East Japan Works, JFE Steel†

Abstract:

JFE Steel's East Japan Works was founded on April 1, 2003 by consolidating the operations of Kawasaki Steel's Chiba Works and NKK's Keihin Works. This paper presents an outline of JFE Steel's East Japan Works and describes features of Chiba and Keihin Districts.

1. Introduction

JFE Steel's East Japan Works was founded on April 1, 2003 by consolidating the operations of Kawasaki Steel's Chiba Works located on the east side of Tokyo Bay and NKK's Keihin Works on the west side. The total crude steel production of the two districts is 8 million tons per year, making East Japan Works the fourth largest integrated steelworks in Japan. Consolidation of the operations of the two districts will improve product quality and delivery, while further strengthening the technological development capabilities. Both districts are located close to a large metropolitan zone, and so they are developing new business operations such as waste recycling. This paper outlines East Japan Works and describes features of its two districts.

2. Management Policy

The management policy of East Japan Works is to create a "robust steelworks full of dreams." Its essential tasks are to achieve the profitability target in JFE Steel's mid-term business plan (more than 10% in terms of ROS) and to markedly increase the ratio of high-value-added products within the total production. In particular, it is intended to increase the production ratio of "Only-one, No. 1" products from the current level of about 7% to more than 15% by the end of fiscal 2005. East Japan Works develops and delivers products which take into account the customers' needs through modern facilities, production using its good location in the Tokyo metropolitan area and technology development.

3. Brief History

3.1 Chiba District

Chiba District was the first integrated steel works constructed in Japan after World War II. The facility started operations in 1951, and with the commissioning of the first cold rolling mill in 1958, the integrated production system from ironmaking to final products was completed. Production increased steadily afterwards, and the annual crude steel production reached 6 million tons in 1969. However, production declined when the high economic growth period of Japan came to an end.

In 1977, the No.3 steelmaking shop came onstream. This was Japan's first basic oxygen, bottom blowing converter and, as such, gathered great attention around the world. In 1994, a large-scale, equipment renewal project was launched, and various modern equipment was installed, as represented by the world's first stainless steel smelting reduction system and the endless hot rolling mill. Thus, Chiba District was reborn as a modern steelworks with world-leading productivity and equipment. Currently, Chiba District operates two blast furnaces and mainly produces high-value-added steel sheet products from an annual level of 4.5 million tons of crude steel.

3.2 Keihin District

Keihin District is NKK's place of origin, where its corporate history as an iron and steel producer started back in 1912. The production of seamless steel pipes began in 1914. After World War II, two basic oxygen, top-blowing converters became operational in 1958, and the annual crude steel production reached 5.5 million tons in 1969. Thereafter, production at Keihin Works decreased as Fukuyama Works increased its production. In 1971, the Ohgishima project was launched in response to environmental concerns and the competitive benefits of equipment consolidation. All facilities up to the primary mills were replaced at Ohgishima Area, which became the most modern steel works in Japan. The works had two large-scale blast furnaces and an annual production capacity of 6 million tons of crude steel. The annual crude steel production reached 5.5 million tons in 1981, but one of the

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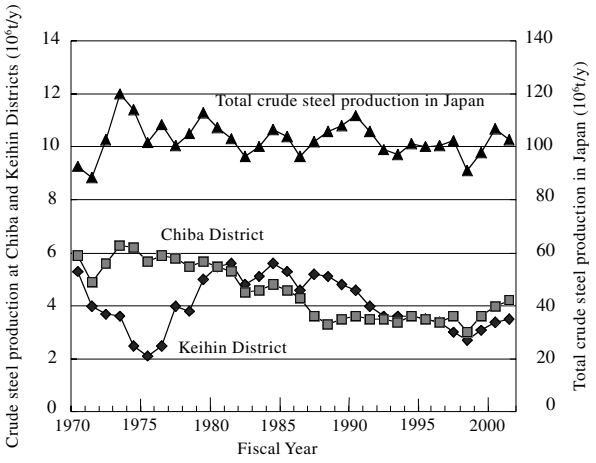

Fig. 1 Crude steel production at East Japan Works

blast furnaces (BF) was taken out of service in 1990. Currently, Keihin Works produces a wide variety of steel product such as plates, sheets, and welded pipes at a level of 3.5 million tons per year **(Fig. 1)**.

