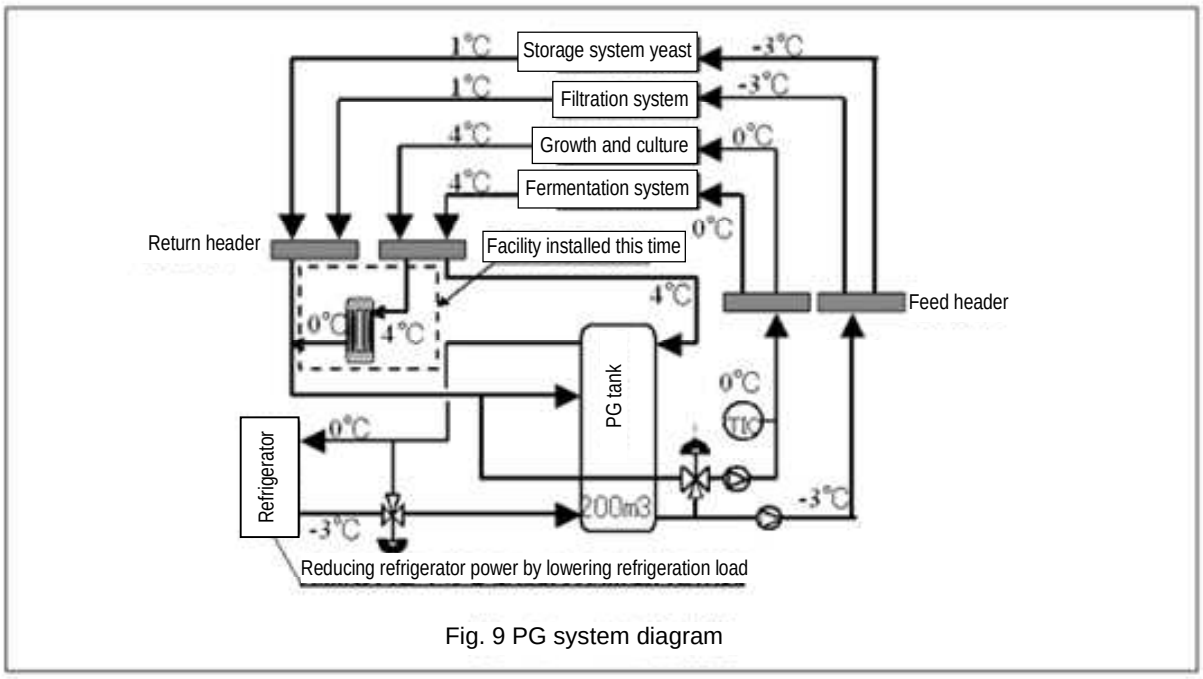

Fig. 9 PG system diagram

(3) Effect of reducing Refrigerator Power

Fig. 10 shows the result of reducing refrigerator power. As a result of the energy conservation measures explained in (1) and (2) of Section 4 and other energy conservation measures listed in Table 1, refrigerator power was significantly reduced in both the beer-cooling system and air-conditioning system.

