Getting Control

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QUARRY ACADEMY

Improving Processes. Instilling Expertise.

ORICA VOLVO SANDVIK

Getting Control

Some practical considerations of cone crusher operation

- feed arrangements
- speed

Feeding Arrangements

- Functionality of a cone crusher.
- The negative effects of poor feeding---how poor feeds cause extra costs to the operation and reduce productivity
- Some ideas how we can determine the source.
- Some ideas how to prevent and cure, reduce costs, increase plant and equipment utilisation and generally increase profitability.

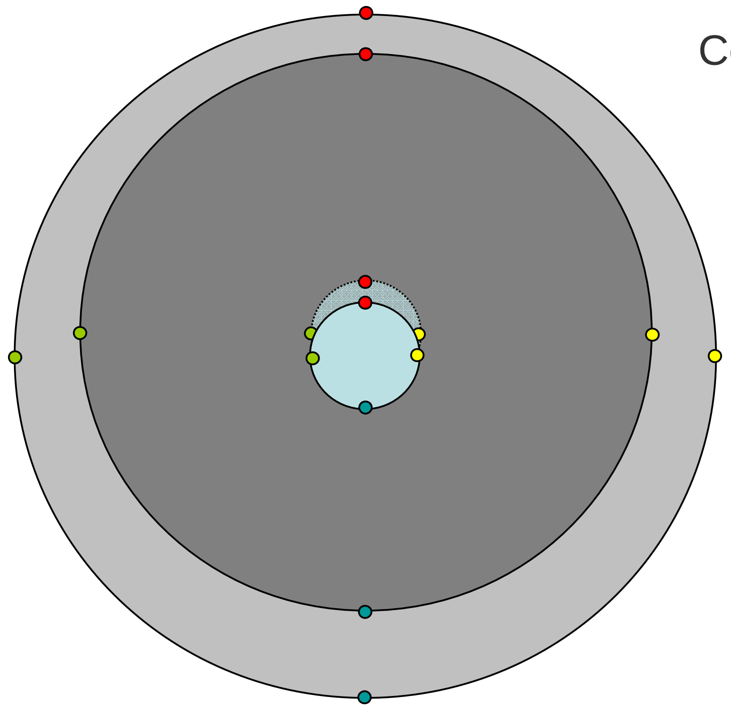
Cone Crusher Function

- A cone crusher has an annular crushing chamber.
- The CSS runs around the chamber so the action is basically rotational.
- Raw material enters the chamber on the OSS and is crushed one half revolution later by the CSS.
- This cycle takes place in most cone crushers 5 to 6 times per second.
- Cone crushers have volumetric capacities.

