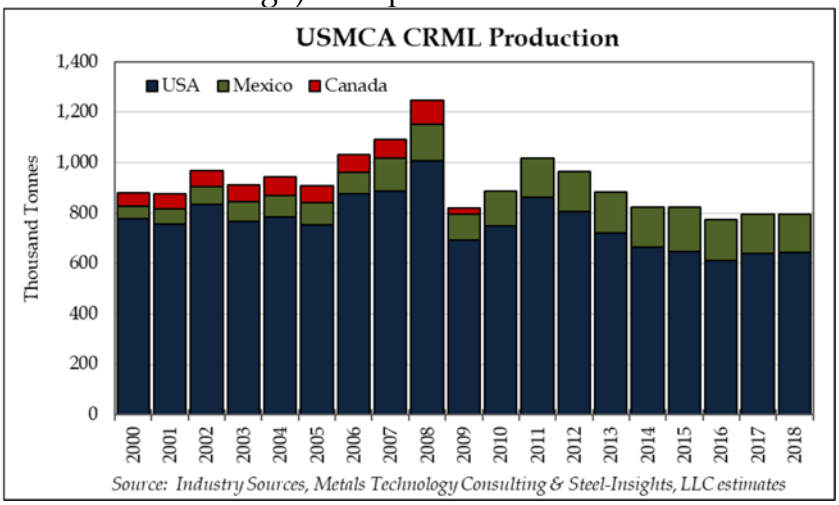
The NOES Chronicle:
Everything Non Grain Oriented

Issue 2

To CRML Or Not To CRML

CRML is **primarily a USMCA (formerly NAFTA) phenomenon** that started in the 1960's and 1970's due to excess cold rolling capacity and low energy costs in the USA. The vast majority of motor manufacturers in Europe and Asia use NOES. CRML uses similar manufacturing processes to cold rolled but has silicon and aluminum additions, vacuum degassing and a very heavy temper pass. Magnetic properties are developed as a result of an anneal after part stamping by the final customer. *(Note: By comparison, NOES doesn't require a customer anneal to achieve the desired properties.)* There are a number of grades, but the majority (perhaps 80%) is described as Type 3 or Type 4, in thicknesses 0.0185", 0.022" and 0.025". There are higher grades containing more silicon, and thicker versions. Not all the suppliers can make the higher grades. The very best grade of CRML has properties similar to M19/M22 NOES but has the disadvantages of not having a coating. The majority of CRML is used in small size, high volume, consumer related fractional horsepower motors (lower than 5 horsepower), in air conditioning / refrigeration motors and in generators. While there might be small differences in performance, CRML and NOES can be used interchangeably in many instances with the final product cost being the major decision driver.

The current USMCA market for CRML is about 800 thousand tonnes (down from 1.2 million tonnes a decade ago) with production in 2019 forecast to be dominated by Nucor at 283 thousand tonnes, ArcelorMittal at 242 thousand tonnes, US Steel at 130 thousand tonnes, Big River Steel at 25 thousand tonnes and Ternium at 144 thousand tonnes in Mexico. Imports are essentially zero and production and consumption of CRML are similar in the USA.



In recent years, USA consumption of CRML has been lower than production due to exports to Mexico. Consumers of CRML include Regal Beloit/ Copeland, Tempel, Nidec, Eurotranciatura (formerly Tecumseh) and Emerson. Most of the major consumers work off annual contracts usually with minimum volumes and prices following CRU (monthly or quarterly, depending on the supplier). Quarterly or six-month rebates are normal based on attainment of minimum volumes. In some cases, freight adjustment allowances are negotiated. Despite tight magnetic and mechanical specifications, CRML is treated commercially

continued on page two

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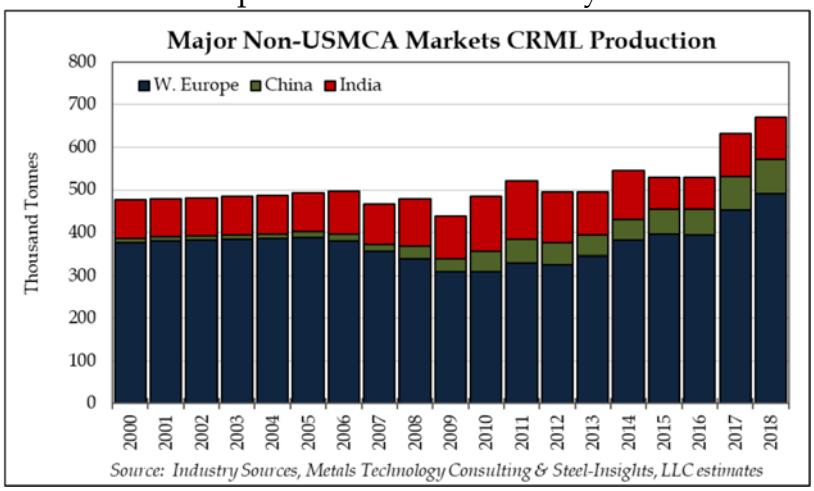
TO CRML OR NOT TO CRML continued from page one

as a commodity, price sensitive product. Scrap return, in the form of clean busheling, is typically a major component of pricing.

