

Pursuing Advances in Technology Management

Osaka Gas regards technology as its most effective differentiating asset and a key element in enhancing competitiveness. For this reason, we have continued to invest strategic resources in technological development. Amid a rapidly changing competitive environment, we are aware of the growing need to quickly incorporate the fruits of our technological development into our businesses. We will pursue the optimal management of technology in response to this changing environment.

(1) Maximizing the Benefits of Investments in Development through a "Selection and Concentration" Policy

In the past, Osaka Gas used coal as the fuel for manufacturing gas. Since then, we have shifted to petroleum and now to natural gas. The technologies we have cultivated in the process have been passed down to the present day. These are our core technologies, which we are continuing to strengthen:

- Carbon materials technologies developed from tar, the main by-product of coal gas
- Catalyst technologies from the era when gas was manufactured from petroleum
- Cogeneration technology for maximizing utilization of energy in the era of natural gas

In selecting development themes, we first identify the relevant key technologies and determine whether or not we can use our existing core technologies to refine those key technologies. Osaka Gas places top priority on acquiring key technologies through its own efforts and also works to obtain intellectual property rights. Peripheral technologies outside our area of expertise are efficiently procured externally.

In the field of gas-related technological development, our aim is to enhance the competitiveness of gas. For this reason, we focus on products that highlight the advantages of gas and R&D themes that help us reinforce our gas-related technologies. To open up new businesses for the future, we promote advances in our core technologies to develop products and technologies aimed at creating new businesses.

(2) Accelerating Development through Stronger Alliances

1. Strategic Alliances

We are proactive in forming alliances with entities possessing technologies and intellectual property that we do not have, and through which we can anticipate synergistic benefits. One example is our development of polymer electrolyte fuel cell (PEFC) cogeneration systems for household use. Here, we draw on two proprietary technologies—reforming technology for making hydrogen from natural gas and technology for heat exhaust recovery—while working together with a cutting-edge fuel cell stack manufacturer.

2. Internal Alliances through Organizational Restructuring

To develop technologies that constantly address the needs of customers and the market, in fiscal 2003 our business units responsible for our household, commercial and industrial customers took over development of technologies related to their own businesses. This will enable the business units to swiftly and flexibly reflect the constantly changing needs of customers in their technological development initiatives. As needs arise, the Technology Division will adjust its development policies and provide support to the business units.

(3) Exploiting the Fruits of Technological Development

1. Linking the Fruits Together

By continuing to improve and develop our core technologies, we constantly seek to refine technologies that will benefit our businesses. Our goal is to create a chain of integrated technological developments based on our core technologies. This involves investigating the potential for using our core technologies to create products that provide new levels of added value. Making full use of catalyst technologies, for example, we have developed natural gas reforming technologies, which in turn we have utilized to develop compact hydrogen production units and PEFC cogeneration systems for household use.

2. Securing and Utilizing Intellectual Property

Intellectual property is one of Osaka Gas's most valuable business resources. In order to acquire and utilize intellectual property in a strategic and effective manner, we are implementing the following three basic policies:

- Promote patent portfolio management
Build a robust patent portfolio by adding peripheral patents to basic patents
- Use intellectual property rights to increase revenue
Engage in proactive licensing activities to increase revenue derived from intellectual property
- Strengthen risk management of intellectual property activities through legal means, as well as educational and other activities based on regulations

These intellectual property policies are fundamental to ensuring effective management of our technological resources. We will continue promoting technological development backed by solid intellectual property rights.

(4) Nurturing Personnel with a Technological Management Mindset

We are nurturing technicians who are fully aware of the importance of technology management. For example, our core technicians participate in courses offered by the Osaka Gas Management of Technology (MOT) School—opened by our affiliate, i-Support Co., Ltd.—and other intellectual property training programs.



MOT Classroom

Major Technological Development Themes

1. Technologies to Enhance the Competitiveness of Gas

Advances in Gas Equipment for Household Use

To maximize the advantages of gas, Osaka Gas will continue creating products in a swift and timely manner that customers choose for their added value.

