Toward a Recycling-oriented Society

Feature Story

New S-TEN1
Innovative Hydrochloric Acid-resistant Steel: Meeting the Challenge of Corrosion Head-on

In this issue

Toward a Recycling-oriented Society
Nippon Steel Environmental Report 2002
More Clearly Worded with a Greater Abundance of Useful Information

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**Feature Story**

**New S-TEN1**
Innovative Hydrochloric Acid-resistant Steel: Meeting the Challenge of Corrosion Head-on

The service environments where steel materials are used vary widely, ranging from mild to extremely corrosive. As a result, corrosion resistance is a key property especially in harsh environments. Moreover, recent years have seen increasing demand for longer service life, an emphasis on the “three Rs” (reduce, reuse and recycle), the need for reductions in environmentally harmful substances and other steps that lower maintenance costs and are conducive to creating a recycling-oriented society.

Nippon Steel develops and supplies new and diverse kinds of corrosion-resistant steels and coated steel sheets to help meet such needs. This article discusses Nippon Steel’s commitment to the development of such materials and technologies and introduces New S-TEN1, a recent innovation in highly corrosion-resistant steel.

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**Application/Market Needs and Recent Technological Progresses**

- **Social/industrial infrastructure**
  - Bridges, offshore structures
  - Plants, energy facilities
  - Buildings (structural, exterior and interior members)
- **Durable consumer goods**
- **Daily commodities**
- **Durable years**
  - 100 years~
  - 50/60 years~
  - 20/30 years~
  - 10/15 years~
  - Several years~
- **Market needs/Technological progresses**
  - Highly corrosion-resistant Super Dyma (Zn-11%Al-3%Mg-Si coated steel sheets)
  - Stainless steel with highly-durable clear coating
  - DYMAGAIN (highly corrosion resistant Zn coated steel sheets for oil storage tanks)
  - WELACC5 (highly corrosion resistant stainless steel plates for LNG facilities and smoke stacks)
  - New S-TEN1
  - S-TEN1 pipe/tubes
  - YUS270 (highly corrosion resistant stainless steel for industrial equipment and machinery)
  - Titanium cladding Coating
  - Highly corrosion-resistant stainless steel coated pipe/tubes
  - Coastal weathering steel for bridges*
  - Titanium for roofing
  - Lead-free coating for automobile fuel tanks (Al coating, Sn-Zn coating, hot-dip galvanizing + Ni coating)
  - Laminated steel sheets
  - Chromate-free coating for home appliances (electrogalvanizing, hot-dip galvanizing)
  - Rust resistance/Surface treatment
  - Corrosion resistance/Corrosion-resistant steel products

*Steel having weathering resistance in the environment of higher concentration of salt than the conventional level
A Growing Selection of Available Materials Combats Corrosion

After a lapse of thirty or so years since the high economic growth of the postwar period, demand is now intensifying in Japan for more effective maintenance and longer life of the nation’s infrastructure. There is also strong demand for reductions in and prohibitions against such environmentally harmful substances as lead and hexavalent chromium. This, in turn, requires that steel materials offer higher corrosion resistance and better adaptability to application environments in a diversity of fields, while performing well under harsher environmental conditions.

Generally speaking, the common practice is to use metallic coatings on consumer goods where rust prevention is the most important concern. Meanwhile, for social and industrial infrastructure where durability is paramount, corrosion-resistant steel is the primary material of choice for ensuring longer maintenance cycles and extended service life.

The properties required for corrosion resistance are not always uniform but vary subtly depending on the service environment. Nevertheless, Nippon Steel’s active cooperation with customers to combat corrosion has produced a growing selection of materials to meet the corrosion resistance requirements found in virtually every field. The company’s efforts in this area are now focused on creating social conditions that will decrease the burdens to be faced by the next generation.
Feature Story

New S-TEN1 Offers a Much Improved Level of Corrosion Resistance

Among Nippon Steel’s superb corrosion-resistant steels is S-TEN1, a low-alloy steel developed in 1965. Essentially destined for use in flue gas-treatment devices at heavy oil-fired thermal power stations, S-TEN1 experienced extensive use, especially as the number of power plants under construction grew during the postwar period of high economic expansion. It is unique among specialty steels in that, notwithstanding its superb corrosion resistance which compares favorably to that of stainless steel, it also excels in workability, weldability and economy of use. The availability of several types of S-TEN makes it possible to choose the best product for the prevailing service conditions. S-TEN1 gained rapid acceptance, became deeply rooted in the market, and at the height of its popularity was always selected from among many competing materials when projects were being designed. As a result, S-TEN1 has remained a best selling product for over thirty years.

