2007 Prize of Director General of Agency for Natural Resources and Energy

Energy Conservation for Fuel through Direct Transportation of Thermal Mass Billets and Introduction of High Performance Industrial Furnace as Heating Furnace

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◎ **Keywords: Rationalization of fuel combustion, recovery for exhaust heat use, prevention of energy loss through radiation, heat transmission, resistance, etc. (prevention of heat loss through radiation, heat transmission, etc.)**

◎ Outline of Theme

Thermal mass billets (semi-finished products) manufactured on a continuous casting line are fed to the feeding slot of the heating furnace of next process by a roller table in a short time to minimize the loss of thermal energy in the thermal mass billets. Honeycomb-type regenerative burners, ceramic fibres for thermal insulation materials and a high performance industrial furnace incorporating a shortened furnace length were introduced to improve the combustion efficiency of the heating furnace, thereby reducing energy consumption and contributing to global environment conservation through the inhibition of greenhouse gas emissions.

◎ Implementation period for the Said Example

March 2005 through July 2007

- Period for formulation of plan:
  March 2005 through December 2005 Total of 10 months.
- Period for implementation of action:
  January 2006 through November 2006 Total of 11 months.
- Period for verifying effectiveness of action:
  December 2006 through July 2007 Total of 8 months.

◎ Outline of the Business Establishment

- Production items:
  Steel bars for steel reinforced concrete and rolled steel for general structures.
- Number of employees: 153 persons.
- Type 1 Designated Energy Management Factory.

◎ Process Flow of Target Facility

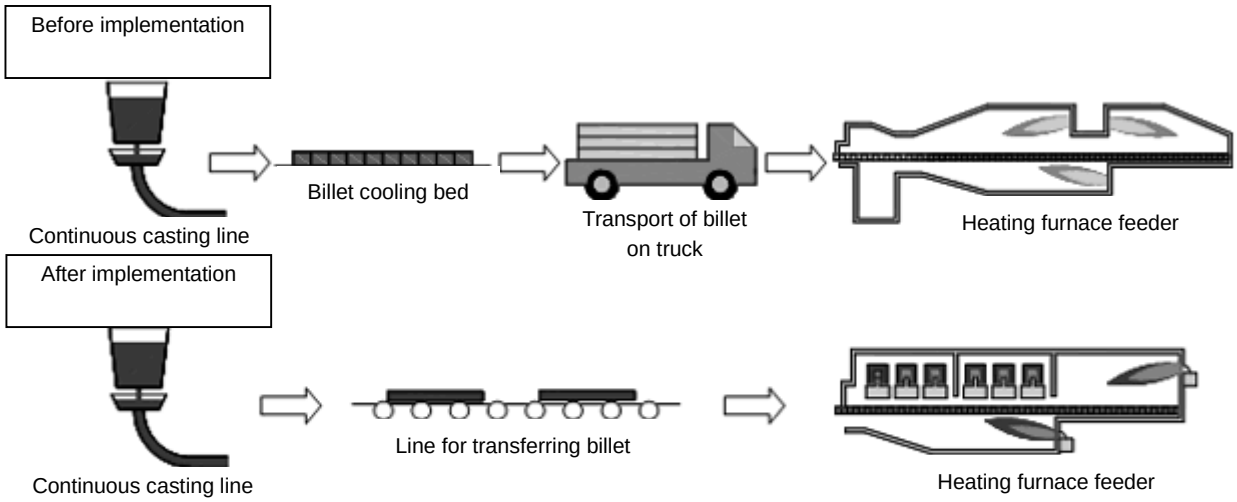

Figure 1: Process for intended facility

1. Reasons for Theme Selection

Energy conservation is becoming an essential issue, which requires businesses to promptly and effectively respond to compliance requirements, such as the “Law Concerning the Rational Use of Energy (commonly referred to as the “Energy Conservation Law”)” and the “Law Concerning the Promotion of Strategies to Cope with Global Warming (commonly referred to as the “Global Warming Strategy Law”, as well as in terms of reducing energy costs, nowadays. Activities are implemented to reduce fuel consumption, as one of the major objectives of our scope, by targeting the heating furnace facility and its related equipments in the rolling mill, which has the highest fuel consumption (energy specific unit) within this business location.