One notable development is KAWACK, a wall-mounted bathroom heater/dryer for existing buildings that is easily installed and has a mist sauna function. The unit sprays mist heated, and the nozzle can be adjusted to suit the body size of the user, enabling customers to enjoy a comfortable wet sauna in their own homes. Another product is NOOK-SILHOE, a new type of gas hot water radiator featuring improved design and ease of installation. It is a radiant heater that heats living rooms and bathrooms by discharging heat produced by the circulation of hot water heated to temperatures ranging between 60°C and 80°C.



Mist sauna



NOOK-SILHOE
gas hot water radiator

Cogeneration System for Household Use

Cogeneration systems are an indispensable part of our gas business. We have worked to spread their popularity in the industrial and commercial sectors by emphasizing their economic and environmental superiority. In March 2003, we released a 1kW-class gas cogeneration system called ECOWILL, which gives ordinary households an opportunity to use a cogeneration system. We also plan to launch a PEFC cogeneration system for household use onto the market in fiscal 2005. This will take full advantage of our superior natural gas reforming technology, as well as heat exhaust recovery technology acquired in developing ECOWILL.

Raising the Efficiency of Cogeneration Systems for Commercial and Industrial Use

Cogeneration technologies for commercial and industrial use promise to play a crucial role in Japan's energy-saving efforts. Osaka Gas has focused its technological development resources on cogeneration for some time, and will continue to do so in the future.

In the small-volume electrical market (between 5kW and 25kW), we are developing a modified version of the Gene-Light Series of micro-cogeneration systems. In the 9.9kW class, we have achieved a generating efficiency of 31.0% (overall energy efficiency 84.0%), the highest in its class, thanks to the adoption of a highly efficient engine and a high-frequency permanent magnet generator. We have also made further improvements to the Miller-cycle gas engine used in our 380kW-class cogeneration system, which had a generating efficiency of 40%. As a result, we have developed a long-stroke Miller-cycle gas engine boasting a generating efficiency of 42% (see Note below).

One option for next-generation cogeneration is the solid oxide fuel cell (SOFC), which has the advantage of high generating efficiency. We are currently evaluating this technology and investigating its potential for systemization.



Long-stroke Miller-cycle gas engine boasting a
generation efficiency of 42%

Note: In a Miller cycle, the expansion ratio is larger than the compression ratio, and for this reason it is also called a "high-expansion-ratio" cycle. It is highly efficient because it extends the piston strokes while suppressing friction loss.

LNG-Related and Gas Transmission/Distribution Technology

Osaka Gas not only develops technologies that help boost sales of gas, but also place high priority on infrastructural technologies that help reduce gas supply costs. We are continuing our efforts in this area in order to enhance our competitiveness.

In 2003, we constructed a 180,000m³ LNG tank, one of the world's largest, at our Himeji Terminal, using technology gained from many years of building LNG tanks. The new LNG tank employs the latest cost-saving technologies, including Invar pipes—which Osaka Gas was the first to commercialize in 2001—for some of the piping. Invar (iron-nickel) alloy has an extremely low linear expansion coefficient, and so is virtually unaffected by contraction or expansion caused by temperature variation. This eliminates the need for bent piping used to absorb thermal contraction, leading to significant cost reductions. By fiscal 2006, we plan to use Invar pipes allowing us to create a seabed gas tunnel with the smallest inside diameter for LNG piping. The pipeline will connect the Senboku LNG No. 1 Terminal with the Senboku LNG No. 2 Terminal.



Himeji No. 8 LNG tank



Invar alloy LNG piping

2. Technological Development to Explore Future Businesses

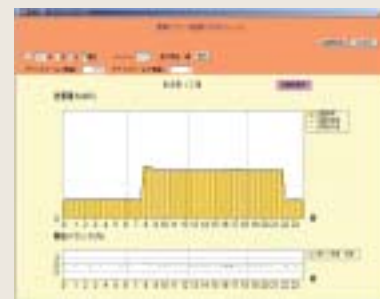
Electricity Business Technology

We are wasting no time in developing both software and hardware technologies required for the electricity business, in order to nurture it into a core energy business second only to natural gas.

In June 2004, we began operating a 50MW power plant at our Himeji LNG Terminal to provide electricity to retail customers. We are currently acquiring know-how and experience related to the construction, operation and maintenance of a large-scale electric power plant scheduled to begin operation at our Senboku Terminal in 2008. We are also developing ancillary functions and a remote monitoring system for formulating electric power generation plans and managing electrical energy consumed at the terminal, as well as electrical energy transmitted to the outside.



