China Steel Technical Report, No. 29, pp.80－85, (2016)

The Improvement of High Pressure Descaling Efficiency to Lower Furnace Temperature and Reduce Fuel Consumption in China Steel No.1 Hot Strip Mill

KUO-CHUAN LI* and KUN-CHENG TUNG**

** Rolling Mill Department II - Hot Rolled Products*
*** Plant Engineering & Maintenance department*
China Steel Corporation

The Goal of this paper is mainly to disclose the improvements of high pressure descaling efficiency to lower furnace temperature and reduce fuel consumption in China Steel (CSC) No.1 Hot Strip Mill (HSM).[1,2,3] By investigating the relationship between the reference nozzle geometry[4] and descaling performance, No.1 Hot Strip Mill has proceeded measurements of enhancing descaling capacity and improving temperature drop in the roughing area successfully, which include modification of High Pressure Scale Breaker (HSB) and rougher mill (R1-R3) descaling, such as the modification of nozzle type and nozzle arrangement. The experiments required an aluminum test plate to determine whether the descaling spray distribution pattern was normal or not, as well as the quality feedback from the downstream mill to ensure the surface quality. With the countermeasures applied, the results showed that the descaling impact force increased and as a consequence there was a reduction in descaling water consumption, a reduced temperature drop in the roughing area but also a significant reduction in the rolled in scale defect.

Keywords: High pressure scale breaker, Furnace temperature, Fuel consumption

1. INTRODUCTION

This paper mainly discusses the improvement of high pressure descaling efficiency to reduce furnace temperature and fuel consumption in China Steel (CSC) No.1 Hot Strip Mill (HSM). No.1 HSM reduced temperature drop improvement in the roughing area, included the modification of the High Pressure Scale Breaker (HSB) and rougher mill (R1-R3) descaling (mainly, the modification of nozzle type and arrangement), the goal was to reduce descaling water consumption, the temperature drop in the roughing area and to enhance the descaling ability to ensure strip surface quality. Figure 1 shows the layout of CSC No.1 HSM.

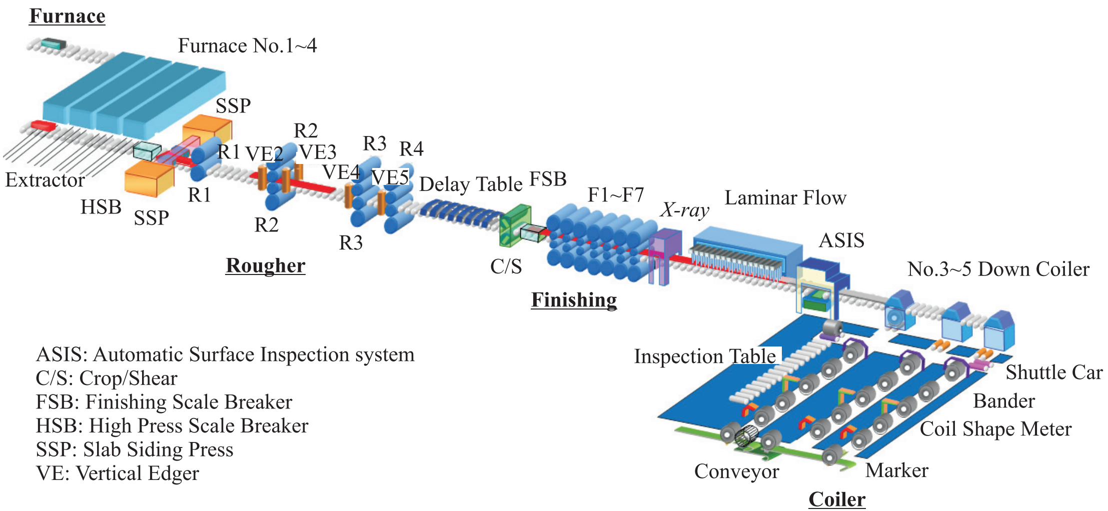


Fig.1. The layout of CSC No.1 Hot Strip Mill.