4. Outline of Equipment

An outline of equipment in East Japan Works is shown in **Table 1**.

5. Features of Chiba District

5.1 Current State of Production

Chiba District produces hot rolled steel sheets, cold rolled steel sheets, coated steel sheets, stainless steel sheets, UOE pipes, iron powder, and other products with a total annual production of 4.22 million tons of crude steel in 2001. The shipment amounts by product type are 1.36 million tons of hot rolled steel sheet, 1.29 million tons of cold rolled steel sheet, and 900 thousand tons of coated steel sheet, out of which stainless steel products account for 360 thousand tons including production at Nishinomiya Plant.

5.2 Features of Chiba District

Chiba District underwent a large-scale renewal project in 1991-1994 under the concept of "creation of the world's strongest steel works specialized in steel sheets and high-end products." It is an urban steel works in harmony with the neighboring communities and the environment and has the following features:

(1) Ironmaking

The No. 6 BF was relined in 1998 for the first time since it was constructed, establishing a world record at that time for the longest furnace life (20 years and 10 months). The relining was completed in just 62 days (another world record) owing to the use of large-sized block rings.

(2) Steelmaking

The No. 3 steelmaking shop produces highly clean steel using a basic oxygen, bottom blowing converter (Q-BOP) and a KTB-type RH degassing system.

The No. 4 steelmaking shop incorporates the world's first commercial-scale chromium ore smelting reduction process and produces highly clean stainless steel using a top-bottom blowing converter and a VOD degassing system. (The smelting reduction process is described later.)

(3) Hot Rolling

High-quality, high-performance products are produced by an ultra-modern hot rolling mill that realized the world's first endless rolling as discussed later. The entire mill is completely automated, and all the processes from entry to exit are operated from a single pulpit.

(4) Cold Rolling

There are two cold rolling shops. The No. 1 cold rolling shop is mainly used for producing can-making materials and other thin-gage steel sheets. The No. 2 shop is mainly used for producing steel sheets for applications such as automobiles, electrical appliances and construction purposes.

The No. 1 TCM (tandem cold-rolling mill) at the No. 1 cold rolling shop can roll steel coils at a speed of 2 800 m/min. The No. 4 CAL (continuous annealing line) at the same shop can anneal cold rolled coils at a speed of 1 000 m/min. Both are the fastest in the world.

The No. 2 cold rolling shop is a multi-purpose shop that can roll a wide variety of sheets from general-purpose steel sheets to high strength specialty steel sheets and stainless steel sheets.

(5) Coating

Chiba District has four types of coating lines: electrogalvanizing, electrolytic tinding line, electrolytic chromium coating and hot dip galvanizing. They produce high-quality coated steel sheets that are well suited to specific applications such as cans and containers, automobiles, electrical appliances and construction purposes.

(6) Stainless Steel

Stainless steel sheets are produced by the world's first 5-feet wide, 12-high cluster mill.

Nishinomiya Plant in Hyogo Pref. produces ultra-thin BA (bright annealed) sheets, and 30 μm ultra-thin foil.

(7) UOE Large-diameter Pipe

The UOE pipe mill is one of the largest in the world and is used for producing large-diameter pipes.