Electricity transmission planning management



Monitoring actual electricity transmission

Environmental Technology

We have jointly developed a catalyst for treating smoke emissions that uses pitch-based activated carbon fibers to simultaneously eliminate sulfur oxides (SO₂, SO₃). This system enables operation using small quantities of water. It also permits reductions of both power and maintenance costs. In February 2004, we established a joint venture company with Mitsubishi Heavy Industries called OMviro Co., Ltd., which will manufacture and sell this catalyst.

The catalytic wet oxidation process is a technology applying our catalytic technologies developed through many years of gas manufacturing. It decomposes various kinds of industrial wastewater and sludge to produce water that is nearly the same quality as tap water. When we handed over a plant in China in 2001, we reduced costs by altering the design and procuring parts from overseas. We are now developing these plants for use in China and Japan.



OMviro demonstration plant using a smoke emission treatment catalyst

Hydrogen Technology

In April 2003, Osaka Gas unveiled a compact hydrogen production unit employing natural gas reforming technology. The unit is used in stations that supply hydrogen for industrial use and for fuel cell vehicles. It has a hydrogen production capacity of 30Nm³/hr, but we plan to extend our lineup to include units with a production capacity of 100 to 300Nm³/hr. By integrating the purifying and reforming units, which previously were separated, we reduced the cost of the unit and halved its size. We are continuing development with a view to making the units even smaller. Demand for hydrogen production units is expected to increase rapidly as fuel cell vehicles become more widely adopted and hydrogen station infrastructure is established.

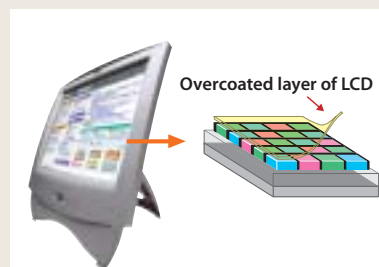
Amid growing expectations of hydrogen use accompanying the popularization of fuel cell vehicles, we are conducting various tests of a natural gas reforming hydrogen supply station, constructed as part of a national government project.



HYSERVE hydrogen production unit using city gas reforming technology

Fine Materials Technology

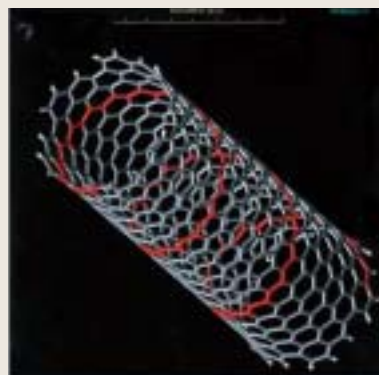
Osaka Gas has employed technologies acquired since the era of manufacturing city gas from coal to develop applications for fluorene derivatives contained in coal tar. We have developed a method for manufacturing 20 or 30 types of fluorene conductors, and are currently marketing these materials. The main markets for fluorene derivatives are the optical and electronics sectors, where such derivatives are attracting attention for their high refraction rates and thermal resistance. This has prompted more and more leading manufacturers to adopt these materials in the lenses of camera-equipped mobile phones and in liquid crystal-related materials. Sales of fluorene derivatives in fiscal 2004 totaled approximately ¥2.0 billion, a three-fold increase over the previous fiscal year. To meet expanding demand for fluorene conductors, we teamed up with the JFE Group to establish a joint fluorene conductor manufacturing company, called Full Fine Co., Ltd. That company's plant has been in full-scale operation since August 2003, with an annual production capacity of 560 tons.



Sample applications of fluorene conductors
Liquid crystal overcoat (above)
Lenses of camera-equipped mobile phone (below)

Nanomaterials Technology

Osaka Gas has employed its experience in carbon materials technologies to develop a new carbon nanotube with amorphous carbon in the interior wall of the tube. We are currently developing this carbon nanotube as a hydrogen storage material as part of our participation in a national government project funded by NEDO (New Energy and Industrial Technology Development Organization). We are also developing a material for electronics applications. Electronics manufacturers who have received samples of this new material have praised it highly.



