Thermal Stain Improvements at Reversing Cold Mills

Authors

Leonardo R. Nieves
hot mill manager, Ternium México,
Monterrey, N.L., Mexico
lnieves@ternium.com.mx

Morales M. Jesus
Ternium México,
Monterrey, N.L., México
jmoralesm@ternium.com.mx

González C. Marco
Ternium México,
Monterrey, N.L., México
mgonzalezch@ternium.com.mx

Sofía Valdez
purchasing director, ASV Supply Inc.,
Laredo, Texas, USA
svaldes@gsgsupply.com

The main quality issue within a reversing cold mill has been strongly related to emulsion carryover and the high process temperature, which are the mechanisms to create a point oxidation randomly located on the strip surface, named "thermal stain." Galvanizing lines do not accept these stains. This paper shows how — after making significant process temperature improvements, and implementing better emulsion control and pinch roll (PR) functionality changes, new PR materials and new air nozzle header design — the occurrence of stains decreased by 40% year over year. Furthermore, due to the quality improvements and the new air nozzle design, the noise level decreased by 10 decibels and there was 20% less air consumption.

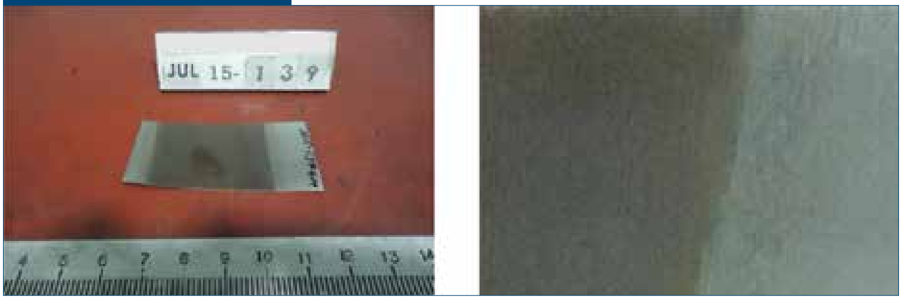
In galvanizing lines, in order to guarantee an adhesion of the coating, it is necessary to have a cold-reduced material (full hard) surface free of defects (such as oxides and/or thermal stains). Layers of oxidation and/or thermal stains not removed in the caustic cleaning that are not distilled in the continuous annealing oven can cause defects that may change coated surface appearance (for low coating thicknesses) and/or coating failure. Oxide particles joined with oil also cause dross in the pan and subsequent adhesions in the sheet.

This paper focuses its analysis on the reversible cold mill No. 3 located at Planta Guerrero (today operated by Ternium México). The machine is a Bliss Machine LTD that started operation in 1978. During its first years, the mill focused on the manufacture of material that was routed to the batch annealing process. With the integration of this plant into Ternium's operation and due changes in the markets, the reversible cold mill No. 3 refocused its production to supply the galvanized lines, and the laminator was forced to adapt to minimizing the generation of defects.

Discussion

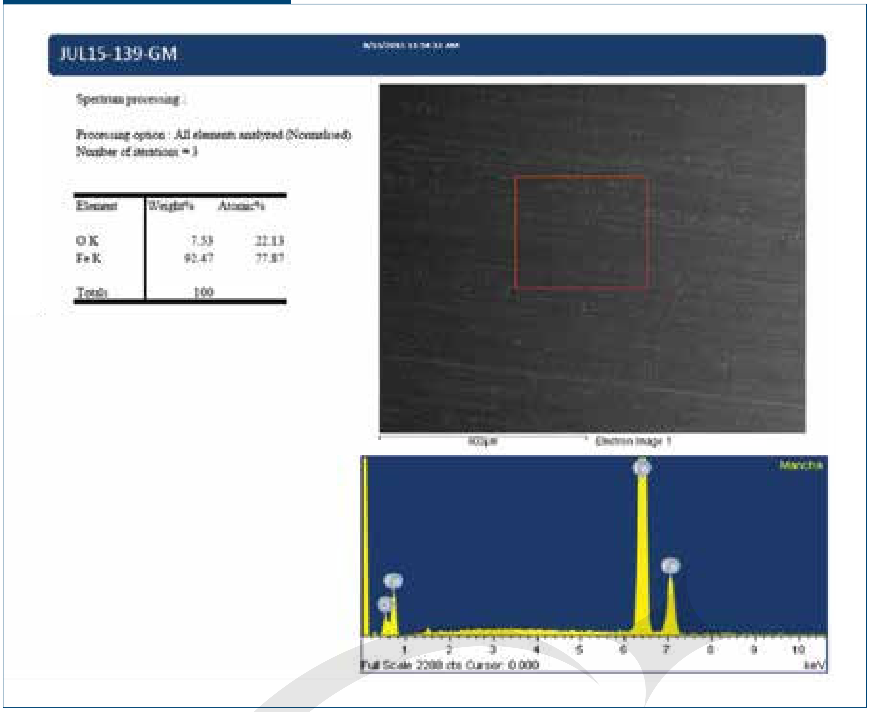
The thermal stains can be observed by the naked eye after being cold reduced (in this case, stains were characterized in the cleaning line). They were detected in both sides and randomly across the width and length; stains could cover the entire width, and could be presented as strips, lines or dots. The thermal stains have an elongated morphology (generally in the sense of rolling),