However, following a radical change in “post-bubble” national energy policy, a growing diversity of energy resources has substantially altered the operating conditions of energy-related equipment. In the case of flue gas-treating devices for conventional heavy oil-fired power stations, corrosion was due to the condensation of sulfuric acid contained in flue gas. But, in the case of power obtained from LNG, moisture is the cause of corrosion. At waste incineration plants, regulations governing dioxin emissions call for the rapid cooling of exhaust gases to temperatures between 130 and 150°C (compared with the conventional temperature of 180°C). This causes the generation of hydrochloric acid from plastics and food waste and has created a new corrosive environment for the steel materials used in these plants.

Nippon Steel’s efforts to find a solution for these emerging corrosive environments have led to the recent development and marketing of New S-TEN1. This new version offers over three times more corrosion resistance than conventional S-TEN1 in the hydrochloric acid dew-point corrosive environments found in waste disposal plants that, in order to meet restrictions on dioxin and other harmful emissions, now operate at reduced exhaust gas temperatures.
New S-TEN1 has entered commercial production with improved resistance to hydrochloric acid dew-point corrosion in addition to providing the properties conventionally associated with S-TEN1. Like its predecessor, New S-TEN1 is offered in three forms: plate, sheet and pipe.

In the form of pipe, New S-TEN1 is used to protect against sulfuric acid dew-point corrosion mainly in heat exchangers such as the air preheaters of heavy oil-fired boilers and the recuperators of coke gas-fired furnaces. Recently, it has become increasingly common to conduct boiler waste heat recovery at near normal temperatures, thereby making it imperative that even the pressure sections of economizers etc. be protected against sulfuric acid and hydrochloric acid dew-point corrosion. Two years ago, the specifications for S-TEN1 pipe were standardized to match the technological criteria for thermal power to facilitate its application in pressure sections. S-TEN1 pipe has since found increasing use in this area.

The share of S-TEN1 pipe in the total amount of steel tubular products used is still small, to be sure, but Nippon Steel has positioned it as a strategic product that promises to advance into niche markets. The company’s pipe, plate and sheet and R&D divisions joined forces in the development and commercialization of New S-TEN1 pipe with the aim of securing the durability of the whole equipment in which it is applied.

There is also S-TEN1-EX which is available for use as fin material for extra-small-diameter tubing wound with fins. Because tube-type heat exchangers are now used worldwide in almost all exhaust gas treating equipment at power and waste incineration plants, aggressive sales campaigns that promote the use of S-TEN1-EX in such plants are currently under way in Japan and abroad.
Feature Story

Waste Incineration Plants Are the Focus of Sales Promotions

Expectations are on the rise for New S-TEN1. This new product shows greatly improved performance over S-TEN1, which for more than thirty years has been marketed for use in the disposal equipment of power and waste incineration plants. S-TEN1 has traditionally met the needs of projects ranging widely in scale, from small to large. It has been used in sheets cut to make small repairs and in the fabrication of large units of equipment. It is unparalleled in the world of specialty steels in terms of its market diversity.

Overseas Attention Focusing on New S-TEN1

S-TEN1 is now gaining attention abroad, especially in East Asia. Since Japan currently stands at the Asian forefront in environmental technology, Korea, Taiwan, China and other East Asian countries are closely watching Japanese developments in this area. In keeping with the growing demand for adequate environmental measures, these countries, like Japan, will soon have to cope with the problem of hydrochloric acid dew-point corrosion, in addition to sulfuric acid dew-point corrosion. When this happens, New S-TEN1 will come into the picture.

New S-TEN1 promises to open new market opportunities while capitalizing on the renowned quality and brand strength of S-TEN1.

Henceforth, efforts will focus on stepping up the promotion of New S-TEN1 for use in waste incineration plants where the potential for growth is great. To this end, Nippon Steel intends to further strengthen intra-company and inter-group-company collaboration and to offer optimum solutions that make the most of New S-TEN1’s excellent resistance to hydrochloric acid dew-point corrosion.

