SUOMEN SOODAKATTILAYHDISTYS
FINNISH RECOVERY BOILER COMMITTEE

Suomen Soodakattilayhdistys ry

Soodakattilapäivä 2013

Sokos Hotel Vantaa

31.10.2013

Raportti 5/2013

(16A0913-E0144)

Raportti 5/2013, Soodakattilapäivä 2013

SOODAKATTILAPÄIVÄ 2013

Sokos Hotel Vantaa, 31.10.2013

OHJELMA

klo	
09.30 - 09.55	**Ilmoittautuminen ja aamukahvi**
09.55 – 10.00	**Avaus** ***Timo-Pekka Veijonen, Suomen Soodakattilayhdistyksen puheenjohtaja***
10.00 - 10.30	**Sähkösuodintuhkan hyötykäyttömahdollisuudet** ***Kurt Sirén, Oy Sirra Ab***
10.30 - 11.00	**Online recovery boiler reduction degree** ***Risto Ikäheimo, Metso Automation***
11.00 - 11.45	**Kahvitauko**
11.45 - 12.15	**Soodakattilan hyötysuhde** ***Lauri Reiman, Oy Indmeas Ab***
12.15 - 12.45	**Latest advancement in recovery boiler intelligent sootblowing technology for improved safety, energy efficiency, and cost reduction** ***Danny Tandra, Clyde Bergemann***
12.45 - 13.45	**Lounas**
13.45 – 14.15	**Uudet vesikemian ohjearvot ja käytäntö** ***Jani Vuorinen, Vesi-ihminen Tmi***
14.15 – 14.45	**Lignin recovery - Andritz's evaluations and development work** ***Paterson McKeough, Andritz Oy***
14.45 – 15.15	**Kahvitauko**
15.15 – 15.45	**Suomen, Pohjois-Amerikan ja Brasilian soodakattilayhdistyksien kuulumiset** ***Markus Nieminen, Soodakattilayhdistys***
15.45 - 16.10	**Sodahuskommittén − Ruotsalais-norjalainen soodakattilakomitea, vuosikatsaus 2012** ***Peter Andersson, Sodahuskommitén***
16.10	**Soodakattilayhdistyksen opinnäytetyöpalkinnon jako**
16.10 – 16.40	**Soodakattilayhdistyksen opinnäytetyöpalkinnon esittely** **Multi-Objective Optimization of Recovery Boiler Dimensions Using Computational Fluid Dynamics** ***Viljami Maakala, Aalto-yliopisto / Andritz Oy***
16.50 – 18.00	**Cocktailtilaisuus**
19.00 –	**Päivällinen, Mestarikabinetti**

SÄHKÖSUODINTUHKAN HYÖTYKÄYTTÖMAHDOLLISUUDET

Kurt Sirén
Oy Sirra Ab

Soodakattilan sähkösuodintuhkan hyötykäyttömahdollisuudet
Osahanke V
Ympäristötyöryhmä

Sähkökemiallinen käsittely

Kurt Sirén
Oy Sirra Ab

Soodakattilapäivä 31.10.2013
Sokos Hotel, Vantaa

Sirra

Sellutehtaan suolapäästöt vesistöihin

- Soodakattilan lentotuhka
- Klooridioksidilaitoksen hapan suola
  - suurempi ympäristövaikutus

Haettu ratkaisuja suolapäästöjen vähentämiseen

Sähkökemiallisen käsittelymenetelmän käyttökelpoisuuden arviointi

Sirra

Sähkökemiallinen käsittely

Elektrolyysi tai dialyysi ionivaihtomembraaneja käyttäen

Membraanien tarkoitus pitää tuotteet erillään, H_2SO_4, NaOH

Edistyksellisin versio bipolaarimembraanielektrodialyysi (BME)

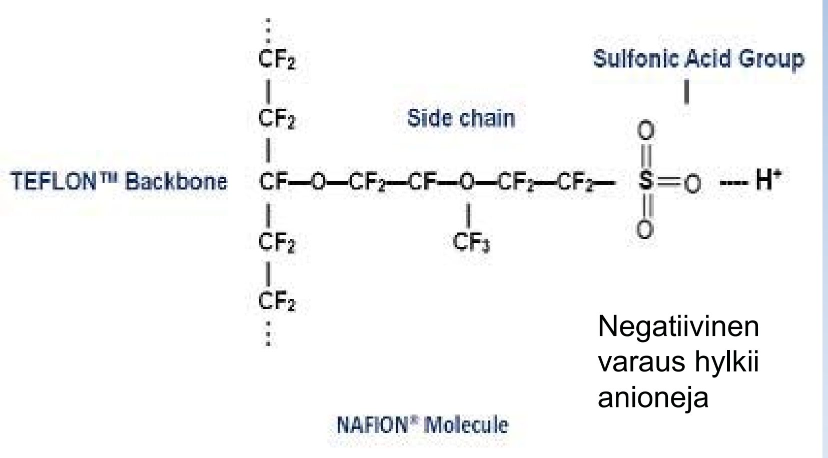
BME -tekniikka tutkittu paljon → uutta?

Tässä hankkeessa tarkasteltu taseen kautta kokonaisvaltaisesti

Membraanit

Kationivaihtomembraanit

Teflonia tai styreeni-divinyylibentseeniä ym.
Varaukselliset ryhmät sulfonaatti- tai/ja karboksyyliryhmiä

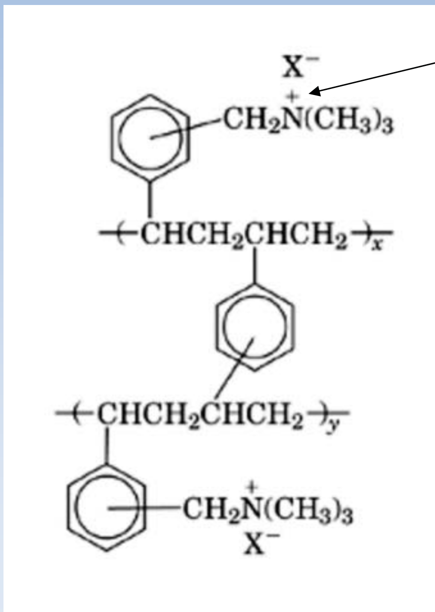


Negatiivinen varaus hylkii anioneja

Kationi liikkuu sulfonaattiryhmästä toiseen membraanin läpi sähkökentän vaikutuksesta. Membraani hylkii anioneja.

Anionivaihtomembraanit

Varaukset kvaternäärisiä ammoniumryhmiä



Anioni liikkuu N^+-varauksesta toiseen

Styreenidivinyyli-bentseeniä

Positiivinen varaus hylkii H^+, Na^+ K^+

Membraanien rajallisuudet

Anionimembraanit: H^+ liikkuva, vaikea estää

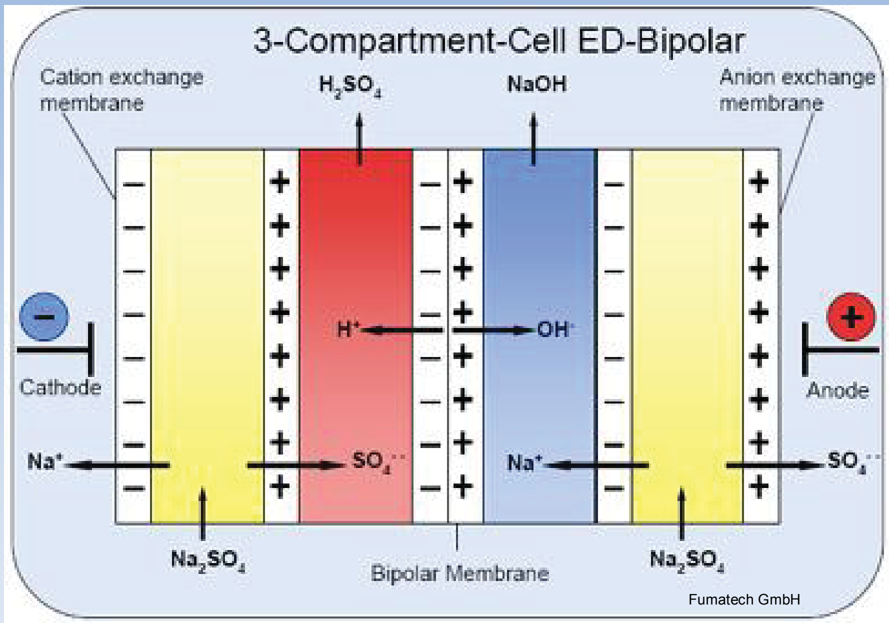
Vuodot alentavat sähkön hyötysuhdetta

H_2SO_4 8 – 10 %

NaOH suurempi väkevyys, vuodot pienempiä

Kationimembraanit herkkiä 2+ ja 3+-kationeille
- saostuvat membraanin sisään alkaliselle puolelle
- rajoittaa membraanin elinikää
- poistettava erittäin hyvin (ionivaihto ym.)

BME, bipolar membrane electrodialysis



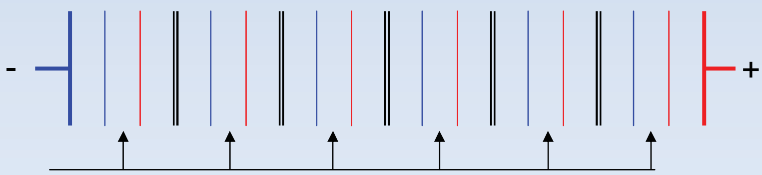
Veden dissosiaatio → sähkökenttä vie OH^- ja H^+ eri puolille, membraanit estävät uudestaan yhtymisen. Vastaioni liikkuu vapaasti toisen membraanin läpi sisään.

BME-tekniikan edut:

Matala jännite, 2,1 – 2,4 V → pieni sähkönkulutus
- vrt. suora elektrolyysi 5,5 – 6 V

Ei hapetus- tai pelkistysreaktioita → ei synny vetyä, happea tai klooria (vain vähän elektrodeilla)

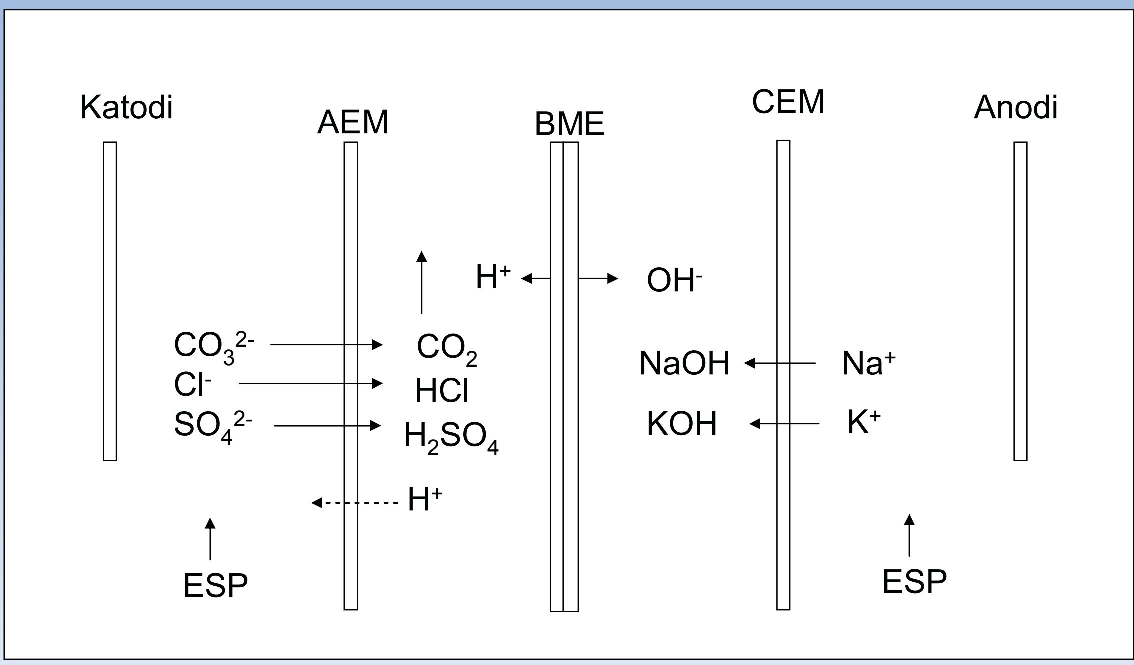
Voidaan liittää soluja peräkkäin → vain yksi katodi ja yksi anodi



Tekniikka sovellettuna suodintuhkalle

- Aikaisemmat tutkimukset käyttäneet puhdasta Na_2SO_4
  - pääkohde ollut klooridioksidilaitoksen jätesuola
- Lentotuhka sisältää myös muita ioneja – mitä tapahtuu niille?

Reaktiot todellisella lentotuhkalla



BME:ssä ei kloorikaasua, vain elektrodeilla hieman happea ja vetyä
Syöttöosastot pidettävä neutraaleina tai alkalisina (pH:n säätö)

Muiden ionien vaikutukset:

CO_3^{2-}: syö tuotettua happoa, mutta hyödyksi H^+-vuodon neutraloinnissa

Cl^-: happo valkaisun kautta ulos → saadaan kloorin poisto

K^+: KOH-pitoinen alkali valkaisuun → saadaan kaliumin poisto

Vahva asia: lipeä ei sisällä karbonaattia!

Vrt: hapetettu valkolipeä voi aiheuttaa likaantumista alkalisissa valkaisuvaiheissa karbonaatin takia

Sirra

ClO_2-jätesuolan käyttö BME-prosessin lähtöaineena

- Jätesuola helpompi lähtömateriaali, vähemmän epäpuhtauksia (Ca^{2+} ym.)
- Jo ennestään happoa → pienempi sähkönkulutus
- Saadaan ympäristöhyöty muttei tasehyötyä talteenotossa (S,K,Cl)
- Parempi vaihtoehto: suolojen yhdistämiinen

Sirra

Taselaskelmat

• Laskettiin BME-prosessin vaikutuksia keskiarvotehtaaseen
- 750 000 ADt/vuosi

• Laskettu:
- ympäristö: suolapäästöt
- talteenotto: S-tase, K & Cl
- taloudellisuus (käyttö)

• Myös yhdistetty muiden prosessien kanssa
- R8 → R10 päivitys
- GLSS (Green Liquor Simplified Stripping)
- lentotuhkan uutto ja kiteytys

Tärkeää: Na, K, S ja Cl tarkasteltava yhtaikaa!

Tässä vain poimintoja taselaskelmista

Vaihtoehto: pelkkä lentotuhka

Korvataan lentotuhkan liuotus membraani-prosessilla, tuotetaan rikkihappoa ja alkalia = NaOH + KOH

- happo on liian laimeata käytettäväksi suoraan MÖ-keitossa, 8-10%
- voidaan sekoittaa ostohapon kanssa tai konsentroida
- parempi käyttää valkaisussa → Cl ulos
- alkali: NaOH + KOH käyttöön valkaisussa → K ulos

Korvataan lentotuhkan liuotus

Vaikutukset

Ympäristö: Lentotuhkan liuotus voidaan lopettaa

	Na	S
Päästöt: kg/ADt	-2,68	-1,65
%	-28	-21

Talteenotto: K ja Cl ulos, tase ei muutu

Lipeä- ja happosäästöä	1,920 k€
Sähkön kulutus	-456 ”
Membraanikulut	-936 ”
Käyttökulut (15 %)	-375 ”
Tuotto	153 k€

Suurin kustannus membraanit (laskuperusteena 1 vuosi)

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Vaihtoehto: suodintuhka ja hapan suola yhdessä

Ympäristö:

	Na	S
Päästöt: kg/ADt	-9,517	-8,007
%	-100	-100

Talteenotto: lentotuhkaliuotus voidaan lopettaa

Lipeä- ja happosäästöä	7351 k€
Sähkön kulutus	-1530 ”
Membraanikulut	-3145 ”
Käyttökulut (15 %)	-675 ”
Tuotto	2001 k€

Suolojen liuotus pois kokonaan

Riskitekijä: membraanin kesto 1 vuosi?

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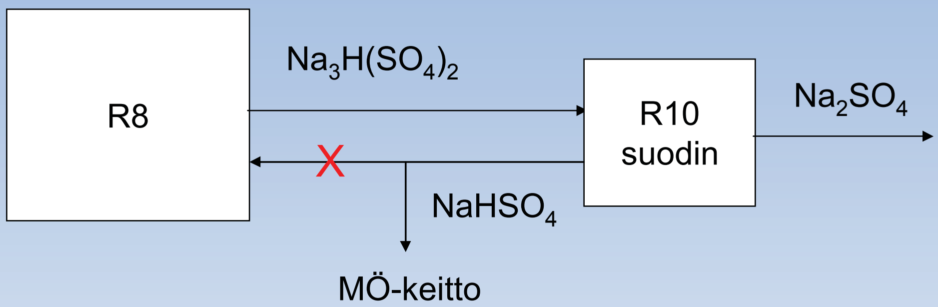
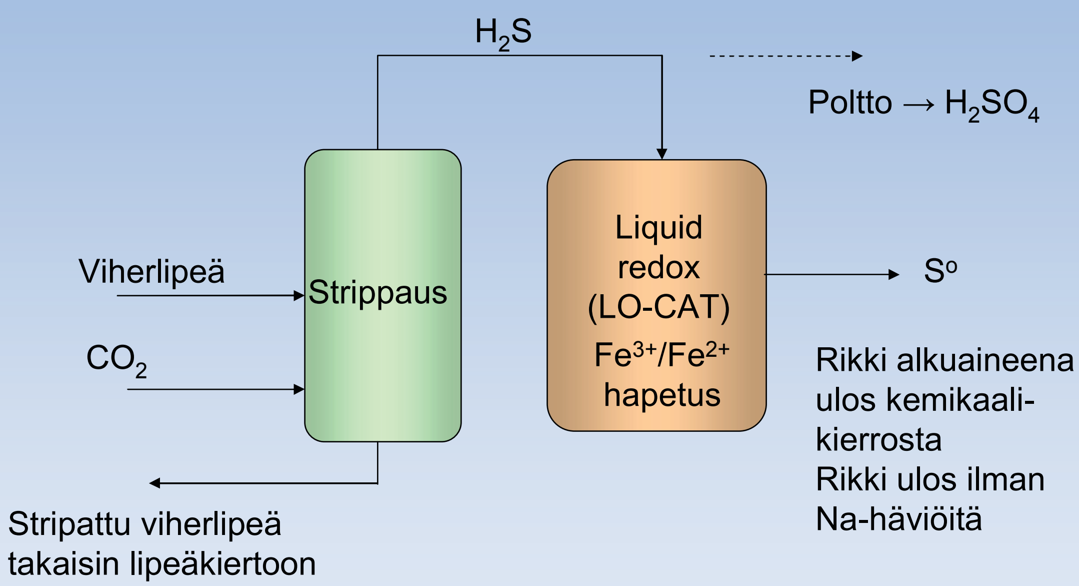
Yhdistäminen muiden keinojen kanssa



- R8-suolan käyttö sellaisenaan MÖ-keitossa mahdollista vain osittain
- R10 –suodin parantaa happamuuden hyötykäyttöä
- $NaHSO_4$ tuo talteenottoon vähemmän rikkiä happoa kohden kuin $Na_3H(SO_4)_2$ mutta enemmän kuin H_2SO_4
- Rikkitase: lentotuhkan liuottamisen lisääminen huono vaihtoehto

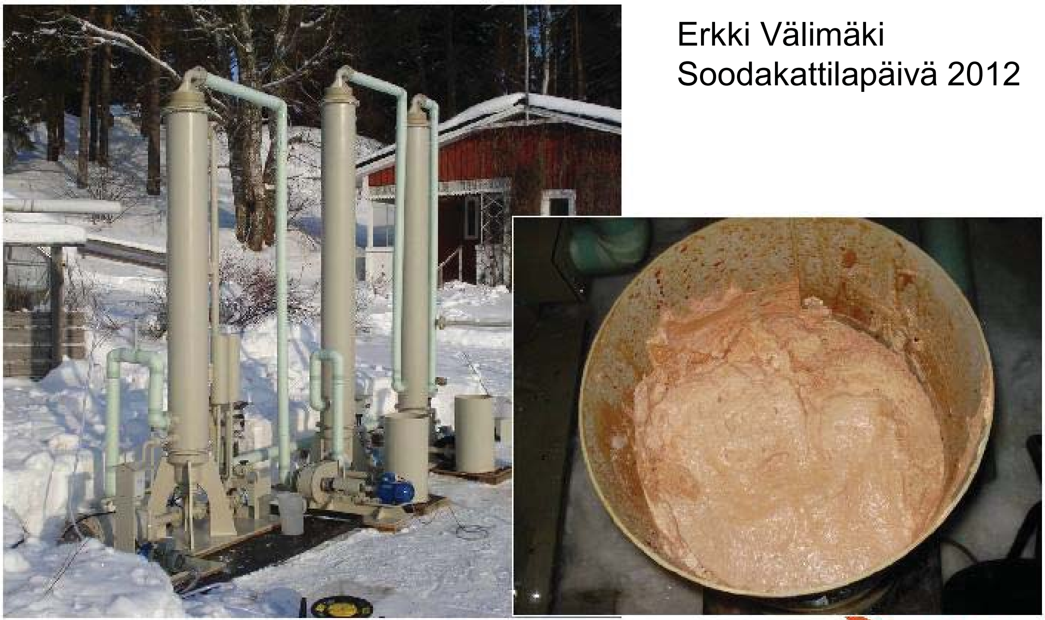
Rikkitaseen hoito: GLSS (Green Liquor Simplified Stripping):



KCL:n rikkiprojektissa kehitetty
Metson kanssa jatkettu pilot-asteelle

Strippaus ja rikinpoisto

Erkki Välimäki
Soodakattilapäivä 2012



17 | © Metso

Sirra metso

Alkuainerikin muodostus tapahtuu helposti, ei herkkä pitoisuusvaihteluille

Eri tekniikoita yhdistämällä:

- Rikkitase hoidetaan GLSS:llä
- Hapan suola sisään talteenottoon:

  - hapan $NaHSO_4$ MÖ-keittoon R10-suotimen kautta
  - neutraali Na_2SO_4 talteenottoon

- K ja Cl -poisto BME-tekniikalla valkaisun kautta tai vaihtoehtoisesti perinteisellä K & Cl -poistoprosessilla

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Vaihtoehto BME + R10 + GLSS

			Na	S
Ympäristö:	Päästöt:	kg/ADt	-9,517	-8,007
		%	-100	-100

Talteenotto: lentotuhkaliuotus lopetettu

Lipeä- ja happosäästöä	5664 k€
Sähkön kulutus	-458 ”
Membraanikulut	-942 ”
Käyttökulut (15 %)	-1008 ”
Tuotto	3256 k€

Suolojen liuotus pois kokonaan
Riskit pienemmät kuin pelkällä BME-prosessilla
Lipeä tehdään kaustisoinnilla, vain osa sähköllä

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Vaihtoehto AshLeach + R10 + GLSS

			Na	S
Ympäristö:	Päästöt:	kg/ADt	-8,314	-7,258
		%	-87	-91

Talteenotto: lentotuhkaliuotus lopetettu, K & Cl-prosessin jätevirta jää → ei nollapäästöjä

Lipeä- ja happosäästöä	3894 k€
Sähkön kulutus (BME)	0 ”
Membraanikulut	0 ”
Käyttökulut (15 %)	-885 ”
Tuotto	3009 k€

Kiteytysprosesseilla samankaltaiset tuotot
Ei membraanien rikkoontumisriskiä

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Johtopäätöksiä

- K & Cl-poisto myös mahdollinen BME-tekniikalla
- Suurin avoin kysymys: membraanien elinikä → kustannus
- Edullisimmat vaihtoehdot näyttävät olevan yhdistelmät R10 + GLSS + BME ja R10 + GLSS + perinteinen K & Cl -prosessi
- On mahdollista lopettaa lentotuhkan ja happaman suolan liuottaminen kokonaan
- BME-lipeä karbonaattivapaa → voidaan välttää kerrostumia valkaisimossa
- Nykyisillä kemikaalihinnoilla taloudellisuus näyttää hyväksyttävältä, mutta 1 v. takaisinmaksuaikavaatimuksesta luovuttava

