JACI Textbook | Learning from social practice cases that have received the GSC Awards

Green and
Sustainable
Chemistry

Introduction to GSC

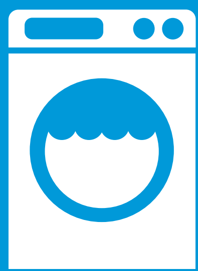
No.1 Revised Edition

Received the Minister of Economy, Trade and Industry Award of the 12th GSC Awards (2012)

New Laundry Proposal for Pioneering a Sustainable Society

Kao Corporation

Kao Corporation views laundry detergents from a Life Cycle Assessment (LCA) perspective in order to realize a sustainable society. Kao has made products compact and developed laundry detergents that dispense with just one rinse cycle instead of the conventional two cycles. Kao proposes "eco together," a new laundry style that reduces environmental impacts together with consumers through just one rinse cycle.



Outline of the GSC Awards and the award-winning company

The GSC Awards are bestowed upon individuals and organizations for their contribution toward the advancement of Green and Sustainable Chemistry (GSC), and several awards are conferred each year. Innovations that contribute toward the development of sustainable industrial technology are awarded the Minister of Economy, Trade and Industry Award; those that contribute toward the development and promotion of science are awarded the Minister of Education, Culture, Sports, Science and Technology Award; those that contribute toward the overall reduction of environmental impact are awarded the Minister of the Environment Award; while small and medium-sized businesses that contribute toward the development of industrial technology are awarded the Small Business Award (established in 2015; renamed to Venture Company Award, Small and Medium-sized Company Award in 2018 and Venture, Small and Medium sized Company Award in 2022). Additionally, innovations that exhibit high potential for future development are awarded the Incentive Award.

Kao Corporation is a chemical manufacturer founded in 1887 (Head Office: Chuo-ku, Tokyo). The company manufactures laundry detergents for household and industrial use, toiletries, cosmetics and foods, and the laundry detergents and toiletries account for the No. 1 share in Japan, and the cosmetics account for the No. 2 share in Japan (including subsidiary companies).

Objective of the textbook series

Global issues, in areas such as resources and energy, global warming, water and food have increasingly become major and complicated concerns. Innovations for achieving both environmental conservation and economic development are needed in order to resolve these issues and realize the sustainable development of society, and expectations for GSC continue to rise. In this textbook series, technologies and products that have received the GSC Awards given to great achievements contributing to the progress of GSC are explained, so that everyone can understand "what is GSC?" and take responsibility for realizing a sustainable society.

*Please refer to The Statement 2015 at the end of the textbook.

What is GSC?

Acronym for Green and Sustainable Chemistry

Definition of GSC

Chemical sciences and technologies which are benign to both human health and the environment, and support the development of a sustainable society

Guidelines of GSC activities

- The chemistry community has been addressing future-oriented research and education, and development towards environmentally-benign systems, processes and products for the sustainable development of society.

- Specifically, in response to the Rio Declaration at the Earth Summit in 1992, the chemistry community has been working in a unified manner linking academia, industry and government to start up Green and Sustainable Chemistry and engage in its activities, in order to advance the pursuance of coexistence with the global environment, the satisfaction of society's needs, and economic rationality. These goals should be pursued with consideration for the environment, safety and health across the life cycles of chemical products, their design, selection of raw materials, processing, use, recycling and final disposal.

- Long-term global issues, in areas such as resources and energy, global warming, water and food, and demographics have increasingly become major and complicated concerns in the present century. Therefore, expectations are growing for innovations, based on the chemical sciences, as driving forces to solve such issues and to achieve the sustainable development of society with enhanced quality of life and well-being.

- The chemistry community will live up to these expectations by strongly advancing Green and Sustainable Chemistry through global partnership and collaboration and by bridging the boundaries that separate industries, academia, governments, consumers and nations.

Examples of GSC

- The general classification is expressed in terms of a combination of the intended social contribution and the means to achieve this goal. With regard to the objectives, the efforts to achieve them have extended in stages from social challenges to difficult long-term challenges, beginning with manufacturing or utilization, and common/basic categories have also been established -

Minimization of resource consumption and maximization of the efficiency of reaction processes for production with reduced environmental impact

1. Chemical technologies and products that lead to reduction in by-product formation and avoid the use of hazardous substances

2. Separation, purification and recycling technologies that reduce the generation and emission of greenhouse gases like CO_2 or toxic/hazardous substances, thus lowering environmental impact

3. Chemical technologies and products that reduce the generation and emission to the environment of greenhouse gases like CO_2 or toxic/hazardous substances

