3. Treatment performance test

This system was mounted onboard a trailer carrier vessel built at our shipyard, and the treating performance was measured for about four months. The result showed that in spite of temporary massive inflow of floating oil, the oil concentrated in the treated water was maintained below 15 ppm.

4. Features

(1) Structure of biological reactor
In the biological reactor that is the hub of the system, in order to be free from the effects of pitching and rolling of the hull during navigation, the sludge sedimentation block is constructed with an original overflow structure.

(2) Oil decomposing bacteria
The microorganisms used in this system are oil decomposing bacteria developed by Mitsubishi Heavy Industries, Ltd., and feature the following points.

(a) An excellent oil decomposing ability is exhibited even in the bilge containing seawater.
(b) Besides being resistant to the surfactant contained in the bilge, the microorganisms have an excellent surfactant producing ability and can thus decompose the oil easily.

(3) Treating performance
The emulsified oil, which is difficult to treat with a conventional bilge separator, can be removed relatively easily, and the quality of treated water is stable.

(4) Maintenance
The existing bilge separator is easily clogged and requires cleaning once every few months, which means considerable expense for maintenance.

By contrast, in this system, no particular maintenance is needed except for checking the air supply amount, nutritious source level, and amount of bacteria, and the maintenance costs can be reduced substantially.

New Cold Rolling Plant at Sumitomo Metal Industries, Ltd., Kashima Steel Works

In recent years, great strides have been made in reducing the labor required in cold rolling plants while improving yield. In addition, there have been marked increases in the quality of the products rolled by such plants. A major issue in raising product quality is improving the thickness accuracy of steel strip edges.

The new, state-of-the-art cold rolling plant supplied by Mitsubishi Heavy Industries Ltd. (MHI) to the Sumitomo Metal Industries, Ltd., Kashima Steel Works began commercial operation in April 1993. In September of the same year the productivity reached its nominal capacity 100,000 tons per month, and it has been operating steadily ever since. In this plant, Pair Cross Mills have been adopted, for the first time ever for cold rolling mill, to the three upstream stands. These Pair Cross Mills provide an epoch-making improvement in thickness accuracy of both edges of steel strips, and improve product quality by means of high reduction rolling. Practically the whole of this cold rolling plant line was manufactured by MHI. The following is an outline introduction to the plant.

1. Main specifications of the plant.

This plant is a tandem mill for sheet gauges. It is principally for general-purpose cold-rolled steel plate, steel plate for automobiles, and high tension steel, and also has capability of rolling stainless steel. The main specifications of the plant are given in Table 1.

The complete line is shown in Fig. 1. The plant is a 5-stand tandem mill in which Pair Cross Mills have been adopted to three upstream stands.

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2. Features of main components

2.1 Pair Cross Mills

Since we first developed the Pair Cross Mill as an original innovation, we have delivered as many as 50 stands of them for use in hot rolling plants. This record has secured us a leading position in this field. (We have also provided a Pair Cross Mill for a hot plate rolling mill.) Now, with the introduction of Pair Cross Mills to cold rolling mills as well, we can be said to have inaugurated the age of the Pair Cross Mill in rolling mills.

A photograph of a Pair Cross Mill is shown in Fig. 2. The main features of the Pair Cross Mill when used for cold rolling are that it increases the thickness accuracy of steel strip edges (that is, it reduces "edge drop"), and that it provides high reduction rolling. Details of these features are as follows:

Mitsubishi Heavy Industries, Ltd.
(1) Higher accuracy of steel strip edge thickness (reduced "edge drop")

When cross rolling is carried out in the upstream cold-rolling passes (where the thickness of the strip is comparatively large), no edge drop occurs at the edges of steel strip; rather, edge-up occurs. The amount of edge-up can be controlled, which means that at the end of 5 rolling passes, rectangular strip profiles without any edge drop can be attained.

The Pair Cross Mills use flat bearings. As a result, it is extremely easy to vary the cross angle during rolling, and in combination with work roll benders, the Pair Cross Mills can continuously roll strips that are free of edge drop for any strip specification.

(2) High reduction rolling

There is now increasing demand for high reduction rolling to meet the needs for higher product quality and production of thinner & wider high-tension steel strips. The Pair Cross Mills are basically 4 Hi mills, which have lower contact surface pressure between rolls than the various 6 Hi mills recently in use, and consequently are better suited to high reduction rolling.