Function

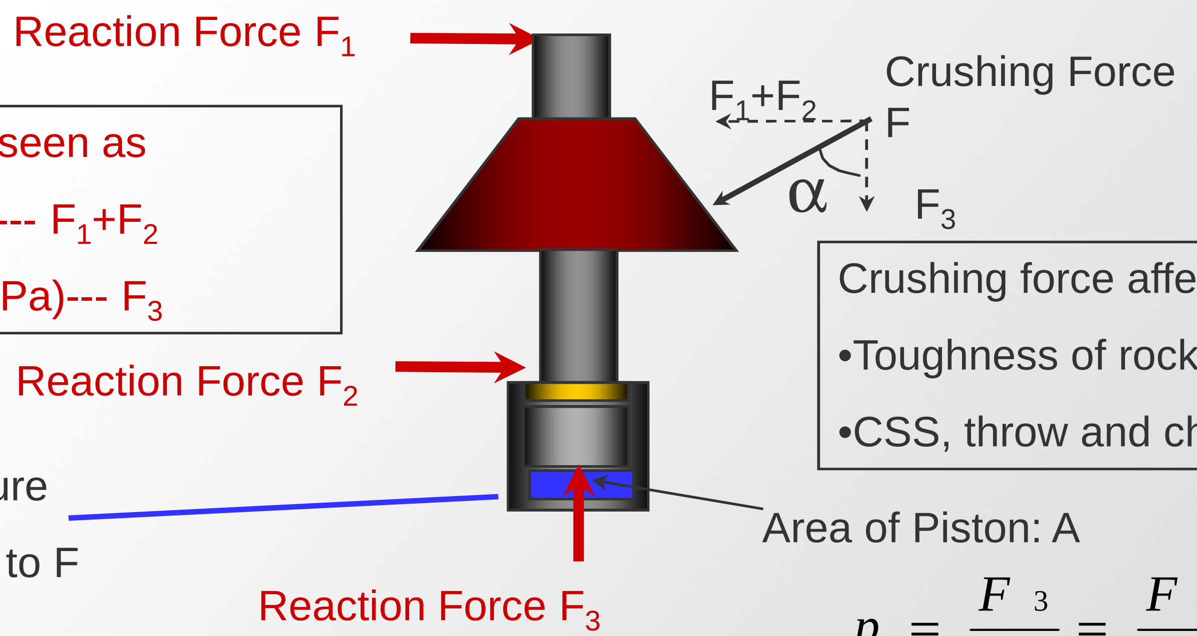
Function

CSS followed 180^0 later by OSS



Reaction to well distributed, unsegregated feed

A similar crushing force will be seen throughout each and every revolution



Reaction forces seen as

Power, hp (kW)---- F_1+F_2

Pressure, psi (mPa)--- F_3

Crushing force affected by

- Toughness of rock
- CSS, throw and chamber profile

Hydroset pressure

i.e. proportional to F

$$p = \frac{F_3}{A} = \frac{F \cdot \cos a}{A}$$

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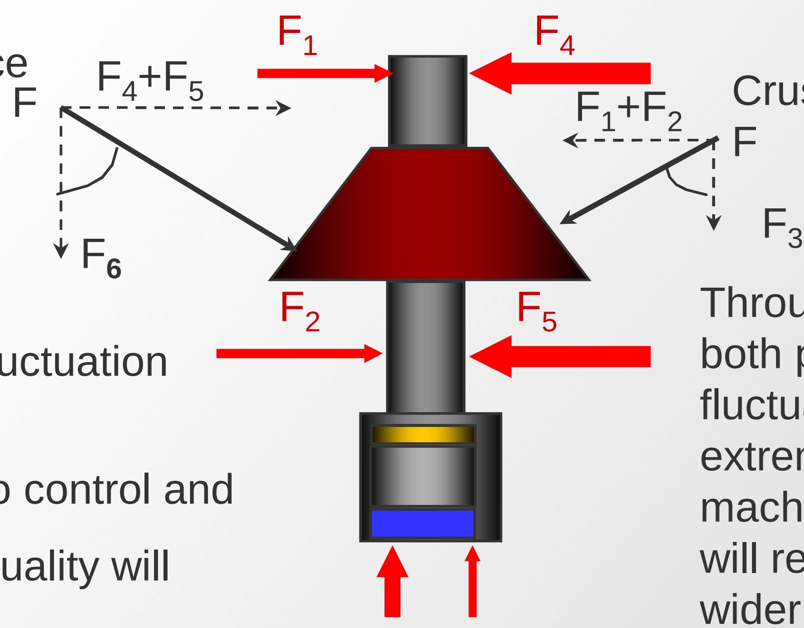
Segregation

Possibly the greastest single factor in destroying crusher performance and process control.

Reaction to uneven,segregated feed



F4 +F5 > F1+F2
F6 > F3

As wear becomes uneven

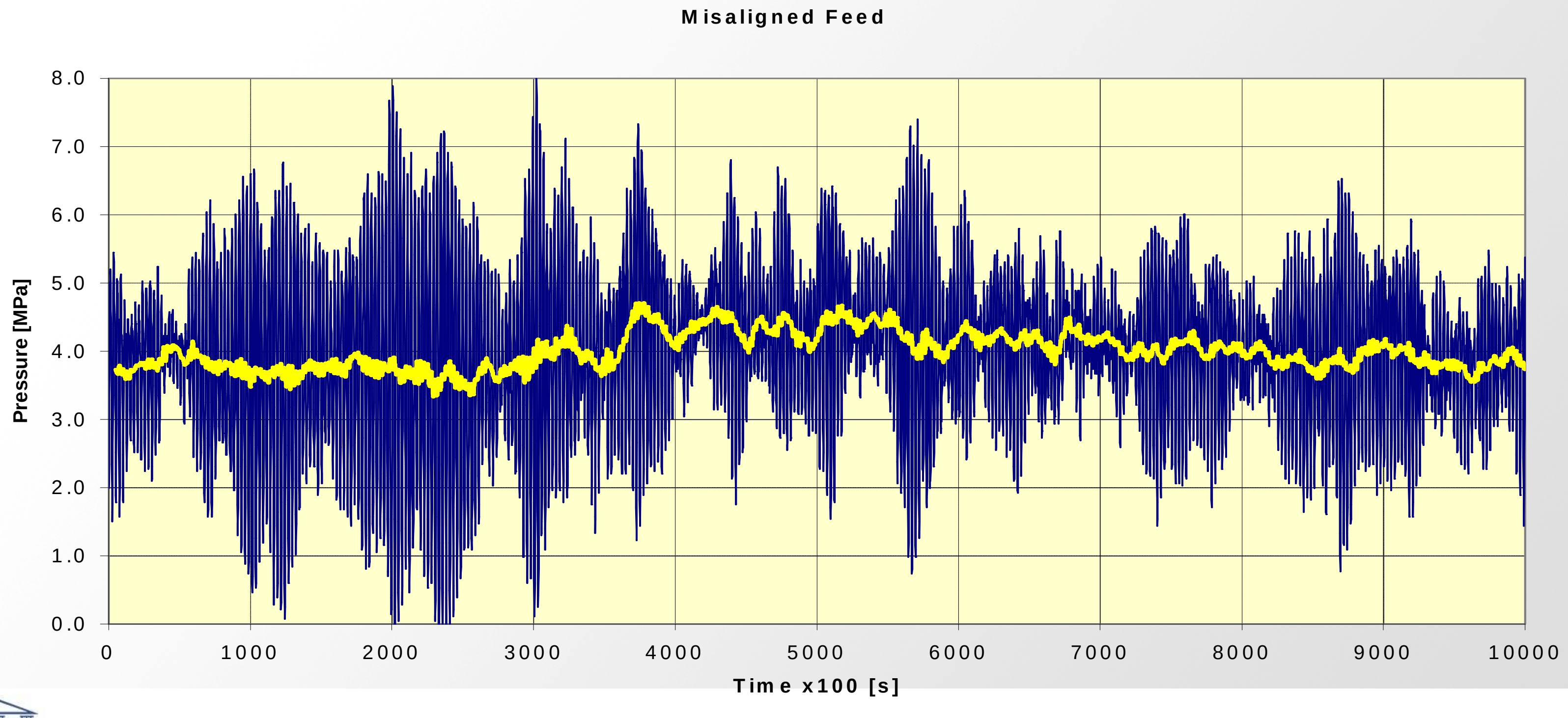
- the power and pressure fluctuation will become exaggerated,
- the setting more difficult to control and
- the product grading and quality will deteriorate.