4. Catalysts and reaction processes that realize the saving of energy and resource and improvement in product yields

Risk reduction of chemical substances beneficial to safe and secure living environment

5. Chemical technologies, products and systems that reduce waste generation

6. Chemical technologies, products and systems that inhibit the generation and emission of hazardous substances and pollutants

Challenges to solve energy, resource, food and water issues

7. Chemical technologies, products and systems to utilize low-grade heat sources, non-conventional resources, and other similar alternatives

8. Chemical technologies, products and systems whereby un-utilized energy and resources can be converted into available energy, transported and stored

9. Chemical technologies, products and systems which decrease the dependence on exhaustible resources such as fossil fuels and scarce minerals and promote the shift to renewable energy and resources, including their storage

10. Chemical technologies, products and systems that contribute to the Three R's: Reduce, Reuse and Recycle

11. Chemical technologies, products and systems that promote the efficiency of production and supply of food, and utilization of water resources

Pioneering challenges to long-term issues aiming to realize a safe, secure and sustainable society with enhanced quality of life

12. Chemical technologies, new products and new operational systems that contribute to the introduction of new social systems, for instance based on ICT, and aimed at solving social issues such as energy and resource consumption, food and water security, disaster prevention and infrastructure improvements, transportation and logistics, medical and health care, education and welfare, and other mega-trends of society

13. Chemical technologies, new products and new operational systems that contribute to the improvement of social and individual comfort whilst reducing and preferably inhibiting environmental impact

Systematization, dissemination, enlightenment and education of GSC including its metrics to be established

14. Systematization of GSC practices and concepts

15. Dissemination, enlightenment and education of GSC practices and concepts

16. Establishment and dissemination of GSC metrics

(Definition from JACI GSCN Council
https://www.jaci.or.jp/english/gscn/page_01.html)

New Laundry Proposal for Pioneering a Sustainable Society

Kao Corporation Inc.

The "The Proposal of New Washing Leading the Sustainable Future Society" of Kao Corporation, which received the Minister of Economy, Trade and Industry Award of the 12th GSC Awards (2012), is characterized by the introduction of Life Cycle Assessment (LCA) into the development of laundry detergents, and the proposal to reduce laundry-related environmental impacts together with consumers by using just one rinse cycle in laundry.

How was this innovation generated that simultaneously satisfies environmental friendliness, social contribution and economic rationality?

1 The Path to Technology Development

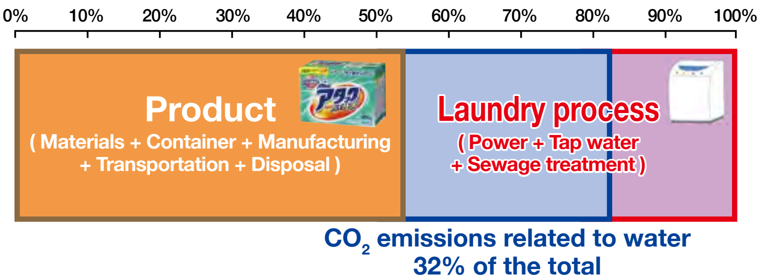
~ What were the intentions that started development toward realizing the sustainable progress of society?

When electric washing machines were popularized in the 1950's, synthetic laundry detergents became commonly used. Until then, clothing was washed by hand using solid soap, but the synthetic detergents capable of removing stains well and being easy to use, along with the electric washing machines, drastically reduced labor required for laundry, and quickly became widespread (Column①). However, from the 1960s to the 1970s, several detergent-based environmental issues were observed, such as the foaming of river/lake water due to detergent-containing wastewater and eutrophication (due to the phosphorus in detergents). To resolve these issues, biodegradable detergents, phosphorous-free detergents were developed.In the 1990's, global environmental problems were brought to public attention, and further environmentally-benign products were desired from a number of viewpoints such as resources and energy. Since then, each manufacturer not only contributes to a comfortable lifestyle or improvement in convenience, but also addresses manufacturing of products for realizing a sustainable society.

Kao Corporation has engaged in making products having low environmental impact from early on, such as starting the development of refill products ahead of other companies. In the late 1980's, the company developed compact powder detergents for clothing capable of carrying out laundry with a smaller amount of detergent, and in the 2000's, had a concept of making liquid detergents compact upon developing the next product. Making the products compact has economical advantages such as reductions in packaging materials and transportation energy, and also leads to a reduction in environmental impact. However, the company did not stop at making the products compact, but also discussed how to add environmental values to the products from a broad perspective.

