NEW RH PLANT
with top availability at Dragon Steel, Taiwan

SMS MEVAC
Secondary Metallurgy

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Authors:
C. M. Yang, General Superintendent Steelmaking Dept.,
Dragon Steel Corp., Taichung, Taiwan. Volker Wiegmann,
Thomas Eichert, SMS Mevac GmbH, Essen, Germany

Figure 1. New RH TOP plant at
Dragon Steel Corp.
NEW RH PLANT
with top availability at Dragon Steel, Taiwan

In 2006 Dragon Steel Corp. awarded an order for a new BOF melt shop to SMS Siemag. One main section of the integrated ladle metallurgical centre is a new RH unit supplied by SMS Mevac. From the first RH heat in March 2010, it took only one more month to achieve a productivity of around 30 heats per day via RH which means a vacuum share of more than 90% of the total production. Prerequisites for this quick success were efficient design and production concepts and optimized process routes for the whole steelmaking shop.

Dragon Steel Corporation, a member of the CSC group, has erected a modern integrated steelmaking plant in Taichung, Taiwan. Its new BOF melt shop is designed for three 220 t converters and a ladle metallurgy centre with two RH-TOP plants and four ladle treatment stations. The entire melt shop is a two-phase project. The first phase was already successfully started up in March 2010. Already 1.5 month after the start-up, the designed capacity was reached. The new RH plant was erected and commissioned by SMS Mevac, figure 1; the first heat was processed in March 2010.

In the second half of 2012, phase 2 of the steelmaking plant will start production. In this phase 2 the third converter and the second RH-TOP plant will be set into operation. With this extension, annual crude steel production capacity at DSC can be increased to 6 million t.

PROCESS ROUTE AND CHARACTERISTICS OF THE STEELMAKING PLANT

Figure 2 shows the principal layout of the steel plant. At Dragon Steel, a hot metal transfer building interlinks the blast furnace site with the steelmaking plant. Hot metal is transferred in open ladles on ladle cars from the blast furnaces to the pre-treatment stations (two twin KR/Kanberra reactors) – two treatment positions respectively – mainly for desulphurization. After pre-treatment the hot metal is transferred to the converter shop.

Once commissioning of phase 2 has been completed during the second half of 2012, three converters will serve three continuous casting plants – with two converters in parallel operation. The new steelmaking plant will have an annual production capacity of 5 million t of liquid steel, around 85% of which is to be treated under vacuum in two RH-TOP plants.

The essential advantages of this compact plant layout are the transportation of the liquid hot metal in open ladles, thus neither a hot metal refilling station nor torpedo cars are required. The routes to the metallurgical processing station are quite short, e.g. the distance between the blast furnaces and the converters is only about 200 m. This reduces hot metal temperature losses but also decreases refractory consumption by the transfer ladles. By applying open ladles instead of torpedo ladle cars for the hot metal transport, the investment costs for transport and maintenance equipment could be drastically cut.

During the first phase of commissioning, two converters are available (220 t tapping weight each, figure 3, usually with one converter in operation and one as standby. Up to 37 heats per day are planned to be produced during this phase, enabling a monthly crude steel volume of up to 230,000 t. The converters are equipped with lamella suspension systems and eight tuyeres for bottom stirring. The oxygen lances have a blowing capacity of up to 760 m³/min (stp).

Dart-type slag retaining devices and sub-lances complete the converter equipment. A gas cleaning plant, a
CHARACTERISTICS OF THE SECONDARY METALLURGICAL TREATMENT STATIONS

As shown in figure 2, the ladle metallurgical centre consists currently (phase 1) of:

1. one RH-TOP vacuum degassing plant (two treatment stations, 1&2),
2. one ladle furnace connected to a common alloying system with wire feeding machine, stirring lance and powder injection equipment.

The RH-TOP plant is designed as a fast vessel exchange system with an annual treatment capacity of 2.3 million t of liquid steel. 35 treatments can be carried out per production day. This covers 95% of the liquid steel production in phase 1. Based on the product mix, about 85% of the liquid steel production requires vacuum treatment. When the third converter will come into operation, together with the second RH unit, it will be possible to vacuum treat more than 4 million t/year of liquid steel.

65% of the entire steel production belong to the group of low carbon grades and will be vacuum treated by what is called the “light treatment” process.
13% require decarburization treatment to lowest final carbon contents, i.e. less than 15 ppm. These are ultra-low carbon grades (ULC), IF grades and electric plate grades.

Deep vacuum treatment to remove hydrogen and/or nitrogen from the steel will be carried out for container steel grades and pipe steel grades. This degassing treatment will be applied to about 7% of the steel production. For the remaining 15% of the planned product mix, no RH treatment is required.

