2018

AF&PA
RECOVERY BOILER PROGRAM
ANNUAL CONFERENCE

FEBRUARY 7, 2018
ATLANTA, GEORGIA

American
Forest & Paper
Association

American Forest & Paper Association
Recovery Boiler Committee

American Forest & Paper Association

2018
AF&PA RECOVERY BOILER PROGRAM
ANNUAL CONFERENCE
ATLANTA, GEORGIA

Atlanta Airport Marriott Hotel
Mercedes Room (16th Floor)

AGENDA

Wednesday, February 7, 2018

7:00 am	Continental Breakfast
7:45 am	General Assembly – Chairman's Report & Review of the AF&PA Antitrust Policy - Karl Morency - Georgia-Pacific LLC
7:55 am	Research & Development Subcommittee Report - Christopher Verrill – International Paper Company
8:05 am	Operation & Maintenance Subcommittee Report - Donald Flach – Georgia-Pacific LLC
8:15 am	Report on BLRBAC Activities - Dean Clay – Boiler Services & Inspection, LLC
8:25 am	Environmental Update - Lawrence Otwell – Georgia-Pacific LLC
8:45 am	Jellyroll Smelt – Formation Mechanisms and Prevention Strategies - Honghi Tran – University of Toronto
9:25 am	Progress Towards Using Acoustics to Model Dissolving Tank Operation - Willy Wong – University of Toronto
9:55 am	Coffee Break
10:10 am	Dissolving Tank Explosion Prevention - Frank Navojosky – International Paper
10:40 am	Smelt Flow Restrictors - Jason Miller – Andritz
11:10 am	Recovery Boiler PPE Improvements - Scott Moyer - WestRock
11:30 am	Protective Clothing for Recovery Boiler Areas - Jim Ellis & Paul Kiernan – Gore

American Forest & Paper Association

Wednesday, February 7, 2018 (continued)

12:00 Noon Luncheon

1:00 pm BLRBAC ESP Subcommittee – Incidents ESP Report
- Dean Clay – Boiler Services & Inspection, LLC

1:15 pm Control of Sulphidity in a Modern Kraft Pulp Mill
- Raymond Burelle – Valmet, Inc.

1:45 pm TAPPI Energy, Recovery & Recaust Committee Report
- Danny Tandra – Clyde Bergemann

2:00 pm Sootblower Safety and Upgrade Guidelines
- Danny Tandra – Clyde Bergemann

2:30 pm Coffee Break

2:45 pm Boiler Inspection Programs for Condition Assessment of Recovery Boilers
- Matt Gilkinson - Babcock & Wilcox

3:15 pm Refractometer Safety and System Updates
- C.A. Vossberg – Electron Machine

3:35 pm Refractometer Safety and System Updates
- Phil Wagner - K-Patents

3:55 pm Refractometer Safety and System Updates
- Mike Sweeney - Liquid Solids Control

4:15 pm Report from the Swedish-Norwegian Recovery Boiler Committee
- Kajsa Fougher – ÅF, Forest Industry

4:30 pm Finnish Recovery Boiler Committee Report
- Markus Nieminen – Poyry
  (Presented by Kajsa Fougher)

4:45 pm Canadian BLRBAC Report
- Pat Terfloth - Industrial Chemical Consulting
  (Presented by Dean Clay)

5:00 pm Closing Remarks

5:10 pm Adjournment

AF&PA – Recovery Boiler Program
Attn: Wayne Grilliot
C/O: APEC, LLC
204 Hiawatha Trail; Springboro, Ohio 45066
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BLRBAC

Report on 2017 Activities and 2018 Plans

Dean Clay for AF&PA Recovery Boiler Annual Conference

BLRBAC Basics

Black Liquor Recovery Boiler Advisory Committee

- Objective - promote improved safety of recovery boilers through the interchange of knowledge, experience and data.
- Meetings in April and October in Atlanta
  - **next meeting April 9 – 11, 2018, notice sent via email**
  - Be sure to check the dates of future meetings
  - October 22 – 24, 2018, **confirmed,** Meeting
- Members from recovery boiler: operating, manufacturing and insuring companies.
  - Only Members can vote
  - Also associate members with direct interest
- Note – BLRBAC is now incorporated.

BLRBAC Internet Site

- blrbac.org
- Guidelines and questionnaires
  - Latest versions
  - Draft revisions for review
    - Interested persons are urged to review and provide comments, before the revisions are voted on for approval.
- Articles of Association & Operating Procedures
- Meeting registration forms and information
- Meeting minutes, current and past (to 2001)
- RBs in Service, U.S., Canada
  - Help keep the lists up to date, name changes, closures

BLRBAC Internet Site, Current Guidelines

- Emergency Shutdown Procedure (Dated: October 2012)
- Safe Firing of Black Liquor in Black Liquor Recovery Boilers (Dated: April 2016)
- Materials & Welding Guidelines (Dated: April 2013)
- Safe Firing of Auxiliary Fuel in Black Liquor Recovery Boilers (Dated: February 2012)
- Fire Protection in Direct Contact Evaporators and Associated Equipment (Dated: February 2012)
- Personnel Safety & Training (Dated: February 2012)
- Application of Rotork Actuators on Black Liquor Recovery Boilers (Dated: October 2005)
- Post ESP Water Level (Dated: January 2005)
- Post ESP Guidelines (Dated: October 2002)
- Boiler Water Management Guidelines for Black Liquor Recovery Boilers (Dated: April 2016)
- Instrumentation Checklist and Classification Guide for Instruments and Control Systems Used in the Operation of Black Liquor Recovery Boilers (Dated: April 2014)
- Thermal Oxidation of Waste Streams in Black Liquor Recovery Boilers (Dated: April 2016)

BLRBAC Updated Guideline Example

- Safe Firing of Black Liquor in Black Liquor Recovery Boilers (Dated: April 2016) **CHANGES are listed at the start of the document**

- **Chapter 2 Definitions: Revised definition of "Managed System"**
  - **A documented procedure which includes a checklist of critical manual valves or devices that is completed by the operator prior to start-up and as needed throughout the operation. The checklist shall identify each valve or device and the proper position, condition or state. Any deviation from the checklist shall be controlled and documented through a jumper policy.**

- **Chapter 4.10 Refractometer Calibration:**
  - **Revised wording of refractometer calibration and refractometer standardization as presented from the Instrumentation Subcommittee on 10/6/2014. More details were provided on standardization procedure.**

- **Chapter 13 Item 9. Steam/water mixture for cooling liquor guns.**
  - **Revised wording to allow steam/water mixture to cool liquor guns as long as proper use of alarms and interlocks are in place to prevent excessive use of water that could enter the furnace.**

BLRBAC Internet Site, Documents for Review and Comments

- Recommended Good Practice For Design Operation and Testing of the Emergency Shutdown System For Black Liquor Recovery Boilers - January 2018 Draft
- Personnel Safety - 2017 Draft
- Recommended Guidelines for the Incineration of Waste Streams in Black Liquor Recovery Boilers - April 2017 Draft
- Recommended Good Practice Fire Protection in Direct Contact Evaporators and Associated Equipment - August 2015 Draft
- Recommended Good Practice Thermal Oxidation of Waste Streams in Black Liquor Recovery Boilers - October 2016 Draft

BLRBAC Executive Committee

- **Chairman – Dave Slagel, International Paper**
- **Vice Chairman – David von Oepen, WestRock**
- **Operator Rep. – Bentley Sherlock, Georgia Pacific**
- **Insurance Rep. – Jim Onstead, FM Global**
- **Boiler Rep. – John Phillips, Andritz**
- **Treasurer – Len Olavessen, LENRO, Inc.**
- **Secretary – Everett Hume, FM Global**

Fall 2017 Meeting

- **Dave Slagel - Chairman:**
- Thank you all for your attendance here at the fall 2017 BLRBAC meeting. It is with tremendous shock and sorrow that I have to announce that our Chairman and friend, John Gray, passed away yesterday afternoon. John had attended BLRBAC for many years. He was elected Vice-chairman during the October 2012 meeting and held that position until becoming Chairman in the fall of 2014.
- John served our nation on a nuclear submarine during the Gulf War. He was employed by Rayonier. He leaves behind his wife and five sons. I'd like us to honor him and recognize his service to his family, our nation, his company, his community and to our organization. May we have a few moments of silence in his honor.

Fall 2017 Meeting Presentation

In recognition of service to the Black Liquor Recovery Boiler Advisory Committee Barbara Holich has provided outstanding and active administrative support for over 50 years for which we are very grateful. Her attention to detail and caring have been invaluable to BLRBAC as we have carried out our mission of helping the paper industry operate black liquor recovery boilers safely. Barbara shares ownership in the positive contribution BLRBAC has achieved over the years.

BLRBAC Subcommittees (10)

- ESP (Emergency Shutdown Procedure)
- Safe Firing of Black Liquor
- Safe Firing of Auxiliary Fuel
- Personnel Safety
- Instrumentation
- Waste Streams
- Fire Protection in Direct Contact Evaporator
- Materials & Welding
- Water Treatment
- Publicity & News

- Review the BLRBAC Minutes to see what the subcommittees are working on

Registration

- Barbara Holich, BLRBAC Secretarial Services
- $125 Advance; $200 @ Door
  - no change in cost
  - for @ Door payment credit/debit cards are accepted.
  - Working towards online advance meeting registration using credit cards – NOT ready yet, goal is to accept for ??, check meeting notice (sent via email, or on website).
- Crowne Plaza Hotel, Atlanta Airport
  - Free shuttle to and from airport/MARTA

- Spring 2017, 189 advance, 57 @ door registrations
- Fall 2017, 204 advance, 57 @ door registrations (highest in a number of years)

How to Participate in a BLRBAC Meeting

- Check the schedule for Open Subcommittee meetings, on Monday
  - Closed meeting are for subcommittee members only, to allow focus on assigned tasks.
  - Open meetings can be found in both the morning and afternoon.
- Attend an open meeting that interests you
  - Review the posted subcommittee agenda (available in the meeting schedule in the advance registration materials), and minutes from the previous meeting on the website
  - Usually they will also accept visitor questions on their guidelines, or related topics.

Participating in BLRBAC – cont'd

Example from the Spring 2018 Meeting Registration Materials, Monday Meeting Schedule

- **8:00 am -- Noon Personnel Safety Subcommittee - (OPEN)**
- Review input from the Membership (if any) for the Common Practices section for Membership review.
- Review initial language for the danger on using valve wrenches on Limitorque manual handwheels
- Review initial language with regard to treating injured employees, in particular follow-up/communication with medical personnel.
- "Unsafe Acts" - open discussion.
- Open discussion, miscellaneous topics

Participating in BLRBAC – cont'd

- Tuesday morning is ESP open meeting, all submitted incidents are reviewed.
  - Attendees have printed incident summaries.
  - Basic information, boiler leak locations and some leak photos are shown on a large screen.
  - Be prepared to take notes to share when you get back to your mill.
- Tuesday, afternoon is the Operating Problem Session, submit questions ahead of time, or go to the microphone. Please share.
- Sunday and Monday nights have supplier sponsored Hospitality events, go and meet people. Tuesday is a single, jointly sponsored, Activity Night, go and meet.

AF&PA Recovery Boiler Program Environmental Update

Lawrence Otwell
Georgia-Pacific LLC
February 7, 2018

Regulatory Reform

- Air and Water Regulatory burden
  - Department of Commerce
  - EPA Findings
  - Industry Priorities for Air Permitting Reform

Industry's NSR Streamlining

1. Improved modeling
2. Ambient Air
3. Plant wide Applicability Limits (PALs)
4. Project Netting
5. Aggregation
6. Routine Maintenance
7. Commence Construction
8. GHG Significant Emission Rate/Threshold rule
9. Fugitives
10. Offsets
11. Debottlenecking

Summary
Subpart MM – RTR

Final Rule Changes

Subpart MM Modification

- **Revised the opacity monitoring allowance for all recovery furnaces equipped with ESPs from 6 percent to 2 percent;**
- **Revised the opacity monitoring allowance for all lime kilns equipped with ESPs from 6 percent to 3 percent;**
- **Added a requirement for recovery furnaces and lime kilns equipped with ESPs to maintain proper operation of the ESP AVC;**
- **Requiries facilities to conduct periodic air emissions performance testing, with the first of the tests to be conducted within 3 years of the effective date of the revised standards, and thereafter no longer than 5 years following the previous performance test;**
- **Reduces the frequency for submitting excess emissions reports from quarterly to semiannually in conjunction with requiring electronic reporting of excess emissions (in the future, as reporting forms are tested and become available - see section IV.F of this preamble);**
- **Requires facilities to submit electronic copies of performance test reports;**
- **Requires facilities to submit initial notifications and notifications of compliance status electronically; and**
- **Requires Subpart MM MACT New Source testing for HAP as Methanol**

Electronic Reporting

- Requires semi-annual excess emissions reports be submitted electronically
  - the initial compliance date for electronic excess emissions reporting will be 1 year after the excess emissions reporting form (*i.e.*, a spreadsheet template) becomes available in the EPA's Compliance and Emissions Data Reporting Interface (CEDRI). A compliance date 2 years after promulgation allows 1 year for beta-testing of the e-reporting form before it is placed into CEDRI, followed by 1 year for facilities to begin using the final form. A copy of the revised semiannual electronic excess emissions reporting form (spreadsheet template) incorporating public comments has been placed in the docket for this action
- Requiring facilities to submit electronic copies of performance test reports;
- Requiring facilities to submit initial notifications and notifications of compliance status electronically;

SSM Provisions

- SSM provisions and allowance have been removed from Subpart MM
- SSM Plans provisions also removed. (GP will be evaluating our position that portions of SSM plans should be maintained as a means of supporting enforcement discretion and defining when standards apply).

Wet Scrubber Parameter Monitoring during Startup and Shutdown

- Removed the requirement to consider wet scrubber pressure drop during startup and shutdown because pressure drop is dependent on gas flow, which is transient during startup and shutdown.
- Continuous compliance is based on scrubber liquid flow rate monitoring during startup and shutdown instead of both pressure drop and liquid flow rate.

Boiler MACT Update

Boiler MACT – Oral Arguments

- ENGO appealed several provisions of the final BMACT court decision.
- Oral Arguments on the BMACT occurred on September 15, 2017
- Primary interest in the court was related to CO limits established at 130 ppm. In the rulemaking, EPA did not establish limits below this level due to very low HAP concentrations.
- Startup/Shutdown work practices were also argued with the court appearing to accept EPA's positions.

EPA – Remanded Standards

- The courts remanded several standards back to EPA to address due to the agency not considering all the units unless burned at least 90% of the fuel.
- EPA has not expressed a high degree of interest in addressing the remanded standards and the rule is not on Agency's Spring agenda.
- The industry is pushing EPA to deal with the rule so that data from the 2012 will be the information used in establishing the new limits.

Reanalyzing Subcategory Floors

Boiler Type	2013 Original	Preliminary EPA (May 2017)	Refined/Improved NCASI Review (August 2017)
HCl Solid Fuel	2.2 E-02	1.61 E-02	2.74 E-02 lb/MMBtu
Biomass Stoker CO	1500	750 - 860	1140 ppm
Fluidized Bed CO	470	212	440 ppm
Mercury Solid Fuel	5.7 E-06	5.33 – 5.36 E-06	5.7 E-06 lb/MMBtu
Biomass FB PM	0.11	0.0165	0.023 lb/MMBtu

Next steps

- All standards remain in place until a mandate from the court.
- Final court ruling on the challenged provisions in the rule would be expected in 1Q18
- Industry will continue to push EPA to address the remanded standards
- **Best case – final rule resolution in Early-2019.**

Emerging Air Issues

- Startup, Shutdown, and Malfunction (SSM) SIP Provisions with 36 states – each state is working through changes to remove provisions noted by EPA as problems.
  - Industry is asking states to consider flexibility in alternative standards during S/S events but EPA is making any alternatives difficult.
  - EPA SIP call is being challenged in DC Circuit Court
- CAER – Electronic information exchange to allow easy access to information and integrates CEDRI, NEI, TRI, GHG reports within one system.
- Next Gen Enforcement Initiative – EPA issued a 5-part plan of enhanced enforcement including more effective permits, advanced monitoring, electronic reporting, expanded transparency, and innovative enforcement.

Emerging issues

- Electronic Reporting Tool for NSPS – Proposed rule hasn't moved forward.
- Air Monitoring with Low Cost monitoring equipment – Citizen Scientist.
- Refrigerant rule finalized in November, 2016. Major changes:
  - covering HFC
  - Management thresholds down to 5# units
  - New reporting requirements for chronic leaking units.
- Revised RMP Rules – significantly greater interactions with community and reporting to agencies. Mandatory audits 3rd party audits. Safer technology reviews. Proposed rule published, but pulled back for additional work.

"Jellyroll" Smelt Formation Mechanisms & Prevention Strategies

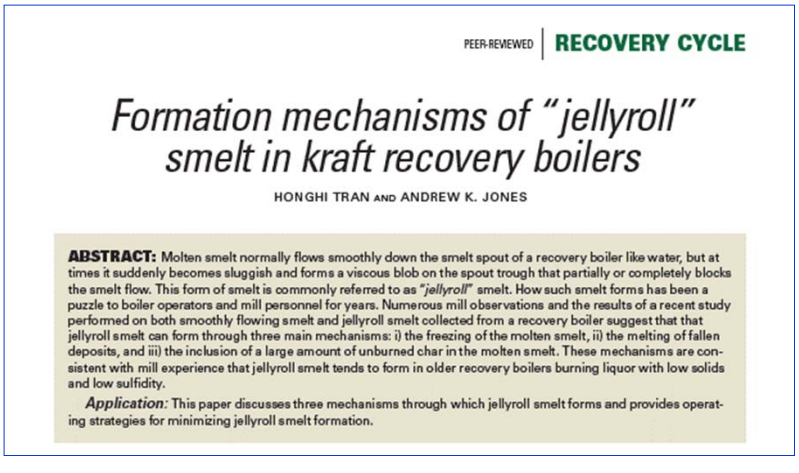
Honghi Tran

University of Toronto
Toronto, ON, CANADA

AF&PA Recovery Boiler Program Annual Meeting and Conference
Atlanta, GA, February 6, 2018

Recent TAPPI Journal Article

- **TAPPI Journal, Vol 16, October, 597-606 (2017)**



PEER-REVIEWED | RECOVERY CYCLE

Formation mechanisms of "jellyroll" smelt in kraft recovery boilers

HONGHI TRAN AND ANDREW K. JONES

ABSTRACT: Molten smelt normally flows smoothly down the smelt spout of a recovery boiler like water, but at times it suddenly becomes sluggish and forms a viscous blob on the spout trough that partially or completely blocks the smelt flow. This form of smelt is commonly referred to as *"jellyroll"* smelt. How such smelt forms has been a puzzle to boiler operators and mill personnel for years. Numerous mill observations and the results of a recent study performed on both smoothly flowing smelt and jellyroll smelt collected from a recovery boiler suggest that that jellyroll smelt can form through three main mechanisms: i) the freezing of the molten smelt, ii) the melting of fallen deposits, and iii) the inclusion of a large amount of unburned char in the molten smelt. These mechanisms are consistent with mill experience that jellyroll smelt tends to form in older recovery boilers burning liquor with low solids and low sulfidity.

Application: This paper discusses three mechanisms through which jellyroll smelt forms and provides operating strategies for minimizing jellyroll smelt formation.

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Outline

- What is “jellyroll” smelt?
- Formation Mechanisms
- Prevention Strategies
- Highlights of Smelt Shattering Research

3

What’s “Jellyroll” Smelt?

- Smoothly flowing smelt suddenly becomes sluggish and forms a viscous blob on the spout trough

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Jellyroll Smelt

- Called “jellyroll” smelt since it resembles the jelly in a jelly roll cake.
- Can block smelt openings
  - Allowing smelt to accumulate
  - Resulting in heavy smelt runoffs
  - Making spout cleaning a dangerous task

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Jellyroll Smelt

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Formation Mechanisms

- Not well understood until recently
- Possible formation mechanisms
  - Smelt freezing
  - Deposit melting
  - Char inclusion
- Any logical mechanism must explain the sudden change in molten smelt fluidity (or viscosity)

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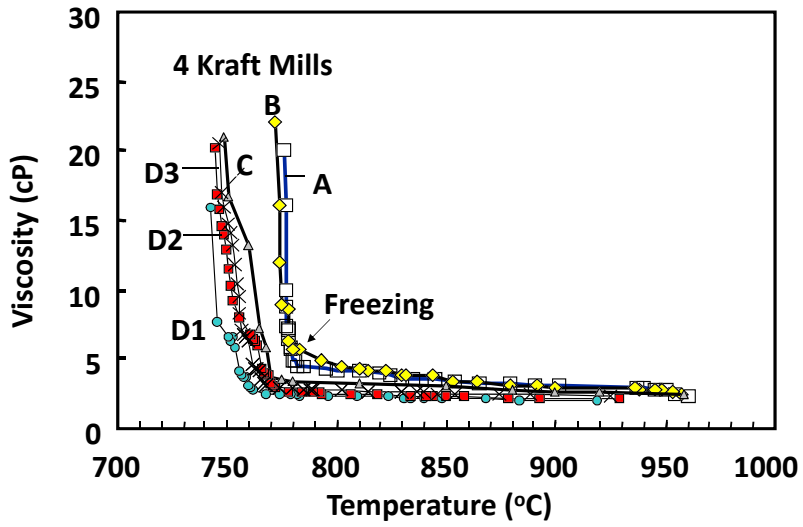
Smelt Fluidity



Tran, H.N. et al (2006)

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Implications

- Smelt flows smoothly as long as it is completely molten
- As molten smelt begins to freeze, it becomes viscous and stop flowing
- SMELT FREEZING can be a cause of jellyroll smelt formation

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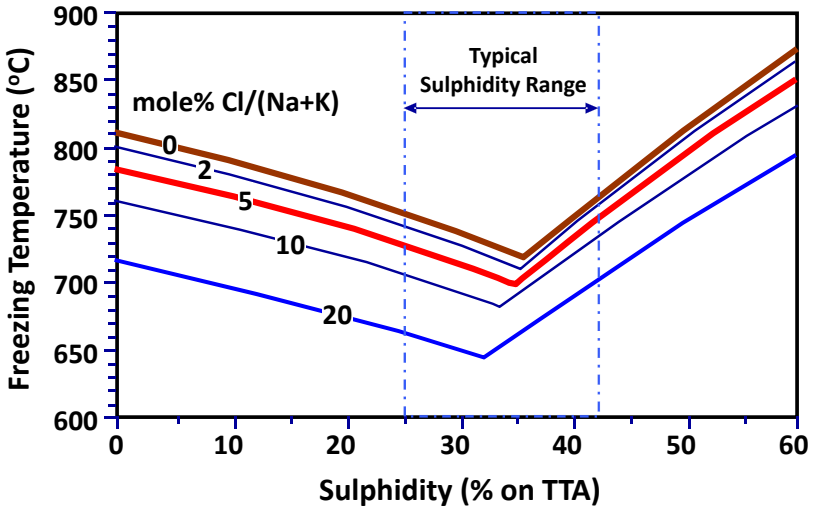
Effect of Smelt Composition on $T_{Freezing}$

For "HARDWOOD" Mills, 5 mole% K/(Na+K), 100%RE



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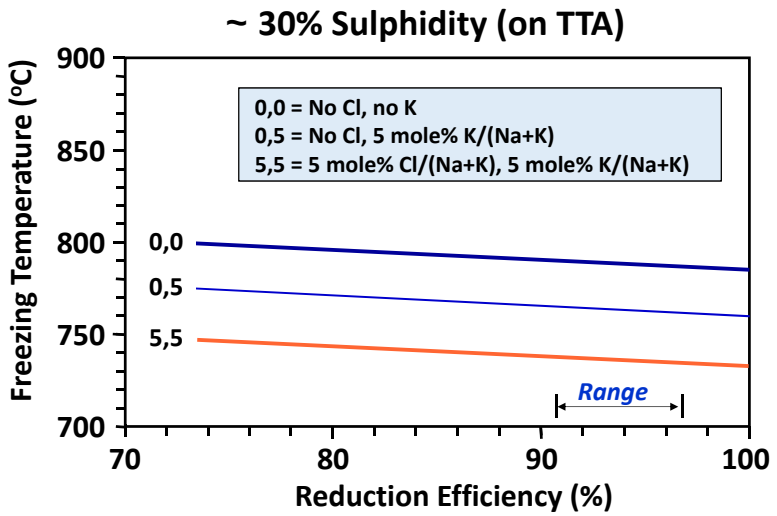
Effect of Smelt Reduction Efficiency (RE)



➔ *Under normal operating range, reduction has little effect*

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Fallen Deposits

- **Properties**
  - Consist of mostly sulphate and carbonate with very little sulphide
  - Either solid or partially molten, but not completely molten
  - Much colder than molten smelt
- **When dropped onto the furnace bed, deposits**
  - Interact with molten smelt
  - Altering smelt composition, temperature and fluidity

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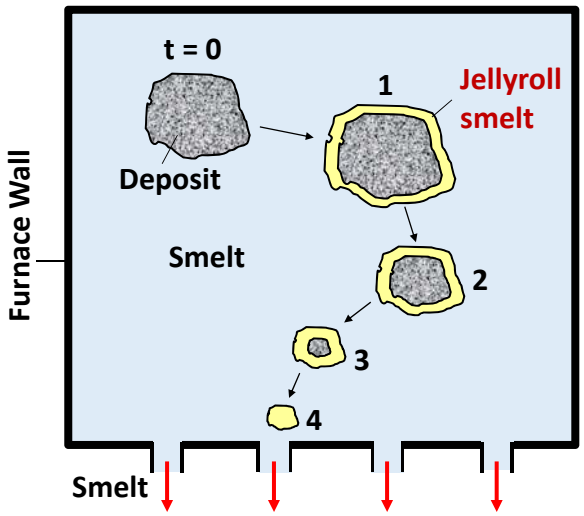
Fallen Deposit and Smelt Interaction



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Jellyroll Smelt Formed by Fallen Deposits

- Formation starts from the deposit surface
  - Deposit surface melting
  - Surrounding molten smelt freezing
- The process continues until the deposit is completely melted and mixed with smelt
- Often observed during boiler start-ups, particularly after a thermal shedding event
  - More deposit falling
  - Lower T_{Smelt}
  - Higher $T_{Freezing}$

  } Smaller ΔT operation

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Fluid Smelt vs. Jellyroll Smelt

Fluid Smelt

Jellyroll Smelt

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Smelt Property Comparison

	Fluid Smelt	Jellyroll Smelt
Reduction, %	95.7	94.7
Sulphidity, % on TTA	20.1	20.3
Water-insoluble, wt%	0.35	1.98
Impurities (NPEs)	0.34	0.60
Char content, wt%	0.01	1.4
Char density, g/cm^3	n/a	0.06

Can this small amount of char make a difference?

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Smelt Property Comparison

	Fluid Smelt	Jellyroll Smelt
Smelt density, g/cm^3	1.8 – 2.0	-
Char density, g/cm^3	-	0.054 (0.014 – 0.110)
Char content, wt%	0.01	1.4
Char content, vol%	1.8	40 - 60

➔ *A char content of 1.4% by mass can occupy half of the smelt volume, severely hindering the smelt flow.*

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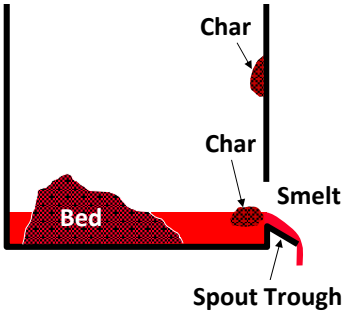
Formation Mechanisms

- Three main mechanisms
  - Freezing of molten smelt
  - Melting of fallen deposits
  - Char inclusion in molten smelt
- One common requirement:
  - Must contain a large amount of solid particles



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Prevention Strategies

- Particles can be
  - Smelt that has partially frozen
  - Fallen deposits that have not melted
  - Partially burned black liquor char
- Minimizing the presence of such particles in the molten smelt is key
- It is important to identify the main formation mechanism

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Formation Mechanism Identification

Mechanism	Signs
Smelt Freezing	• Smelt looks normal (pink); contains little char • Low bed temperature • Low liquor sulfidity • Low S/Na2 molar ratio (between 0.2 and 0.3)
Fallen Deposits	• Smelt look pale (pinkish); contains little char • Smelt has an unusually high sulfate content (low reduction efficiency < 50%) • High S/Na2 molar ratio (between 0.5 and 1)
Char Inclusion	• Smelt looks black; contains a large amount of char (unburned liquor) • High dregs content in green liquor

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Prevention Strategies

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Jellyroll Smelt formed by Smelt Freezing

- Operating at high ΔT
- Increasing lower furnace temperature ("Hot bed" operation)
- Keeping the liquor sulfidity between 33 and 38% on TTA to lower smelt freezing temperature

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Jellyroll Smelt formed by Fallen Deposits

- Minimizing large deposit build-ups in the superheater region during normal boiler operation;
- Minimizing massive deposit falling at once, particularly during boiler start-up and thermal shedding events

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Jellyroll Smelt formed by Char Inclusion

- Controlling char bed height to minimize bed collapsing;
- Avoiding liquor burning on the furnace walls that forms large lumps of char near smelt spout openings;
- Keeping char away from spouts by increasing primary air flow, pressure and temperature

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Dissolving Tank Research Update

- Smelt-Water Interaction
- Smelt-Shatter Jet Interaction
  - Can jellyroll smelt be shattered?
- Dissolving Tank Acoustic Analysis
- Dissolving Tank Hydrodynamics

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Jellyroll Smelt - Shatter Jet Interaction

Taoxin Jiang (MASc Student)

Co-supervised by: Markus Bussmann and Honghi Tran

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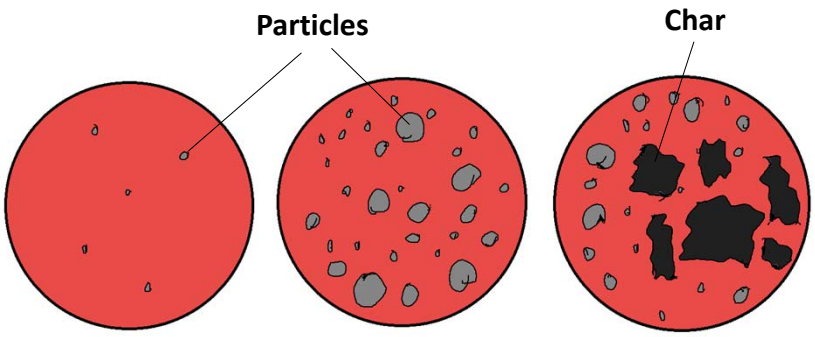
Smelt Composition



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Objectives

- Indirect estimation of jellyroll smelt "viscosity"
  - Model fluid: corn syrup/sugar crystals/water
- Shattering behaviour of viscous fluid
- Mathematical modeling

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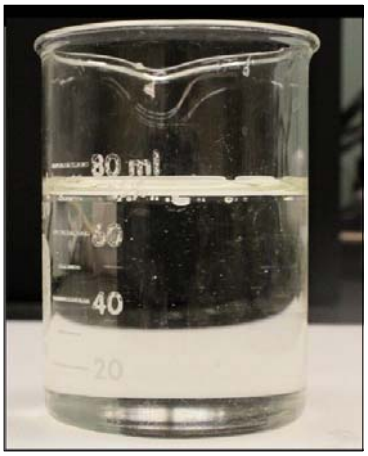
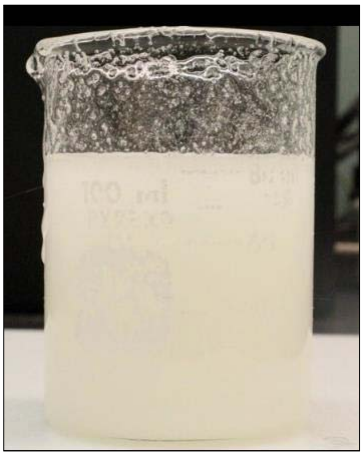
Model "Jellyroll Smelt"



Corn Syrup
(~ 10,000 cP)



80% Corn Syrup +
20% Sugar Crystals
(~ 12,000 cP)

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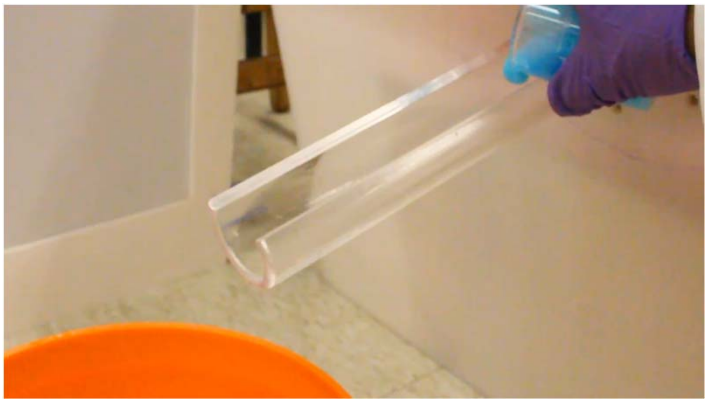
Estimation of Jelly Roll Smelt Viscosity

- 80% corn syrup-20% sugar crystals



➔ *Apparent viscosity of jelly roll smelt: 10,000 – 100,000 cP*

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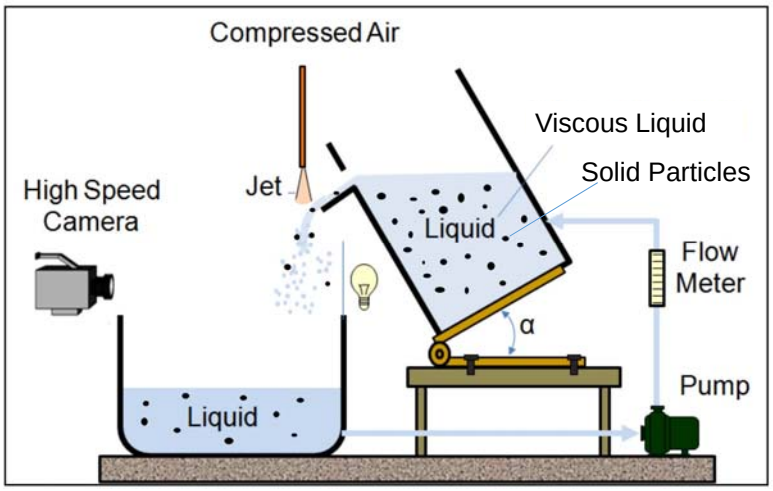
Experimental Setup



