MANAGING CAPPED PRODUCTS

Midwest Mine Services

INTRODUCTION

- Tim Meighan – Midwest Mine Services
  - 11 years industry experience

- Dan Melosso – Sandvik
  - 4 years industry experience

WHAT IS A "CAPPED" PRODUCT

- A product that is overproduced with regards to sales, typically measured on annual or multi-year sales projections
- This product is often created by necessity; sometimes due to plant configuration or the desire to keep overall plant throughput at a target rate

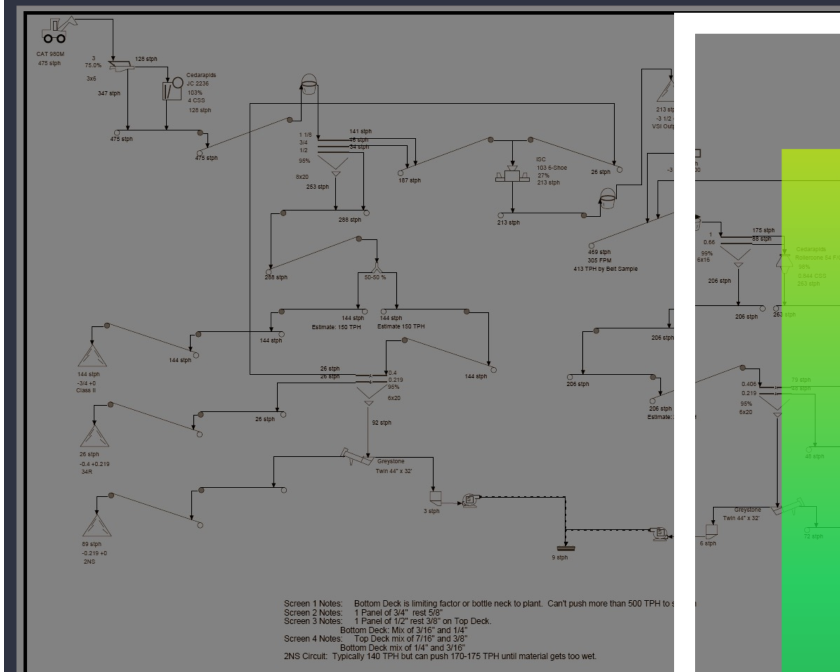
Ex. Producing 21A vs. sending forwards in a plant

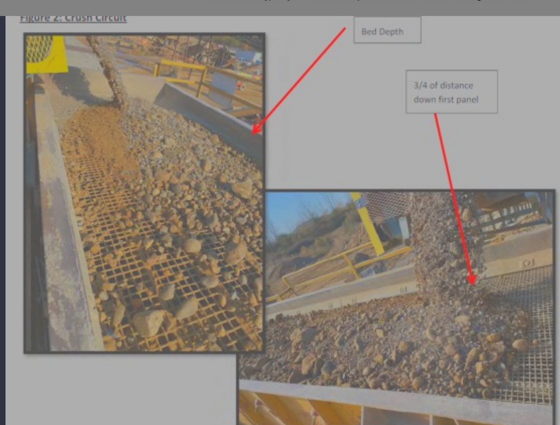
Other Common Terms:

By-Product Tailings Waste Material

IMPACTS OF CAPPED PRODUCTS

- What did it cost to produce this product?
  - How far did the product travel through the plant?
  - How much additional wear did this product cause?
  - Does this material need stockpiled somewhere else in the plant? Re-handled?
  - Is there a different opportunity for this product to be marketable?
- At the end of the day, any product that is produced at a plant has a $$$$ figure whether saleable or not
- As a capped product, this can be considered a non-liquid asset.
- Were there missed opportunities? Jobs that were not awarded/received due to lack of inventory of in-demand products



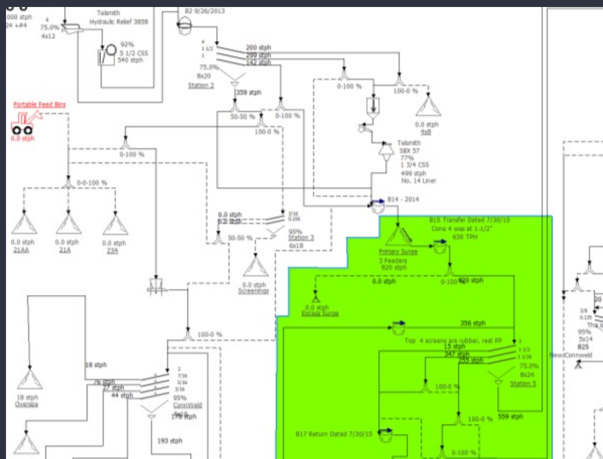


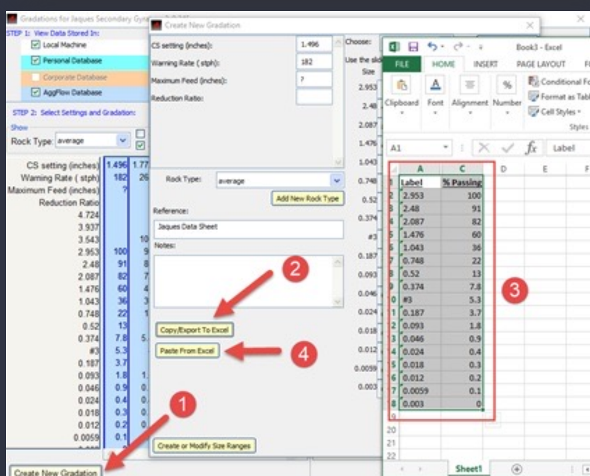
MANAGING THE CAPPED PRODUCTS

General Steps:

- On site plant observation during operation
- Plant schematic through use of Aggflow
    - General picture and flow of the plant
    - Aerial image through drone or flight surveys
    - Belt sampling – Specifically input gradation to plant, before/after crushers and screens
- Understand key equipment – Crushers and Screens – Affecting product percentages
- Examining current products – Where does the gradation fall in the allowable specification?

Bottom Line – Identify the key points in the plant that are affecting the ability of the plant to be flexible. Plant flexibility is one of the most effective ways to balance and manage the capped product issue.





AGGFLOW ANALYSIS

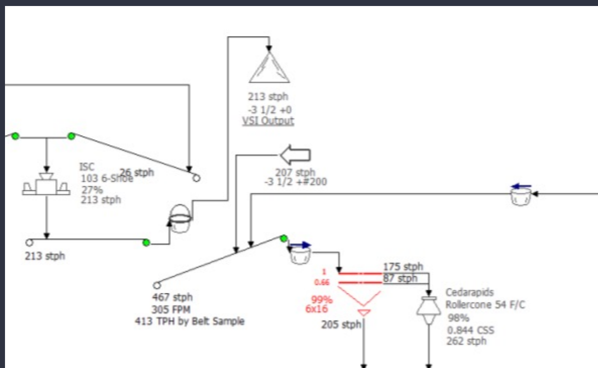
Trash in = Trash Out

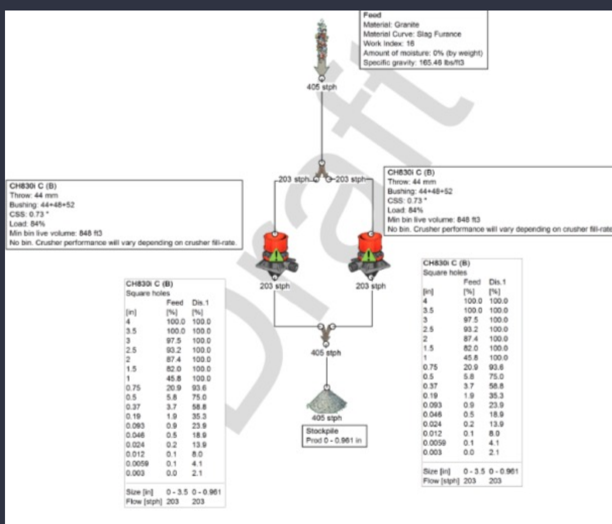
- Aggflow is an industry tool that is widely used to model and predict how a certain plant configuration will operate
- Document the overall flow of material through the plant
- Conveyors can be shown for ease of understanding but does not affect how the projections are calculated
- When a Aggflow is first run with just basic information it is generally nothing more than a plant schematic – A rough draft
- Hence the saying trash in / trash out

AGGFLOW ANALYSIS

Refining the Aggflow

- Creating an Aggflow model that is truly representative of the conditions observed at the plant
  - Matching TPH calculations to key points in the plant
    - Product rates in Aggflow vs. actual conditions
    - Belt scale readings vs. Aggflow conditions
  - Matching projected gradations vs. belt cut data
  - The goal here is to develop an accurate, baseline Aggflow model to allow for simulations to be run





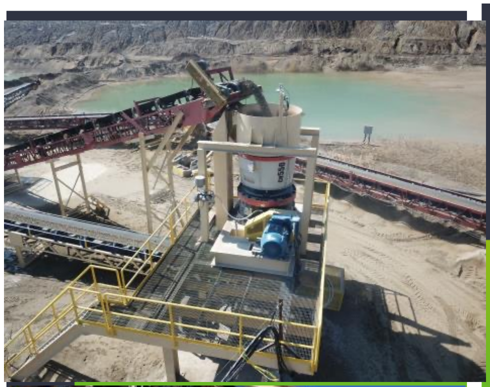
AGGFLOW ANALYSIS

Refining the Aggflow

- Observed Gradations (Aggflow Sample Buckets)
- Screen Efficiency Adjustments
- Screen Open Area Adjustments
- Product Flow across a screen
- Altering the flow of material to “force” recirculating conditions with Aggflow splitters
- Breaking the continuous flow of material to force an observed condition
- Additional Modeling Techniques and back-feeding of data
  - Ex. Sandvik Plant Designer Software

CRUSHERS

- Jaw Crushers
  - CSS / Jaw Dye
- Horizontal Impactors
  - Speed of rotor
  - Dummy Bars
  - Gap Settings
- Vertical Impactors
  - Table Speed
  - Quantity of Shoes, material, shape
  - Anvil location, material
  - Style of machine – Autogenous, Semi-Autogenous, ROR
- Cone Crushers
  - Concave and Mantle Liners
  - Chamber Design – Steep vs. Shallow
  - CSS
  - Eccentric Speed
  - Throw Settings
  - Unique Conditions
  - Automation – Optimize for Particle Shape. Or Horsepower Utilization