Throughout every revolution both power and pressure will fluctuate considerably, causing extreme cyclic stress on machine component parts. This will require the setting to be run wider than necessary

Zero reaction at any point during the revolution will suggest a portion of the chamber is empty

El Teniente,Chile CH880, tertiary application

Misaligned/segregated feed - High pressure amplitudes



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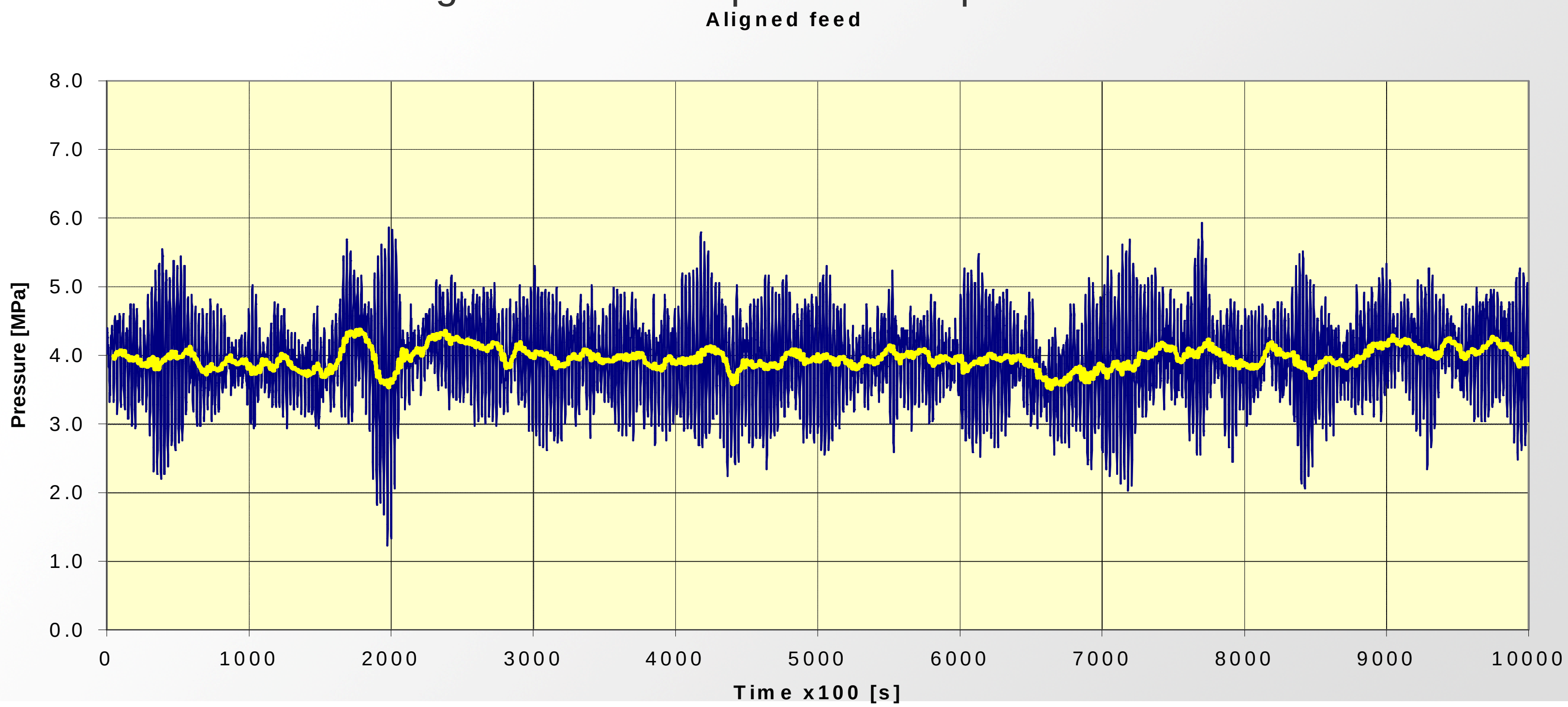
Improved segregation

Aligned feed- Low pressure amplitudes



What are the negative effects?

- High power and pressure will cause the crusher to be run at wider than necessary settings resulting in coarser product therefore higher recirculating loads with increased conveying, wear and crushing costs.
- Occasionally the necessity for increased crushing will demand increased capital investment.
- Segregated and poorly distributed feeds will cause the crusher liners to wear unevenly, again with deteriorating performance and associated costs.
- Product will become coarser and cubicity, often in critical products, will deteriorate. Costs??

What are the negative effects?

- Segregation and uneven wear will cause reduction in liner life through premature exchange. Costs??

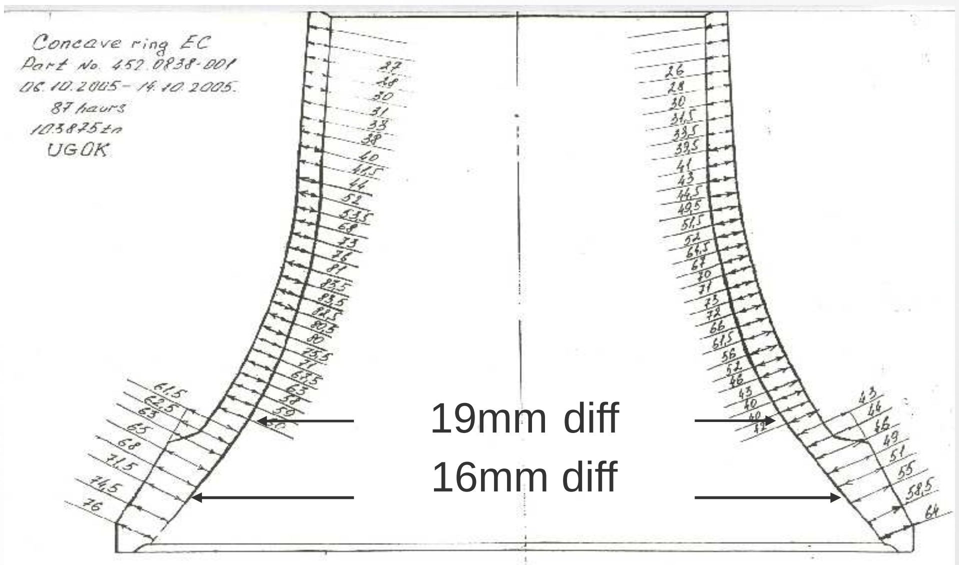
- Segregation and uneven wear will cause reduction in mechanical component life, often leading to traumatic failure and the costs of unplanned stoppages.