2. Understanding and Analysis of Current Situation

(1) Understanding Current Situation

Specific unit of fuel energy used for heating furnace before implementation (FY2004)

1.722×10^{-2} kiloliters/ton (crude oil equivalent)

∵ Fuel consumption record: 6475.1 kiloliters (crude oil equivalent); Production amount: 375,913 tons.

(2) Analysis of Current Situation

1) Decrease of temperature due to billet transportation

The temperature of the billets produced on the continuous casting line is approximately 1,000 degrees Celsius, however, the temperature drops to approximately 600 degrees Celsius after they go through a process with a duration of about 20 minutes, which involves leaving them temporarily on stand by on the billet cooling bed, loading them onto special trucks, transferring them to the rolling mill, unloading them from the special trucks and transporting them to the feeding slot of the heating furnace.

2) Recovery of exhaust heat from heating furnace exhausts gases

The temperature of air used for combustion in the burner of the heating furnace is about 500 degrees Celsius and the air undergoes a heat exchange with the exhaust heat of exhaust gases through the recuperator.

3) Other current specifications of heating furnace

The length of the heat furnace is 25 m and its burner combustion capacity is 23.5 million kcal/hour. The furnace can heat billets from room temperature to adequate temperature within a specified time. This performance exceeds the level required for a heating furnace to handle the thermal mass billets. Furthermore, since plastic materials are widely used as thermal insulation materials inside the heating furnace, thermal insulation is poor.

