ICRI PANEL - CASE STUDIES IN CONVERTING IRON TYPES IN PRODUCTION

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Cored Wire Injection

What is Cored Wire?

- Cored wire is a 13mm hollow steel tube packed with magnesium, silicon, calcium and TRE powders.
- It is shipped in a 10500’ roll from which the wire is pulled up from the center by a wire feeder that delivers a desired amount of wire into a ladle of iron.
- A controller regulates the amount of wire fed at a selected feed rate.
- Adjustments are easily made as conditions change.

Basic Equipment

- Treatment ladle with the best height to diameter ratio possible.
- A cored wire feeder.
- Treatment enclosure with captured exhaust.
- A lid to cover the ladle during treatment to control iron splashing.
- Wire.

How is Cored Wire Injection Used?

- Two molding centers:
- 1) Desulfurize and nodulize for our green sand cope and drag line.
- 2) Desulfurize only for the Disa Flexipour process.

Why do we used Cored Wire?

- We are predominantly a grey iron foundry that produces a small volume of ductile iron.
- While melting with a cupola and holding in a resistance rod holding furnace, sufficient superheat for traditional desulfurization is rarely available.
- A charge mix change to achieve lower cupola S is not practical.
- The cored wire is a good compromise regarding temperature loss and it works well for us.

Cope and Drag Line Use

- Here, we desulfurize and nodulize in one step starting with about an .08 S.
- 1800# of iron plus ~140’ of wire results in ductile base iron with .035- .045% Mg.