- ALL IN ALL CONSIDERABLE COST TO THE OPERATION.

Case study
Segregation

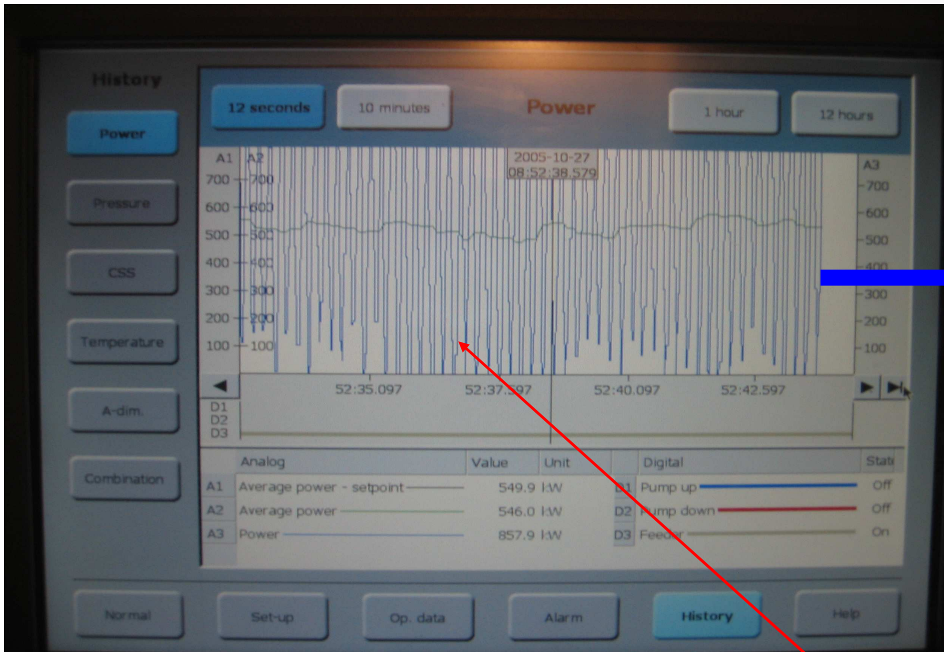
CH870 EC
Iron ore

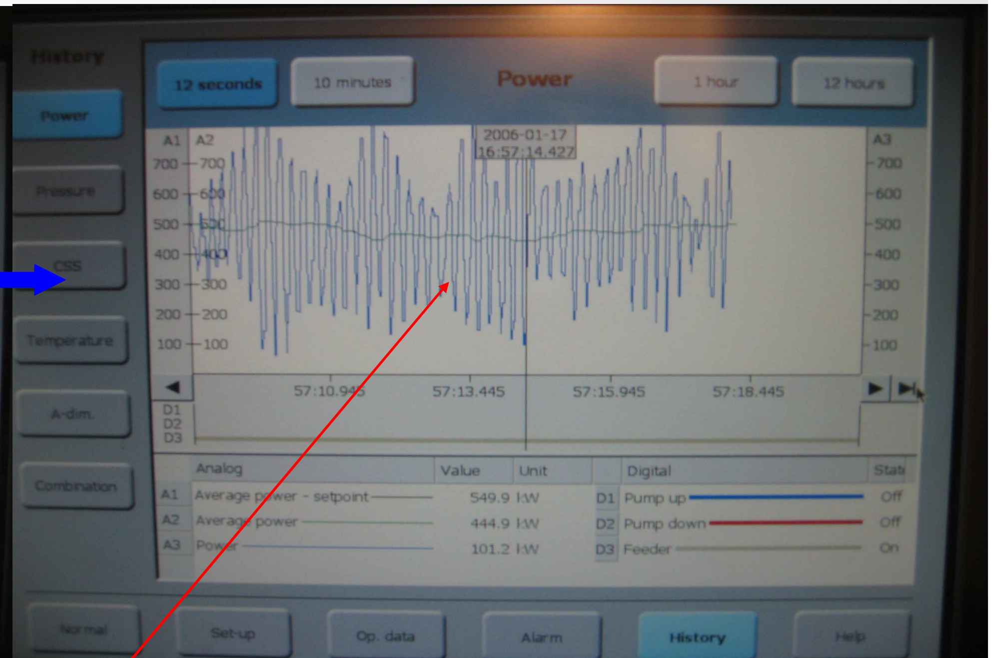
Negative effect of uneven wear



Demands much higher scrap weight----increased operating costs

Improvements after fitting an RFD

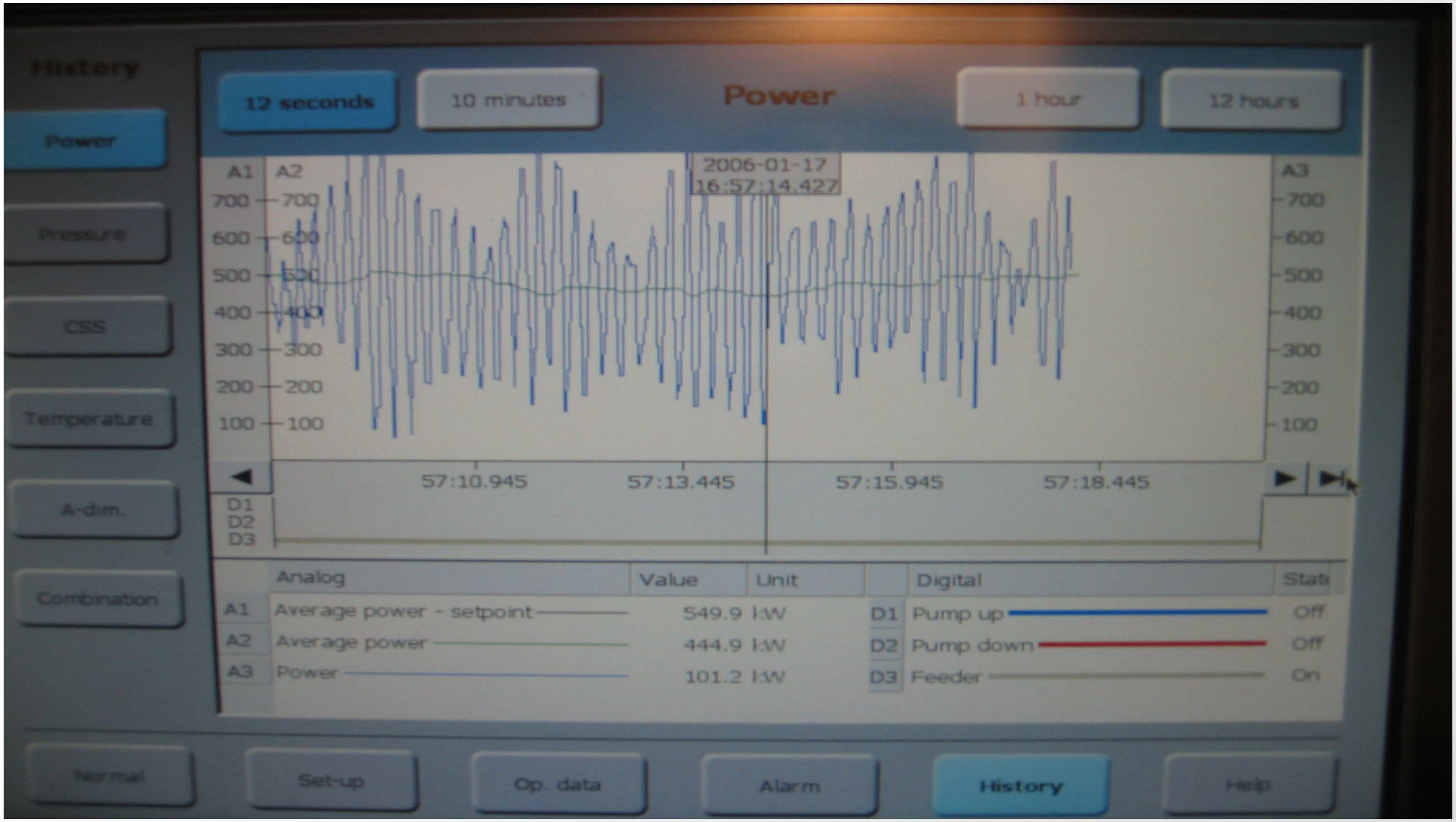




27. 10. 05

Each amplitude represents 1 cycle

17. 01. 06