ONLINE RECOVERY BOILER REDUCTION DEGREE

Risto Ikäheimo
Metso Automation

Metso Recovery Analyzer
Metso Metra

Risto Ikäheimo

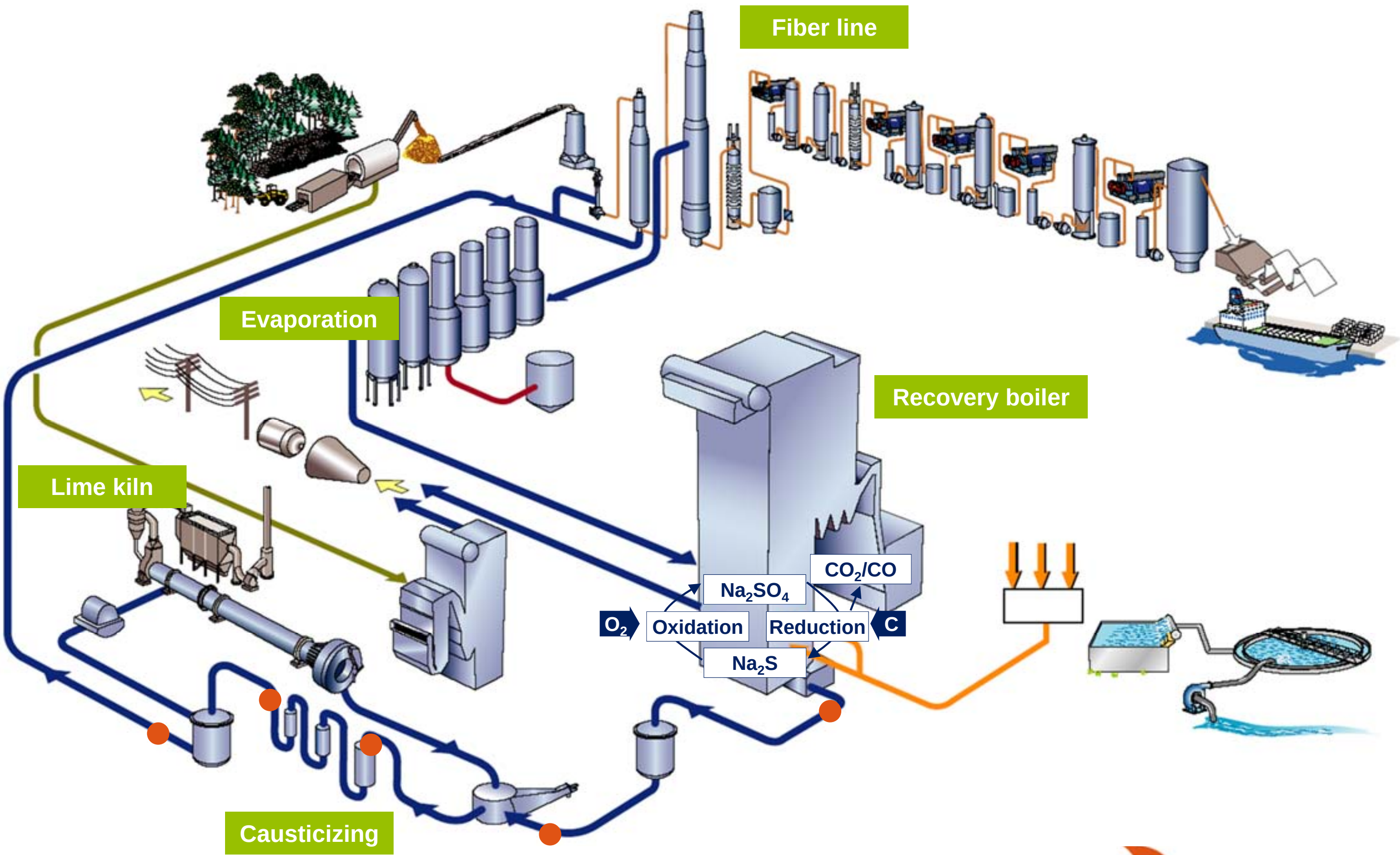
Product manager

Antti Kokkonen

Diploma thesis worker

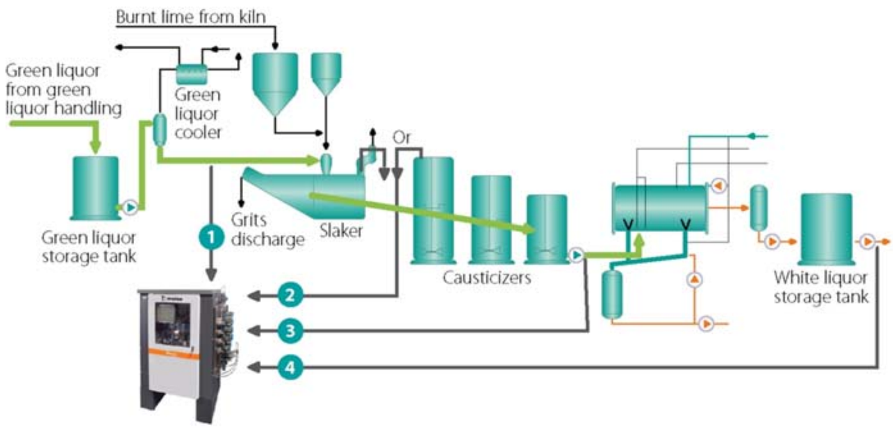
Kraft pulp mill process

● Metso Metra measurement location



Metso Recovery Analyzer

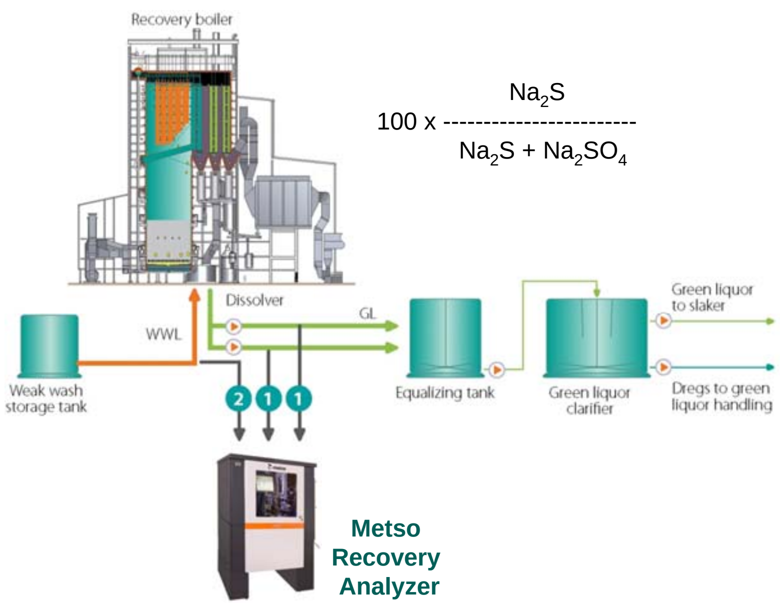
Causticizing applications



1. Green liquor - TTA measurement and trim control and feed forward measurement for CE control
2. Lime milk at first causticizer – or top of the slaker - Fast feedback of Causticizing Degree CE%
3. Lime milk after last causticizer - Long feedback of Causticizing Degree CE%
4. White liquor for cooking - CE% and EA

Recovery boiler measurement applications

Green liquor clarifier



$$100 \times \frac{Na_2S}{Na_2S + Na_2SO_4}$$

TTA control after dissolver (1&2)

- Stabilize TTA level
- Enable TTA level increase without scaling
- Less water in recovery loop → energy savings, stronger white liquor

Reduction degree measurement after dissolver (1)

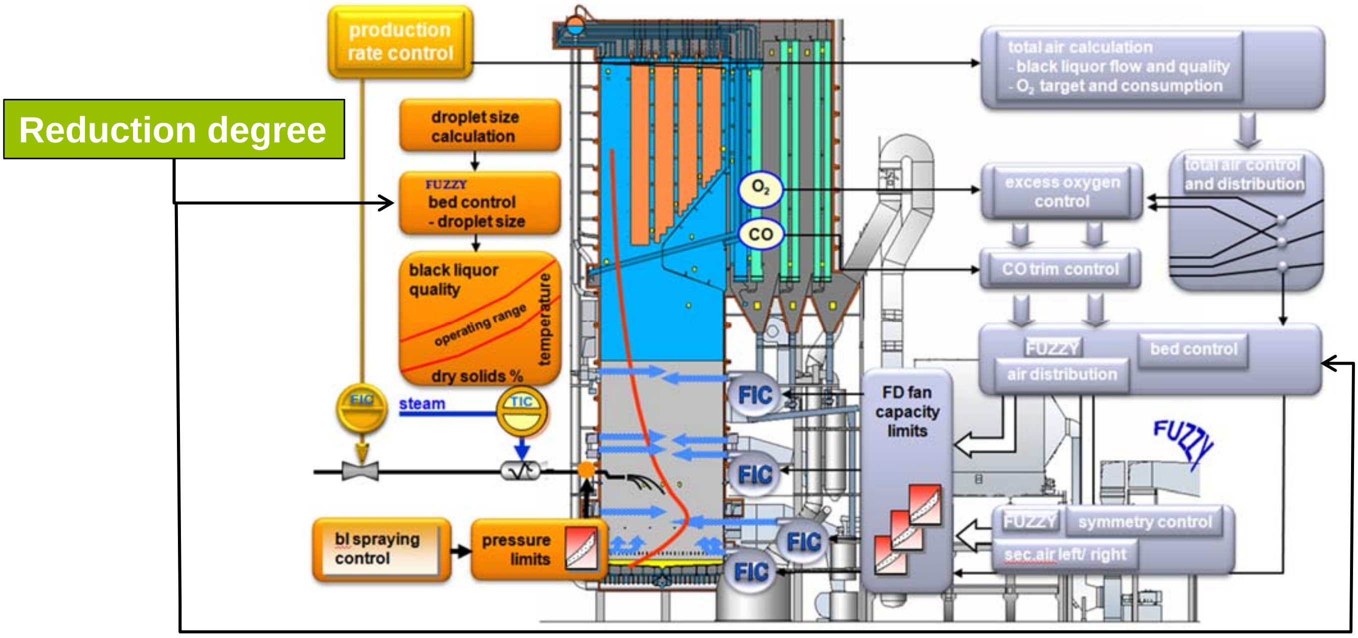
- Measures the degree of reduction from sodium sulfate into sodium sulphide
- Enables improved recovery boiler reduction degree management

Measurements can be used with Advanced Process Controls to:

- Precisely control dissolving tank green liquor density and TTA
- Improve overall boiler reduction degree and operation

INTERNAL

Metso Metra reduction degree analysis is integral part of optimizing boiler controls



Metso titrator family

Metso Recovery Analyzer

Metso Alkali
for cooking

Metso AT
for sulfite cooking

Metso Recovery Analyzer

- Introduces the Metso modular analyzer concept for chemical recovery process
- On line, multipoint, modular analyzer
- Green liquor, lime milk, white liquor alkali analyses based on standard laboratory titration method ABC-titration/SCAN 30:85.
- Technology is mill proven in over 600 sampling locations.
- Recovery boiler reduction degree analysis based on standard laboratory titrations
- Flexibility and expandability in analyses capacity when needs grow, with more speed and through put
- Cost effective and easy interfaces and installation , new diagnostics and supporting tools for life cycle services
- Safe, automatic sampling – no need for manual testing and presence at process site environment

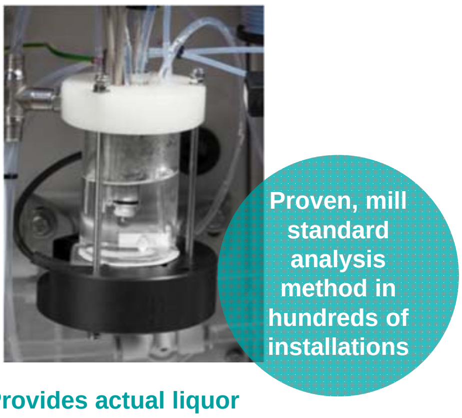
Metso Recovery Analyzer

Online measurements available from day one

- Provides actual liquor chemistry titration results
- No calibration required – online measurements available from day one
- Automatic flushing and acid washing sequences
- Liquor conductivity changes do not affect measurement results
- Can be used to measure manual liquor samples
- Rugged design ensures high uptime and low maintenance
- Large titrator reference base and field proven controls

Metso Recovery Analyzer
Measurement options

Standard Titration



Provides actual liquor chemistry titration results (ABC-titration/SCAN 30:85)
Analyzer measures HCl consumption at each equivalence point and calculates: Na_2CO_3, NaOH, Na_2S and EA, AA, TTA, CE% and S% values for the sample

Reduction Degree Titration

Recovery boiler reduction degree (includes ABC-titration)
Na_2S analysis by titration method and Na_2SO_4 titration with optical inflection point detection

Concept and performance features
Expandable per customer needs

SD-701

SD-702

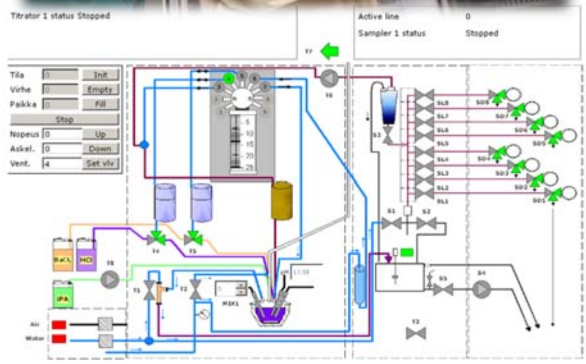
SD-802

Metso Recovery Analyzer	Measurements	Single analysis unit model	Dual analysis unit model	Single or dual analysis unit with building
Sample handling and measurement unit	NaOH,Na_2CO_3,Na_2S & EA,AA,TTA,CE%S%	1-8 sample point	1-16 Sample point	1-16 sample point
Reduction degree (Optional)	Reduction degree Na_2SO_4	1	1	1
Speed	ABC ABC+ Reduction degree	6-7 measurement/h 3-4 measurement /h	12-14 measurement/h 9-11 measurement /h	
Description		• Dedicated analyzer for recovery boiler measurements • For Single causticizition line measurements	• Faster analyzer for single causticization line measurements • Dual causticizing line measurements	Analyzer protection container for severe process environment

INTERNAL

User friendly interfaces - easy access to on-time process information

- Simple and efficient connectivity
- Touch screen for operating
  - Includes configuration, diagnostics, measurement history and trends
  - Preventive maintenance and troubleshooting information
- Connections to DCS
  - Modbus
  - Analog and binary outputs, binary inputs
  - OPC server
- Remote service
  - Remote connection capability included as standard via Ethenet



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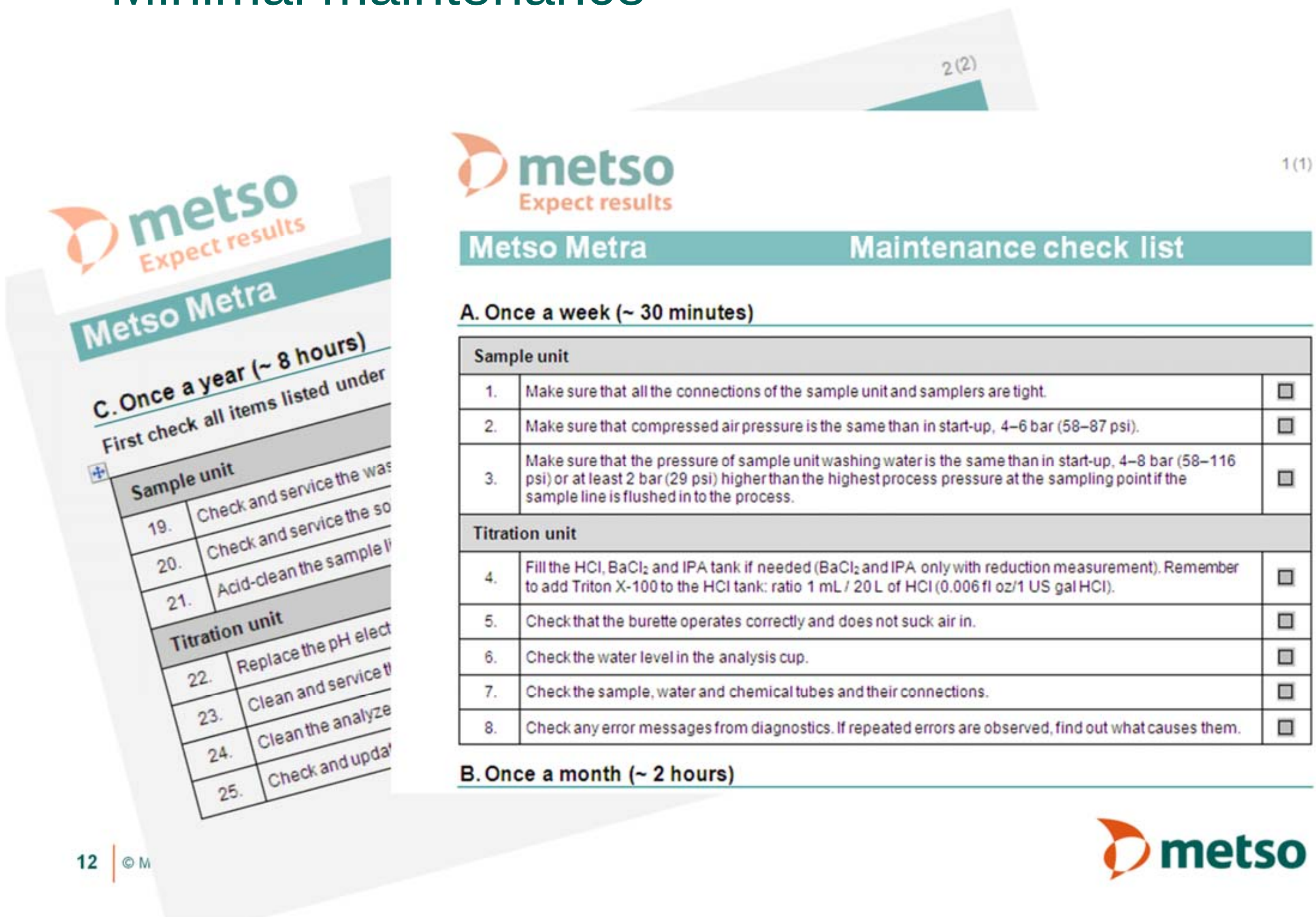
Minimal maintenance



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Expect results

1 (1)

Metso Metra — Maintenance check list

A. Once a week (~ 30 minutes)

Sample unit		
1.	Make sure that all the connections of the sample unit and samplers are tight.	☐
2.	Make sure that compressed air pressure is the same than in start-up, 4–6 bar (58–87 psi).	☐
3.	Make sure that the pressure of sample unit washing water is the same than in start-up, 4–8 bar (58–116 psi) or at least 2 bar (29 psi) higher than the highest process pressure at the sampling point if the sample line is flushed in to the process.	☐
Titration unit		
4.	Fill the HCl, $BaCl_2$ and IPA tank if needed ($BaCl_2$ and IPA only with reduction measurement). Remember to add Triton X-100 to the HCl tank: ratio 1 mL / 20 L of HCl (0.006 fl oz/1 US gal HCl).	☐
5.	Check that the burette operates correctly and does not suck air in.	☐
6.	Check the water level in the analysis cup.	☐
7.	Check the sample, water and chemical tubes and their connections.	☐
8.	Check any error messages from diagnostics. If repeated errors are observed, find out what causes them.	☐

B. Once a month (~ 2 hours)

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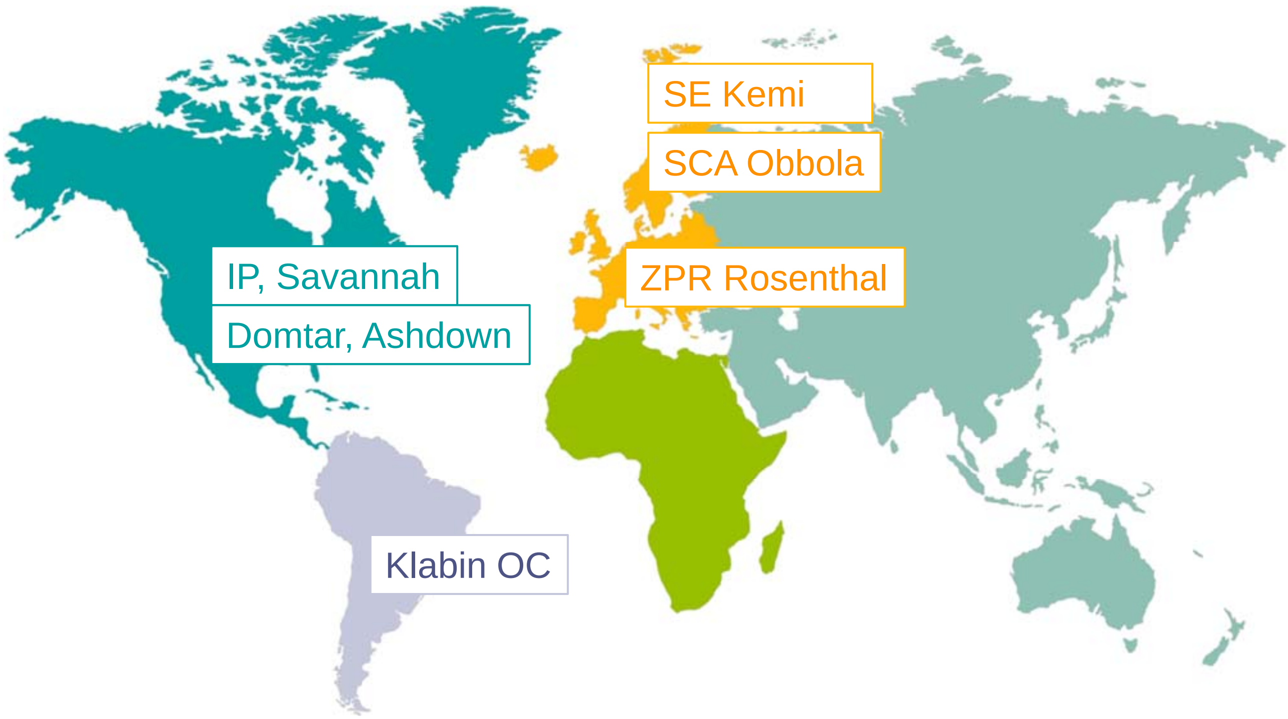
Metso Recovery Analyzer world wide



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Recovery boiler

Measurement applications

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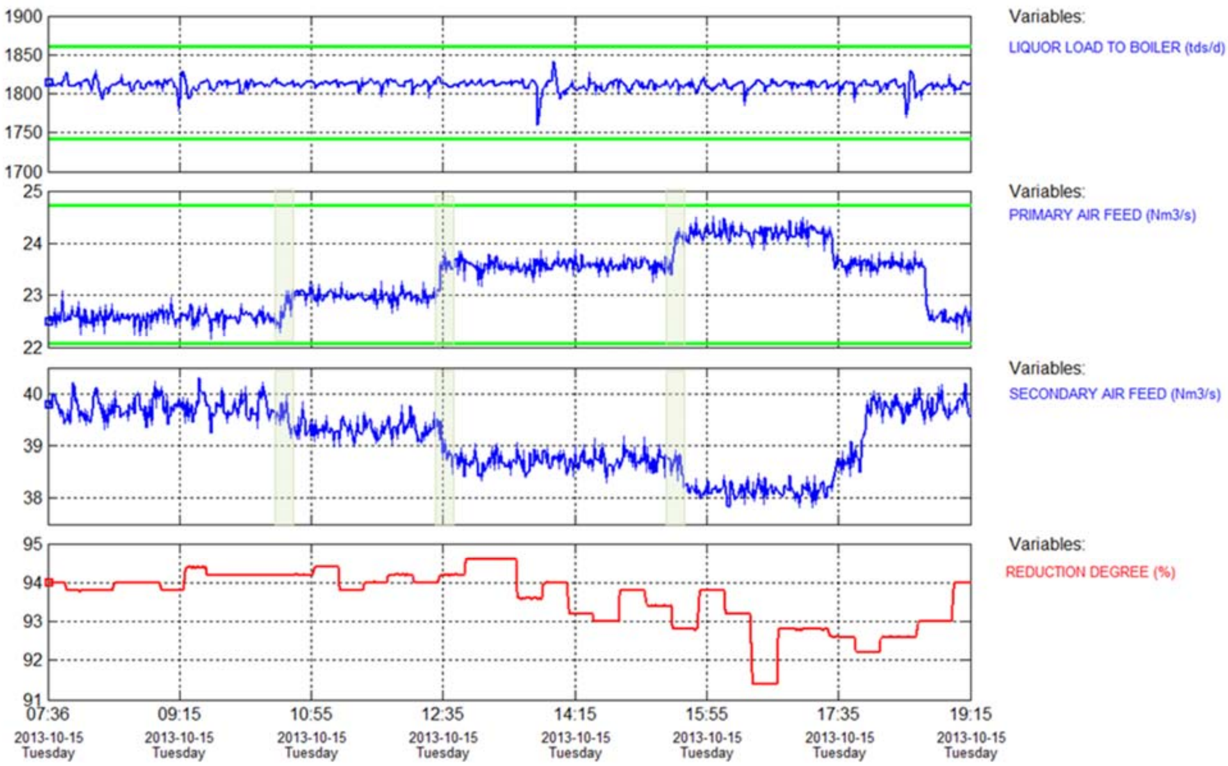
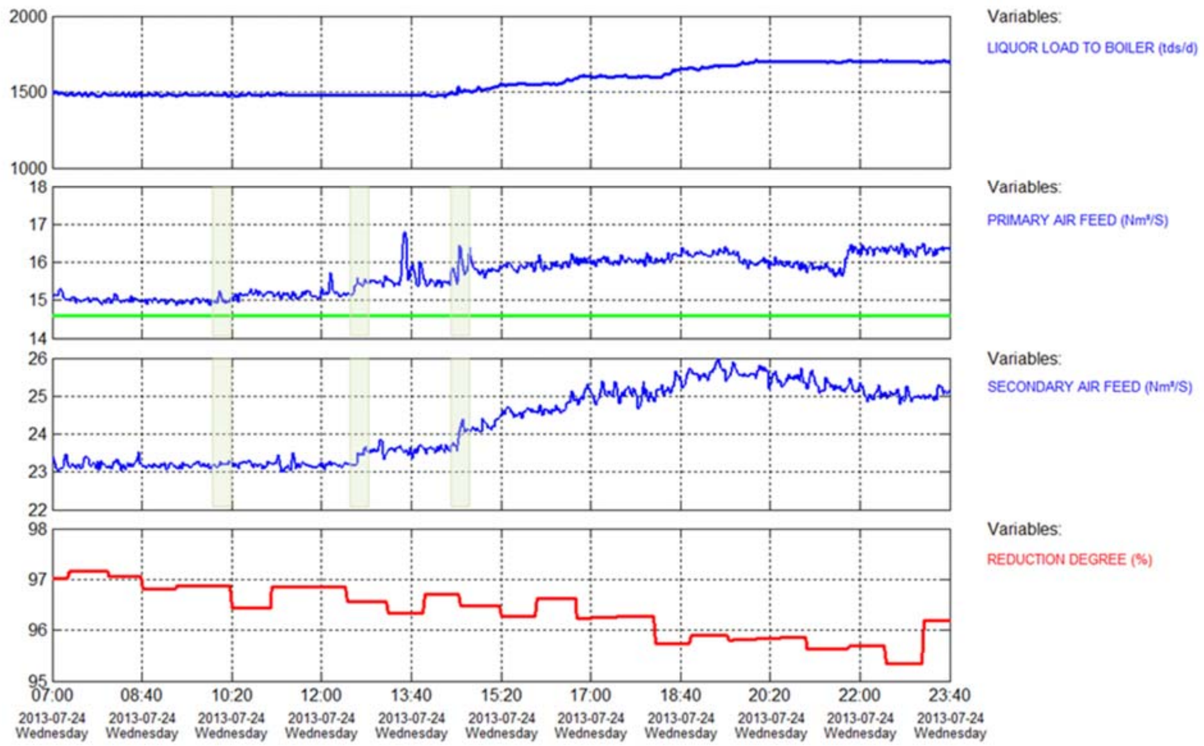
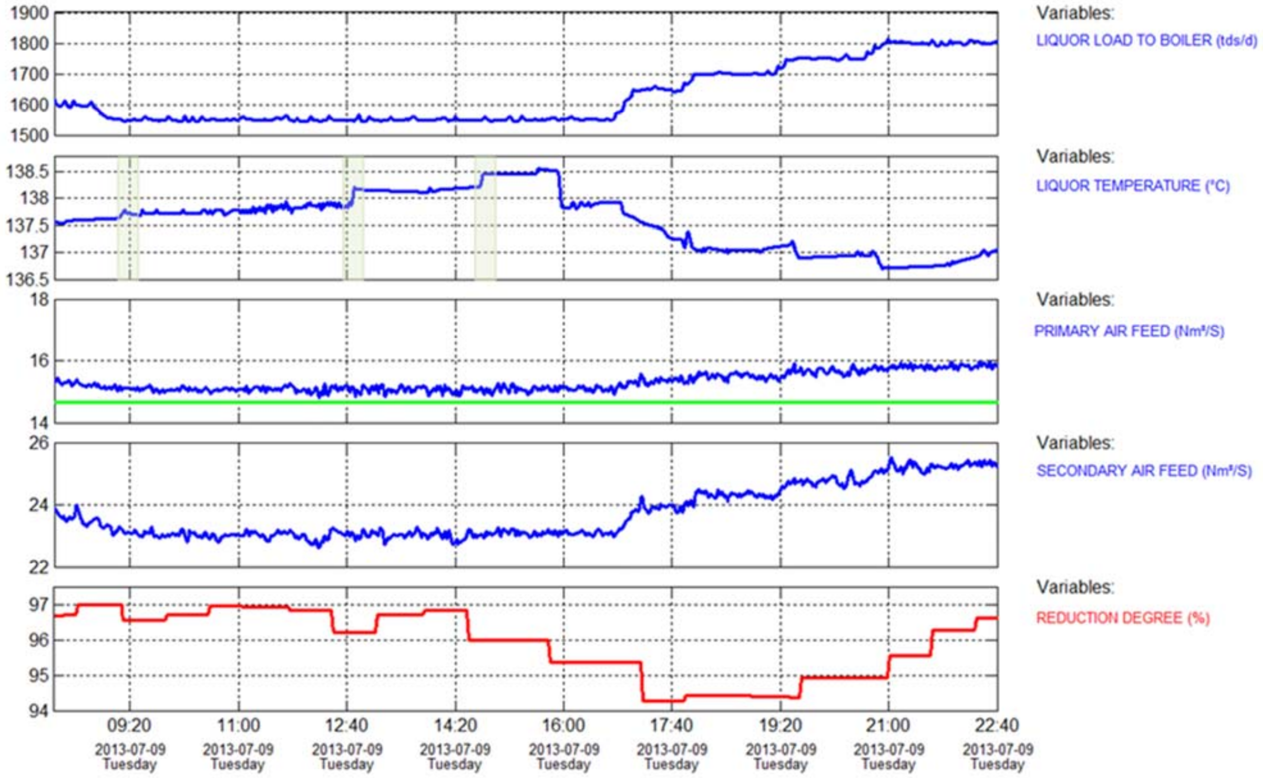
FURNACE LOWER PART AIR ADJUSTMENTS



