

HYPER UC-MILL

- Advanced Cold Rolling Mill for a Low-carbon Society -



Primetals Technologies Japan, Ltd.

In recent years, for the purpose of improving the fuel efficiency of engine vehicles and reducing the load on motors of hybrid vehicles and electric vehicles to reduce CO₂ emissions, there has been strong demand for the weight reduction of vehicle bodies. Accordingly, the adoption of high-tensile strength steel sheets has been rapidly increasing. At the same time, demand for hard and thin electrical steel sheets is also increasing, as is the need for efficiency improvement and reduction in the size of on-board electric motors. In response to such demands from society, steel making companies need a rolling mill that can produce thinner and harder materials more efficiently. Primetals Technologies has developed HYPER UC-MILL (6-high rolling mill), which has work rolls 20-30% smaller than those of UC-MILL (6-high rolling mill), a leader in the cold rolling, to meet these needs. This mill achieves a higher level of shape controllability and lower load for rolls, features heavier reduction capability than that of the existing UC-MILL, and has the significant advantage of driving the work rolls despite their small diameter. To date, we have received orders for a total of seven HYPER UC-MILLS, three of which are already operating and four of which are currently being designed and manufactured. The mill is significantly contributing to the production of hard and thin materials (high-tensile strength steel and high-grade electrical steel sheets). This report presents the characteristics of HYPER UC-MILL, the effects of its use, and an example of its application to a tandem cold mill for the production of high-grade electrical steel sheets ordered from Shougang Qian'an Electric Vehicle Electrical Steel Co., Ltd. (China) in Jan. 2020.*

** HYPER UC-MILL is a registered trademark of Primetals Technologies Japan, Ltd.*

1. Characteristics of HYPER UC-MILL

1.1 Inheriting UC-MILL core technology

HYPER UC-MILL inherits the core technology of UC-MILL, which has been widely delivered to the cold rolling industry to date. The most significant characteristic of UC-MILL is that the deflection of the work rolls caused by the rolling load can be significantly reduced compared with 4H-MILL (4-high rolling mill).

Figure 1 compares the characteristics of UC-MILL with those of 4H-MILL. UC-MILL is a breakthrough technological innovation in which undesirable contact areas between the work roll and the back-up roll existing on the outer sides of the rolled material in the case of 4H-MILL is eliminated by applying an intermediate roll between the two. The specific effects of this UC-MILL core technology are shown below.

- (1) The diameter of the work rolls can be made smaller because the deflection is reduced, which makes it possible to roll harder materials and thinner materials.
- (2) The excellent shape control ability is achieved due to the large bending effect of the work roll and the intermediate roll.
- (3) A roll crown to compensate for deflection is not required, so roll inventory can be improved.

UC-MILL has received high praise for these characteristics, and more than 430 UC-MILLS have been put into operation worldwide since its development.