Screens

- Size of Screen
  - Length (efficiency) vs. Width (capacity)
- Relief Decks
- Inclination
- Alternative Media
  - Ex. Urethane with embedded wire
- Screen Direction of Rotation
- Stroke and RPM settings
- Auxiliary Screens –
  - Ex. High Frequency
  - Single deck

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MIDWEST MINE SERVICES

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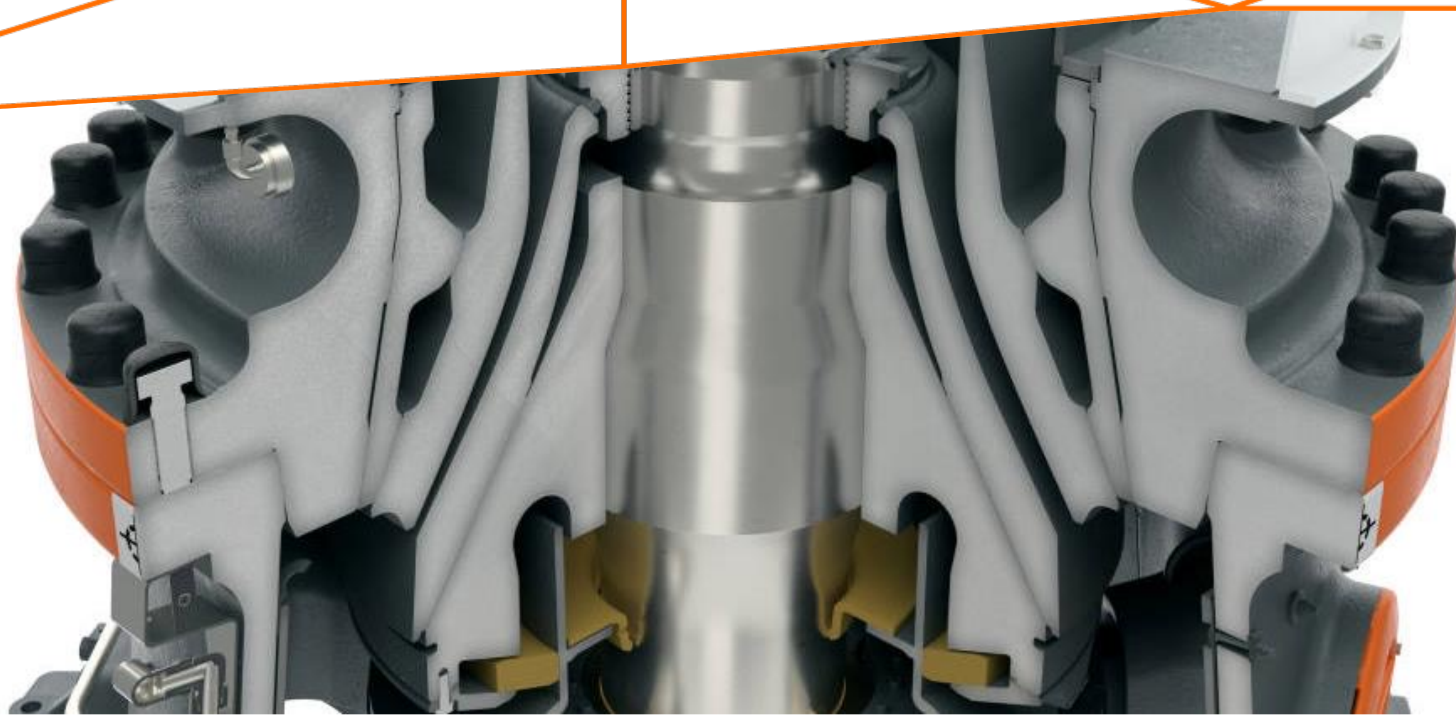


1.) MODEL THE PROCESS (PLANTDESIGNER®)

2.) OPTIMIZE OUTPUT (CRUSHING CHAMBER SIMULATOR®)

PLANTDESIGNER

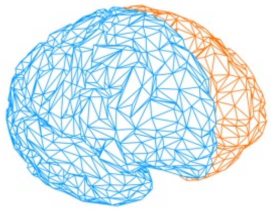
ABOUT - GENERAL

- Process flow modelling software, similar to those widely used today, specific to Sandvik equipment

- The software is mainly used for modelling entire crushing and screening circuits, but can also be used for modelling individual pieces of equipment

- Important to note, it’s a tool. Results need to be interpreted and other factors considered by an experienced applications engineer.

DOES NOT
REPLACE
YOUR BRAIN!



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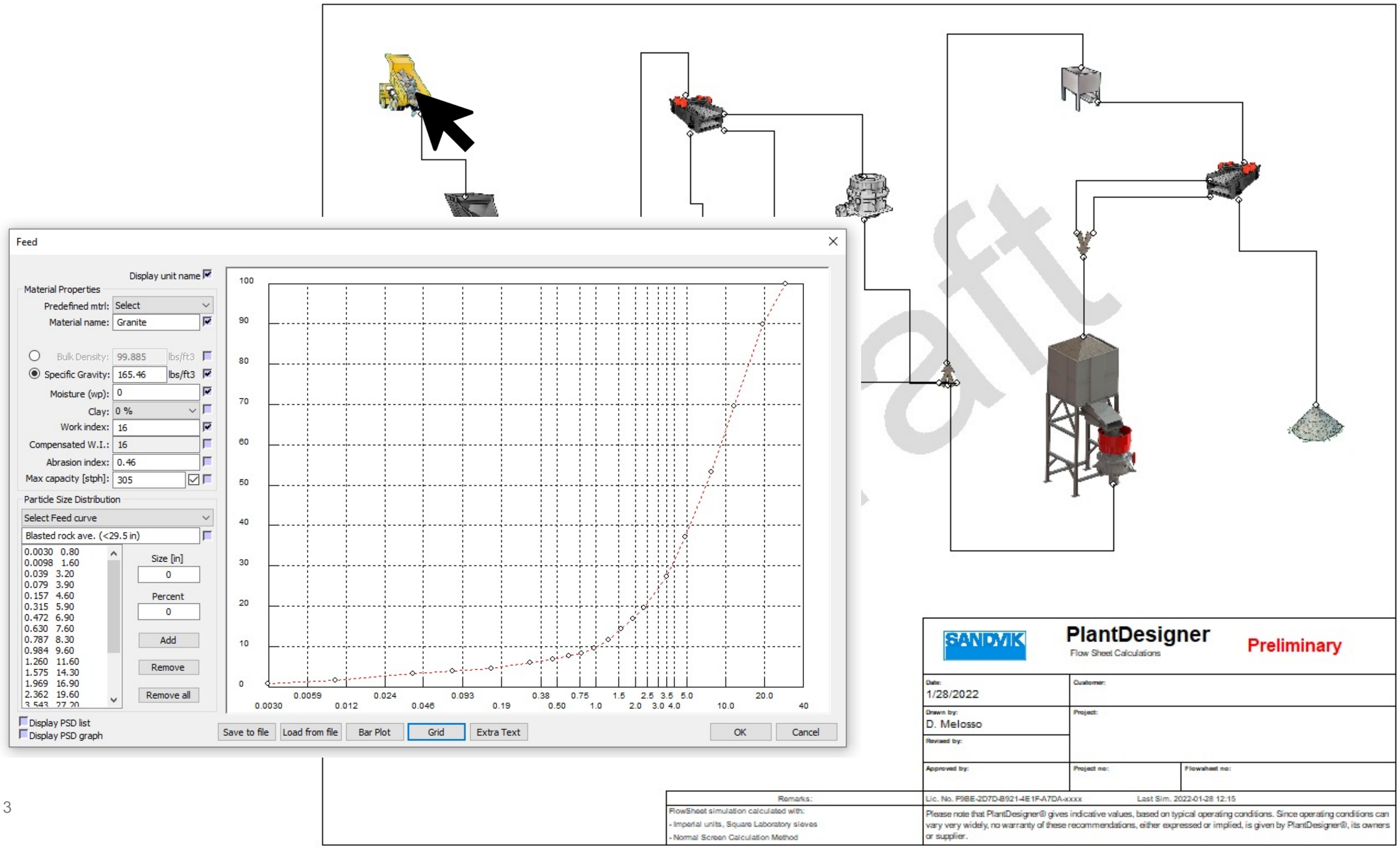
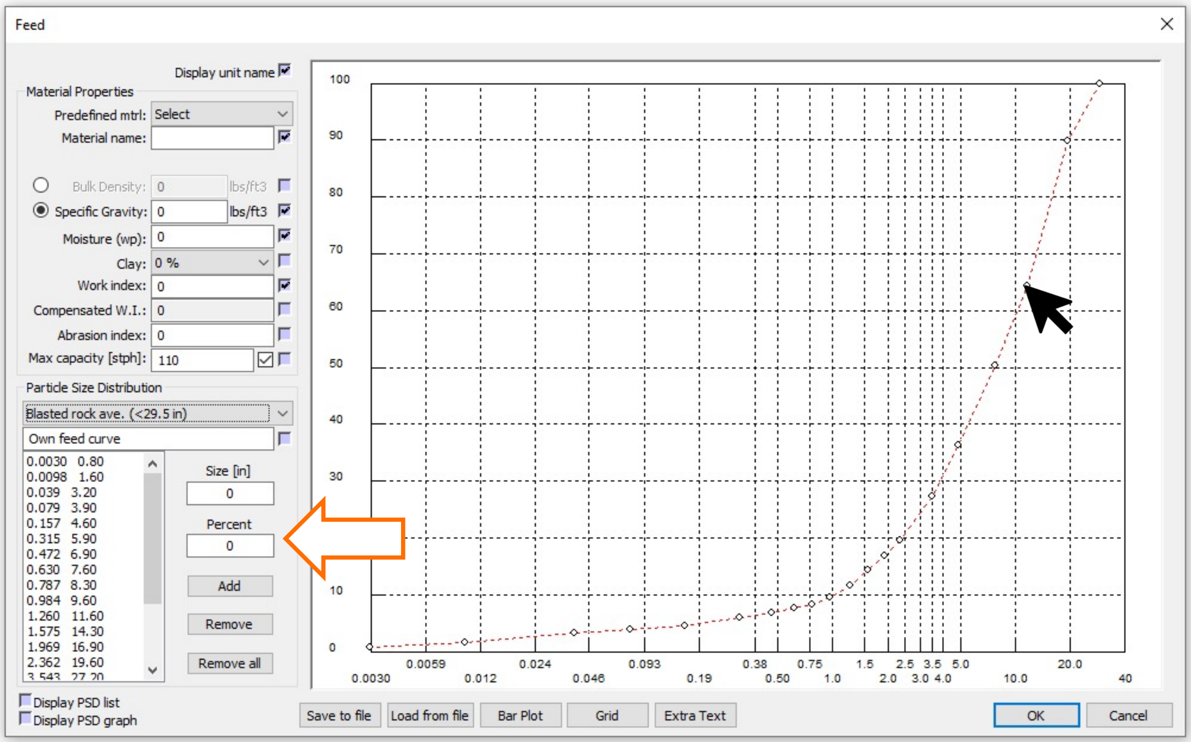
OVERVIEW