Kao Corporation used LCA to assess and improve the environmental value of their products in the entire laundry system (from the laundry process to disposal) (Column②). LCA involves environmental-impact evaluation throughout the life cycle of a product, from raw-material procurement to product design/ manufacturing, transportation, use, and disposal. The findings indicated that the environmental impacts were almost the same between the part related to the product from manufacturing to disposal, and the part related to the use of detergents during laundry. Furthermore, 65% of the carbon dioxide emissions related to detergent use can be attributed to the water used during laundry (Fig. 1).

Japan is believed to be a country with a lot of rain and rich water resources, but the resources are limited. Japan has many slope lands and short rivers, which cause rain water to flow immediately out to sea, preventing much of the water from being utilized. Furthermore, a large



※ According to a Kao survey in June 2009.
Calculated using life cycle assessment (LCA) based on the ISO 14040 series.
Fully automatic top-loading washing machine (capacity 8 kg)
Clothing amount: 4 kg, Water volume setting: 47 L
Two-rinse cycle setting
(Water meter: 130 L, Wattmeter: 67 kW)

Fig. 1: Life-cycle CO_2 emissions of laundry detergents (from manufacturing to disposal)

amount of energy is required to transport water from water-purification plants to households and from households to sewage. A reduction in water usage for laundry can reduce the environmental impact of the laundry process. However, prior to the technology developed by Kao Corporation, no products were manufactured to reduce the amount of water used for laundry.

The company worked on the development of a product capable of reducing the amount of water used for rinsing. Merely reducing the amount of water used in one rinse cycle causes the washing machine to stop rotating. Therefore, the amount of water used for one rinse cycle was left unchanged, and the number of rinse cycles was reduced from two to just one.

Column 1

What is a detergent?

Around 3000 B.C., the oil and ash of a sheep burned as an offering to God were washed away by rain and accumulated in the river soil, accidentally resulting in the formation of soap. Soaps were first imported into Japan by Portuguese ships at the end of the 16th century. Initially only used by people of high status such as generals, soaps became available to the general public at the end of the 19th century. During World War I, synthetic detergents were developed from petroleum as substitutes for soap. The washing ability of soaps and detergents is attributed to surfactants. Soaps are derived from oils and fats from animals and plants and contain fatty-acid salts as the major component, whereas detergents contain surfactants other than fatty-acid salts as the major component.

Surfactant molecules contain a water-compatible hydrophilic part (hydrophilic group) and an oil-compatible lipophilic part (lipophilic group). The amphiphilic nature of surfactant molecules enables the mixing of water and oil. Surfactants exhibit penetration, emulsion, dispersal, and reattachment-prevention actions and are utilized in soaps, detergents, medicines, cosmetics, and foods.

For stain removal, the lipophilic groups of surfactant molecules gather around the oil stain (such as sebum) attached to cloth fibers, entering the space between the stain and fibers. Subsequently, the stain is separated from the fiber by an emulsion/dispersal action. The surfactant encloses the stain to form a micellar structure dispersed in water, which is washed away by rinsing with water (Figure).

(Reference: "Soap and detergent in daily life" (Kurashi no naka no Sekken/Senzai in Japanese) edited by Japan Soap and Detergent Association, etc.)

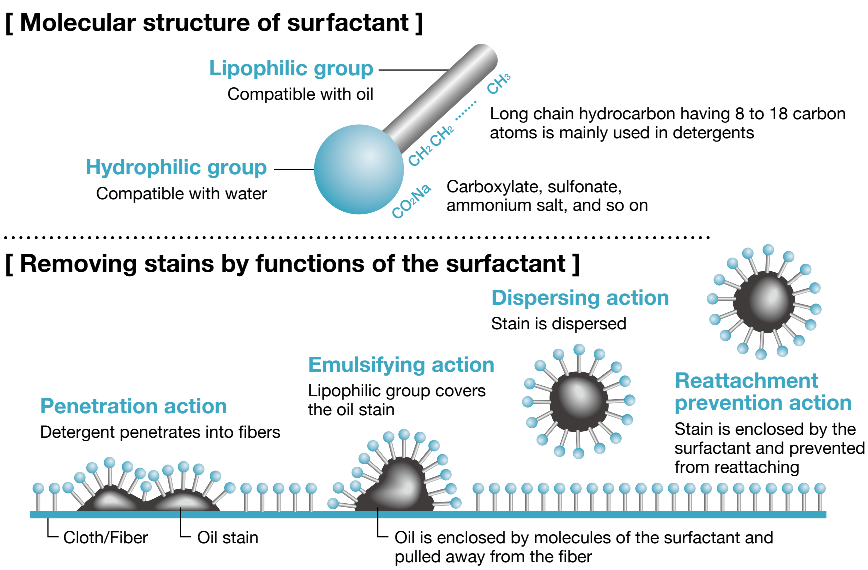


Figure: Structure of surfactant and mechanism for removing stain

(Reference: Japan Soap and Detergent Association) http://jsda.org/w/03_shiki/senzaimemo_01.html

2 Toward Resolution of Issues

~ What types of technological challenges did the developers face and how did they resolve them?

