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CASE STUDY

Easing bottlenecks using Lean Six Sigma tools

Specialty-alloy workforce owns and solves Melt Shop problems

An Implementation Engineers Engagement

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Specialty-alloy workforce owns and solves Melt Shop problems

A bottleneck with its primary product in the Melt Shop created a huge issue for our client, a specialty-alloys manufacturer. Current market demand and prices meant that its Ohio facility operated with thin margins and limited discretionary spending. To mitigate risk and work within spending limits, a very focused engagement was ordered to address the bottleneck and also engage its workforce in adopting a continuous improvement process while teaching Lean Six Sigma problem-solving methodology.

Meeting tells workforce what to expect

The vanadium in FeNiMo, our client's primary product, was creating problems. If the vanadium content is more than 2% or NiMo content is less than 45%, the product is rejected and re-melted. When the NiMo content is increased, it can be sold at a higher margin. 55% NiMo is a good thing as it draws the premium price.

The task was to ensure that the amount of vanadium in FeNiMo was kept low while increasing the NiMo content. A three-week Lean methodology engagement would involve the Melt Shop; Furnace No. 2 and its personnel, operation, and support; and include a Kaizen event.

A kickoff meeting gave an overview of the Lean Six Sigma and Kaizen event, its data requirements, studies to be conducted, and the resources needed to support the Kaizen.

A Project Charter was also created.

Project Charter (Implementation Engineers)

Project Name: Melt Shop Furnace #2

Problem Statement: Since January 1st, 2013 the FeNiMo output from Furnace #2 is experiencing 24.5% non-conformance for the vanadium concentration being over 2% and 66% non-conformance for nickel and molybdenum being below 55% concentration.

Objective: Define and understand the impact of the furnace #2 inputs and how they affect the quality of FeNiMo.

Standardize the procedure of how blends and batches are created and added to Furnace #2.

The goal is to reduce Non-Conformance (NC) levels to their 2012 averages of 13% NC for [V] and 28% NC for [NiMo]

Primary Metric(s): FeNiMo Quality (% NC due to V, % NC due to NiMo)

Secondary Metric(s): FeV Quality

Project Toolbox: ☐ Lean Manufacturing ☐ Six Sigma Methodologies ☐ Nike "Just Do It!" ☑ Combination of Tools

Project Approach: ☐ Kaizen Event ☐ Traditional Project Management ☑ Combination of Approaches ☐ Other

Project Start: 9/9/2013 **Duration(Wks):** 3 **Project End:** 9/29/2013

Team Size: 6 **Team Involvment:** ☐ Part-time ☑ Full-time ☐ Combination

Team Roster Worksheet:

	Name	Expertise	Hrs/Wk
1	Wayne Johnson	Material Operator	40
2	Charles Seaman	Furnace Operator	40
3	Jack Kemp	Process Engineer	40
4	Ralph Michaels	Accounting	40
5	Doug McDougle	Melt Shop Process Engineer / QA Manager	30
6	John McCain	Shipping and Receiving Manager	10
7	Candy Randall	Melt Shop Superintendent	5
8	Will Judson	Lab Supervisor	5