2. EXPERIMENTAL METHOD

2.1 Reasons for improvement

Limited by insufficient R2 and Finishing Mill (FM) motor power, Soaking zone Temperature (SRT) was around 1220℃ in 2009 to 2011 and Rougher Mill (RM) temperature drop averaged 185℃. The revamping of R2 motor was carried out from September 15th to October 5th, 2011, and the power was increased from 9000kW(DC) to 12000kW(AC). And then the revamping of F1~F7 motors was carried out from April 19th to May 29th, 2013, and the power was increased from 7500kW(DC) to 10000kW(AC). Since there was enough power to overcome the increase in rolling force caused by slab temperature drop, we did the improvements step by step from October 2011.

2.2 Improvement

The modifications of the HSB and rougher mill (R1-R3) descaling over different periods from October 4th 2011 to March 13th 2014. And then started to reduce furnace temperature and R4 delivery temperature targets from January 2014.

2.3 The modification HSB and R1-R3 descaling

The target includes, reducing water consumption, reducing RM temperature drop, increasing descaling effect and obtaining a better surface quality. The plan of modification includes, a spray pattern test (utilizing an aluminum test plate to make sure that the descaling spray pattern was normal after the modification), surface quality feedback (tracking of the surface quality is normal downstream), proceeding step by step (matching the progress of revamping and commissioning) and mill rolling stability (proceeding to the next stage after getting a stable rolling model setup and control).

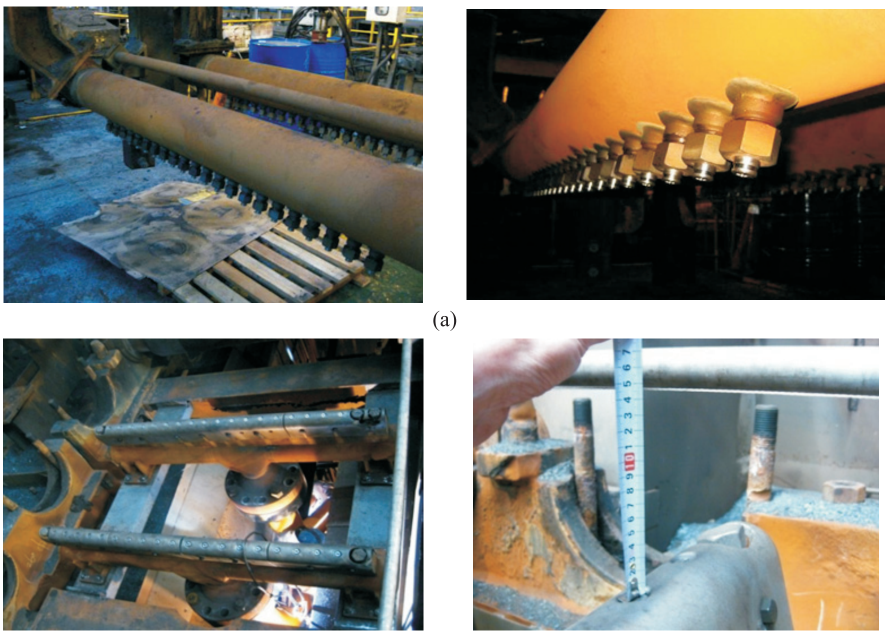
The methods of modification includes, using a low flow rate and a high impact nozzle, shortening the spray distance (using long-nose tips with protection), changing nozzle geometry (rotation angle, spray angle, etc.), plugging one of the adjacent nozzles (shortening overlap, less interference) and checking the descaling pattern is normal.

HSB and R1-R3 descaling were modified (changing the model, using long-nose tips, changing nozzle geometry and plugging one of the adjacent nozzles). But HSB long-nose tips and plugging one of the adjacent nozzles were kept as per the original.

The results include an increase in impact force. With a reduction in water consumption, RM temperature drop, SRT and fuel consumption.

2.4 Modification of high pressure scale breaker descaling

The modification of HSB descaling was carried out on October 4th, 2011, The level of the bottom header was raised and the spray distance shortened. The top & bottom nozzles were changed to high impact nozzles and the flow rate was also reduced. The effects were impact force was increased: 5% to 13% and water consumption was reduced: 20% to 34%. Figure 2 shows the modification of HSB descaling.



(a)

(b)

Fig.2. The modification of HSB descaling: (a) top nozzles: reduce nozzle flow rate, use high impact nozzles, (b) bottom nozzles: reduce nozzle flow rate, use high impact nozzles, raise the level of Bottom header (#1 header 190mm/#2 header 235mm →145mm).