In order to make liquid detergents compact, the liquid detergent needs to be concentrated. To reduce the rinse cycle to just one time, a technology is required for quickly washing out the detergent remaining in the clothing, without decreasing detergency. Accordingly, the development team took on the challenge of developing a technology for simultaneously achieving ultra-concentration and high rinsing property while retaining detergency.

First, ultra-concentration can be achieved by reducing the water content that occupies more than half of the liquid detergent. However, a water-content reduction solidifies the detergent, making its dissolution in water challenging (Keyword①: Phase diagram). This presents an antinomic technical challenge.

Surfactants comprise molecules with hydrophilic (compatible with water) and lipophilic (incompatible with water) groups. Reducing the water content of a liquid detergent causes the surfactant molecules in the detergent to stack up (facing the same direction), forming a layer structure (left-hand-side image in Fig. 2). This reduces the contact area of the hydrophilic groups with water, making the dissolution of the surfactant in water challenging.

Then, the development team searched for

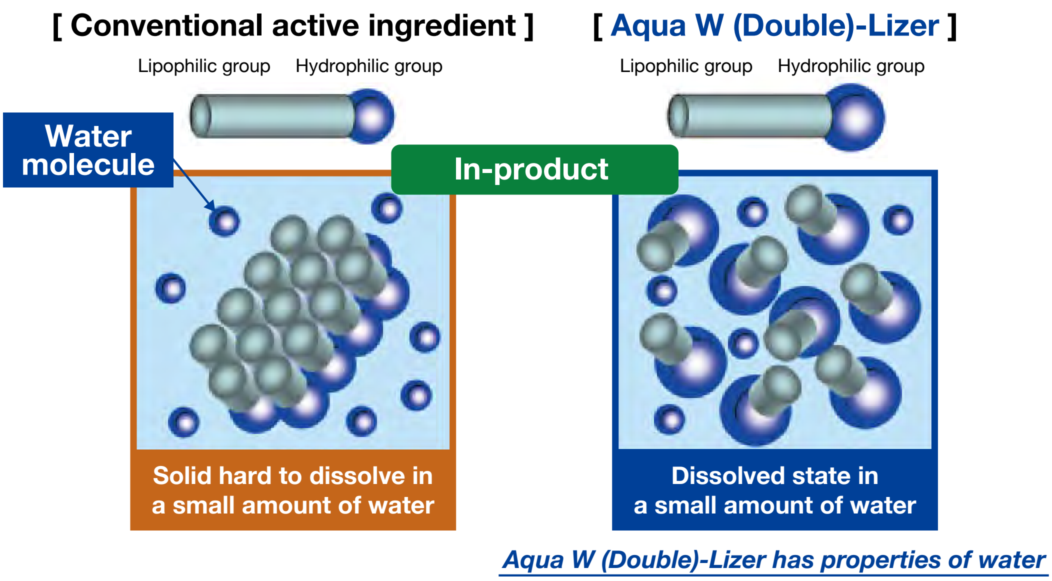


Fig. 2: New active ingredient "Aqua W (Double)-Lizer"

Keyword ❶ : Phase diagram

A phase diagram shows the state (phase) of a substance under the different temperatures, pressures, and concentrations of the system within which the substance exists. When the concentration or the temperature of the surfactant is changed, the micelle shows variable phase behaviors.

Keyword ❷ : Self-organization

A phase diagram shows the state (phase) of a substance under the different temperatures, pressures, and concentrations of the system within which the substance exists. When the concentration or the temperature of the surfactant is changed, the micelle shows variable phase behaviors.

※Knowledge of thermodynamics is required to understand these phenomena in detail.
Please refer to the literature on page 8.