(a) The work roll of 6 Hi mills comes into contact with a small-diameter intermediate roll. By contrast, the work roll of the Pair Cross Mill comes into parallel contact with a large-diameter backup roll making for low average contact surface pressure between rolls.
(b) In 6 Hi mills, the contact between the work roll and the intermediate roll is not uniform which means local high contact surface pressure between rolls. In the Pair Cross Mill, however, the work roll and the backup roll come into parallel, uniform contact with each other. Consequently, the contact surface pressure between rolls is uniform and, therefore, low overall.

(3) Unification of work roll crowns

The Pair Cross Mill has a wide range of work roll crown control functions; crown amounts required for the rolling of a wide variety of specifications of strip, thermal crown amounts, as well as crown amounts required for edge-up can all be controlled by pair cross rolling. As a result, work roll initial crowns can be unified, and only a few work rolls need to be kept as spares. This means not only lower roll unit costs, but is also a major factor in the achievement of wide-ranging automation of the roll shop, which will be touched upon later.

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Fig. 2 External view of Pair Cross Mill

Fig. 1 Layout of the new cold rolling plant
(4) Improved product surface gloss
Use of Pair Cross Mills in cold rolling improves the surface gloss of products. In addition, gloss can be controlled by changing the cross angle. This gloss improvement effect, now a reality in cold rolling, can be expected to broaden its range of applications in the future to include skin pass mills, stainless steel rolling, as well as aluminum rolling.

(5) Dynamical crossing during rolling
Because the new cold rolling plant performs continuous rolling, it requires a function for varying cross angles during rolling, that is, dynamical crossing. To provide this function, the Pair Cross Mills are equipped, for the first time in the world, with flat bearings in which the rollers are arranged in a fan-formation. These bearings lessen crossing friction during rolling making dynamical crossing possible. The bearings are at this moment in trouble-free, regular operation.

(6) New-type mill hood
The photo in Fig. 2 shows the new-type hood employed in the plant. We believe this hood, created by our design center, to be worthy of the 21st century.

2.2 Entry equipment.
We have a long and successful record of constructing entry equipment and remodeling existing entry equipment for continuous cold rolling mills. The entry equipment in the new, continuous operation cold rolling plant is a summation of our experience in this field. All line entry functions, including coil insertion of the two pay-off reels, threading of the coil and through the system, etc., are fully automatic.

2.3 Delivery equipment
Like the entry equipment, the delivery equipment, which includes rotary shears, threading guides, and reels for continuous operation, incorporates the best design features culled from our experience. The tension reel is of a carousel type of our own original design with two mandrel shafts.

Inspection line equipment used for strip threading, checks, etc., are all fully automatic. There are also vertical type loopers that pass strips to the 2nd story level, where the operator in the Overall Control Room (located on the 2nd story level) can inspect them.

2.4 Fully-automated chock remover
Formerly, the installation and removal of chocks, a high-frequency and important operation in roll shops, was time-consuming and required many hands. Now, however, our fully-automated chock remover, the first of its kind in the field, performs these operations automatically. This remover, together with the reduced number of work rolls required (thanks to unification of the work roll crowns), means wide-ranging automation in the shop where the new cold rolling plant is installed, and contributes greatly to realizing personnel reductions.

This multi-function, robot-type chock remover performs fully automated handling of all upstream Pair Cross Mill work rolls, downstream mill work rolls and intermediate rolls.

3. Future prospects for the plant
Recently, reduced strip edge drop has become a firm trend in cold rolling, and dynamical crown control has become commonplace. Against this background, the Pair Cross Mill, which combines the ability to reduce edge drop by means of dynamical crossing with a capability for high reduction rolling, can be expected to become the main stream of cold rolling mills in the future. Furthermore, we can expect increased demand in the future for fully automated operation of the entire line including entry and delivery equipment for the purpose of realizing reductions in personnel. The automated features of the plant described above can make an important contribution to meeting such demand.

Flue Gas Desulfurization System Using the Magnesium Process

While the SO₂ discharge regulations are being tightened as a countermeasure against acid rain, the installation of flue gas desulfurization systems for facilities burning fossil fuels or fixed SO₂ generating sources has become essential. Particularly, as a treatment system for gas discharged from boilers for industrial (in-company power generation) plants or petroleum refining facilities, the magnesium system which is compact, with less equipment than other systems, and which affords higher desulfurization efficiency, compared with other systems, is used in many cases.

Mitsubishi Heavy Industries, Ltd. has delivered 14 flue gas desulfurization systems using the magnesium process, and all these systems are operating satisfactorily. For the present, 4 units are being manufactured and being constructed. Not only that, but studies to make the apparatus

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Fig. 1 Appearance