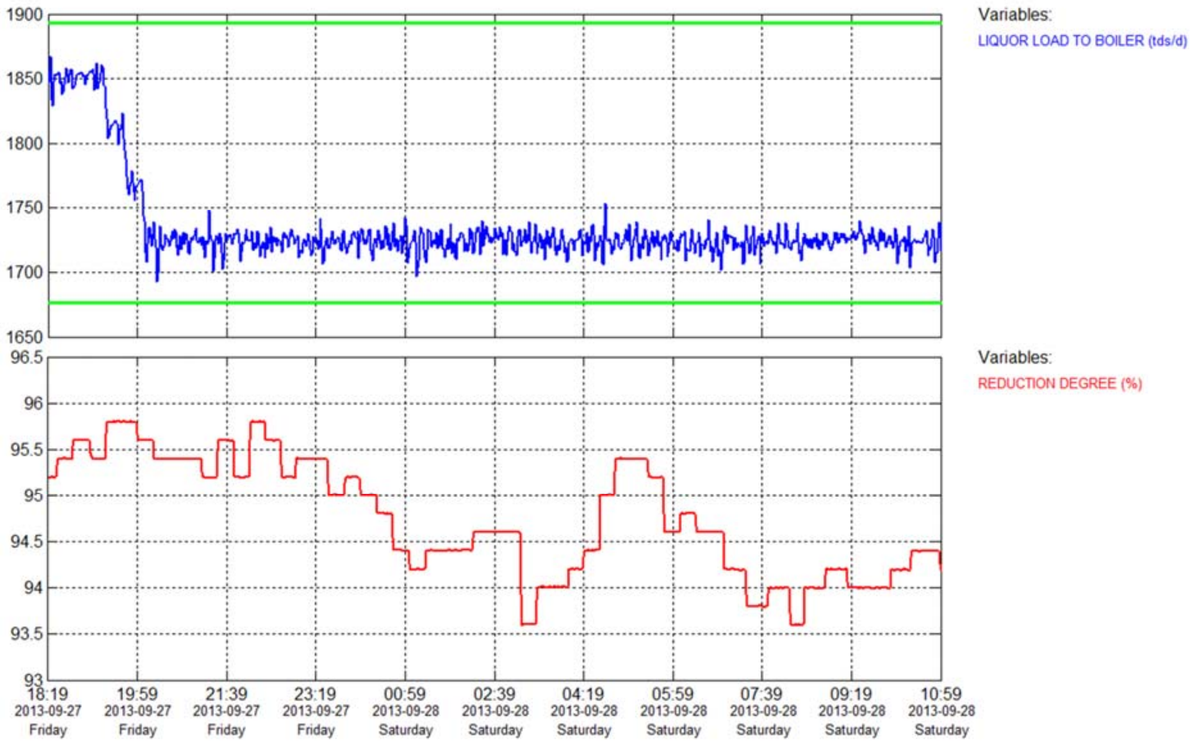
FURNACE LOWER PART AIR FEED INCREASE TEST



DROPLET SIZE INCREASE TEST



BLACK LIQUOR LOAD CHANGE



Summary of analyzer benefits

- Increased white liquor active chemical content results in increased pulping capacity, less dead load and lower energy consumption in evaporators, recovery boiler and lime kiln
- Reduced liquor strength variability improves digester operation resulting in more uniform pulp quality and higher yield
- Reduced TRS (total reduced sulfur) emissions from the lime kiln and better re-burnt lime quality due to less carryover in the lime mud
- Reliable chemistry based measurement results can be used in process start-ups to shorten the ramp up time to normal production
- Absolute measurement provide solid foundation for process management and control even during process disturbances — problem causes can be located fast and their impact in process running and liquor quality variability minimized.
- Better process management and control enables
  - Minimized under- and over liming situations
  - Reduced acid washing frequency
  - Improved filter operation
- Automated laboratory testing according to a standard method provides repeatable on time process information 24/7/365

Metso deliver benefits in liquor cycle

- Production
  - Increased boiler capacity
  - Increased reduction deg.
  - Higher availability
  - Increased power generation
- Quality
  - Target white liquor properties
- Environment
  - Reduced emissions
  - Safety
- Costs
  - Reduced fossil fuel consumption
  - Reduced make up lime
  - Reduced make up NaOH
  - Reduced steam consumption

SOODAKATTILAN HYÖTYSUHDE

Lauri Reiman
Oy Indmeas Ab

IndMeas
Industrial Measurements

Soodakattilan hyötysuhteen määrittäminen mittauksiin perustuvalla laskentamallilla

Diplomityö

Soodakattilapäivät 2013

20.10.2013 Lauri Reiman, Indmeas Oy

IndMeas
Industrial Measurements

Sisältö

- **Diplomityö**
  - Miksi?
  - Miten?
  - Havainnot
- **Jatkotoimet**
  - Mitä sitten?

IndMeas
Industrial Measurements

MIKSI – Tutkimuksen tausta:

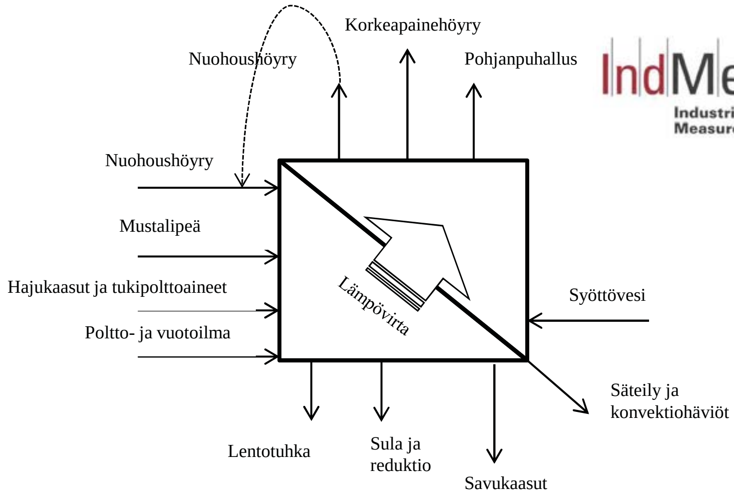
- **Käytössä olevien soodakattiloiden hyötysuhteita ei ole määritelty, tai sitä ei käytetä ohjaamaan soodakattilan ajoa.**
- **Polttoainetehon määrittäminen mustalipeälle haastavaa**
- **Reduktion sitoma lämpö heikentää perinteisesti laskettua hyötysuhdetta**
  - Tarvitaan hyötysuhdelaskenta, joka erottaa reduktion häviöistä
- **Indmeas:n kokemus voimalaitoskattiloista:**
  - Hyötysuhdelaskentaa hyödyntämällä voidaan löytää merkittäviä parannuksia ajotapoihin ja tuottaa säästöjä laitokselle.

IndMeas
Industrial Measurements

MITEN – Tutkimussuunnitelma:

- **Rakentaa laskentamalli soodakattiloiden energiahyötysuhteen ja reduktion huomioivan kokonaishyötysuhteen laskentaan.**
  - Perustuu epäsuoraan menetelmään eli häviöiden kautta määritettyyn hyötysuhteeseen.
  - Tarkoitus päästä parempaan tarkkuuteen ja saavuttaa mittauksilla varmuutta laskentaan.
  - Määrittää epävarmuus laskennalle
- **Saadun hyötysuhdetiedon avulla paikannetaan muuttujia, joilla energiataloutta voidaan parantaa.**

Laskelmat:



- Höyryntuotanto tunnetaan hyvällä tarkkuudella
- Ongelma: Suurimmat häviöt määritettävä.
  - Q: Sulahäviö ? - A: Alkuainetaseet
  - Q: Savukaasuhäviö ? - A: Kalibrointi/puhallinyhtälö
- Mittausten epävarmuus tunnetaan tai saadaan tilastoista
  - > Voidaan määrittää hyötysuhteelle epävarmuus
- Mustalipeävirta: $\dot{m}_F = \dfrac{Q_{abs} + Q_{sk} + Q_{CO} + Q_{RC} + Q_{ilma} + Q_{nuohSK} - P_{mek} - Q_{apu}}{NHV + h_F - h_{smelt} - h_{FA}}$,

Alkuainetaseiden kautta lasketaan sulavirta ja savukaasujen koostumus

Polttoaineen koostumus

Kalorimetrinen lämpöarvo:		12,790
	p-%	±
C	31,392	1,1783
H	3,216	0,20434
IO	28,905	1,7904
Na	20,961	1,5851
Na+K	23,112	1,5621
K	2,151	erotus
S	5,115	
Arviot		
N	0,130	0,07
Cl	0,500	0,3
O	36,533	erotus

Sulavirran koostumus

Laskennallinen sulavirta	
Yhdiste	mol/kgka
K2S	0,099608017
Na2S	1,557929229
Na2SO4	0,092771493
Na2CO3	2,357598658
K2CO3	0,10694214

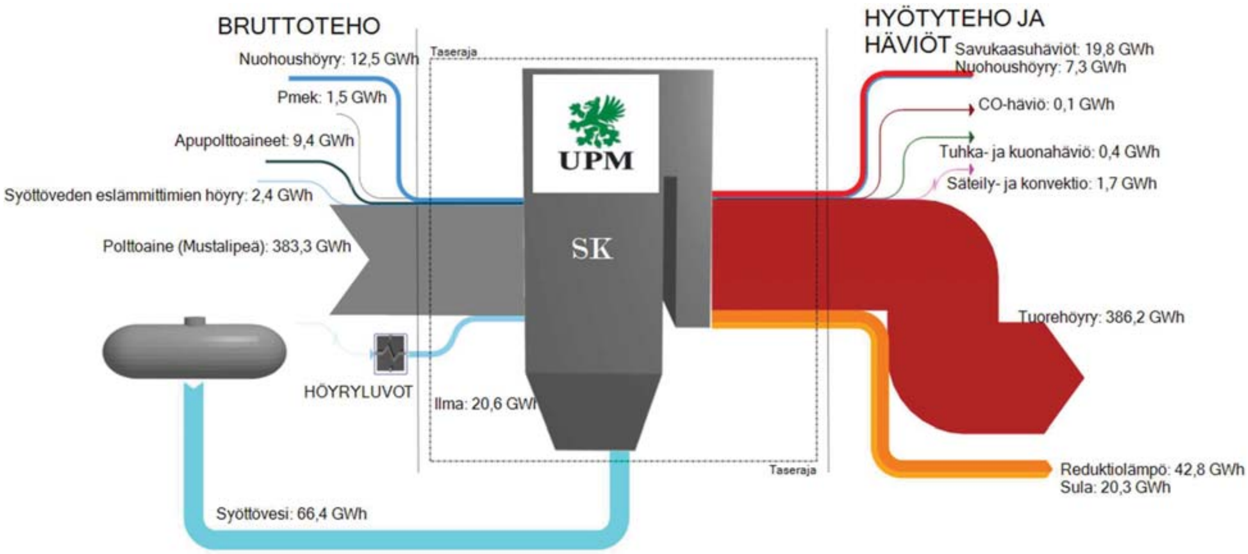
Palavan mustalipeän koostumus

Laskennallinen polttoaine	
Alkuaine	%
Hiili	23,11425347
Vety	2,700192846
Happi	9,100379834
Typpi	0,108173325
Rikki	1,251759324
Kosteus	16,78975028
"Tuhka"	46,91869967

Sulahäviö ja reduktioenergia

Savukaasun koostumus ja savukaasuhäviö

Työn tuloksena laadittu Sankey



joulukuu 2010

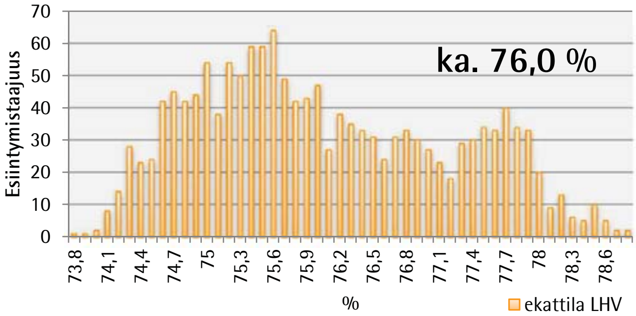
Havainnot

Kattilahyötysuhteessa merkittävää hajontaa

Perinteinen hyötysuhde

$$\eta_{LHV} = \frac{Q_{abs}}{Q_{BRUTTO}}$$

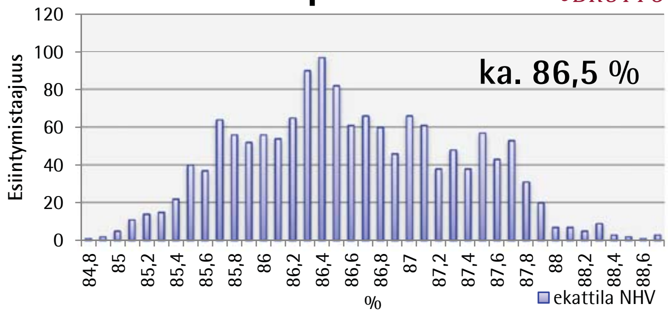
Pietarsaari



Epävarmuus: ±1,337 %-yksikköä

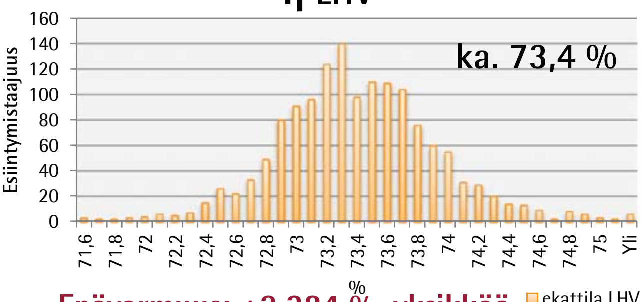
Reduktion huomioiva hyötysuhde

$$\eta_{NHV} = \frac{Q_{abs} + Q_{dR}}{Q_{BRUTTO}}$$

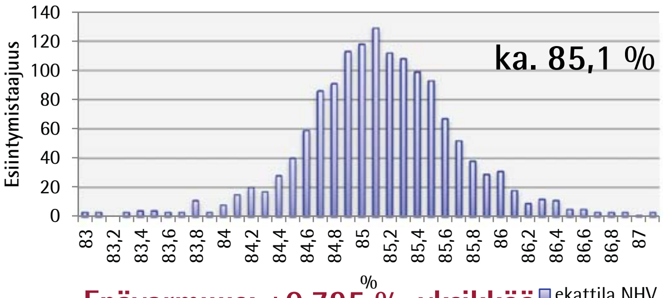


Epävarmuus: ±0,584 %-yksikköä

Kemi



Epävarmuus: ±2,384 %-yksikköä

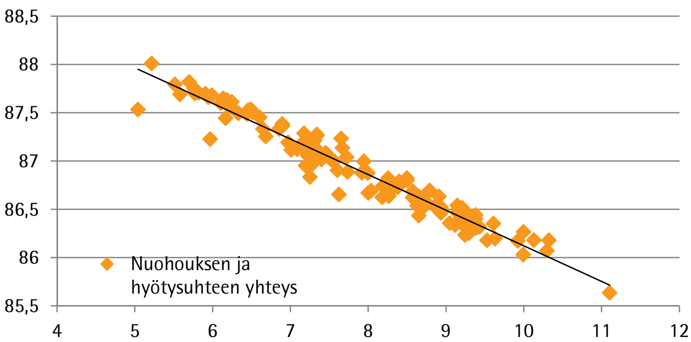


Epävarmuus: ±0,795 %-yksikköä

Nuohous laskee hyötysuhdetta

Nuohous (Pietarsaari):

1. Nuohousmäärä vaikuttaa:
   - +2,7kg/s höyryä -> - 1 % hyötysuhteessa.



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Nuohoushöyryn lähde ratkaisee

- **Kemi**
  - Sähköntuotanto kasvaa, kun höyryä ei oteta ennen tulistimia.
  - Jos nuohoushöyry otetaan turbiinilta, kun sähköteho yli 65 MW -> Sähköntuotanto kasvaa 9,81 GWh vuodessa.
- **Pietarsaari**
  - Sähköntuotanto kasvaa, kun höyryä ei oteta ennen tulistimia.
  - Jos nuohoushöyry otetaan turbiinista jo 25,5 barissa, sähköntuotanto kasvaa 1,2 GWh vuodessa.

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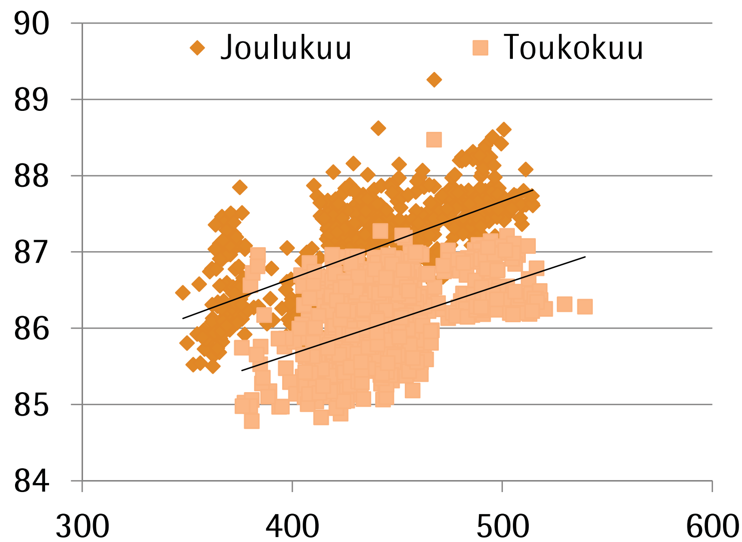
Vuodenajalla suuri merkitys savukaasuhäviöön

Savukaasu (Pietarsaari):

1. **Toukokuussa loppulämpötila 13,8 ℃ joulukuuta korkeampi**
   - \> 7,3 MW suurempi savukaasuhäviö
   - \> n. 1 %-yksikön alhaisempi hyötysuhde

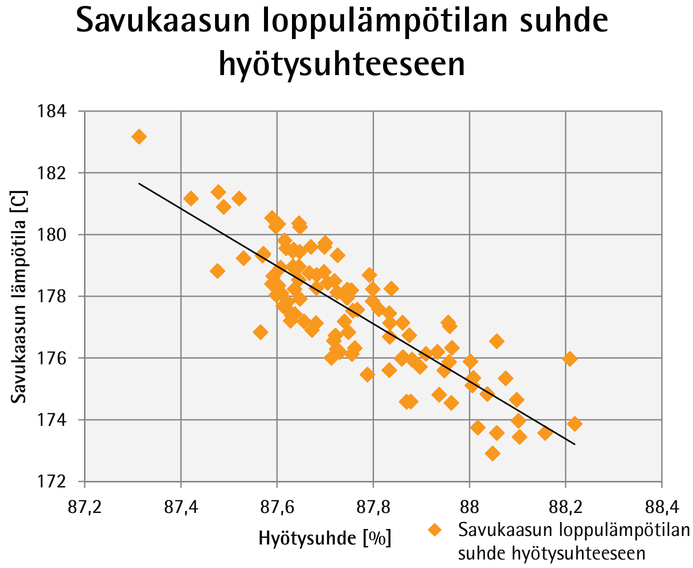


2. **Savukaasun happi kasvaa, kun laskennallinen kattilakuorma pienenee.**
   - \> Mahdollisesti liian suuri ilmakerroin poltossa ?

Savukaasun loppulämpötila vaikuttaa suoraan hyötysuhteeseen.