Figure 1



Thermal stain sample – macroscopic appearance.

Figure 2



Thermal stain sample – microscopic appearance.

with shades ranging from blue to dark brown, and occur in irregular sizes. They are also known as oil stains at Ternium.

From a microscopic point of view, thermal stains are thin layers of iron oxide (<1 µ mm). Because of the thickness of the oxide layer, it was not possible to prepare a sample large enough to analyze the cross-section of the stain. However, the following figures show how, using the scanning electron microscope and x-ray diffraction analysis in the defect area, slight iron formations could be observed. In the defect area, it does not only affect elements of the base material. This comparison helps to confirm the presence of a corrosion phenomenon.

This corrosion phenomenon is initiated by the rolling oil solution (99% water) remaining on the surface of the sheet and then it is coiled (humidity). Factors such as temperature, time and the amount of emulsion carrying over contribute directly to corrosion severity; therefore high temperatures of roller cooling, poor lubrication and inefficient sweeping mechanisms are the main causes for this defect.

In the case study (MF3), by 2015 there was a declassed material (rework/secondary) generation of around 1% monthly. Fig. 3 shows a monthly breakdown for 2015.

Improvements made in MF3 were focused on these causes and will be detailed in the following sections. The actions were taken simultaneously for each of the causes by carrying out a master plan. For didactic purposes, each of the actions will be described separately by root cause.

Coil Temperature — The first hypothesis was based on factors that promote corrosion (humidity and temperature), because the solution is basically water (99%). If the temperature of the base material (coil) is higher than 100°C, the water would evaporate and the stain problem would disappear. This hypothesis was ruled out immediately because even when the temperatures were around 100°C, the defect occurrence remained steady.

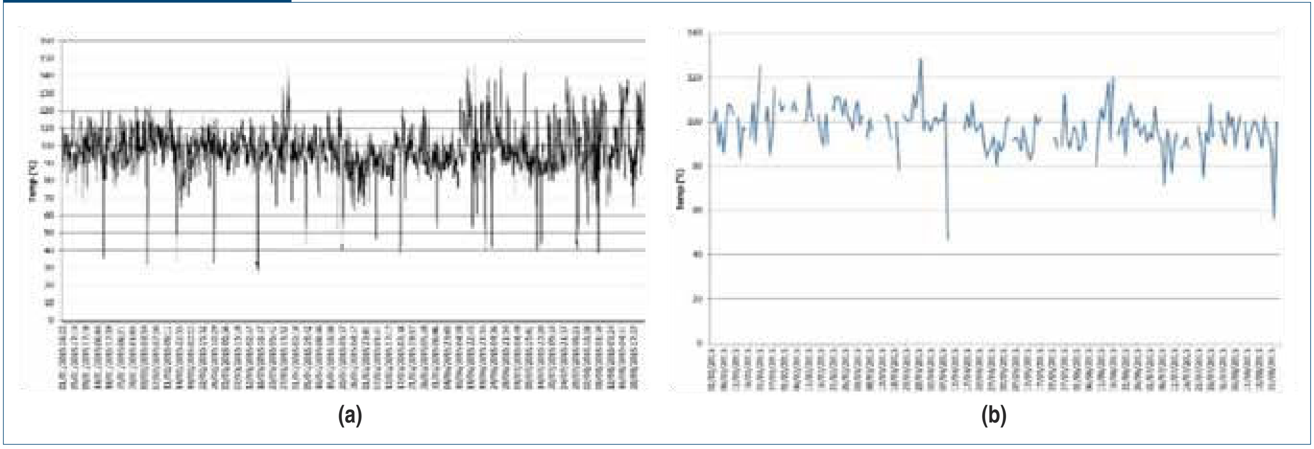
After correlating the MF3 coiling temperature versus the intensity of the defect revealed by the inspection at the cleaning line (batch annealing routed), it was observed that for coils wrapped in temperatures lower than 80°C, defects logarithmically decreased. That is why this paper's main objective became controlling any source of coil temperature increase and maintaining winding temperatures below 80°C. The first steps were to adjust and correct the header configuration and nozzles.