Feed
Display unit name
Material Properties
Predefined mtrl: Select
Material name: Granite
Bulk Density: 99.885 lbs/ft3
Specific Gravity: 165.46 lbs/ft3
Moisture (wp): 0
Clay: 0 %
Work index: 16
Compensated W.I.: 16
Abrasion index: 0.46
Max capacity [stph]: 305
Particle Size Distribution
Select Feed curve
Blasted rock ave. (<29.5 in)
0.0030 0.80
0.0098 1.60
0.039 3.20
0.079 3.90
0.157 4.60
0.315 5.90
0.472 6.90
0.630 7.60
0.787 8.30
0.984 9.60
1.260 11.60
1.575 14.30
1.969 16.90
2.362 19.60
Size [in]
Percent
Add
Remove
Remove all
Display PSD list
Display PSD graph
Save to file
Load from file
Bar Plot
Grid
Extra Text
OK
Cancel
PlantDesigner
Flow Sheet Calculations
Preliminary
Date:
1/28/2022
Customer:
Drawn by:
D. Melosso
Project:
Revised by:
Approved by:
Project no:
Flowsheet no:
Remarks:
FlowSheet simulation calculated with:
- Imperial units, Square Laboratory sieves
- Normal Screen Calculation Method
Please note that PlantDesigner® gives indicative values, based on typical operating conditions. Since operating conditions can vary very widely, no warranty of these recommendations, either expressed or implied, is given by PlantDesigner®, its owners or supplier.

FEED PARAMETERS

PARTICLE SIZE DISTRIBUTION



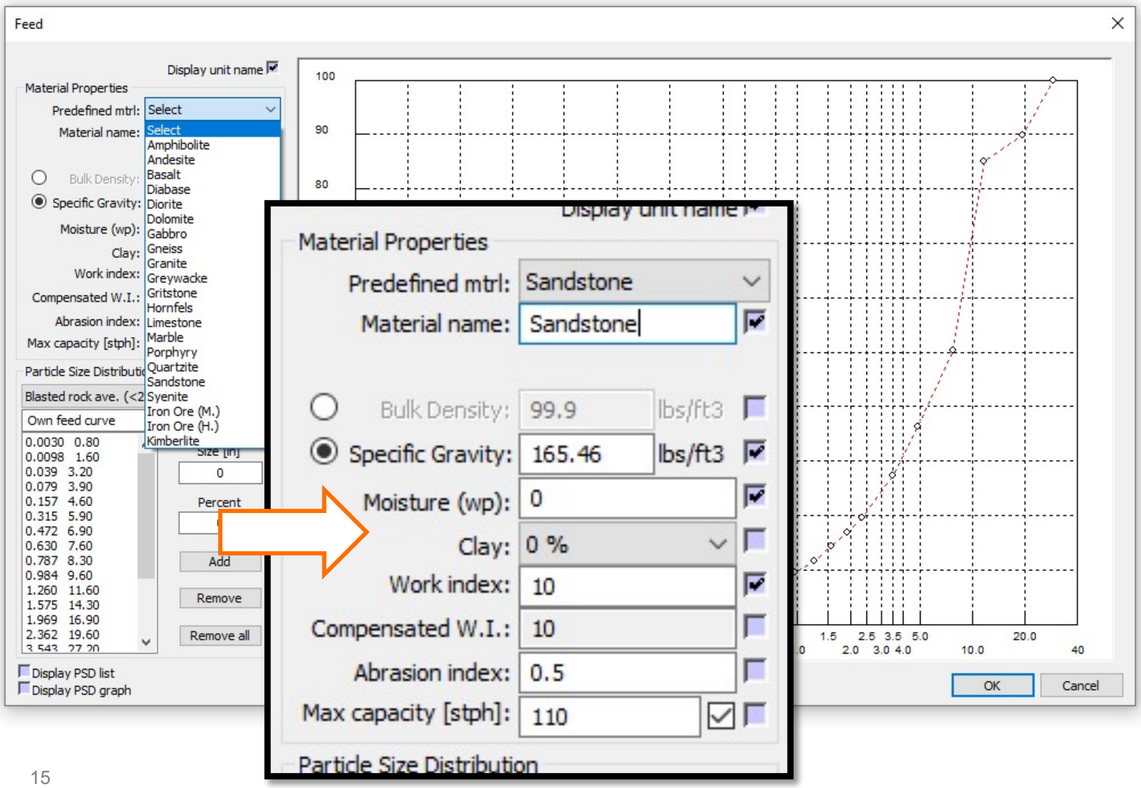
Pre-loaded feed distributions of raw feed for shot rock, limestone, sand & gravel (i.e.: Standardized curves)

Drag-and-drop data-points

or add manually change to make curve reflect on-site conditions

FEED PARAMETERS

MATERIAL PROPERTIES



Pre-loaded with generic material characteristic. i.e.: the materials hardness (Wi), the abrasion (Ai), density.

Vary other parameters like clay, moisture.

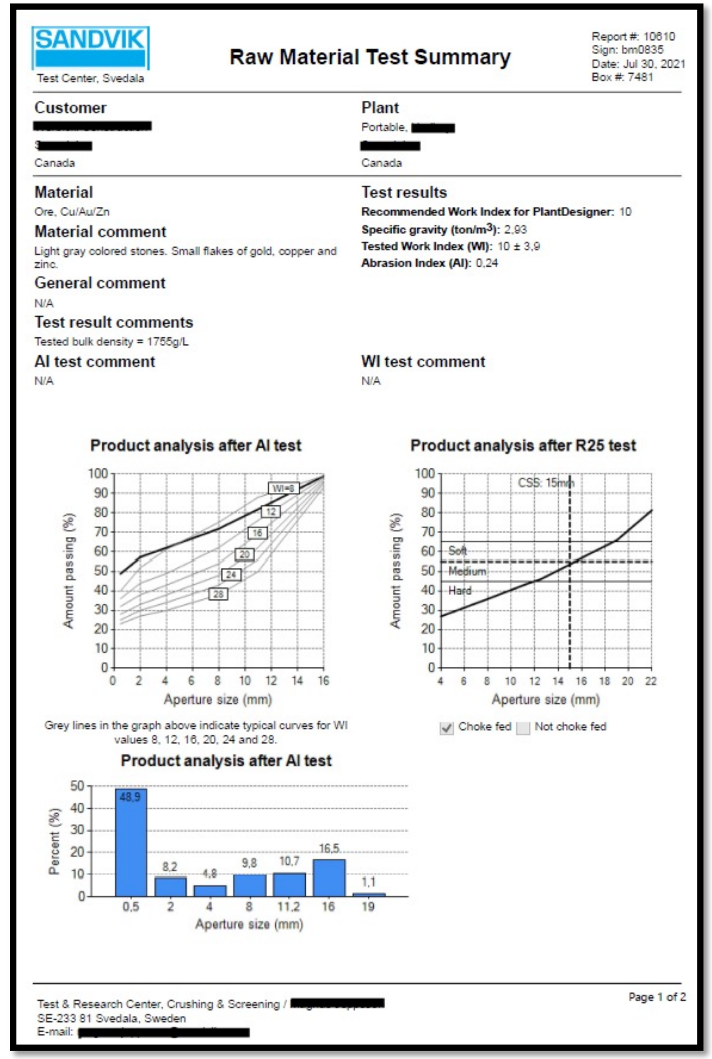
Based on Sandvik's database of >10,000 rock samples.

Ideally, you'd want to have your material tested for most accurate model

MATERIAL TEST REPORT

EXAMPLE

- **Work Index** testing (kWh/t) - Wi
  - Indication of energy required to fracture stone
- **Abrasion Index** – Ai
  - Not same as hardness
  - Indication of silica content in rock
- **Specific density** (kg/m³)
  - Measure of rocks weight per unit volume
  - Increased capacity. Impact on compensated Wi
- **Friability**
  - A measure of the materials tendency of generating fines



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Test Center, Svedala

Raw Material Test Summary

Report #: 10610
Sign: bm0835
Date: Jul 30, 2021
Box #: 7481

Customer
[redacted]
Canada

Plant
Portable, [redacted]
Canada

Material
Ore, Cu/Au/Zn

Material comment
Light gray colored stones. Small flakes of gold, copper and zinc.

General comment
N/A

Test result comments
Tested bulk density = 1755g/L

AI test comment
N/A

Test results
Recommended Work Index for PlantDesigner: 10
Specific gravity (ton/m^3): 2,93
Tested Work Index (WI): 10 ± 3,9
Abrasion Index (AI): 0,24

WI test comment
N/A

Grey lines in the graph above indicate typical curves for WI values 8, 12, 16, 20, 24 and 28.