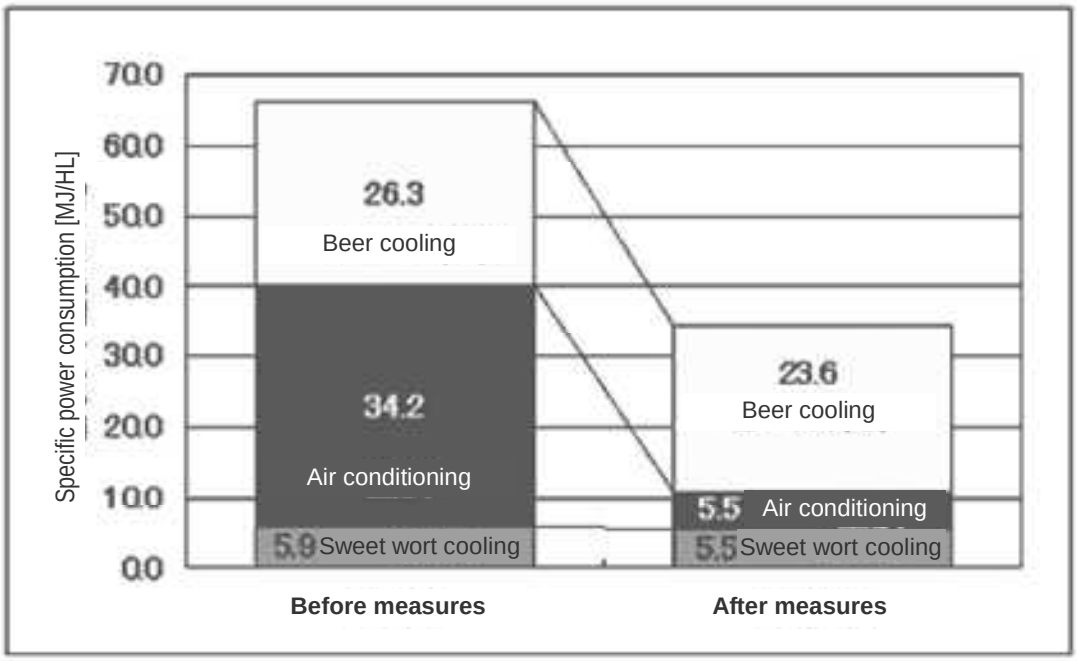

Fig. 10 Reduction of Specific Power Consumption of Refrigerator Power

5. Effects of Measures

Fig. 11 shows changes in specific energy consumption. As a result of taking a wide variety of energy conservation measures in each process, specific energy consumption could be reduced by 32% of the fiscal year 1999 level as of the end of June 2004.

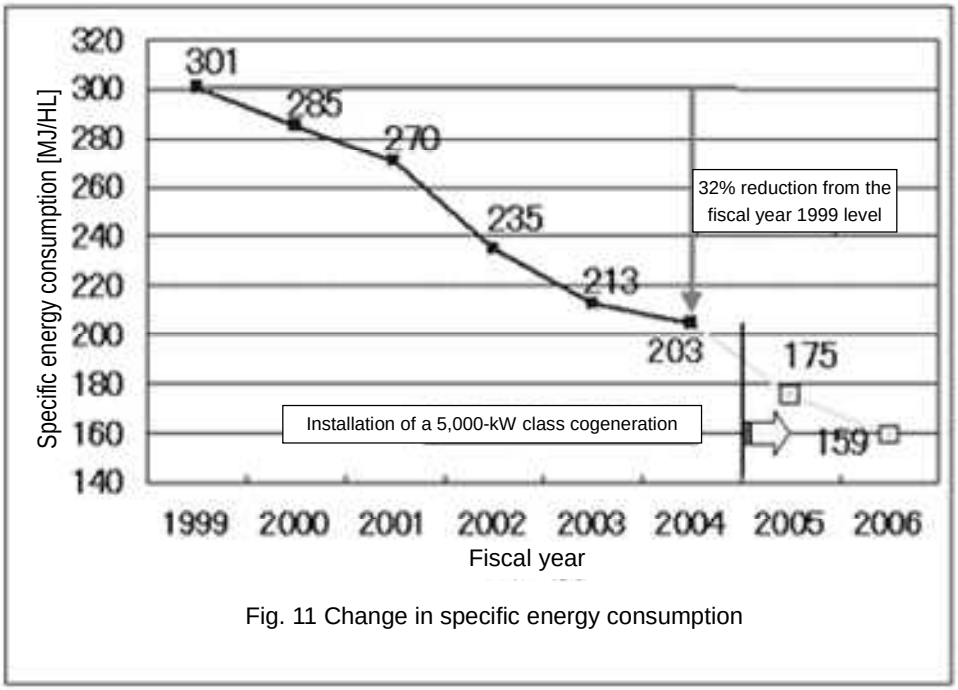

Fig. 11 Change in specific energy consumption

6. Conclusion

At this manufacturing site, a 32% reduction in specific energy consumption of the fiscal year 1999 level could be achieved by taking various energy conservation measures. In addition, installation of the 5,000-kW class gas turbine cogeneration system at the end of this year promises achievement of a reduction in specific energy consumption of 175 MJ/HL in 2005. New energy conservation measures are further taken with the aim of achieving a reduction in specific energy consumption of 159 MJ/HL in 2006.

7. Future Plan

Energy conservation measures will be taken at all breweries of Asahi Breweries in the expectation that a 10% reduction in carbon dioxide emissions of the fiscal year 1990 level, which is the original goal, will be achieved by 2008.