Savukaasuhäviö (Kemi):

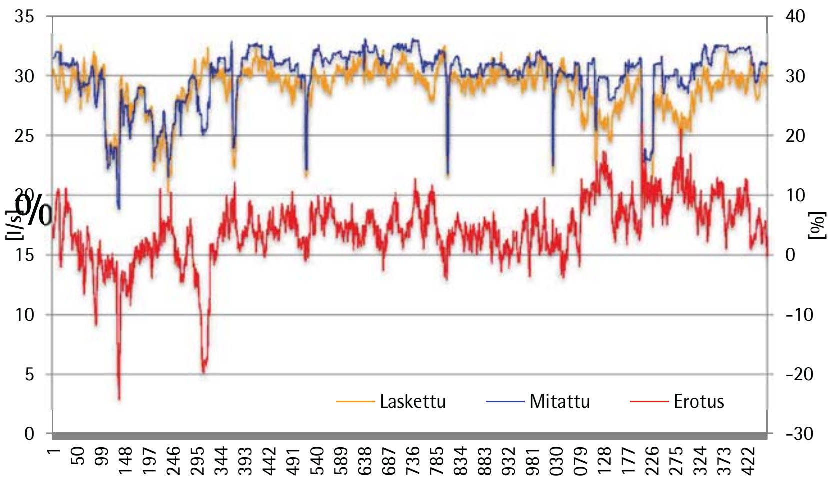
- Tyypillisellä tehoalueella 310–315 MW
- Kun savukaasun lämpötila nousee 10 ℃, laskee hyötysuhde 0,7 %-yksikköä



Mustalipeän teho voidaan laskea tunnetulla tarkkuudella

Mustalipeävirtaus (Kemi):

- Laskennallisen ja mitatun virtauksen välinen ero ka. +4,2% ±10,6 %
- Jos laskentaan suoraan mustalipeän teho saadaan epävarmuudeksi vain ±3,9 %



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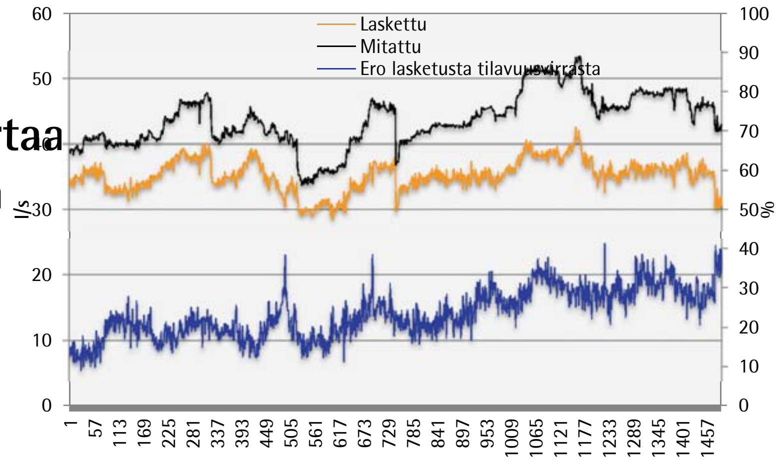
Mustalipeän mittaus eroaa laskennallisesta merkittävästi

Mustalipeävirtaus (Pietarsaari):

- Laskennallisen ja mitatun virtauksen välillä merkittävä ero ka. +23,6% ±5,7 %

- Laskennallista mustalipeävirtaa voidaan käyttää ajon tukena



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Jatkomahdollisuudet

Taseanalyyseillä täsmäytetyt energiaraportoinnit

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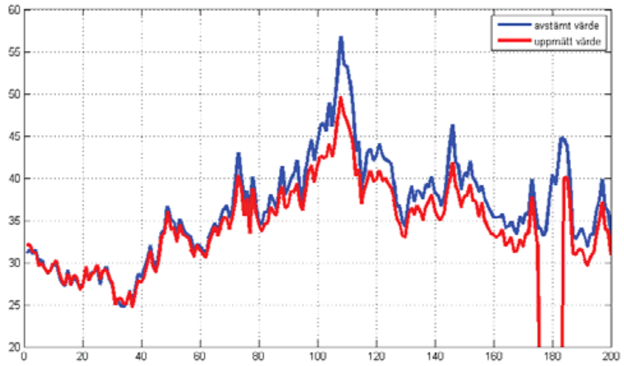
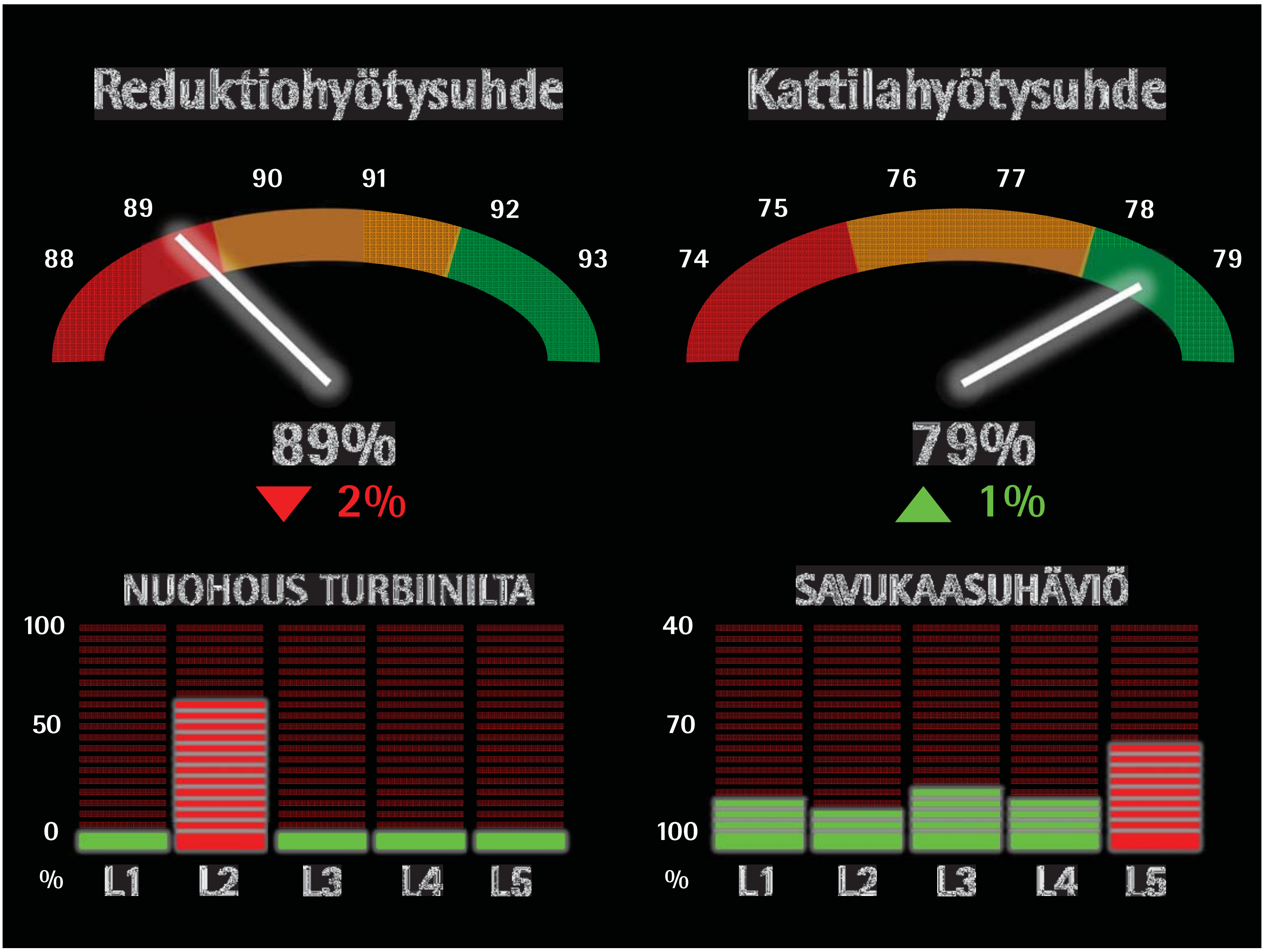
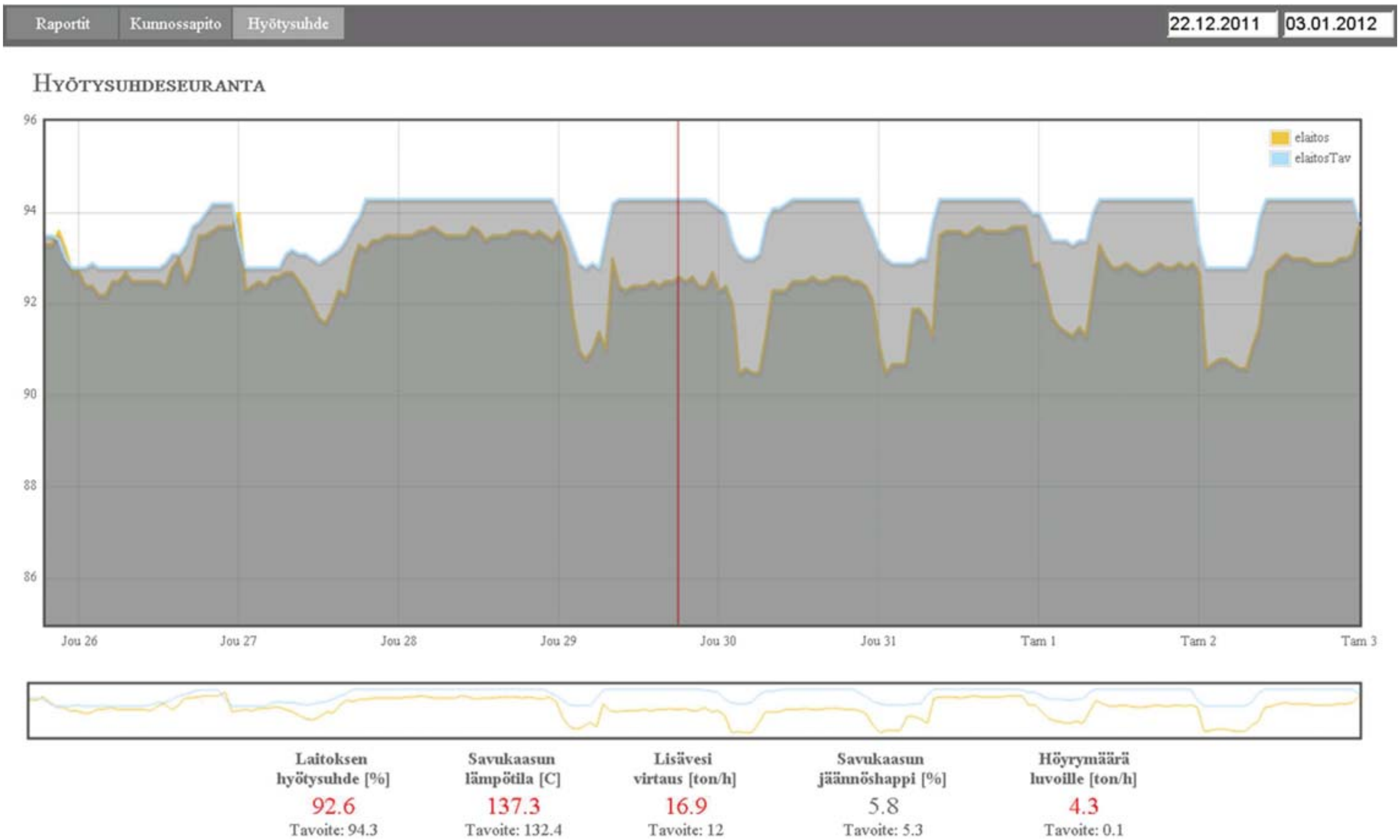


	MITATTU [MWh]	TÄSM [MWh]
Tuorehöyry	18 000	18 000
Lämmöntalteenotto	6 120	5 120
TUOTANTO	**24 120**	**23 120**
SÄHKÖ	720	720
VP-höyry	3 600	3 600
MP-höyry 1	3 600	4 640
MP-höyry 2	5 760	5 760
Kaukolämpö	6 480	5 900
Sisäinen käyttö	1 656	2 050
Häviöt	-	450
KÄYTTÖ	**21 816**	**23 120**
ERO - MWh	2 304	0
ERO - %	10	0



Optimihyötysuhde auttamaan operaattoreita



IndMeas Industrial Measurements

Yhteystiedot:

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LATEST ADVANCEMENT IN RECOVERY BOILER INTELLIGENT SOOTBLOWING TECHNOLOGY FOR IMPROVED SAFETY, ENERGY EFFICIENCY, AND COST REDUCTION

Danny Tandra
Clyde Bergemann

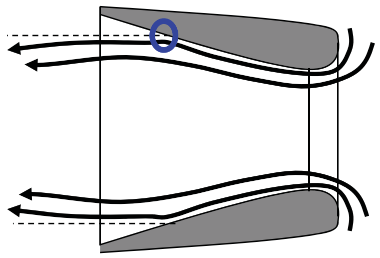
Latest Advancement in Recovery Boiler Cleaning Technology

Clyde Bergemann Power Group Americas
Technology & Product Development

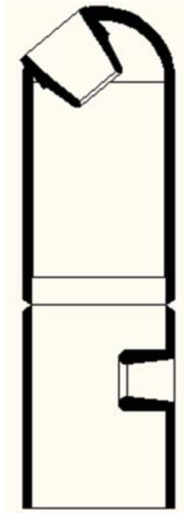
Overview

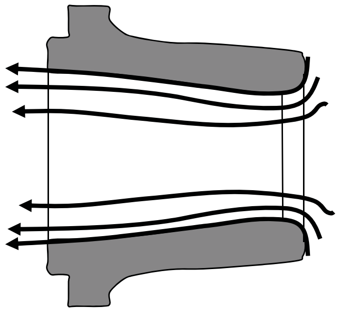
- **Demands**
  - ➔Improve SB Jet Force / Cleaning Performance
  - ➔Don't use too much of my valuable steam
  - ➔Less manpower to maintain my sootblowers
- **R&D and Product Focus**
  - ➔Nozzle Technology
  - ➔Low Pressure Sootblowing
  - ➔Intelligent SB Reporting & Sootblowing

Nozzle Technology



Conventional Nozzle





CFE – Leading Edge

Fully Expanded (CFE III)

Installations

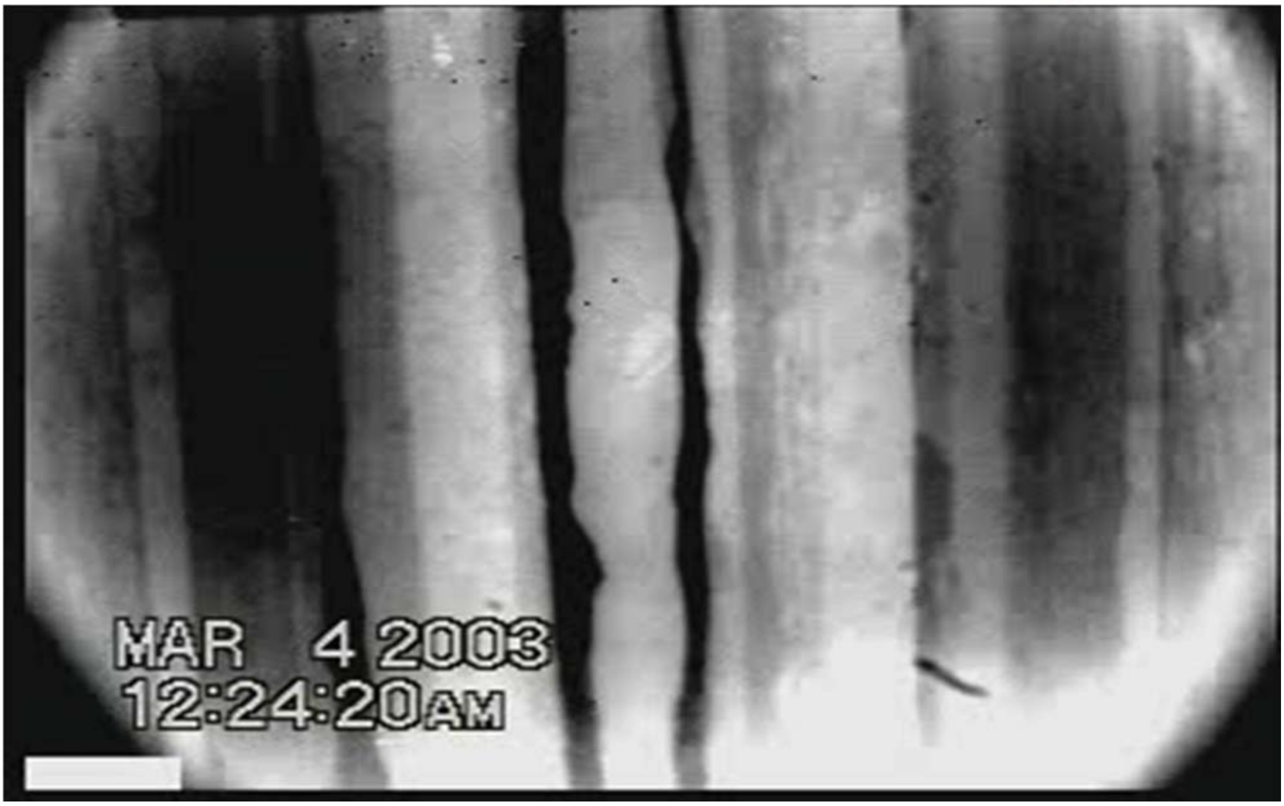
Fully Expanded (CFE III) used in > 80% New RB

Year	Pulp Mill	Boiler OEM	# of Blower
2000	Varo Sweden	Andritz	80
2000	Bowater, Canada	Andritz	60
2001	Lwarcel, Brazil	CBC	27
2001	RIPASA, Brazil	CBC	78
2002	Weyerhaeuser, Canada	Kvaerner	76
2002	Arauco Valdiva	Kvaerner	86
2002	Stendal, Germany	Andritz	80
2003	Soporcel, Portugal	Andritz	82
2003	SCP, Ruzomberok	Andritz	52
2003	APP, China	Kvaerner	112
2004	ITATA, Chile	Kvaerner	92
2004	Portucel, Portugal	Andritz	60
2004	Weyerhaeuser, OK, USA - RS/LP	Andritz	88
2005	CMPC Chile	Andritz	90
2005	Orsa	CBC	22
2005	Weyerhaeuser, Canada	Kvaerner	72
2005	APPM, India	EnMas	30
2005	Cenibra, Brazil	CBC	84
2006	Suzano, Brazil	Kvaerner	92
2006	TNPL, India	EnMas	29
2006	ENCE, Uruguay (Pending)	Kvaerner	84
2006	Bahia Pulp, Brazil	CBC	84
2006	Weyerhaeuser, USA, RS/LP	Andritz	80
2006	ITC, India	EnMas	29
2006	Abhishek, India	EnMas	28
2006	Seshasayee, India	EnMas	28
2006	KYMI, Finland	Kvaerner	94
2008	Russian Recovery Boiler	Andritz	76
2008	Aracruz Guaiba, Brazil, RS/LP (Pending)	Metso	114
2009	PCA Valdosta, RS/LP	Andritz	76
2010	Eldorado, Brazil, RS/LP	Metso	116
2011	Suzano Maranhao, Brazil, RS/LP	Metso	120
2012	Montes del Plata, Uruguay	Anditz	114

CFE – Leading Edge

- International Paper
- Lincoln Paper
- Temple Inland
- Clearwater
- Weyerhaeuser

Desuperheating SB Steam @ PPV



Overview

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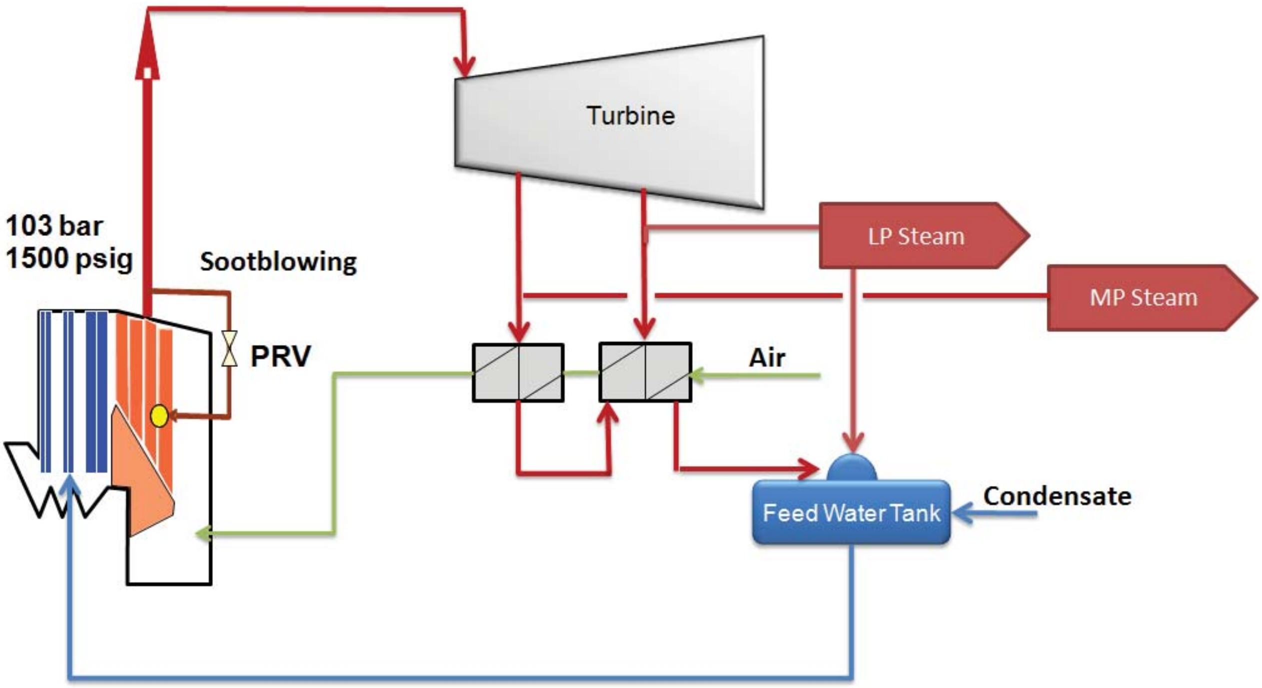
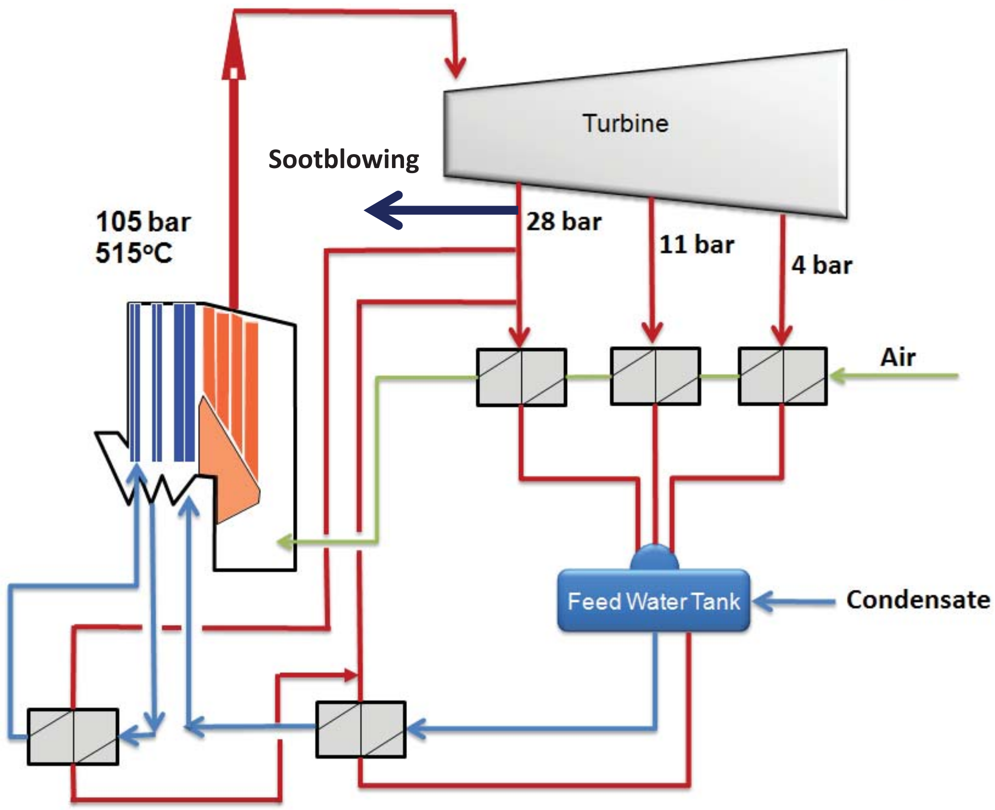
  - ➔Intelligent SB Reporting & Sootblowing

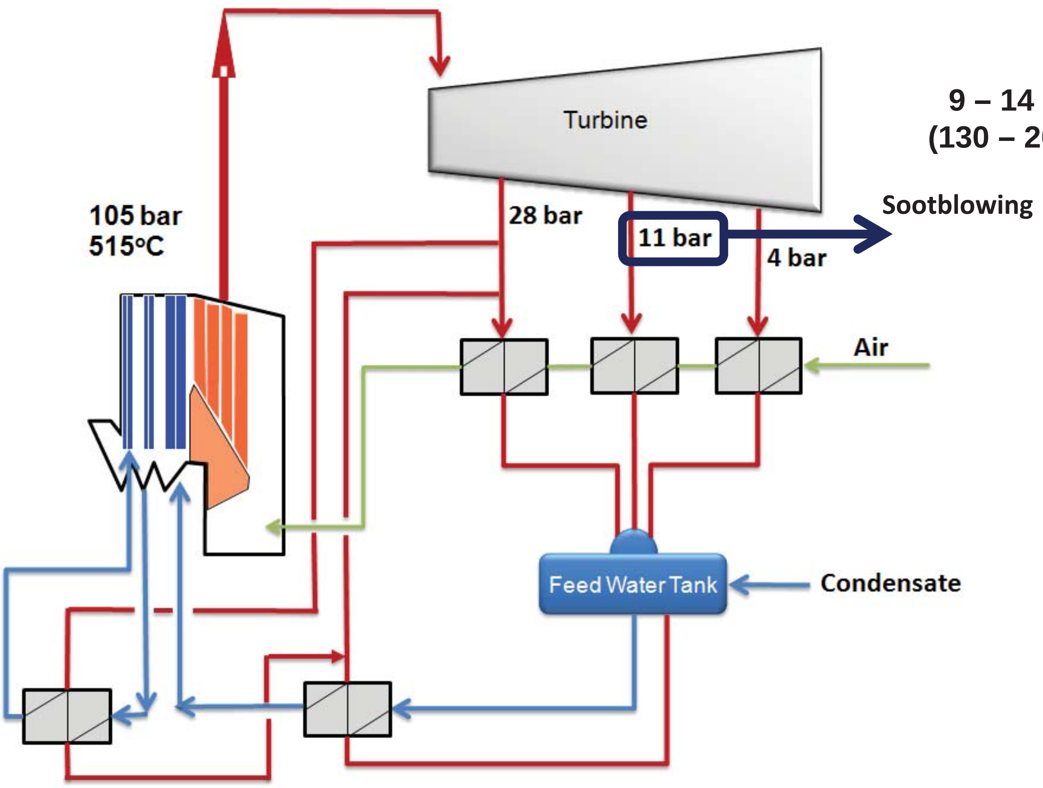
Sootblowing 20+ years ago



Sootblowing 10+ years ago

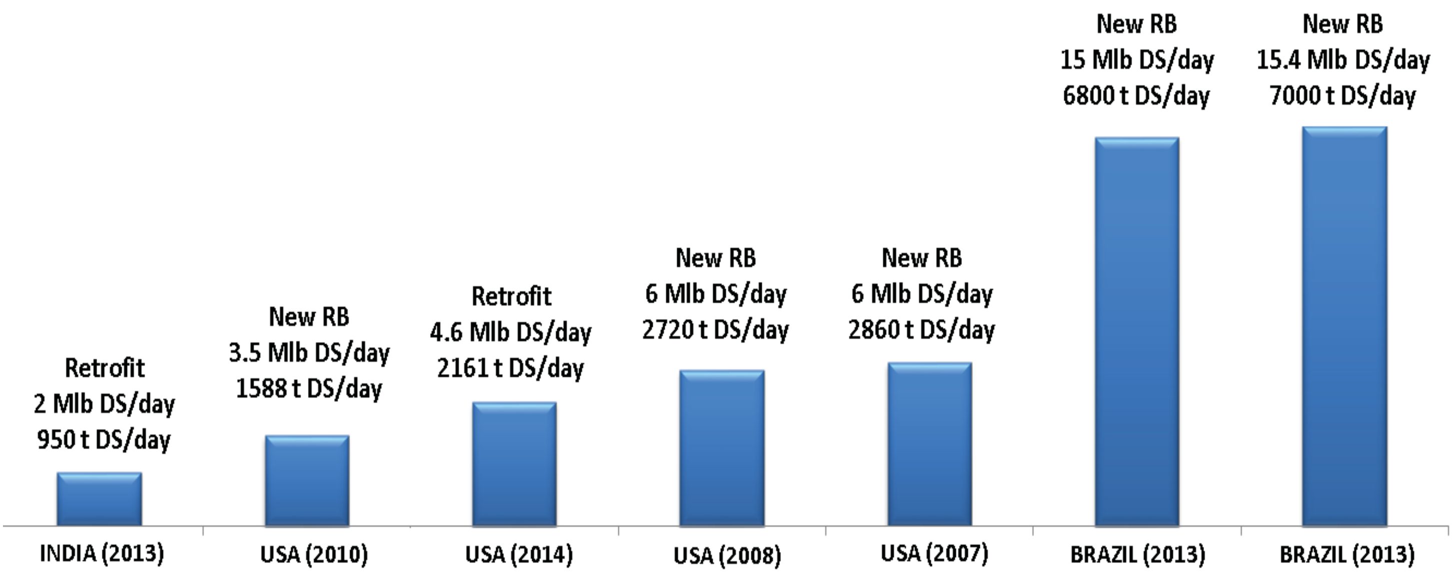


Latest Tech



9 – 14 bar
(130 – 200 #)