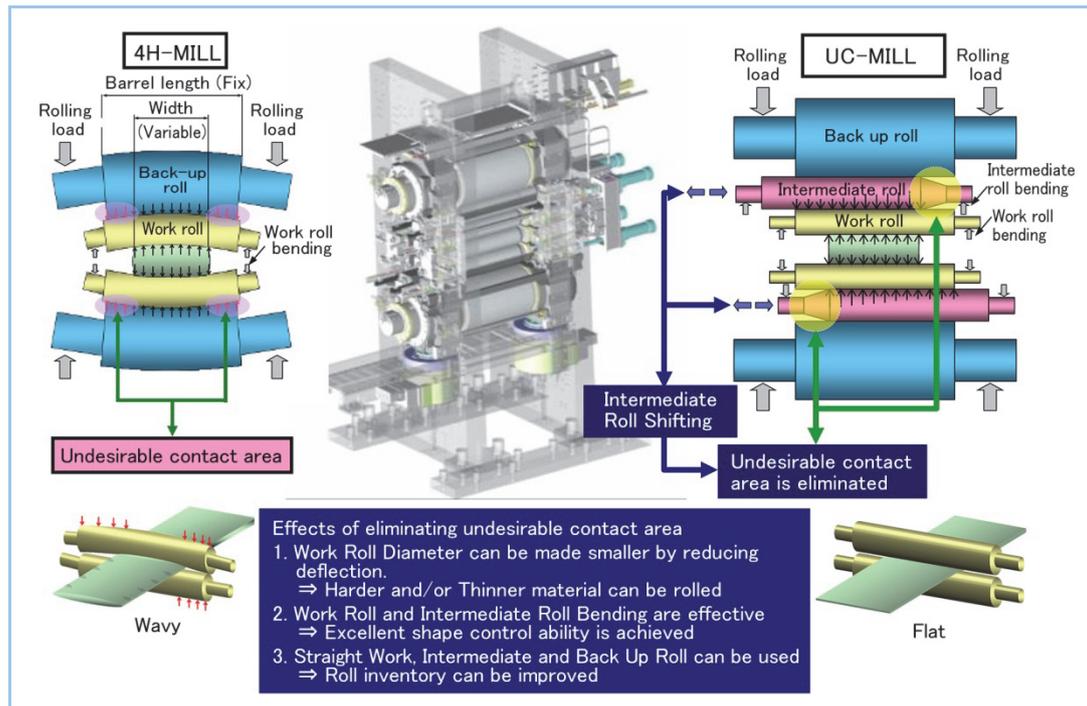


Figure 1 Features of UC-MILL

1.2 Work rolls 20-30% smaller in diameter

For HYPER UC-MILL, a reduction in diameter of 20-30% compared with the existing standard UC-MILL described above were attained.

Figure 2 compares HYPER UC-MILL and the standard UC-MILL. As shown in this figure, the diameter of the work rolls of HYPER UC-MILL was reduced, while the diameter of its intermediate rolls was made larger compared with the standard UC-MILL. The combination of these roll diameters results in the following significant advantages.

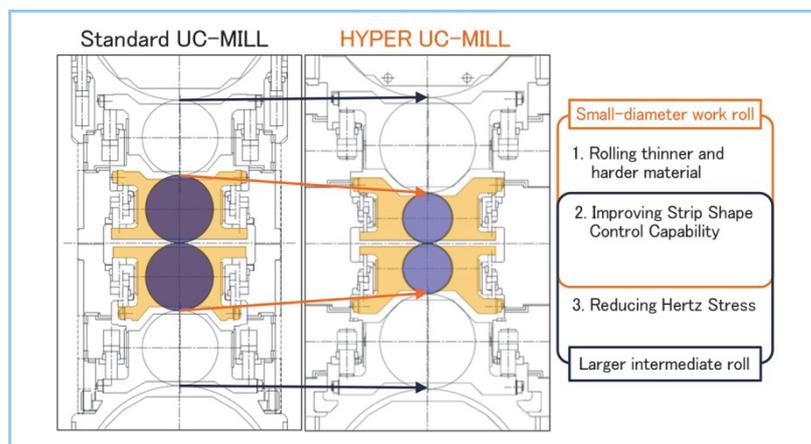


Figure 2 Comparison of HYPER UC-MILL and standard UC-MILL

- (1) The smaller-diameter work rolls make it possible to roll even higher-strength materials and thinner materials.
- (2) The combination of the small-diameter work roll and the large-diameter intermediate roll improves the shape control capability.
- (3) The adoption of the large-diameter intermediate roll reduces hertz stress (contact pressure) between the intermediate roll and the back-up roll.

Figure 3 compares typical examples of the relationship between the work roll diameter and the strip width by mill type. The development of UC-MILL significantly reduced the diameter of work rolls compared with 4H-MILL, which was the mainstream in the past, and the development of

HYPER UC-MILL achieved a similar degree of reduction in the work roll diameter compared with UC-MILL.

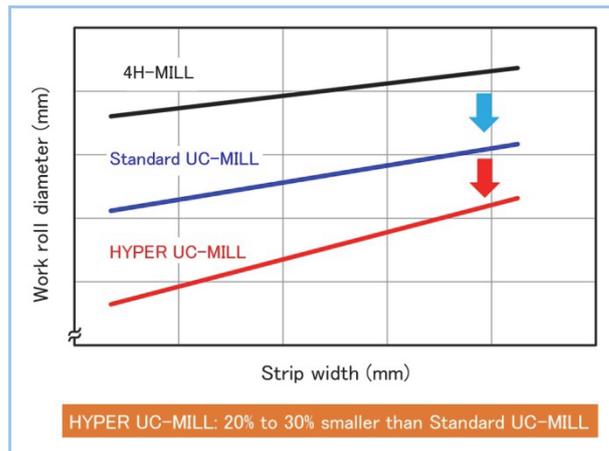


Figure 3 Work Roll Diameter and Strip Width

2. Effects brought about through the use of HYPER UC-MILL

This section presents two revamp examples of the effects brought about through the use of HYPER UC-MILL.