Choke fed Not choke fed

Test & Research Center, Crushing & Screening / [redacted]
SE-233 81 Svedala, Sweden
E-mail: [redacted]

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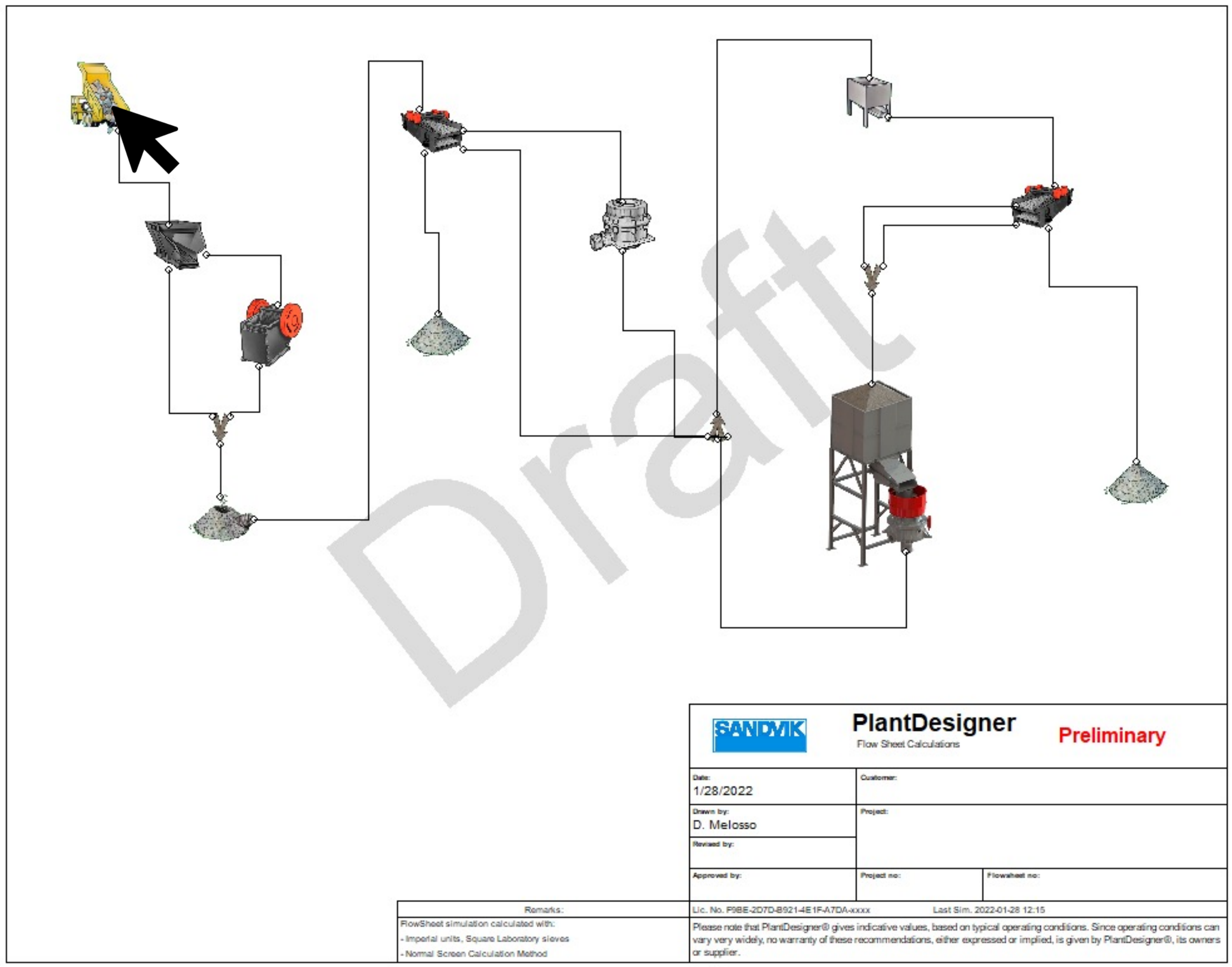
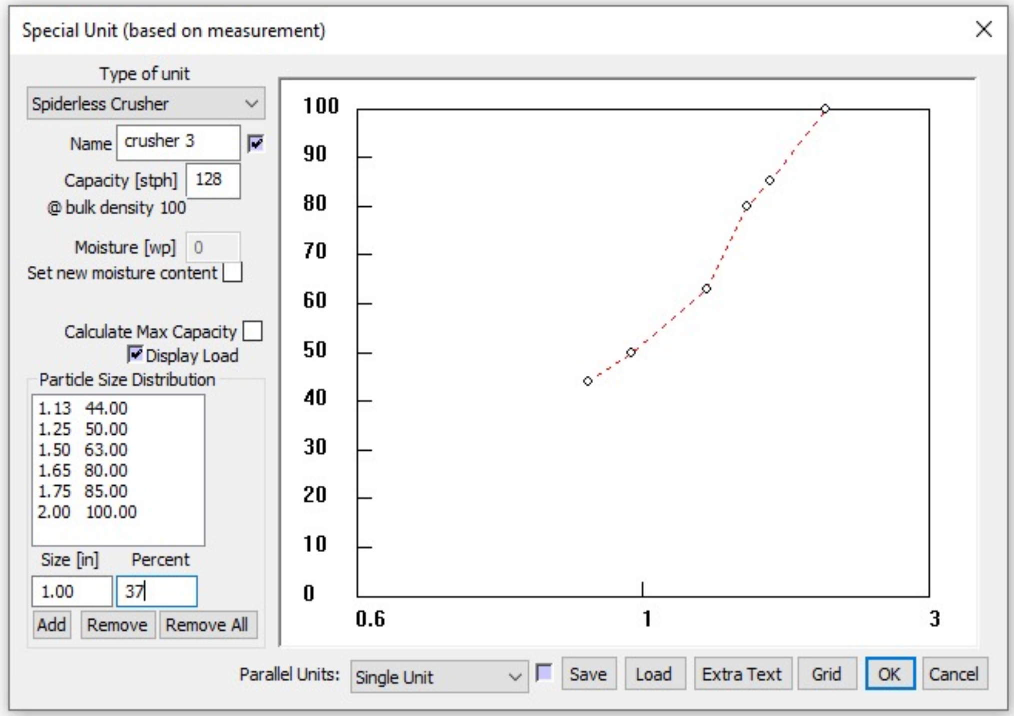
OVERVIEW

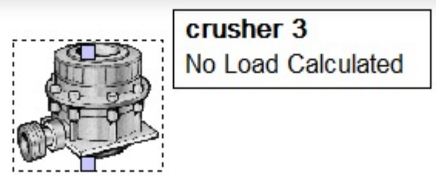

Draft
PlantDesigner
Flow Sheet Calculations
Preliminary
Date:
1/28/2022
Customer:
Drawn by:
D. Melosso
Project:
Revised by:
Approved by:
Project no:
Flowsheet no:
Remarks:
FlowSheet simulation calculated with:
- Imperial units, Square Laboratory sieves
- Normal Screen Calculation Method
Lic. No. F9BE-2D7D-B921-4E1F-A7DA-xxxx
Last Sim. 2022-01-28 12:15
Please note that PlantDesigner® gives indicative values, based on typical operating conditions. Since operating conditions can vary very widely, no warranty of these recommendations, either expressed or implied, is given by PlantDesigner®, its owners or supplier.

EQUIPMENT

DYNAMIC MODELLING

- Generally, process modelling software use manufacturer published data (i.e.: brochure data). No info on input / assumptions
- PlantDesigner uses more detailed information to adjust equipment parameters and performance according to changing inputs. (only for Sandvik equipment)
- PlantDesigner also allows for the use of non-Sandvik equipment. Information must be manually entered based on site collected or brochure data (no dynamic calcs. / adjustment factors)





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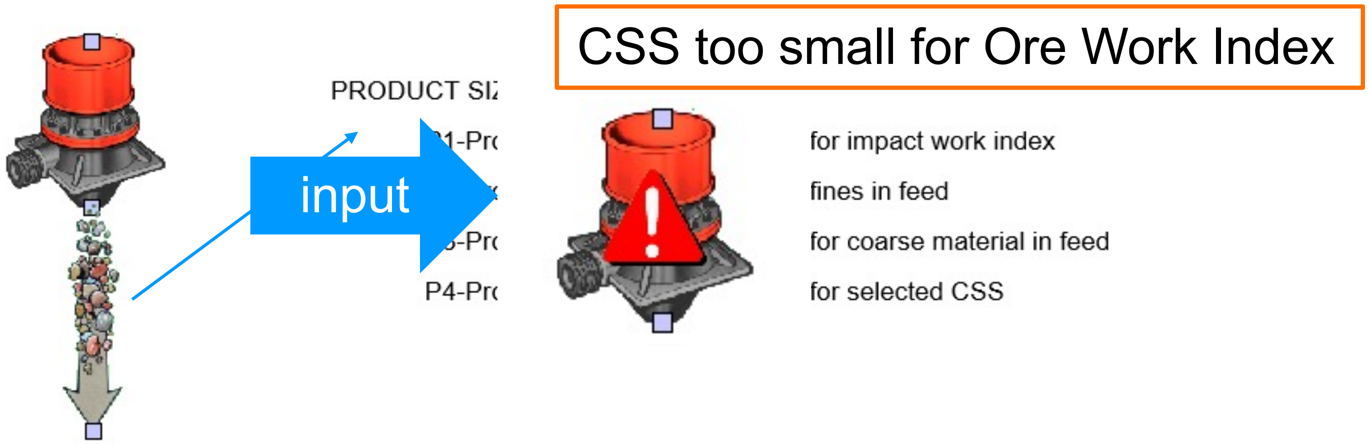
DYNAMIC MODELLING (CONTINUED)

ADJUSTMENT FACTORS

- PlantDesigner will dynamically change equipment performance according to a series of correction factors related to process inputs.

- The software will also take into account conditions that may lead to issues out in the field.



CAVEATS

RELY ON APPLICATION ENGINEERS

- Although providing a good indication of what you should expect on the field, you shouldn't **<u>only</u>** rely of software when designing / optimizing a plant.

- Software uses algorithms / formulas for calculating, which contain certain assumptions that a human being then needs to account for.

- Conversely, software sometime **<u>doesn't</u>** account for certain things that may appear in the real life.