(8) Iron Powder and Welding Consumable

Chiba District is the only comprehensive iron

Table 1 Main production facilities at East Japan Works

Class	Equipment		Chiba District		Keihin District	
			No.	Outline	No.	Outline
Iron-making	Blast furnace (BF)	BF number (Inner volume)	2	No. 5 : 2 584 m^3, No.6 : 5 153 m^3	1	No. 1 : 4 907 m^3
	Sintering machine		1	No. 4 : 237 m^2	1	No. 1 : 450 m^2
	Coke batteries		3	No. 5, 6, 7, 260 ovens	2	No. 1, 2, 198 ovens
Steel-making	Converter		2 2	No. 3 : 322 t/charge No. 4 : 185 t/charge (Stainless smelting reduction, Decarburization)	2	250 t/charge
	Electric arc furnace		—		1	50 t/charge
	Continuous casting machine	Slab CC	2	No.3 (2 ST), No.4 (1 ST, Stainless and specialty steel)	2	(4ST)
		Billet CC	—		1	(6ST)
	Slabbing mill	Number of soaking pits, Mills	—		9+1 +1	Soaking pit : 9, Universal mill : 1, Blooming mill : 1
	Degassing equipment	RH degasser	2	RH degasser : 1, VOD degasser : 1	2	RH degasser : 1, VOD degasser : 1
Rolling	Hot rolling	Hot rolling mill	1	(Width/Thickness) 600-1 900 mm/0.8-25.0mm	1	(Width/Thickness) 600-2 300 mm/1.2-25.4 mm
		Skin pass mill Shear, Slitter	1	(Width) 600-1 900 mm	1	(Width/Thickness) 600-2 350 mm/1.2-6.9 mm
	Cold rolling	Pickling line	3	1PK (Width/Thickness) 600-1 900 mm/1.0-6.5mm, 5PK (Width/Thickness) 600-1 710 mm/1.2-5.5mm, 6PK (Width/Thickness) 600-1 310 mm/1.8-4.5mm,	1	(Width/Thickness) 600-1 600 mm/1.2-6.0 mm
		Tandem mill	2	2TCM (Width/Thickness) 630-1 295 mm/0.1-0.6mm, 3TCM (Width/Thickness) 600-1 672 mm /0.2-3.2 mm	1	TCM (Width/Thickness) 600-1 305 mm/0.15-1.6mm
		Continuous annealing line (CAL)	4	(Max. width) 1 067 mm, 1 300mm, 1 067 mm, 1 880 mm (4 CAL with an incorporated DR mill)	—	
		Temper mill	2	(Width) 580-1 100 mm, 800-1 880 mm	—	
		DCR mill	1	(Width/Thickness) 457-1 120 mm/0.06-0.80 mm	—	
	Coating	Electrogalvanizing line (EGL)	1	(Width) 760-1 830 mm	—	
		Continuous galvanizing line (CGL)	2	(Width) 700-1 850 mm, 610- 1 550 mm	3	(Width) 610-1 228 mm, 610-1 300 mm, 610-1 300 mm
		Electrolytic tinning line (ETL)	1	(Width) 457-1 067 mm		
		Tin-free steel line (TFL)	1	(Width) 457-1 067 mm		
		Color line	—		3	(Width) 610-1 220 mm, 610-1 220 mm, 50-1 305 mm
	Stainless steel	Substrate annealing and pickling line	1	(Width/Thickness) 650-1 600 mm/1.5-8.0 mm	1	Pickling only, (Width/Thickness) 400-1 020 mm/2.3-3.5 mm
		Reverse mill (SCM)	1	(Width/Thickness) 650-1 600 mm/0.2-5.5 mm	1	(Width/Thickness) 400-1 070 mm/0.03-3.0 mm
		(Zr)	3	(Width/Thickness) 300-1 270 mm/0.02-2.0 mm	—	
		Annealing and pickling line	1	(Width/Thickness) 650-1 600 mm/0.4-5.5 mm	—	
		Bright annealing line	2	(Width) 600-1 300 mm	2	(Width) 400-1 070 mm
	Plate	Reheating furnace	—		4	Continuous type: 2, Batch type: 2
		Finishing mill	—		1	6 400 kW, (Width)1 000-5 300 mm
		Heat treatment furnace	—		2	Tempering furnace, Standard quenching furnace
Pipes	UOE pipe	Press	2	U press (3 600 T), O press (67 000 T)	—	
				(Dia.) 508 -1 626 mm		
		Welding machine	8	Inside : 4 , Outside : 4	—	
	ERW pipe		—		1	(Dia.)Round pipe : 177.8-609.6 mm, Square tube : 200-500 mm
	BW pipe		—		1	(Dia.)21.7-114.3 mm
	S-PLP		—		1	(Dia.)21.7-168.3 mm
	L-PLP		—		1	(Dia.)89.1-812.8 mm (NF pile : 900 mm)
Power plant	Power generating equipment	(On-site)Thermal power generator	4	453 000 kW	4	430 000 kW

powder producing place in Japan and produces iron powder for powder metallurgy and chemical processing. It also produces some kinds of welding consumables.