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Experimental Variable Parameters

Variable Parameter	Conditions
Viscosity	5 – 12000 cP
Liquid flow rate	0.6 – 6 LPM
Shatter jet supply pressure	50 – 300 kPa

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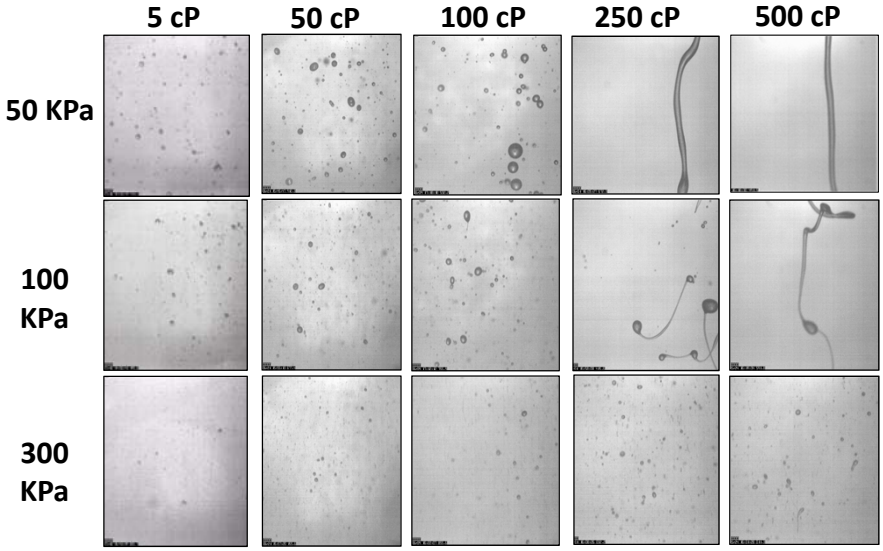
Experimental Results at 2.5 LPM



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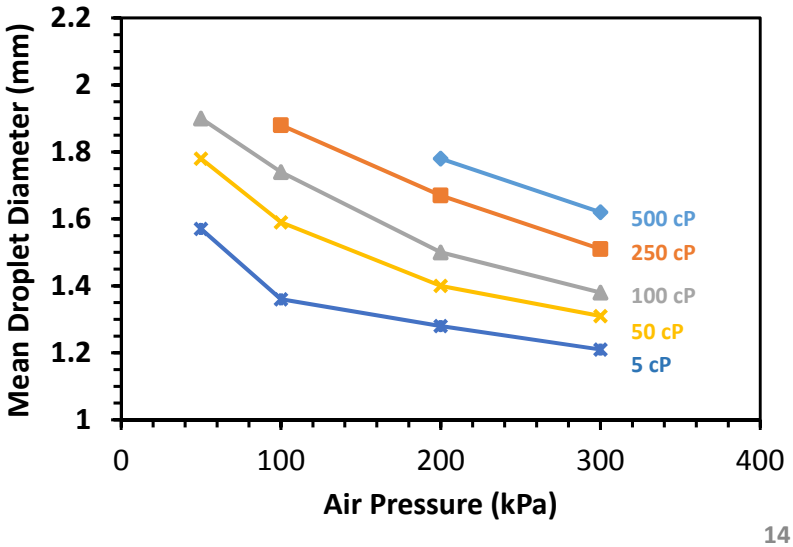
Mean Droplet Diameter at 2.5 LPM



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Viscous Liquid Shattering Tests

300 kPa (43.5 psi), 6 LPM (1.6 USGPM)

1000 cP

12000 cP

35

Mathematical Modeling

Input

- Gas, liquid flow velocity
- Material properties

Model

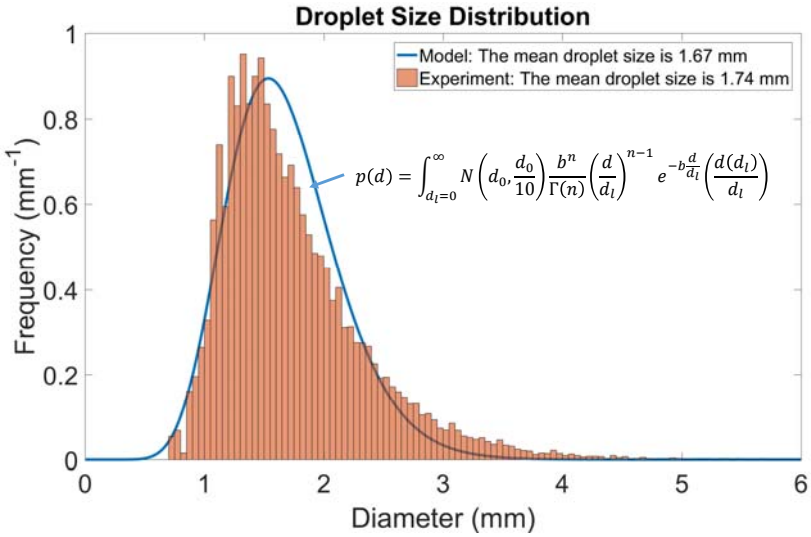
- Shear instability
- RT instability
- TAB model

Output

- Mean droplet size
- Droplet size distribution
- Breakup time
- Maximum shatterable viscosity

36

Model Prediction vs Experimental Result



Operating Condition: 100 cP, 100 kPa and 2.5 LPM

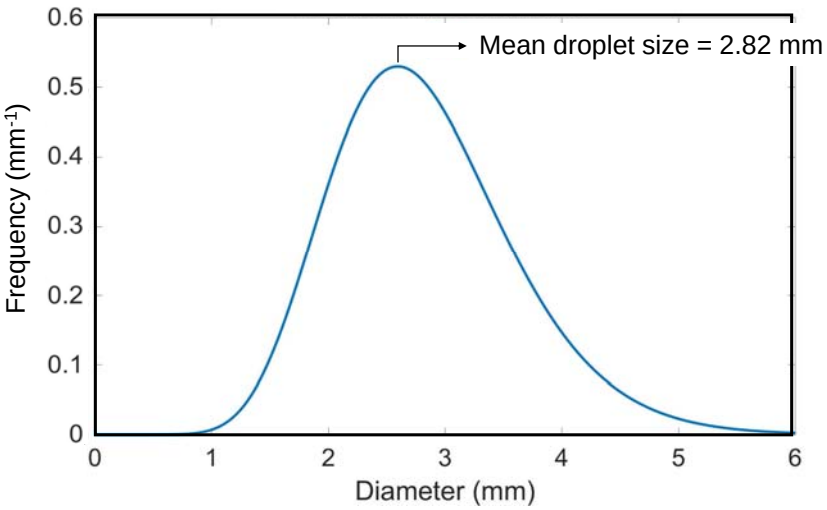
37

A Case Study with Model

Parameters	Values
Shatter jet nozzle size	3 cm ID
Shatter jet pressure	25 psi
Smelt flow Rate	1 L/s
Smelt density	2 g/cm^3
Smelt viscosity	5 cP
Smelt surface tension	0.21 N/m

38

Predicted Droplet Size Distribution



39

Summary

- Viscosity of jelly roll smelt: 10,000 – 100,000 cP
- Higher the viscosity, lower the shattering effectiveness
- A mathematical model is being developed to predict
  - Droplet size distribution
  - Maximum shatterable viscosity

40

Progress Towards Using Acoustics to Model Dissolving Tank Operation

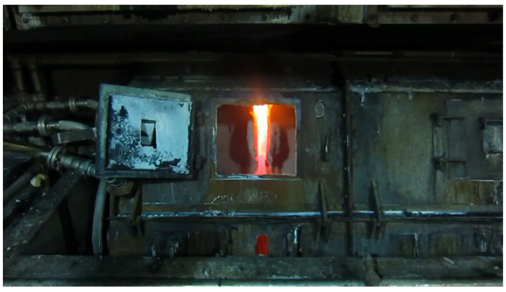
Willy Wong

with Brian Wang, Markus Bussmann and Honghi Tran

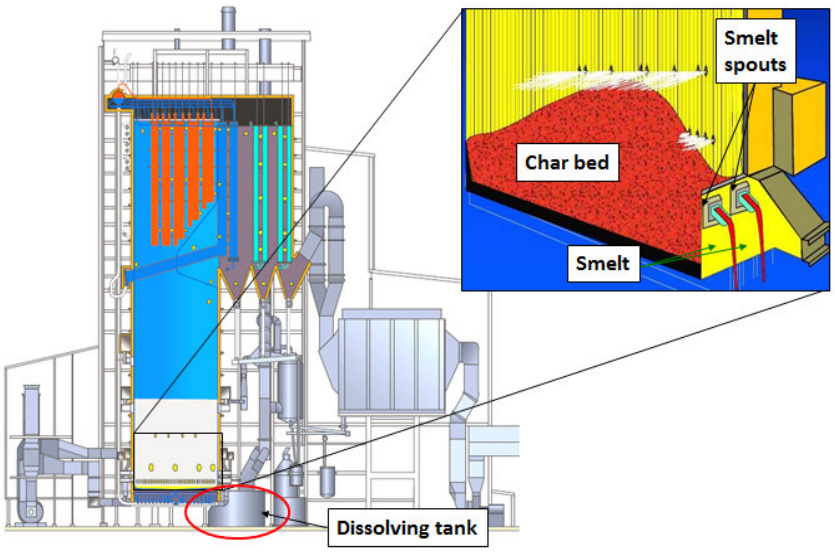
UNIVERSITY OF TORONTO

Process control room at Irving Mill, New Brunswick

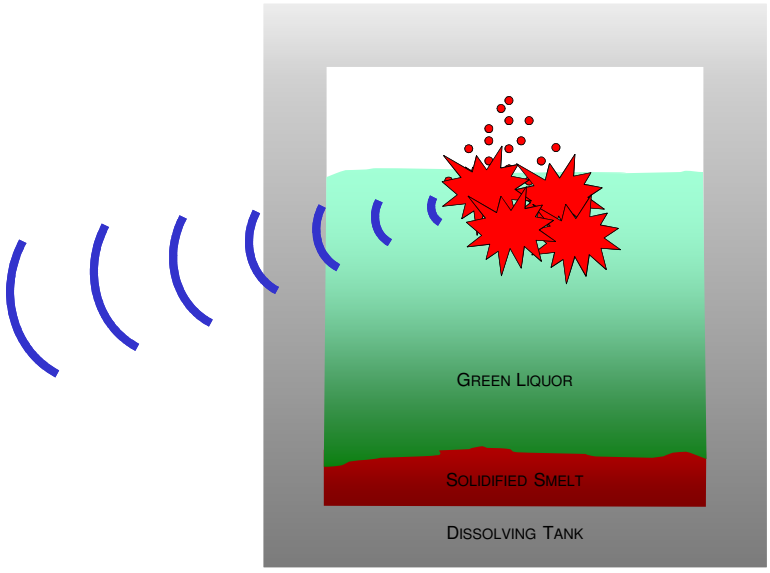
Smelt shattering

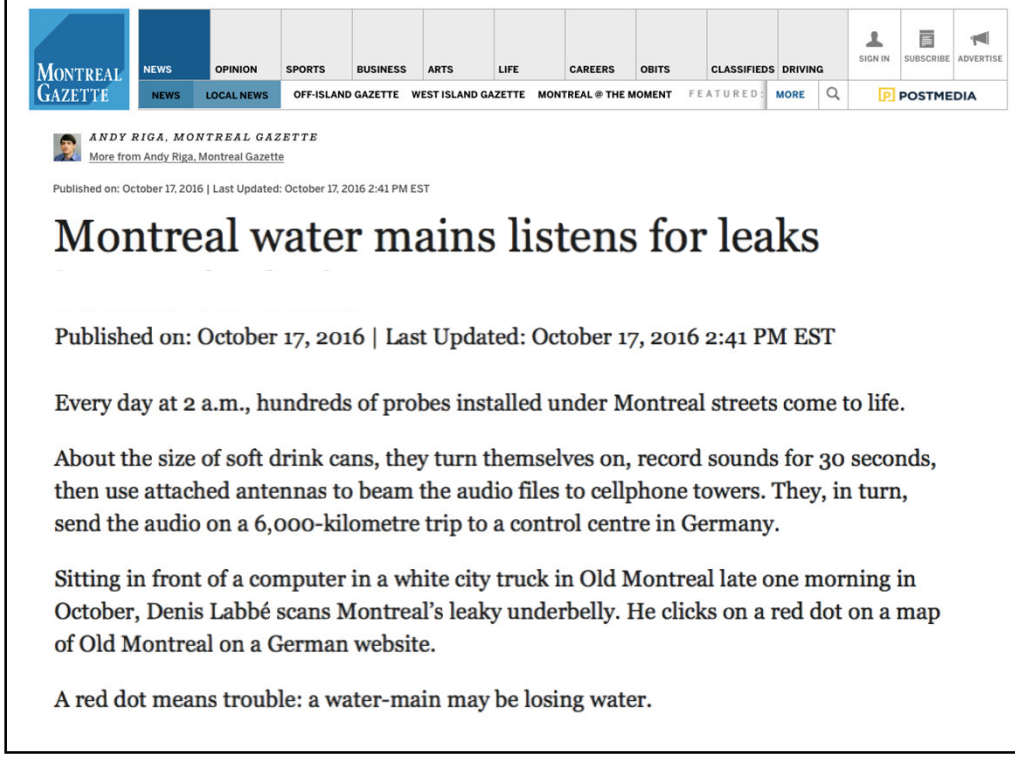


Smelt dissolution



Sound/vibration for monitoring operation





MONTREAL GAZETTE

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ANDY RIGA, MONTREAL GAZETTE
More from Andy Riga, Montreal Gazette

Published on: October 17, 2016 | Last Updated: October 17, 2016 2:41 PM EST

Montreal water mains listens for leaks

Published on: October 17, 2016 | Last Updated: October 17, 2016 2:41 PM EST

Every day at 2 a.m., hundreds of probes installed under Montreal streets come to life.

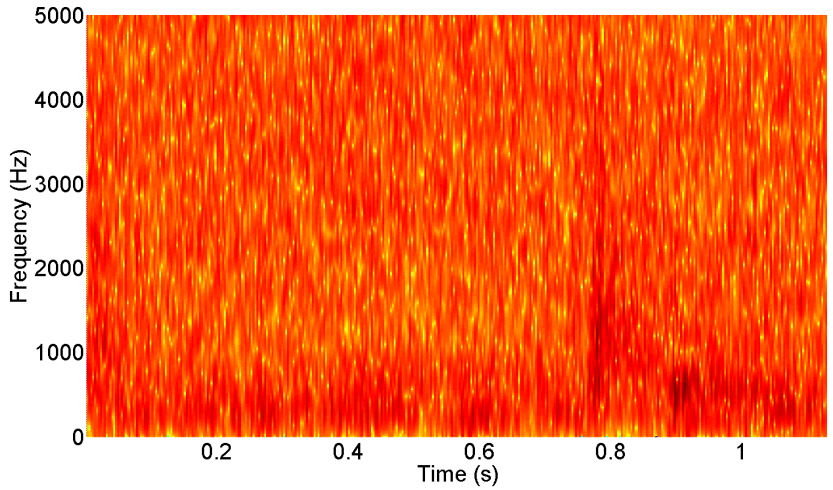
About the size of soft drink cans, they turn themselves on, record sounds for 30 seconds, then use attached antennas to beam the audio files to cellphone towers. They, in turn, send the audio on a 6,000-kilometre trip to a control centre in Germany.

Sitting in front of a computer in a white city truck in Old Montreal late one morning in October, Denis Labbé scans Montreal's leaky underbelly. He clicks on a red dot on a map of Old Montreal on a German website.

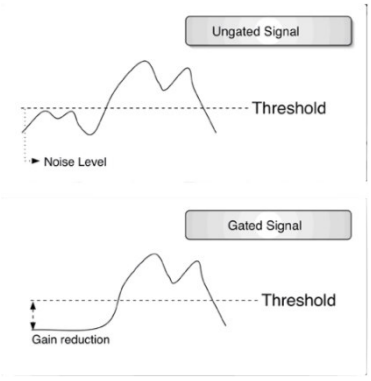
A red dot means trouble: a water-main may be losing water.

Sources of noise

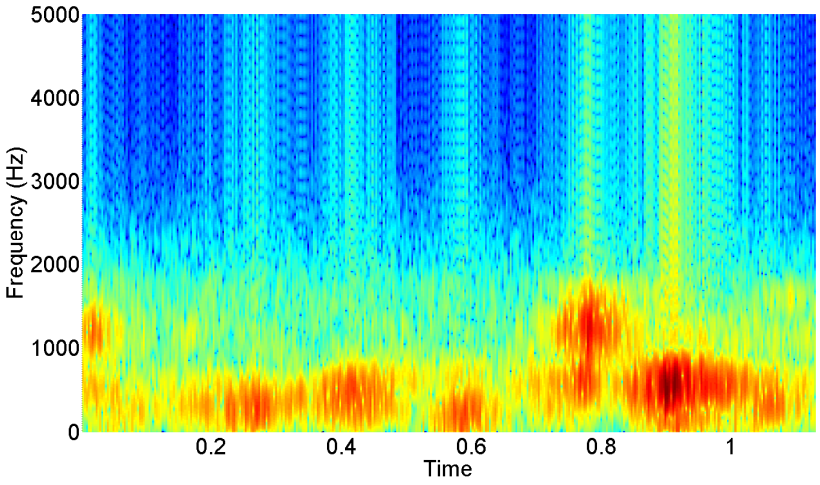
- Other machines
- Shatter jets, shattering
- Vapor explosions



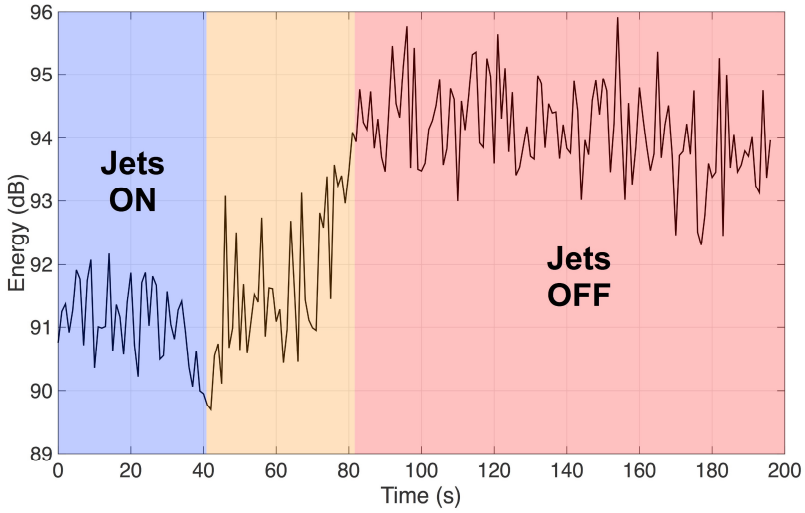
Noise gating



$$|W(f)| = \begin{cases} |X(f)|, & |X(f)| > |\alpha N(f)| \\ 0, & \text{otherwise} \end{cases}$$

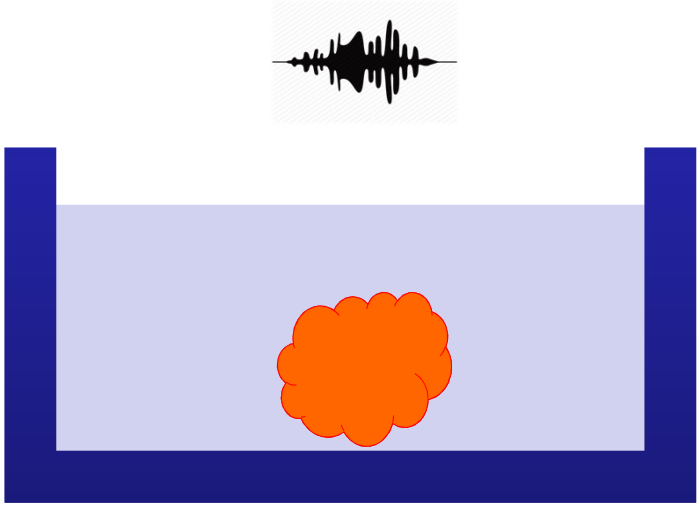


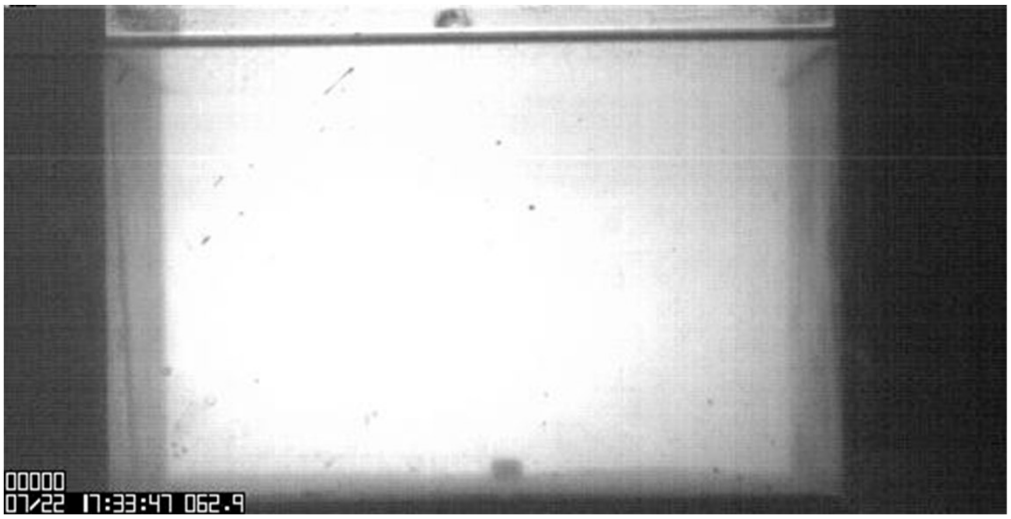
Sound intensity measurements



Can we get meaningful information from sound and vibrational transducers?

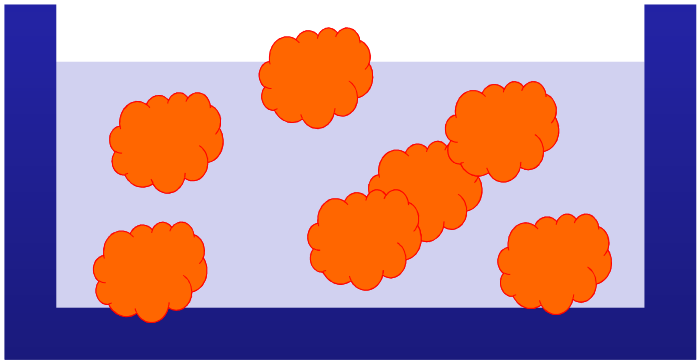
Single explosions



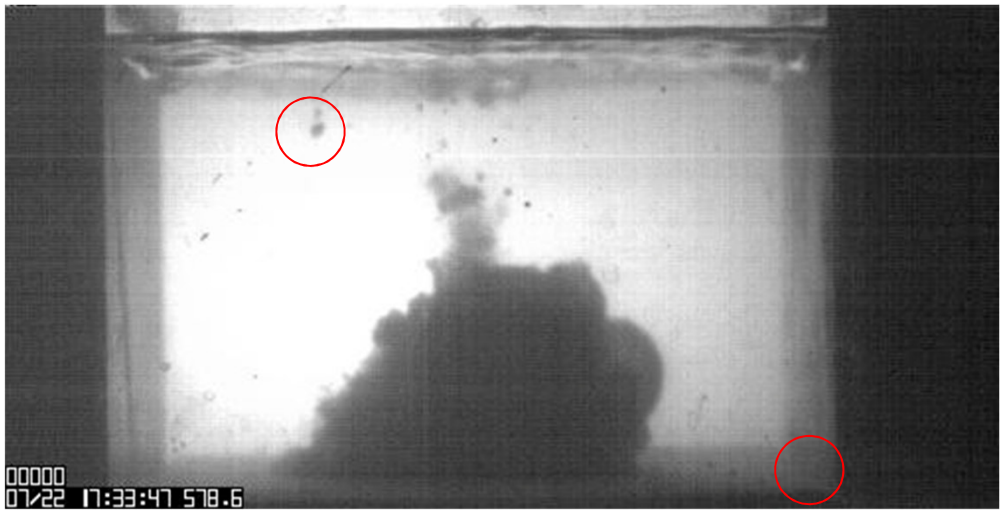


In collaboration with Eric Jin

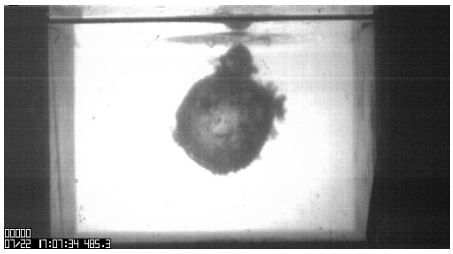
Multidroplet triggering



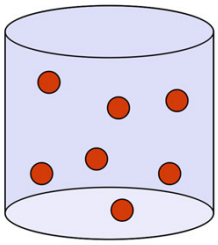
16



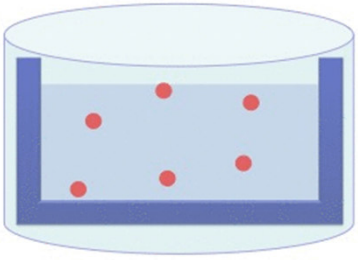
In collaboration with Eric Jin



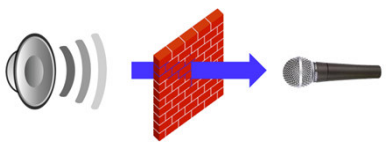
Cavitation



Spatial Droplet Distribution

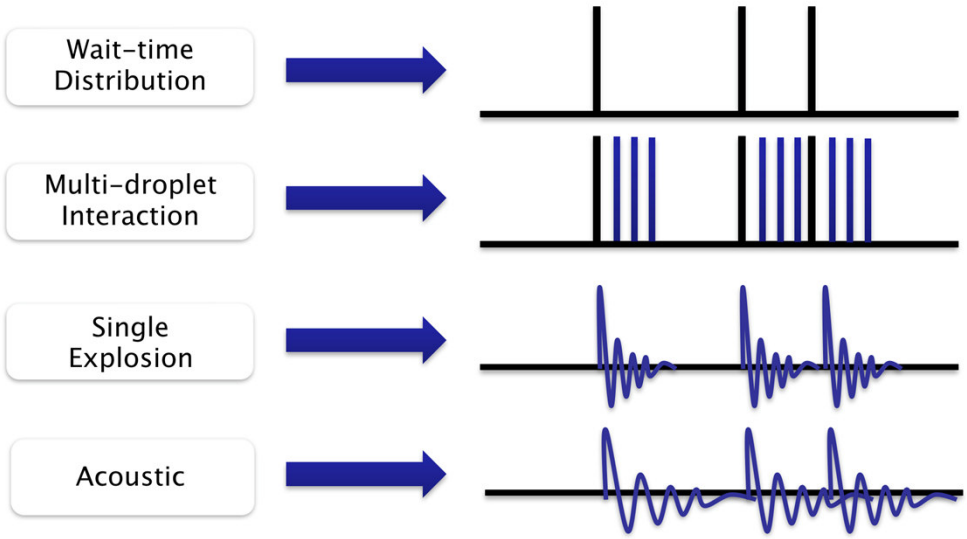


Wait-time of Events

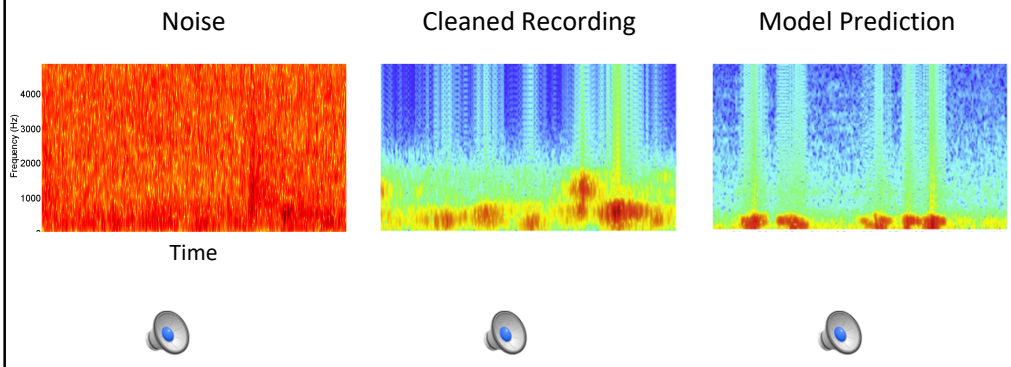


Acoustic Transmission

Acoustic model

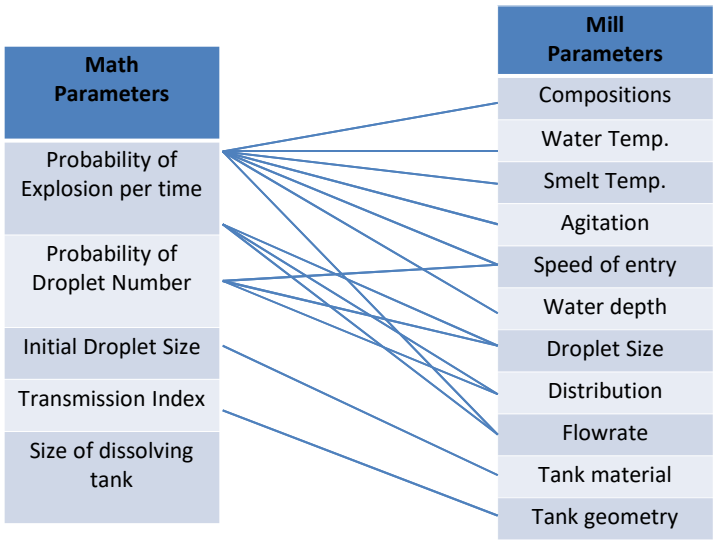


Artificial dissolving tank sounds

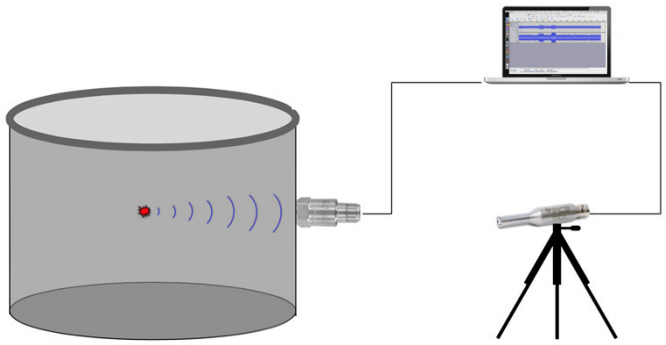


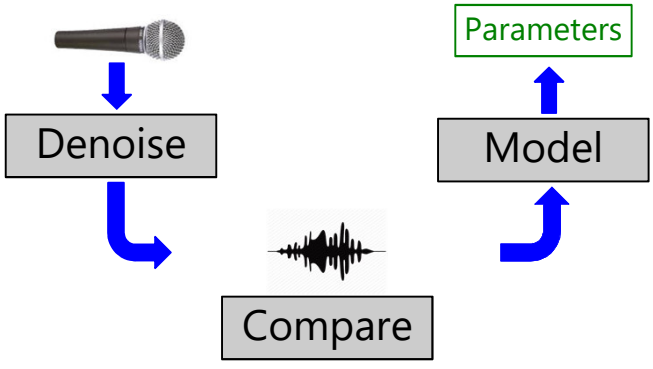
Problem statement

Forward problem
Inverse problem



Active monitoring device





Acknowledgements

- AF&PA Recovery Boiler Subcommittee
- Brian Wang, PhD student
- Dr. Eric Jin
- Honghi Tran and Markus Bussmann

ANALYSIS OF DISSOLVING TANK VIOLENCE

Thomas M. Grace

Recovery Boiler Committee Annual Meeting

February 12, 2014

Phase 1 of Dissolving Tank Study

- Detailed analysis of dissolving tank explosions on BLRBAC's dissolving tank explosion list
  - 32 explosions analyzed
- Review of data from AF&PA dissolving tank survey with emphasis on conditions relevant to heavy smelt runoff and violent dissolution
  - 88 responses to survey were analyzed
- Reports on these two aspects prepared

Dissolving Tank Explosions

- 32 dissolving tank explosions reported to BLRBAC for which information was available were analyzed
- Emphasis placed on operational practices that contributed to the violent event
- Cross-correlation with furnace design elements and dissolving tank conditions included
- Large spreadsheet developed and used to analyze data
- Heavy runoff of smelt involved in 29/32 incidents
- Remaining 3 incidents analyzed separately

Summary of Heavy Runoff Incidents

- 20 incidents occurred in sloped floor units
  - 12 had spouts on front wall
  - 8 had spouts on rear wall
- 5 incidents occurred in decanting bottom units
  - 3 had spouts on two side walls
  - 1 had spouts on front wall
  - 1 unknown which is spout wall
- 4 incidents occurred in partial decanting units
  - All 4 had spouts on rear wall

Pattern Shown in Sloped Floor Units

- Incidents involved plugged spouts and heavy runoff out of one spout once it was opened
  - Little difference between front wall and rear wall spouts in this regard
- Prolonged operation (hours) with significant heat input and spouts plugged before one spout was opened
  - Heat input provided by auxiliary fuel only
  - Black liquor firing was not or only minimally involved
  - Heat inputs averaged about 50% of MCR
  - Smelt pools inevitable under these conditions – right by spouts with depths of 18 – 24 inches in some cases
- Smelt rush developed quickly and limited operators ability to deal with it

Sloped Floor Pattern Continued

- Slag fall from upper furnace was a factor in essentially all incidents
  - Contributed to plugging of spouts
  - Source of most of the smelt involved in runoff
  - Sulfate rich slag would lower sulfidity of smelt being produced and could effect smelt flow characteristics
- Explosions tended to intensify once they began
  - Damage from initial explosions changed how smelt entered the dissolving tank and conditions within the tank
  - Progressive nature specifically mentioned in over half of the incidents
  - Smelt dissolution system not very robust
- Shatter jets did not handle heavy runoff very effectively