Figure 4 presents an example of the revamp of a reversing cold mill at Maanshan Iron & Steel (China) from a standard UC-MILL to HYPER UC-MILL in 2018. This mill, dedicated to the production of electrical steel sheets, was made capable of producing even higher-strength and thinner products by this revamp, earning the technology a good reputation.

As shown in Figure 4, the rolling data before and after the revamp indicate the significant effect that in the case of rolling a material of the same steel type and same entry/exit thickness, both the number of passes and the rolling load in each pass can be reduced.

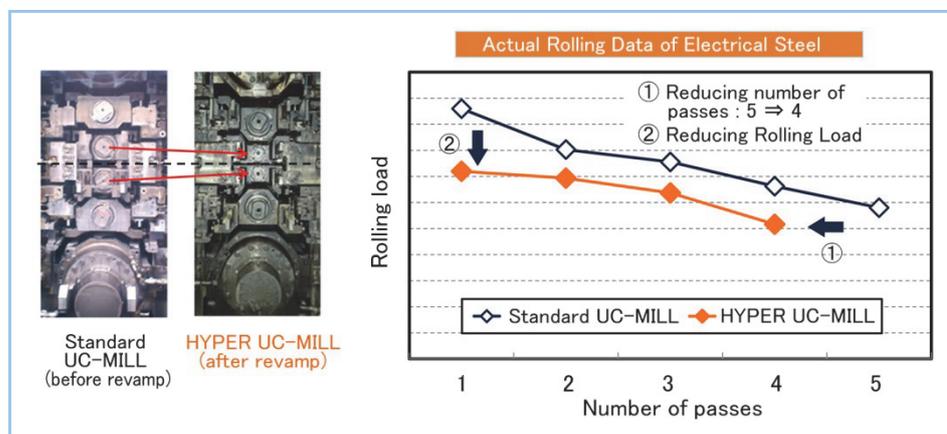


Figure 4 Example of revamp to HYPER UC-MILL on Reversing Cold Mill

The following is an example of applying HYPER UC-MILL to a tandem mill. Revamping a 4Hi-MILL of the existing 5-stand tandem mill to a HYPER UC-MILL significantly improved the rolling reduction ratio of its stand and made it possible to roll high-strength steel thinner as a result.

3. Applying HYPER UC-MILL to TCM for producing electrical steel sheets

Table 1 lists the orders received for HYPER UC-MILL, three of which are for reversing cold mills and four of which are for tandem cold mills. In terms of the type of project, four are for revamps and three are for new construction. All of these orders aim to improve the production capability of high-strength materials and thin materials such as high-tensile strength steel sheets and electrical steel sheets.

Table 1 Supply References of HYPER UC-MILL

Customer	Project Type	Summary		
Maanshan Steel No.3 RCM 【 Running】	Reversing Cold Mill: New	Type Start Up Material	Single Reversing Cold Mill 2013 Electrical Steel	
Maanshan Steel No.1 RCM 【 Running】	Reversing Cold Mill: Revamped to HYPER UC-MILL	Type Start Up Material	Single Reversing Cold Mill 2018 Electrical Steel	
A Company 【 In Progress】	Tandem Cold Mill: Revamping to HYPER UC-MILL	Type Start Up Material	4-strand Tandem Cold Mill 2020 Electrical Steel, HSS	
B Company 【 Running】	Tandem Cold Mill: Revamped to HYPER UC-MILL	Type Material	5-strand Tandem Cold Mill AHSS	
C Company 【 In Progress】	Tandem Cold Mill: Adding HYPER UC-MILL to Existing Line	Type Start Up Material	6-strand Tandem Cold Mill 2021 AHSS	
D Company 【 In Progress】	Reversing Cold Mill: New	Type Start Up Material	Single Reversing Cold Mill 2021 Low Carbon Steel (0.2 mm)	
Shougang Qian'an 【 In Progress】	Tandem Cold Mill: New All HYPER UC-MILL with Work Roll Shifting Function	Type Start Up Material	6-strand tandem Cold Mill 2022 Electrical Steel, AHSS	