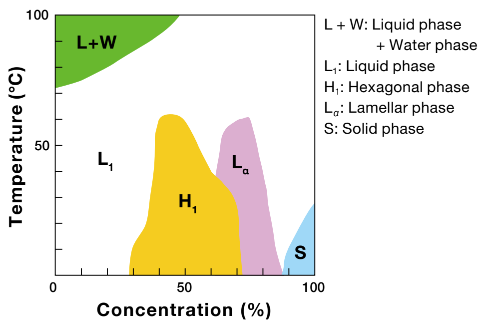


Figure: Phase diagram of surfactant - water system a surfactant that does not solidify even in a concentrated state by examining various surfactants, referring to the principle shown in the phase diagram which indicates properties of the surfactant and so on, and finally found a suitable surfactant. Little attention had been paid to this surfactant in terms of detergents for clothing, but it was found that the surfactant would satisfy the targeted properties after modifications were made. The development team enlarged the part of the hydrophilic group within the molecules to prevent the surfactant from forming the layer structure, allowing the surfactant to be mixed with water more easily, and slightly changed the shape of the hydrophilic group to prevent the molecules from aggregating (Right image in Fig. 2). The thus formed surfactant having high hydrophilicity was used as a base in combination with a conventional surfactant, enabling a state of being dissolved in water to be maintained even in a small amount of water, and the liquid detergent that had previously been 1 kg was successfully concentrated down to 400 g.

A surfactant having high hydrophilicity that hardly remains in the fibers of clothing is suitable for increasing rinsing power. On the other hand, a surfactant having high lipophilic properties compatible with clothing stains such as sebum is more suitable for improving detergency. This presents an second antinomic technical challenge. To resolve this issue, the surfactant having high hydrophilicity was combined with the conventional surfactant having a good stain-removing effect to exhibit larger effectiveness.

When these two types of surfactants are combined, mobility of the surfactant molecules is increased, and the molecules quickly move towards the stain in the cloth. When the molecules surround the stain and form a spherical micelle (Keyword② : Self-organization), the micelle became immediately separated from the cloth due to its high hydrophilicity. The developed surfactant shows excellent rinsing properties and high detergency, comparable to conventional detergents (as confirmed by a verification test).

Thus, a brand-new type of detergent was born.

Column 2

What is LCA?

Life cycle assessment (LCA) is a technique for evaluating the environmental impact of a product throughout its life cycle (from raw-material procurement to product design/manufacturing, transportation, utilization, and disposal). Although anti-pollution measures had been taken against the manufacturing process of the product until now, the ongoing focus on global environmental problems raised the issue of understanding how each stage of the life cycle of the product affects the ecosystem and taking countermeasures, leading to the development of LCA. Currently, LCA is approved for international standardization by the International Organization for Standardization (ISO) and is widely recognized in international society. Many companies are operated by taking the environment into consideration based on LCA, from a viewpoint of sustainability, and Kao Corporation is one of such companies (Figure).

(Reference: Japan Environmental Management Association for Industry https://www.jemai.or.jp/ , etc.)

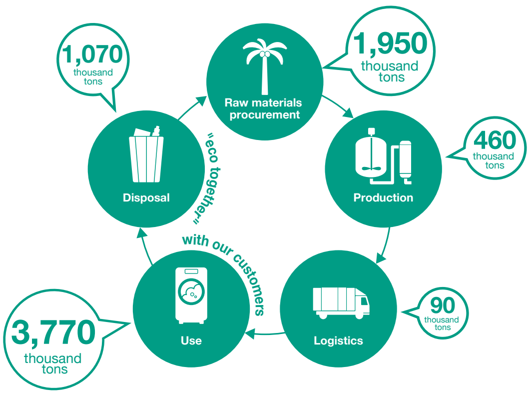


Figure: CO_2 emissions throughout the life cycle of Kao products

(Values calculated by Kao from January to December 2014 in Japan (excluding the use and disposal of products for industrial use))

3 Contribution to Society

~ What is the contribution of this novel technology to society?

The Kao product was released as "Attack Neo" in 2009. The company succeeded in concentrating liquid detergents for the first time in the world, and making the product compact resulted in the reduction of transportation cost and packaging containers for liquid detergents. Since the detergents exhibit high detergency with a small amount, the amount of use of the detergents is reduced, which enables the influence of waste water on the environment to be reduced as well.

Furthermore, the unique proposal of "just one rinse cycle" surprised consumers. As two-rinse cycles are common in Japan, washing machines are generally designed on this premise. Therefore, a team from Kao Corporation examined washing machines from different manufacturers and proposed a method to operate one-rinse cycles.

At first, the one-rinse operation bewildered many consumers. However, this concept has been completely accepted with time, and new washing machines contain a button for one-rinse cycling. The utilization of one-rinse cycles has reduced laundry time considerably, increasing the spare time available to individuals and organizations.