Decanting Bottom Units

- Pattern less consistent than with sloped floor units
  - Most involved plugged spouts and heavy runoff after one spout opened
  - But plugging was more intermittent and spouts seemed to be opened more easily
  - All five incidents did have large amount of smelt enter tank in a short time
- All five associated with events that would drop slag from the upper furnace and produce high sulfate smelt
- Black liquor firing was involved in 4/5 incidents, providing considerable heat input and a source of smelt

Decanting Bottom Units Continued

- Shatter jets were not capable of dealing with the heavy runoff
- In 3/5 incidents damage to spouts or shatter jets led to intensifying violence
- High dissolving tank level and splash up into spouts involved in 2 incidents
- Lack of robustness of smelt dissolution system contributed to violence experienced

Partial Decanting Units

- All 4 incidents involved heavy smelt runoff
  - Not evident that plugged spouts were a dominant factor
- All 4 occurred while operating at high rates on black liquor (4/4) and auxiliary fuel (3/4)
  - Heat inputs of 87 – 100% MCR
- In ¾ the bed was observed to be growing and liquor and air adjustments were being made
  - Bed high in other incident but considered to be normal
- Not connected with slag falls from upper furnace
- Smelt sulfidity and jelly-roll smelt involved in 2 incidents
- Intensifying violence because of damage to shattering system and spouts from early damage

Remaining Three Explosions

- Operation for a considerable period with smelt entering tank without water going in and then adding water
- Inadequate agitation and circulation in the dissolving tank
- Problems with density measurement and control led to insufficient water entering tank when running at 86% MCR
  - Red hot smelt observed in tank

Overall Explosion Summary

- Floor shape and spout location significant factor
- Prolonged heating with plugged spouts will cause smelt pools and is a dangerous situation
- Black liquor firing with plugged spouts not a significant factor in sloped floor units – black liquor firing more important in decanting and partial decanting units
- Need more effective ways to prevent plugged spouts or open them after a slag shedding event
- Damage sustained early on as an explosion incident proceeds can create conditions that accelerate violence
- Heavy runoff incidents develop rapidly and limit the time available for operators to take effective action

Explosion Summary Continued

- Smelt rushes can change trajectory of smelt entering tank and cause shatter jets to miss stream
- Jelly-roll smelt can dribble off spouts and cause shatter jets to miss
- High sulfate smelt resulting from slag falls involved in most runoff incidents – may have an effect on smelt flow characteristics as well as amount of smelt
- Conditions in the dissolving tank (level, density, mixing) can affect the degree of violence

Analysis of Survey Data

- Survey responses gave a somewhat different picture of heavy smelt runoff than the explosion data
- Dissolving tank explosions are generally on the extreme end of violent smelt dissolution
  - There is a spectrum of runoff magnitudes and degrees of violence
  - Most heavy runoff incidents do not do damage (or only do minor damage) and are not reported to BLRBAC

When Pull Liquor for Plugged Spouts

- Sloped floor units all had firm guidelines on when liquor would be pulled
  - Dependent on number of spouts and number plugged
    - 2 spouts – pull when both plugged, reduce rate when 1 plugged
    - More than 2 spouts – all pull liquor when all spouts plugged
      - Some pull with 1 or 2 spouts still open
      - More flexible with more spouts – common to base firing rate on number open
- Decanting bottom units had fuzzier guidelines – additional conditions besides number of spouts plugged
  - Half pull liquor when all spouts plug – not necessarily at once
  - Evidence of a smelt pool a factor in some decisions
  - Willingness to continue burning liquor while trying to open spouts
  - Operator judgment a bigger factor in decision making

When Pull Auxiliary Fuel

- Sloped floor units
  - < half pull when all spouts plugged
  - 1/3 pull when evidence of a smelt pool
  - 1/5 pull only if there is heavy runoff
  - 1/10 won't pull aux fuel – use it to help open spouts
  - Many look on aux fuel firing as a way to keep spouts open or aid in opening them
- Decanting and partial decanting units
  - Similar responses as sloped floor units
  - Much greater reliance on black liquor firing

Experience With Heavy Runoff

- 80% of respondents had experienced heavy runoff
- Survey response on causes of heavy runoff differs considerably from the pattern in dissolving tank explosions which is dominated by opening plugged spouts
- Fuel and air changes implicated in many replies
  - Changes in heat input can increase local smelt production and give smelt surges

Causes of Heavy Runoff

- Opening plugged spouts
- Burning down the char bed
- Start up with a bed or slag in the unit
- Fuel and air changes
- Liquor chemistry and jelly roll smelt

Steps to Manage Heavy Runoff

- Managing/controlling the combustion process
  - Reduce firing rates, especially black liquor
  - Air adjustments in lower furnace
- Keeping spouts open
- Control liquor chemistry
- Activate backup shatter jets
- A few use flow restrictors or spout plugs
- Dissolving tank density and level control

Liquor / Smelt Chemistry

- Liquor chemistry and jelly-roll smelt indicated to be an important factor in smelt runoff and tank violence
- Sulfidity was most important liquor property
  - 65% of respondents mentioned sulfidity
- 74% of respondents said jelly-roll smelt was a problem
  - 66% of these said sulfidity
  - 18% said combustion problems
  - 15% said cold bed
- There is no doubt that smelt sulfidity affects smelt viscosity and that this contributes to dissolving tank violence

Effect of Sulfate-Rich Slag

- Smelt consists of three major components: Na_2CO_3, Na_2S, and Na_2SO_4
  - Especially when recovering from a trip or chill and blow
  - Material falling from upper furnace is rich in sulfate
- Sulfidity measurements based on TTA ignore the sulfate and give an erroneously high value for sulfidity
- The true effect of sulfate-rich slag is to dilute the sulfide and lower the sulfidity, possibly contributing to high-viscosity smelt

Behavior of Slag on the Hearth

- Can plug spouts – depends on design
- Must be melted to be removed from furnace – requires heat
- Minimal interaction with carbon in char
  - Tends not to wet char
  - Sulfate remains sulfate
- Melted slag dilutes other smelt and lowers sulfidity
- Slag cools when contacted by primary air – thus bed responds to air adjustments differently than normal smelt and char

Possible Phase 2 Activities

- More effective ways to keep spouts open or open plugged spouts quickly
  - Consensus procedures for opening plugged spouts
  - Evaluate potential of automatic spout rodders
  - Safe, effective easy-to-use spout torches
  - Evaluate effectiveness of raising spout level on sloped floor units
  - Means to keep spouts open in anticipation of slag falls
- More effective smelt shattering systems
  - Determine state of the art
  - Evaluate how systems can be made more robust
  - What is most effective shattering medium and how to apply it
- Mitigation of heavy smelt flows once a rush has begun
  - Evaluate effectiveness of current approaches

Possible Phase 2 Activities, continued

- Effective strategies for using internal heat to help unplug spouts
  - Limitations due to availability and location of hearth burners
  - Guidelines on how much heat to use and where to apply it
- Full understanding of the role of high sulfate slag on smelt flow characteristics and runoff events
  - Interact with University of Toronto programs
- Emergency dissolving tank control algorithm that can be switched on when heavy runoff occurs or is anticipated
  - Develop basis for specifying what is needed

My Summary

- Measures for PREVENTION of the situation must be the key focus.
- Maintaining good liquor characteristics and bed control is key
- Maintaining a flow path from the Boiler to the Dissolving tank at all times is CRITICAL
- Whenever all spouts plug, The bed must be evaluated and all fuel should be pulled. A procedure to specifically deal with this situation must be established and followed.
- A lead Person must be identified to be the overall observer of the bed or dangerous pooling conditions in the RB during an “All spouts plugged” scenario until normal operations are re-established.

My Summary cont'd

- Additional resources in the spout pit during upsets if needed is key. A good spout torch should be available together with proper procedures for it's use.
- Having good clear guidelines and procedures for operators addressing high risk situations is imperative.
- Making it clear to operators that production will NOT take precedence over a plugged spout condition is a MUST

ANDRITZ Pulp & Paper

Smelt Flow Restrictor

Improving operational safety of recovery boilers

Jason Miller

www.andritz.com

We accept the challenge!

Smelt Flow Restrictor

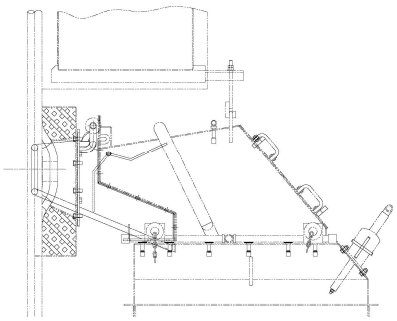
The Challenge:
To improve safety during recovery boiler upset conditions and heavy smelt flows.

Description

ANDRITZ's patented smelt flow restrictor has been designed to minimize or abate the risks associated with heavy smelt flows. In these conditions, a restrictor plate can be lowered to the 'closed' position to significantly reduce smelt flow to the dissolving tank.

Features

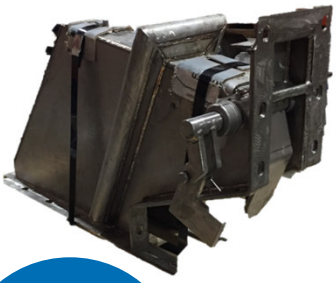
- Keep operators out of harm's way during periods of unstable operation.
- Restrict and regulate smelt flow into dissolving tank during upset conditions.



Smelt Flow Restrictor
Problem

Improve SAFETY:

- Upset conditions in a recovery boiler or during restarts when pooling occurs can result in irregular and heavy smelt flows into the dissolving tank.
- These heavy flows may not be adequately disturbed by the shatter jets and can result in excessive explosions in the dissolving tank and can result in equipment damage or pose a danger to personnel.
- The smelt flow restrictor minimizes these risks by partially blocking the smelt spout opening and significantly reducing the flow of smelt into the dissolving tank.



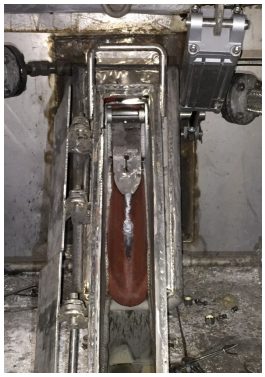
Reduce risk of dissolving tank explosions

Smelt Flow Restrictor
Concept

To improve safety during recovery boiler upset conditions and heavy smelt flows.

- Utilizes a simple mechanical means to significantly reduce smelt flow during upset conditions in the recovery boiler.
- Restrictor plate assembly is actuated by an air cylinder and solenoid.
- Air and electrical connections for cylinder operation and push button remote open/close capabilities.

Smelt Flow Restrictor
Concept



▲View of smelt restrictor in 'closed' position during test installation in May, 2017.

Keep operators at a safe distance:

- Can be activated either by local control box near spout deck or remotely via the DCS.
- During boiler upset conditions, operators can activate the smelt restrictors and safely leave the area rather than remaining to manually plug spouts.

Fail-safe operation:

- Utilizing a 'lock-in-last' fail-safe operating device, the restrictor will remain in it's previous state in the event of an electrical or instrument air failure.

Smelt Flow Restrictor
Concept

To improve safety during recovery boiler upset conditions and heavy smelt flows.

- Internal restrictor plate currently expected for one-time use.
- Top of upper hood modified to include access door for easy access for restrictor plate removal.
- Can be "tested" on some frequency (weekly, monthly, etc.) by operators utilizing local push button controls
- Upper mini hood assembly retrofit.

Smelt Flow Restrictor

Technology Path Forward

To improve safety during recovery boiler upset conditions and heavy smelt flows.

- Continue final trials through 2nd quarter 2018
- Implement any final changes as needed.
- Ready for sales in 3rd quarter 2018.

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February, 2018

Recovery Boiler PPE Improvements

Scott Moyer, WestRock
Presented to AF&PA

WestRock

Recovery Boiler PPE Improvements

Outline:

- Background
- Smelt Testing
- Task Based Review process
- New Policies
  - PPE Matrix
  - Other
- Summary

WestRock

Background

Flame retardant jacket

"Burn-throughs" on left sleeve, chest, and collar.

Green liquor saturating left side of jacket, front and back.

3

WestRock

Background

- Previous PPE standard (aluminized Kevlar) very hot (for person wearing)
  - Heat stress injuries experienced
- Better materials are now available
- Other risks identified since previous corporate policy written

4

WestRock

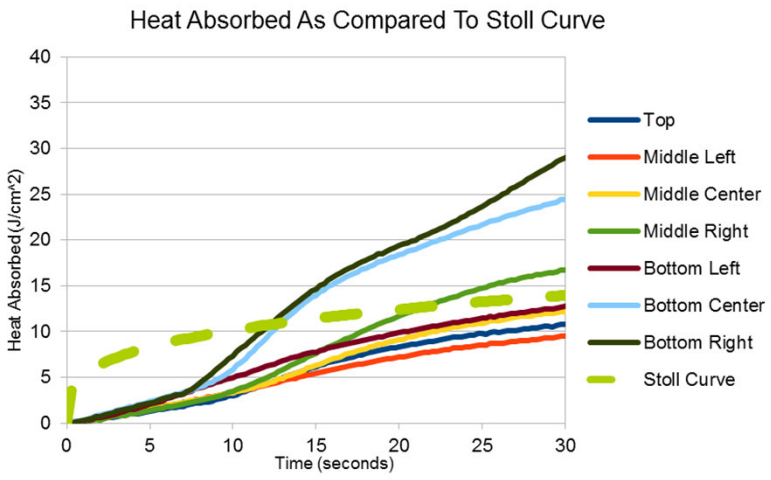
Background

- A team was assembled to improve current policy / PPE
  - 5 mills represented
  - Operators and safety personnel included
  - Smelt pour testing with fabric supplier
  - Performed HazRac risk analysis of Recovery Boiler tasks and developed PPE Matrix
  - Six Sigma processes were used

5

WestRock

Smelt Testing



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Smelt Testing

Test performed on several materials – CarbonX, shown **above**, was chosen

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Face Shield Test

Polycarbonate

Propionate (preferred)

Note: Propionate has been observed to become soft at elevated ambient temperatures and detach from frame. 2.5 mm thick propionate does not have this issue, also tests with high temperature 2.5mm polycarbonate were positive

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HazRAC Scoring

Task	Hazard	FACE	EYES	HANDS	FEET	ARMS	TORSO	LEGS	HEAD / NECK	FREQUENCY		PROBABILITY		SEVERITY	HazRAC Score
Routine Cleaning of smelt spouts	Smelt, green liquor, weak wash, steam, flue gas, fire, GL vapor	X	X	X	X	X	X	X	X	3		1	RANKED BASED ON FACE SHIELD IN ADDITION TO BELOW	6	10
Unplugging smelt spouts	Smelt, green liquor, weak wash, steam, flue gas, fire, GL vapor	X	X	X	X	X	X	X	X	2		1		6	9
Other tasks near smelt spouts (air port rodding on same elevation as spouts)	Smelt, green liquor, weak wash, steam, flue gas, fire, GL vapor	X	X	X	X	X	X	X	X	2		1		6	9
Hopper / downleg unplugging (not opening manway)	SALT CAKE, FLUE GAS, LIQUOR, CONDENSATE (pending blr design)	X	X	X	X	X	X	X	X	1		1	Follow LEO	6	8
cleaning inside of doghouse	Smelt, green liquor, weak wash, steam, flue gas, fire, GL vapor	X	X	X	X	X	X	X	X	1		1		6	8
Air port rodding Above spouts (on separate platform)	Hot air, char, hot pipes, green liquor, smelt. Gl VAPOR	X	X	X		X	X	X	X	3		1		4	8
Working around black liquor systems	Caustic burn, Thermal Burn	X	X	X	X	X	X	X	X	2		0	heavy liquor more hazardous	6	8
Liquor gun unplugging	Black Liquor / Flue Gas / Char / fire / LEO / LIQUOR BURN	X	X	X	X	X	X	X	X	1		0		6	
Liquor gun insertion / Removal	Black Liquor / Flue Gas / Char / fire / LEO / LIQUOR BURN	X	X	X	X	X	X	X	X	2		0		4	6
Liquor gun / port rodding	Black Liquor / Flue Gas / Char / fire / LEO / LIQUOR BURN	X	X	X	X	X	X	X	X	2		0		4	6
Working around green liquor systems	Caustic burn, Thermal Burn	X	X	X	X	X	X	X	X	2		0		4	6
Black Liquor Sampling	Caustic burn, Thermal Burn, flashing	X	X	X	X	X	X	X	X	2		0	enclosed sample - bp	4	6
Green Liquor Sampling	Caustic burn, Thermal Burn	X	X	X	X	X	X	X	X	2		0	enclosed sample - bp	4	6
Opening RB Doors (not lower furnace) (ON LIQUOR)	Flue gas blowback (Hot flue gas, salt cake, burning char)	X	X	X	X	X	X	X	X	1		0		4	5
Air Port Rodding	Hot air, char, hot pipes, soft tissue injuries	X	X	X		X			X	3		0		2	5
Hopper Inspections	SALT CAKE, FLUE GAS, LIQUOR, CONDENSATE	X	X	X	X	X	X	X	X	2		0		2	4
Rodding draft taps	Flue gas blowback (Hot flue gas, salt cake, burning char, fire)	X	X	X		X			X	2		0		2	4
Opening upper FURNACE inspection doors	Flue gas blowback (Hot flue gas, salt cake, burning char, fire)	X	X	X	X	X			X	2		0		2	4
LIGHTING OFF AUX GUNS	Hot air, char, hot pipes, soft tissue injuries, hot oil, steam	X	X	X	X	X		X	X	2		0		2	4
Opening RB Doors (not lower furnace) (NOT ON LIQUOR)	Flue gas blowback (Hot flue gas, salt cake, burning char)	X	X	X	X	X	X	X	X	1		0		2	3

HazRAC Uses:
- Frequency
- Severity
- Probability

To measure Risk

PPE Added→

	Neck protection	FREQUENCY	PROBABILITY	SEVERITY	HazRAC Score	% Hazard Reduction
...pouts	X	3	-1	4	6	40%
	X	2	0	4	6	33%
...ts (air port ...as spouts)	X	2	-1	4	5	44%
...ng (not	X	1	1	4	6	25%
cleaning inside of doghouse	X	1	-1	4	4	50%
Air port rodding Above spouts (on separate platform)		3	-1	2	4	50%
Working around black liquor systems		2	0	6	8	0%
... gun unplugging	X	1	0	4	5	29%
Liquor gun insertion / Removal		2	-1	2	3	50%
Liquor gun / port rodding		2	0	4	6	0%
Working around green liquor systems		2	0	4	6	0%
Black Liquor Sampling		2	0	4	6	0%
Green Liquor Sampling		2	0	4	6	0%
Opening RB Doors (not lower furnace) (ON LIQUOR)		1	-1	2	2	60%
Air Port Rodding		3	0	2	5	0%
Hopper Inspections		2	0	2	4	0%
Rodding draft taps		2	0	2	4	0%
Opening upper FURNACE inspection doors		2	0	2	4	0%
LIGHTING OFF AUX GUNS					4	[illegible]
Opening RB Doors (not lower furnace) (NOT ON LIQUOR)		1	0	2	3	0%

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Recovery Boiler PPE Matrix

Task	Leather Work Gloves	High Temp Leather Gloves	High Temp Water-proof Gloves	Face Shield	Smelt Jacket	Welder's Jacket / Nomex	Aluminized Suit	High Temp Neck Protection
Any Task within boundary of smelt spouts		×		×	×			×
Air Port Rodding / Aux burner lightoff	×			×		×		
Hopper / downleg unplugging (not opening manway)			×	×	×			×
Liquor gun unplugging			×	×	×			×
Liquor gun insertion / Removal			×	×	×			
Liquor gun / port rodding			×	×		×		
Black Liquor Sampling		×		×		×		
Green Liquor Sampling		×		×		×		
Opening Manway Doors (not lower furnace) (ON LIQUOR)		×		×			×	
Opening Manway Doors (not lower furnace) (NOT ON LIQUOR)		×		×		×		
Rodding draft taps		×		×		×		
Hopper Inspections		×		×		×		
Opening upper FURNACE inspection doors		×		×		×		

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Smelt Gear

Existing Jacket
Aluminized Carbon Kevlar

New Jacket
Carbon-x, with FR lining

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Smelt Gear

Two options for face shield, extend length or lower cup
Both are made of propionate.

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Smelt Gear

Neck and ear protection

Gloves

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Recovery Boiler PPE Equipment Matrix

Item	Requirements	Example	Supplier / Part #	Manufacturer / Part #	Item Description	CATID Passport	CATID JDE	Comment
4. Face Shield	• Hard Hat Mounted • Tested for Smelt • 0.06" minimum thickness • Extended side protection • Min Length 9.75" • Or separate Chin Cover / Cup **Propionate is best against smelt. Polycarbonate will not protect from high temperature liquids or chemicals.**		34963884 30037782 48302467	**Honeywell** FH66 6750CL F3400CGCL	Bracket Shield Clear Chin Cover	429704 545608 0000594515	421225 416120 2816649	Bracket is Stock, Shield and Chin Cover are Special Order. Minimum order 12 for shield and chin cover
			05924675 34963884	**Honeywell (North)** 4199CL FH66	Face Shield Bracket	36928 429704	411743 421225	Stock Items
			82208349 48306336 44022077	**MSA** 10116627 10115856 10149029	Bracket Face Shield Clear Chin Cover	0000594526 0000594527 0000594514	2816633 2816631 2816634	Special Order Minimum order 10 for bracket and face shield Minimum order 5 for chin cover
			82208349 83941138	**MSA** 10116627 10115851	Bracket Extended Face Shield w/o Chin Cover	0000594526 0000594525	2816633 2816630	Special Order Minimum order 10 for bracket Minimum order 5 for face shield

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Recovery Boiler PPE Equipment Matrix

Item	Requirements	Example	Supplier / Part #	Manufacturer / Part #	Item Description	CATID Passport	CATID JDE	Comment
5. Smelt Jacket - Lined	• Length = Mid-thigh to knee • Raised collar with closure • Oversize sleeves with closure • 9.5oz CarbonX CR80 Repel with 7oz FR Cotton under layer. • FR under layer incorporated into this jacket			Chicago Protective				
			52914751	648CX8CON-7.5-V	Hood	0000594378	2798673	HV = High visibility striping
			52912284	602CX8MSC-SM	Coat-S	0000594380	2798674	
			52912391	602CX8MSC-S-SM	Coat-S-w/HV	0000594381	2798675	
			52913829	602CX8MSC-MED	Coat-M	0000594382	2798676	
			52913886	602CX8MSC-S-MED	Coat-M-w/HV	0000594383	2798677	
			52913951	602CX8MSC-LRG	Coat-L	0000594384	2798678	
			52913993	602CX8MSC-S-LRG	Coat-L-w/HV	0000594385	2798679	
			52914017	602CX8MSC-XLG	Coat-XL	0000594386	2798680	Special Order
			52914058	602CX8MSC-S-XLG	Coat-XL-w/HV	0000594387	2798681	3 Week Lead
			52914231	602CX8MSC-XXL	Coat-2X	0000594388	2798682	
			52914306	602CX8MSC-S-XXL	Coat-2X-w/HV	0000594389	2798683	
			52914397	602CX8MSC-3XL	Coat-3X	0000594390	2798684	
			52914504	602CX8MSC-S-3XL	Coat-3X-w/HV	0000594392	2798685	
			52914546	602CX8MSC-4XL	Coat-4X	0000594393	2798686	
			52914611	602CX8MSC-S-4XL	Coat-4X-w/HV	0000594394	2798687	
6. Smelt Jacket - Unlined	• Length = Mid-thigh to knee • Raised collar with closure • Oversize sleeves with closure • 9.5oz CarbonX CR80 Repel with Must be worn with FR undergarment		31761737	602CX8MSCNL-SM	Coat-S-unlined	0000594528	2816639	
			31761901	602CX8MSCNL-MED	Coat-M-unlined	0000594529	2816640	
			31762016	602CX8MSCNL-LRG	Coat-L-unlined	0000594530	2816641	Special Order
			31762107	602CX8MSCNL-XLG	Coat-XL-unlined	0000594531	2816642	3 Week Lead
			31762164	602CX8MSCNL-2XL	Coat-2X-unlined	0000594532	2816643	
			31762230	602CX8MSCNL-3XL	Coat-3X-unlined	0000594533	2816644	
			31762313	602CX8MSCNL-4XL	Coat-4X-unlined	0000594534	2816645	

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Recovery Boiler PPE Equipment Matrix

Item	Requirements	Example	Supplier / Part #	Manufacturer / Part #	Item Description	CATID Passport	CATID JDE	Comment
9. High Temp Neck Protection	• Protection required covering back and sides of neck • FR material		07149818	Honeywell (North) WC75	Welder Cap with Neck Protect, Universal Size	0000594509	2816648	Stock Item
			77949857	Pro-Safe 77949857	CarbonX Hood, Black, FR, Universal Size	0000594517	2816638	Stock Item
			48244099	Chicago Protective 690-CX11VF4VST	11oz Black CarbonX Spark Deflector w/ Velcro Front	0000594510	2816632	Special Order 3 Week Lead
			81636003	Oasis, Inc 91FR9B	Blue Oasis Fire Resistant Helmet Snood	508544	2670789	Special Order

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Other Requirements

- Neck protection required for high risk tasks
  - Spout area
  - Liquor gun unplugging
  - Hopper unplugging
- Hard hat mounted face shield required
- Face shield must be propionate
- Face shield must be extended length or have lower cup
- Restricted access areas to be identified at spouts, and liquor guns
- Flange wraps on black, green liquor piping (in high traffic areas)
- Each mill to perform HazRac assessment

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Summary

- Valuable information and buy-in from mill PPE trials
- Use of a risk assessment tool helped to identify high risk tasks and evaluate risk reduction for applied controls
- Applied similar process to Ash Hopper Safety (wood fired boilers)

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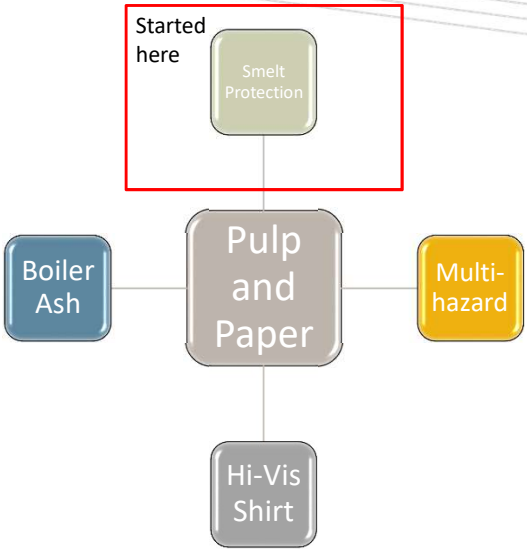
Protective Apparel for the Pulp and Paper Industry

Presented by:
Jim Ellis, Paul Kiernan
When: February 7, 2018
Where: AF&PA Recovery Boiler Program

Presentation Outline

- Gore Approach
- Smelt Protection
  - Test Method Development
  - Technology and Key Material Attributes
  - End User Feedback

Gore investigating several areas within P&P that might have gaps in protection or unmet needs in comfort

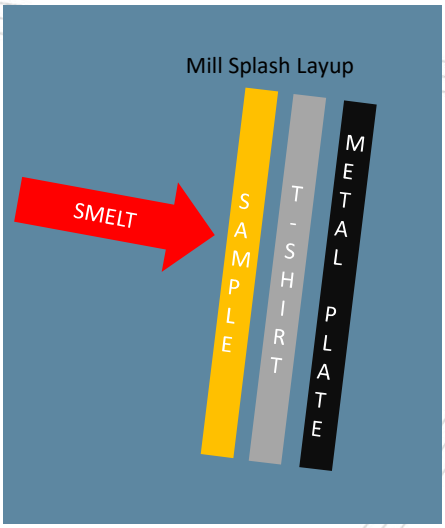


Life on the Spouts

Smelt Temperature	650-925C	1200-1700F
Environmental Temperature	37-55C	100-130F

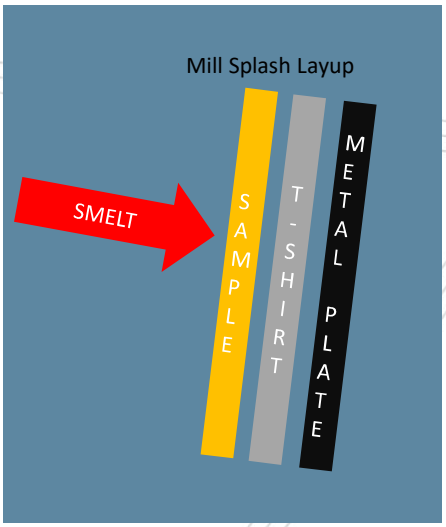
Many mills are in humid environments

Initial Mill Splash Testing



Mill Splash Results

Description	19osy Aluminized Aramid Blend	8.5osy O-Pan (Carbon Fiber)
SAMPLE		
T-SHIRT		



ASTM F955 Apparatus

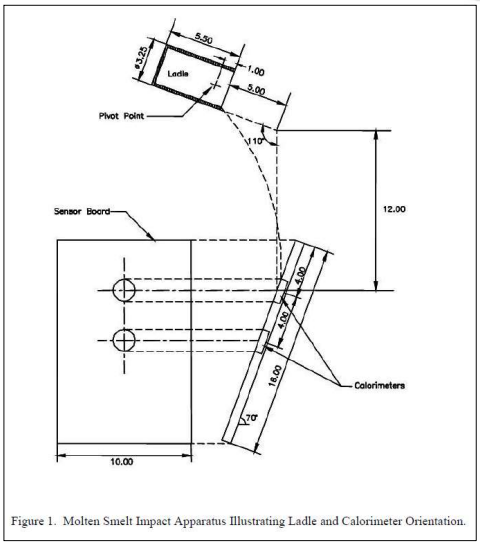
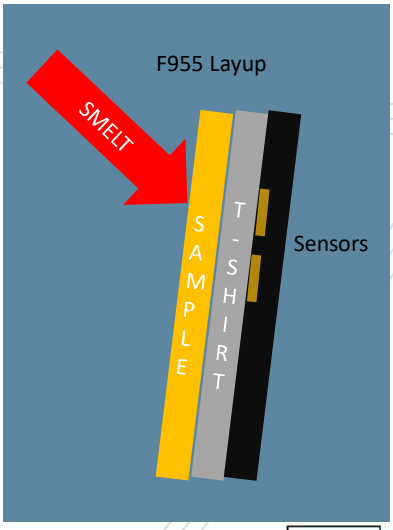
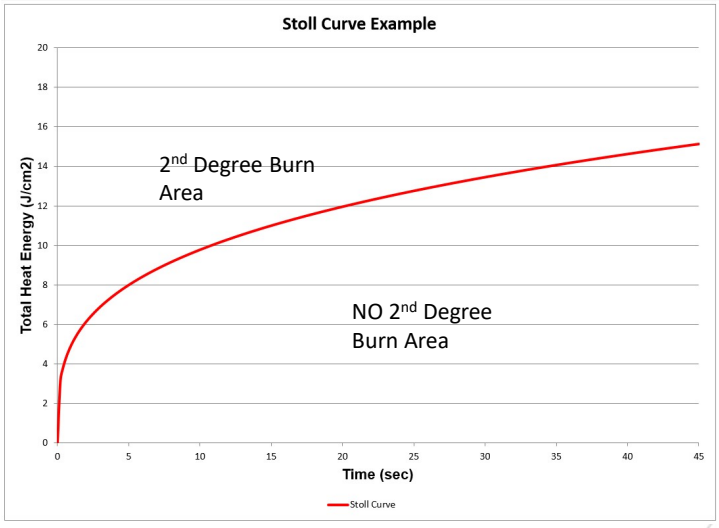


Figure 1. Molten Smelt Impact Apparatus Illustrating Ladle and Calorimeter Orientation.