Installations



Overview

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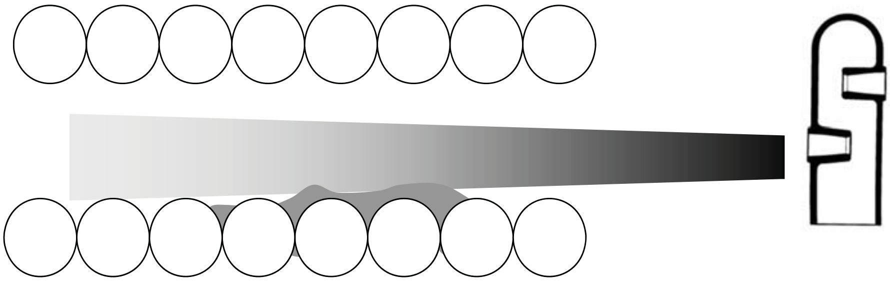
Two most important factors for the sootblower to successfully remove deposits

1. SOOTBLOWING TIMING (SmartClean ISB)
2. JET POWER (Sootblower Nozzle)

Sootblowing TIMING (1 of 2)

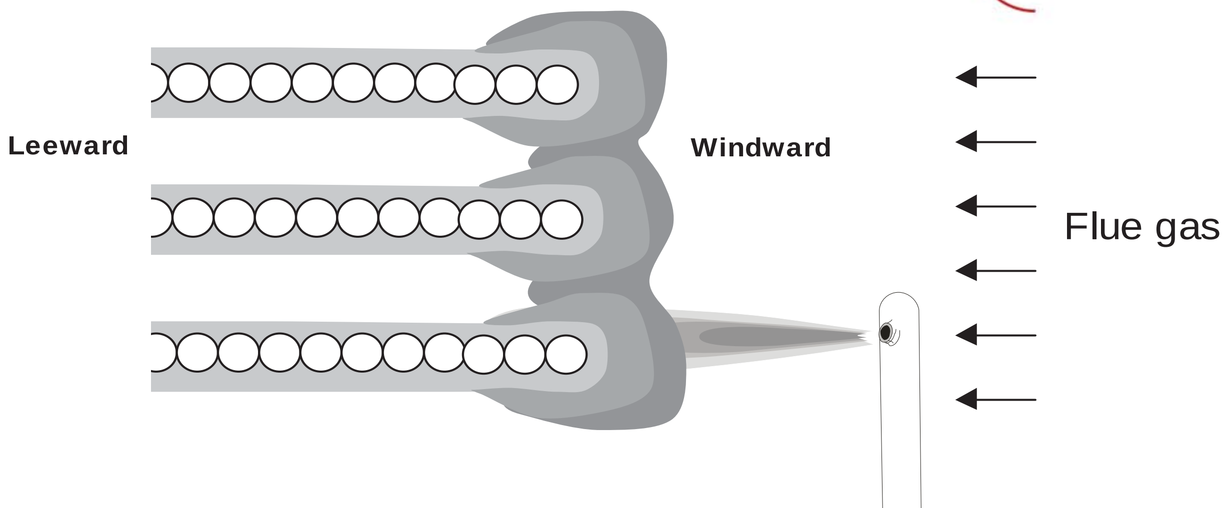


Even if we have **<u>STRONG</u>** Jet power but **<u>BAD</u>** timing

➔ Deposit is still in the very “early stage”

➔ Steam Wasted

Sootblowing TIMING (2 of 2)



STRONG Jet power but **BAD** timing

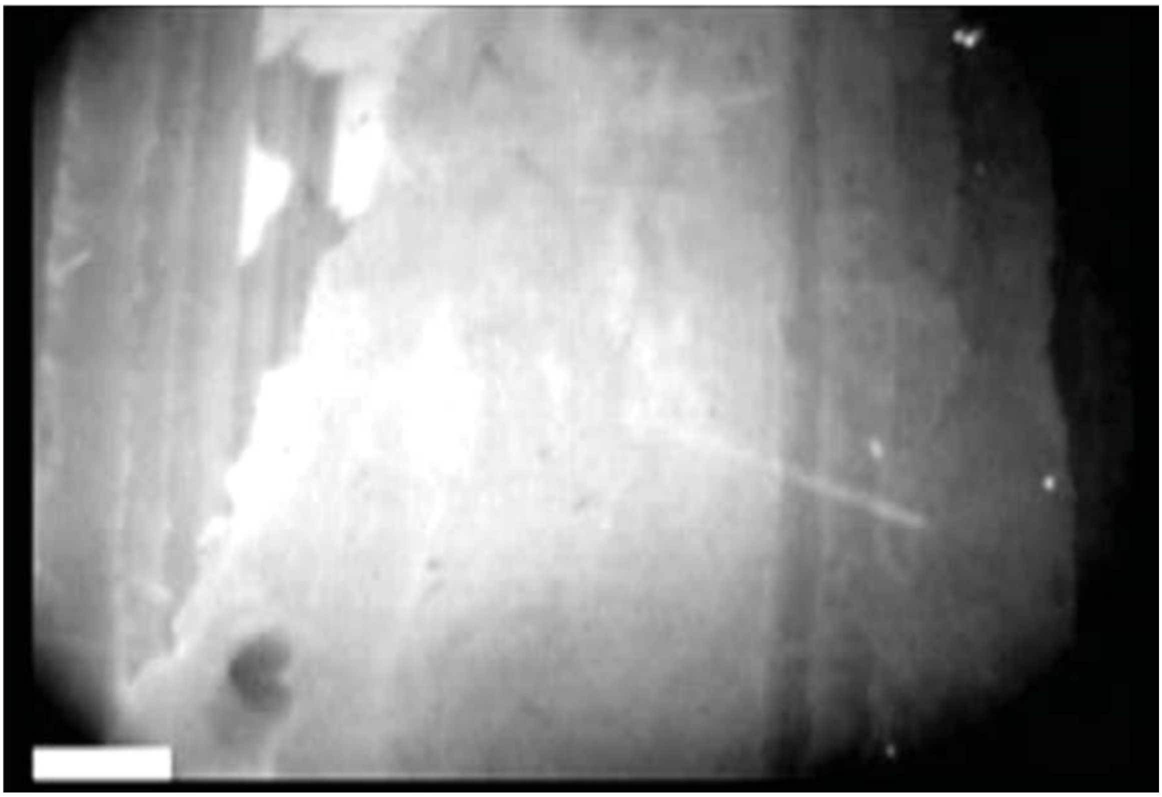
➔ Deposit grown to a very large size

➔ Increasing jet power may result in falling clinker, damaging boiler floors

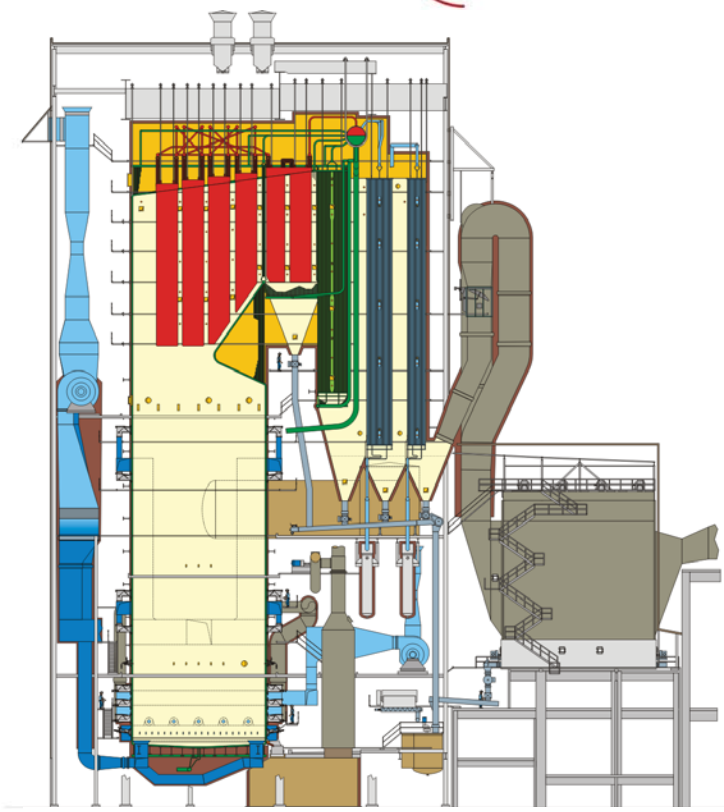
➔ Steam Wasted

Powerful Jet Power ALONE is insufficient

Sootblowing TIMING is Crucial



How to determine the correct timing

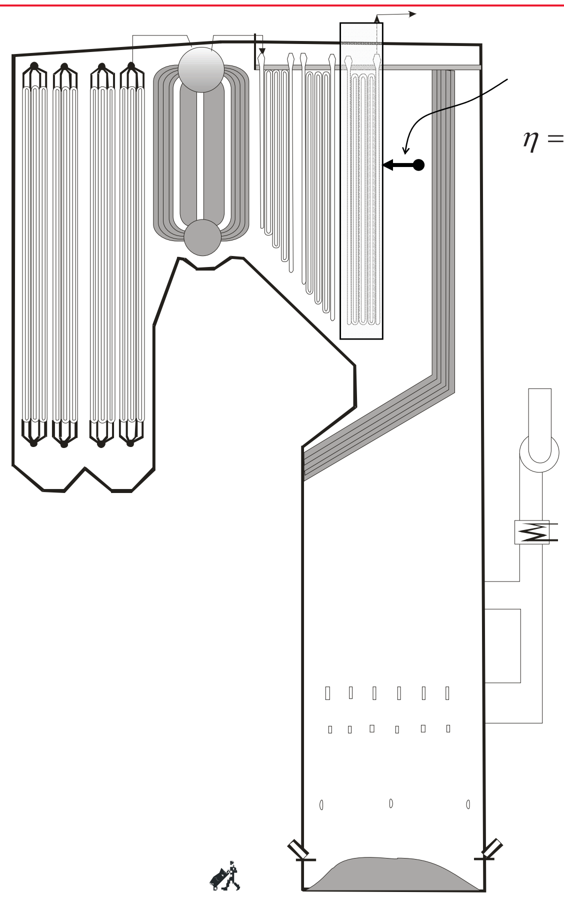


How do we get fouling information

Utilizing mass and energy balances

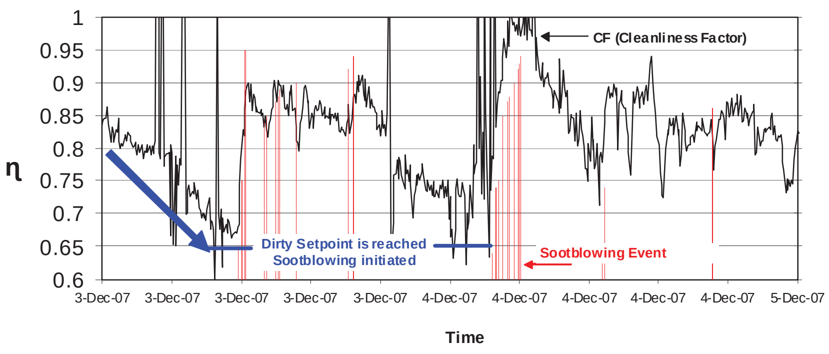
1. Black Liquor Information
   - ➔ Flow Rate, Chemistry, Heating Value, etc
2. Steam Side
   - ➔ Pressure, temperature, flow rate of the steam in/out of exchangers (incl. Attemperator flow)
3. Gas Side
   - ➔ Available temperatures and pressure difference (DP) measurements.

Energy balance



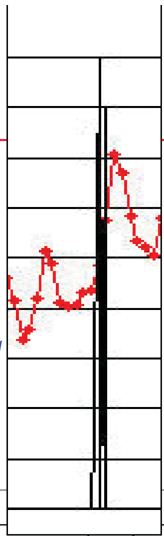
$$\eta = \frac{\text{Actual heat transfer to the water/steam inside the heat exchanger}}{\text{Total available heat input to the heat exchanger}}$$

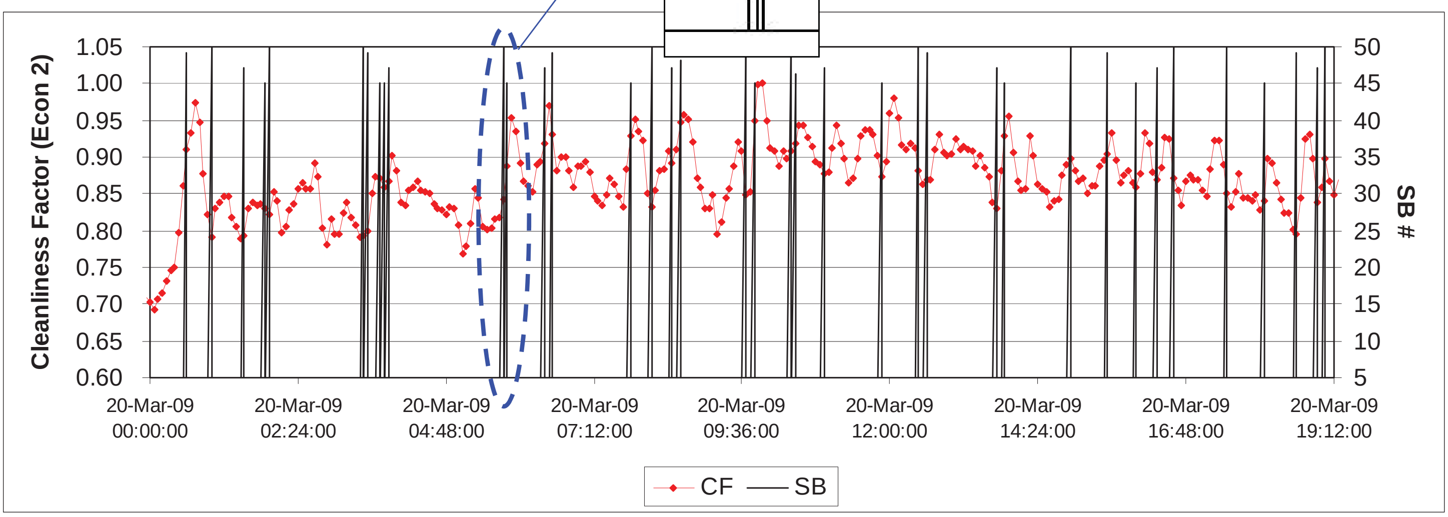
$$\eta = \frac{Q_{Actual\ Heat\ Absorption}}{Q_{Heat\ Input}}$$



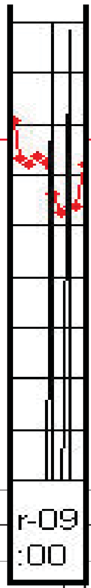
Good and Poor Timing

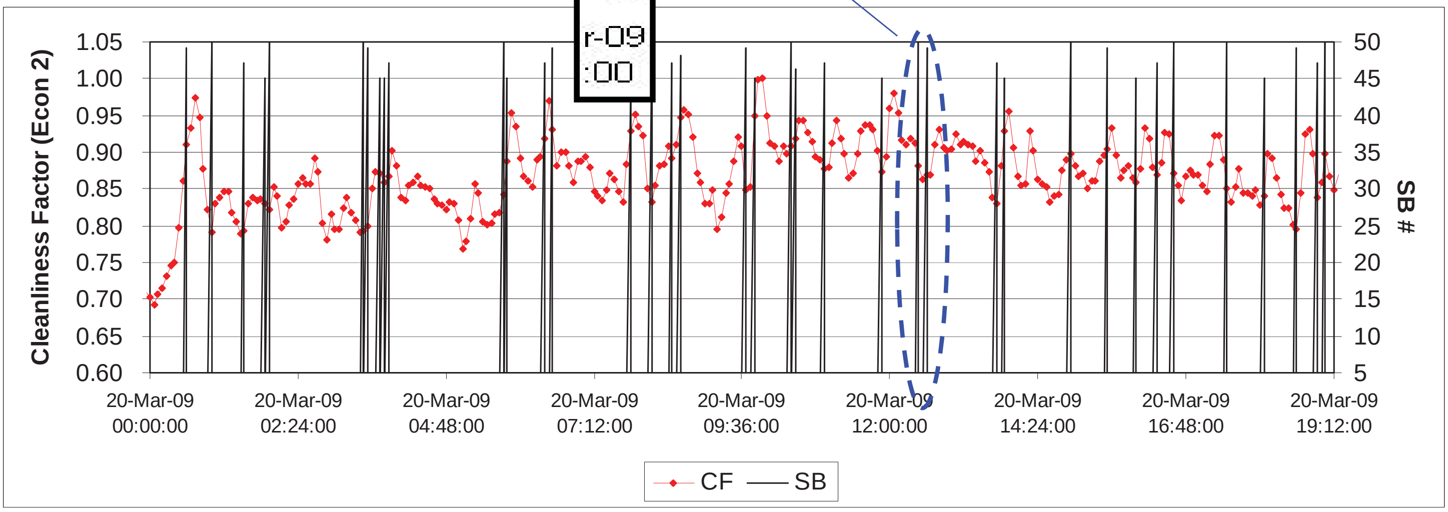
Right sootblowers operated /
Good Sootblowing timing



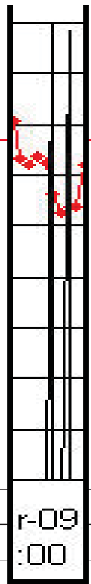


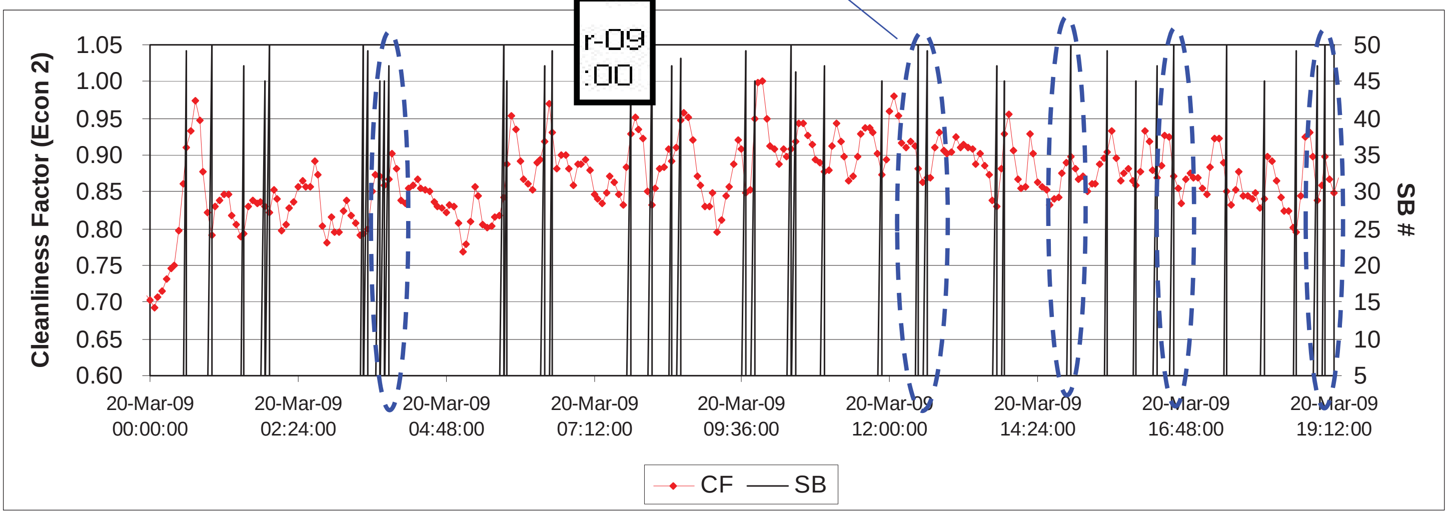
Wrong sootblowers / poor Sootblowing timing





Wrong sootblowers / poor Sootblowing timing



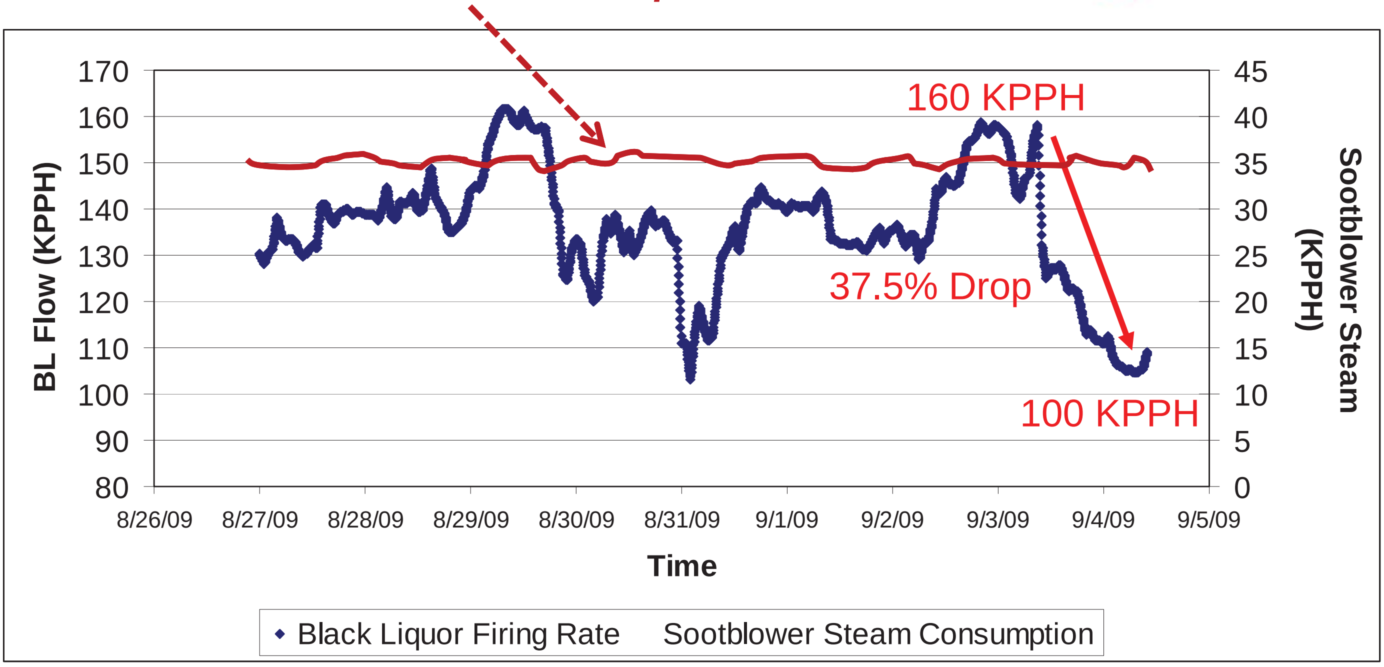


Sources of wasted steam

- In addition to bad sootblowing timing….
- Static setpoint for SB cleaning flow contributes to the unnecessary SB steam loss.