A good applications engineer will always factor in experience and human judgement

AUTOMATION SYSTEM
MANAGING CAPPED PRODUCT

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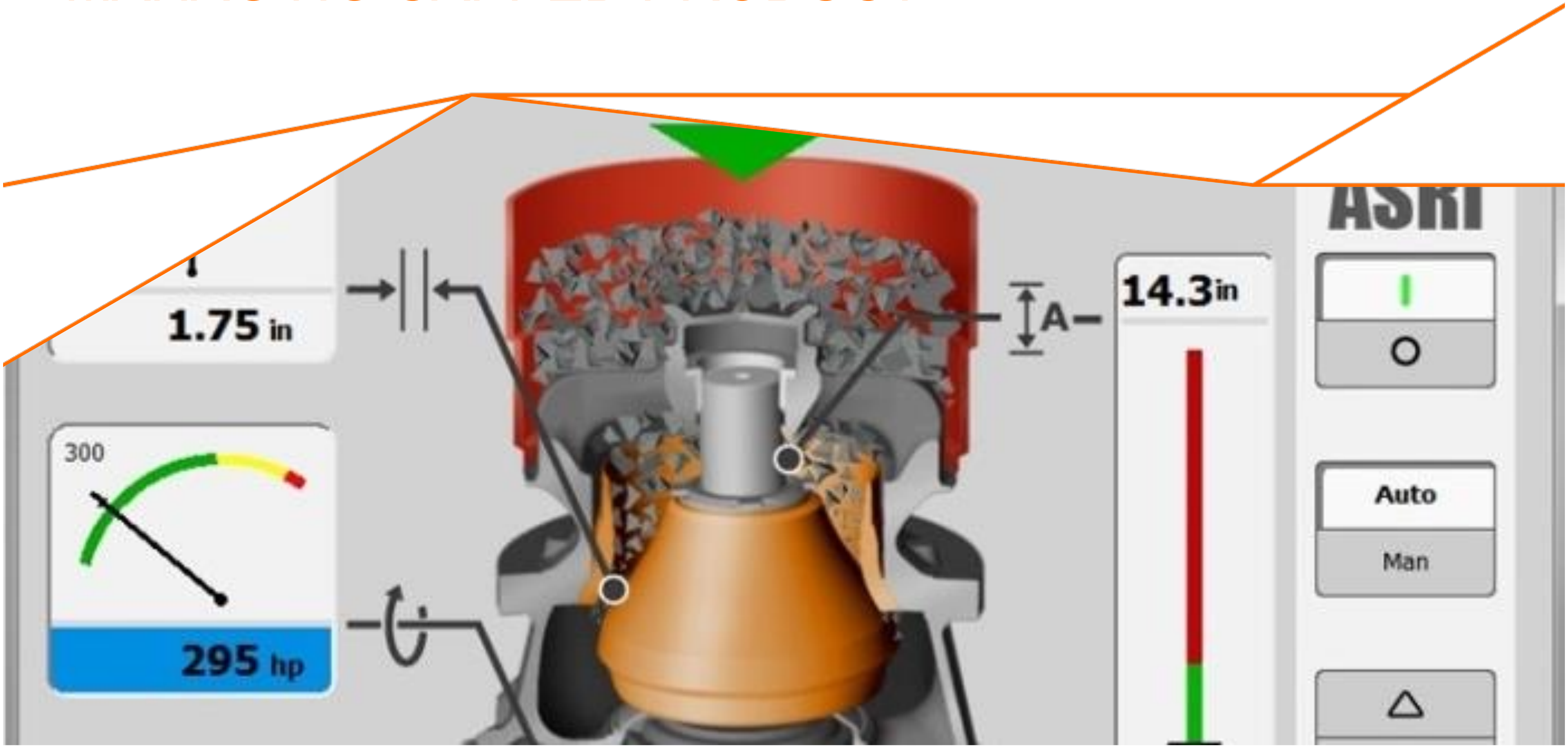

AUTOMATION ON A CONE CRUSHER

WHAT SHOULD IT DO?

At a **minimum**, an automation system should:

- Be able to adapt to changing feed conditions **under full load.**
  - Requiring a throttling of other systems to adjust is not a true automation system
- Protect a crusher from over working in conditions that will lead to failure.
- Ensure a constant performance.
- Account for wear between calibrations.

An **ideal** the automation system should do the above, as well as:

- Provide operator visibility of auxiliary systems (Lubrication system, hydraulics, dust exclusion, etc.)
- Provide control work of auxiliary systems.
- Provide simple troubleshooting and temporary bypassing of sensors.

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AUTOMATION ON A CONE CRUSHERS

WHY SHOULD IT DO THIS?

- A crusher that doesn't adapt to changing feed conditions won't produce a constant output.
- A crusher that can't compensate for wear will lead to a changing production over time.
- Adjustable programs to be able to target product gradations. (e.g.: Multi-CSS)

MANAGING CAPPED PRODUCT

- May lead to your crusher to produce more of what you don't want.
- Cyclical production between calibrations. Recirculating load vs. wear in liners. (Cost per ton.)
- Avoids running campaigns for tricky products. Avoids rehandling and blending (Cost per ton).

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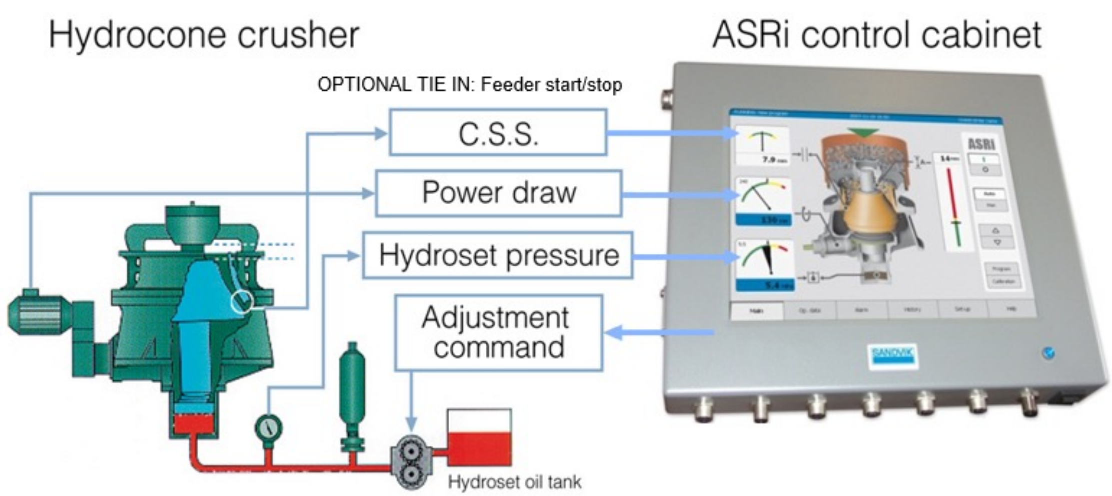
EXAMPLE OF AUTOMATION

- Collects data for power draw (kW), Close side setting (CSS) and Crushing forces (MPa)
- Adjusts CSS in real time according to changing site conditions.
- Can be configured to compensate for wear (think abrasive applications).
- System also allows for tying in the “Feed allowed” signal to integrate into PCS.



CRUSHING PROGRAMS

AUTO-LOAD

- Crusher will work within operator defined power and pressure limits
  - Close until kW / MPa limits are reached.
  - Allows for better wear compensation.
  - Reduces likelihood of having recirculating load due to improper CSS.

AUTO-CSS

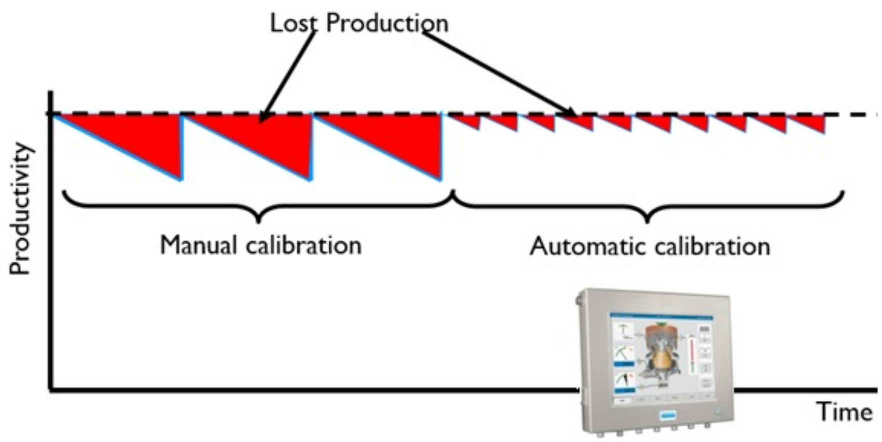
- Crusher will work to hold a given CSS
  - High level of control over the product output.
  - Constant product output

MULTI-CSS

- Alternate between two (2) CSS settings.
  - Useful for long fractions to be produced in single stockpile.

AUTOMATIC CALIBRATION

DON'T WASTE YOUR UPTIME



If you don't know the setting you're crushing at, you don't know what you're making.

- Recirculating load or increased fines
- Rehandling
- Think double loss (lost potential revenue plus loss in cost)
- Increased cost / ton (e.g.: Wear)

- Although your crusher may be loaded (i.e.: Pulling amps), the product you're making may not be what you're looking to sell and thus, may be increasing your capped product. Caution when using amp draw as the metric for crusher performance.

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SUMMARY

BENEFITS OF AUTOMATION

- More control over your crushing operation, regardless of feed conditions.
- Maximum use out of your investment for lower opex; Think wear compensation.
- Spend more time making what you want and less time making what you don't.
- More constant production of sellable end product.

ALL THIS TRANSLATES TO MORE SELLABLE PRODUCT ON THE GROUND, LESS WASTE, AND MORE PROFIT.