Tests performed with **500g** (1.1lb) of Smelt at 843C (1550F) over new cotton T shirt

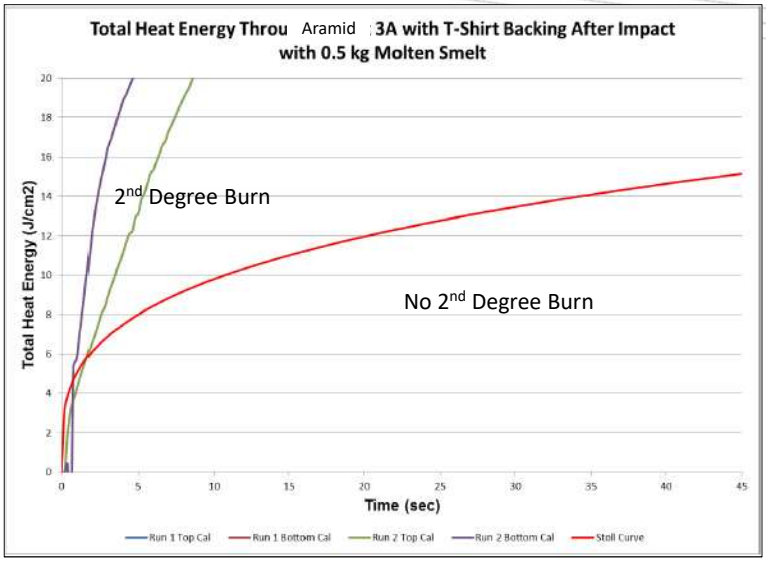


Stoll Curve Explained

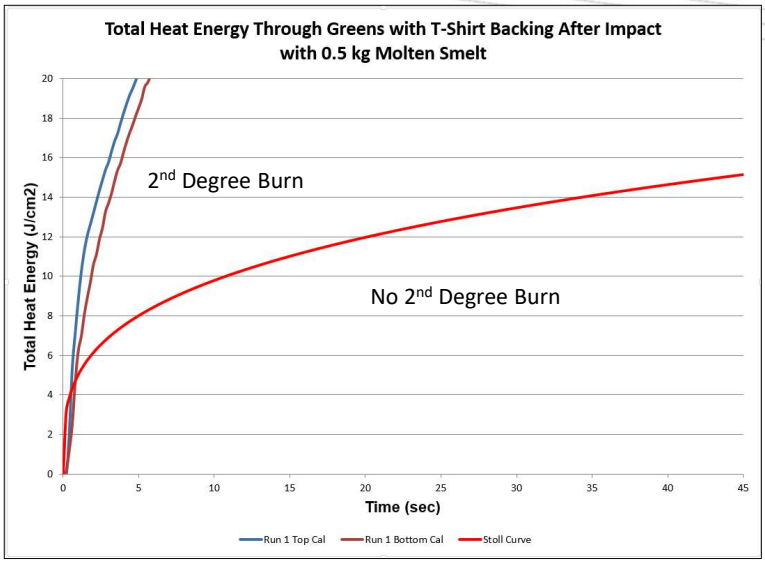


What we discovered

Aramid Blend – 4.3oz/yd^2



"Greens" – 12oz/yd^2



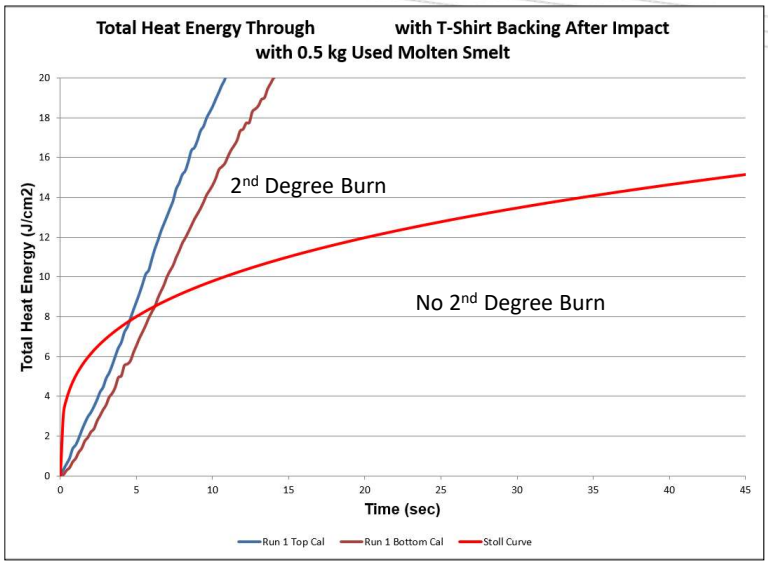
Confidential Gore Technology

O-Pan (Carbon) Fiber – Back Coated with Silicone

Tests performed with 500g (1.1lb) of Smelt at 843C (1550F) over wet cotton T shirt

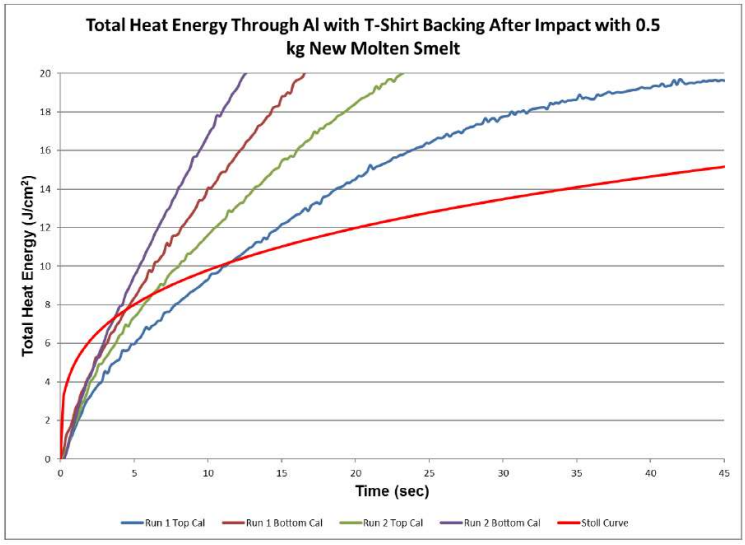
Confidential Gore Technology

O-Pan Fiber – Silicone Coated 8.5oz/yd^2



Confidential Gore Technology

Aluminized Aramid



Confidential Gore Technology

Molten Splash in ASTM F955 – Slow Motion
Gore Vulcan Molten Splash Protection

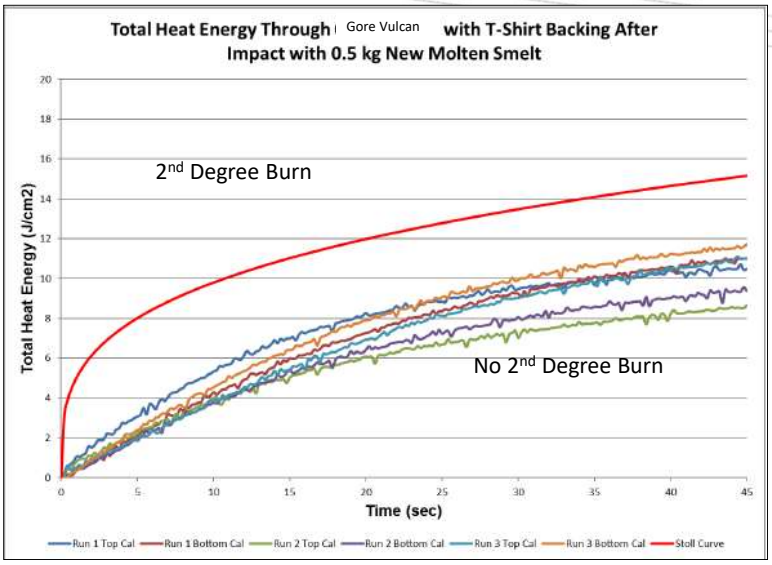
Tests performed with 500g (1.1lb) of Smelt at 843C (1550F)

Wall #1 – Quick Shedding

Wall #2 Char Formation

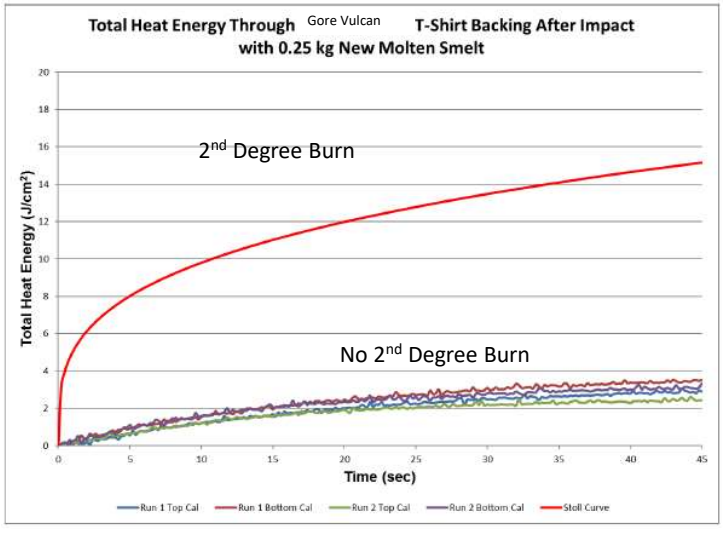
Wall #3 Barrier Integrity

GORE® Vulcan –4.3oz/yd²



Confidential Gore Technology

GORE® Vulcan – 4.3oz/yd²



Confidential Gore Technology

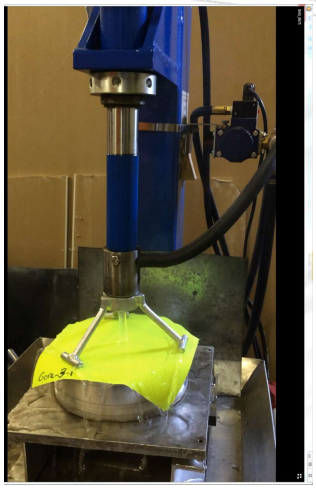
Liquid Splash Gap – Green Liquor

Green Liquor Splash Testing – Green Welding Jacket

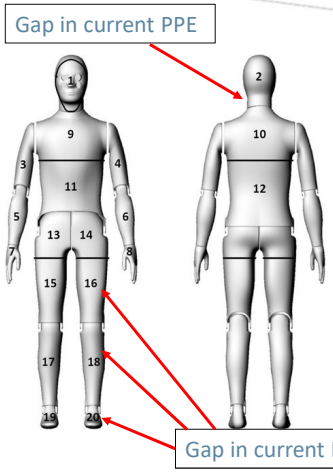
Hot liquid protection testing - benchtop

Location and protocol

- University of Alberta
  - Swatch samples
  - Hot liquid fixed at 85 °C
  - 10 sec exposure
  - Minimum 60 sec data collection
  - No undergarments
- Black liquor testing at mill



Overview of “gaps” in molten protective apparel



Boiler Worker Burn Prediction Map

Body Point	PPE Used	PPE upgrade
1	Face Shield	None
2	Hard hat	Lower neck protection
3 &4	Long sleeves	Molten splash protective
5 & 6	Long sleeves	Molten splash protective
7 & 8	Welder Gloves	Molten splash protective
9 & 10	FR Jacket	Molten splash protective
11 & 12	FR Jacket	Molten splash protective
13 & 14	Some jackets	Molten jacket (40” min.)
15 & 16	Not protected	Molten jacket (Trench)
17 & 18	Not protected	Molten splash pants
19 & 20	Inconsistent	Dip tested to 1700°F w/metatarsal guard

Gore Vulcan Ensemble Options

Wear Trial Culmination

- 50+ Garments at 12+ Mills
- Confirmed materials and design provide enhanced worker comfort due to significant garment weight reduction compared to alternatives (O-Pan, Wool, Aluminized)
- Actively selling

Questions?

BLRBAC ESP Subcommittee

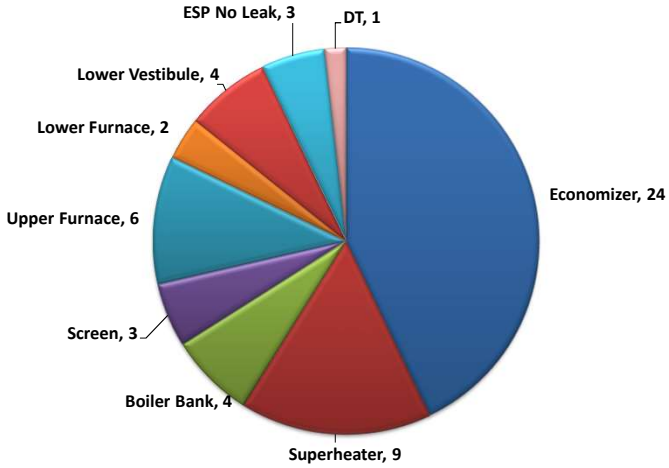
2017 Incidents ESP Report,
covering Spring and Fall Meetings
for AF&PA
Wednesday, February 7, 2018

Dean Clay, taken from J. Andrews BLRBAC ESP reports

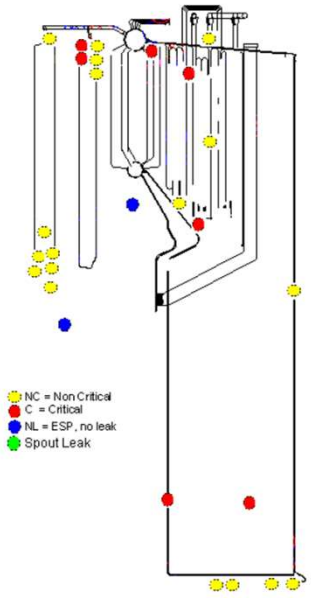
Incident Questionnaire Review

- 56 North American incidents (54 in 2016)
  - -NO Smelt Water Explosions (0)
  - -1 Dissolving Tank Explosion (1)
  - -18 Critical (20)
  - -34 Non-critical (32)
  - - 3 ESP – No Leak (1)
  - - No Smelt Spout Leak (3)
  - – 20 ESP'd (14)
    - 11 Critical
    - 71% of Critical that Should ESP (55%)
- 3 International Incidents (11 in 2016)

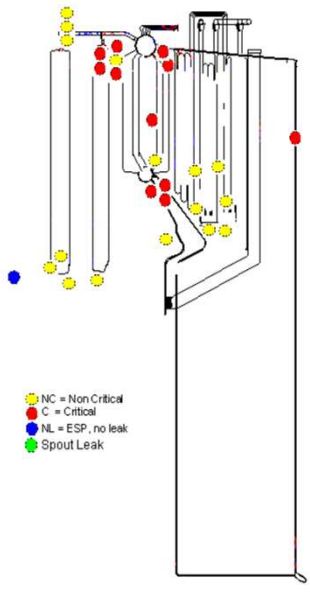
Incident Locations

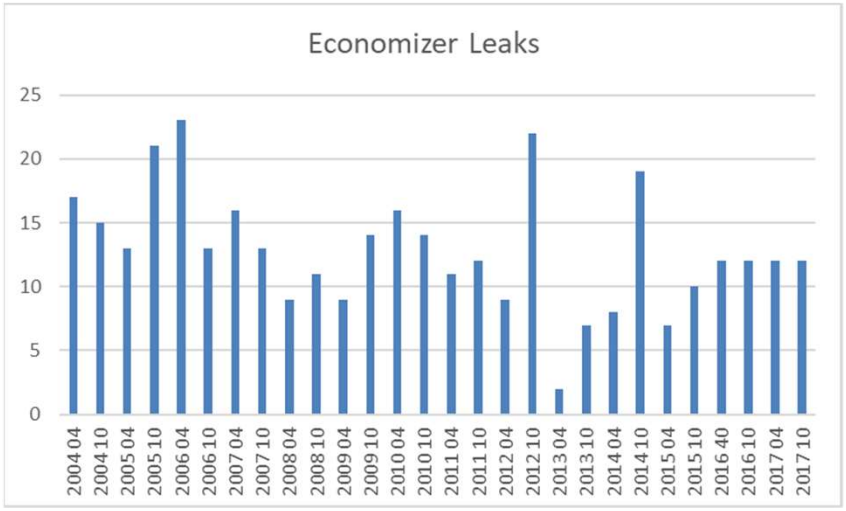


Spring 2017 Incident Locations



Fall 2017 Incident Locations

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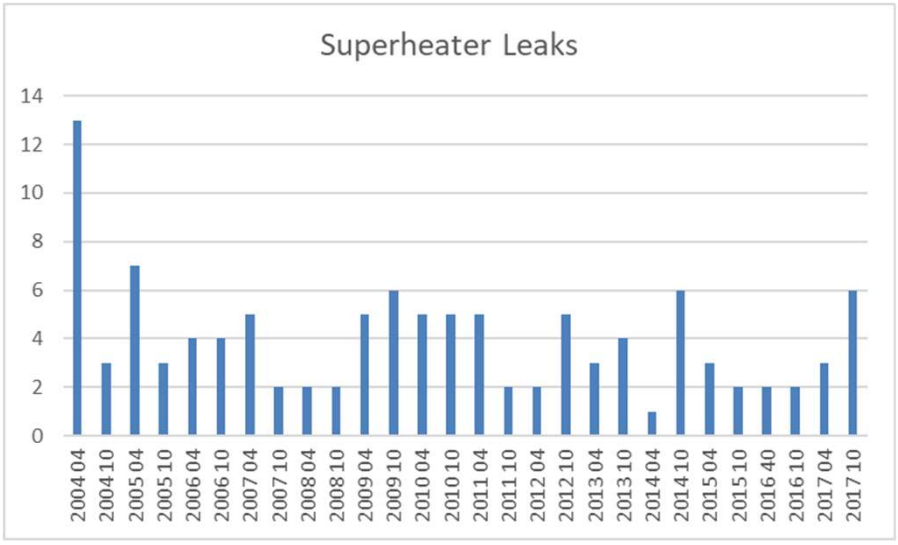
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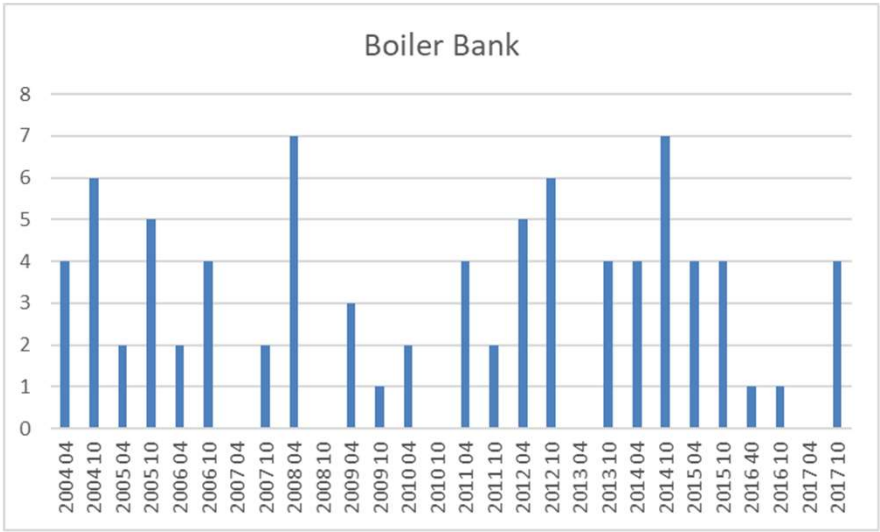
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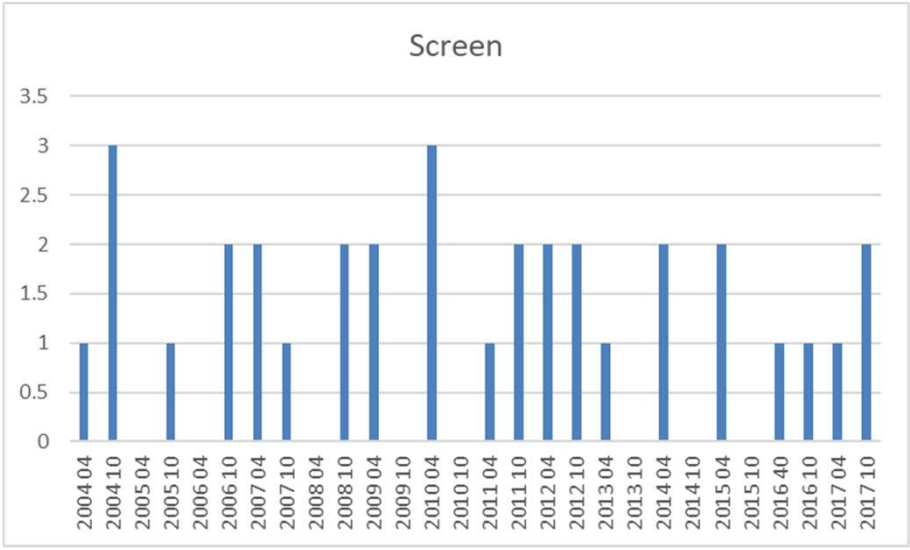
2015 10
2016 40
2016 10
2017 04
2017 10

7


Screen
3.5
3
2.5
2
1.5
1
0.5
0
2004 04
2004 10
2005 04
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2006 04
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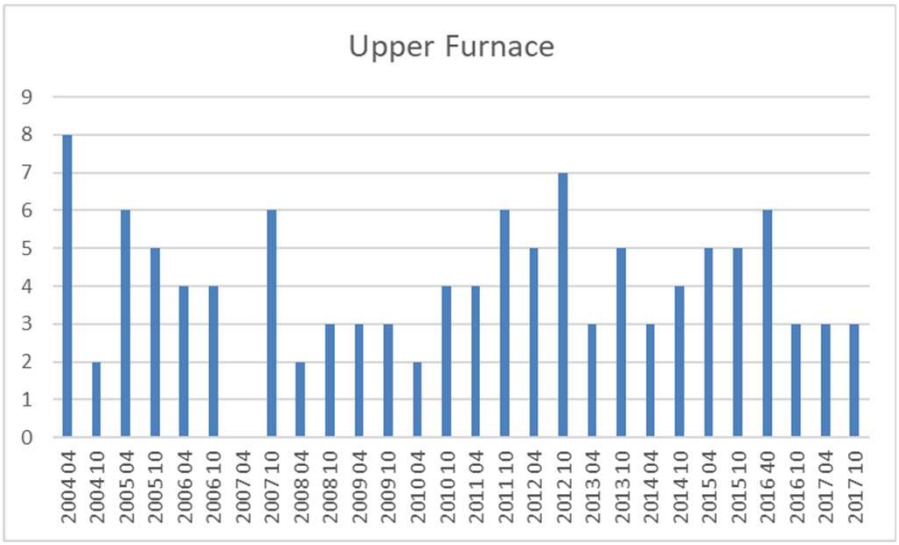
8


Upper Furnace
9
8
7
6
5
4
3
2
1
0
2004 04
2004 10
2005 04
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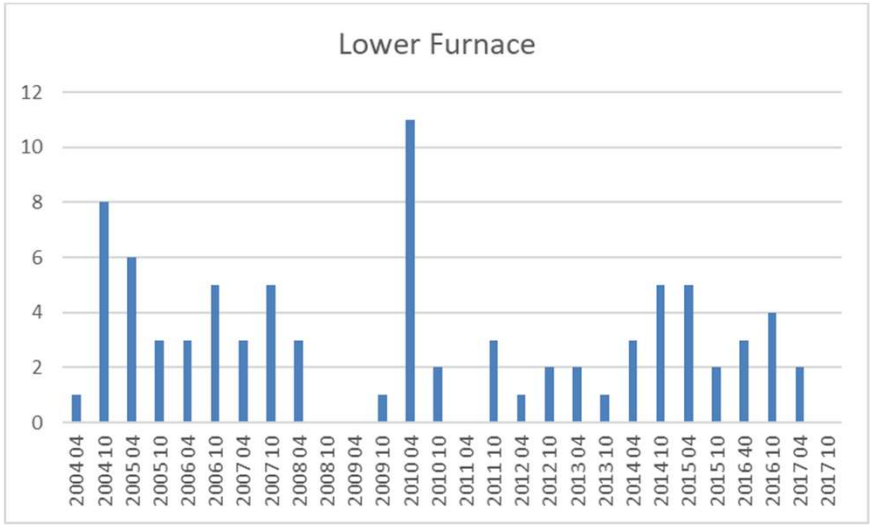
9


Lower Furnace
12
10
8
6
4
2
0
2004 04
2004 10
2005 04
2005 10
2006 04
2006 10
2007 04
2007 10
2008 04
2008 10
2009 04
2009 10
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2010 10
2011 04
2011 10
2012 04
2012 10
2013 04
2013 10
2014 04
2014 10
2015 04
2015 10
2016 40
2016 10
2017 04
2017 10

10

BLRBAC Reported Leaks (US + Canada) 2004 thru 2017

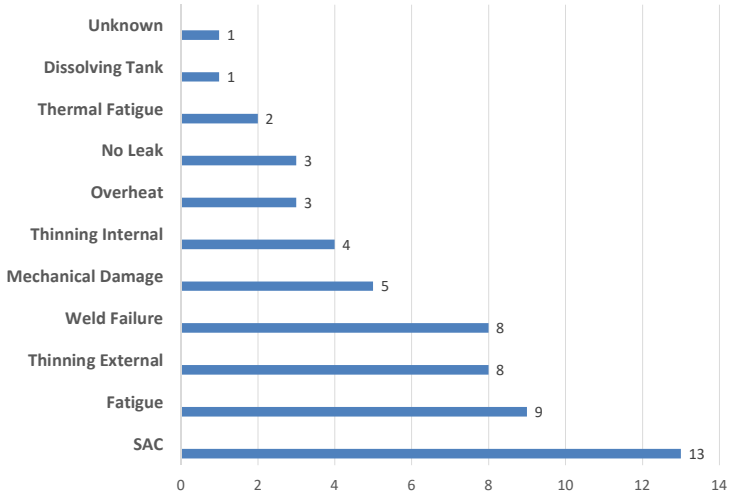
Location	14 Year Total	Average/Year
Economizer	359	25.6
Upper Furnace	114	8.1
Superheater	112	8.0
Boiler Bank*	84	6.0
Lower Furnace	84	6.0
Screen*	34	2.4
Smelt Spout	27	1.9

*Two Smelt-Water Explosions Recorded 2004 thru 2017, One from Boiler Bank Leak and One Screen Tube Leak

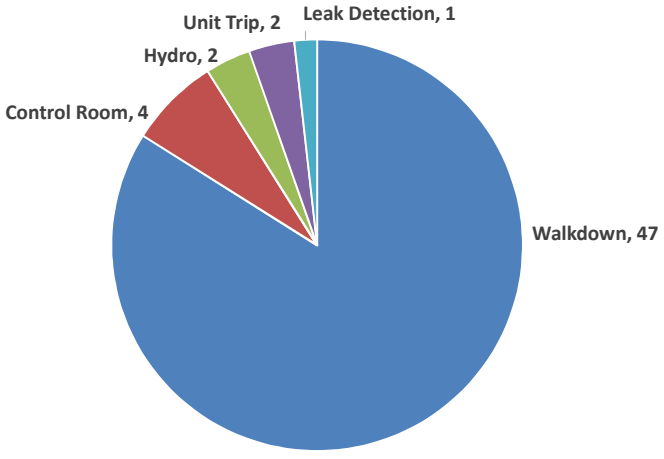
Leaks by Boiler Type

- Drums
  - 1 - 16
  - 2 - 40
  - 3 - 0
- Back End
  - Large Economizer - 41
  - Cascade - 9
  - Cyclone - 6

Leak Cause



How Discovered

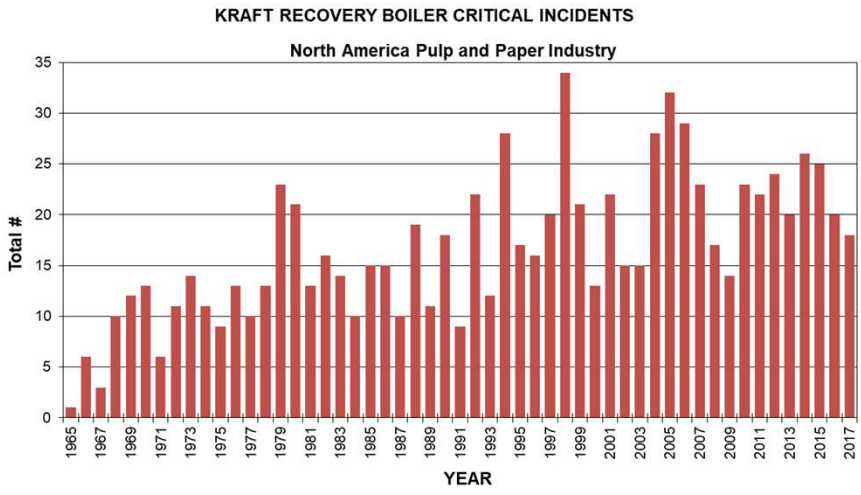


Leak Detection Systems

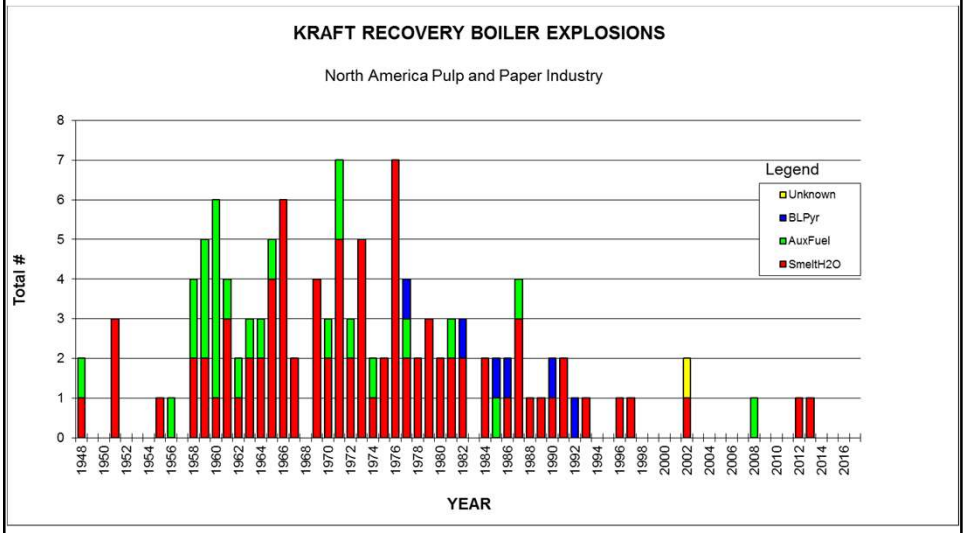
- Leak Detection Systems installed – 28
- 50% said had LDS (28/56)

- Identified leak – 1
- Confirmed leak - 5

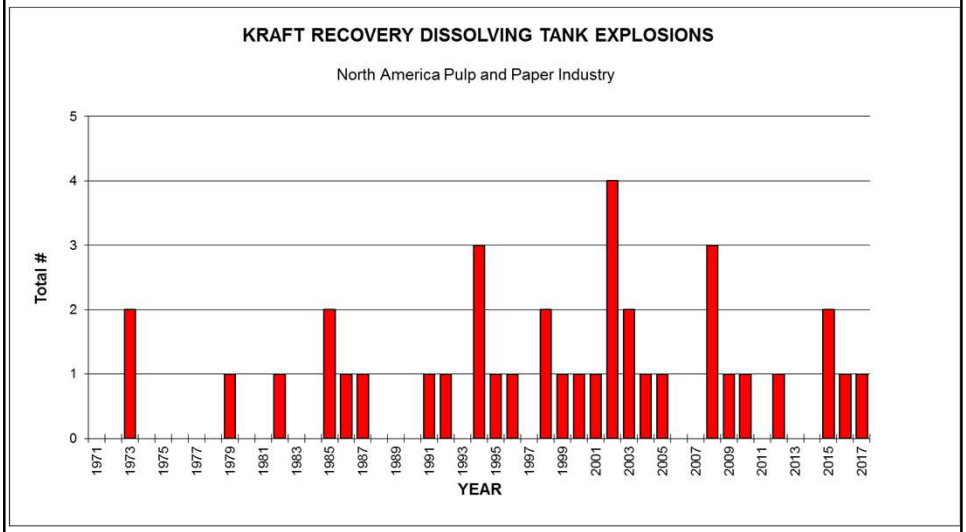
Critical Incidents to Date



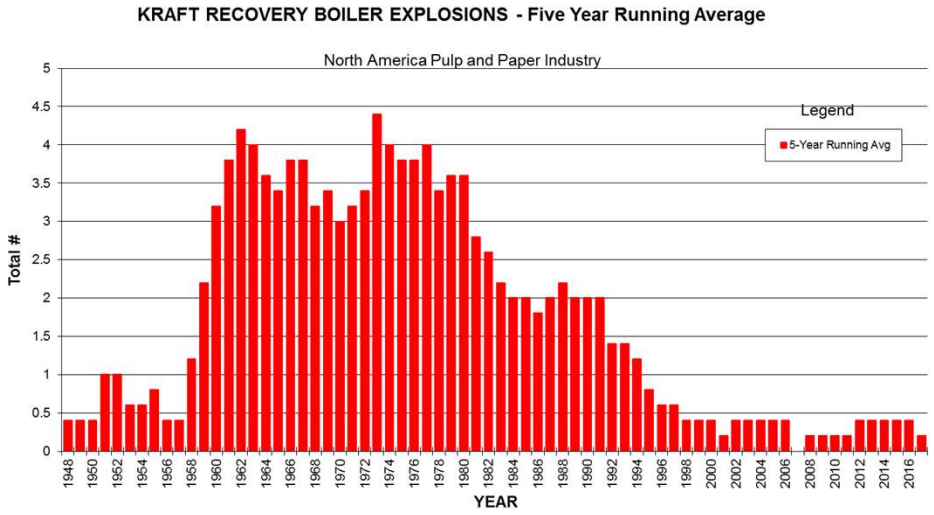
Boiler Explosion History



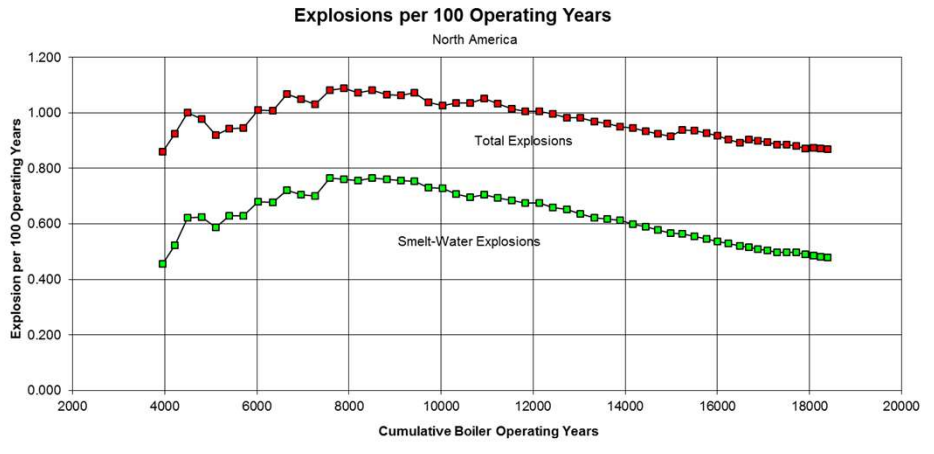
Dissolving Tank Explosions



Explosion History - Five Year Avg.



Explosion History per 100 Oper Yr



Smelt-Water Explosion on 22-Sept-2017

- Will report in April 2018 BLRBAC Meeting
- Daishowa Marubeni International, Peace River, Alberta, Canada
- Sheared sootblower lance in superheater impacted floor tube, caused leak
- 1176 hours downtime reported

Learnings

- Inspect and maintain vibration restraints in Economizer
- Check slip joint for feedwater line in lower ash hopper for freedom of movement
- Include location of economizer and generating bank baffles in operator training
- When repairing leaks at superheater clips, replace clip at a different spot away from repair weld

Learnings

- Implement inspection plan for SAC on older boilers (>15 years)
  - TAPPI TIP 0402-38 Guidelines for detecting and mitigating waterside cracking (SAC)
- Inspect lower header under spouts for weak wash corrosion
- Maintain integrity of skirts in spout hoods
- Develop procedures for plugged spouts in accordance with Chap 10 SFBL
  - Follow procedure in spite of production pressures
- Spout torches are good tool for opening plugged spouts

Learnings

- Create boiler side view diagram that clearly indicates sections of the boiler where leaks would be potential Critical Incidents and post in control room.
- First Assume the Worst – better to assume a worse case and then prove it is wrong than always assuming the best case. Confirmation Bias
- Boiler should not be hydrostatically tested until bed is sufficiently cool for water wash
- Consider bypassing the torque limits of any motorized valve that is part of ESP – not just the Rapid Drain Valves.