This technology has also changed the impact on the environment. When the number of rinse cycles is reduced from two to one, both the amount of water and electricity used by a standard household using a top-loading-type washing machine are reduced by 22%. An LCA at this stage indicates 21% and 22% reductions in CO_2 emissions at the product and household levels, respectively, with a total CO_2-emission reduction of 21% (Fig. 3).

Thus, this technology that received the GSC Award introduced a new concept in which the environmental impacts are reduced not by the products alone but by working together with the consumers. It gave us consumers an opportunity to think about water and the environment and to take action.

Kao Corporation is refining this technology further to improve the detergency, reduce the laundry time, and use recyclable raw materials. The technology is becoming more and more advanced for realizing a sustainable society.

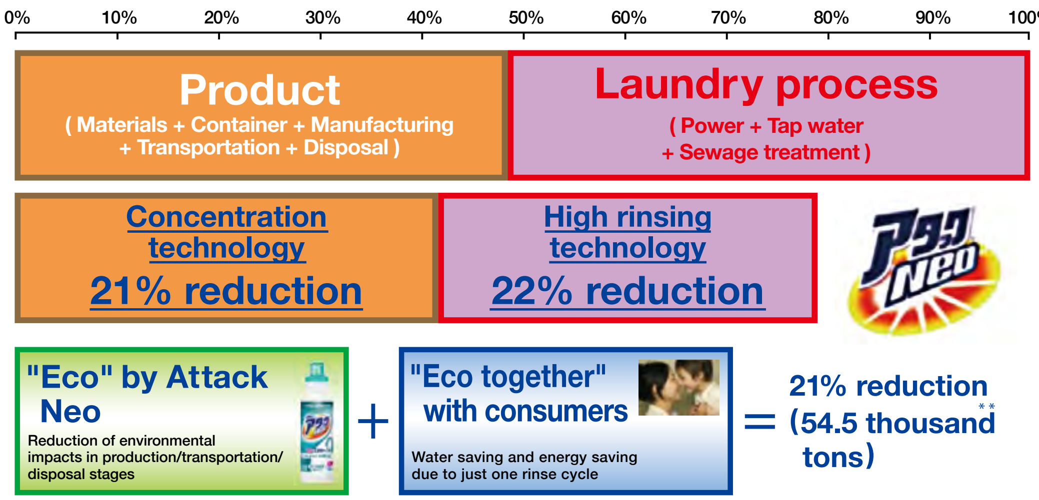


Fig. 3: Reduction effect on environmental impacts by Attack Neo (LCA perspective)

※ According to Kao survey in June 2009
Fully automatic top loading washing machine
(capacity 8 kg)
Clothing amount:4 kg, Water volume setting: 47 L
Two rinse cycle setting
(Water meter 130 L, Wattmeter 67 kW)
One rinse cycle setting
(Water meter 102 L, Wattmeter 52 kW)
**
According to Kao survey in 2011 of "Neo" series Comparison with using conventional type detergent (Attack Bio Gel)
Approximate values based on sales in 2011

Column 3

In more detail : Technology that solves problems

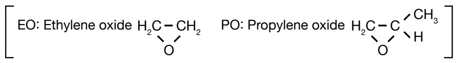
Surfactants can be classified as ionic surfactants (which form ions on water dissolution) and nonionic surfactants (which do not form ions on water dissolution). The ionic surfactant includes an anionic surfactant in which a hydrophilic group is formed into an anion after ionization when dissolved in water, a cationic surfactant in which the hydrophilic group is formed into a cation, and an amphoteric surfactant in which the hydrophilic group is formed into both. There are many types of surfactants, which are accordingly used to match the purpose and application. The anionic surfactant is used for laundry detergents in most cases.

The surfactant forms a micelle having a shape in accordance with the concentration of the surfactant in a solution. The shapes of the micelle include a spherical micelle, a rod-like micelle, a lamellar micelle and so on, and the shape taken by the micelle depends on conditions such as the structure, solvent, PH value and temperature of the surfactant (refer to Keyword).