(9) Infrastructure

A 480-MW on-site power plant generates approximately 95% of electricity consumed in Chiba District. It also has an on-site oxygen plant with a capacity of 100 000 m^3/h.

The port facilities include a berth that can accommodate ships of more than 150 000 dead-weight tons and an all-weather product-loading wharf.

(10) Others

Dust generated at the No. 4 steelmaking shop is subjected to smelting reduction by a dust-smelting furnace to recover valuable metals such as Ni and Cr.

Two Thermoselect-type gasifying and melting lines started operation in Sep. 1999. Each can treat and recycle wastes at a rate of 150 t/day and can nearly completely eliminate dioxin emissions, while recycling 100% of wastes brought in as fuel gas and industrial materials.

The site of the former East Plant in Chiba District is being redeveloped as part of the Soga Specified District Redevelopment Plan announced by Chiba City in Oct. 2001. The commercial district and part of Chiba City Comprehensive Sports Park are scheduled to become operational in 2004.

The following particularly unique features of Chiba District are described below.

5.3 Endless Rolling Process

The No. 3 hot rolling shop was commissioned in 1995, and the world's first commercial endless rolling began in 1996. In endless rolling, a sheet bar is heated by induction heating and then contact-bonded before the strip enters the finish rolling process. This provides fully continuous finish rolling, which significantly contributes to the increase in productivity and energy saving. It also can produce extremely thin and wide steel sheets that could not be produced by the conventional hot rolling. Moreover, high-quality, high-performance materials such as those with extremely excellent drawability can be produced by lubricated rolling.

5.4 Stainless Steel Smelting Reduction Process

The No. 4 steelmaking shop which was commissioned in 1994 is the world's first smelting reduction process for producing chromium-based stainless steel. In the smelting reduction process, chromium ore charged into hot metal in the furnace is directly smelted and reduced by carbon-bearing material. Compared to the conventional process which uses ferrochromium that requires a significant amount of electricity, the CO_2 emission is significantly reduced, making a large contribution to the preservation of global environment. The vacuum oxygen decarburization (VOD) method is adopted to ladle refining to produce highly clean, high-quality stainless steel.

5.5 Production Control System: JUST-Delivery

A production control system named JUST-Delivery was established in Chiba District to enhance customer loyalty. In this system, production is controlled all the time at three levels of monthly plan, weekly plan, and daily plan. Production timing is thoroughly controlled, and any deviation occurring in a day is immediately adjusted during the same day. As a result, the lead time from order entry to product delivery is significantly shortened, which enhances customer loyalty.

6. Features of Keihin District

6.1 Current State of Production

Keihin District produces steel plates, hot rolled steel sheets, coated steel sheets, electric resistance welded pipes, semi-finished products as well as special product such as 6.5%Si steel sheet. The annual crude steel production in 2001 was 3.4 million tons. The shipments by product type in the same year were 1.1 million tons of steel plate, 900 thousand tons of hot rolled steel sheet, 600 thousand tons of cold rolled and coated steel sheet, 400 thousand tons of welded pipe, and 360 thousand tons of semi-finished products.

6.2 Features of Keihin District

Keihin District is a steel works where a wide variety of high value added products is produced. Since it is located in the Tokyo metropolitan area, urban type businesses such as recycling of wastes and facilities for protection of the environment such as pollution control have been emphasized. The main features of Keihin District are as follows:

(1) Ironmaking and Steelmaking

In ironmaking, the CFC (center feeding of coke) practice allows the use of large amounts of low-grade coal.

In steelmaking, the zero slag process produces high-quality molten steel while conserving energy and the consumption of resources.

(2) Steel Plate and Hot Strip Rolling

In steel plate rolling, a rolling mill with the longest barrel in Japan is used to produce the biggest volume of high value added, heat treated plates in Japan.

In hot strip rolling, a mill with the longest barrel in Japan and facilitated with a sophisticated, controlled cooling equipment is used to produce high grade, high tensile strength steel sheets.