2.5 Modification of R1 descaling

The modification of R1 descaling was carried out on March 13th 2014. Including, lengthening top & bottom nozzle tips to 110mm, shortening spray distance and reducing nozzle flow rate, using the latest high impact nozzles, modifying spray angle and plugging one of the adjacent nozzles. The effects were impact force was increased: 6% to 12% and water consumption was reduced: 56.3%. Figure 3 shows the modification of R1 descaling.

2.6 Modification of R2 descaling

The modification of R2 descaling delivery was carried out on October 29th 2013 and R2 entry descaling on November 27th 2013. Including, lengthening R2 Delivery & Entry nozzle tips (top: 50mm, bottom: 110mm), shortening spray distance and reducing nozzle flow rate, using the latest high impact nozzles, modifying the spray angle and plugging one of the adjacent nozzles. The effects were impact force was increased: 3% to 7.5% and water consumption was reduced: 50% to 54.4%. Figure 4 shows the modification of R2 descaling.

2.7 Modification of R3 descaling

The modification of R3 descaling was carried out on December 24th 2013. Including, lengthening R3 nozzle tips (top: 50mm, bottom: 110mm), shortening spray distance and reducing nozzle flow rate, using the latest high impact nozzles, modifying the spray angle and plugging one of adjacent nozzles. The effects are Impact force was increased: 6% to 12% and water consumption was reduced: 57.2% to 60.9%. Figure 5 shows the modification of R3 descaling.

2.8 Use of an aluminum plate to determine whether the descaling pattern was normal

For example, we did a R2 delivery descaling pattern. The results were that the overlap of the top descaling pattern was around 11.5cm to 12cm (too big) and the overlap of the bottom descaling pattern was around 1.4cm to 1.8cm (normal). Figure 6 shows the descaling pattern.

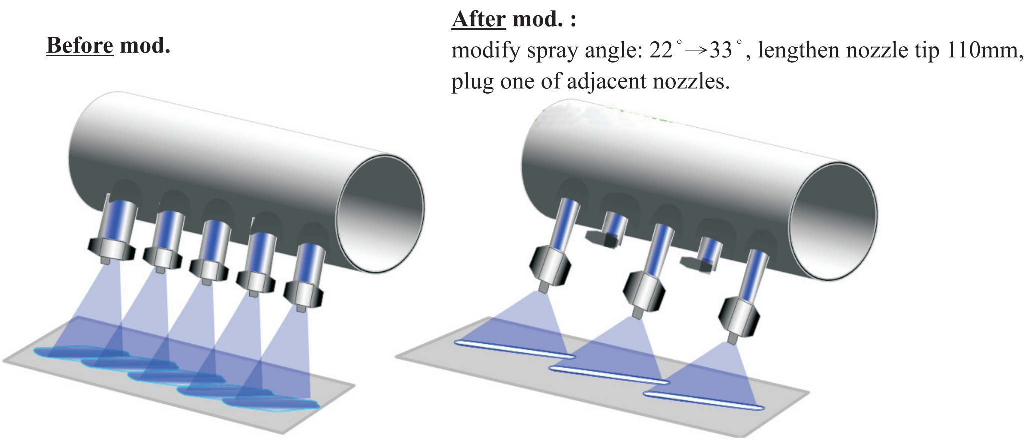


Fig.3. The modification of R1 descaling.

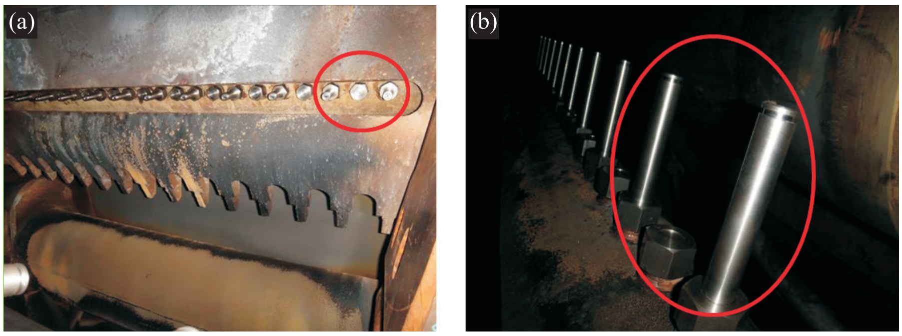


Fig.4. The modification of R2 descaling: (a) top nozzles: use high impact nozzles & Lengthen nozzle tip 50mm (b) bottom nozzles: use high impact nozzles & Lengthen nozzle tip 110mm.