Black Liquor Flow Rate (KPPH)

Sootblower steam consumption

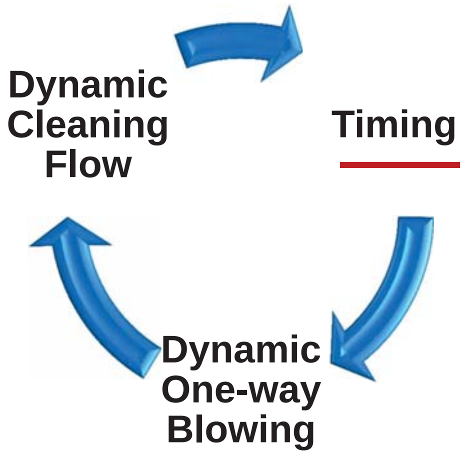


Conventional Sequence Based Sootblower:

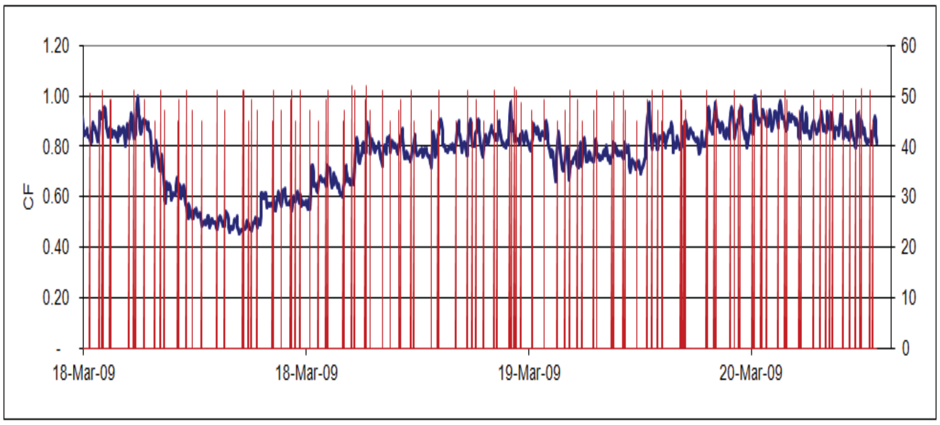
Constant steam consumption regardless the liquor firing load

SMART Clean

- How do we save steam ?
- How do we prevent plugging ?
- How do we alert operator of danger ?
- Rule Based Operation

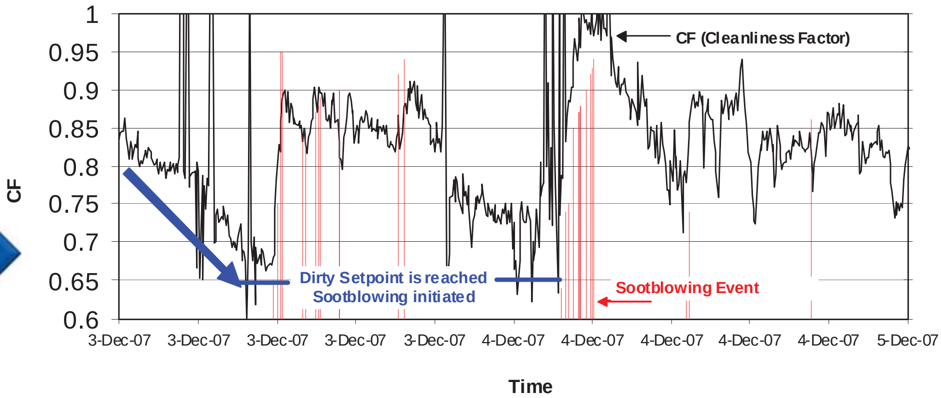


How do we save steam



Conventional sequence based sootblowing

SMART Clean



SMART Clean

- How do we save steam ?
- How do we prevent plugging ?
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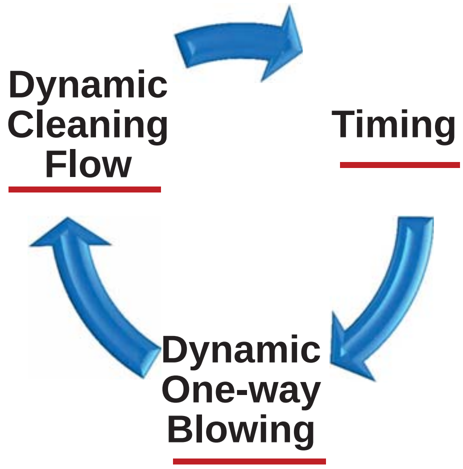
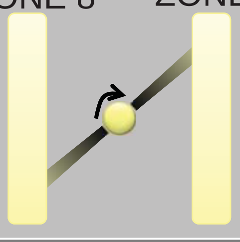
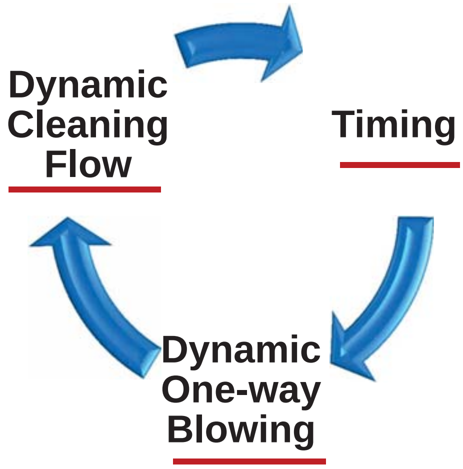


Steam Saving Strategy

Conventional ISB	NEW SMART Clean
Static setpoints	**Static with an option to set it as dynamic**
• 1-way blowing • 2-way blowing • Conditional 1-way • Decision based on static snapshot of historical data ZONE 8 ZONE 9  *Always 2-way even if zone 8 demands 1-way while zone 9 demand 2-ways.* ***WASTE of Steam***	• Same feature as the old system but add • Dynamic setpoint based on • $\%Removal\ Rtr = \frac{Removal\ (lb) retract}{Removal\ (lb) retract + insert}$ • 1-way if %Retract is low • 2-way if the zone is in trouble • Zone Specific ***Optimal usage of steam***
• Cleaning flow rate is a static setpoint	• Cleaning flow rate can be set as a function of %BL flow rate.

SMART Clean

- Guideline to set the cleaning flow….



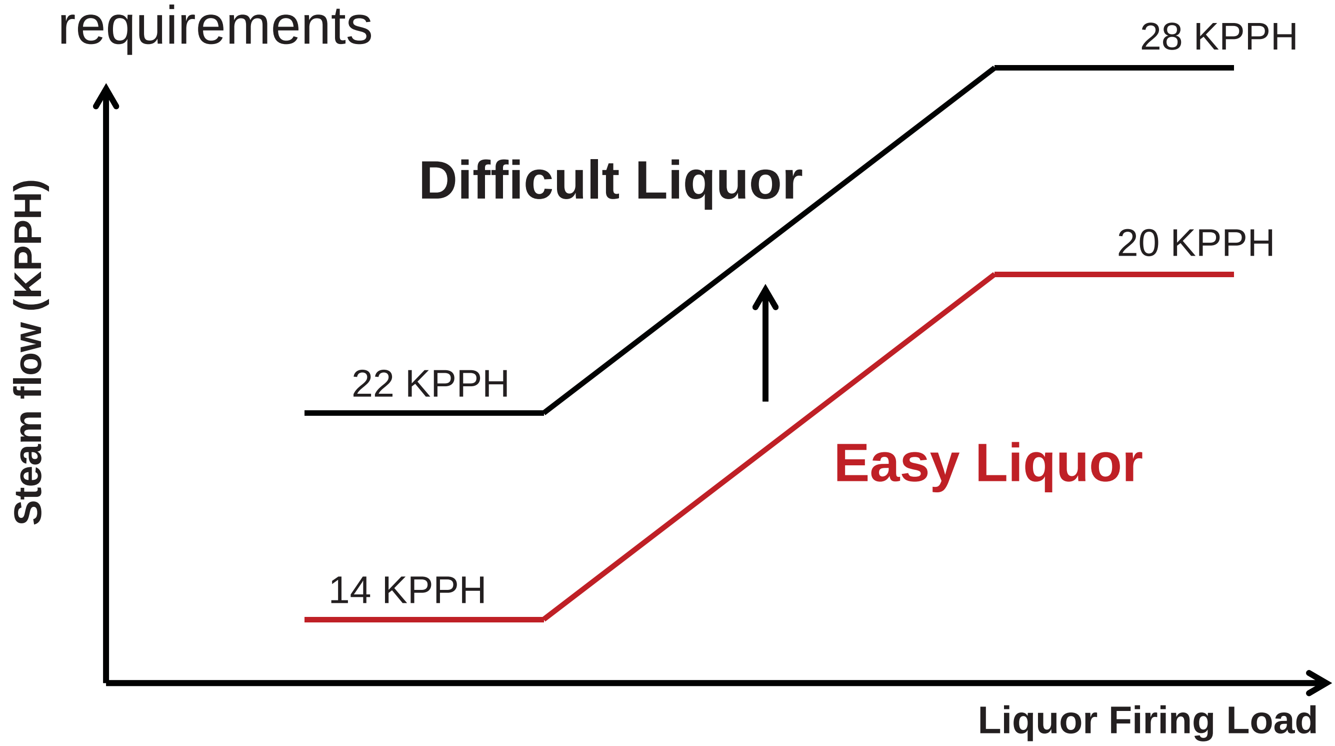
Example: Load based cleaning setpoint

	%BL flow rate	Cleaning Force
Very Low	< 50%	800 N (180 lbf)
Low	50% – 70%	900 N (200 lbf)
Typical	70% - 100%	1050 N (240 lbf)
High	> 100%	1200 N (270 lbf)

- The type of the nozzle determine steam KPPH
- Old inefficient nozzle requires more KPPH

How do we save steam

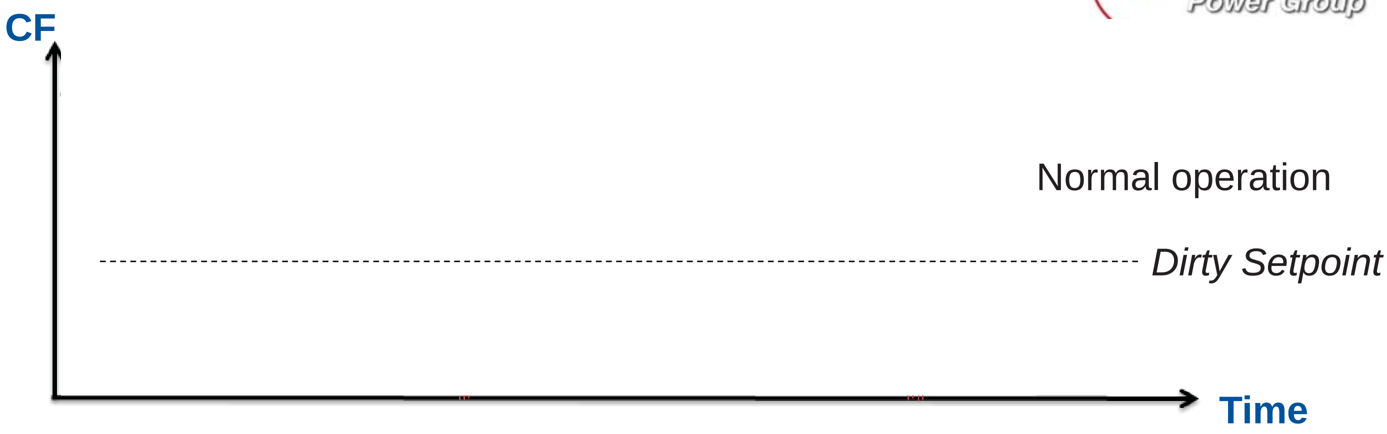
- Liquor Chemistry may increase the cleaning flow requirements



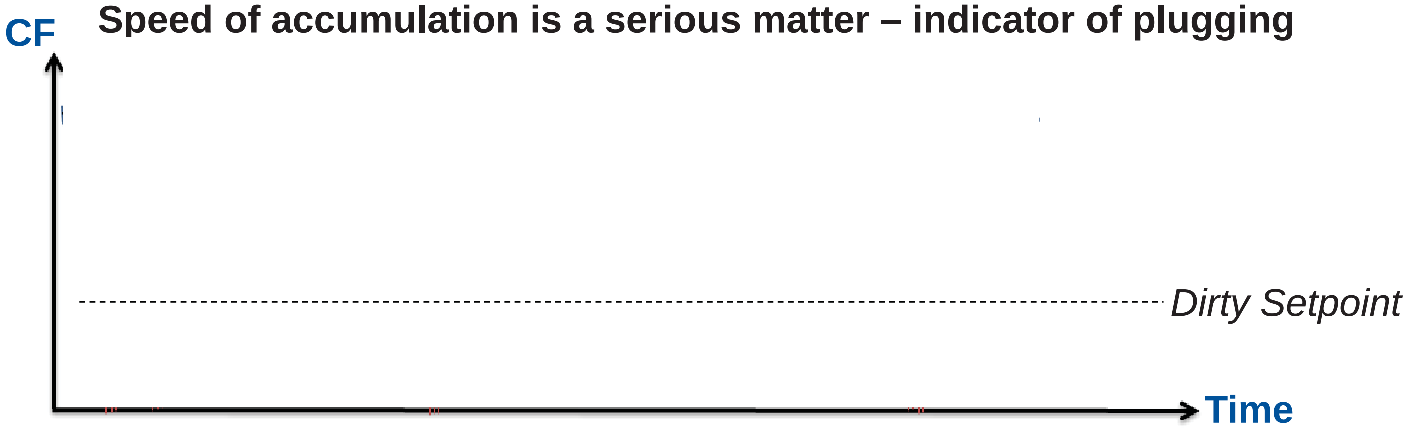
SMART Clean

- How do we save steam ?
- How do we prevent plugging ?
- How do we alert operator of danger ?
- Rule Based Operation

How do we help prevent plugging



Speed of accumulation is a serious matter – indicator of plugging



SMART Clean

- How do we save steam ?
- How do we prevent plugging ?
- How do we alert operator of danger ?
- Rule Based Operation

- Over cleaning can damage boiler tubes
- Stuck sootblower that goes undetected is a serious issue

2002 Oct. - 18	**EXPLOSION NO. 158**
Location:	**Weyerhaeuser, Plymouth, North Carolina**
Unit:	No. 5 Recovery Boiler. CE Contract No. 20673. Startup 1976. Revamp 2001 by B&W, Contract No. 63-C-03006.
Size:	5.8 million ppd solids. Operation- 863,000 lb/hr @ 875 psig & 825F. Design @ 1040 psig. 2 drum crossflow bank/ large economizer
Incident Date:	May 8, 2002
Leak/Incident Loc:	**Boiler Bank** – in Row 34, tube # 12 sheared off at the steam drum and tub # 13 cracked at the mud drum
Downtime hrs due to leak/total:	Hours out of service due to leak – 2566 hours (110 days)/
ESP?	ESP initiated. Current irrevocable policy is to stay out of area 12 hours.
Classification:	**EXPLOSION** – Smelt/water
How discovered:	Investigation after explosion.

Stuck sootblower – 4 hours

- Over cleaning can damage boiler tubes
- Stuck sootblower that goes undetected is a serious issue

2001October – 5	
Location:	**Weyerhaeuser, Flint River Mill, Oglethorpe, Georgia**
Unit:	No. 1 Recovery Boiler. B&W Contract No. PR-198. Start-up 1980.
Size:	4.3 million ppd solids. Operating @ 900 psig & 825F. Design @ 1175 psig. 2 drums/large 5 pass economizer
Incident Date:	March 20, 2001
Leak/Incident Loc:	**Economizer** - 270º circumferential crack around tube at top of attachment weld for the hold down bar lug in front row of tubes. Lug supports lowest baffle/vibration bar closest to lower headers
Downtime hrs due to leak/total:	Total downtime 52.3 hours
ESP?	No
Classification:	**Non-critical Incident**
How discovered:	Water/steam flow alarmed. Later discovered water in economizer hopper.
Leak detection:	Mass balance (chemical derived) type leak detection system was in operation but will not detect an economizer leak.
Sequence of events:	Sootblower No. 63 indicated 'power off'. Operator went to check & observed wrong SB. Started getting leak detection alarms for total steam flow. Operator would acknowledge, clear alarm, then alarm started again; this continued to end of shift. Hoppers were checked for water. At 7h-15m, alarm started for 'excessive feedwater loss'. At 10h-15m, technician found blown fuse in No. 63 starter. Went to inspect SB & found it fully inserted with steam flow. Blower retracted. During the 10 hours, no steam flow indication as 3 blowers at a time blowing & 4th exceeded steam flow upper limit. 'Excess FW' alarm continued for 5 h, then 'suspect tube leak' alarmed. No water in boiler hopper & water chemistry OK. At 15h-15m from 'power off' indication, turned off all SBs and walked boiler down. Found leak. Shutdown.
Bed cooling:	No
Wash adjacent tube:	No
Repair procedure:	Sectioned out tube for minimum replacement length of 18". Tube ends weld prepped and new section butt welded. Welds checked with shear wave (UT) & PT inspection. Tube sounded to verify no obstruction. Hydro tested.
Root cause:	Corrosion fatigue cracking initiated on inside of tube as a result of sootblower being stuck for extended period of time. Heat and vibration caused concentrated stress at hold down bar attachment weld
Future prevention:	Sootblower control system modified to prevent the blowers from running if a failure was detected on any individual blower
Last full inspection:	October 2000

- Over cleaning can damage boiler tubes
- Stuck sootblower that goes undetected is a serious issue

Spring 2006 -12	
Location:	**International Paper, Pine Bluff Mill, Arkansas**
Unit:	No. 3 Recovery Boiler. B&W Contract PR-60. Startup 1960. Replacement economizer ~ 20 yrs old
Size:	1.17 million ppd solids. Steam flow 202,000 lb/hr. Operating @ 1250 psig & 950F. Design @ 1425 psig. 2 drum boiler/ horizontal tube economizer/ DCE
Incident Date:	January 24, 2006
Leak/Incident Loc:	**Economizer** – a 1/8" pinhole leak was found in the 3rd tube below a tube that ruptured. Rupture in tube No. 3, element No. 3, sootblower pass No. 38
Downtime hrs due to leak/total:	Total downtime 73 hours
ESP?	Yes. Shift manager was in control room and immediately initiated ESP
Classification:	**Non-critical incident**
How discovered:	Control room operator observed a sudden loss of water in the steam drum and high furnace pressure.
Leak detection:	No
Sequence of events:	See above
Bed cooling:	Mill has an installation for using bicarbonate with nitrogen for cooling
Wash adjacent tube:	Yes
Repair procedure:	Sections of tubes replaced with new material
Root cause:	Pin hole leak resulted from erosion by sootblower steam
Future prevention:	Tube area closely monitored with inspection and repair. Tube shields are in place.
Last full inspection:	Visual & PT inspection of area during annual I&R May 2005. Acid cleaned May 2004

How do alert danger

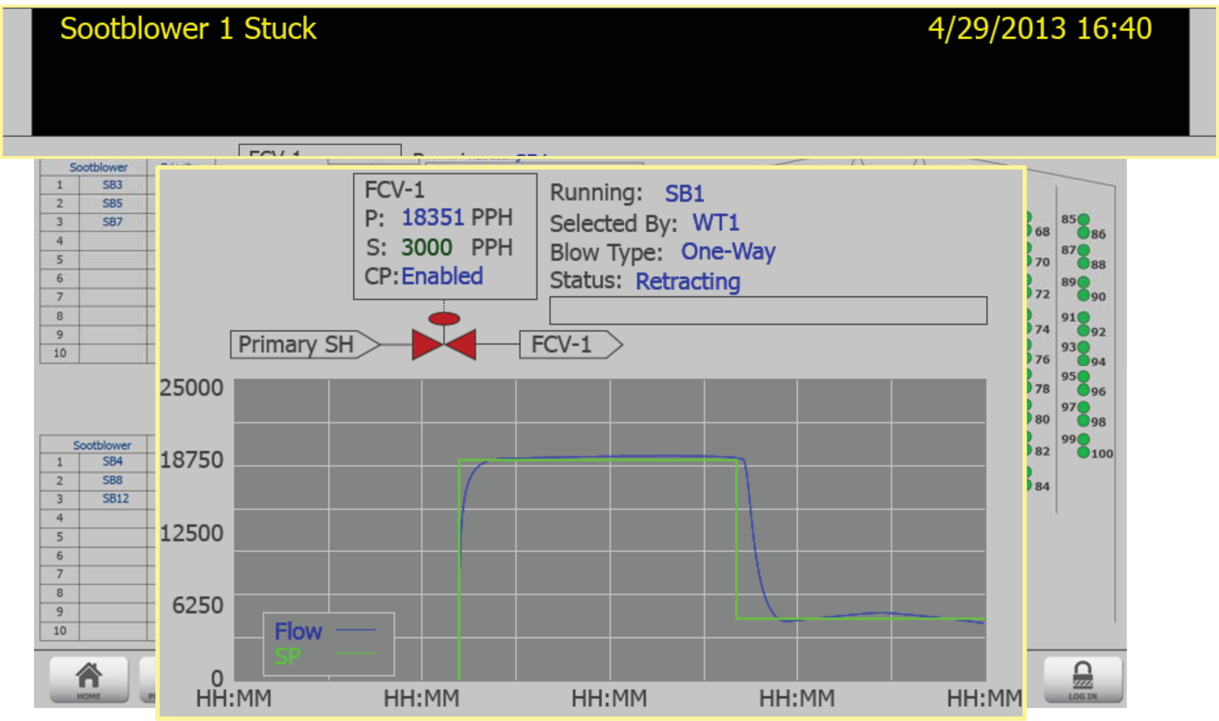
- Over cleaning can damage boiler tubes
- Stuck sootblower that goes undetected is a serious issue

2001October – 14	
Location:	**Smurfit-Stone Container Corporation, Brewton Alabama**
Unit:	Recovery Boiler No.2. B&W Contract No. PR-79. Start-up 1963
Size:	1.1 million ppd solids. Operating @ 860 psig & 830F. Design @ 975 psig. 2 drum/ DCE
Incident Date:	May 19, 2001
Leak/Incident Loc:	**Superheater** – primary superheater tube in Platen No. 20 (from right side) sheared off just below roof formed as a continuation of front wall tubes. Tube, next to sootblower cavity, sheared 12" below the roof at a 30º bend in tube that passes through the roof for support and then enters tube row on other side of cavity (a 180º bend). 3rd failure in same bend of 3 elements
Downtime hrs due to leak/total:	Downtime due to ESP – 54-3/4 hrs/total downtime – 65-1/2 hrs
ESP?	ESP was performed. Irrevocable policy is to stay out of recovery area 8 hours
Classification:	**Non-critical Incident**
How discovered:	Operator got a furnace high pressure alarm, a swing in drum level, a drop in steam flow, with a blowing noise in furnace
Leak detection:	None installed
Sequence of events:	Based on above discoveries, operator ESPd the boiler
Bed cooling:	No
Wash adjacent tube:	No
Repair procedure:	Removed superheater element and plugged stubs at headers
Root cause:	Stress fatigue due to cyclic stress as a result of sootblower operation. All 3 failures in area where blowers reverse.
Future prevention:	Installed ½" x 4" x 4' flat bar across the sootblower cavity; bar strapped to tubes with u-bolts to prevent tube movement
Last full inspection:	Inspection March 2001. Chemically cleaned 15 years ago