In order to make these coiling temperatures feasible and sustainable, corrections were made in the configuration and application of flows in the heads of

Figure 3

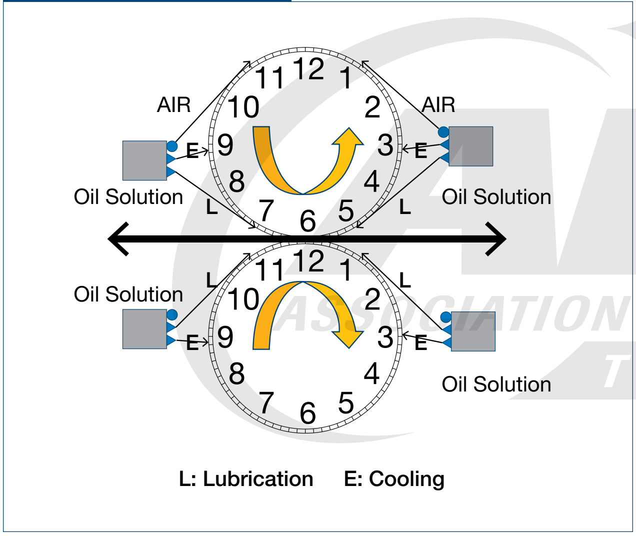
Thermal stains declassed material (2015).

Figure 4



Coil temperature: all products (a) and 26 and 29 gauge (b).

Figure 5

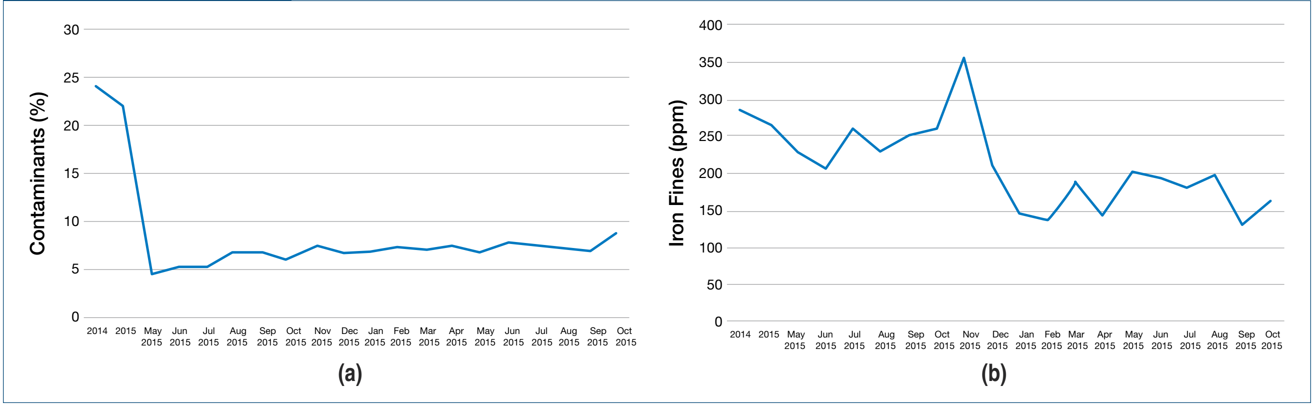


Headers (air/solution) configuration.

the work rolls. To do this, the appropriate configuration (nozzles according to prints) and geometry of the emulsion heads (Fig. 5) were revised. The emulsion flow was increased by applying the four headers in the last two passes (changing work instructions) and achieving at least 2.5 bar at headers due lower pressures, which means lower impact angles toward the work rolls and therefore less coverage area for cooling and lubrication.

Rolling Oil (Solution) — For cold rolling processes, oil solution fulfills a double role: the first, as already mentioned before, is related to work roll cooling (temperature), and the second is basically reducing friction that originated between the work rolls and the substrate (lubrication). In this sense, the concentration of oil, amount of iron fines and concentration of heavy oils (contamination) are key parameters in maximizing lubricity.