Learnings

- Involve Purchasing and Stores in Management of Change process to assure correct parts are available.
- When leaks occur, inspect similar areas for the same issue. If it happens on one side wall it will probably be a problem on the other.
- Include roof tubes at superheater sootblower lanes, especially if the blowers are closer than 3 feet to roof.
- Review superheater clearing procedures on start up to look for temperature spike on tube thermocouples. Standard startup curves may not be sufficient in unusual cases

Learnings

- Check alignment of sootblowers in superheater section during outages to make sure they are not rubbing on tubes
- Keep condensate out of sootblowers
  - Utilize thermal drains or orifice plates to drain condensate
  - Make sure steam lines to blowers are sloped back to the steam supply header
  - Maintain poppet valves
  - Maintain pipe insulation
- Inspect boiler screen / rear wall tubes at ash hopper attachment on B&W units for cracking. Review Service Bulletin

Collection of Past ESP Subcommittee Learnings

- BLRBAC ESP Subcommittee Published Incident Learnings 2005 - 2017 (from BLRBAC minutes)
- Organized by four General Topics, combining similar learnings (meeting code is S05=Spring 2005; F05=Fall 2005)
- General Topics (Ctrl + Click to go to a topic)
  - **Operations, Training, Procedures and Management**
  - **Design, Maintenance and Inspection**
  - **Controls**
  - **Water Treatment**

Combined ESP and Post-ESP Document

Posted by BLRBAC for Review and Comments, then vote

- Chapter 1 Purpose
- Chapter 2 Design
- Chapter 3 Post ESP Procedures
- Chapter 4 Re-Entry to Boiler after ESP
- Chapter 5 Procedure for Testing ESP
- Chapter 6 References

Boilers in Service

- North American Total - 191
-

	US	Canada
– Number	146	40
– Avg Age	39.2	39.6
– Max Age	65	70

- Oldest
  - – Kruger Three Rivers, PQ
  - – 1947 Alstom
- Contact Dean Clay with any Corrections or Updates

Incident Questionnaires

- Obtain Up to Date Questionnaire from website www.blrbac.org
- New Fill-in Form Questionnaire (dated 9-Oct-2017)
- Submit to Dean Clay at dclayesp@gmail.com
  - – Or to dclay@bsimail.com
  - – Please use Word .doc or .docx files, not .pdf
  - – Please use .jpg illustrations
- Look for confirmation of receipt from Dean

Control of Sodium-Sulphur Balance in a Modern Kraft Pulp Mill

AF&PA Recovery Boiler Program
2018 Annual Conference, February 7-8
Atlanta, GA

Originally Presented at:
Tappi Peers 2017 Conference
Norfolk, VA, November 2017

Presented by: Raymond Burelle
Authors:
- **Asta Humalajoki**
- **Martin Wimby**
- **Eevi Smolander**
- **Mats Nordgren**
- **All Valmet**

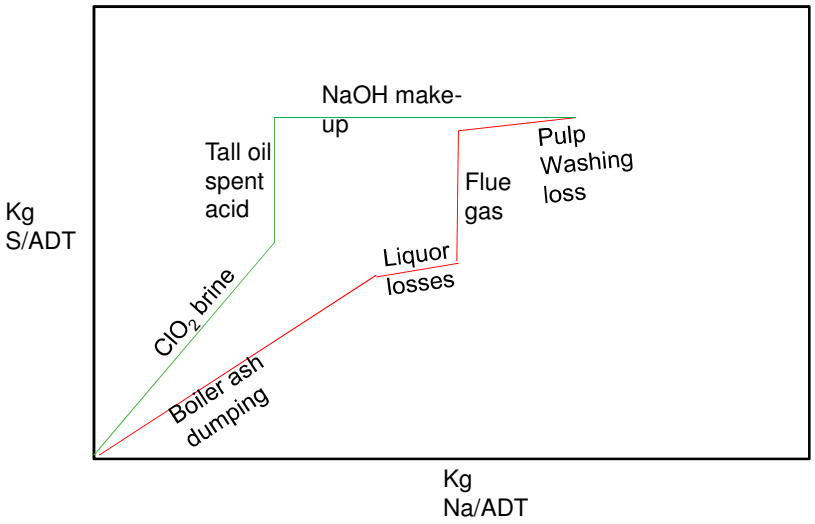
Valmet

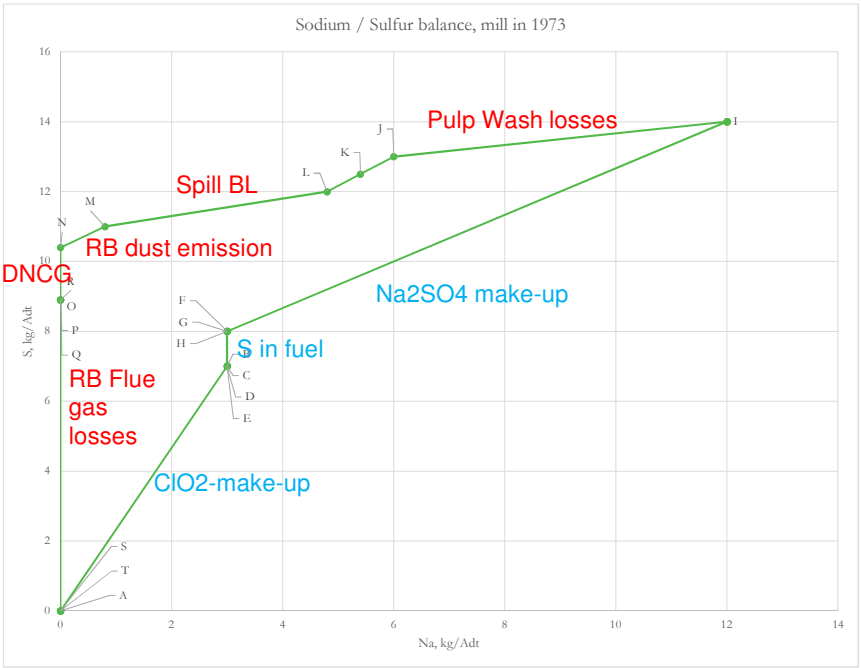
The ”closed” liquor circuit in the Kraft process

Estimation of chemical flows:	
Charge, Active Alkali	22% as NaOH on dry wood
Pulp yield	47%
Sulphidity	32%
Sodium charge	~ 300 kg/Adt
Sulphur charge	~ 75 kg/Adt
Modern mill:	
Sodium loss	3,5 kg/ADT
Sulphur loss	1,9 kg/ADT
1973 mill:	
Sodium loss	12 kg/ADT
Sulphur loss	14 kg/ADT

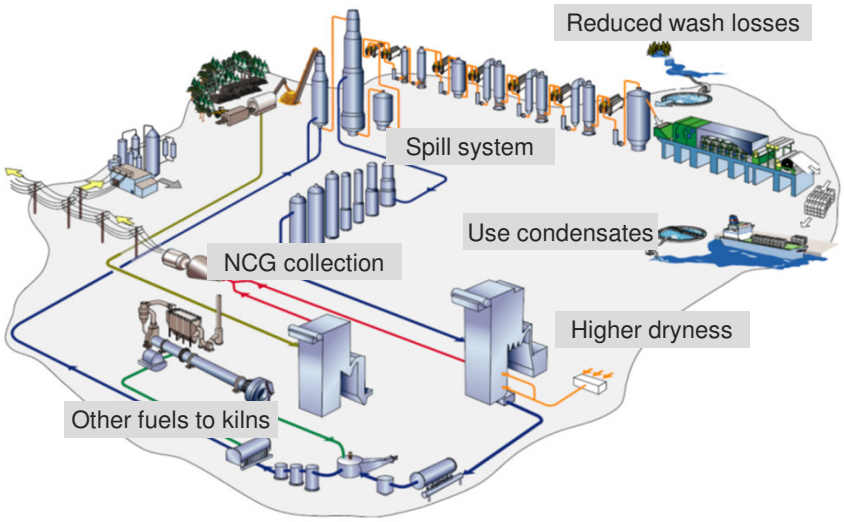
Vector diagram

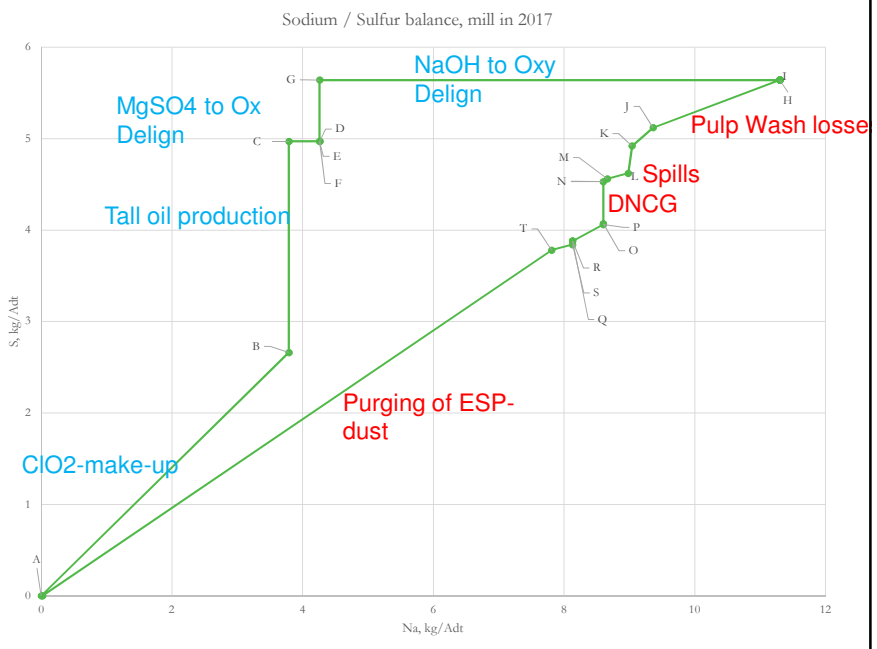
A useful way to visualise the Na-S-balance

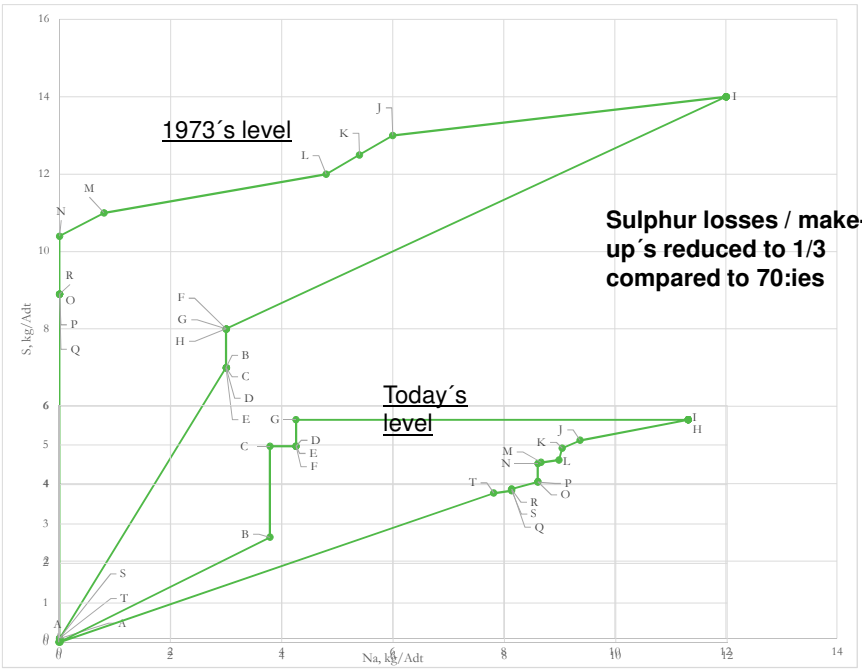




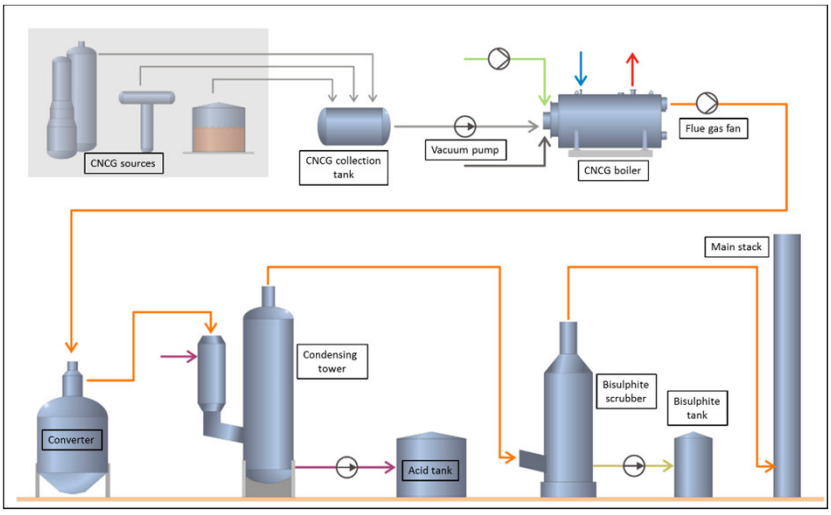
What has been done since 1973?







Sulphuric acid plant



Sulphuric acid production

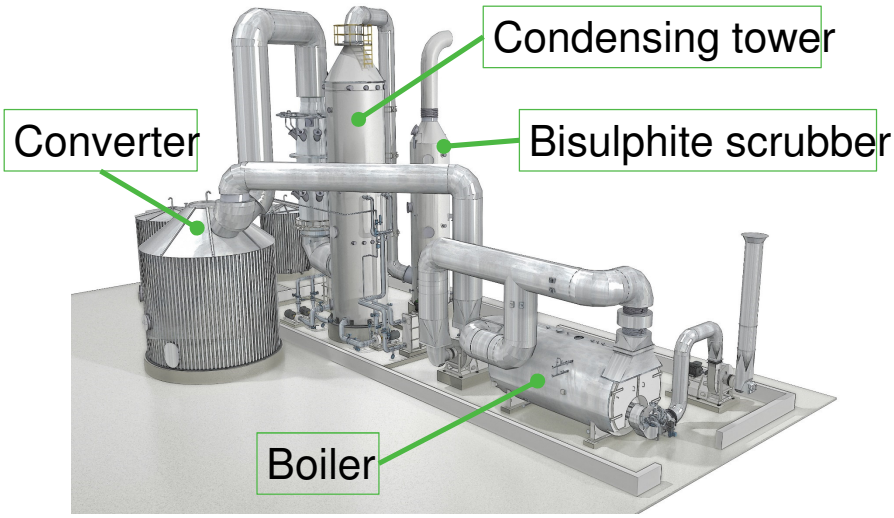
- $2\ SO_2 + O_2 = 2\ SO_3 + heat$
- $SO_3 + H_2O = H_2SO_4 + heat$

- End concentration 50…70 w-%

Sulphuric acid plant

- Acid can be diluted on-site
- End users such as;
  - Effluent treatment plant
  - Tall oil plant
  - Lignoboost
  - Bleaching plant

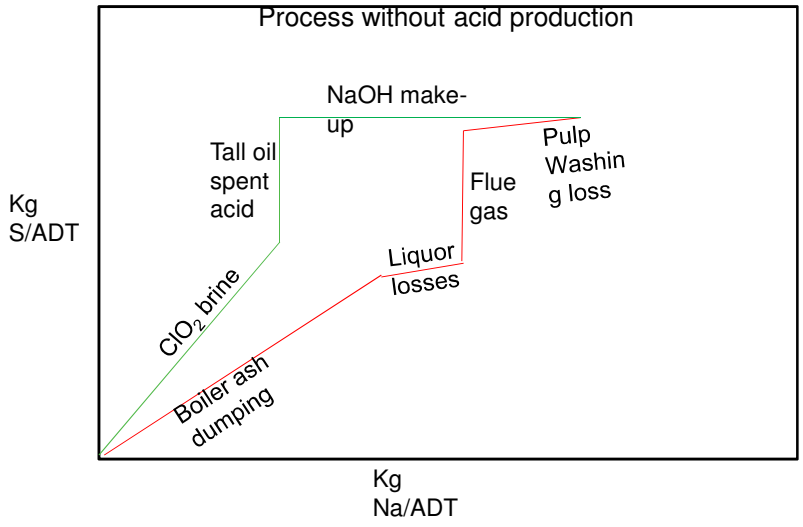
Sulphuric acid plant



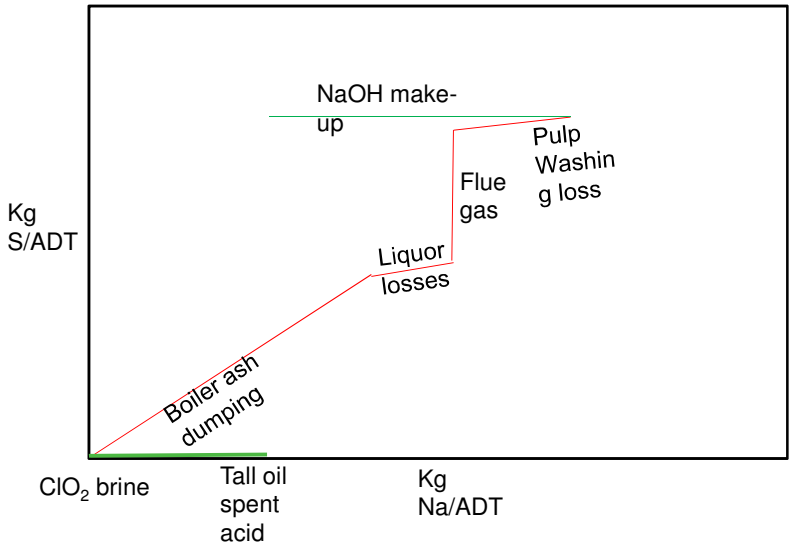
How does the sulphuric acid plant affect the vector diagram?

- The sulphuric acid production is based on mill internal sources
- Assuming that the acid can replace all sulphuric acid that is used in the mill, the major contributors to the sulphur surplus are eliminated

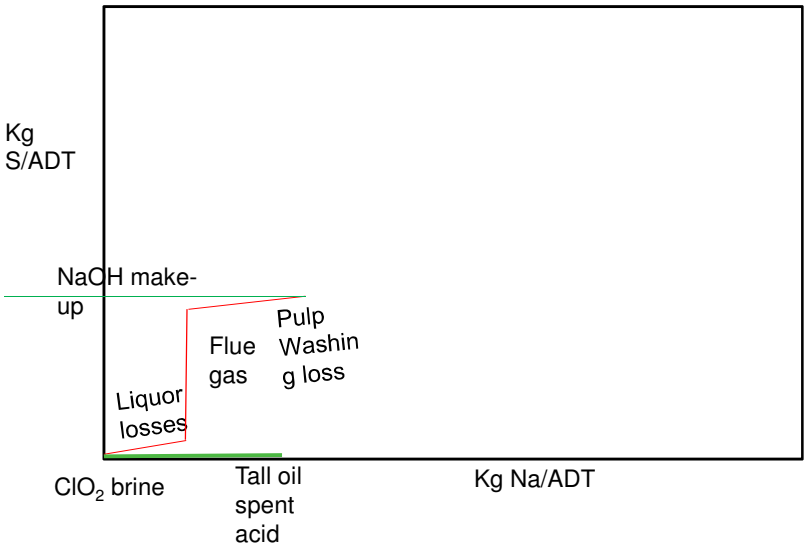
The sulphuric acid plant in the Vector diagram



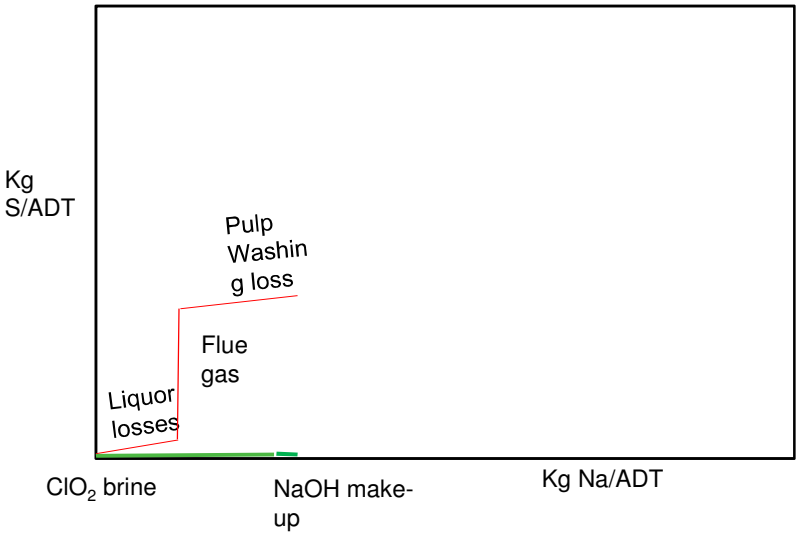
Step 1: remove the sulphur intake



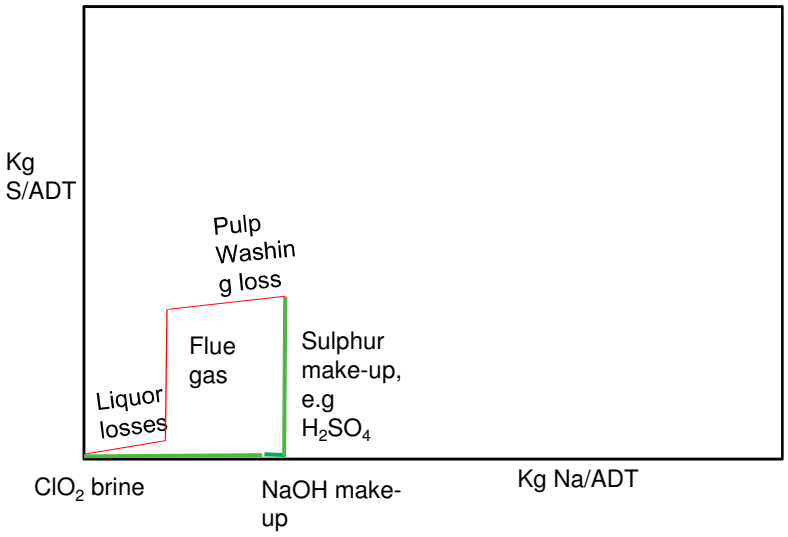
Step 2: Stop ash dumping



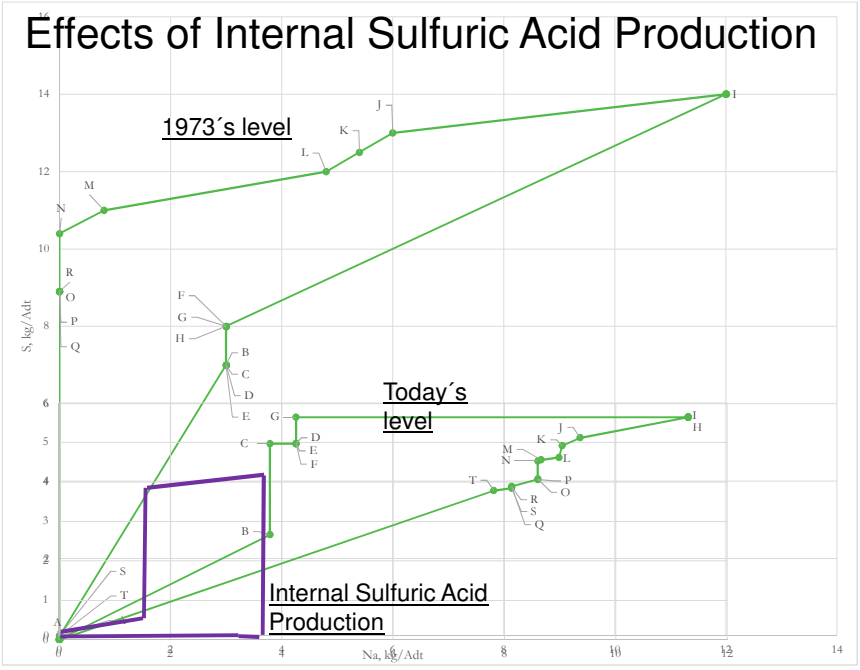
Step 3: Close sodium balance



Step 4: Close sulphur balance



Effects of Internal Sulfuric Acid Production



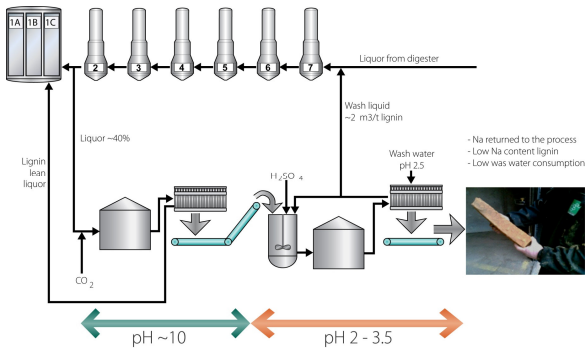
Implication of the sulphuric generation in the 2017 mill

- Sodium make-up is in the closed modern case drastically reduced
- In the 2017 case with internal sulphuric acid production the ClO2 brine is sufficient to cover process losses of sodium and thereby eliminating the NaOH make-up. (13,5 → 0 kg/Adt).
- The required sulphuric acid production corresponds to 5 kg S/ADt

Sulphur sources

- In a normal mill the thumb rule is that 3 – 5 kg S/Adt is release to strong gas and methanol
- This means that we may need other sources, at least if the mill makes tall oil
- One way to increase the sulphur release is heat treatment of the liquor. This can add another 5 kg S/Adt
- A solution that can separate an even larger sulphur flow is green liquor stripping, our solution is called Sulphide Conversion Process (SCP).

Lignin separation

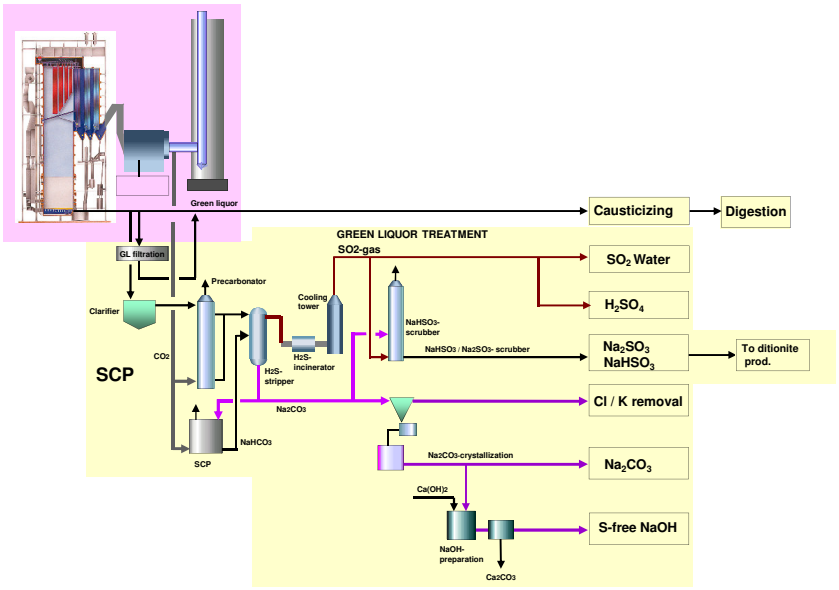


- Acid consumption ~200 kg/ton lignin
- Extractable lignin ~300 kg/Adt
- Maximum Sulphur intake ~ 19 kg/Adt

Sulphuric acid use

- ClO_2 generation
- Tall oil production
- Lignin separation
- Methanol purification
- Bleach plant
- Etc.

Kraft Pulpmill Balance Control



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Conclusions

- In a modern kraft mill, sulphur intake through ClO2 spent acid and tall oil spent acid exceeds the losses from the process
- To compensate for that, recovery boiler ash is dumped, which causes a sodium loss
- By producing sulphuric acid with streams from the closed liquor cycle, the excess sulphur is eliminated and thus, both sodium and sulphur is saved
- With lignin separation, using sulphuric acid, the sulphur intake increases even more and green liquor will have to be used as sulphur source

Thank you for your attention

TAPPI

Energy, Recovery & Recaust Committee Report

American forest & Paper association - Recovery Boiler Program
2018 Annual Conference & Meetings
Atlanta, Georgia

TAPPI

Technical Association of the Pulp and Paper Industry

Mission Statement

- To fosters the vitality of the global forest products, pulp, paper, tissue, packaging, and associated industries by delivering unsurpassed technical knowledge, valuable networks, and professional growth for our members.

TAPPI
Energy, Recovery & Recaust Committee

- Under TAPPI Engineering Division
- Formerly known as the Steam & Power/Energy Management Committee
- Four Sub-Committees & the chairs
  - Recovery & Power Boiler (Bentley Sherlock*)
  - Energy Management (Ben Bunner)
  - Water Treatment (Jim Graham)
  - Lime Kilns & Recaust (Peter Gorog)
- Mr. Sherlock has expressed his interest to step down…
  - But agree to continue to lead the sub-committee until we find for his replacement. We are actively searching for his replacement

TAPPI TIPS

- **TAPPI Technical Information Papers** (TIPs) are documents containing specialized information (e.g., data, software, calculations) used in the manufacture, evaluation and description of pulp, paper, and related products, written in a standardized format which is readily useable by the industry.

TAPPI TIPS

- WORKING GROUP
  - WORKING GROUP CHAIR (WGC)
  - TWO OR MORE WORKING GROUP MEMBERS
  - THREE OR MORE TAPPI MEMBERS
  - WGC AND AT LEAST TWO GROUP MEMBERS MUST WORK FOR DIFFERENT COMPANIES

TAPPI TIPS

- Published in 2017
  - 0416-02 “Definitions of Black Liquor Recovery Furnace Availability”, Issued in 1998, Reinstated in 2017, WGC = LEN ERICKSON
- Up for review in 2018
  - 0416-09 “Collection and Burning of Concentrated Noncondensible Gases: Regulations, Design, and Operation”, WGC = L. PAUL JOHNSON
  - 0416-20 “Recovery Boiler Sootblowers: Practical Guidelines”, WGC = D.TANDRA
- Newly formed working group
  - WI 170416.02 “Sootblower Safety & Upgrade Guideline”, WG = M.I. JAMEEL, ALARICK TAVARES, JASON MILLIER, MARKUS BUSSMANN

Upcoming Events

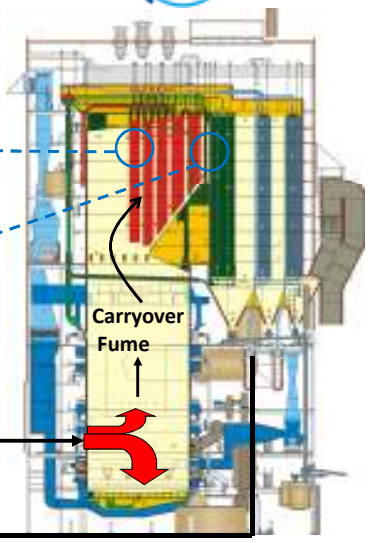
- **TAPPI PEERS** Pulping, Engineering, Environmental, Recycling, Sustainability Conference 2018
  - October 28 – 31, 2018 in Portland Oregon
- **Energy Recovery Recaust Committee Meeting**
  - Right after BLRBAC Spring 2018 Meeting Wednesday, April 11, 2018

Recovery Boiler Sootblower Safety & Upgrade Guideline

AF&PA Recovery Boiler Program

2018 Annual Conference & Committee Meeting

Recovery Boiler



Sootblower

- RB Sootblowers are operated continuously to prevent **costly plugging**
- Hence, good maintenance program is crucial for the safety & profitability of the mills

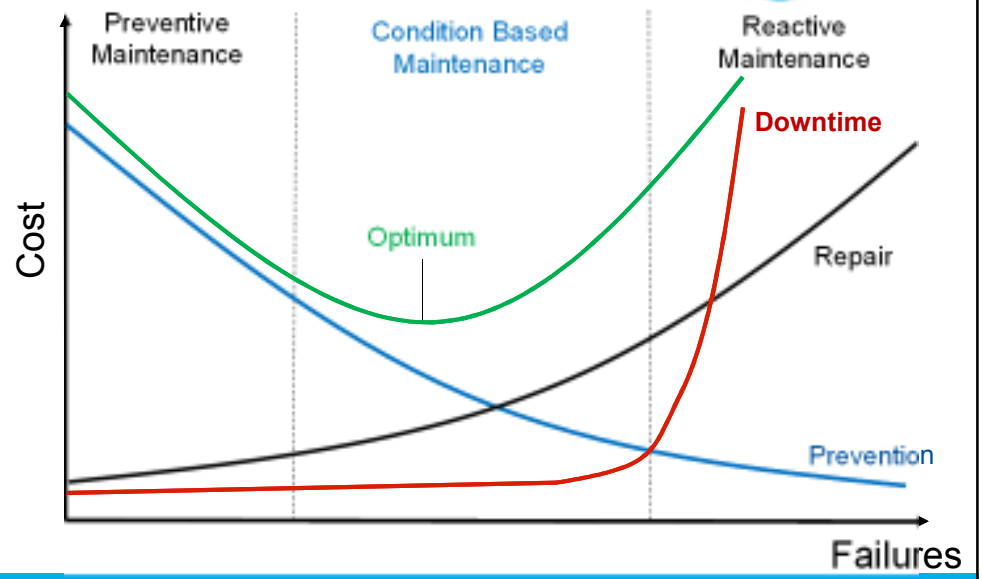
Failure leading to cataclysmic event

- Failure is **NOT** a single, cataclysmic event. You don't fail overnight. Instead, failure is a few errors in judgement, repeated every day - Jim Rohn
- Are there any the necessary correction that we choose to ignore now, that will lead to a costly cataclysmic event in the future?