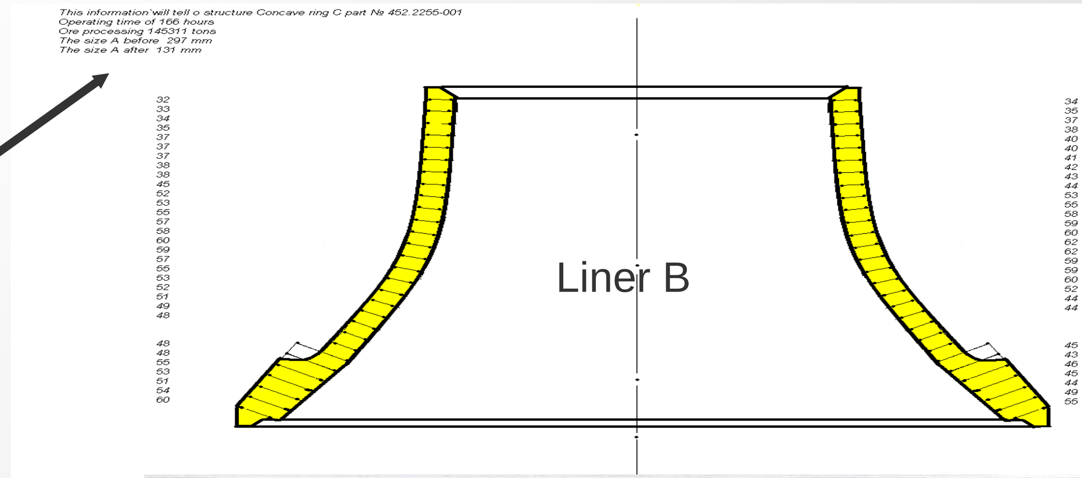

History
Power
Pressure
CSS
Temperature
A-dim.
Combination
12 seconds
10 minutes
Power
1 hour
12 hours
A1
A2
A3
2006-01-17
16:57:14.427
700
600
500
400
300
200
100
57:10.945
57:13.445
57:15.945
57:18.445
D1
D2
D3
Analog
Value
Unit
Digital
A1 Average power - setpoint 549.9 kW
A2 Average power 444.9 kW
A3 Power 101.2 kW
D1 Pump up Off
D2 Pump down Off
D3 Feeder On
Normal
Set-up
Op. data
Alarm
History
Help