Animation

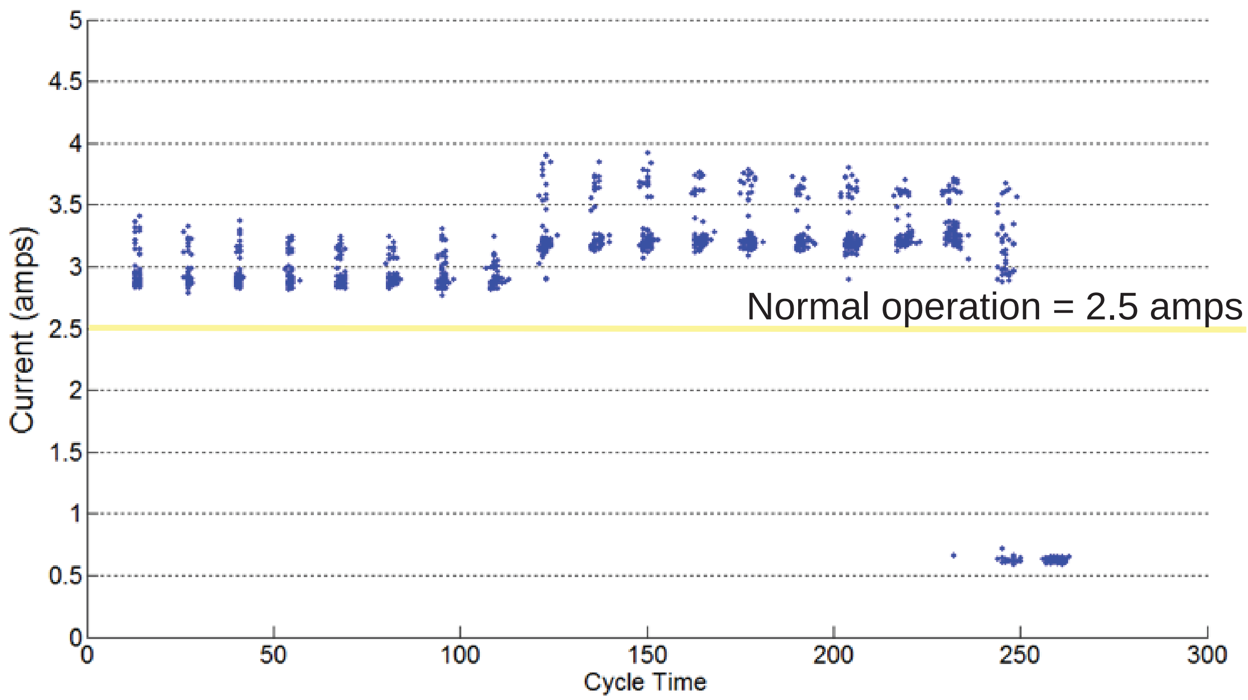
Sootblower Stuck

- Detect stuck sootblowers, automatically reduce flow and generate an alarm

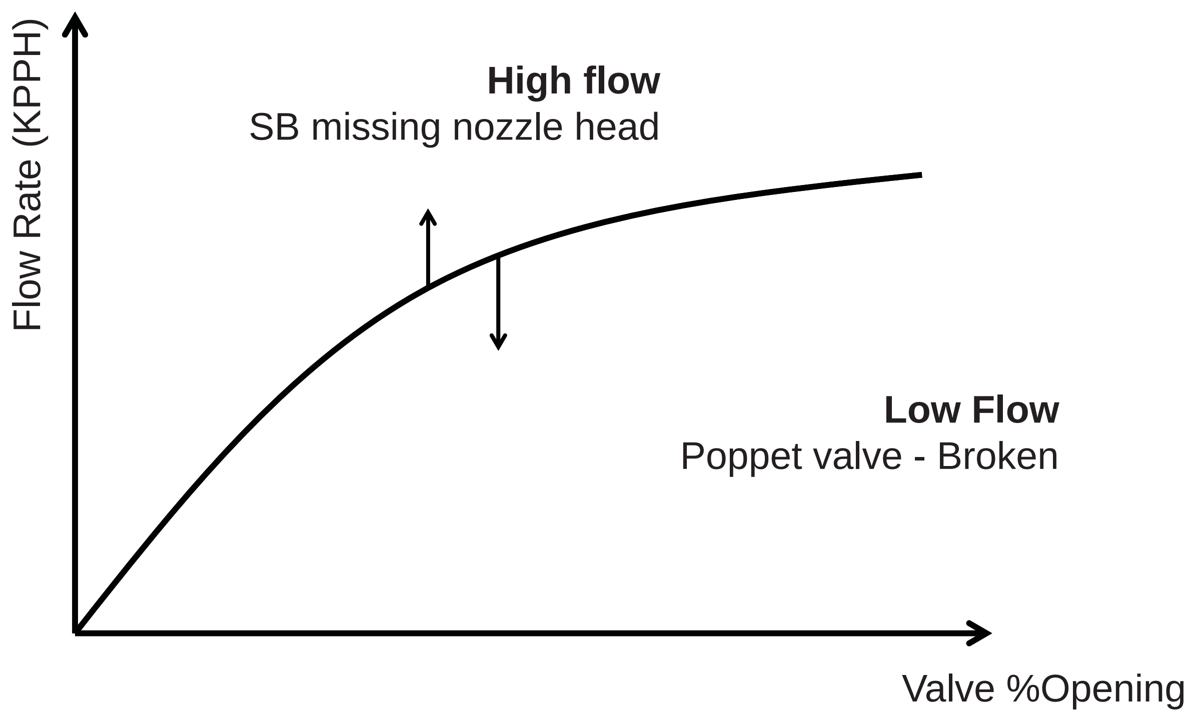


Example: Motor Current

K42 Recovery Boiler 3



Valve opening Vs Flow Rate



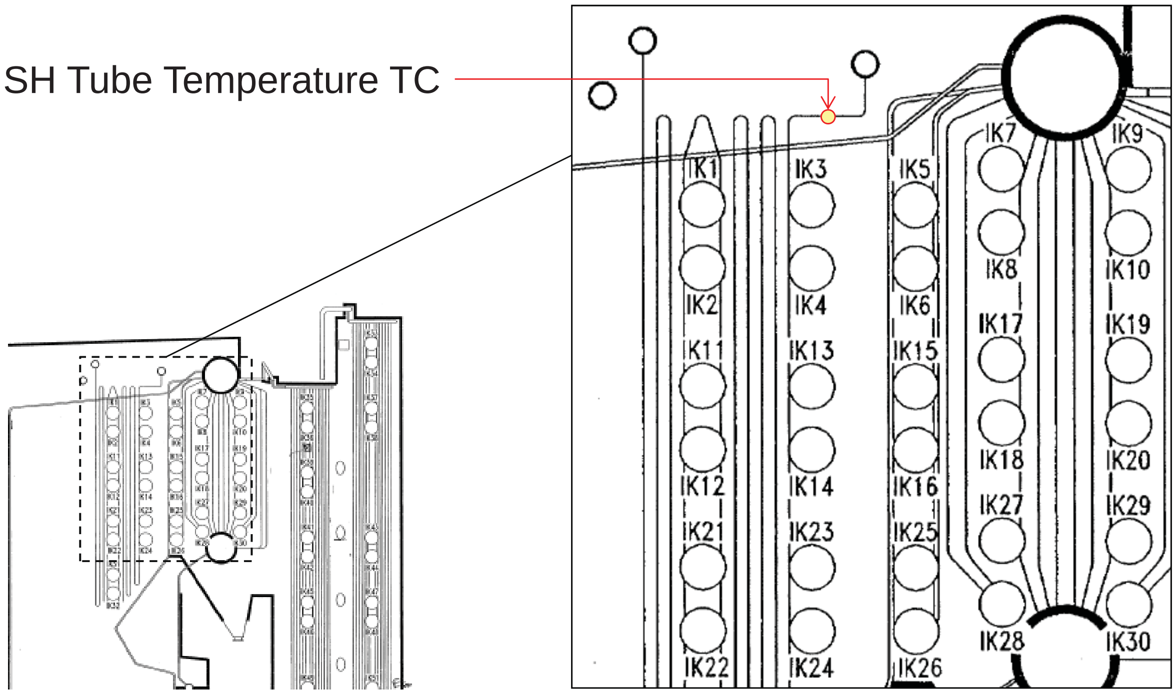
SMART Clean

- How do we save steam ?
- How do we prevent plugging ?
- How do we alert operator of danger ?
- Rule Based Operation

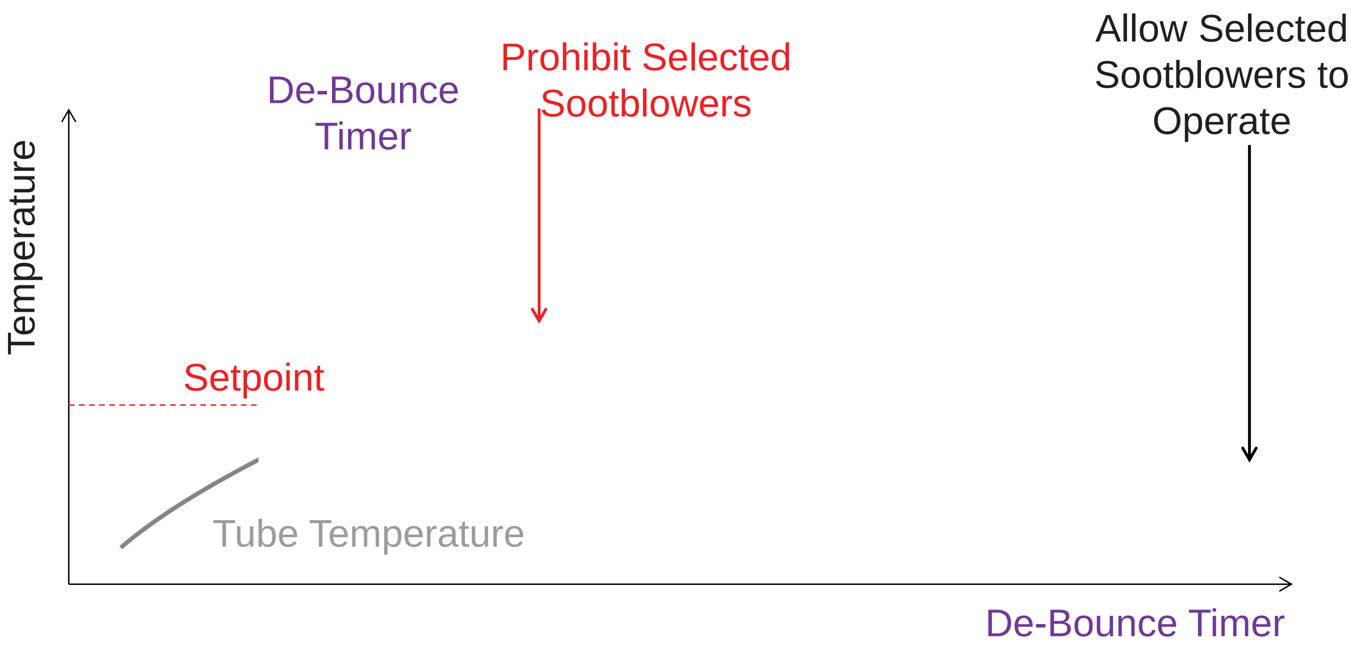
Rule Based

- Prevent certain SB(s) to be operated OR Run certain SB(s) if a condition is met
  - ➔ Opacity
  - ➔ T_{main} control

- Superheater sootblowers are often disabled due to high superheater tube temperatures.



- Rules can operate or prohibit sootblowing based on supplemental boiler operational feedback



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UUDET VESIKEMIAN OHJEARVOT JA KÄYTÄNTÖ

Jani Vuorinen
Vesi-ihminen Tmi

UUDET OHJEARVOT JA KÄYTÄNTÖ

Soodakattilapäivä 2013, Vantaa

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Ohjearvot 2011


Suomen Soodakattilayhdistys ry

Vesikemian ohjearvot

Jani Vuorinen, Maija Vidqvist
Teollisuuden Vesi Oy

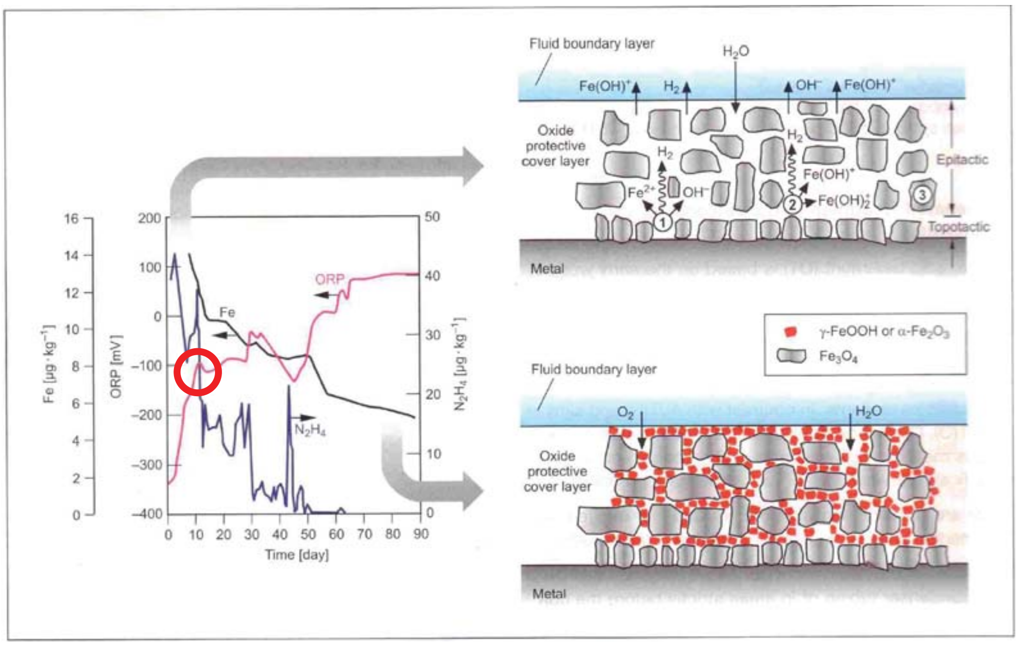
9.12.2011

- Julkaistu 2011
- Esitelty 2012
- Esittelee tyypillisiä vesipuolen ongelmakohteita/-tyyppejä
- Syöttövesi- ja kattilavesikemia
- Valvonta

Syöttövesikemiasta

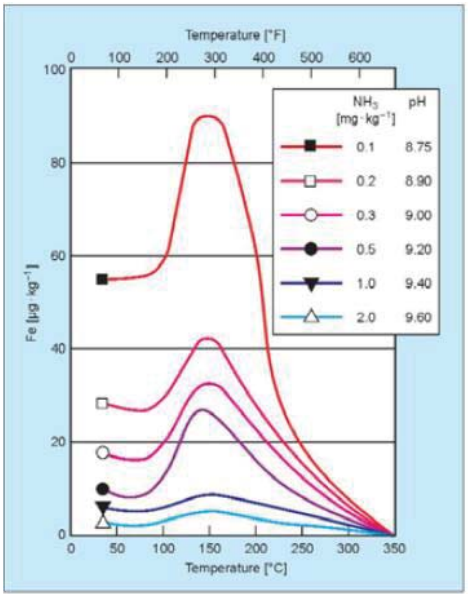
- Rauta ja monimetalliprosesseille (kupari) oma kemiansa
- Hapenpoistokemikaalin käytön arviointi ja mahdollisuuksien mukaan minimointi.
- pH tason nosto raudan niukkaliukoisuus alueelle.
- Ammoniakin käyttäminen ja orgaanisten amiinien käytön vähentäminen

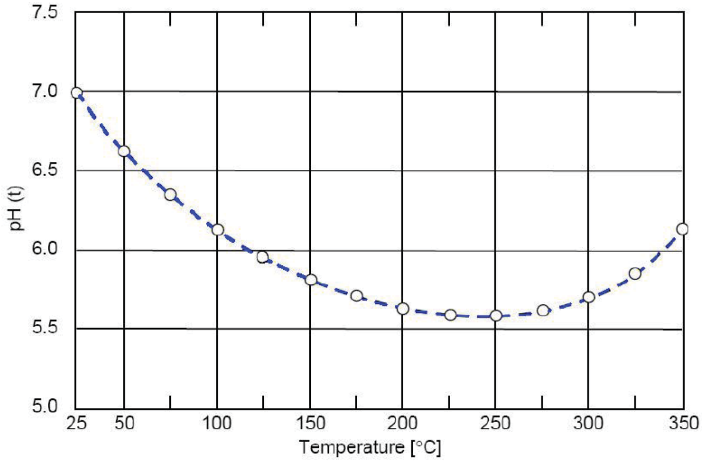
Hapenpoistosta



Kuva 1. hapetus-pelkistyspotentiaali ja oksidikalvo / J.A Mathews 2012

Raudan liukoisuudesta

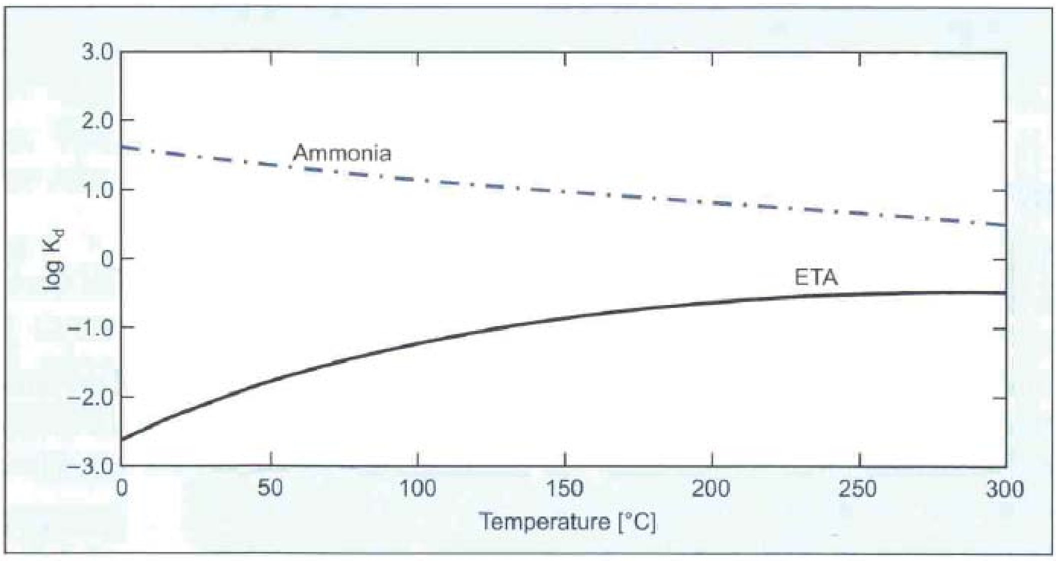




Kuva 3. Neutraalin veden pH lämpötilan funktiona / J. Mathews 2010

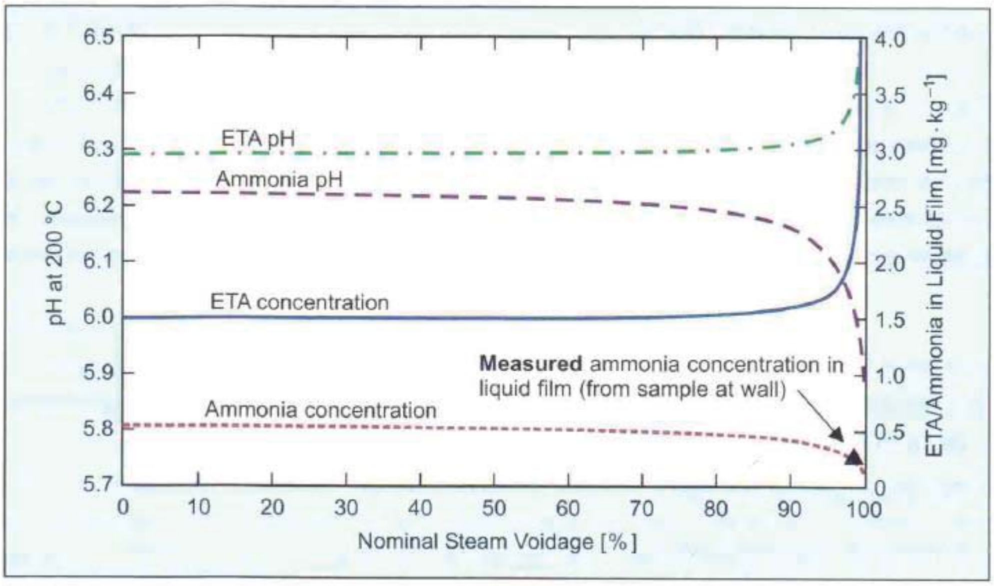
Kuva 2. Raudan liukoisuus, pH ja lämpötila eri ammoniakkipitoisuuksilla / P. Sturla 1973

Ammoniakki ja ETA



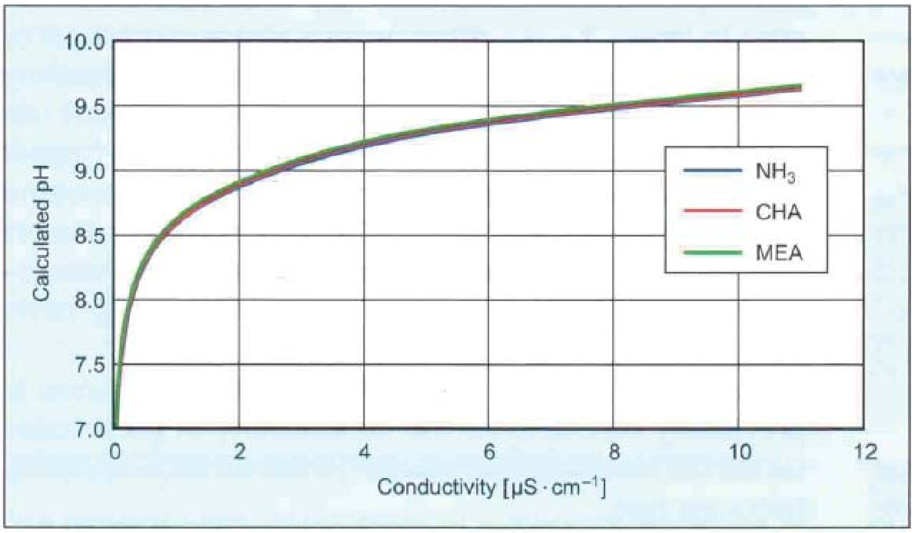
Kuva 4. Ammoniakin ja ETA:n jakautumiskerroin lämpötilan funktiona / C. Lertsurasakda 2013

Ammoniakki ja ETA



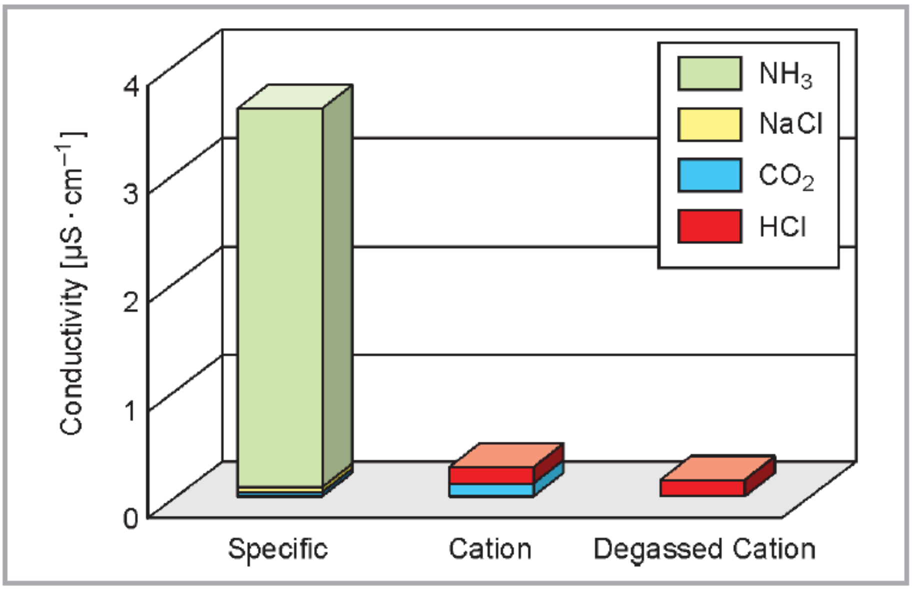
Kuva 5. Nestefilmin laskennallinen pH ammoniakilla ja ETA:lla höyryn osuuden funktiona lämpötilassa 200 °C / C. Lertsurasakda 2013

Suora johtokyky



Kuva 6. Amiinien, monoetanoliamiini (MEA) ja sykloheksyyliamiini (CHA) sekä ammoniakin pH vs jk kuvaaja / W. Hater 2013

Johtokyvystä



Kuva 7. Suora, kationivaihdettu ja kaasupoistettu kationivaihdettu johtokyky / D. Gray 2005

Case 1

- Kiinteän polttoaineen kattila 82 bar/525 °C
- Kahden painetason HRSG KP 82 bar/525 °C ja MP 5 bar/195 °C.
- Tavoitteena:
  - vähentää orgaanisen aineen määrää vesi-höyrykierrossa valvonnan helpottamiseksi
  - laskea höyryjen kationivaihdettua jk sekä
  - nostaa vesi-höyrykierron pH:a ilman TOC pitoisuuden nousua

Case 1

- Korvattiin käytetyn kemikaalin MOPA NH_3:lla
- Laskettiin hapenpoistajan annostelua
- Nostettiin SYVEn pH tasoa noin 9,0 → 9,3 – 9,4
- Saavutettiin:

Case 1

Syöttövesi, ammoniakki/orgaaninen amiini ei kuparimateriaaleja		Optimoitu vesikemia (O)	Toimintaraja 1 (TR 1)			
			ammoniakki	ammoniakki ja orgaaninen amiini	Lähtötilanne	Muutos
pH		9,3 - 9,6	9,3 - 9,6		8,96	9,34
Kationivaihdettu johtokyky [1]	mS/m	≤ 0,02	0,03	0,05	0,05	0,05
SiO_2	µg/kg	≤ 5	10			
Na	µg/kg	≤ 5	10			
TOC [2]	µg/kg	< 100	200	600	630	180
O_2	µg/kg	5 - 20 [3]	1 - 5		< 10	< 5
Fe (kokonais)	µg/kg	≤ 5	10			

Taulukko 1. Ohjearvotyön SYVE ja Case 1.

Case 2

- Soodakattila 100 bar/498 °C
- Tavoitteena:
  - vähentää orgaanisen aineen määrää vesi-höyrykierrossa
  - laskea höyryjen kationivaihdettua jk sekä
  - saavuttaa mahdollisuus nostaa vesi-höyrykierron ja erityisesti ensilauhteen pH:a ilman TOC pitoisuuden nousua

Case 2

Syöttövesi, ammoniakki/orgaaninen amiini ei kuparimateriaaleja		Optimoitu vesikemia (O)	Toimintaraja 1 (TR 1)			
			ammoniakki	ammoniakki ja orgaaninen amiini	Lähtötilanne	Muutos
pH		9,3 - 9,6	9,3 - 9,6		9,3	9,3
Kationivaihdettu johtokyky (1	mS/m	≤ 0,02	0,03	0,05	0,02	0,02
SiO_2	µg/kg	≤ 5	10			
Na	µg/kg	≤ 5	10			
TOC (2	µg/kg	< 100	200	600	1000	500
O_2	µg/kg	5 - 20 (3	1 - 5			
Fe (kokonais)	µg/kg	≤ 5	10		≈ 5	≈ 5

Taulukko 2. Ohjearvotyön SYVE ja Case 2.

Case 2

Höyry, ammoniakki/orgaaninen amiini - fosfaattikemia ei kuparimateriaaleja		Optimoitu vesikemia (O)	Toimintaraja 1 (TR 1)			
			ammoniakki	ammoniakki ja orgaaninen amiini	Lähtötilanne	Muutos
pH		9,3 - 9,6	9,3 - 9,6		9,3 →	9,3
Kationivaihdettu johtokyky (1	mS/m	≤ 0,02	0,03	0,05	0,04 →	0,03
SiO_2	µg/kg	≤ 5	10			
Na	µg/kg	≤ 5	10			
Cl	µg/kg	< 3	3			
SO_4	µg/kg	< 3	3			
TOC (2	µg/kg	< 100 (3	100 (4	500 (4	800 →	300
Fe (kokonais)	µg/kg	≤ 5	10		≈ 5 →	≈ 5

Taulukko 3. Ohjearvotyön TUHÖ ja Case 2.