Fig.5. The modification of R3 descaling: (a) top nozzles: use high impact nozzles & lengthen nozzle tip 50mm, (b) bottom nozzles: use high impact nozzles & lengthen nozzle tip 110mm.

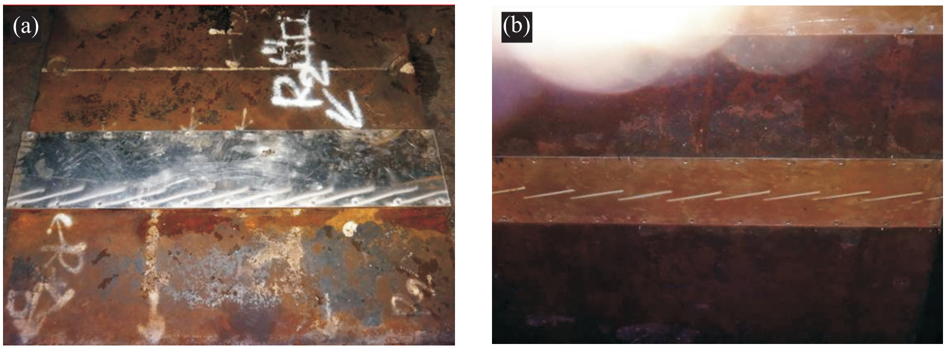


Fig.6. Descaling pattern: (a) top descaling pattern, overlap are around 11.5cm~12cm (too big), (b) bottom descaling pattern, overlap are around 1.4cm~1.8cm (normal).

2.9 Reduced furnace temperature and R4 delivery temperature target

We started to reduce the temperature for all material (SRT was reduced by 8 to 15℃) from January 2014, which included electrical steel, medium silicon, high silicon and R4 delivery temperature targets were reduced as well (low carbon steel: reduced by 10℃, structural steel & alloy steel: reduced by 5℃).

2.10 The challenge: stable mill rolling

Since the temperature was reduced, Level-2 Model setup and Level-1 control must be modified or tuned, which include FM setup (FSU)[5], hydraulic looper control[6] and profile setup (automatic profile and flatness control)[5].

3. RESULTS AND DISCUSSION

3.1 The comparison of Rougher Mill water consumption

We compared the water consumption before and after modification. The total water consumption was reduced by 42.48%. Figure 7 shows the comparison of water consumption between the before modification and after modification in descaling.

3.2 Soak zone temperature and Rougher Mill temperature drop

We started to improve the descaling efficiency from October, 2011. The average SRT: 1188℃ in 2014 and the target SRT: 1185℃. We reached the target on Jun., Aug., and Sep. of 2014. The average RM temperature drop SRT-R4 Delivery temperature (SRT-R4DT) was 154℃ in 2014, the effect was better than previous years. Figure 8 shows the achievement of reducing furnace temperature (SRT) and the Rougher Mill temperature drop (SRT-R4DT).

3.3 Fuel consumption

The target fuel consumption for the furnace was for less than 330Mcal/t. Every month of 2014 the target was reached with an average fuel consumption of 306℃ Mcal/t. The effect was better than previous years. Only fuel consumption in February and December were higher than other months because of low production, but also reached the target. Figure 9 shows the achievement of reducing fuel consumption of the furnace.

3.4 Total benefit

The total benefit from January to December 2014 was NT$18,218,665 as shown in Fig.10.