New S-TEN1 came about by consolidating Nippon Steel’s comprehensive capabilities. Through horizontal collaboration that includes partnerships with group companies, Nippon Steel can provide customers with an unrivaled level of superior solutions. Henceforth, Nippon Steel is committed to furthering progress in corrosion protection technology and to responding positively to the diverse needs of society by carefully considering environmental conservation issues and making the most of steel’s recyclability.
Toward a Recycling-oriented Society

Nippon Steel Environmental Report 2002
More Clearly Worded with a Greater Abundance of Useful Information

The newly issued “Nippon Steel Environmental Report 2002” is the fifth such publication produced by Nippon Steel. In addition to retaining the basic framework of the 2001 edition for purposes of continuity, this edition offers far more substantive content with new articles supported by up-to-date charts and photos. Also, in response to outside opinion and legislative action taken during the last year, greater disclosure of information is supplemented by an editorial emphasis on plain and unambiguous reporting.

Major revisions found in the new edition are as follows:

• Stepped-up disclosure of environmental accounting information
• Stepped-up disclosure of information reflecting legislative changes to environmental laws
• Disclosures expanded to include information regarding activities of Nippon Steel’s subsidiary and affiliate companies that reflects the adoption of consolidated financial statements
• More substantive articles on Nippon Steel’s commitment to environmental solutions through engineering
• More substantive articles on environmental communications
• Incorporation of outside opinions expressed by entities such as the Global Environmental Forum, an environmental NGO

The major topics discussed in Nippon Steel Environmental Report 2002 are introduced below.

Topic 1: Results of Trial Calculations of Nippon Steel’s CO₂ Emissions Revealed

Pursuant to the steel industry’s “Voluntary Action Programs for Environmental Protection by Steelmakers” —targeting a 10% reduction in its energy consumption from the 1990 level by 2010, Nippon Steel has worked out and has been implementing a long-term energy-saving plan. The plan sets the target for the reduction of unit energy consumption per ton of crude steel produced at 4.4% below the 1995 level by 2010. This endeavor has produced steady results, with a 0.8% reduction already achieved in fiscal 2001 or a 1.1% reduction, when the effects of coke-oven conversion of waste plastics to usable resources are taken into account.

In this relation, the 2002 edition revealed the results of trial calculations of carbon dioxide emissions, amounting to about 56 million tons in fiscal 2001.
Toward a Recycling-oriented Society

**Topic 2: Effects of Environmental Conservation Efforts Revealed in Trial Calculations**

The effects of environmental conservation efforts are divided into those that can only be presented as specific amount of materials or specific development examples and those that can be converted to monetary values. The 2002 edition states that the effects of Nippon Steel’s environmental conservation efforts are worth ¥1,300 million based on trial calculations that take into account the sales of waste materials recycled as reusable resources—zinc dust, scale etc.— and the resultant savings in final disposal costs.

**Topic 3: Scope of Disclosed Information Expanded to Include Actions of Subsidiaries and Affiliates**

Reflecting the shift to consolidated financial statements, the 2002 edition expands its coverage of topics such as product contributions to both the environment and environmental management. It now includes the activities of Nippon Steel’s subsidiary and affiliate companies.

**Eco-products:** Introduction of the NOMST method marketed by Nippon Steel Composite Co., Ltd. and a roofing system for photovoltaic power generation that is offered by Sanko Metal Industries Co., Ltd.

**Environmental management:** Coverage includes an environmental meeting organized by Nippon Steel’s subsidiary and affiliate companies along with attainment by some of ISO14001 certification.

**Topic 4: Greater Elaboration of Commitment to Environmental Solutions through Engineering**

Nippon Steel's extensive use of engineering to achieve solutions in environmental and energy areas as well as other diverse fields of business is introduced in detail. The 2002 edition highlights the marketing of GTL (gas to liquid) technology, which is now gaining attention for its clean energy producing characteristics, and the eco-friendly steel-frame structure of the Waseda Jitsugyo School. This school was designed and built using unique environmentally sound mechanisms, including a natural lighting and ventilation system, heating and cooling equipment that rely on well water, and a solar power generation facility.
Toward a Recycling-oriented Society

The 2002 edition also features, in addition to the examples cited, more substantive information about Nippon Steel’s basic environmental policies and its medium-term environmental management programs and goals. This is done by clarifying the scope of the report’s coverage, program target dates and other crucial matters. It also provides a full and detailed account of Nippon Steel’s communications with local communities regarding environmental issues.

The circulation of the 2002 edition will total 10,000 issues to be delivered to government agencies, educational institutes, customers, mass media and other interested entities. It will also be available on the Nippon Steel website. The English version will appear on the website by the middle of November, 2002.

Henceforth, the Nippon Steel Environment Report will be published annually and will continue to give full consideration to social and environmental needs and to legislative activity. It will pursue more comprehensive disclosure of data and will diffuse in every quarter a clear understanding of Nippon Steel’s commitment to improve its impact on the environment.