The current major non-USMCA markets for CRML total about 670 thousand tonnes compared to about 475 thousand tonnes in 2000 with production dominated by Western Europe at 490 thousand tonnes, China at 80 thousand tonnes and India at 100 thousand tonnes. Imports are essentially zero and production and consumption of CRML are similar. The only potential capacity addition that we are aware of is potentially at Arvedi, Italy.



To NOES In North America Or TO NOES Not

NOES uses the same melting, hot rolling and cold rolling equipment as CRML but the product is differentiated by finishing in a specialized continuous anneal line with a coating applied to both sides. *(Note: While the product is differentiated in the anneal line, the actual final properties are achieved through the different metallurgy and the production process at the mill.)* Additional annealing by the stamper isn't required but does have advantages in some applications prompting some producers to include final annealing as part of their processing.

Metallurgically, NOES is different from CRML with greater alloy additions of silicon (Si) of up to 3.0% compared to a typical of just 0.4% in CRML. Consequently, the range of grades and applications is greater. The coating is a distinct advantage. NOES grades may be considered in terms of three categories: a) low grades (one grade in China, 50H800, accounts for about half of the country's eight million tonnes of supply); b) middle and high grades (requiring hot band anneal); and c) specialty automotive electric vehicle (EV/HEV)/high frequency grades.

High grade NOES requires specially designed or modified continuous annealing furnaces (including ceramic rolls, extra refractory, zone segmentation, closer tension controls and, in the better producers' cases, a decarburization section). *(Note: Earlier this year POSCO announced a dedicated high grade NOES line targeting EV market growth.)* Low grade NOES would not normally be produced on these lines due to the underutilization of the higher performance equipment that has been designed to run high and specialty EV/HEV grades.

continued on page three

TO NOES IN NORTH AMERICA continued from page two

(Note: We would liken it to using a Ferrari to drive to work. It's completely capable of performing the task, but a complete "waste" of a high-performance motor vehicle.) Thus, many mills target specific NOES grades to specific grade annealing lines to optimize costs and total production volume. Unlike the batch annealing equipment used to produce CRML, a "continuous" annealing line fixes discreet market volume increases based on the line size, typically 100 to 150 thousand tonnes per line. Hot band annealing (normalizing) is required to achieve the performance characteristics of medium to high grade NOES products. Balancing the capacity of the normalizer to obtain optimal economic benefit can be a challenge.

SMS Technology producing top quality electrical steels: Based on our market feedback, all of the SMS technology NOES grades respond well to annealing reducing the requirement of developing separate semi-processed and fully processed grades, in our opinion. *(Note: Several producers in Europe offer semi-processed NOES grades, designated AP or HP with lower alloy content but higher permeability after a required customer anneal after stamping).* That being said, as always with any new steel production line, even with substantial supplier assistance, **there's a steep learning curve to move from basic to high grade NOES, perhaps at least six months to a year to produce the very best grades**.

Market profile: There's only one USMCA manufacturer of NOES remaining in the marketplace: AK Steel out of its Butler, PA mill with finishing at its Zanesville, OH facilities utilizing old, low efficiency equipment in multiple locations, making it a high cost producer compared to other international producers. *(Note: AK Steel's hot mill was installed in 1954 and is limited to processing "light-weight" slabs of 16,000 pounds (7.3 tonnes) compared to its peers at 40,000-42,000 pounds. The 3-stand cold mill was installed in the 1960s.)* AK Steel currently produces about 50 thousand tonnes of NOES per year (capacity in 2004 was 110 thousand net tons), mostly of the high grades.

Imports into the USA market are about 30 thousand tonnes per year, to supply the consumption of about 65 thousand tonnes per year. Total USMCA consumption is about 131 thousand tonnes per year (or less than 1% of the global market) with low exports of 17 thousand tonnes.

USMCA NOES consumption growth is expected to be 3.5% per year for the next decade with consumption growth in the USA rebounding to 5% as manufacturing migrates back due to recent business friendly legislation. Mexico will likely continue to have volatility in its consumption but is expected to shift back to a generally positive up trend.

Steel-Insights, LLC's monthly publication "The NOES Chronicle" is available on an annual subscription basis for $2,000 per year. Additional NOES offerings include a detailed industry analysis report and a HEV market report and forecast. For further details, please contact Becky E. Hites at becky.hites@steel-insights.com.

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