**GENERAL LAYOUT OF THE RH PLANT**

Figure 4 shows a schematic illustration of the RH plant design. This fast vessel exchange type plant is characterized by two vessels available for one treatment position. Each vessel system is placed on a vessel transfer car. Both systems can move between the treatment position, standby position and maintenance position. In both maintenance positions, a hydraulic lifting system is installed to remove the lower vessel parts. A vessel exchange can be carried out within max. 8 min. In the treatment position, two synchronously operated hydraulic cylinders lift the frame with the ladle up until the required snorkel immersion depth is reached. A four-stage steam ejector vacuum pump has the capacity to evacuate the entire system to final vacuum pressures of less than 1 mbar within 3.5 min. Snorkel maintenance will be carried out by a separate snorkel maintenance car with equipment for slag removal and snorkel gunning. The alloying material is stored in 17 high level bunkers. The addition under vacuum is executed by means of a vacuum hopper system, a scale hopper for ferrosilicon (FeSi) and two rotary feeders for carbon and aluminium respectively.

The secondary metallurgical centre is completed by an atmospheric ladle treatment station (LTS) having lances for temperature measurements and sampling, connection to the alloy addition system, wire feeding machine, purging lance and powder injection system. The operating principle of the fast vessel exchange concept and the various positions are schematically shown in Figure 5. In the maintenance positions, the lower vessel parts are changed. The ladles coming from the converters are placed on the ladle transfer car at the take-over point (BOF). After the RH treatment, the car is moved to the caster take-over point (CCM) in the bay near the continuous casting plant Figure 6.

The same route is used by the snorkel maintenance car located behind the RH treatment position. The spraying of the outer surface of the snorkel is carried out manually. The inner parts are maintained by using an automatically operated gunning system.

The atmospheric ladle treatment station is located beside the RH plant. The ladle transfer car of the atmospheric ladle treatment station is also used for transporting the empty, preheated hot metal ladles. The ladle treatment station cover is connected to the dedusting system of the plant.
RAMP-UP CURVE

Figure 7 illustrates the development of production in the new steel plant. During a first short hot commissioning period of approx. three weeks, only twelve RH treatments were carried out. During these treatments, all metallurgical functions could be tested. The reliability of all plant components were checked and adjusted where required.

Steel production started on March 3, 2010. Already two months after start-up, on average 30 RH treatments per day were achieved. Also the designed production capacity of 95% of liquid steel production was achieved during that time. In November 2010, almost 99% of the entire BOF production were vacuum treated in the RH plant, i.e. 34 RH treatments every day. Such high reliability and plant availability were due to the optimized plant concept with high standards in the key components such as the vacuum pump, vessel design or TOP lance equipment.

A very important criterion for productivity and availability is the high snorkel life achieved. During eleven months of production an average snorkel life of 193 treatments was reached. A maximum life time of 263 treatments was also recorded. As a result of this good snorkel life and more than 30 treatments per day, lower vessel exchange becomes necessary after around seven to eight production days. If the snorkel life time was reduced by about 20%, the exchange would have to be carried out already after five to six days.

Figure 8 shows the start-up curve of the RH-TOP plant for the first two months of production. The increase in daily treatments from around five to 30 is actually impressive. The designed capacity of the RH plant was already reached within two months after the start-up.

INITIAL METALLURGICAL RESULTS AND RH TREATMENT PATTERN

According to the different metallurgical tasks, like vacuum carbon deoxidation, decarburization or degassing, different treatment types are applied. Figure 9 shows a typical RH treatment pattern for ultra low carbon steel.
grades. After converter tapping, the steel will be homogenized by means of lance stirring at the stirring station behind the converter. Final temperature and sample will be taken. The RH treatment starts immediately after the ladle is lifted into the required position. Controlled pump down is executed by means of the vacuum control system according to pre-defined pump down curves.

Final carbon contents below 14 ppm are reached within decarburization periods of less than 17 minutes. The vacuum treatment is completed after 26 minutes and the total cycle time will not exceed 30 minutes. Mechanical snorkel cleaning will be carried out virtually after every decarburization treatment. Gunning of the snorkels takes place after three to four decarburization treatments.

CONCLUSION

With the two commissioning steps of the new BOF melt shop at Dragon Steel successfully completed in the second half of 2012, the CSC group will have extended its steelmaking capacity by another 6 million t/year. The modern and efficient plant concept and the possibility to produce high quality steel provided by the new ladle metallurgical centre enable the company to tackle future market demands.
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