Challenges

- Reduction in maintenance manpower
- New maintenance team who is not necessarily have the right training / knowledge to run a maintenance program that ensures the fitness of the mill's equipment
- Many run their sootblower to failure – Reactive Maintenance

Challenges

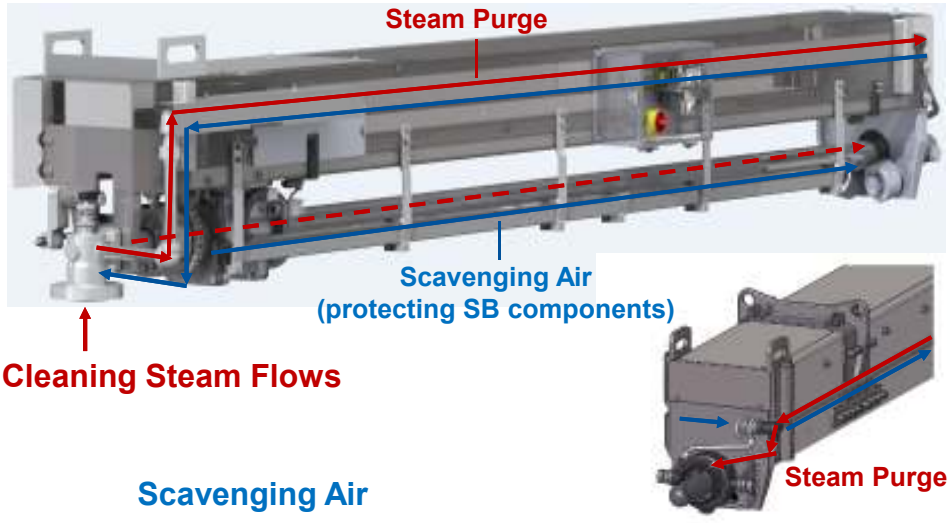


Few Examples

Early signs of safety issue that <u>often</u> ignored

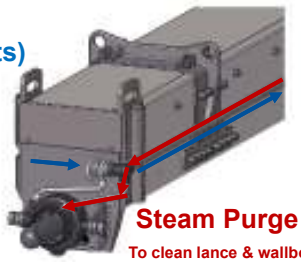
- Scavenging Air to prevent harmful gas to enter Sootblower
- Misalignment

Steam & Air Flows in a Sootblower



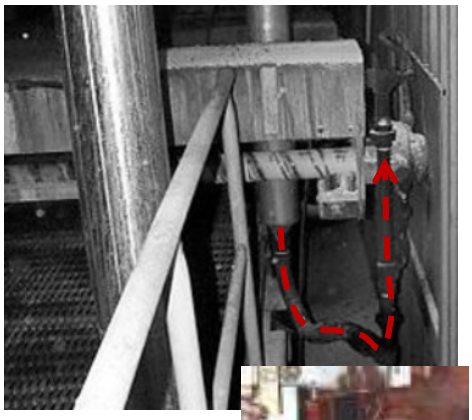
- **In operation ONLY when the sootblower is in <u>REST</u> position**

Steam & Air Flows in a Sootblower



- In operation ONLY when the sootblower is in REST position

Scavenging Air



WRONG

What happen if the harmful gas enters SB

- Damaged SB components
  - ➔ Check valve corrosion
  - ➔ Poppet valve plugging

What happen if the harmful gas enters SB

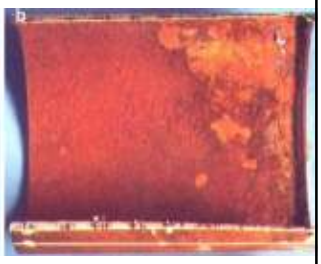
- Damaged SB components
  - ➔ Check valve corrosion
  - ➔ Poppet valve plugging

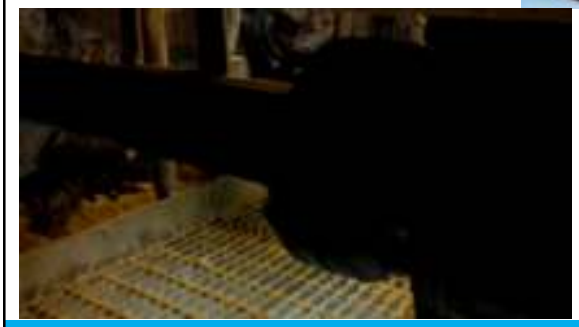
Canopy Bent due to plugged poppet valve

*May result in **lance overheating** due to insufficient steam cooling flow due to plugged poppet valve*

What happen if the harmful gas enters SB

- Damaged SB components
  - ➔ Check valve corrosion
  - ➔ Poppet valve plugging
  - ➔ Lance tube corrosion





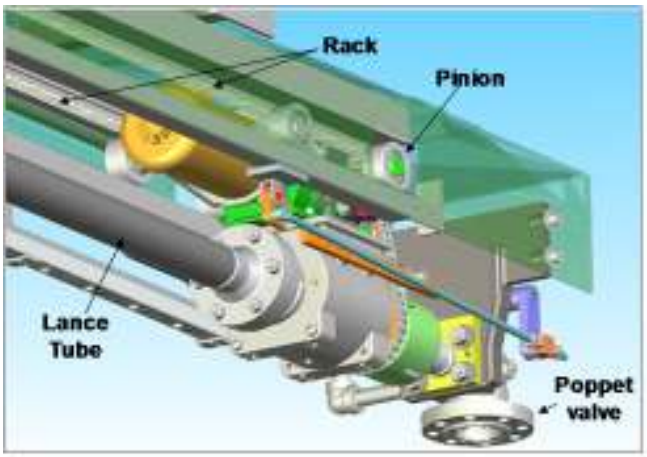
Few Examples

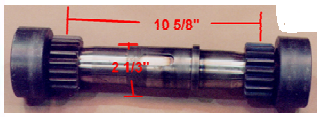
Early signs of safety issue that <u>often</u> ignored

- Scavenging Air to prevent harmful gas to enter Sootblower
- Misalignment

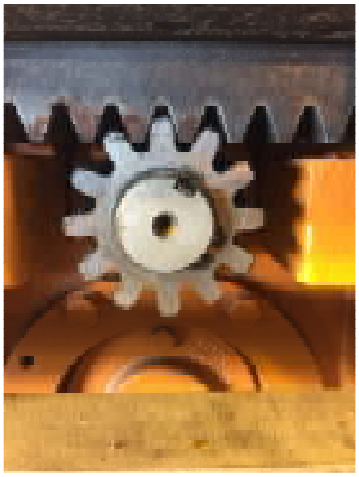
Misalignment as major safety issue

- Rack & Pinion Misalignment

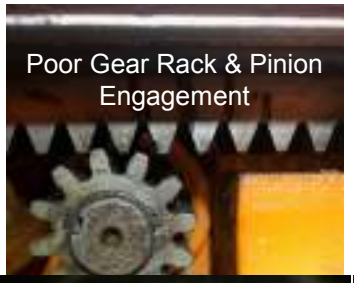




Rack & Pinion Misalignment

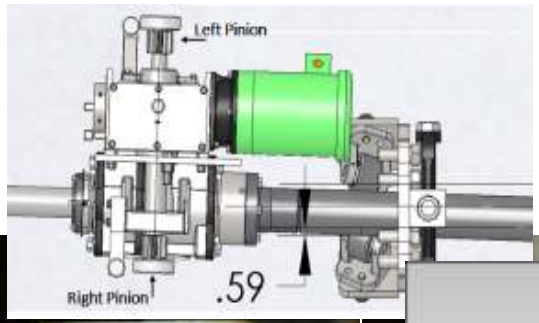


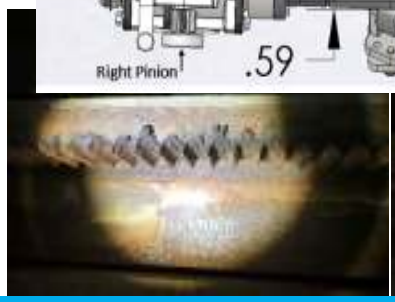
Rack & Pinion Misalignment



Rack & Pinion Misalignment

- Lance & Feed tubes receive the most torture





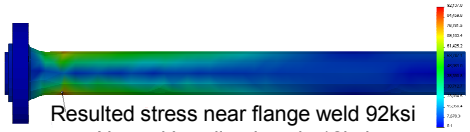
Resulted stress near flange weld 92ksi
Normal Loading is only 12ksi

Misalignment as major safety issue

- Rack & Pinion Misalignment
- Plugged Wallbox

Normal

Initial stage of Plugging

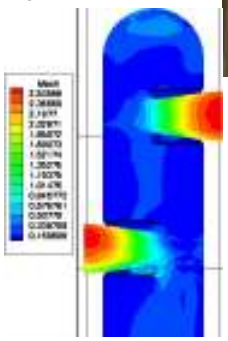


Resulted stress near flange weld 92ksi
Normal Loading is only 12ksi

Plugged

Misalignment as major safety issue

- Rack & Pinion Misalignment
- Plugged Wallbox
- Bent Lance Tube
  - → Lance overheating
  - → Poor Nozzle Design, causing lance imbalance
  - → Clinker fall



Old nozzle design

Clinker Falls

Quick Recap

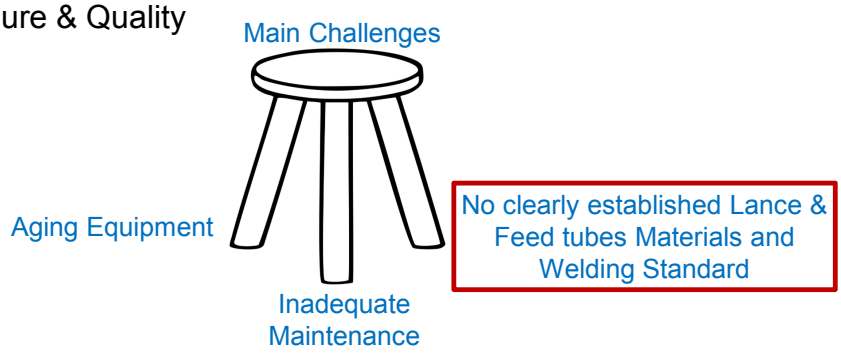
Safety Issue	Impact	What to look
Scavenging Air Not In Operation	• Corrosion of critical components	• U Shape Air hose • Flue Gas inside the SB
Misalignment • Rack & Pinion Misalignment • Plugged Wallbox • Bent lance tube	• Premature mechanical failure on critical components	• Premature or uneven wear on the racks • Lance not properly riding on the front rollers
Others (discussed further in TAPPI TIPs) • Condensate • Poppet valve leak • Electrical (Limit Switch, JB, etc)		

Safety Concerns

- Lance & Feed tubes failure – Exposing those in the surrounding areas with high pressure steam
- Lance tube may also launch inside the boiler and damage boiler tubes
- Carriage losing traction – Steam pressure pushes the carriage to move forward at high speed and damage the boiler wall.

Recommendation

- **Know where to look** early sign of sootblower safety issue:
  Through Training, Certification, Good Succession Plan.
- **Follow yearly FTO (Fitness To Operate) Assessment:**
  to detect problems early and avoid costly repair through NDE
- **Pay Attention** to Lance / Feed Tubes Materials, Welding Procedure & Quality



ASME Code & industry Interpretation

- Companion Guide to the ASME Code Volume 1, page 444 – 446 illustrate the jurisdictional limits of "Boiler Proper Piping" (BP), "Boiler External Piping & Joint"(BEP), and "Non-Boiler External Piping" (NBEP).
- It produces Figure 100.1.2 (B) which indicates that sootblowers is **NOT** under BP or BEP, meaning that sootblower is **NOT** under the jurisdiction of BPVC (Boiler & Pressure Vessel Code).
- But rather, it is under NBEP and the jurisdiction of B31.1 power pressure piping code.

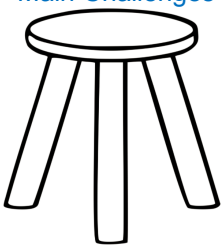
ASME Code & industry Interpretation

- Some in the industry further argue that B31.1 only applies up to the poppet valve and NOT downstream of the poppet valve since we have two large nozzles vented to atmospheric pressure.
- But ASME Code also says that **it is the owner's responsibility** to select the Code Section which most nearly applies to a proposed piping installation.
- This might be interpreted as the sootblower manufacturer has the responsibility to select their own code section

Recommendation

- **Know where to look** early sign of sootblower safety issue:
  Through Training, Certification, Good Succession Plan.
- **Follow yearly FTO (Fitness To Operate) Assessment:**
  to detect problems early and avoid costly repair through NDE
- **Pay Attention** to Lance / Feed Tubes Materials, Welding Procedure & Quality

Main Challenges



Aging Equipment

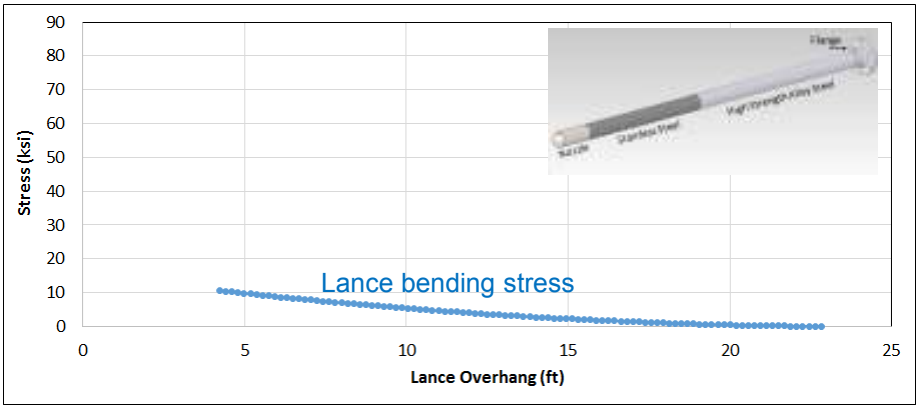
Inadequate Maintenance

No clearly established Lance & Feed tubes Materials and Welding Standard

Material: *ASME B31.1*
Welding: *ASME Section IX BPVC*

Sootblower Lance & Tubes Code

- Material Selection (B31.1 Power Piping Code)
  - ➔ Allowable Stress ≤ Yield Strength / 3.5



Sootblower Lance & Tubes Code

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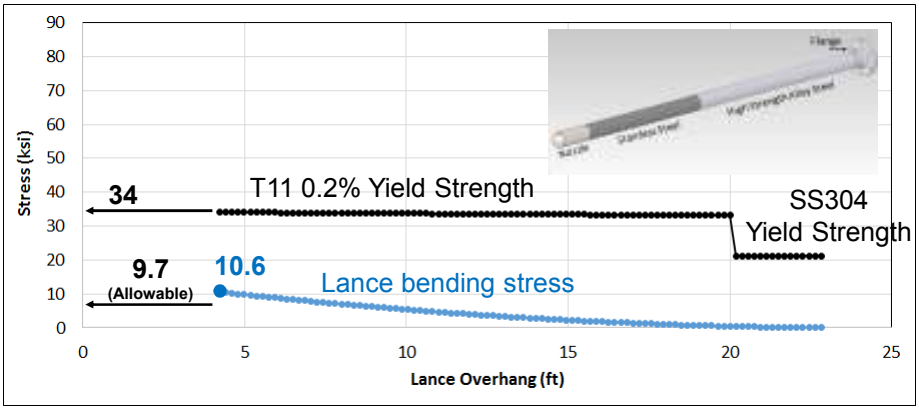

Sootblower Lance & Tubes Code

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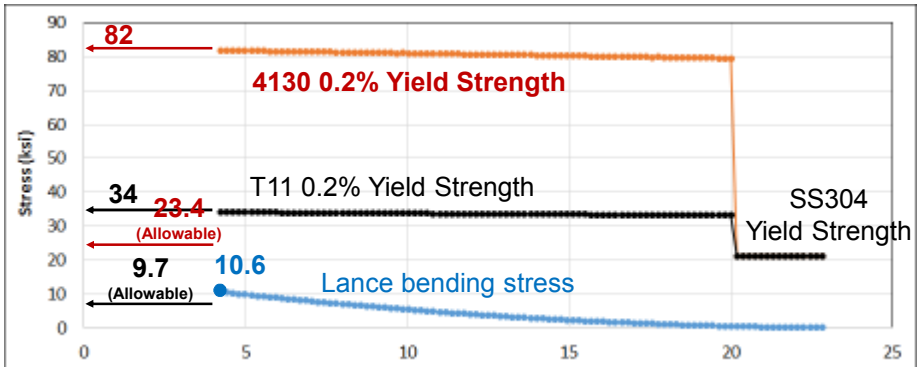
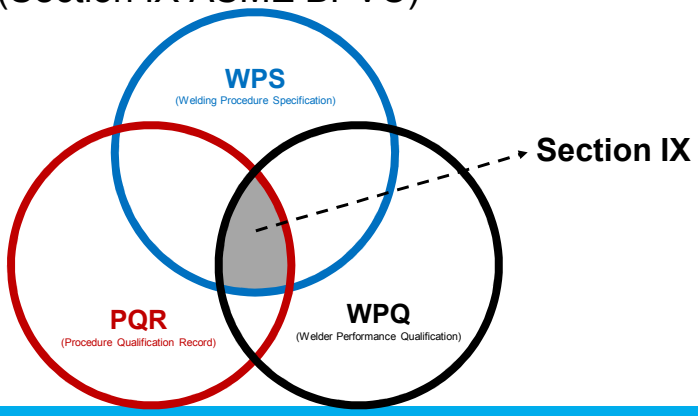


T11 and SS304 may not be able to meet this requirement

(Depend on sootblower length – the longer the SB the more likelihood T11 and SS304 won't meet the code requirement)

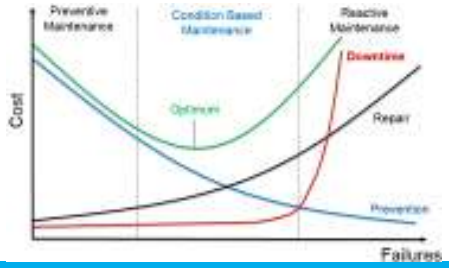
Sootblower Lance & Tubes Code

- Material Selection (B31.1 Power Piping Code)
  - ➔ Allowable Stress ≤ Yield Strength / 3.5
- Welding (Section IX ASME BPVC)



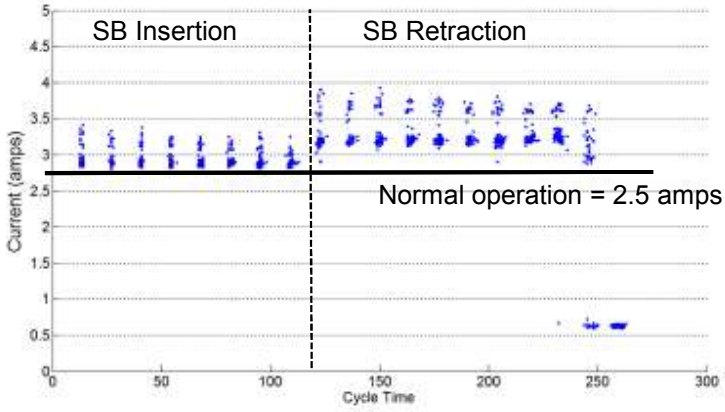
Recommendation

- **Know where to look** early sign of sootblower safety issue: Through Training, Certification, Good Succession Plan.
- **Follow yearly FTO (Fitness To Operate) Assessment:** to detect problems early and avoid costly repair through NDE
- **Pay Attention** to Lance / Feed Tubes Materials, Welding Procedure & Quality: Material selection ASME B31.1, Welding ASME Section IX
- **Use Condition Based Maintenance (CBM):** don't need huge investment



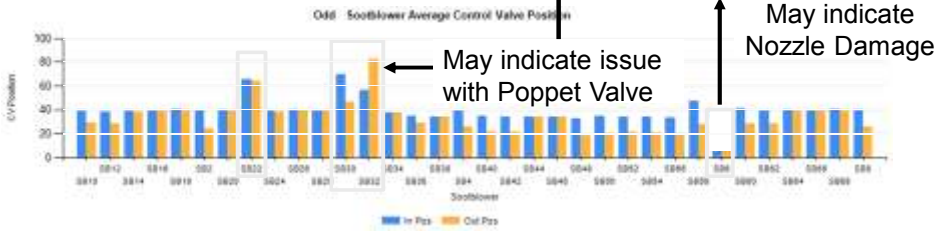
Feedback Sensors (1 / 2)

- Sootblower motor ampere
  - ➔ High amperage indicates binding. If left unresolved, it could result in costly repair / replacement of sootblower components (Gearbox, Rack, lance, etc)



Feedback Sensors (2/2)

- The correlation between the Control valve % opening and the resulting steam flow rate can be used to detect sootblower issues.



Recommendation

- **Know where to look** early sign of sootblower safety issue:

  Through Training, Certification, Good Succession Plan.

- **Follow yearly FTO (Fitness To Operate) Assessment:**

  to detect problems early and avoid costly repair through NDE

- **Pay Attention** to Lance / Feed Tubes Materials, Welding Procedure & Quality: Material selection ASME B31.1, Welding ASME Section IX

- **Use Condition Based Maintenance (CBM):** don't need huge investment

Key Takeaways

- You don't have to take huge investment to apply simple condition based maintenance.
- You can use already-collected-data to intelligently monitor your SB equipment and run good maintenance program even with limited manpower.
- Invest in good training to educate your frontline maintenance team
- Failure is **NOT** a single, cataclysmic event. It is an error in judgement repeated everyday … (Jim Rohn)

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Boiler Inspection Programs for Condition Assessment of Recovery Boilers

Matt Gilkinson
Project Coordinator – Condition Assessment

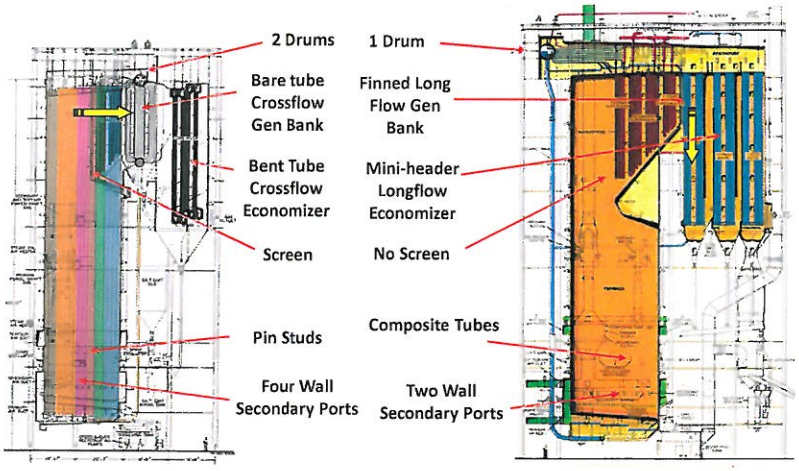
TRANSFORMING OUR WORLD | 150 YEARS

February 7, 2018

Introduction

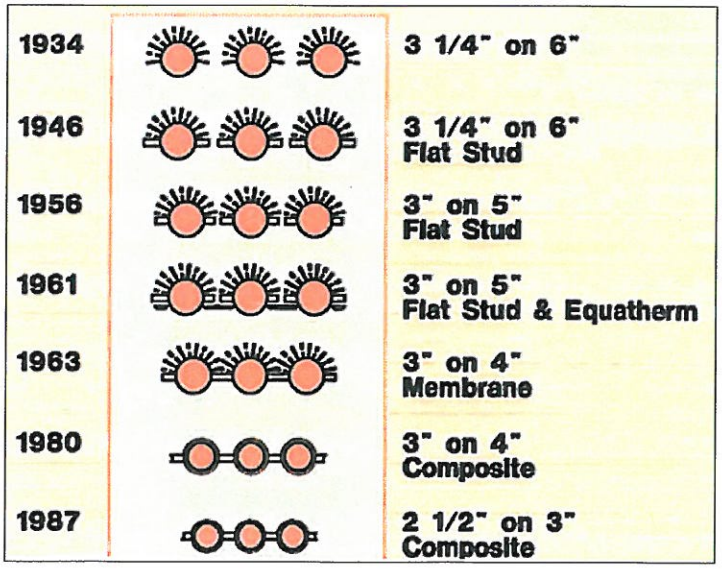
- Longer outage cycles require reevaluation of condition assessment criteria
- Emphasis on components with finite life due to degradation and failure from corrosion and cyclic stress
- Wide range of boiler designs due to the aging boiler fleet
- Repair/inspection needs are dependent on vintage, age, operational influences, historical maintenance practices

Two Drum to Single Drum Evolution



B&W

Evolution of Wall Construction



B&W

Condition Assessment Objectives

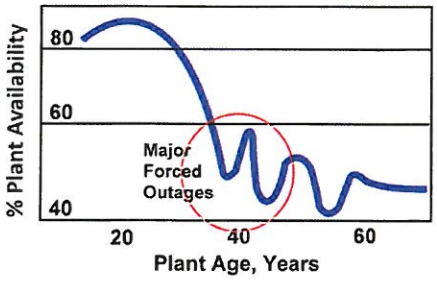
A more thorough inspection and maintenance program designed to:

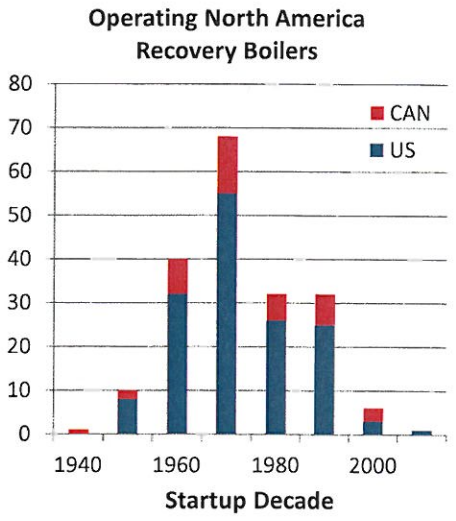
- Reduce forced outages
- Improve plant reliability
- Control maintenance costs

Reliability Centered Maintenance (RCM) process

5

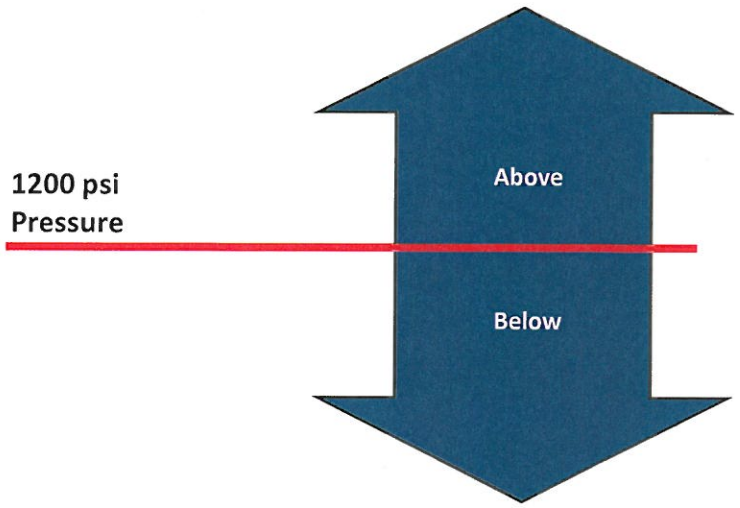
Recovery Boiler Availability / Age





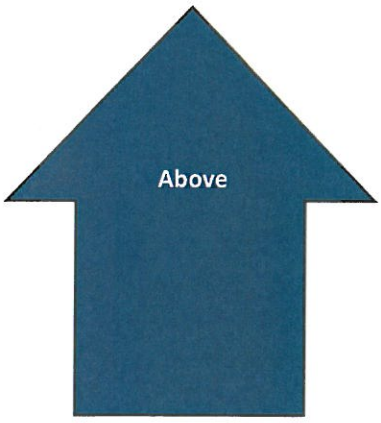
6

Main Classifications of Boilers



7

Boiler Aging Problems



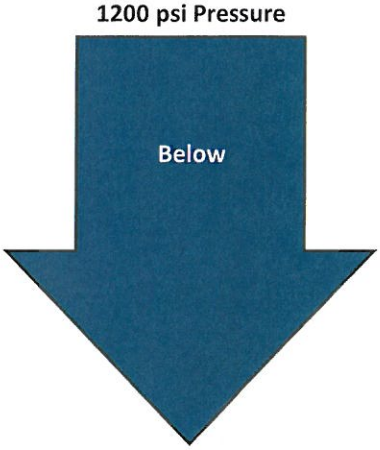
1200 psi Pressure

Composite tubes or WOL
Lower Furnace

- **Lower temperature components (<900F)**
  - Corrosion/erosion
  - Fatigue
- **Higher temperature components (≥900F)**
  - Fatigue
  - Corrosion/erosion
  - Overheating

8

Boiler Aging Problems



- Boiler corrosion/erosion
- Mechanical failures
- Fatigue
- Overheating

Pin Stud or Metal Spray
Lower Furnace

Condition Assessment Considerations

- **How many years of service are required?**
  - Outage cycle (≥ 18 months)
  - Long-term component life
- **At what capacity will the boiler be operated?**
- **Will the boiler operate continuously between outages?**
  - Water wash / chill and blow frequency
- **What systems may be upgraded or replaced?**
  - Air system modifications can influence corrosion patterns
- **Failure history?**
  - Emergency shutdowns?
- **Liquor chemistry changes?**
  - Sulfidity or side streams


Boiler Fitness Survey for Condition Assessment of Industrial Boilers

Condition Assessment structure and details are discussed in:
BR-1635 "Boiler Fitness Survey for Condition Assessment of Industrial Boilers"
B&W PSB-58 "Care, Management and Maintenance of Older Boilers"

Critical System and Components

Critical components or systems can be prioritized by the effect they have on:

- **Safety** – anything with the potential to damage personnel or property
- **Reliability** – failures that could lead to forced outages and lost production
- **Performance** – effects on unit efficiency and emissions

11

Steam Drum Inspection

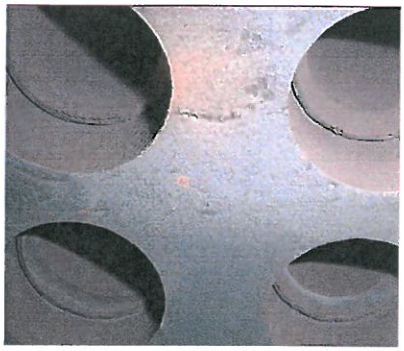
- Steam drum is the most expensive component of the boiler
- Surface corrosion or deposits related to water chemistry
- Ligament cracking at rolled tube holes
- Plugged tube clusters in rolled tube generating bank
- Corrosion cracking at welded stubs
- Condition of steam separating equipment

Inspection methods

- LPT or MPT for surface indications

12

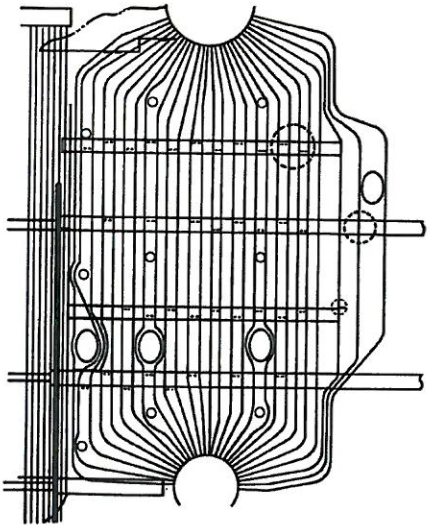
Ligament Cracking



18

B&W

Two-Drum Generating Bank



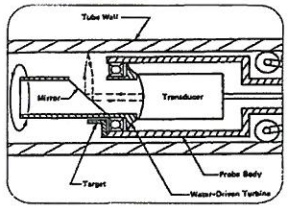
19

B&W

IRIS Tube Inspection System

Internal rotational inspection system

Generating Bank Tubes – Heat Exchangers – Feed Water Heaters

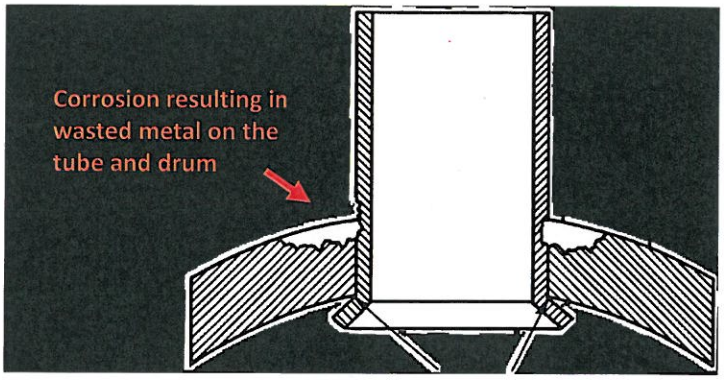


C Scan profile of tubing displays thickness color-coded representations of the tube

Typical inspection results consist of the minimum wall thickness over the length of each tube inspected.