CRUSHING CHAMBER OPTIMIZATION

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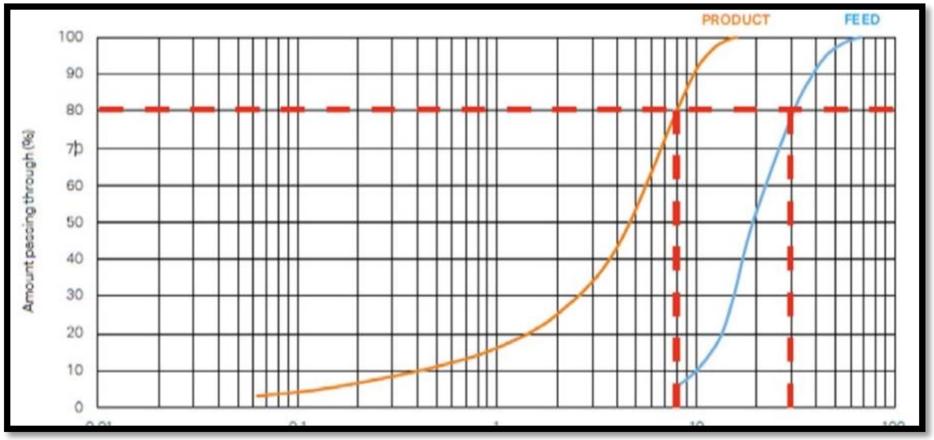
CRUSHING CHAMBER SIMULATOR

OPTIMIZATION TOOL

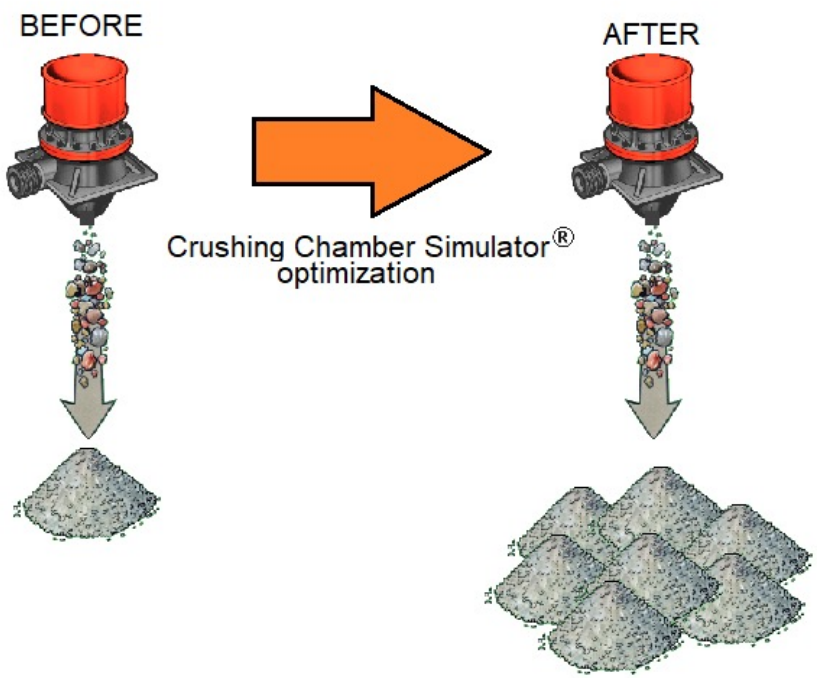
Once a plant has been commissioned and the kinks worked out (e.g., segregated feed), the Crushing Chamber Simulator® Tool can be the next step in your process optimization (e.g.: Managing your capped product)

The software uses an algorithm to predict crusher outputs from site collected data, in order to target specific production targets.



CRUSHING CHAMBER SIMULATOR

OPTIMIZE CONE CRUSHER



- Software requires collecting field data (See appendix) which the program uses to predict crusher* output.

- The Crushing Chamber Simulator® reverse engineers the breakage function of the material and can then be used predict the impact of a parameter change (e.g.: Changing the crusher model) will have on the crusher output.

*Only for Sandvik cone crushers

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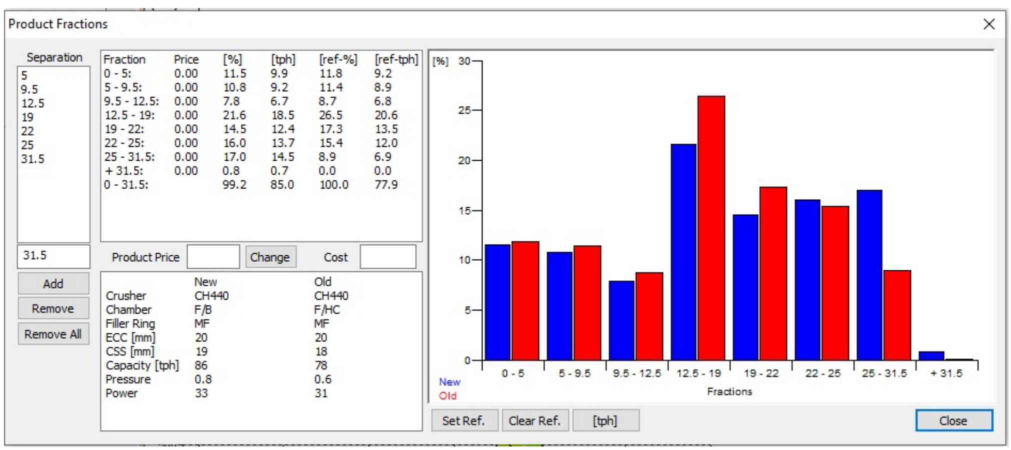
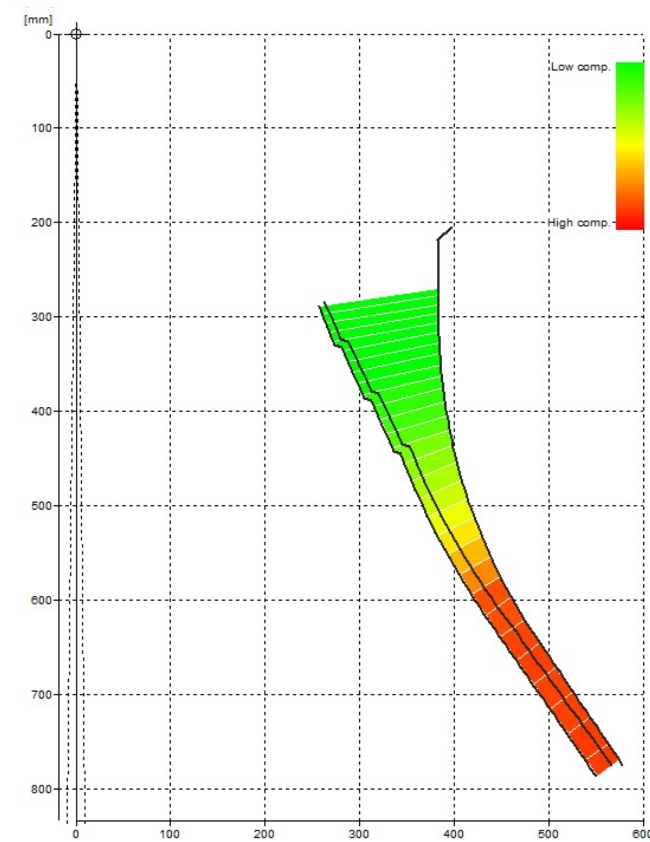
AT A GLANCE

CRUSHING CHAMBER

- Software will allow for analyzing the crushing chamber alignment, view pressure and breakage zones.





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APPENDIX

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Sandvik Process Optimization

LIFECYCLE OPTIMIZATION DEPARTMENT
GLOBAL PROCESS TEAM

CRUSHING CHAMBER ANALYSIS – OPTIAGG
APPLICATION QUESTIONNAIRE

VERSION:04
OCTOBER 2020

0. SAFETY

BEFORE ALL ELSE, RECALL THAT SAFETY ON SITE IS PARAMOUNT. PLEASE BE SURE TO TAKE ANY AND ALL NECESSARY PRECAUTIONS (E.G.: LOCKOUT – TAGOUT, PPE, …) BEFORE CONDUCTING ANY MATERIAL SAMPLES.

1. SAMPLE DETAILS

CUSTOMER	
QUARRY / MINE SITE	
PROVINCE / STATE / CITY	
ADDRESS	
DATE	

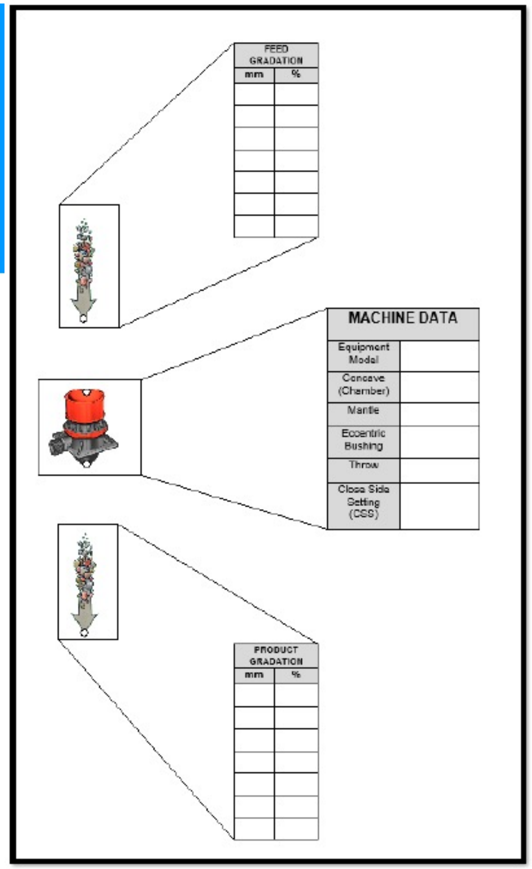
2. BELT CUT SAMPLES (SEE IMAGE BELOW)

DETERMINE AN APPROPRIATE SAMPLE SIZE FOR THE APPLICATION IN ORDER TO OBTAIN A REPRESENTATIVE SAMPLE. FOR EXAMPLE, A 100 KG OF MATERIAL MAY BE EXCESSIVE IF ANALYZING FINE MATERIAL, JUST AS A 20 KG MAY NOT BE REPRESENTATIVE IF A COARSER PRODUCT IS BEING ANALYZED. AS A RULE OF THUMB, A ONE (1) METER, OR THREE (3) FOOT, BELT CUT IS SUFFICIENT.