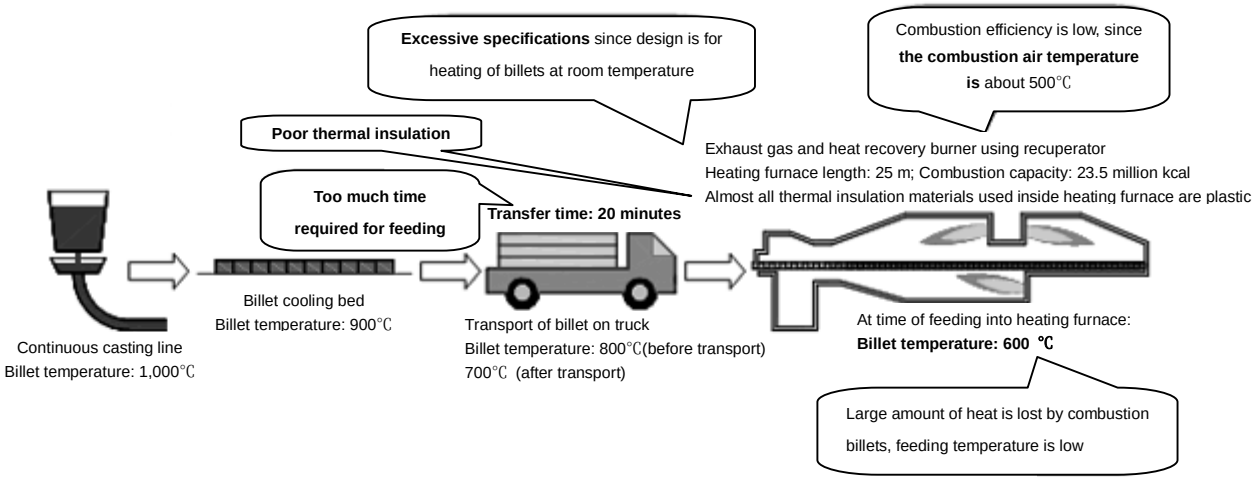

Figure 2: Summary of intended facility before implementation

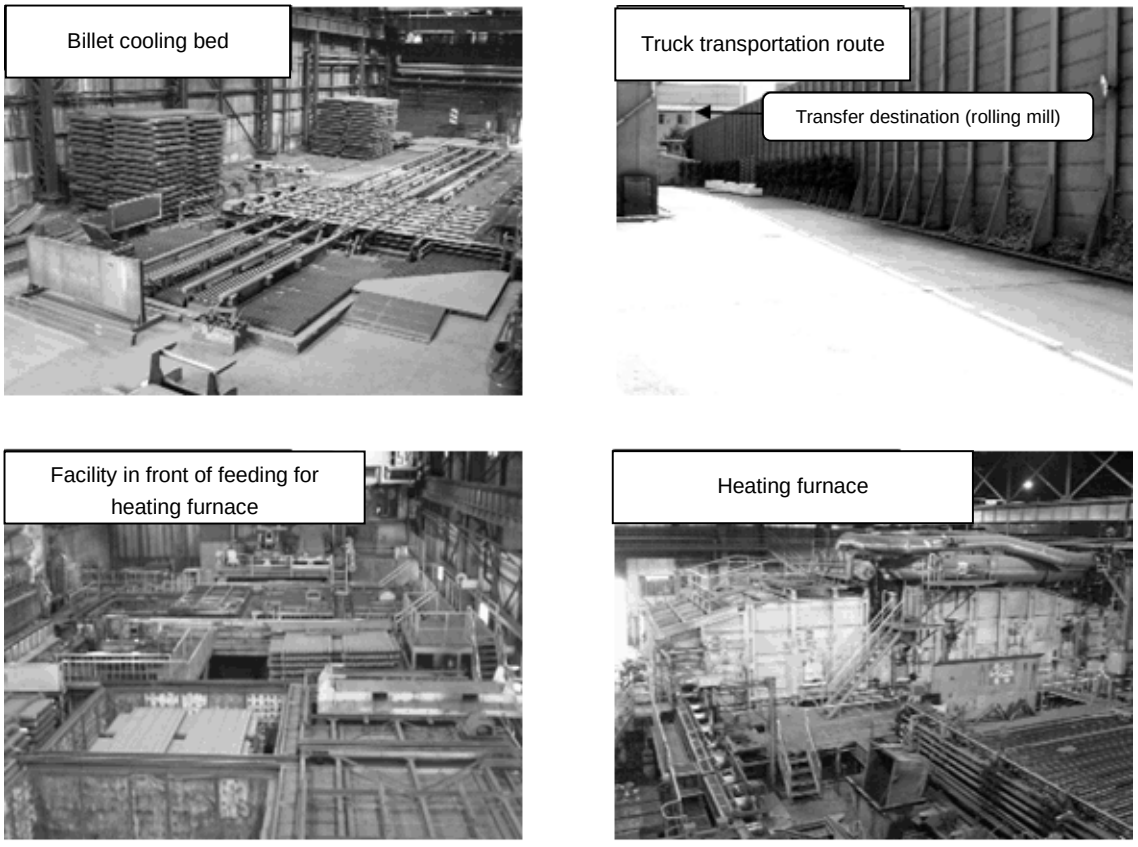

Figure 3: Photograph of intended facility before implementation

3. Progress of Activities

(1) Implementation Structure

A project to directly link the steel mill and rolling mill was launched, with decisions for the following division of roles:

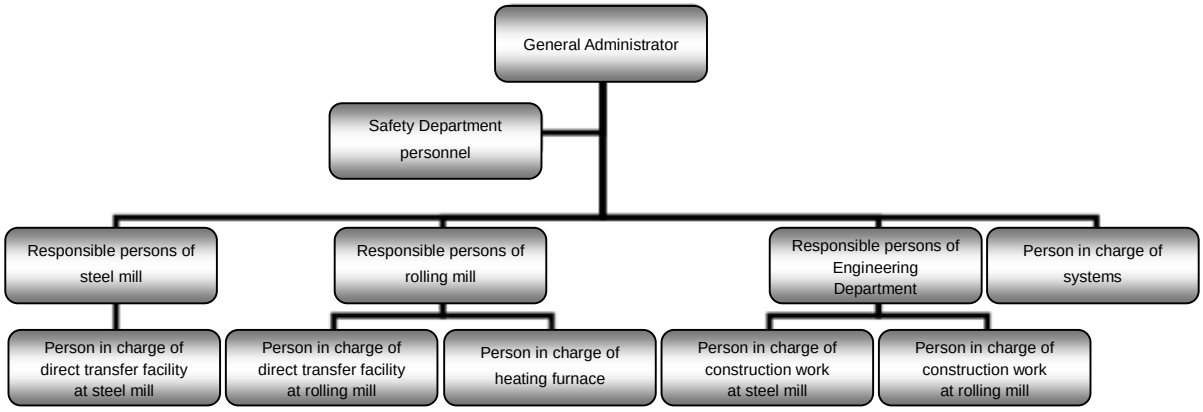

Figure 4: Framework for implementing activities

(2) Target Settings

Lower the fuel consumption rate to the same level as peer companies which use the latest facilities.

More specifically, achieve a heating furnace fuel intensity of 1.221 x 10-2 kiloliter/ton (reduction of 0.501 x 10-2 kiloliters/ton, crude oil equivalent for both figures).

(3) Problem Points and their Investigation

1) Problem Points

A. The distance transferring the billet is approximately 200 meters and we must across a municipal road between the continuous casting line and the heating furnace. The issue is how to hold the temperature drop to minimum while the billet transfer to the stage where it is fed into the heating furnace under such conditions.

B. The next issue is to increase the temperature of the combustion air, which is low for the burner combustion of the heating furnace.

C. Once the lowering of the billet temperature is minimized through steps taken by A, how can the heating furnace capacity match such conditions?

2) Investigations

A. A decision was made to construct a facility that will link the continuous casting line with the heating furnace using a row of roller tables, which crosses the municipal road following the construction of underground pits at either end of the crossing and connects them with a tunnel under the municipal road to enable the transfer of billets across the

road (billets are then lowered at the pit in front of the crossing, transferred under the road through the underground tunnel and lifted up at the pit on the other side of the crossing). The lowering of the billet temperature will be kept to a minimum through the increased transfer speed and through the installation of a covering on the transfer line.

B. A decision was made to adopt regenerative heaters.

C. A decision was made to change the furnace for a more compact one to match the billet's temperature at the time of feeding into the heating furnace, which is assumed to be changed through steps taken for A.