Figure 6

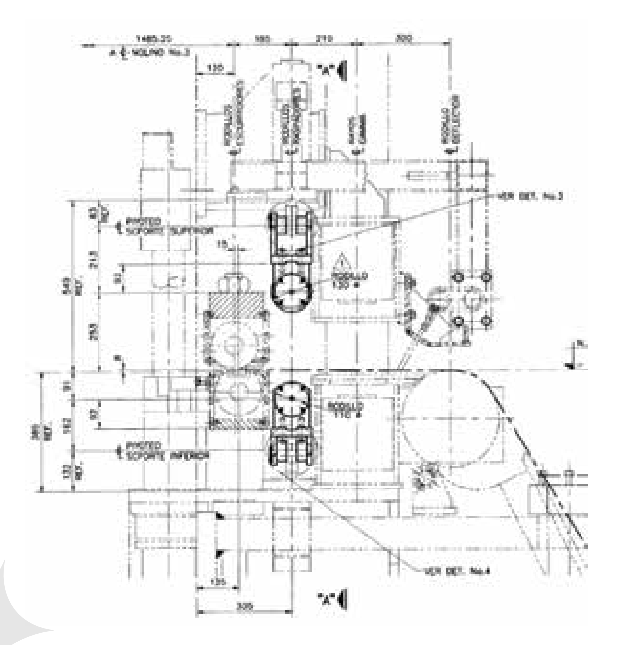


Oil solution: contaminants (tramps) (a) and iron fines (b).

A dedicated task force (consisting of operations, maintenance and the oil supplier) was incorporated into the daily management to monitor, detect, plan and correct heavy oil leaks in the mill (i.e., meropa, hydraulic and oil-mist). Meanwhile, maintenance and replacement of the magnetic filters were executed (changing bent magnetized tubes basically), tube and rubber sweeper change frequency was increased, and filter speed was increased 10% in order to guarantee greater uptake of iron fines.

Vacuum filter (Hoffman) was checked for vacuum capacity, specifically filter paper specification. Paper filtering capacity was adjusted to 10 microns (from 50 microns to 40 microns). Fig. 6 shows a contamination and iron fines concentration chart, and how they were impacted by the actions taken. In this, sense not only is the condition of heavy oils and iron fines the emulsion improved, but less corrective maintenance (such as skimming) or partial change of emulsion are required, which translates to savings in oil consumption.

Figure 7



Roll configuration in the exit section.

Carryover — The amount of solution that is dragged and subsequently rolled up (humidity) is the last piece to be controlled in order to break the corrosion cycle described earlier. During the development of this paper, two important actions were taken to reduce/eliminate solution carrying over. As seen in Fig. 7, there are two barriers designed to stop the emulsion carryover: squeegee rolls and scraper rolls. In both cases, the mechanisms were rehabilitated in order to improve the application pressure; in addition, the material of the upper scraper rolls was modified from hypalon to a compound with greater draining capacity.

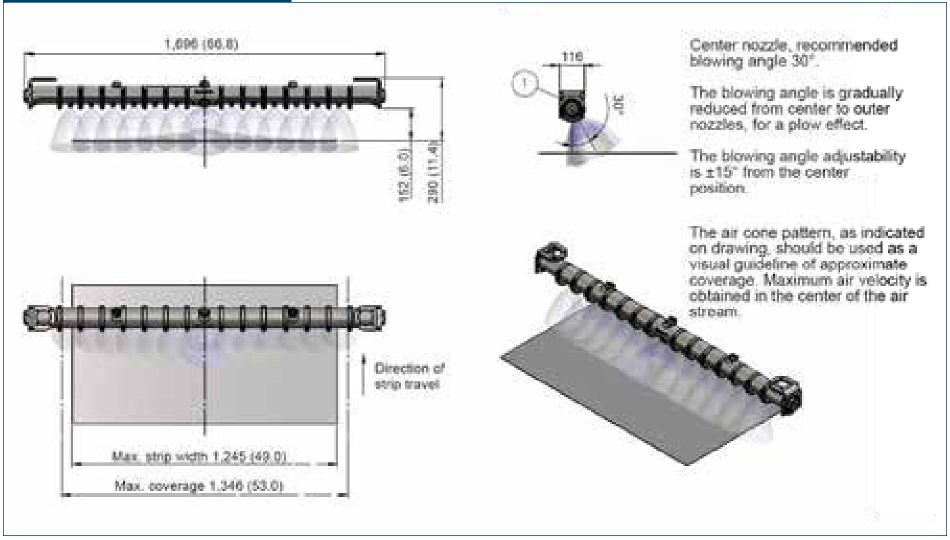
Finally, air headers with greater sweeping capacity (higher speed) using special nozzles were designed and installed. These headers not only ensured the proper sweep, but also decreased noise generation in the area and saved air consumption.