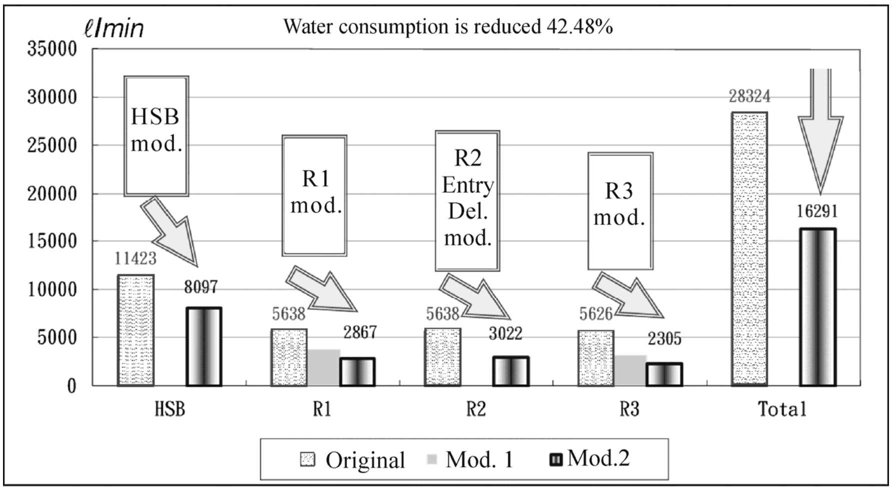


Fig.7. The comparison of water consumption between the before modification and after modification in descaling.

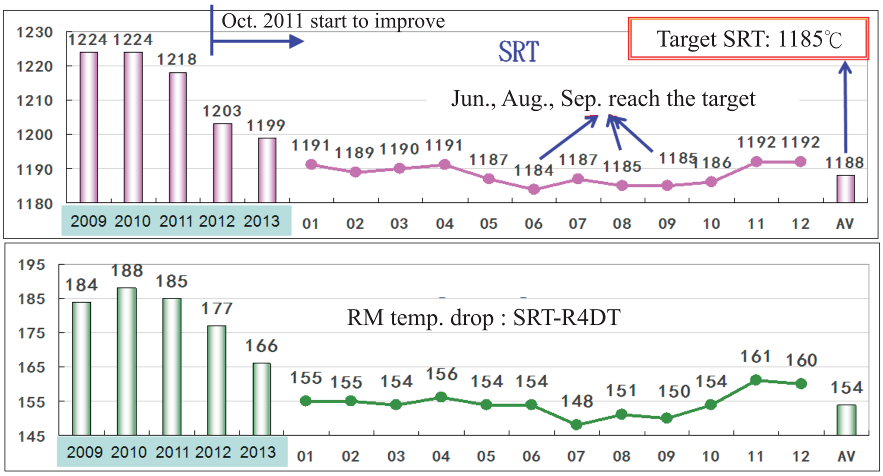


Fig.8. The achievement of reducing furnace temperature (SRT) and Rougher Mill temperature drop (SRT-R4DT).

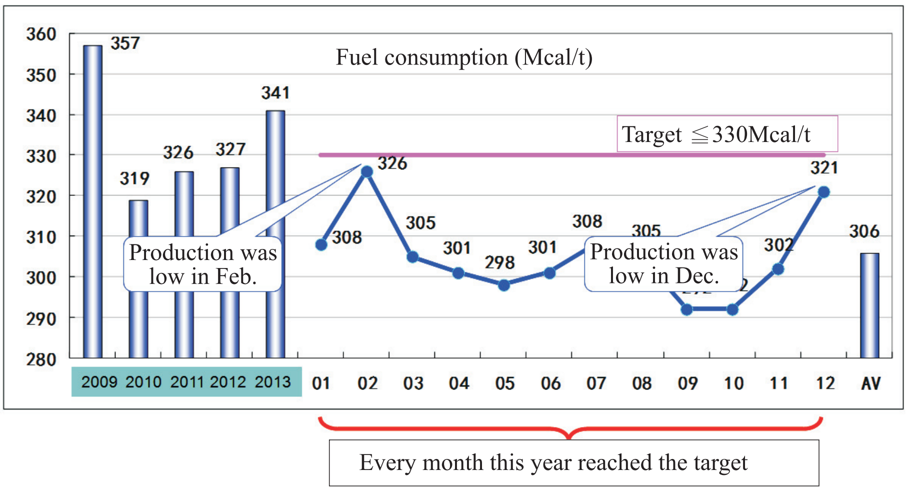


Fig.9. The achievement of reducing fuel consumption of furnace.