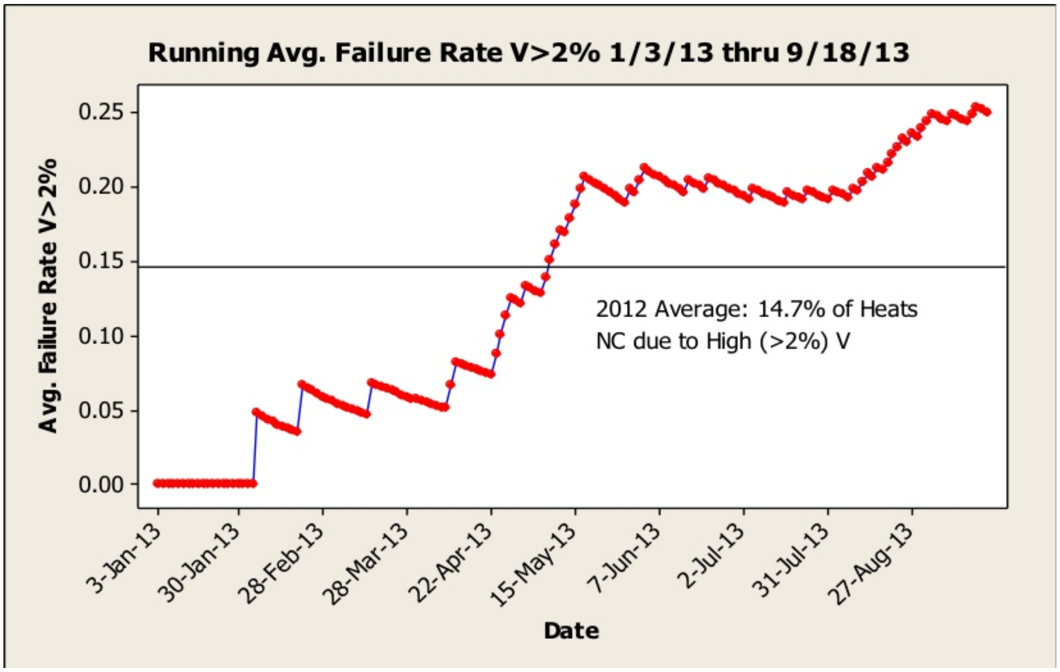
Project Leader	Project Owner	Project Sponsor	Financials
Jack Kemp	Candy Randall	Simon Bills	Butch Tellis

Defining the current state of FeNiMo production

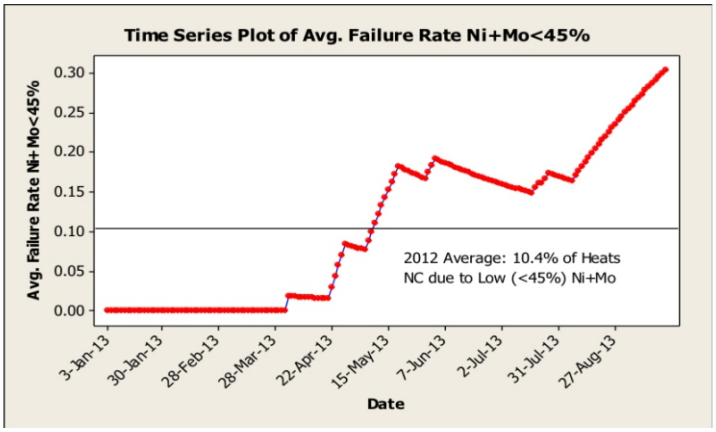
In the first week, the team created a current state baseline to understand the task. This baseline measured the benefit in financial terms, and the Kaizen would allow the business to plan and operate better. The baseline focused around Furnace No. 2 and included detailed data on:

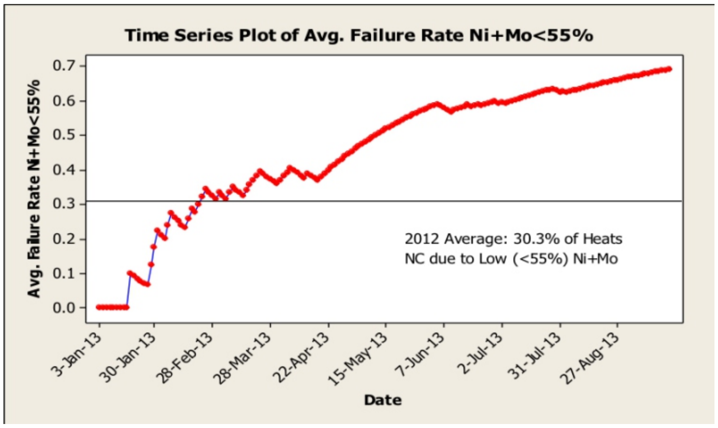
- Reject rates
- Product demand
- Equipment capacities (Delay, Rate and Quality)
- Productivity statistics
- Labor loading

We needed to know how many heats of FeNiMo were being rejected because of too much vanadium. The time-series plot below shows that and reveals a negative step change that occurred in April 2013:



Similarly for the NiMo content, we needed to know how many heats were rejected due to lack of it in heats at both 45% and 55% levels. This graph shows that measurement had deteriorated in 2013:





Finding out what affects NiMo in FeNiMo

During Week 2, the Kaizen event activities were as follows:

- Management kickoff verbalizes commitment to team
- Kaizen training for team members
- Team Waste Walk
- Current State data analysis by team
- Team discussions, brainstorming for improvement of Current State
- Trystorm ideas
- Brainstorm addition ideas
- Finalize plans for permanent changes

As a part of the data analysis step, we wanted to see everything that went into Furnace No. 2 and relate it to the FeNiMo results. This process involved going through four different spreadsheets and marrying the data between them:

- Roast Catalyst Chemistry
  - What is the composition of Roasted Catalyst in a truck?
- Blend Definitions
  - What makes up each blend (Composition, Weights)?
  - What makes up each batch (Blends, FeO, MgO, etc.)?
- FeNiMo Component Analysis
  - What batch went into each heat (from Heat Sheet)?
  - What other raw materials (lime, Al, crushed DI, etc.) goes into each heat?
- FeNiMo Heat Chemistry
  - What were the final chemistry results on a heat of FeNiMo?

We asked, “What affects NiMo in FeNiMo?” To answer that question, we did a multiple regression analysis using historical data, and looked at every blend input (catalyst, cleanings, baghouse dust) and every batch input (blends, lime, sand, MgO). We analyzed each FeNiMo chemistry results.

For NiMo, the significant predictors of its variability were sulfur, NiO, Cr2O3, MnO, Fe2O3, P2O5, TiO2, MoO3, MgO, CaO, and FeO blend. These factors made up 24% of the total weight going into Furnace No. 2 but explained 70% of the variability in NiMo.

We did the same regression analysis of the vanadium in FeNiMo and this time the significant predictors of its variability were V_2O_5, SiO_2, water, Fe_2O_3, P_2O_5, Al_2O_3, MgO, CaO, baghouse dust, cleanings, FeO blend, crushed DI. These factors make up 92% of the total weight going into Furnace No. 2 but explain only 28% of the variability in vanadium.

Despite carbon not showing up in the regression analysis, its interactions were assumed to play an integral part in controlling vanadium. We looked at the average [V] in heats at each carbon level (1%-7%) and discovered that when carbon levels go over 5%, the FeNiMo averages over 2% vanadium.

Influencers discovery and implementing the plan

During Week 3, implementation was the goal, and activities included:

- Install permanent changes
- Monitor results
- Create and execute a training plan
- Formulate a 30/60/90-day action plan
- Create audit plan
- Quantify benefits
- Prepare Final Report-Out
- Team dry run of Final Report-Out
- Present final report-out to Champion and plant staff

During the Kaizen, the team took samples and ran experimentation of different blends. The sampling timing and technique was a significant influencer. The makeup of the blend also was a significant influencer. The team changed the timing of the sample test and changed when iron was added. Previously, iron was added in a skip pan prior to sampling. The change added iron to all the skip pans, so it had a chance to blend in. These were the big drivers. Specifically, for Furnace No. 2 sampling. A new plan was developed to provide consistent timing of sampling:

- Change box filling / loading sequence (to get the FeO in quicker)
- Take sample when there is approximately 5000 lbs on both sides in the hopper
- Take samples at the same feed time cycle
- Determine the amount of FeO required based on the DI slag sample
- Adjust the amount of FeO being loaded for the next batch.

NEXT STEPS ›

- Schedule a meeting with our team to learn about our enCompass® methodology and how IE can improve your operations.

- Interested in learning more about the topic covered in this case study? Call us at 1-312-474-6184 and reference the paper you're interested in. We would love to discuss your initiatives.

- Visit www.implementation.com to find out more about our services.

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At our core, Implementation Engineers is a data-driven, global firm with a razor-sharp focus on enhancing mining and manufacturing operations.

We have volumes of success stories, and they can all be attributed to our revolutionary enCompass® methodology. This industry-first approach gives us not only the knowledge to inform you of what needs to be done, but the power to actually implement those solutions for lasting impact.

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