Wear life improvement after fitting RFD

166hours

145311tonnes

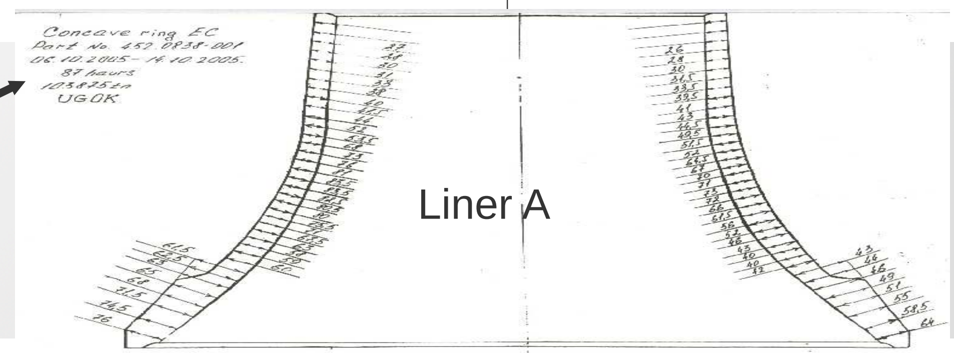
875tph



87 hours

103875 tonnes

1194tph



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Cost comparison

	Liner A	Liner B
Hours	87	166
Tonnes	103875	145311
Tonnes/hr	1194	875
Average setting over liner lifetime	80mm	60mm
Differential wear	19mm	5mm
% oversize	47	22
Tonnes/hr oversize	561	193
Tonnes/hr product	633	682
Additional cost assuming €0.5/ton	€280/hour	€96.5/hour
Wear cost (assuming €8000 per set)	8000/633 x 87 =€0.145/tonne of product	8000/682 x 166 =€0.071/tonne of product

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Early Prevention

- During the design stage, whether a new plant or plant extension or replacement crusher is being planned, careful consideration is required to the design of the feeding arrangement.
- Material normally arrives in a stream, from a conveyor, feeder or chute—the need is for even full width distribution with no segregation.
- Height can be an ally when available and employed to constrain material, change flow direction, combat segregation and remove impact, but a deadly enemy when working against us.

Early Prevention

- Flexibility in design---e.g.... the opportunity to alter the position and speed of the material discharge point and trajectory.

- Each feed arrangement design is unique, can be complex and may require several compromises

- THE OPERATIONAL SUCCESS AND OVERALL OPERATING COST OF THE INSTALLATION WILL DEPEND ON A SATISFACTORY DESIGN.

Late cure

- WHY segregation

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Belt width and speed

Belt width and speed

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Static distributors and splitters

Summary

Poorly designed crusher feeds leading to segregation or uneven distribution are extremely costly and often remain so for the life of the operation. These costs result from:

1. Re-crushing oversize through running crushers wider than necessary.
2. Detrimental effects on product quality.
3. In serious cases increased capital expenditure.
4. Energy and wear costs as oversize is transported around the plant.

Summary

5. Poor utilisation of manganese liners through uneven wear.

6. Poor utilisation of component parts through extreme cyclic overloading.

7. In serious case traumatic unplanned mechanical failures.

8. Lost business opportunities.

Improved feeding

I hope we have given an insight into some causes, consequences and possible solutions to poor feeding.

Segregation and /or poor distribution, if they already exist can and should be improved.

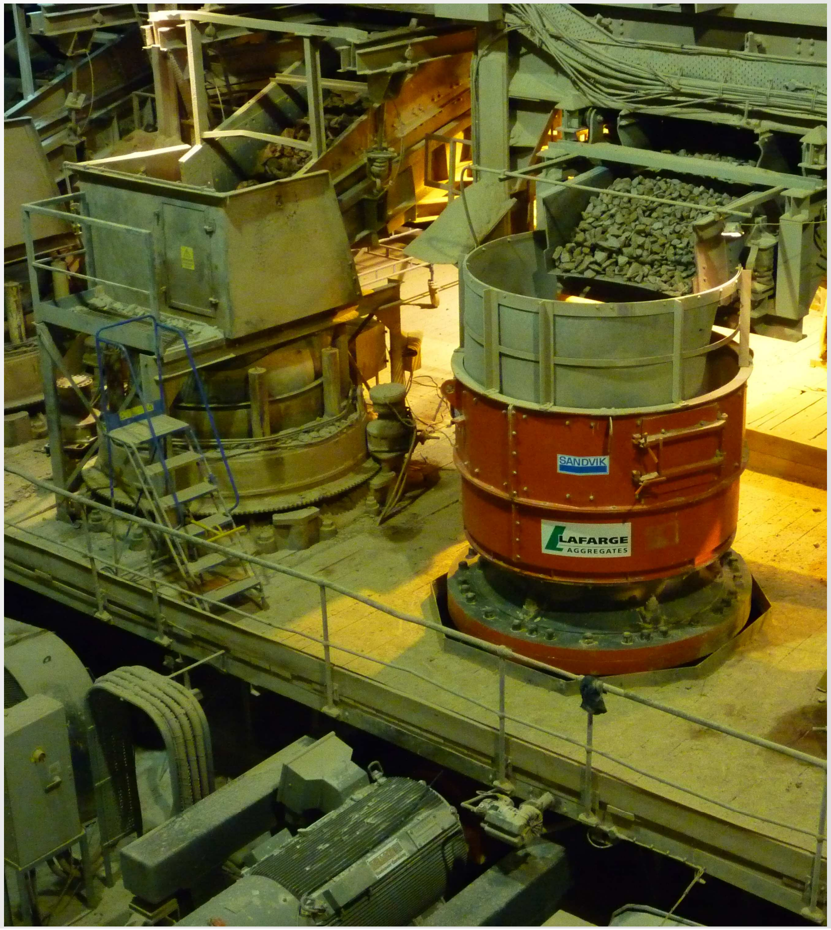
If you want to know more please enter the workgroup……………………..