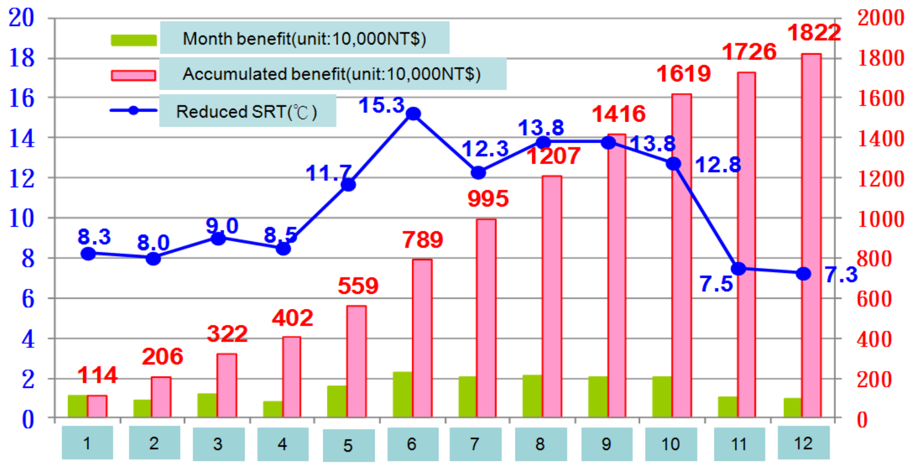


Fig.10. The benefit.

4. CONCLUSIONS

The modification of the HSB and rougher mill (R1-R3) descaling was done during different periods from October 4th 2011 to March 13th 2014 in No.1 Hot Strip Mill. The modification was mainly to the nozzle type and arrangement. By investigating the relationship between the reference nozzle geometry and descaling performance, we have proceeded expectation for measurements of enhancing descaling capacity and improving temperature drop in the roughing area successfully. The experiments also required an aluminum test plate to determine whether the descaling spray distribution pattern was normal or not, as well as the quality feedback from the downstream mill to ensure the surface quality.

Limited by insufficient R2 and FM motor power, we did the revamping of R2 motor which was carried out in 2011, the power was increased from 9000kW (DC) to 12000kW(AC). And then the revamping of F1~F7 motors were carried out in 2013, the power was increased from 7500kW(DC) to 10000kW (AC). Since there was enough power to overcome the increase in rolling force caused by slab temperature drop, we did the improvement step by step from October 2011.

We started to reduce furnace temperature and R4 delivery temperature targets from January 2014. Since the temperature was reduced, Level-2 Model setup and Level-1 control must be modified or tuned to get a stable mill rolling, which include FM setup, hydraulic looper control and profile setup.

Finally, we reached our goal of reducing descaling water consumption, the reduction of temperature drop in the roughing area and enhanced the descaling ability to ensure strip surface quality. After evaluating, the descaling impact force was increased and water consumption was reduced by 42.48%. Due to the reduction in furnace temperature, there is not only a reduction in fuel consumption, but also a reduction in rolled in scale defects. The total cost benefit was NT$18,218,665 (during the period of January to December 2014).

REFERENCES

1. Kuo-Chuan Li and Kun-Cheng Tung: Lowering Furnace Temperature to Reduce Fuel Consumption in CSC No.1 Hot Strip Mill, Mining & Metallurgy, 2015, vol.59, no.4, pp.98-111.
2. Bi-Kun Cheng, Kun-Cheng Tung, and Chao-Chi Huang: Study and Improvement on the Rolled-in Primary Scale Defect, Technology and Training, China Steel, 2010, vol.35, no.1, pp.14-24.
3. Chao-Chi Huang, Chun-Chao Shih, Kun-Cheng Tung and Bi-Kun Cheng: A High Quality, Low Energy Consuming Low Temperature Hot Rolling Process, Mining & Metallurgy, 2012, vol.56, no.3, pp.32-41.
4. J.W. Frice: More Efficient Hydraulic Descaling Header Designs, MPT International, 2004, vol. 2, pp.90-94.
5. Wei-Yi Chien, Yen-Liang Yeh, and Lo Wei: The Renewal and Improvement of Setup Models in No.1 Hot Strip Mill, Corporation Technology and Training, China Steel, 2015, vol. 40, no.2, pp .12-21.
6. Fu-Kai Chan: Tuning Process of Hot Strip Mill Loopers, Technology and Training, China Steel, 2015, vol.40, no.2, pp. 38-49. □