15

Near-Drum Corrosion



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Furnace Inspection

Considerations

- Fire-side corrosion / erosions
- Cold-side corrosion
- Stress-assisted corrosion

Inspection methods

- Visual inspection
- UT inspection
- EMAT for bare carbon steel tubes
- Tube sampling
- Copper sulfate or MLO for composite layer
- LPT inspection around openings

Tube Wall Loss Assessment

Measurement methods

- Ultrasonic thickness testing (UT)
- EMAT

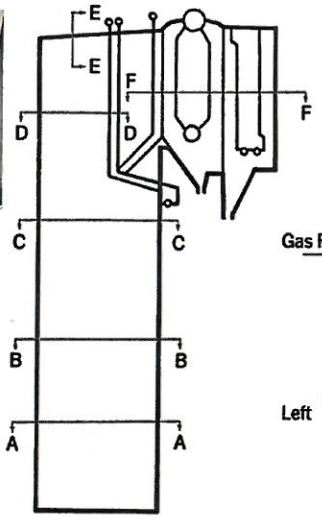
Criteria for evaluation

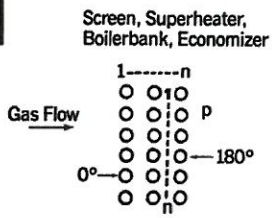
- ASME minimum wall

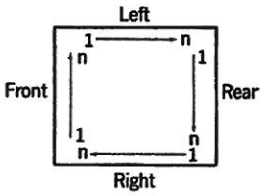
Data analysis

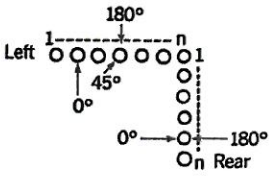
- Trends and focus areas

Ultrasonic Test Locations







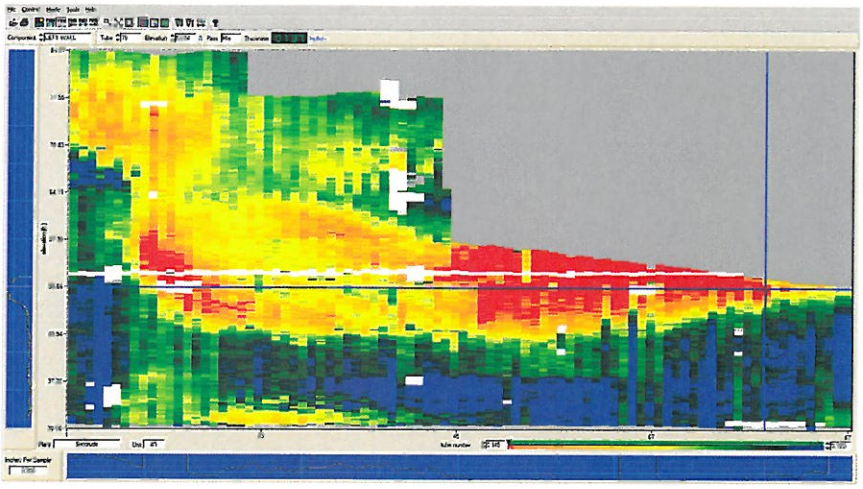


EMAT System Advantages

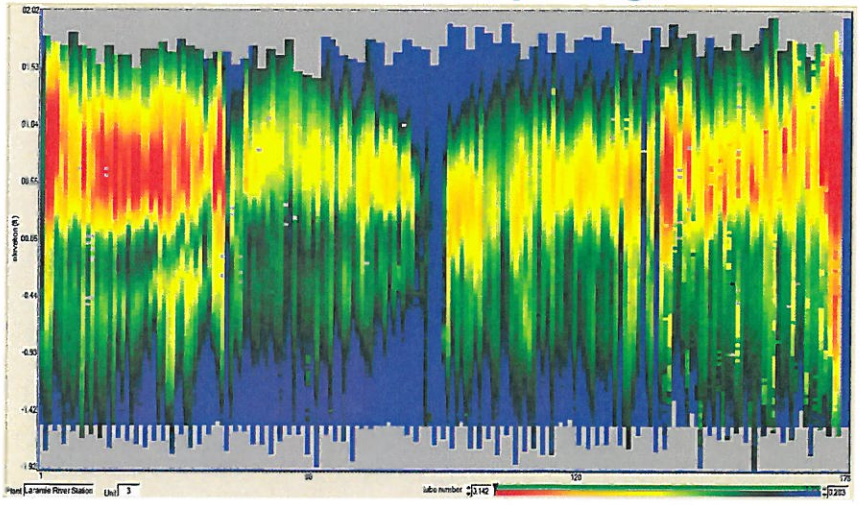
A major step forward in nondestructive examination (NDE) technology

- No couplant
- Faster than previous UT scanning methods for ID tube damage
- More sensitive for detection of ID initiated damage when scanning
- More productive for tube thickness data acquisition

EMAT Data Acquisition On Upper Furnace Walls

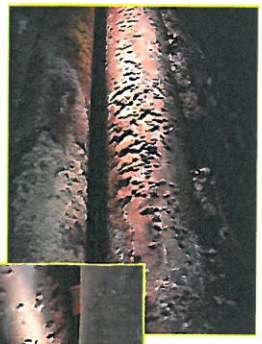


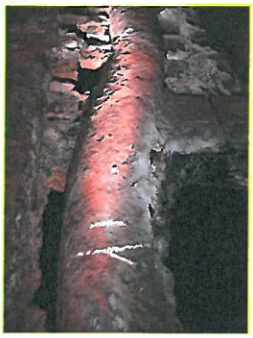
EMAT Data Acquisition at Sootblower Openings



Cold-Side Corrosion

- Can be prevalent in areas of high moisture and high ash accumulation
- Look for it around sootblower openings especially
- Most damage likely occurs while the unit is down and cold, allowing moisture in the air to turn salt cake accumulations into an acidic paste

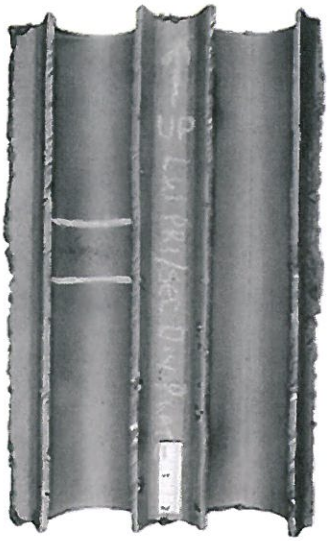




B&W

Stress-Assisted Corrosion (SAC)

- Identified in mid 1980s
- Waterside phenomenon
- Predominantly attachment welds
- Concentrated load at weld
- Most common in lower furnace
- Found by X-ray, phased-array ultrasonic testing (PAUT), or destructive examination



B&W

Stress-Assisted Corrosion (SAC)

- PSB-29 first issued by B&W in 1987 to discuss phenomena in furnace wall tubes
- B&W developed design details to minimize stress concentrations in attachment welds by 1990

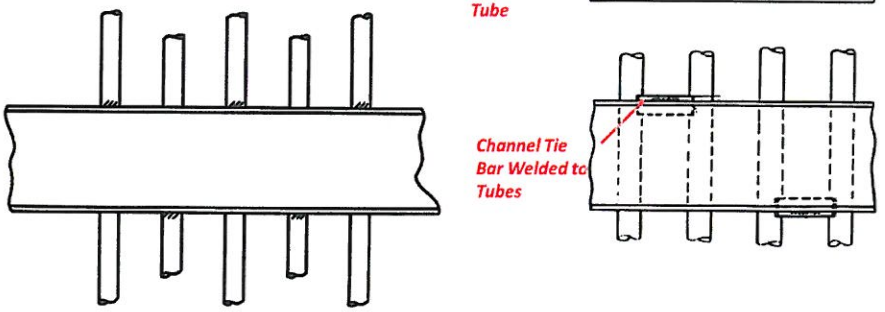
Stress-Assisted Corrosion (SAC)

Recent Experience

- Lower furnaces with post 1990 attachments are not showing signs of SAC
- Signs of SAC are showing up on vintage furnace panels higher in the furnace

Current Design

Generating Bank Tie Bar



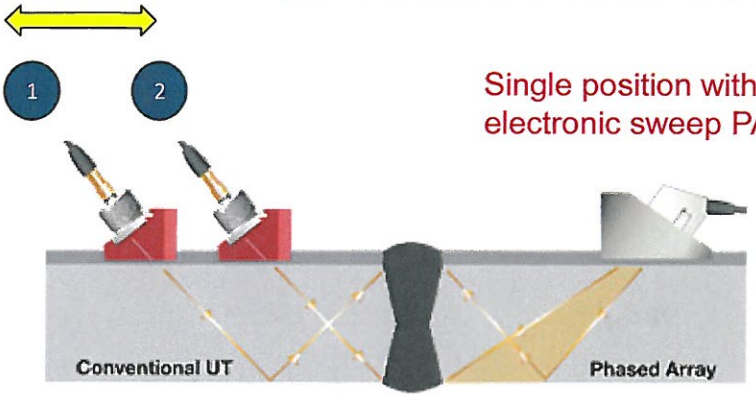
Old Design

New Design

Phased-Array Ultrasonic Testing (PAUT)

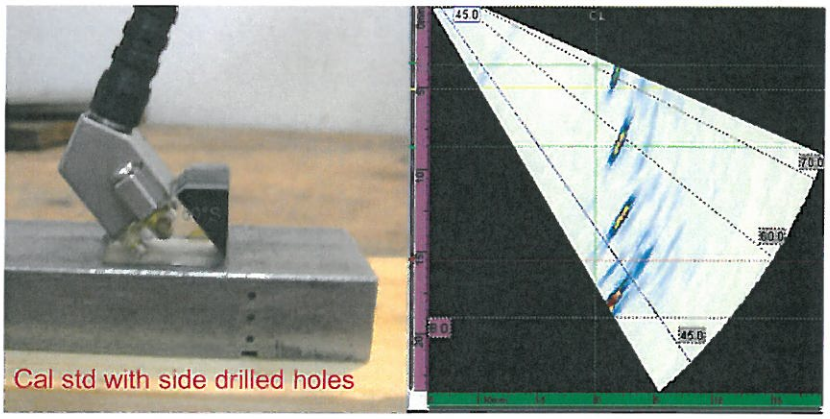
Raster scan in conventional UT

Experience, skill and attention of technician are critical to success

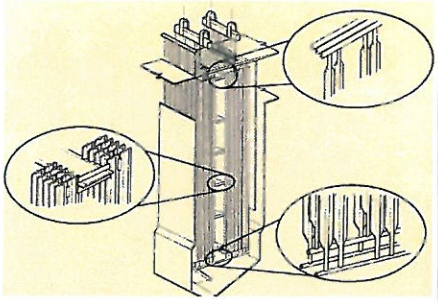


Single position with electronic sweep PAUT

Phased-Array Ultrasonic Testing (PAUT)



Economizer Inspection



Tube-to-Header Welds

Fin Terminations

Inspection Plugs/Caps

Inspection Plugs/Caps

31

B&W

Flow-Assisted Corrosion

- Caused by localized dissolution of iron from the piping into flowing water
- Inspection methods include UT and boroscope
- Material upgrade can eliminate future problems – P2 or P11 material
- Tighter chemistry control will reduce corrosion rate
- Refer to PSB-54A

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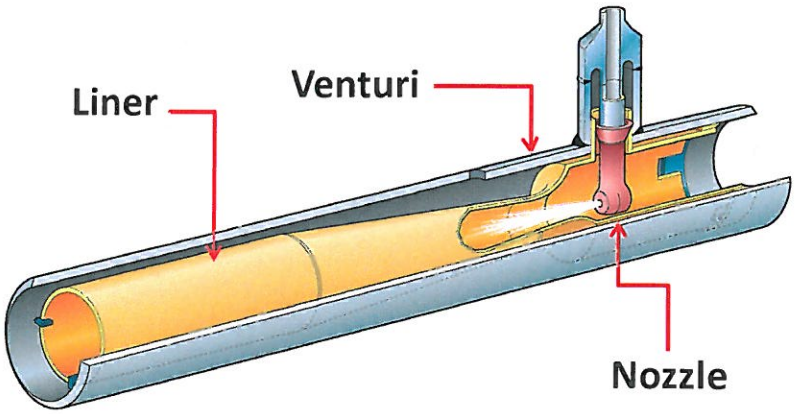
B&W

Attemperator Inspection



Attemperators should be inspected by boroscope every 5 to 7 years

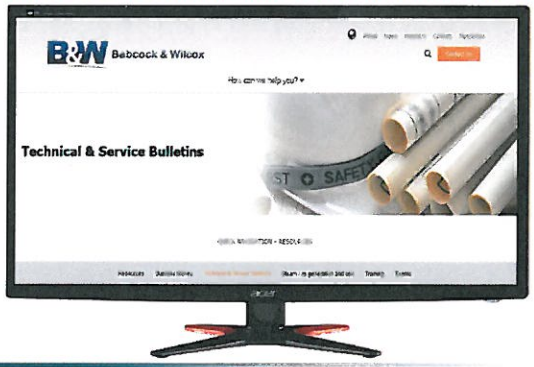
Video Probe Inspection

B&W Web Site Resources

Babcock & Wilcox provides safety and operational information in the form of plant and technical service bulletins for:

- Boilers
- Pulverizers
- Other power plant auxiliary equipment

http://www.babcock.com/en/resources/technical-service-bulletins



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Electron Machine Corporation

Refractometer Safety and System Updates

American Forest & Paper Association

AF&PA Recovery Boiler Program 2018 Conference
February 7, 2018

C.A. Vossberg

Introduction

- EMC History and Focus on RBSS

We Measure our success via the following Key Performance Goals:

- **Safety -** Safeguarding the mill staff while addressing the unique risks and challenges associated with heavy Black Liquor
- **Value** – Reduced cost of Operation, Maintenance, increased MTBF, Training and World Class Service
- **Dependability -** Rugged design and construction worthy of the harsh Black Liquor environment with minimal downtime, reduced MTTR
- **Ease of use -** Backward compatible upgrades, intuitive design, and consistent approach to the interface and logic
- **Innovation -** Continuous improvement regarding Safety, Value, Dependability, and Ease of use for all RI applications

Electron Machine Corp.
15824 CR450W, PO Box 2349, Umatilla, FL 32784
352-669-3101 sales@electronmachine.com

Refractometer Safety and System Updates

Focus on sensing head removal for Black Liquor applications

- No slip-stream/by-pass allowed for line breaking (Recovery Boiler)
- Difficult to install slip-stream/by-pass for line breaking (Evaporation)
- Other applications, such as Green Liquor, have unique considerations and is not in the scope of this presentation

Refractometer Safety and System Updates

1. Design considerations
2. Electron Machine's system
3. Operation with Safeguard Tool
4. Installation considerations
5. Safety and Training considerations
6. Preventative maintenance and failure indications

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Sensor Design Considerations

- Sensor design requirements dictate isolation (removal) system
- Rugged components to minimize need for maintenance
- Minimal exposed wetted parts
- Accurate & repeatable for measurement and temperature range
- Protruding probe into pipeline for accurate response to solids/temperature changes with minimal disruption of flow
- Predictive maintenance capability
- Long-term value (initial cost, repair cost and frequency)

Isolation System Design Considerations

- Safe and intuitive use with training and minimal tools
- Design should be rugged and with minimal moving parts
- Sealing surfaces resistant to temperature, abrasion, chemicals
- Maintenance requirements, frequency, and effects if neglected
- Positive indication of safety before there is no other option
- Potential false safety indicators avoided
- Indication for wear that does not affect safe operation
- Long-term value (initial cost, repair cost and frequency)

Refractometer Safety and System Updates

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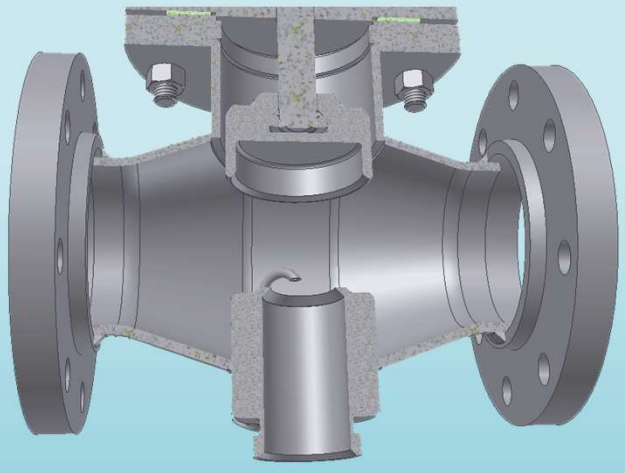
EMC's Refractometer Sensor and Isolation Valve Adapter



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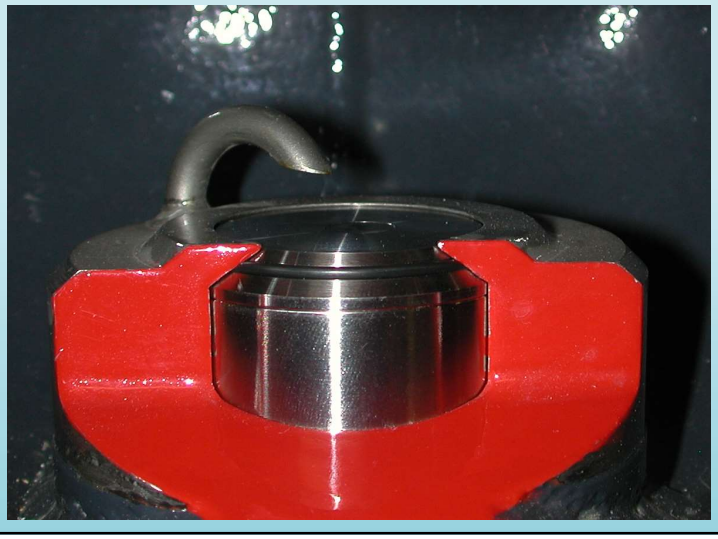
EMC's Refractometer Sensor and Isolation Valve Adapter



Refractometer Safety and System Updates

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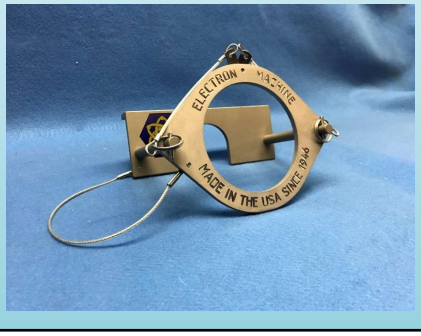
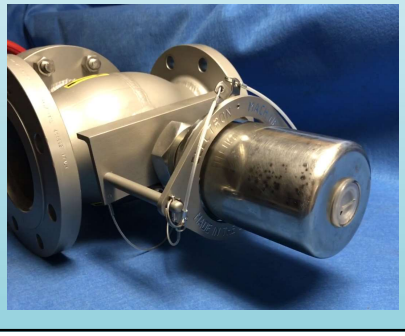
Isolation Valve Adapter
Safeguard Tool

- Safeguard Tool developed as additional measure of safety
- Tethers Refractometer Sensor to Isolation Valve Adapter
- Tested to over 1000lbs of force





Isolation Valve Adapter
Operation

- Video demonstration and current documentation on website
- Link to Isolation Valve Adapter Demonstration with Safeguard tool

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Refractometer Safety and System Updates

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Installation Considerations

- Upward or horizontal flow with sensing head parallel to ground
- Accessibility (3-4' above grade)
- Ergonomic location (access to handwheel and sensor)
- Distance from process disruptions (3X pipeline diameter)
- Location of steam (purge/drain solenoid close as practical)
- Check valve installed directly on purge nozzle fitting
- Maintenance plug easily accessible with O-ring installed
- Location of support equipment (water source, eye wash, shower, etc.)

Refractometer Safety and System Updates

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Safety and Training Considerations

- Only trained staff to perform related work on RBSS
- PPE appropriate for line break activity
- "Dry Run" with spare Isolation Valve Adapter (table-top)
- Training video and procedure available on-line, Subject Matter Expert training available on all facets of the MDS including the Adaptors
- EMC documentation available for Job Safety Analysis by installation site personnel
- All internal maintenance and repair by Electron Machine only
- 10 year recommended time in service before factory reconditioning

Safety and Training Considerations

- Complimentary initial on-site training for Isolation Valve Adapter with Safeguard Tool using pressurized water
- Complimentary on-site refractometer audits
- Complimentary “Subject Matter Expert” training program at EMC headquarters
- Training available on-site with demonstration equipment for all refractometer products
- On-line documentation available for current procedures and instructions

Refractometer Safety and System Updates

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Preventative Maintenance During Operation

Preferable to identify potential failures before they occur

- Monthly intervals
- Inspect for abnormal conditions (error/warning logs, voltages, leaks, etc)
- Special attention to LED voltage and trend
- Verification of steam purge system function and condition
- Hand wheel in proper position (fully open if in service)
- Maintenance plug accessible with O-ring installed
- Safeguard tool accessible and in good condition

Preventative Maintenance Major Outage

Preferable to preemptively replace wear items during outage

- Not to exceed 18 months and when pipeline is verified safe
- Recommended time in service of Isolation Valve Adapter 10 years
- Sensor inspection and calibration (or exchange)
- Check valve replacement
- Steam purge solenoid valve condition (or replacement)
- Verify torque specifications, proximity switch function, purge tube and sealing surface condition

Conclusion

- RBSS pose unique challenges for equipment and staff safety
- Design is essential in reducing safety risks and increasing MTBF
- Installation Considerations are *essential* for both Safety and normal Operation
- The development of Subject Matter Experts in the use of the Isolation Valve Adaptor, in addition to proper PPE, are recommended to reduce all risks associated with maintenance
- Preventive Maintenance must include:
  - MDS system and Sensing Heads
  - Check Valves
  - Steam Purge Solenoids and Valves
- The Isolation Valve Adaptor and Safeguard Tool is simple to use, over engineered for strength and integrity, and increases safety.

Questions?

C.A. Vossberg, President
Brad Osborne, Product Manager, Pulp/Paper
Electron Machine Corporation
www.electronmachine.com

K-PATENTS®
PROCESS INSTRUMENTS

REFRACTOMETER SAFETY

American Forest & Paper Association

Phil Wagner
Director of Technical Services
K-PATENTS, Inc.
Naperville, IL

1

K-PATENTS

K-PATENTS®
PROCESS INSTRUMENTS

- Pulp & Paper companies turn to K-PATENTS for robust, repeatable, and reliable inline % solids liquor measurements.
- K-PATENTS offers patented digital technology providing drift-free and low-maintenance solutions.

2

REFRACTOMETER SAFETY
Essential requirements

K-PATENTS® PROCESS INSTRUMENTS

- **Equipment**
- **Training**
- **Manufacturer's Instructions**
- **PPE**
- **Safety Procedures**

3

EQUIPMENT

K-PATENTS® PROCESS INSTRUMENTS

- ***Maintain*** in proper working operation
- Keep ***updated*** to latest manufacturer's recommendations
- Do not ***modify*** or use non-original equipment

4

TRAINING

K-PATENTS® PROCESS INSTRUMENTS

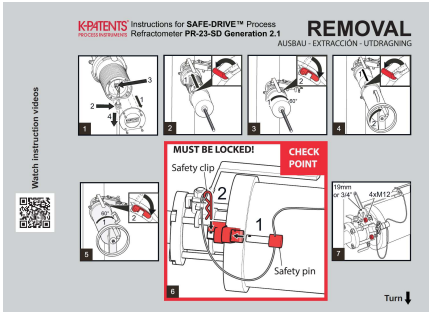
- Maintain a ***formal training program***
- Train personnel on ***periodic basis*** (e.g. annual basis)
- ***Practice*** on offline training equipment
- ***Certify and document*** personnel trained

5

MANUFACTURER'S INSTRUCTIONS

K-PATENTS® PROCESS INSTRUMENTS

- Follow manufacturer's ***instructions*** at all times
- Use the ***correct*** instructions for equipment in use
- Do not ***skip steps*** or take shortcuts



6

PPE

K-PATENTS® PROCESS INSTRUMENTS

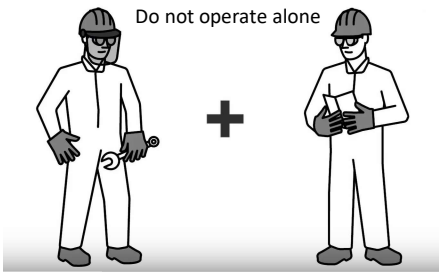
Wear proper PPE!
(Personal Protective Equipment)

7

SAFETY PROCEDURES

K-PATENTS® PROCESS INSTRUMENTS

- Follow mill safety ***procedures*** at all times
- Do not operate safety equipment ***alone***
- Form a safety ***team*** of user and supplier



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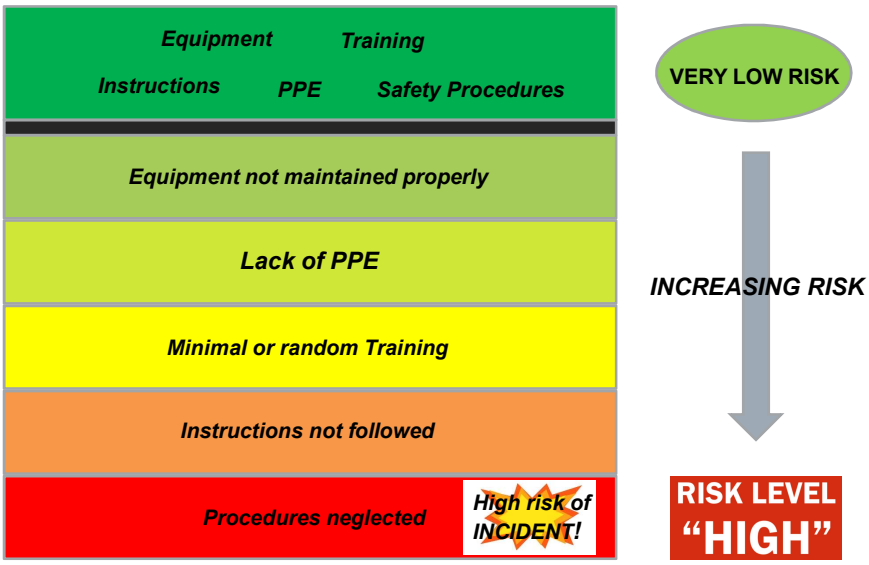
Safety Level Bar

K-PATENTS® PROCESS INSTRUMENTS



9

Other Considerations

K-PATENTS® PROCESS INSTRUMENTS

- Use reliable high-quality instrumentation of good design

  ➡ Lowers risk by minimizing need to pull sensors unexpectedly. *Service around planned outages*.

10

Other Considerations

K-PATENTS® PROCESS INSTRUMENTS

- Continuous safety layers added & innovation

Added safety features

11

Other Considerations

K-PATENTS® PROCESS INSTRUMENTS

- Equipment documentation – Readily available:
  - Internet access
  - Videos – Website and YouTube™

Start Video

INSERTION: https://youtu.be/AtEomBFhK1w
REMOVAL: https://youtu.be/ZaXQ6N5DSLE

http://www.kpatents.com/products/pulp_paper-industries/products-for-chemical-recovery/pr23sd_pulp

See Manual for full instructions

QR link to video

12

Recap: Keep Your Safety Bar Raised!

K-PATENTS® PROCESS INSTRUMENTS

Equipment *Training*

Instructions *PPE* *Safety Procedures*

13

K-PATENTS® PROCESS INSTRUMENTS

End of presentation.

Thank you!

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2018 AF & PA RECOVERY BOILER PROGRAM ANNUAL CONFERENCE

LIQUID SOLIDS CONTROL INC.

PROCESS MEASUREMENT ACCURACY KNOWN WORLDWIDE!

REFRACTOMETER SAFETY & SYSTEM UPDATES

PRESENTED BY: MICHAEL SWEENEY

SAFETY FIRST

Safe use of our products is of utmost importance to LSC.

Please follow all of your mill's standard safety procedures and Personal Protection Equipment requirements in addition to these instructions.

KISS Engineering Method

Keeps It Short & Simple.

- Our focus is to keep the use of our products as simple as possible and be able to be repaired by an average technician.
- This is a key reason why the LSC gate adaptor isolation valve has been so effective for the last 4 decades.
- No special tools are required and every technician has what is needed in their tool bag. (Adjustable wrench & 3/16" Allen Key)

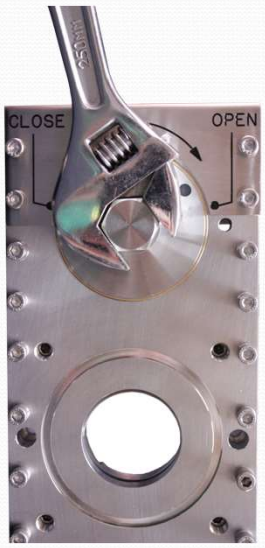
CLOSING THE GATE VALVE

The gate is normally in the "OPEN" position.

Simply place an adjustable wrench on the 1" hex nut and turn it half a turn to the "CLOSED" position shown by the black dot indicators.

At this point it is important to make sure the lock port hole is 100% clear. This can be done by putting the lock back through the hole.

As long as the lock port hole is open, the sensing head is now successfully isolated from the active line.



SENSING HEAD REMOVAL DEMONSTRATION

IMPROVED BAFFLE ASSEMBLY

All of LSC's equipment is built to the highest standards, using only the finest most durable materials available. Even so, parts can wear out in certain corrosive applications considering they can be used for decades.

Therefore we have a new removable baffle option for our pipe sections.
With this small & highly polished design we have eliminated pluggage problems associated with 80% BLS.

- Ensures process always flows and measurement is always accurate.

- The use of Duplex material provides for many years of success, but if and when the part needs to be replaced, you will not need to replace the entire pipe section. Simply unbolt the old worn out part and replace it with a new baffle.

OPTIONAL BAFFLE WASH DESIGN

If your process is thick and has tendency to build up,
you may want to consider adding a steam wash to your baffle.

- If you elect to go with this option, your baffle would have a small 1/8" wash port running down the center.
- Every time the refractometer is scheduled to perform a prism wash, the baffle wash can also be activated.
- This small amount of steam will keep everything clean and flowing.

HIGH TEMPERATURE LED LIGHT SOURCE

Our new LEDs are better designed to handle the higher temperatures associated with the modern recovery boilers used in today's pulp and paper industry.

- These new LEDS run at less than half the voltage during operating temperatures.
  down as low as 3 VDC + / -
- So far the expected lifespan has been 5 times longer than our previous version.
- These new LEDs have the same form, fit and function, so nothing changes inside your existing sensing head.
- Simply remove the old LED and install the new HT LED into existing components.

IMPROVED AUTOMATIC PRISM WASH VALVES

Our automatic prism wash is supplied with an ASCO Solenoid NEMA 4X, water-tight design which is required for the harsh applications our refractometers are often installed. As for chemical resistance, this series uses Teflon® impregnated surfaces for the aluminum actuators bodies and all other exposed metal is 300 Series stainless steel.

- More reliable double-acting actuator lasts longer by using 2 opposing spring modules one on each end of the actuator.
- Operates with as little as 50 PSI.
- Maintains the “fail safe spring to close” feature.
- New bracket design allows for easy bolt on installation.

Thank you for your time!

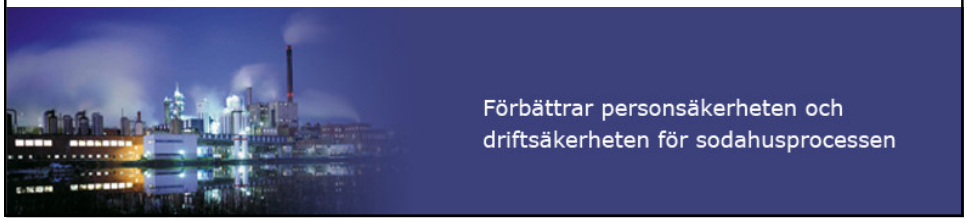
Find out more @ www.liquidsolidscontrol.com

Such as Brochures, RFQ forms and On-site / in-house repair services and manuals.