Carbon nanotube

Intellectual Property Activities of the Osaka Gas Group

Disclosing Information On Intellectual Property Activities

From the standpoint of technology management, the Osaka Gas Group has made aggressive efforts at intellectual property activities, including strategically acquiring intellectual property rights as the result of technological development, acquiring patents on business models to promote business using IT, and garnering licensing revenues*.

As the value of intellectual property has grown in importance to corporate management, we would like to introduce the intellectual property activities of the Osaka Gas Group to promote a firm understanding of our strategic initiatives.

*Note: Our intellectual property activities are based on the slogan "Get a patent, start your business" of American entrepreneur Jay S. Walker.

1. Intellectual Property Applications

Current Status of Applications

As the Osaka Gas Group advances selection and concentration in line with business strategies, the Company has strategically applied for patents in keeping with its patent portfolio management* objective of building up a base of potent patents.

We are securing influential patents through applications for patents central to **residential cogeneration technologies**, which contribute significantly to solving energy and environmental problems, and **technologies related to polymer electrolyte and solid oxide fuel cells**.

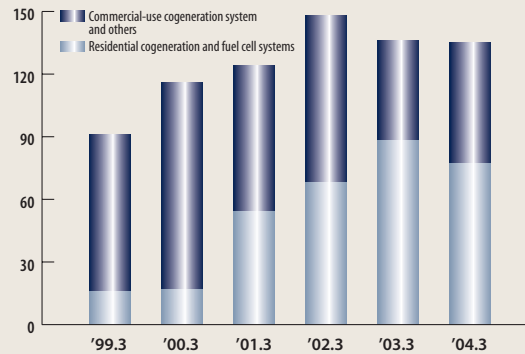
Osaka Gas is also taking an aggressive approach to applying for patents on business models that use IT such as electricity retail systems ahead of electric power liberalization and work for customers such as services and maintenance. In fiscal 2000 and 2001, Osaka Gas aggressively applied for patents on critical business models across operations, including marketing.

We are also applying for patents on design and trademarks. As of fiscal 2004, the Osaka Gas Group had applied for a total of 718 industrial-related patents.

Number of Patent Applications (Osaka Gas Group)

	'99.3	'00.3	'01.3	'02.3	'03.3	'04.3
Number of patent applications	988	1,095	979	904	760	638
(of which business model patents)	17	25	157	159	108	61

Patent applications for cogeneration and residential fuel cell systems



*Note: 1. Patent portfolio management is a management approach where business strategies entail the acquisition of patent portfolios centered on the basic patents to core technologies, along with their related patents.
2. All patent applications on a domestic basis

Example of patent application Patent strategy for residential fuel cell systems

The following is an example of a strategic application for patents related to residential fuel cell technology.

(1) Osaka Gas applies independently for patents on core technologies.

1. Reformers

Osaka Gas is working to win patents independently on fuel reformers and catalytic technologies, an area where Osaka Gas is strong in its expertise.

2. Self-learning control system (operation control technology)

We are applying for patents related to operational control of fuel cell systems, including self-learning control, which has the greatest impact on energy conservation.

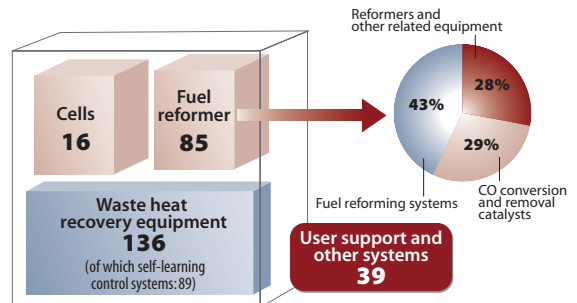
(2) Patent application strategy for non-core technologies (cells, etc.)

Osaka Gas is forming alliances with manufacturers based on the foremost principle of accelerating commercialization.

In some cases, the Company applies patents jointly with those manufacturers.