Wire Treatment

Wire Feeder

Wire Being Drawn from the Cage

Slagging and Sampling

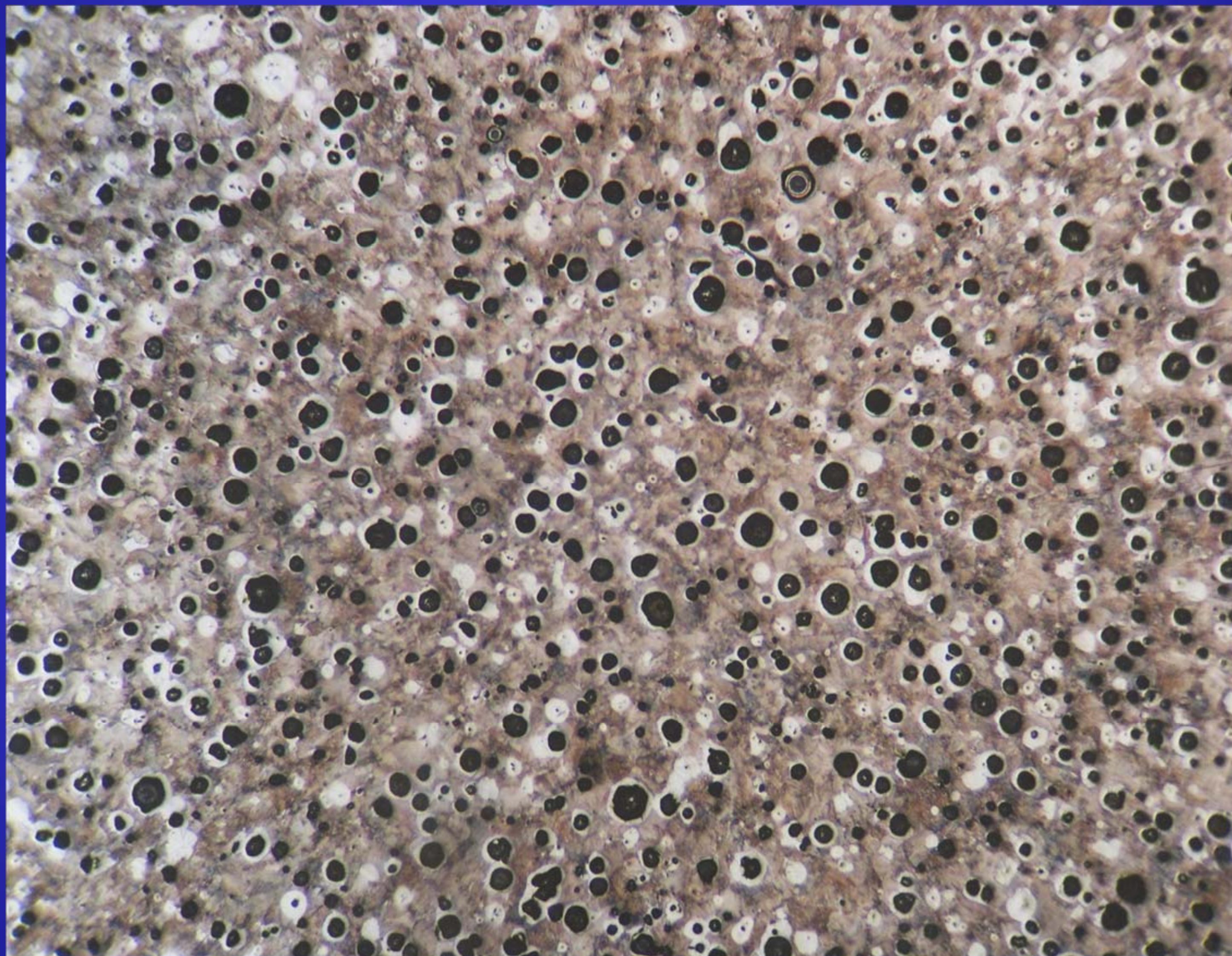
Cope and Drag Alloy Additions

- The first ladle treated gets and additional 10’ of wire to counteract any oxides that have built up in the treat ladle or bottom pour during preheating.
- As the iron is transferred into a bottom pour ladle, we add about 0.5% of foundry grade 75% FeSi and a few ounces of LF10X flux.
- Two K20 Germalloy inserts are placed in the pouring basin.