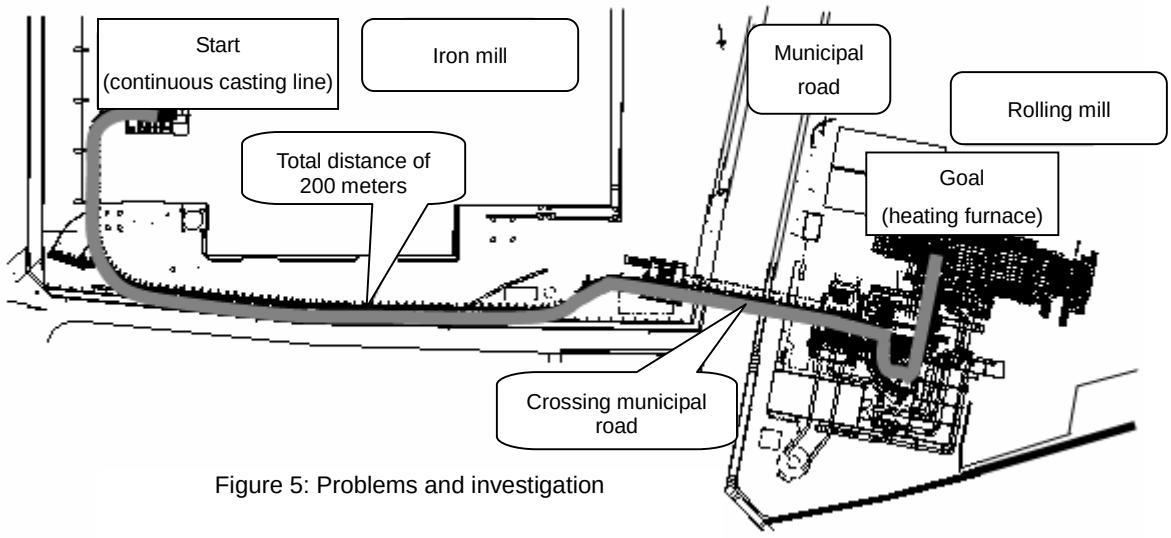

Figure 5: Problems and investigation

4. Details of Measures

(1) Direct transfer of billets from continuous casting line to heating furnace

A decision was made to transfer billets over the entire distance of 200 meters in two minutes (average speed of 1.7 m/s), despite the lifting and lowering en route of the transfer, as well as the acceleration and deceleration that takes place at the pit stops. This has been accomplished with the adoption of a maximum speed of 3 m/s, the fastest level verified by previous technical records, in order to prevent the lowering of the temperature, as little as possible, which occurs during the transport of billets produced in the continuous casting line.

(2) Introduction of high performance industrial furnace as heating furnace

1) Introduction of honeycomb-type regenerative burners

Honeycomb-type regenerative burners, offering the highest heat exchange capacity among the currently available technologies, were introduced, although ball-type regenerative

burners, which offer superior maintainability, were considered, since priority was placed on the amount of energy conservation. The heat exchange rate is considered academically to be 75% for ball-type and 92% for honeycomb-type burners.

2) Shortening length of heating furnace

The length of the furnace was shortened from 25 meters before modification to 20 meters after modification, resulting in a reduction by 20%. This was accomplished by setting the combustion capacity of burners at 20% lower than before modifications. These results were derived from a calculation that presumes the temperature of the billets following the direct transfer to be 720 degrees Celsius rather than 600 degrees Celsius which was the average temperature of the billets feeding into the heating furnace before implementation of the modification.

3) Adoption of ceramic fibres as thermal insulation materials for heating furnace interiors

Ceramic fibres that offer superior thermal insulation were adopted in order to conserve energy, although almost all, except for a portion of the fire proofing materials used in the heating furnace prior to the modification, were made of plastic.

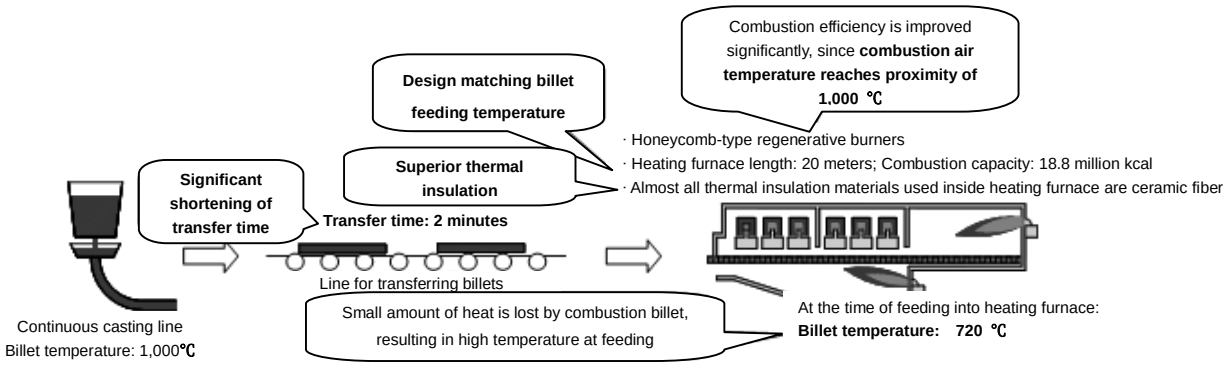

Figure 6: Summary of intended facility after implementation of case example

Figure 7: Photograph of intended facility after implementation of case example

5. Effects achieved after Implementing Measures

Targeted figures:

Table 1: Effectiveness of implementation
(Items 1 and 2 apply only to intended facilities, whereas item 5 has a fixed fuel price)

		Before action	After action	Reduction target	Reduction record	Achievement rate
(1) Amount of conserved energy (crude oilequivalent)	Unit consumption [kl/t]	1.722×10^{-2}	1.079×10^{-2}	0.501×10^{-2}	0.643×10^{-2}	128%
	Amount of consumption [kl/year]	6,475	4,130	2,007	2,345	117%
(2) Carbon dioxide emission [carbon dioxide ton/year]		12,699	8,100	3,936	4,599	117%
(3) Rationalization of transfer operation (crane and truck operations)		Allocation of four persons. Transfer costs involved.	Allocation of no persons. Transfer costs not involved.	△Saving of labor by four persons. Reduction of transfer costs.	△Saving of labor by four persons. Reduction of transfer costs.	100%
(4) Rationalization of billet management (inventory capacity comparison) [t]		5,365	3,945	1,420	1,420	100%
(5) Economic effects [JPY million/year]		-	-	146.7	188.8	129%

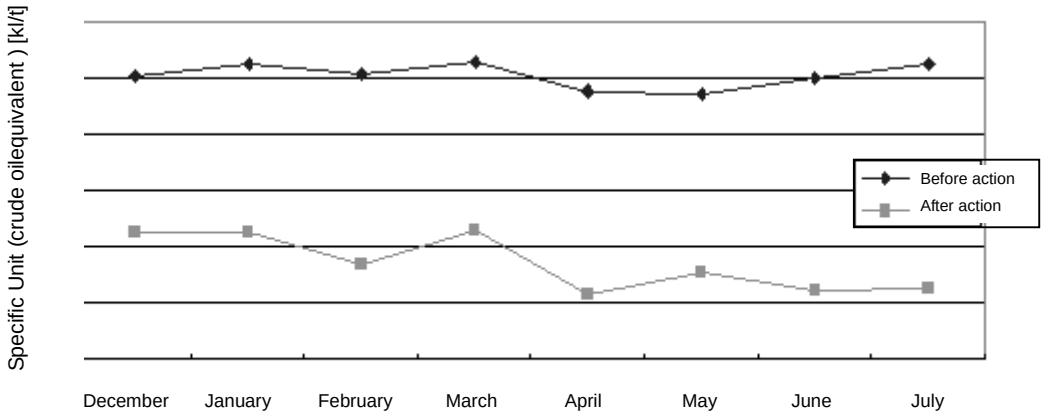

Figure 8: Transition of monthly energy amounts (specific unit)

6. Summary

A significant amount of energy conservation has been achieved through improvements made to the facilities and operating methods, broadening the scope for improving revenue and expenditure relating to fuel energy as well as energy conservation activities that have in the past been implemented within the rolling mill alone and now include the steel mill.

These modifications were the largest ever conducted at the site since the establishment of the plant and as such a number of trial and errors ensured during the consideration stage. It was possible to find clues of solutions which led to confidence for further action in the future,

through the review of case examples at other business locations and other companies, as well as technical consultations provided by manufacturers. Furthermore, it has also been possible to reduce the burden of facility investments through support from the New Energy Development Organization (NEDO).

7. Future Plans

The actions detailed below will be undertaken in order to maximize the energy conservation through the use of the implemented facility:

(1) Optimization of combustion of heating furnace

Optimum condition, such as more detailed heat patterns for each individual furnace operation time, furnace pressure, air ratio for individual series, exhaust gas amount for individual series and regenerative burner switchover timing for individual series, will be established within FY2007.

(2) Direct transfer facility

A direct transfer facility for all billets will be made available within FY2007, with the intention of completely eliminating to “zero” problems that arise within the facility, through strategies implemented with regards to facilities that may be prone to problems (such as a swivelling table, lowering conveyer, lifting conveyer, turning device, direct feeding table, ante-furnace table).