Patent applications for residential fuel cell systems

(Cumulative patent applications as of March 31, 2004)



2. Ownership and Usage of Intellectual Property Rights

Ownership of Patent Rights

[Energy Businesses]

In the LNG and gas transmission/distribution fields, Osaka Gas owns patents that contribute to cost reductions and safety, including patents on the **non-excavation construction method** and **underground facility inspection technology**. In commercial/industrial-use fields, the Company owns innovative patents on advanced environmental technologies, including **those related to wastewater processing technology using catalytic wet oxidation (CWO)**, which is being commercialized in China, and **sludge melting technology**, as well as the patents on **cogeneration and fuel cells**. In the residential field, Osaka Gas owns patents on residential

cogeneration systems as well as the rapidly growing **floor heating systems and bathroom heating and drying equipment**.

[Non-Energy Businesses]

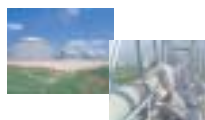
The Osaka Gas Group is strategically acquiring patents on materials technologies for fields expected to grow in the future. These patents relate to: **lithium ion rechargeable battery materials**, which are used in fuel cells and electric automobiles; **pitch activated carbon fibers**, which function as a catalyst in desulfurization and denitration; **fluorene**, which acts as a next-generation optical material; and **carbon nanotubes**, which can be used as hydrogen storage materials and electron emission materials.

Number of Patents Owned by the Osaka Gas Group (as of March 31, 2004): 1,280

Production, transportation and supply fields: 377

[Breakdown of Technology]

- LNG plant facilities (e.g. Invar alloy LNG piping)
- Method of pipeline construction (e.g. Non-excavation construction method)
- Pipeline maintenance (e.g. Underground facility inspection technology)



Commercial/industrial-use energy field: 228

[Breakdown of Technology]

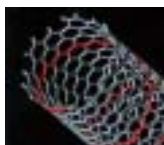
- Cogeneration
- Fuel cells
- Environmental Preservation Technologies (e.g. Wastewater processing technology)



Materials technology field: 163

[Breakdown of Technology]

- Lithium ion rechargeable battery materials
- Carbon fibers used as a catalyst in desulfurization and denitration
- Fluorene
- Carbon nanotubes



Residential energy field: 328

[Breakdown of Technology]

- Residential cogeneration systems
- Floor heating systems, bathroom heating and drying equipment



There are 184 more patents that are not classified in the aforementioned fields.

Use of Intellectual Property (Earnings Growth)

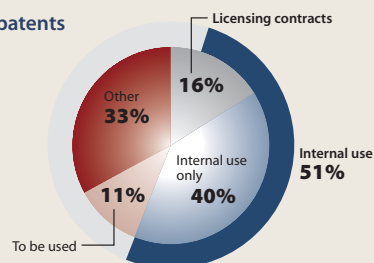
Aiming to aggressively use its intellectual property, Osaka Gas is effectively executing 51% of its owned patents. This far exceeds the average 30% ratio of active patent usage at companies in Japan.

For patents that can be used outside the Company, the Osaka Gas Group cashes in on licensing revenues through the following activities:

- Planning and implementation of licensing strategies that use external specialists
- Deployment of licenses overseas through Web-based patent distribution markets
- Further identification of patents that can be sold externally by inventorying owned patents

By the end of fiscal 2004, Osaka Gas has concluded licensing contracts for approximately 16% of its patent holdings, generating fiscal 2004's annual royalty revenues of about ¥240 million by licensing patents related to fuel cell technology to six companies LNG tanks to three companies and pipeline safety equipment to two companies, etc.

Use of owned patents



3. Intellectual Property Risk Management

Rules Regarding Acquisition of Intellectual Property

Osaka Gas is making efforts to strengthen risk management for intellectual property. In April 2002 the Company formulated Rules Regarding the Acquisition of Intellectual Property, which entails the following elements, to govern internal intellectual property activities:

- Internal organization work responsibilities, authority and operating rules
- Proactive measures and responses to disputes with third parties
- Handling of confidential information
- Ownership and recognition and compensation for corporate inventions and creations

Educational Activities

We provide the following educational and training opportunities for Osaka Gas Group employees in an effort to strengthen overall intellectual property activities and risk management.

- Intellectual property training for managers, new employees and mid-level technicians
- Training seminars about trademarks and copyrights
- Classes on patent portfolio management
- Lectures by intellectual property professionals outside the company