(3) Coating (Hot Dip Galvanizing)

The wide product lineup includes Galvalume (55%Al-Zn), Galfan (5%Al-Zn), and pre-painted steel sheets.

(4) Special Steel Sheets

An ultra-modern, 12-high cluster mill produces Invar, shadow mask material (36%Ni) which boasts the largest market share in Japan.

The 6.5%Si steel sheet named Super E-Core is produced by a chemical vapor deposition (CVD) method that is not used anywhere else in the world for this purpose.

(5) Infrastructure

Large berths can accommodate ships of more than 200 000 dead-weight tons.

The works has an ideal plant layout with all the facilities from raw material receiving to ironmaking, steelmaking, rolling, and product shipping arranged in a straight line.

Keihin District is fully equipped with facilities for pollution control and environmental protection.

(6) Others

Various recycling businesses are promoted including the feeding of waste plastics into blast furnaces.

The particularly unique features of Keihin District are introduced below. They are 6.5%Si steel sheet, Nano-Hiten and the waste plastics blast furnace feeding system.

6.3 6.5%Si Steel Sheet, "Super E-Core"

The 6.5%Si steel sheet marketed under the trade name of Super E-Core is a unique electrical steel sheet with superior characteristics. JFE Steel was the first in the world to commercially produce such a material.

The properties of electrical steel sheets are significantly affected by the Si content. It has been well known since the early days that iron core loss becomes minimum at the Si content of 6.5%. It was believed, however, that such material could not be commercially produced because it was not possible to cold roll the material with a Si content exceeding 3.5%. JFE Steel developed the continuous CVD technology, where Si is added to the 3%Si steel sheet by reacting the sheet with $SiCl_4$, becoming the first in the world to commercially produce 6.5%Si steel sheets.

This material exhibits an extremely low iron core loss in high-frequency regions and is extensively used in applications such as high-frequency transformers, reactors and motors. It was recently used for manufacturing high-efficiency inductors for fuel-cell hybrid vehicles. The demand for 6.5%Si steel sheet is expected to increase rapidly.

6.4 Nano-Hiten

"Nano-Hiten" is a new type of high tensile strength steel that was developed by applying nano technology to steel production for the first time in the world. The most important issue in recent years with regard to automotive steel sheet is how to provide higher strength. However, increasing the strength without sacrificing formability is extremely difficult, particularly with high strength steels greater than 590 MPa. In collaboration with the R&D center of the company, Keihin District developed the world's first, epoch-making technology of dispersing nano-micron sized precipitates within a steel material. The target of increasing strength while maintaining excellent formability was achieved, even though it had been believed impossible. "Nano-Hiten" exhibits extremely low deformation resistance during rolling compared to the conventional high strength steel sheets. Moreover, it does not require any sophisticated temperature control. Therefore, it can be produced almost anywhere in the world where the slabs are available. This is a new generation of high strength steel sheet that can quickly respond to the needs of global procurement by automakers.

6.5 Waste Plastics Blast Furnace Feeding System

In Keihin District, the world's first waste plastics blast furnace feeding system was started in 1996. In this system, waste plastics, which provide the same carbon material as coke, are processed for feeding into BF by crushing and agglomerating before being injected into the BF. The injected plastics are gasified at elevated temperatures of about 1 400°C in the furnace and contribute to the reactions for reducing and melting iron ore in the same manner as coke. This system has an extremely high energy utilization efficiency, wherein 80% of the total energy contained in the injected plastics is effectively used for the reactions in the furnace. Other waste plastic recycling methods generally require pre-treatment processes for removing seals and labels followed by washing. This system does not require such pre-treatment. Further, since the hydrogen contained in plastic is also used for the reducing reaction, CO_2 emission is reduced by up to 30% compared to the case where coke is used. The resulting contribution to global warming prevention is significant.

7. Summary

JFE Steel's East Japan Works has two major mer-

its: the scale merit coming from its annual crude steel production of 8 million tons and also its location in a major urban area. Fully utilizing these advantages, East Japan Works intends to increase profitability by producing high-value-added products and expanding environmental businesses, while becoming a model for the new generation of urban steel works and realizing a “robust steel works full of dreams.”