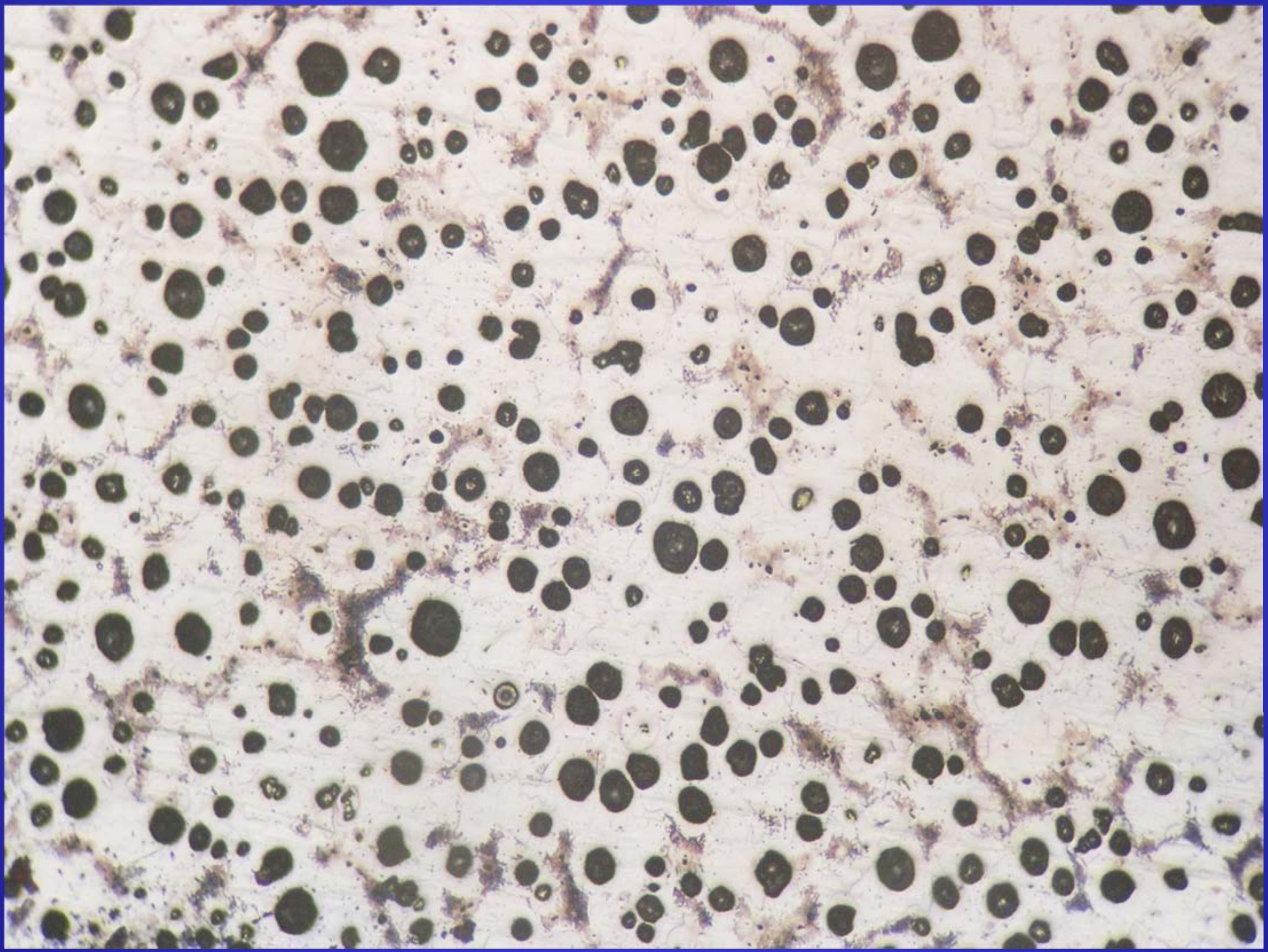
Sampling

- A vent pin style sample, from the poured mold, is used for determining nodularity and the presence of carbides.
- The vent pin is retrieved from the last mold poured before the next treatment is added.
- If the micro is good, no further testing on the castings is done.
- If a questionable micro is observed, castings are segregated for 100% inspection.
- A spectro sample is also poured to monitor the Mg level.