CHECKLIST

- ☐ FEED BELT CUT SAMPLE PARTICLE SIZE DISTRIBUTION (PSD)
- ☐ SAMPLE LENGTH (METERS OR FEET)
- ☐ SAMPLE WEIGHT (KG OR LBS)

- ☐ PRODUCT / DISCHARGE BELT CUT SAMPLE PSD
- ☐ SAMPLE LENGTH (METERS OR FEET)
- ☐ SAMPLE WEIGHT (KG OR LBS)
- ☐ DISCHARGE CONVEYOR SPEED* (See "NOTES" Below)



3. CRUSHER DETAILS

CRUSHER MODEL		
CH SERIES	CS SERIES	SERIAL NUMBER S/N:
420	420	
430	430	
540 (830i)	-	
440	440	
550 (840i)	550 (840i)	
660	660	
860i	-	
865i	-	
870i	-	
880i	-	
890i	-	
895i	-	

CRUSHER CONFIGURATION			
CHAMBER		SETTING	
CONCAVE		ECC. BUSHING AND THROW	
MANTLE		CLOSE SIDE SETTING	

OTHER (RECOMMENDED)	
POWER (kW) – ASRi / ACS	
PRESSURE (MPa) – ASRi / ACS	
*CAPACITY – (See "NOTES" Below)	

4. CUSTOMER OBJECTIVE

IT'S IMPORTANT TO DETERMINE PRECISELY WHAT YOU ARE TRYING TO ACHIEVE, THAT IS WHAT YOU ARE TRYING TO OPTIMIZE. PLEASE LIST BELOW.
EXAMPLES MAY INCLUDE:

- MAXIMIZING A GIVEN FRACTION (e.g.: Maximize 14mm – 20mm fraction)
- IMPROVING WEAR PATTERNS (e.g.: Selecting a more appropriate Chamber for application)
- REDUCING FINES
- ETC….

OBJECTIVES	
No.1	
No.2	
No.3	
No.4	
No.5	

CASE STUDY: CONE CRUSHERS

- While cone crushers can be capital intensive, the flexibility these machines can bring to a plant can sometimes justify the expenditure
- A closed circuit (crusher and screen) if sized properly can allow for multiple modes of production
- Ex. Production of a 1” minus material (6A, 34R, Man Sand) vs. Production of a 3/8” minus material (34R, Man Sand)
- Historically, this could be accomplished but would often require significant reductions in plant feed rates to accommodate the recycle load a “re-grind” mode brings

Could this be accomplished with a single crusher/screen combination? And allow for no reduction in plant throughput?

CASE STUDY: CONE CRUSHERS

Mode 1: 5/8”

Existing Plant Mode	New Plant Mode
200 TPH Feed	250 TPH Feed
80 TPH 5/8” x 3/8”	45 TPH 5/8”
50 TPH 3/8” x Sand	65 TPH 3/8”
70 TPH Man sand	115 TPH Sand

Mode 2: No 5/8”

Existing Plant Mode	New Plant Mode
150 TPH	225 TPH
10 TPH 5/8” x 3/8”	20 TPH 5/8”
49 TPH 3/8” x Sand	70 TPH 3/8”
68 TPH Man sand	125 TPH Sand

CASE STUDY: CONE CRUSHERS

Adjustable Throw Setting(s)

- Capable of being adjusted at time of liner change
- This throw setting allows for a corresponding increase/decrease in capacity
- This throw setting also allows for a corresponding change in minimum achievable closed-side setting

Advanced Automation

- Protecting the crusher from "packing" and high pressure loads
- Floatable head for rapid response to pressure peaks before damage is encountered

CASE STUDY: RESULT

Customer was able to completely eliminate the production of the capped product:

1) Increase saleable tons – manufactured sand and 34R
2) Eliminated expense for re-handling stockpiled material
3) Enabled production of 5/8” material in future years due to depletion of existing inventory
4) Depletion of existing inventory recaptured the non-liquid assets as previously mentioned in this presentation

All positive effects to this company’s bottom line!

CONE CRUSHERS

Unique Challenges

Example: Customer able to sell coarse gravel, sand, but no intermediate fines (1/4” x 3/8”)

Traditionally trying to re-crush this material down to sand is often done with an impactor (VSI)

Could a cone crusher be used in this application to minimize wear but also protect the machine?

CONE CRUSHERS

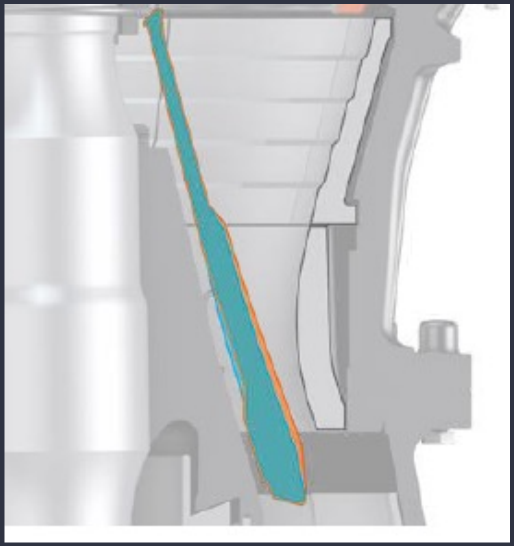
Packing is often caused by material being crushed too fine and filling the chamber, preventing movement through the crushing zone – No particle gaps to allow particles to tumble through

Increase particle movement through chamber by:

Steepening chamber

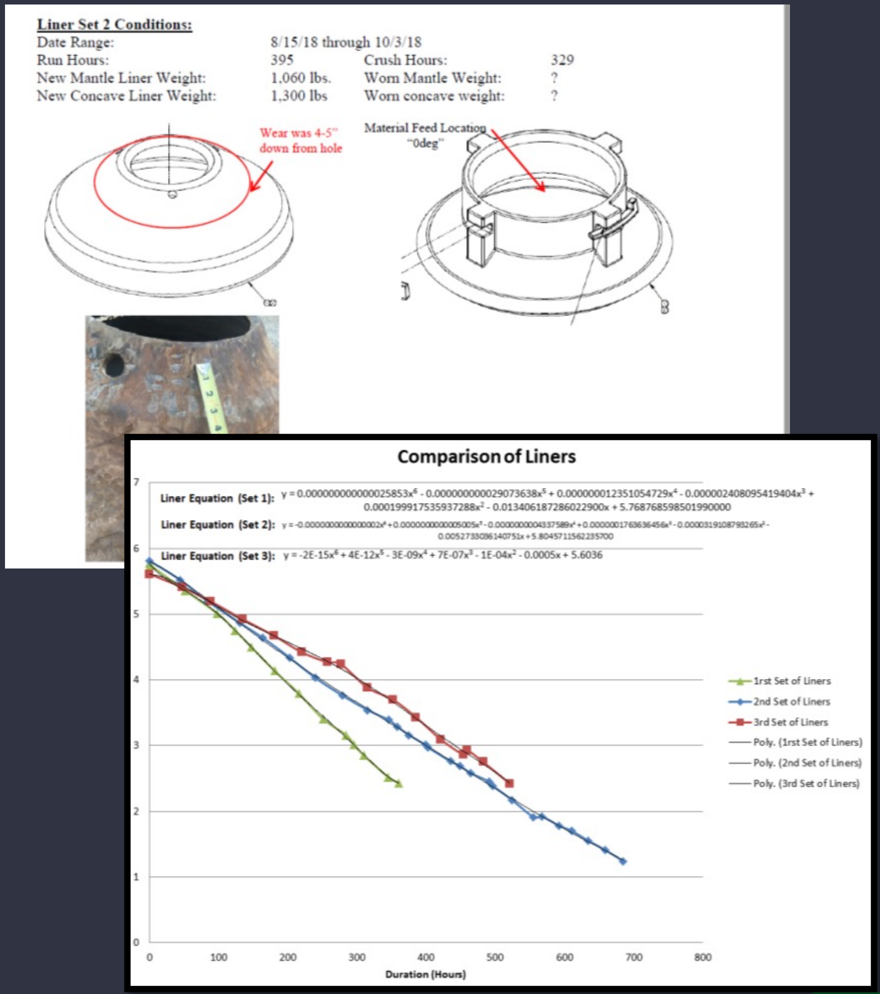
Increasing stroke

Addition of water



TERTIARY CONE CRUSHER

- Major Components for the Project:
  - 200 HP cone crusher selected to crush 1/2” x 1/4” material down to 3/32” minus.
  - Application is an aggressive, non-traditional approach to producing sand
  - Generated increase in sellable product while reducing waste inventory
  - Midwest Mine Services provided customer with components and continuous consultation to ensure success.
  - Customer currently seeing 14% increase in sand production



CASE STUDY: SCREENS

- An improperly sized screen may contribute to excess generation of undesirable “capped” product
- What is often seen is a screen that is undersized, resulting in carry-over of material that has already been crushed down to size
- In a closed circuit crushing spread this will result in particles that get reduced through an additional pass – Reduction Ratio
  - Ex. Instead of a ¾” particle meeting 6A spec, this particle now passes through the crusher an additional time reducing it’s size 3-4x.
    Now this 6A material has been reduced down to a sand or smaller.