Sodahuskommittén

Report from the Swedish-Norwegian Recovery Boiler Committee

AF&PA Recovery Boiler Conference 2018
Kajsa Fougner, ÅF
Secretary of the Swedish-Norwegian Recovery Boiler Committee (SNRBC)



Sodahuskommittén

Topics

- Members and organization
- Recovery Boilers in Sweden and Norway
- Reported incidents
- Recommendations and standardization
- Certification of operators
- Experience sharing day
- Recovery Boiler meeting
- Prioritized projects

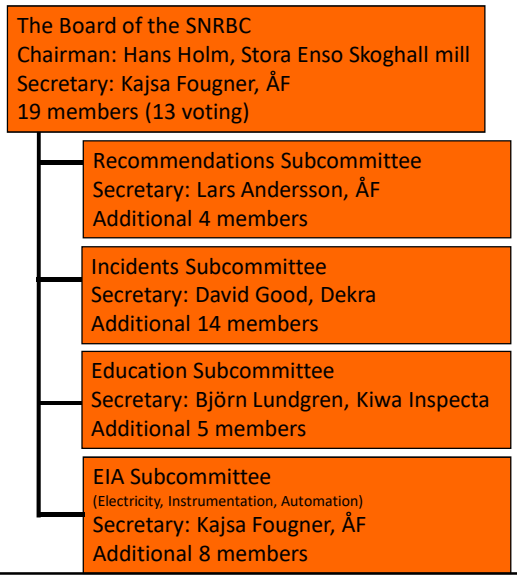
Sodahuskommittén

Members

- All mills producing kraft pulp and Domsjö in Sweden (22 mills), and Borregaard in Norway
- Recovery boiler manufacturers (Andritz and Valmet)
- 3rd party (Dekra, Force and Kiwa Inspecta)
- Swedish Paper Industry Workers' Union

Sodahuskommittén

Organization



Sodahuskommittén

Recovery Boilers in Sweden and Norway

Autumn 2016
- Increased capacity recovery boiler Södra Cell Värö

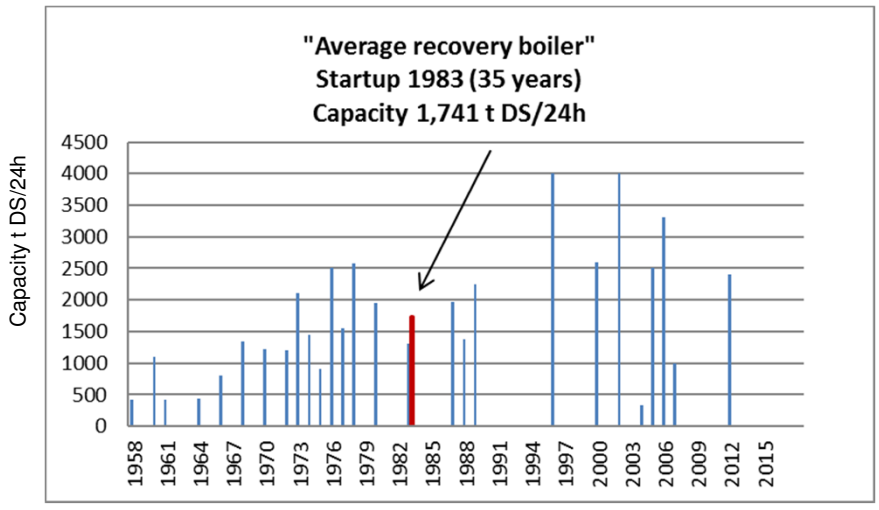
Autumn 2013
- The boiler in SCA Munksund was converted to single drum
- New evaporator line in BillerudKorsnäs Skärblacka

Summer 2013
- Closure of Södra Cell Tofte, Norway

Summer 2012
- Start up of a new boiler in Holmen Iggesund (the two old boilers were shut)

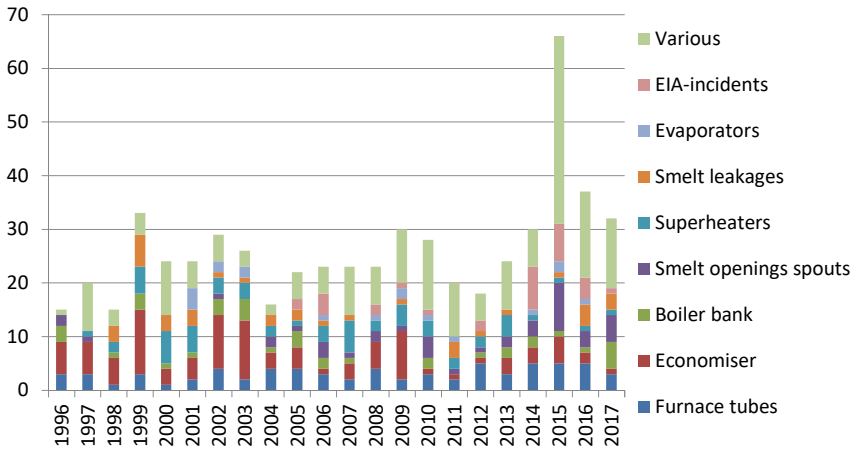
Sodahuskommittén

Recovery Boilers in Sweden and Norway



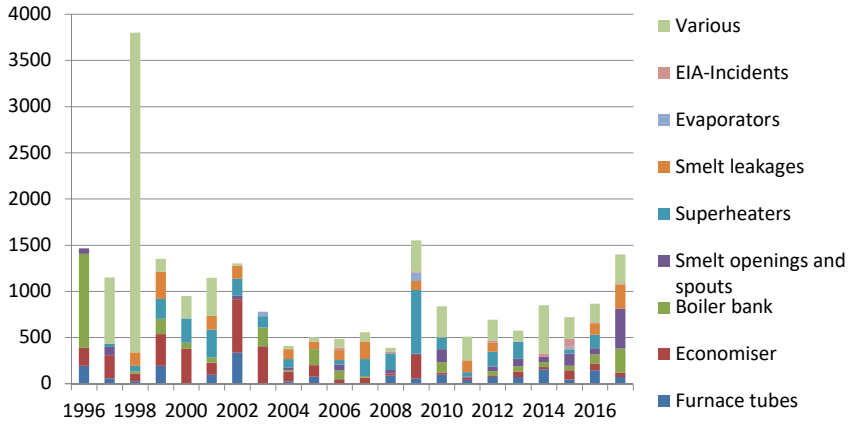
Sodahuskommittén

Reported incidents
- Amount of incidents



Sodahuskommittén

Reported incidents
- Down time [h]



Sodahuskommittén

Recommendations

The SNRBC has 40 recommendations, divided in areas like:

B: Construction and equipment
C: Operation and operational disturbances

B: Konstruktion och utrustning

Nr.	Titel	Utgåva	År
B1	Sodapannors konstruktion och utrustning	3	2013
B2	Säkerhet i sodahusbyggnader	1	2001

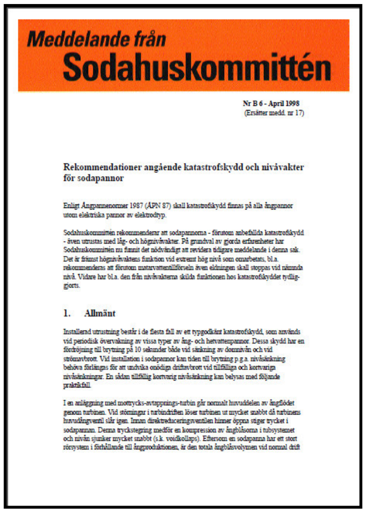
C: Drift och driftstörningar

Nr.	Titel	Utgåva	År
C1	Information om kritiska tillstånd och händelser i sodahuset.	2	2003
C2	Information om sodapannedrift samt förebyggande och åtgärdande av driftstörningar.	2	2001

Updating of the recommendations every third year

Sodahuskommittén

Recommendations



Meddelande från
Sodahuskommittén

Nr B 6 - April 1998
(Ersätter medd. nr 17)

Rekommendationer angående katastrofskydd och nivåvakter för sodapannor

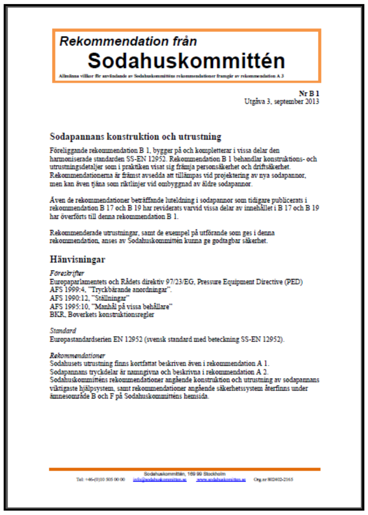
Enligt Ångpannenormer 1987 (ÅPN 87) skall katastrofskydd finnas på alla ångpannor utom elektriska pannor av elektrodtyp.

Sodahuskommittén rekommenderar att sodapannorna - förutom anbefallda katastrofskydd - även utrustas med låg- och högnivåvakter. På grundval av gjorda erfarenheter har Sodahuskommittén nu funnit det nödvändigt att revidera tidigare meddelande i denna sak. Det är främst högnivåvaktens funktion vid extremt hög nivå som omarbetats, bl.a. rekommenderas att förutom matarvattentillförseln även eldningen skall stoppas vid nämnda nivå. Vidare har bl.a. den från nivåvakterna skilda funktionen hos katastrofskyddet tydliggjorts.

1. Allmänt

Installerad utrustning består i de flesta fall av ett typgodkänt katastrofskydd, som används vid periodisk övervakning av vissa typer av ång- och hetvattenpannor. Dessa skydd har en fördröjning till brytning på 10 sekunder både vid sänkning av domnivån och vid strömavbrott. Vid installation i sodapannor kan tiden till brytning p.g.a. nivåsänkning behöva förlängas för att undvika onödiga driftavbrott vid tillfälliga och kortvariga nivåsänkningar. En sådan tillfällig kortvarig nivåsänkning kan belysas med följande praktikfall.

I en anläggning med mottrycks-avtappnings-turbin går normalt huvuddelen av ångflödet genom turbinen. Vid störningar i turbindriften löser turbinen ut mycket snabbt då turbinens huvudångventil slår igen. Innan direktreduceringsventilen hinner öppna stiger trycket i sodapannan. Denna tryckstegring medför en kompression av ångblåsorna i tubsystemet och nivån sjunker mycket snabbt (s.k. voidkollaps). Eftersom en sodapanna har ett stort rörsystem i förhållande till ångproduktionen, är den totala ångblåsvolymen vid normal drift



Rekommendation från
Sodahuskommittén

Allmänna villkor för användande av Sodahuskommitténs rekommendationer framgår av rekommendation A 3

Nr B 1
Utgåva 3, september 2013

Sodapannans konstruktion och utrustning

Föreliggande rekommendation B 1, bygger på och kompletterar i vissa delar den harmoniserade standarden SS-EN 12952. Rekommendation B 1 behandlar konstruktions- och utrustningsdetaljer som i praktiken visat sig främja personsäkerhet och driftsäkerhet. Rekommendationerna är främst avsedda att tillämpas vid projektering av nya sodapannor, men kan även tjäna som riktlinjer vid ombyggnad av äldre sodapannor.

Även de rekommendationer beträffande luteldning i sodapannor som tidigare publicerats i rekommendation B 17 och B 19 har reviderats varvid vissa delar av innehållet i B 17 och B 19 har överförts till denna rekommendation B 1.

Rekommenderade utrustningar, samt de exempel på utförande som ges i denna rekommendation, anses av Sodahuskommittén kunna ge godtagbar säkerhet.

Hänvisningar

Föreskrifter
Europaparlamentets och Rådets direktiv 97/23/EG, Pressure Equipment Directive (PED)
AFS 1999:4, "Tryckbärande anordningar".
AFS 1990:12, "Ställningar"
AFS 1995:10, "Manhål på vissa behållare"
BKR, Boverkets konstruktionsregler

Standard
Europastandardserien EN 12952 (svensk standard med beteckning SS-EN 12952).

Rekommendationer
Sodahusets utrustning finns kortfattat beskriven även i rekommendation A 1.
Sodapannans tryckdelar är namngivna och beskrivna i rekommendation A 2.
Sodahuskommitténs rekommendationer angående konstruktion och utrustning av sodapannans viktigaste hjälpsystem, samt rekommendationer angående säkerhetssystem återfinns under ämnesområde B och F på Sodahuskommitténs hemsida.

Sodahuskommittén, 169 99 Stockholm

Sodahuskommittén

Recommendations approved 2016/2017

B1 Recovery boiler construction and equipment
B9 Guidelines on equipment for soot blowing for recovery boilers
B15 Prevention of leakage of ion exchange mass to boiler water
B18 Recovery boiler safety system

C1 Safe burning in the recovery boiler, risk management and critical conditions
C4 Quality of feed water, condensate, feed water, boiler water and steam

D4 Repair and maintenance welding in recovery boilers

F3 Safe shutdown (new recommendation)

Sodahuskommittén

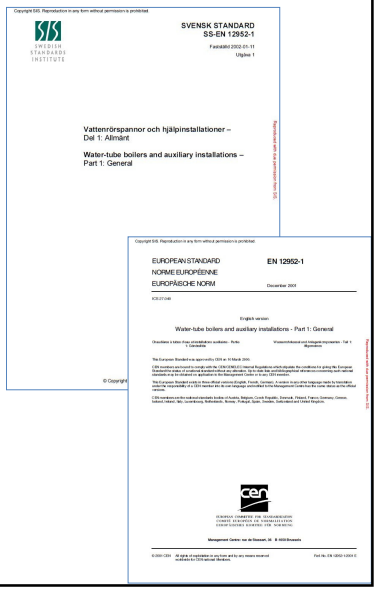
Standardization

- We are members in the Swedish Standardization, SIS

- We are represented in the Swedish Working Group TK285, Boilers

- We take part in the CEN Standardization work for the boiler standard: EN 12952, “Water tube boilers”.

- We inform our mills about news related to standardization


SVENSK STANDARD
SS-EN 12952-1

Vattenrörspannor och hjälpinstallationer –
Del 1: Allmänt

Water-tube boilers and auxiliary installations –
Part 1: General

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 12952-1

December 2001

English version:

Water-tube boilers and auxiliary installations - Part 1: General

Sodahuskommittén

Certification of recovery boiler operators

The education take place during three occasions, one week each.

The minimum accepted recovery boiler experience until examination and certification is 2 years.

All certificates need to be updated/renewed each 7th year.

The "re-examination test" is web-based and divided into three main parts:

- Recovery boiler design
- Combustion optimization
- Safety

Reconfiguration ongoing!
Adaption to new Swedish regulation concerning pressure vessels

Sodahuskommittén

Experience sharing day 2017

Operators and other persons from member companies meet and discuss important topics.

2017 the topic was

"How do we act during critical situations, how can safe actions be supported?"

- How does it look in our home mills

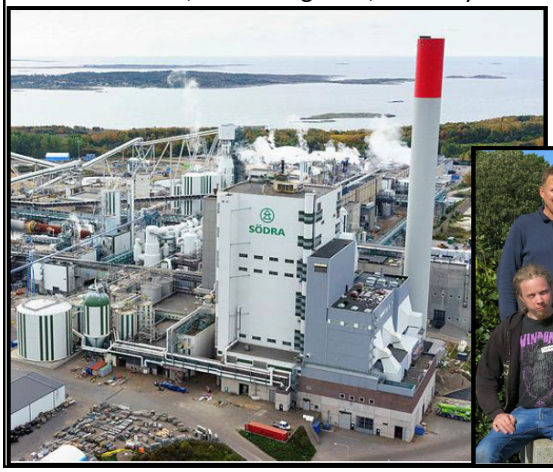
– Recent situations, routines, instructions

- Regulations, norms, recommendations
- Discussions

Sodahuskommittén

Recovery Boiler Meeting 2017

…was hosted by Södra Cell Värö. Participants went on tour in the upgraded mill and also in the UNESCO world heritage Grimeton radio station.
Presentations, dinner together, recovery boiler operator certificates!



Sodahuskommittén

Prioritized projects 2017/ 2018

PIA – Paper Industry Database
Summary of data in PIA, accidents, incidents, observed risks – focus on risks related to smelt spout openings

Risk Analysis Recovery Boiler (continuation) – SIL classification
Guidelines on risk analysis of recovery boiler incl

- required safety functions in a recovery boiler
- by SNRBC recommended SIL-level (Safety Integrity Level) for each safety function

SUOMEN SOODAKATTILAYHDISTYS
FINNISH RECOVERY BOILER COMMITTEE

Finnish Recovery Boiler Committee Report 2016-2017

Markus Nieminen

SUOMEN SOODAKATTILAYHDISTYS
FINNISH RECOVERY BOILER COMMITTEE

Content

1) Overview to FRBC
2) Overview to Finnish recovery boilers
3) Incident statistics 1997 - 2017
4) Activities

SUOMEN SOODAKATTILAYHDISTYS
FINNISH RECOVERY BOILER COMMITTEE

1) Overview to Finnish recovery boiler committee

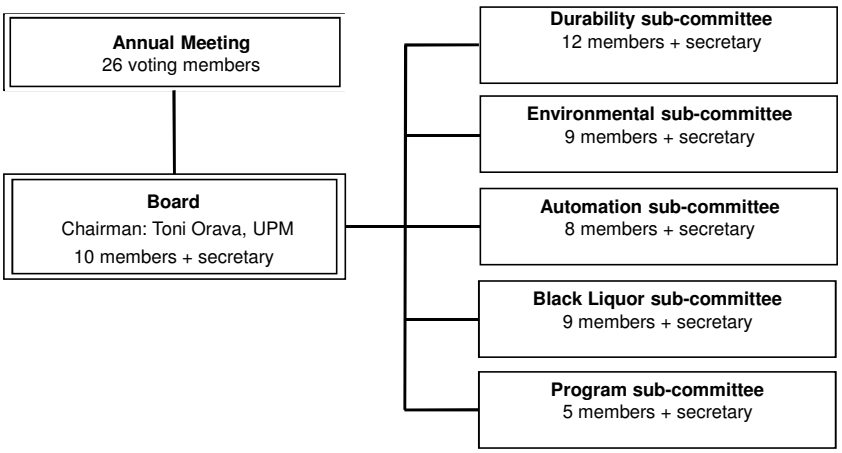
SUOMEN SOODAKATTILAYHDISTYS
FINNISH RECOVERY BOILER COMMITTEE

Introduction

- The Finnish Recovery Boiler Committee (FRBC) has promoted safe, economic and environmentally friendly operation of recovery boilers and closely related processes since 1964.
- The Committee
  - collects information about incidents involving recovery boilers and provides details of these to its members
  - publishes guidelines, recommends practices and arranges conferences and meetings
  - conducts and supports research projects related to safe operation and improved economy of recovery boilers

SUOMEN SOODAKATTILAYHDISTYS
FINNISH RECOVERY BOILER COMMITTEE

Organisation



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FINNISH RECOVERY BOILER COMMITTEE

Members

- The members of the Committee include pulp mills, recovery boiler manufacturers, a number of insurance engineering and inspection companies and research organisations in Finland.
- Total 30 members, including 15 pulp mills
  - 26 voting members, 4 universities
- There is a yearly member fee

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FINNISH RECOVERY BOILER COMMITTEE

2) Overview to Finnish recovery boilers

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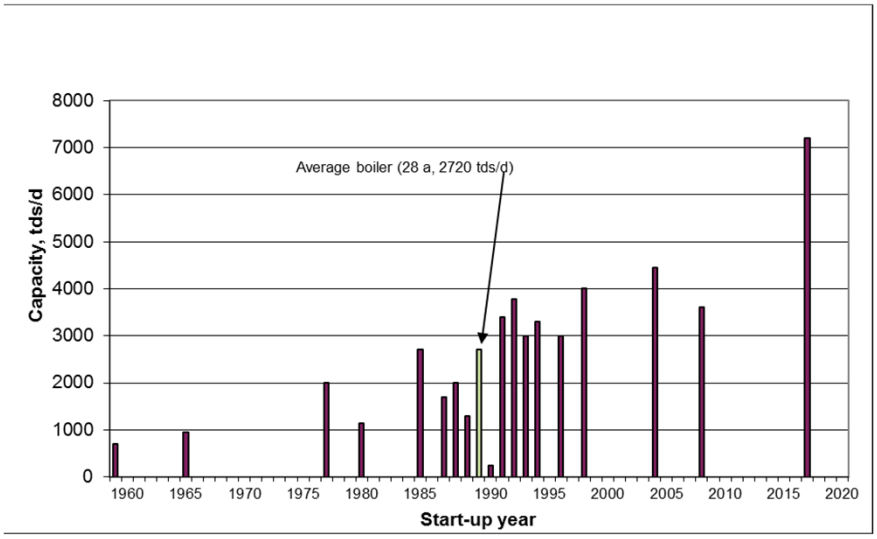
FINNISH RECOVERY BOILER COMMITTEE

Finnish recovery boilers



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Finnish recovery boilers

- No. of recovery boilers 17
  - Oldest started up in 1959, CE boiler (700 tDS/d) in Kotka Mills
  - Newest (2017) and biggest (7200 tDS/d, Valmet boiler) in Metsä Fibre Äänekoski mill
  - Smallest is in Stora Enso Heinola mill, Tampella boiler 250 tDS/d
- Number of mills 15
  - 2 mills operate more than one RB
- Average boiler age 28 yrs
- Average boiler capacity 2720 tDS/d
- Combined capacity 46 260 tDS/d

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FINNISH RECOVERY BOILER COMMITTEE

Finnish recovery boilers - updates

- LignoBoost lignin separation plant (50 000 t/a) has been in operation at Stora Enso's Sunila mill since 2015
  - Lignin is dried to >95% with lime kiln flue gases
  - Lignin is used as fuel in lime kiln but also sold out in big bags
- Construction of the new Äänekoski mill has been ongoing since summer 2015 (replaced the existing mill started up in 1985)
  - The mill started up in mid-August 2017 – on schedule and on budget
  - Demand for softwood pulp is increasing steadily, most strongly in Asia, particularly in China.
  - Largest investment in history of Finnish pulp&paper industry (investment value of EUR 1.2 billion, USD 1.45 billion)

SUOMEN SOODAKATTILAYHDISTYS
FINNISH RECOVERY BOILER COMMITTEE

The new Äänekoski pulp mill

- The annual pulp production 1.3 million tonnes (existing 0.5)
  - 800,000 tonnes softwood and 500,000 tonnes hardwood pulp
- Yearly wood consumption 6.5 million cubic metres (existing 2.4)
  - ~10% increase in the consumption of pulpwood in Finland
- No fossil fuels
  - Lime kiln burns product gas from bark gasifier
- Electricity production 1.8 TWh per year
  - 2.4 times more electricity than it is consumes
  - Increasing the share of renewable energy in Finland by more than 2 %
- Recovery boiler capacity 7 200 tDS/d (biggest in Finland)
  - Furnace floor area 323 m^2, furnace height 68 meters

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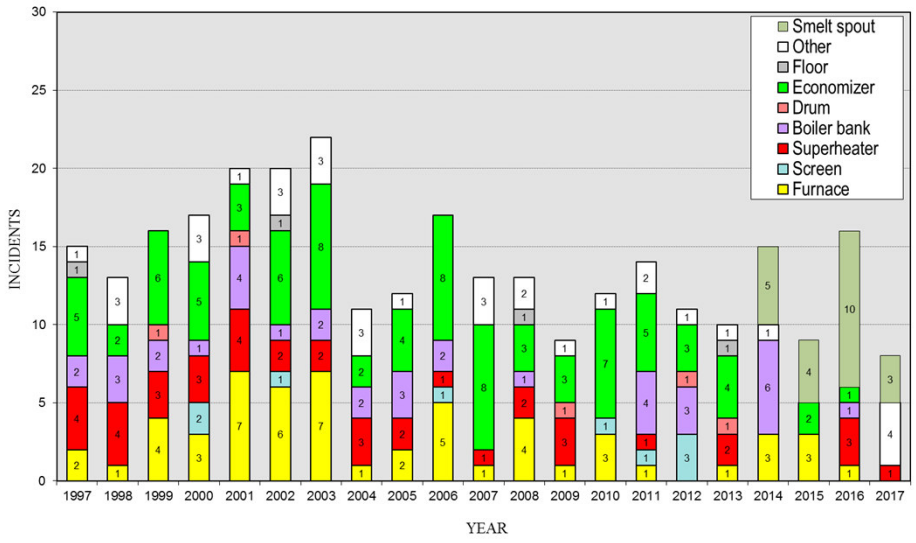
FINNISH RECOVERY BOILER COMMITTEE

3) Incidents statistics 1997 - 2017

SUOMEN SOODAKATTILAYHDISTYS
FINNISH RECOVERY BOILER COMMITTEE

INCIDENTS 1997-2017



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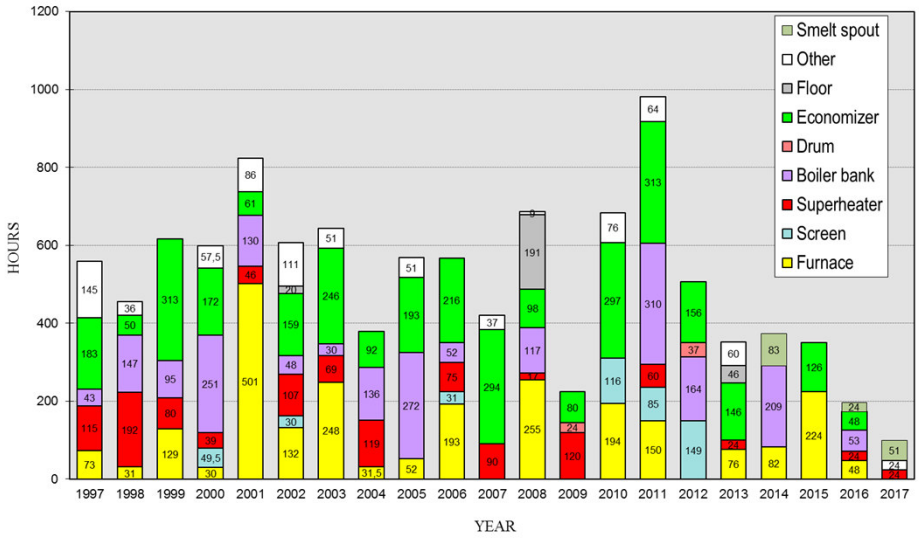
DOWNTIME IN FINLAND 1997-2017



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Venting/discharge piping related to recovery boiler

- One of venting pipes (this was connected to superheater collection chamber) ruptured during water pressure test at 85 bar
- Only 15 minutes before there was people at location
- These pipes are not included to normal inspection, but sometimes it could be good to check the condition

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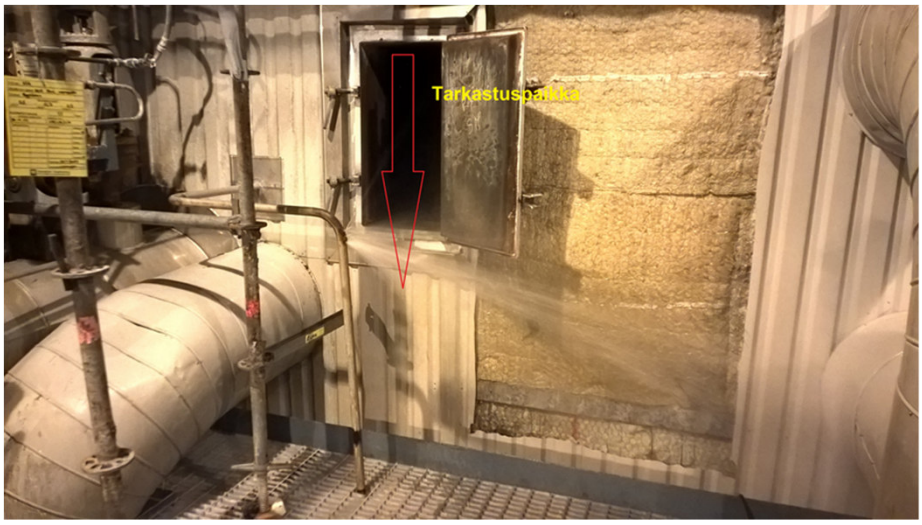

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FINNISH RECOVERY BOILER COMMITTEE

4) Activities

SUOMEN SOODAKATTILAYHDISTYS
FINNISH RECOVERY BOILER COMMITTEE

Recent Activities

- FRBC history book project
  - Completed summer 2017 (after three years of work)
  - Was started in 2014 to celebrate Committees 50 years jubilee
  - Based on archive material but also interviews of people who have had close involvement with Committee
- Operators day -seminar was arranged second time in spring 2017
- Projects:
  - Review of recovery boiler leak detection systems
  - Smelt spout study / recommendation
  - Study on overlay welded tubes
  - Study on NCG formation, safe collection and efficient destruction

SUOMEN SOODAKATTILAYHDISTYS
FINNISH RECOVERY BOILER COMMITTEE

Projects

- Review of recovery boiler leak detection systems
  - Aim is to collected experiences from different leak detection systems used in recovery boilers. New technologies (if any) are also reviewed
  - Every mill in Finland has system based on the feedwater/steam difference (accuracy varies from ~1 kg/s to 9 kg/s)
  - 1/3 of the Finnish mills has chemical balance calculation using phosphate as a tracer. This kind of system enables higher accuracy and identification of critical leaks and separation from non-critical leaks.
  - Acoustic emission based systems are not used anymore
  - ➢ The best solution would be to use all three systems together

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FINNISH RECOVERY BOILER COMMITTEE

Projects

- Smelt spout study / recommendation
  - In recent years several incidents related to smelt spouts have been reported to FRBC database
    - one of main challengies when pursuing longer running times between annual shutdowns (over 12 months)
  - Process data related to smelts spouts has been collected
  - Recommendation work is still ongoing
    - There is no simple solution since every mill has different problems
    - Study on smelt properties in under consideration

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FINNISH RECOVERY BOILER COMMITTEE

Projects

- Study on overlay welded tubes
  - The objective is to perform thermal and mechanical analyses on tubes made by weld overlay process
  - This type of tubes are typically used in waste incineration plants. Also, recovery boilers in South / North America, but not in Finland.
- Mill audit study on NCG formation, safe collection and efficient destruction
  - Incidents have happened mostly in NCG collection/transfer systems, not in the incineration i.e. recovery boiler
  - FRBC recommendation covers only inceneration, not the collection or transfer
  - Aim is to expand the recommendation to cover also these parts

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FINNISH RECOVERY BOILER COMMITTEE

NCG study - remarks

- Chip silo and the use of flash steam
- Deposit accumulation to the NCG ducts
- DNCG dilution air and more closed collection systems
- Condensate draining systems: size, amount and location of drains and slope of piping should be paid attention to
- Concentration measurements and a hazard and operability study (HAZOP) shall always be made when NCG system is modified.
  - Together with the supplier of the NCG system
- Better communication between departments for example information about disturbacies (fibreline -> recovery)

SUOMEN SOODAKATTILAYHDISTYS
FINNISH RECOVERY BOILER COMMITTEE

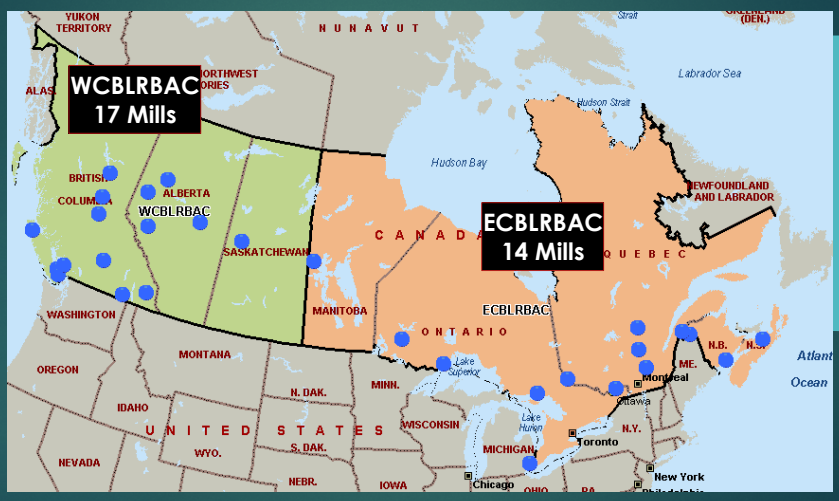
Finnish Recovery Boiler Committee Report 2016-2017

Thank you

Eastern and Western Canada BLRBAC Report to AF&PA

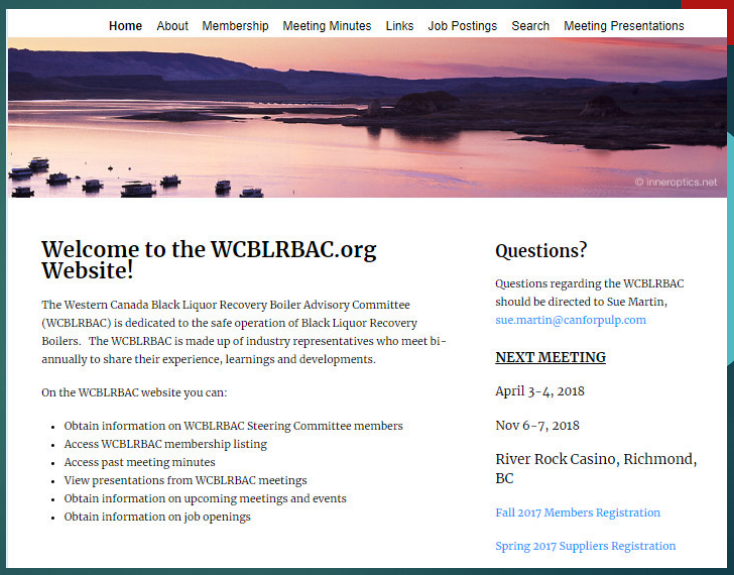
Feb 2018
Pat Terfloth

Eastern and Western Canada BLRBAC



WCBLRBAC

- Founded in 1965, in 53rd year!
- Spring and Fall Meeting held in 2017
- 2018 meetings Apr 3-4 and Nov 6-7
- Two-day meeting format
- Website is www.wcblrbac.org



WCBLRBAC MEMBERSHIP AND CONTACT INFORMATION*

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Aleksandar Stefanov	Babcock & Wilcox		Edmonton, AB	780-489-0404	587-334-7786		astefanov@babcock.com

*Available on website

PRESENTATIONS* TO WCBLRBAC

Fall 2017

American Forest & Paper Association Recovery Boiler Program - Wayne Grilliot

ESP Power and Its Relation to ESP Rebuilds - B&W

Operator Training Simulators for Recovery Boilers - Automan Controls

Ion Exchange Resin Testing - How Do I Understand What Has Been Reported? - Purolite

Fall 2016

High Purity Oil Maintenance for Steam Turbines

Start-up & Shutdown Boiler Oxygen Protection to Prevent SAC

Spring 2016

Building Confidence Through Knowledge Transfer

Improving Safety of Burner Management Systems

Key Considerations in Pulp Mill Cogeneration Integration

Precipitator Dust Purification

Fall 2015

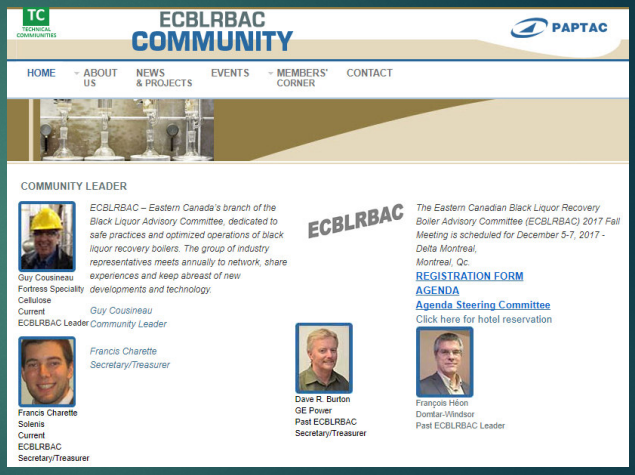
Inspection of Boiler Tubes and Boiler Tube Welds

Boiler Tube Scale Deposit Measurement

*Presentations available for viewing and download from the website

ECBLRBAC

- ECBLRBAC combines the PAPTAC Steam and Steam Power Committee and the former ECBLRBAC into a single group hosted by PAPTAC since 2013
- Annual meetings, 2-day open meeting format with a third day for a local mill tour
- 2017 meeting held Dec 5-7
- Combination of incident reviews, operating, safety, environmental discussions and technical presentations
- Website is www.paptac.ca/ecblrbac/



WC/ECBLRBAC ESP Incident Reports

Mill	Incident Description
Alberta-Pacific Industries, Athabasca, AB	Generator bank tube rupture due to fireside plugging of generator bank and tube overheating. Found heavy tube deposits on cold (back-side) of tube. Seven tubes in total affected and will require replacement.
Hinton Pulp, Hinton, AB	Economizer tube leak due to weld defect in a previously plugged tube. Four additional superheater leaks were discovered during hydrostatic testing. All superheater leaks were on welds of finger bars.
Daishowa-Marubeni, Peace River, AB	Preliminary discussion only, incident under investigation and will be reported at spring 2018 Atlanta and WCBLRBAC meetings. Sootblower lance pierced floor tubes.
Resolute St. Felician, St. Felician, QC	Hole in seal box, 11 tubes affected
Fortress Specialty Cellulose, Thurso, QC	Diluted NCG detonation in ducting
Fortress Specialty Cellulose, Thurso, QC	Hand hole cap leak in economizer

Comparison of Recovery Boilers USA vs Canada

	USA	CANADA
TOTAL NUMBER	149	41
AVERAGE AGE, YEARS	38.8	38.7
OLDEST, YEARS	65	70