Case study speed

Some practical considerations.

Cone crushers have volumetric capacities which can be adjusted by

- chamber volume--- but this is limited as the prime criteria is to match with the feed size.
- eccentric throw.
- speed as each revolution of the eccentric can be seen as a “crushing cycle”



Feed

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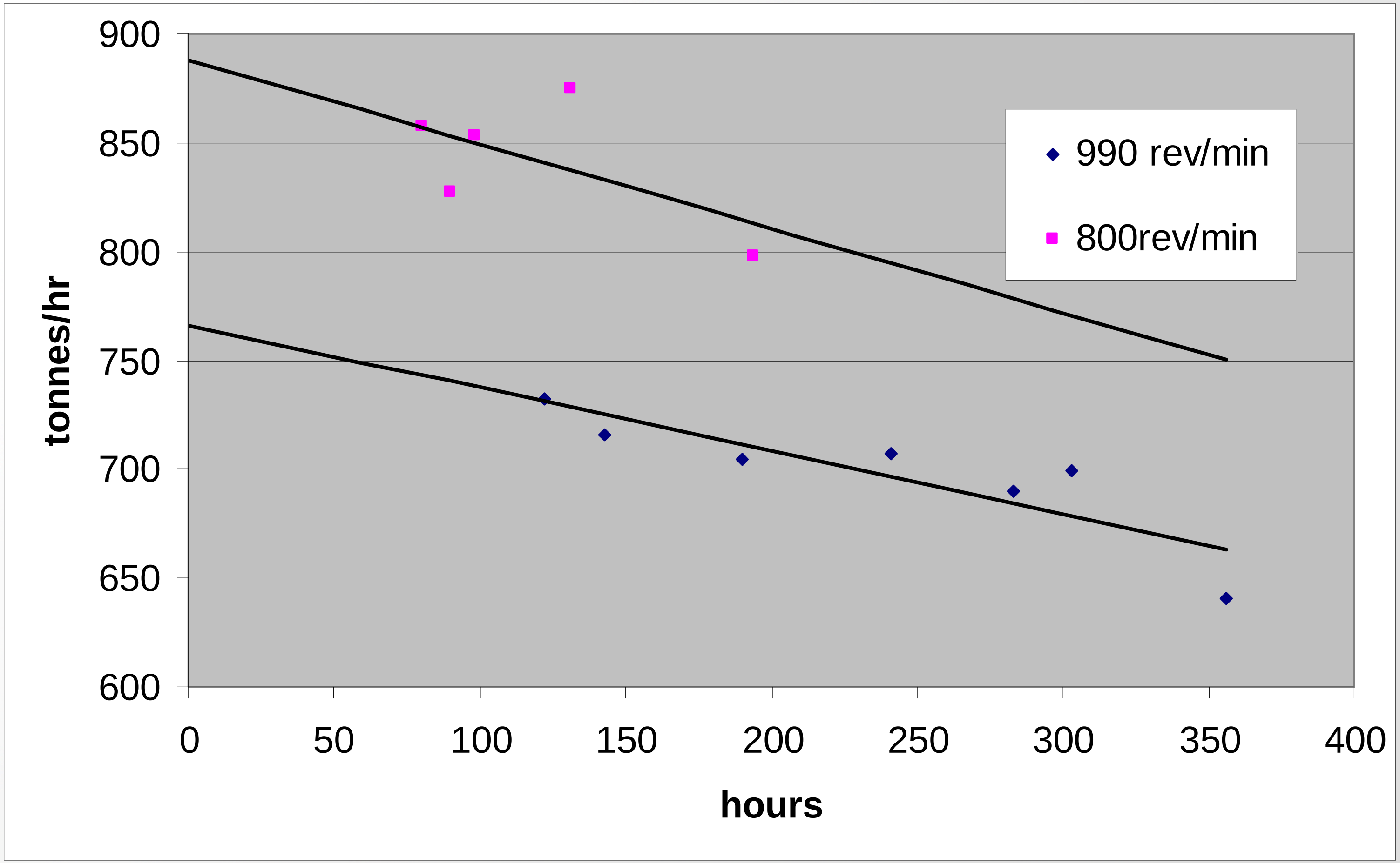
12 hour operation

CSS	:	40
Average kW	:	248
Pressure mPa	:	<3.0

Comparison & Trend.