CASE STUDY: SCREENS

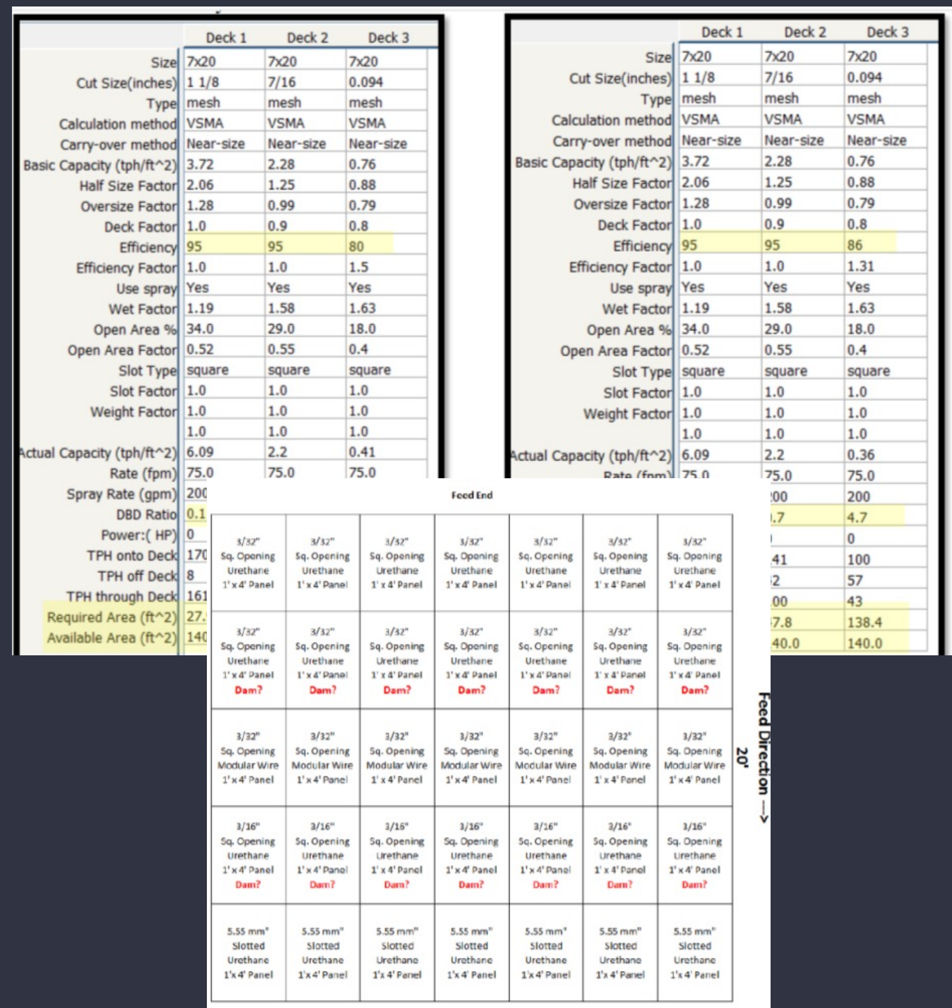
- 7’ x 20’ Triple Deck Incline Screen
  - Producing base and wash products – 250 TPH
  - Producing no base, only wash products – 150 TPH

  - Top Deck Media: 1-1/8” Urethane
  - Middle Deck Media: 7/16” Urethane
  - Bottom Deck: 3/32” Urethane

- Historically, the plant would be slowed down to maintain a clean cut on the bottom deck – Too much sand carrying over the bottom deck

CASE STUDY: SCREENS

- Solution:
  - Construct an Aggflow to model current conditions
  - Understanding % Open area and the impact that this has both in the plant and in the Aggflow model
  - Incorporate modular wire media in strategic locations within the screen deck to improve material throughput and eliminate the carry-over
- Result
  - Cleaner 3/8” x ¼”
  - Improved plant throughput
  - Improved manufactured sand throughput (more product making it through bottom deck)



	Deck 1	Deck 2	Deck 3
Size	7x20	7x20	7x20
Cut Size(inches)	1 1/8	7/16	0.094
Type	mesh	mesh	mesh
Calculation method	VSMA	VSMA	VSMA
Carry-over method	Near-size	Near-size	Near-size
Basic Capacity (tph/ft^2)	3.72	2.28	0.76
Half Size Factor	2.06	1.25	0.88
Oversize Factor	1.28	0.99	0.79
Deck Factor	1.0	0.9	0.8
Efficiency	95	95	80
Efficiency Factor	1.0	1.0	1.5
Use spray	Yes	Yes	Yes
Wet Factor	1.19	1.58	1.63
Open Area %	34.0	29.0	18.0
Open Area Factor	0.52	0.55	0.4
Slot Type	square	square	square
Slot Factor	1.0	1.0	1.0
Weight Factor	1.0	1.0	1.0
	1.0	1.0	1.0
Actual Capacity (tph/ft^2)	6.09	2.2	0.41
Rate (fpm)	75.0	75.0	75.0
Spray Rate (gpm)	200		
DBD Ratio	0.1		
Power:(HP)	0		
TPH onto Deck	170		
TPH off Deck	8		
TPH through Deck	161		
Required Area (ft^2)	27.		
Available Area (ft^2)	140		

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Deck Factor	1.0	0.9	0.8
Efficiency	95	95	86
Efficiency Factor	1.0	1.0	1.31
Use spray	Yes	Yes	Yes
Wet Factor	1.19	1.58	1.63
Open Area %	34.0	29.0	18.0
Open Area Factor	0.52	0.55	0.4
Slot Type	square	square	square
Slot Factor	1.0	1.0	1.0
Weight Factor	1.0	1.0	1.0
	1.0	1.0	1.0
Actual Capacity (tph/ft^2)	6.09	2.2	0.36
Rate (fpm)	75.0	75.0	75.0
		00	200
		.7	4.7
			0
		41	100
		2	57
		00	43
		7.8	138.4
		40.0	140.0

CASE STUDY: GRADATION GAPS

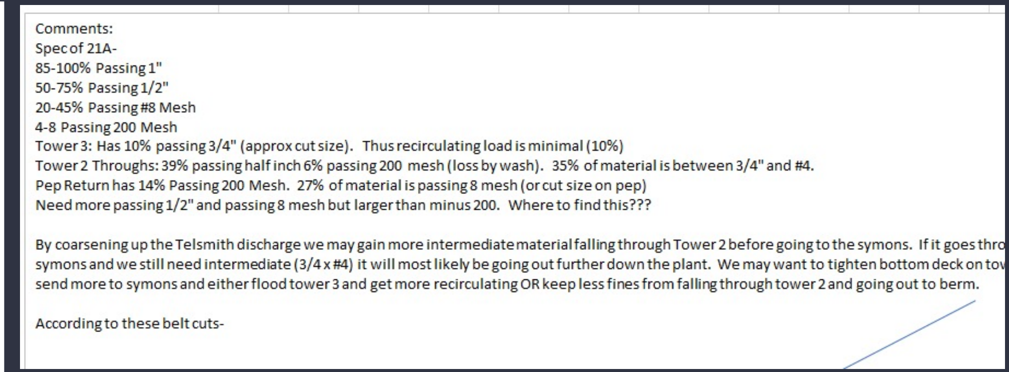
- Lastly, there is sometimes the potential to blend material back into a densely graded aggregate to:
  - Dispose of excessive fines
  - Increase saleable tons
- Ex. 750 TPH limestone plant with the following product spread:
  - 21A, 6a, Screenings
  - 21A product inconsistent in gradation, specifically a gap of material existing between ½” and #8 mesh.
  - 21A is also too fine, -#200 mesh is out of spec (too fine)

Sieve	Mass Retained	Cum Mass Retained	Ind % Retained	% Retained	% Passing	Target	Specification
1 1/2"	0.00	0.00	0	0	100		<100
1"	335.00	335.00	8	8	92		85-100
3/4"	805.00	1140.00	20	29	71		
1/2"	687.00	1827.00	17	46	54		50-75
3/8"	319.00	2146.00	8	54	46		
#4	660.00	2806.00	17	71	29		
#8	321.00	3127.00	8	79	21		20-45
#16	175.00	3302.00	4	83	17		
#30	88.00	3390.00	2	86	14		
#50	62.00	3452.00	2	87	13		
#100	66.00	3518.00	2	89	11		
#200	48.00	3566.00	1	90	10		4-10
PAN	26.80	3592.80	10	100	0		

Size	C3 Telsmith Discharge % Passing	C5 Recirculating Load % Passing	PEP Return PEP Throughs % Passing	Product 21A % Passing	C19 Tower 1 Throughs % Passing	C18 Tower 2 Throughs % Passing	S20 Combined Base % Passing
2	100	100					
1 1/2	93.3	94.9	100		100	100	
1	72.4	61.4	83.1	85-100	89.1	89.5	100
3/4	57.3	10.5	69.5		76.6	56.1	67.8
1/2	38.4	2.6	51.8	50-75	57.8	39.5	51.8
3/8	30.2	2.1	45		50.1	33	45.7
#4	19.5	1.9	33.1		36.3	21.8	32.5
#8	13.9	1.9	27.4	20-45	29.2	15.8	25.4
#16	11.1	1.8	24.5		25.5	12.3	21.3
#30	9.5	1.8	22.7		23.2	10.3	18.9
#50	8.3	1.8	20.5		20.9	8.8	16.4
#100	6.4	1.6	14.9		16	7	12.8
#200	5.43	1.58	12.23	4-8	13.5	5.87	10.86

CASE STUDY: GRADATION GAPS

- Plant is capped on screenings but produces this as a by-product of the production process and fines generated by the tertiary crushing process
- Examine the gradation, by introducing a washed #10 screenings, this product gradation is better balanced, improving the % passing #8 mesh while decreasing the % passing 200 mesh.


Comments:
Spec of 21A-
85-100% Passing 1"
50-75% Passing 1/2"
20-45% Passing #8 Mesh
4-8 Passing 200 Mesh
Tower 3: Has 10% passing 3/4" (approx cut size). Thus recirculating load is minimal (10%)
Tower 2 Throughs: 39% passing half inch 6% passing 200 mesh (loss by wash). 35% of material is between 3/4" and #4.
Pep Return has 14% Passing 200 Mesh. 27% of material is passing 8 mesh (or cut size on pep)
Need more passing 1/2" and passing 8 mesh but larger than minus 200. Where to find this???

By coarsening up the Telsmith discharge we may gain more intermediate material falling through Tower 2 before going to the symons. If it goes thro
symons and we still need intermediate (3/4 x #4) it will most likely be going out further down the plant. We may want to tighten bottom deck on tov
send more to symons and either flood tower 3 and get more recirculating OR keep less fines from falling through tower 2 and going out to berm.

According to these belt cuts-

CASE STUDY: ALTERNATIVE PRODUCTS

- Waste may be an inherit issue that may not be able to be completely removed
- Ex. Tailings to a pond
  Fine Sand
- Explore alternative products
  - Golf Course Sands
  - Cattle Bedding Sands
  - Windmill Foundations
  - Septic Field Fill
  - Other uses?

QUESTIONS