One point to be noted in this table is the case of application to a tandem mill producing electrical steel sheets of Shougang Qian'an Electric Vehicle Electrical Steel Co., Ltd. (China). **Figure 5** illustrates the technology required for a tandem mill producing high-grade electrical steel sheets. Such a mill producing electrical steel sheets must be ① a smaller-diameter work roll mill that meets the increasing demand for harder and thinner materials aiming at higher efficiency and smaller size, ② a continuous tandem mill that satisfies the requirements for high quality and high productivity, and ③ a work roll shifting mill that responds to the strict strip thickness accuracy in the strip width direction (minimizing of the edge drop) as a quality requirement specific to electrical steel sheets. Thus, we developed HYPER UCMW (HYPER UC-MILL with Work Roll Shifting Function) as shown in **Figure 6** and enabled edge drop control to meet all of requirements ① to ③ for a tandem cold mill producing electrical steel sheets.

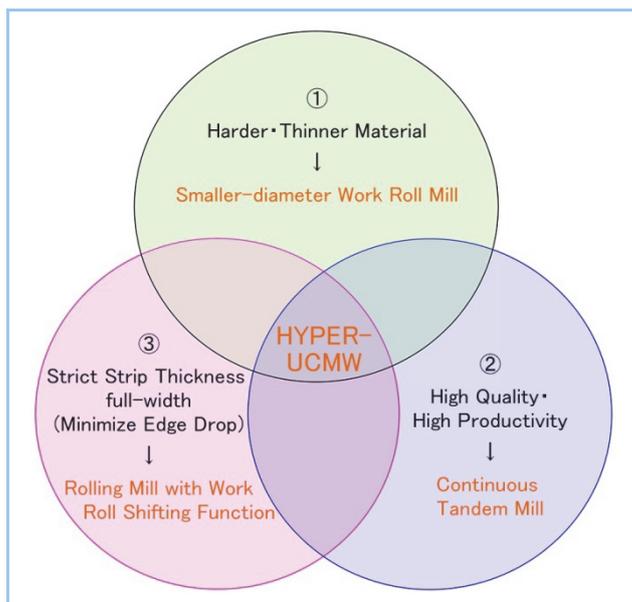


Figure 5 Technologies required for producing High-Grade Electrical Steel

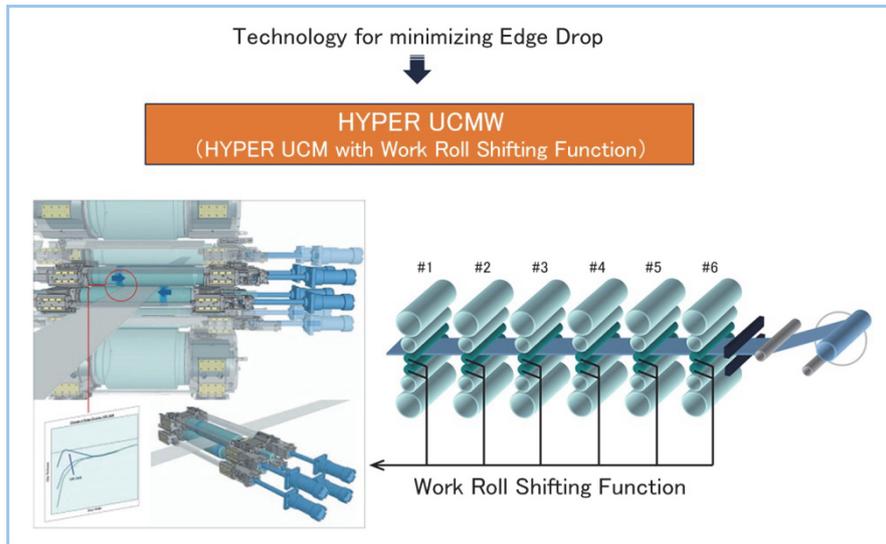


Figure 6 HYPER UC-MILL with work roll shifting function

4. Future prospects

We will continue to improve HYPER UC-MILL technology to contribute to the stable rolling of high-strength materials and thin materials such as high-tensile strength steel sheets and electrical steel sheets to realize a low-carbon society. In particular, our smaller-diameter work rolls continue to be in strong demand among customers, so we will continue to proceed with development to meet this need.