Micro from Unit 3 As-Cast



Micro from U3 Ductile after Subcritical Anneal



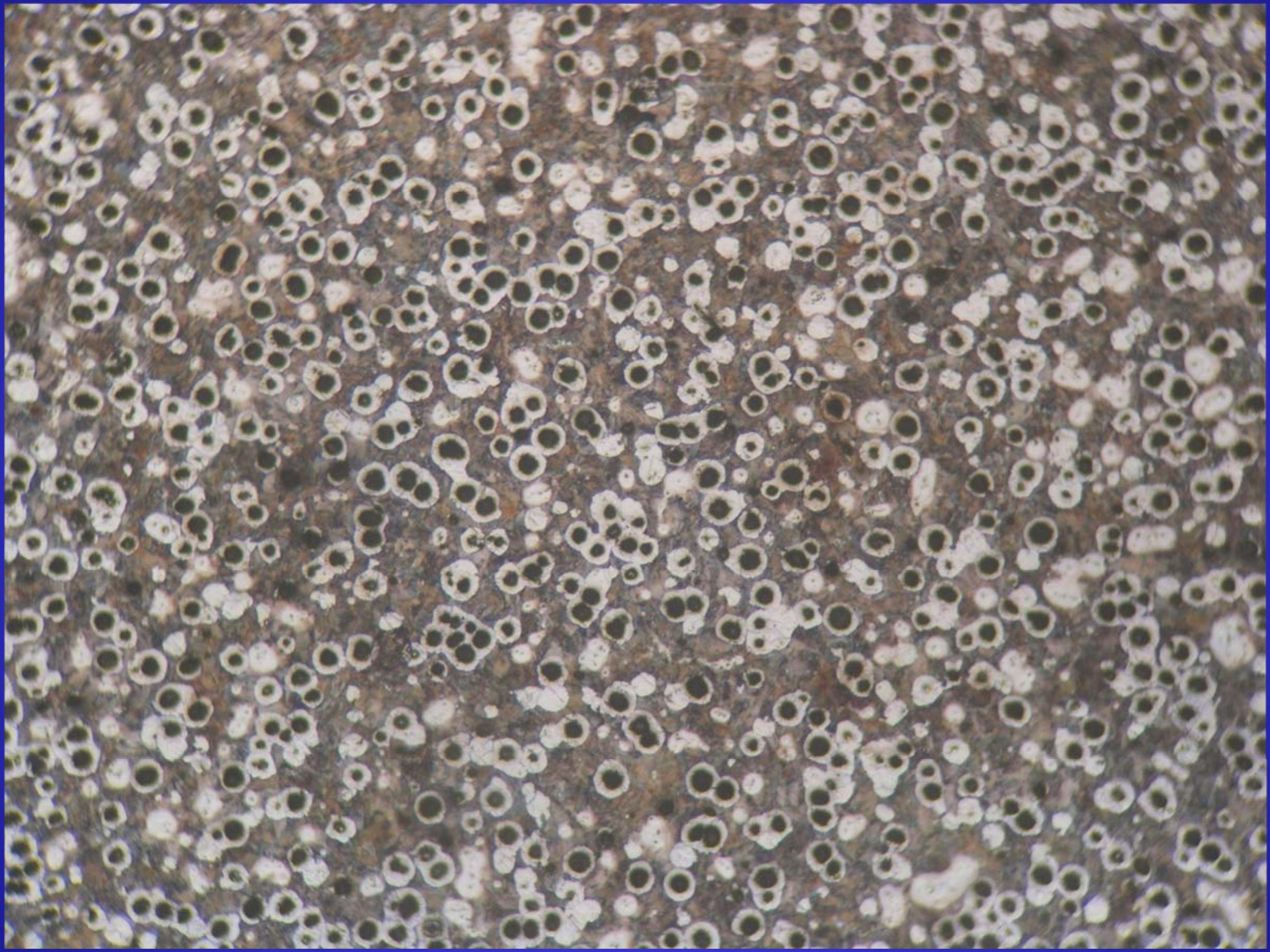
Disa Ductile Iron Production

- This process starts with lowering the sulfur in the Disa furnace. Starting at minimum heel, 5000# is taken out of the furnace and overtreated with cored wire.
- Final Mg levels in the treatment ladle .08- .14%
- This iron in put back into the Disa pressure pour furnace and the furnace is cycled.
- This process is done two more times. The Disa furnace sulfur ends up about .02%.