Conclusions

Thermal stains or oil stains in cold-rolled material could improve if the following three factors are controlled: (1) refrigeration (decreasing coil temperature), (2) lubricity properties of oil solution (less amount of fines iron and tramps reduction of heavy oils and grease) and (3) carryover sweeping. As shown in Fig. 9, thermal stains average generation is less than 0.5%. Additionally, due to the change in technology in the sweeping air header, an improved noise generation of 10 dB and a 750 scfm decrease in compressed air consumption were also realized.

Additionally, and as a correlated effect of actions taken over the oil solution conditions, contamination

Figure 8



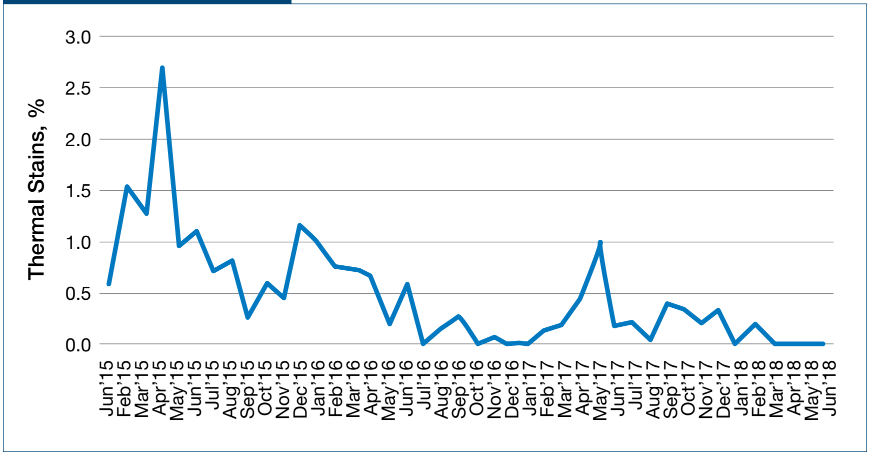
Air headers.

levels improved and the amount of iron fines drastically decreased the rolling oil consumption because it was no longer necessary to perform skimming practices nor drain the oil solution tanks.

Acknowledgments

The authors are grateful to the entire maintenance, process and operative teams of Ternium México who dedicated their experience and job to improve the MF3's quality performance (especially thermal stains), following up, fixing and validating of every activities committed in this paper.

Figure 9



Thermal stains declassed material (2015–2018).

References

1. H. Kaescher, *Corrosion of Metals: Physicochemical Principles and Current Problems,* Springer-Verlag Berling Heidelberg, N.Y., 2003.
2. L. Vignolo and D. Borlini, *Confined Jet Dryer — A Definitive Answer to Solution Stains in Cold Rolling,* Italy, 2015.
3. *Metal Handbook, 9th ed., Vol. 13, Corrosion,* ASM International, Metal Park, Ohio, USA, 1987. ✦

AISTech — This paper was presented at AISTech 2019 — The Iron & Steel Technology Conference and Exposition, Pittsburgh, Pa., USA, and published in the Conference Proceedings.

Did You Know?

POSCO Developing Precision Location Tag

A POSCO research and development subsidiary is partnering with two technology firms to develop a location-tracking tag to be used in its plants.

In a statement, the subsidiary, PiBEX, said it is working with U.S.-based Energous Corp., a developer of wireless charging technology, and Korea's SK telesys, which manufactures communications equipment.

"We are working with SK telesys and Energous to design and build an ultrawide band tracker device which not only stands up to the elements through a waterproof design, but also brings charging convenience, and most importantly helps manage risk within our factories," said PiBEX chief executive Myung-sik Chun.

Ultrawide band technology is a type of radio communication that uses low power and can transmit large amounts of data over short ranges. It can be used to precisely locate objects, even in areas where signals could be disrupted. The tag that is being developed also would incorporate Energous Corp.'s wireless charging technology, called WattUp.

"PiBEX and POSCO's interest in our WattUp technology for its UWB tracking tag represents a step forward for the company into the industrial market. Our WattUp wireless charging technology is especially applicable for industrial applications because of its scalability, small footprint and our ability to charge both at contact as well as at a distance," said Energous president and chief executive Stephen R. Rizzone.

"We are proud to have a worldwide leader in the steelmaking industry integrating our technology to ease the charging of devices they rely on 24/7 and bring greater efficiency and safety to the industrial workplace," he added.