990 v 800 rev/min
40mm CSS

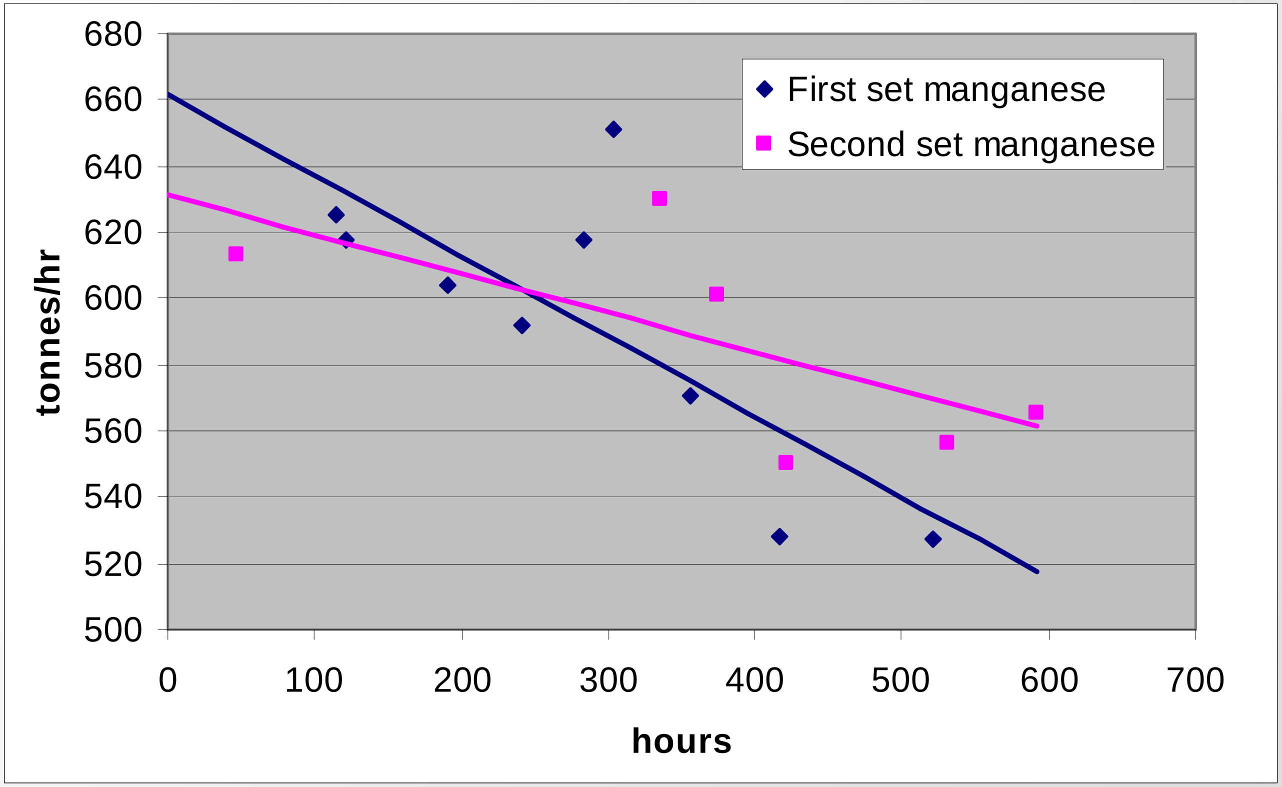


	Average of 8 tests at 40mm CSS 0ver first 194hrs with new liner. Speed 800 rev/min	Average of 3 tests at 40mm CSS 0ver first 194hrs with new liner Speed 990rev/min (standard)
Size	%passing	%passing
-75mm	99.0	100.0
-63mm	93.7	98.9
-50mm	76.8	89.3
-40mm	56.6	67.0
-31.5mm	42.8	49.3
-16mm	22.5	25.2
-10mm	15.5	16.9
-5mm	9.3	10.2
Capacity range	798-875tonnes/hr	731-746 tonnes/hr
Average capacity	843 tonnes/hr	736tonnes/hr
% increase in capacity	14.5%	
63 x 40mm production	37.1%	31.9%

Production

	800rev/min	990rev/min
Ballast yield	37.1%	31.9%
Ballast yield	312.75 tonnes/hr	234.78 tonnes/hr
Ballast increase	78 tonnes/hr	

Verification of capacity reduction through wear



Liner life
30mm CSS

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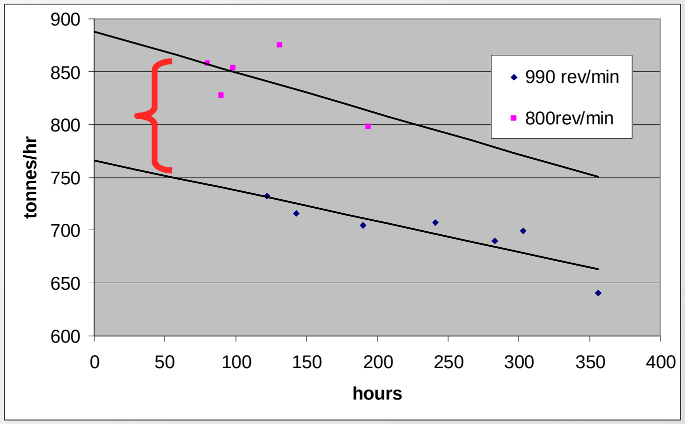
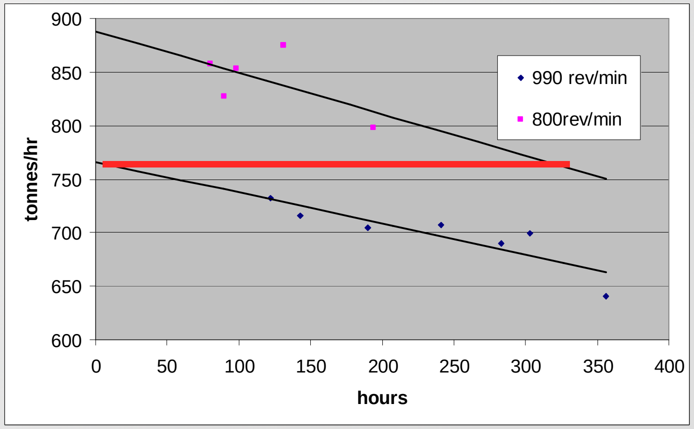
Summary

1. having established the optimum average production through the correct selection of chamber and throw it is possible to use speed to adjust for changes in demand.



2. as there is a relationship between capacity and speed the latter can be used to sustain capacity by compensating for the deterioration caused by changes in chamber profile.



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