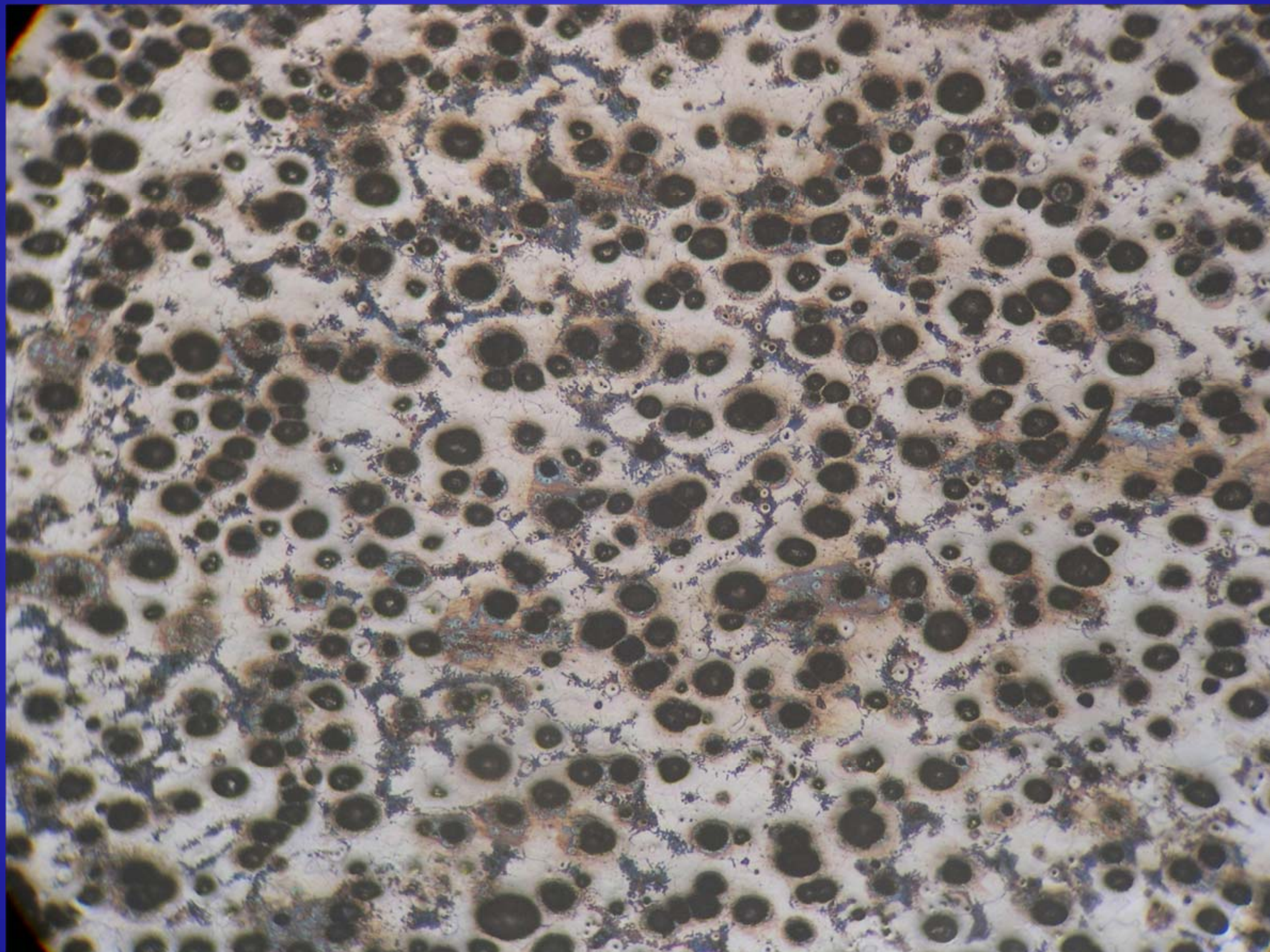
Disa Ductile Iron Production

- The next morning before production starts, the process is repeated two more times.
- The resulting furnace sulfur is < .005%. Occasionally, we may run up to .005% Mg in the furnace.
- Once production has started, iron from the main holding furnace is treated to maintain < .005 S in the Disa furnace.
- A 1.2% addition of Globe IM4 to carryout the Flexpour process.

Disa Ductile As-Cast



Disa Ductile After SC Anneal



Correction Factors

- All the in-process spectro samples include some S in the analysis.
- I, rightly or wrongly, assume that any S is tied up with Mg. So, I use the following formulas to determine where we are:
- CS = S- (Mg x 1.33)
- CMg = Mg- (S x 0.75)
- Thus far these have worked well for us.
- I will not go above 0.008% CS in the furnace.

Treatment Efficiency

Many factors influence the Mg recovery with this process. Tecpro literature lists the following as factors that influence recovery:

- Base iron sulfur level
- Iron quantity
- Height to diameter ratio of the ladle
- Treatment temperature
- Wire feed speed
- Mg content of the wire
- Desired final Mg level

Treatment Efficiency

- Our base S level ranges between .07- .10%. We add more or less wire depending on the S level in the furnace.
- For the cope and drag line we do 1800# treats. For the Disa 5000# of iron is treated.
- The cope and drag H/D ratio is 1.4:1. For the Disa it is about 1:1.
- Treatment temperatures vary significantly. The resistance rod furnace doesn't influence temperature greatly.
- A wire feed speed of 90'/ min. works well for us.

Treatment Efficiency cont.

- The powder inside the wire contains about 30% Mg, 41% Si, 7.5% Ca and 0.7% RE.
- The target Mg level in our bottom pour ladle is 0.035- 0.045% Mg. In the Disa furnace for production the target is 0.005S

Base Iron Chemistry

	Cope and Drag	Disa
• Carbon	3.45- 3.65%	3.40- 3.60%
• Silicon	2.00- 2.30%	2.20- 2.40%
• Mn	.5- .6%	.5- .6%
• Cr	0.15- 0.25%	0.15- 0.25%
• Cu	0.15- 0.25%	0.15- 0.25%
• Mo	0.03- 0.05%	0.03- 0.05%
• Ni	0.05- 0.08%	0.05- 0.08%

Final Chemistry

	Cope and Drag	Disa
• Carbon	3.45- 3.60%	3.40- 3.60%
• Silicon	2.80- 3.10%	2.65- 2.85%
• Mg	0.035- 0.045%	0.035-0.050%

Mg Recovery

- Using the Tecpro formula:

$$Mg_{rec.}(\%) = \frac{0.76 \times \Delta S(\%) + Mg_{Fe}(\%)}{Mg_{addition}(\%)} \times 100$$

- Cope and drag Mg recovery - 35- 50%
- Disa Mg recovery - 40- 55%

Mechanical Properties

	Tensile (PSI)	Yield (PSI)	Elong. (%)
After SC Anneal	80,000	58,000	17
As-Cast	93,000	75,000	6-10

Pros and Cons- Cope and Drag

Pros

- Lower temperature loss from treatment vs. CaC_2.
- Rapid treatment time.
- Easy to retrieve samples.
- Batch process.
- Repeatable.

- Con

- Short work time to pour before iron is cold.

Pros and Cons-Disa

Pros

- Does not require iron w/Mg in the furnace.
- Repeatable.
- Pouring does not slow the line speed down w/ Flexpour system.
- Temperature loss can be recovered by inductor.
- High nodule counts.

Cons

- Changeovers lengthily.
- Cannot obtain chilled spectro samples.
- Each casting should be checked for nodularity.
- Y-blocks on pattern plate.

Thank you to DIS and ICRI for sponsoring this joint meeting and to Waupaca Foundry- Etowah for inviting us to tour their facility.