When the water content was reduced to concentrate the liquid detergent, the surfactant conventionally used was not able to disperse and aggregated to form the lamellar micelle that was difficult to dissolve. To resolve this issue, the newly developed nonionic (nonion) surfactants were combined with anionic surfactants. In this nonionic (nonion) surfactant, the hydrophilicity/hydrophobicity balance was controlled by adding ethylene oxide (EO) serving as a hydrophilic group to a higher alcohol having a hydrophobic alkyl group (RO-), and the size of the hydrophilic group was controlled by further adding propylene oxide (PO) having a methyl group thereto. Thus, low viscosity was maintained without the lamellar micelle being formed even in a high concentration, and a stable spherical micelle was formed when diluted in the washing process to suppress reattachment to the fibers, thereby achieving just one rinse cycle. Accordingly, ultra-concentration, high washing property and high rinsing property were achieved.

$$\mathrm{R{-}OH} + \left[\begin{matrix}\mathrm{EO}\\ \mathrm{PO}\end{matrix}\right] \longrightarrow \mathrm{R{-}O{-}(EO)_m/(PO)_nH}$$

Higher alcohol — Newly developed nonionic surfactant



Questions

For deeper understanding

Through this case study, discuss the following questions from the viewpoint of GSC (Green and Sustainable Chemistry).

Q1 Discuss which of the GSC cases best applies to the technologies and products of this teaching material, along with the reasons.

Q2 Surfactants can be classified into several categories. Discuss the different types of surfactants highlighting their unique features.

Q3 Define a micelle and the critical micelle concentration.

Q4 Discuss some other measures that have been taken to reduce the environmental impact of surfactants. And state your opinions regarding these initiatives based on the definition of GSC.

Introduction of literature

Helpful materials

1) "Basis of modern surface and colloid chemistry, third edition" (Dai 3 pan, Gendai kaimen colloid kagaku no kiso in Japanese) edited by The Chemical Society of Japan (Maruzen Publishing Co., Ltd.)
2) "Organic functional materials" (Yuki kino zairyo in Japanese) by Mitsuru Akashi, Koji Araki, Atsushi Takahara (Tokyo Kagaku Dojin Co., Ltd.)
3) "Basis of surface and colloid chemistry" (Kaimen colloid kagaku no kiso in Japanese) by Ayao Kitahara (Kodansha Ltd.)
4) Surface chemistry" (Kaimen Kagaku in Japanese) by Masatoshi Chikazawa and Kazuo Tajima (Maruzen Publishing Co., Ltd.)
5) "Chemistry and application of surface activity" (Kaimen kassei no kagaku to oyo in Japanese) by Manabu Seno, Kaoru Tsujii (Dainippon tosho Co., Ltd.)

"The Statement 2015" declaring global partnership towards implementing GSC was adopted at the 7th International GSC Conference (GSC-7) held in 2015, 12 years after the previous Conference in Tokyo.

(See JACI Website: http://www.jaci.or.jp /images/The_statemant_2015_final_20151118.pdf)

The Statement 2015

We, the participants of the 7th International GSC Conference Tokyo（GSC-7）and 4th JACI/ GSC Symposium make the following declaration to promote “Green and Sustainable Chemistry（GSC）” as a key initiative in the ongoing efforts to achieve global sustainable development.

The global chemistry community has been addressing future-oriented research, innovation, education, and development towards environmentally-benign systems, processes, and products for the sustainable development of society.

In response to the Rio Declaration at the Earth Summit in 1992 and subsequent global Declarations, the global chemistry community has been working on challenges in a unified manner linking academia, industry, and government with a common focus to advance the adoption and uptake of Green and Sustainable Chemistry. The outcomes include the pursuance of co-existence with the global environment, the satisfaction of society’s needs, and economic rationality. These goals should be pursued with consideration for improved quality, performance, and job creation as well as health, safety, the environment across the life cycles of chemical products, their design, selection of raw materials, processing, use, recycling, and final disposal towards a Circular Economy.

Long-term global issues, in areas such as food and water security of supply, energy generation and consumption, resource efficiency, emerging markets, and technological advances and responsible industrial practices have increasingly become major and complicated societal concerns requiring serious attention and innovative solutions within a tight timeline. Therefore, expectations are growing for innovations, based on the chemical sciences and technologies, as driving forces to solve such issues and to achieve the sustainable development of society with enhanced quality of life and well-being.

These significant global issues will best be addressed through promotion of the interdisciplinary understanding of Green and Sustainable Chemistry throughout the discussion of “ Toward New Developments in GSC. ”

The global chemistry community will advance Green and Sustainable Chemistry through global partnership and collaboration and by bridging the boundaries that traditionally separate disciplines, academia, industries, consumers, governments, and nations.

July 8, 2015
Kyohei Takahashi
on behalf of Organizing Committee
Milton Hearn AM, David Constable,
Sir Martyn Poliakoff, Masahiko Matsukata
on behalf of International Advisory Board
of 7th International GSC Conference Tokyo (GSC-7),
Japan July 5-8, 2015

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GSC : Green and Sustainable Chemistry

Chemical sciences and technologies
which are benign to both human health and the environment,
and support the development of a sustainable society.

Introduction to GSC

Learning from social practice cases that received the GSC Awards

Global issues, in areas such as resources and energy, global warming, water and food have increasingly become major and complicated concerns. Innovations for achieving both environmental conservation and economic development are needed in order to resolve these issues and realize the sustainable development of society, and expectations for GSC continue to rise. In this textbook series, technologies and products that have received the GSC Awards given to great achievements contributing to the progress of GSC are explained, so that everyone can understand “what is GSC?” and take responsibility for realizing a sustainable society.

Special Edition

“Introduction to SDGs” Sustainable Development Goals GSC plays a driving role in SDGs

Let's change the world towards a sustainable future!

The SDGs are global goals adopted by the United Nations, and it is essential to harmonize the three elements of economy, society, and the environment in order to achieve sustainable development. This way of thinking is shared with the GSC, which aims to achieve both environmental conservation and economic development for the sustainable development of society. As a special issue, this text aims to explain the SDGs from the perspective of the GSC and encourage everyone to think about and put them into practice.

No.1

New laundry proposal for pioneering a sustainable society

Kao Corporation

The "new laundry proposal for pioneering a sustainable society" of Kao Corporation, which received the Minister of Economy, Trade and Industry Award of the 12th GSC Awards (2012), is characterized by the introduction of Life Cycle Assessment (LCA) into the development of laundry detergents, and the proposal to reduce laundry-related environmental impacts together with consumers by using just one rinse cycle in laundry. How was this innovation generated that simultaneously satisfies environmental friendliness, social contribution and economic rationality?

No.2

Novel Non-phosgene Polycarbonate Production Process Using By-product CO_2 as Starting Material

Asahi Kasei Corporation

The great success of this technology is that unlike the conventional polycarbonate production process, it does not use toxic phosgene as a starting material. At the same time, the technology was revolutionary because it achieved saving of both resources and energy. More than 10 years have passed, and the technology has been widely commercialized all over the world. This worldwide use was highly regarded, and the process became the first technology by a Japanese company to receive the Heroes of Chemistry Award from the American Chemical Society in 2014. What kind of technology is involved in this world-renowned polycarbonate production process?

No.3

Development of Carbon Fiber Composite Materials for Lightweight Commercial Airplanes

Toray Industries, Inc.

TORAY's carbon fiber reinforced plastic developed through over 40 years of research and development has features of high toughness (material tenacity) in combination with light weight and flexibility. The high toughness carbon fiber reinforced plastic (high toughness CFRP) realizes weight reduction of airplanes which is effective in improving fuel consumption, and makes a substantial contribution to reducing environmental impact.

No.4

Development and Commercialization of High Performance Transparent Plastics Derived from Plant-Based Raw Material

Mitsubishi Chemical Corporation

"DURABIOTM", the transparent engineering plastic made from renewable resources developed by the company, not only contributes to the reduction of environmental impact, but also realizes performance exceeding that of conventional engineering plastics in terms of optical characteristics, weathering resistance, etc.

No.5

Development of High-Performance Reverse Osmosis Membrane Contribution to the solution of global water issues

Toray Industries, Inc.

This reverse osmosis membrane can be used in not only seawater but also river water, sewage wastewater, and various other water treatment systems, providing high quality water while saving energy.

No.6

Development of Low Environmental Load Battery for Idling-Stop System Vehicle with High Charge Acceptance and High Durability

Hitachi Chemical Co., Ltd.
(Currently Energywith Co., Ltd.)
Hitachi, Ltd.

Idling-stop systems heavily burden on the battery, causing existing batteries to rapidly degrade, with short battery lifetimes. This technology resolves this problem and contributes to the reduction in CO_2 emissions.

No.7

Development of Water-based Inkjet Ink for Food Package

Kao Corporation

Kao Corporation developed a “water-based inkjet ink” for printing on the plastic films used for packaging daily commodities and food.
The ink maintains a high image quality and has lower volatile organic compound emissions, thereby reducing its environmental impact.

No.8

Development and Commercialization of a New Manufacturing Process for Propylene Oxide Utilizing Cumene Recycling

Sumitomo Chemical Co., Ltd.

Sumitomo Chemical Co., Ltd. developed a new manufacturing process for propylene oxide, which is used as a raw material for polyurethane and other materials.
The new process enables high yields of propylene oxide while reducing its environmental impact.

You can read them in “PDF” and “HTML” that is easy to read on mobile phones.

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