Standardityö kattilakemiassa

- Työryhmä 85
- Valmistunut 8501 ”Voimalaitoksen vesikemia. Näytteenottolaitteisto, suunnittelu ja hankinta”
- Työstetään 8502 ”Voimalaitoksen vesikemia. Näyte- ja kemikaaliannosteluyhteen sijoittaminen prosessiin”

PSK Standardisointi
PSK Standards Association

STANDARDI
Ehdotus 10
2013-09-26

PSK 8501

VOIMALAITOKSEN VESIKEMIA. NÄYTTEENOTTOLAITTEISTO. SUUNNITTELU JA HANKINTA
Power plant water chemistry. Sampling system. Design and procurement

Ristiriitatapauksissa pätee suomenkielinen teksti

In the case of a conflict the Finnish text shall prevail

Sisällys

Contents

1 SOVELTAMISALA

Tässä standardissa annetaan ohjeita voimalaitoksen vesikemiassa tarvittavan näytteenottolaitteiston suunnitteluun ja hankintaan. Lisäksi standardin liitteenä on hankintalomake, joka ohjaa hyväksi koettujen ratkaisujen valinnassa.

1 SCOPE

This standard provides instructions for the design and procurement of a sampling system for power plant water chemistry. The standard also contains a procurement form providing guidance for the selection of well proven solutions.

2 VIITTAUKSET

PSK 7807 Hitsausyhteet. Veden näytteenottoyhde. 2001

PSK 7808 Hitsausyhteet. Kylläisen höyryn näytteenottoyhde. 2001

2 REFERENCES

PSK 7807 Weldable branch couplings. Water sample probe. 2001

PSK 7808 Weldable branch couplings. Saturated steam sample probe. 2001

MYYNTI: PSK Standardisointiyhdistys ry, PUH. (09) 72 880 880
WWW-OSOITE: www.psk-standardisointi.fi, SÄHKÖPOSTI psk(a)psk-standardisointi.fi

PSK 7809 Hitsausyhteet. Tulistetun höyryn näytteenottoyhde. 2001

SFS 3977 Putki-, säiliö- ja laite-eristykset. Mitoitus. 2008

SFS 3978 Putki-, säiliö- ja laite-eristykset. Lämpöeristystyön suoritus. 2009

PSK 7809 Weldable branch couplings. Superheated steam sample probe. 2001

SFS 3977 Insulation of pipes, vessels and equipment. Dimensioning. 2008

SFS 3978 Insulation of pipes, vessels and equipment. Application of thermal insulation. 2009

3 KÄSITTEET JA MÄÄRITELMÄT

Näytteenottojärjestelmä
on kokonaisuus näytteenotosta näytteen keräilyyn/analysointiin, mikä mahdollistaa kattilalaitoksen vesi-höyrypiirin vesikemian ja kunnon valvonnan laitoksen eri käyttötilanteissa.

Edustava näyte
tarkoittaa virhelähteistä vapaata näytettä. Virhelähteitä voivat olla esimerkiksi väärä virtausprofiili prosessiputkessa tai näyteputken sisäpuolinen korroosio.

Monifaasisysteemi
tarkoittaa tilannetta, jossa virtauksessa esiintyy kaksi tai useampia olomuotoja esimerkiksi kiinteitä oksideja, saostumia, nestepisaroita tai höyryä samanaikaisesti.

Isokineettisyys
tarkoittaa näytevirtausta näytteenottoyhteeseen samalla nopeudella kuin päävirtaus on prosessiputkessa. Isokineettisessä näytteenotossa kaikki olomuodot ovat näytteessä edustettuina samassa suhteessa kuin päävirtauksessa.

Epäjatkuvuuskohta
aiheuttaa virtausprofiilin muutoksen, joka on epäedullinen näytteenotolle. Näytteenottokohta pitää olla riittävän kaukana esimerkiksi säätöventtiileistä ja putken käyristä, jotta näytteestä saadaan edustava.

Tasapaino
tarkoittaa näytelinjan sisäpinnan ja tulevan näytteen välistä olotilaa, jolloin näyte on edustava.

3 TERMS AND DEFINITIONS

A sampling system
is a complete assembly from sample-taking to sample collection/analysis, enabling control of water chemistry and condition monitoring of the water/steam circulation in boiler plants in different operating situations.

A representative sample
is a sample free of error sources such as a wrong flow profile in a process pipe or corrosion inside a sample pipe.

A multiphase system
means a situation where the flow contains two or more phases of medium simultaneously, for example solid oxides, precipitation, fluid drops or steam.

Isokineticity
means the sample flow entering a sample probe at a velocity equal to that of the overall stream in the process pipe. In isokinetic sampling, all phases of medium are represented in the sample in the same ratio as in the overall stream.

Discontinuity
causes a change in the flow profile which is unfavourable with respect to the sampling procedure. The sampling point must be located adequately far from, for example, control valves and pipe elbows in order to ensure a representative sample.

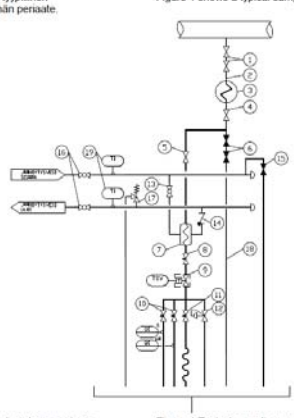
Equilibrium
means the state between the inner surface of the sampling line and the incoming sample, when the sample is representative.

4 JÄRJESTELMÄN KUVAUS

Kuvassa 1 on esitetty tyypillinen näytteenottojärjestelmän periaate.

4 DESCRIPTION OF SAMPLING SYSTEM

Figure 1 shows a typical sampling system design.



Kuva 1 Näytteenottojärjestelmän periaate

Figure 1 Typical sampling system design

Kuvassa 1 esitetty näytteenottojärjestelmä koostuu seuraavista osista:

1 Prosessiyhde ja juuriventtiili
2 Näytteenottoputkisto
3 Esijäähdytin
4 Käsikäyttöinen turvaventtiili
5 Tuloventtiili
6 Puhallusventtiilit
7 Näytejäähdytin
8 Näytteenrajoitusventtiili
9 Näytteenlämpösuojaventtiili
10 Näytteensäätöventtiilit
11 Käsinäyteventtiili
12 Vastapainesäädin
13 Jäähdyttimen jäähdytysveden tuloventtiili
14 Jäähdyttimen jäähdytysveden takaiskuventtiili
15 Jäähdytysveden ilmaus- ja näyteventtiili
16 Jäähdytyskierron sulkuventtiilit
17 Jäähdytysveden varoventtiili
18 Puhalluslinja
19 Lämpömittarit

The sampling system presented in figure 1 consists of the following components:

1 Process connection and root valve
2 Sampling line
3 Pre-cooler
4 Manual safety valve
5 Inlet valve
6 Blowdown valve
7 Sample cooler
8 Sample regulating valve
9 High temp shut-off valve
10 Sample control valves
11 Grab sample valve
12 Back pressure valve
13 Cooling water inlet valve
14 Cooling water check valve
15 Cooling water venting and sampling valve
16 Cooling circulation shut-off valves
17 Cooling water relief valve
18 Blowdown line
19 Thermometers

Tilaaja	
Tehdas / laitos	
Projekti	
PI-kaavio liitteenä Kyllä ☐ Ei ☐	**Toimintakuvaus liitteenä** Kyllä ☐ Ei ☐

Suunnitteluarvot

Positio	Näyteenotto-putki	Suunnittelu-paine PS	Suunnittelu-lämpötila TS	Käyttö-paine	Käyttö-lämpötila °C
QX-007	Syöttövesi	240 bar	222 °C	bar	222 °C
QX-010					
QX-222					

Analyysimittaukset

Positio	Näyteenottoputki	pH	C	Ck	DC	O_2	Na	SiO_2	Lab		
QX-007	Syöttövesi	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
QX-010		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
QX-222		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

pH = happamuus
C = sähkönjohtavuus
Ck = sähkönjohtavuus kationivaihtimen jälkeen
DC = sähkönjohtavuus kationivaihtimen ja kaasunpoiston jälkeen
O_2 = liuennut happi
Na = natriumpitoisuus
SiO_2 = silikaattipitoisuus
Lab = laboratoriomittaus

Jäähdytysvesi

Vesi ☐ Vesi/glykoliseos ☐ ___/___%

Käyttölämpötila	°C
Korkein lämpötila	°C
Suunnittelupaine	MPa
Kloridipitoisuus	mg/dm^3
Happamuus	pH

Liitäntä laitokseen

Näytteenottokeskusken äärimitat (K x L x S)

Jäähdytysvesiputkisto DN xx / PN xx

Näytevesikourun poistoputken liitäntä DN xx / PN xx

Näytelinjojen liitännät: Päittäishitsaus ☒ Holkkihitsaus ☐ Puristusrengas ☐

2013-09-26

LIGNIN RECOVERY –
ANDRITZ'S EVALUATIONS AND DEVELOPMENT WORK

Paterson McKeough
Andritz Oy

Lignin recovery – Andritz's evaluations and development work

Paterson McKeough, Joel Leffler and Johan Riseń

www.andritz.com

Soodakattilapäivä, Vantaa, 31.10.2013

We accept the challenge!

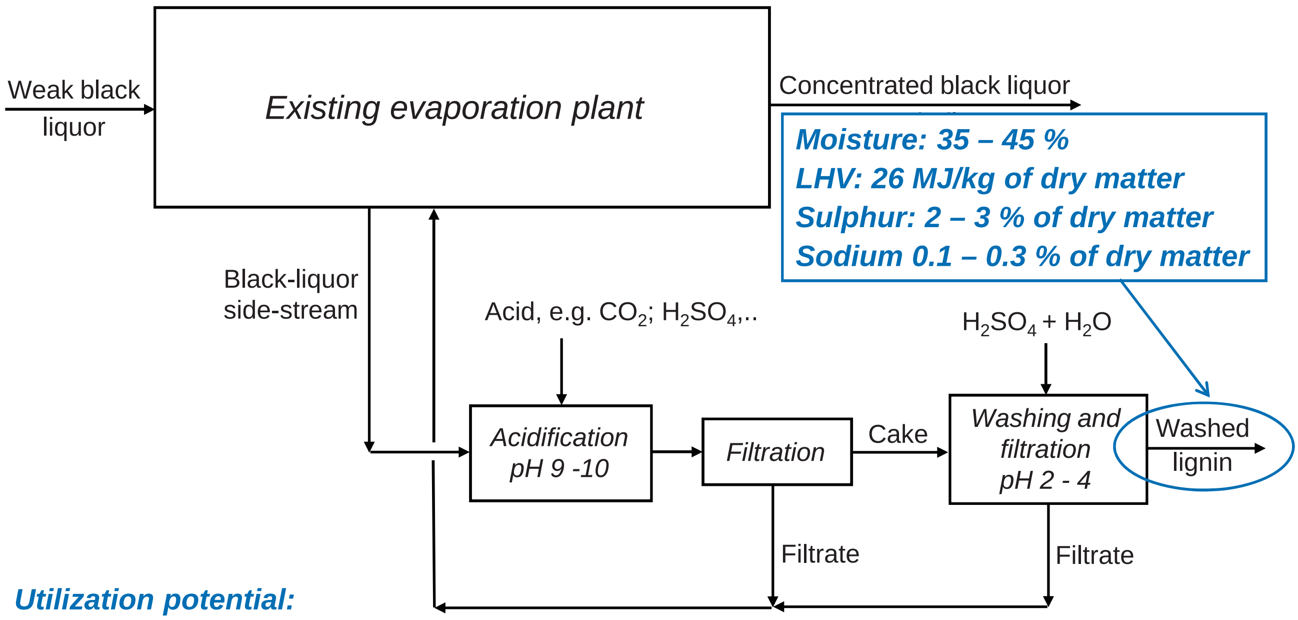
Lignin recovery – Andritz's evaluations and development work

Part 1. Pre-studies

- Main principles / features of process
- Cost estimates
- Cost competitiveness vs. those of existing products
- Conclusions and outcome of pre-studies

Principles of recovery of lignin from kraft black liquor

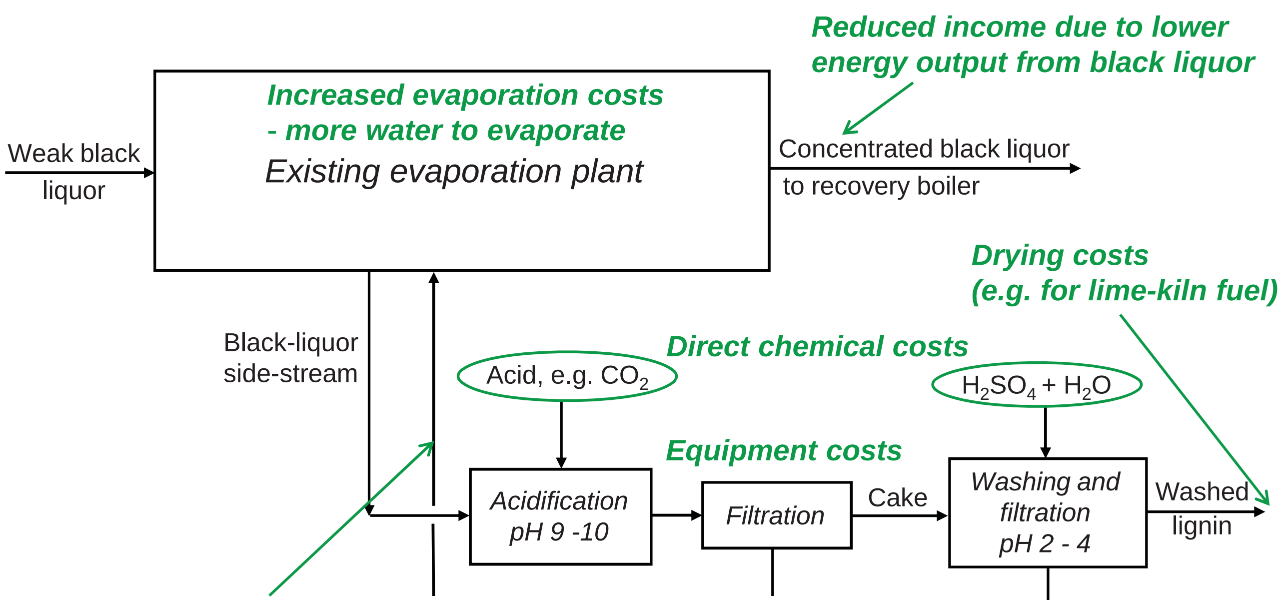
Essentially known technology, commercially applied earlier on



Utilization potential:
- ***in near future: as fuel, e.g. lime-kiln fuel (after drying)***
- ***higher-value applications expected in the longer term***

Principles of recovery of lignin from kraft black liquor

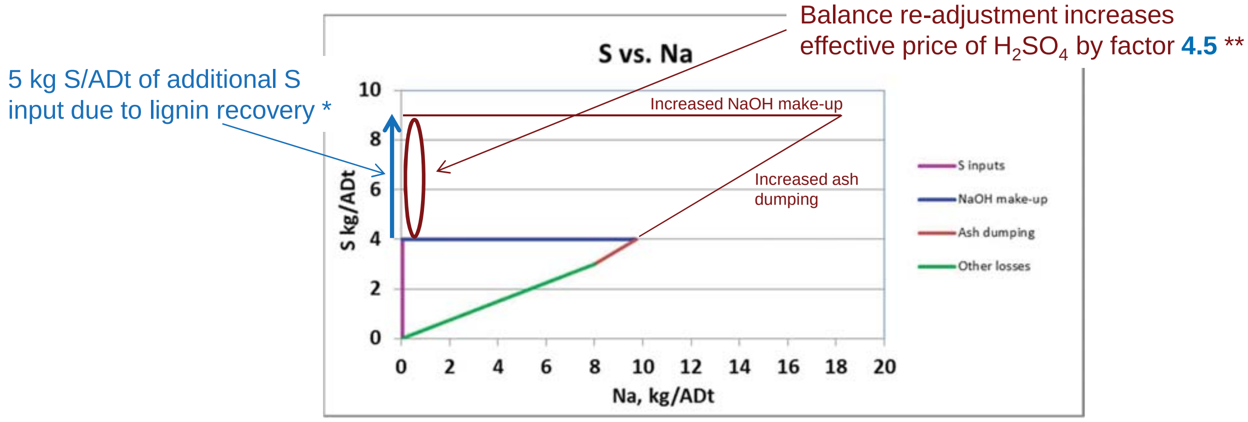
Production costs



Costs of re-adjusting mill Na/S balance. These indirect chemical costs are significant because of the considerable S input to the cycle (with H_2SO_4). E.g. for a withdrawal of 10 % of black-liquor energy, the S input would be at least 5 kg S per ADt.

Indirect costs of sulphuric-acid utilization

Case 1: Prior to H_2SO_4 input, mill already has moderate to high S input with ash dumping being used to control the mill sulphidity level. This is the least advantageous initial situation, leading to the highest balancing costs.



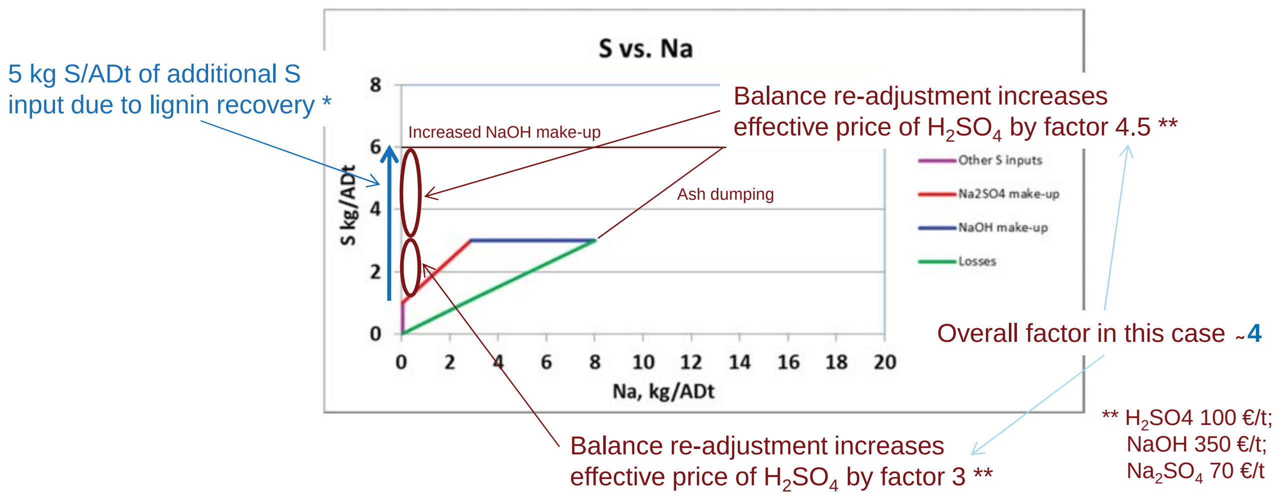
** H_2SO4 100 €/t; NaOH 350 €/t

* Lignin production 75 kg/ADt, which, in the case of recovery-boiler de-bottlenecking, would allow about a 10 % increase in pulp production

ANDRITZ Pulp & Paper

Indirect costs of sulphuric-acid utilization

Case 2: Prior to H_2SO_4 input, mill has relatively low S input and, furthermore, ash dumping is not required to purge non-process elements. This is the most advantageous initial situation, leading to the lowest balancing costs.



** H_2SO4 100 €/t;
NaOH 350 €/t;
Na_2SO_4 70 €/t

* Lignin production 75 kg/ADt, which, in the case of recovery-boiler de-bottlenecking, would allow about a 10 % increase in pulp production

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Our pre-studies: example of estimated operating costs

	€/t of lignin solids
Operating costs	
Loss of black-liquor energy for producing steam @ 16 €/MWh	115
CO_2 for acidification @ 125 €/t	35
H_2SO_4 for washing @ 100 €/t	20
NaOH for re-adjusting Na/S balance* @ 350 €/t	75
Extra steam for evaporation @ 21 €/MWh	20
Heat for lignin drying @ 23 €/MWh	10
Electricity @ 50 €/MWh	15
Labour, including maintenance	15
Total operating costs	**305 €/t**
	42 €/MWh of lignin solids

Two major cost areas:

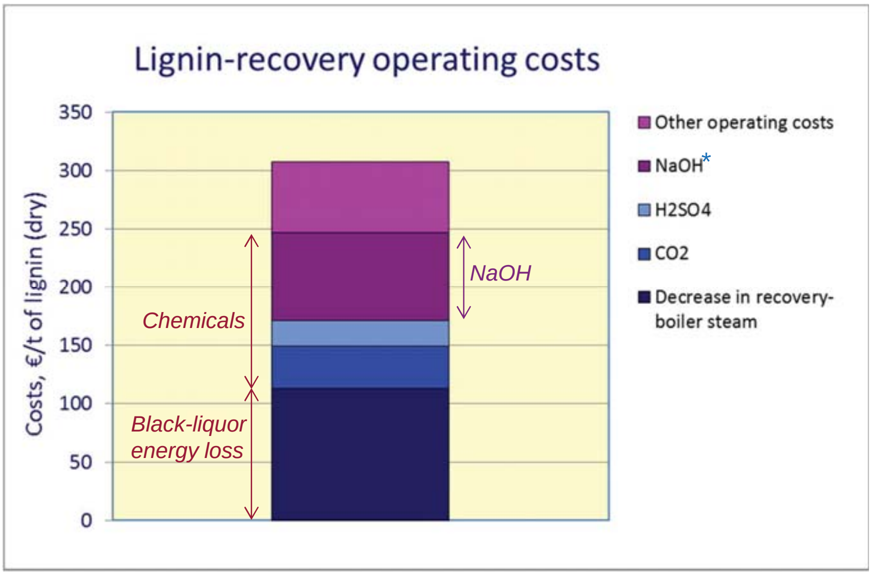
(1) loss of energy production in recovery boiler

(2) cost of chemicals

* all added S in added H_2SO_4 purged via ash dumping; Case 1 from previous slide

Our pre-studies: example of estimated operating costs

And in graphical form:

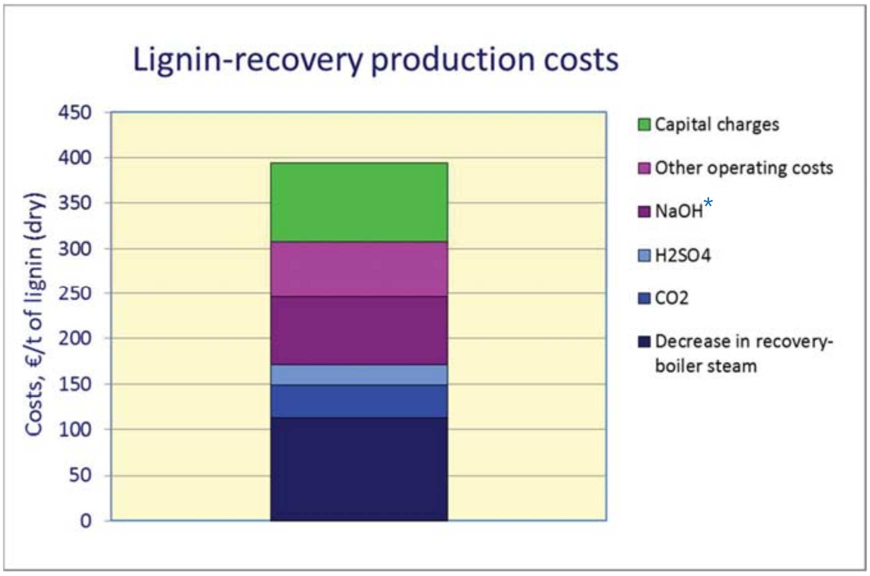


* all added S in added H_2SO_4 purged via ash dumping; Case 1 from previous slide

Our pre-studies: example of estimated production costs

Production costs = operating costs + capital-related charges

Bases of estimate of capital-related charges: (1) capacity of plant: 50 000 t/a lignin dry matter, (2) estimated cost of plant 23 M€, (3) capital-charges factor 20 % p.a., covering also overheads, insurances, etc.**



* all added S in added H_2SO_4 purged via ash dumping; Case 1 from previous slide

** Includes dryer; assumes existing evaporator can handle increased evaporation demand

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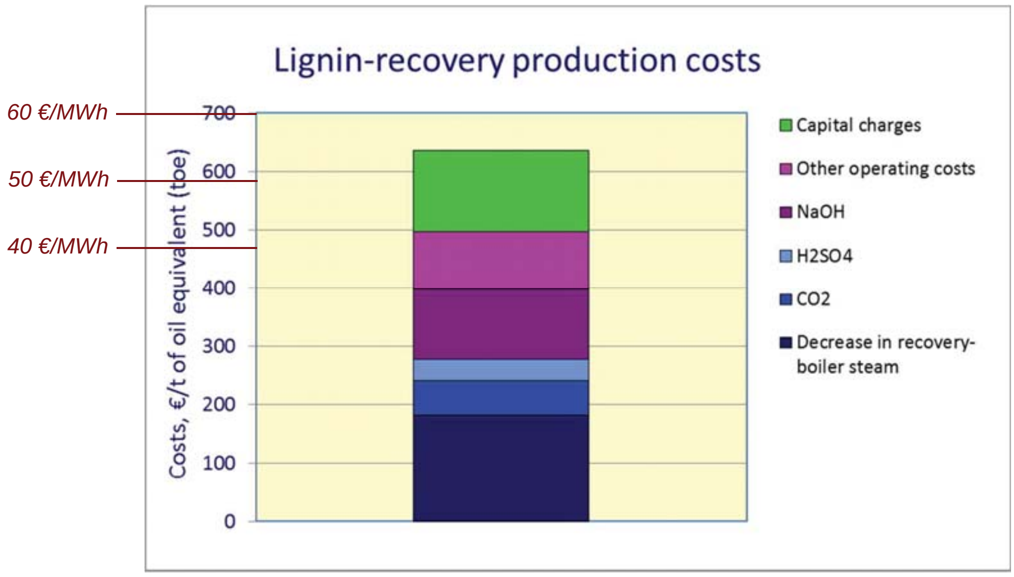
Our pre-studies: example of estimated production costs

Production costs = operating costs + capital charges

And presented as € per ton of oil-equivalent (toe):



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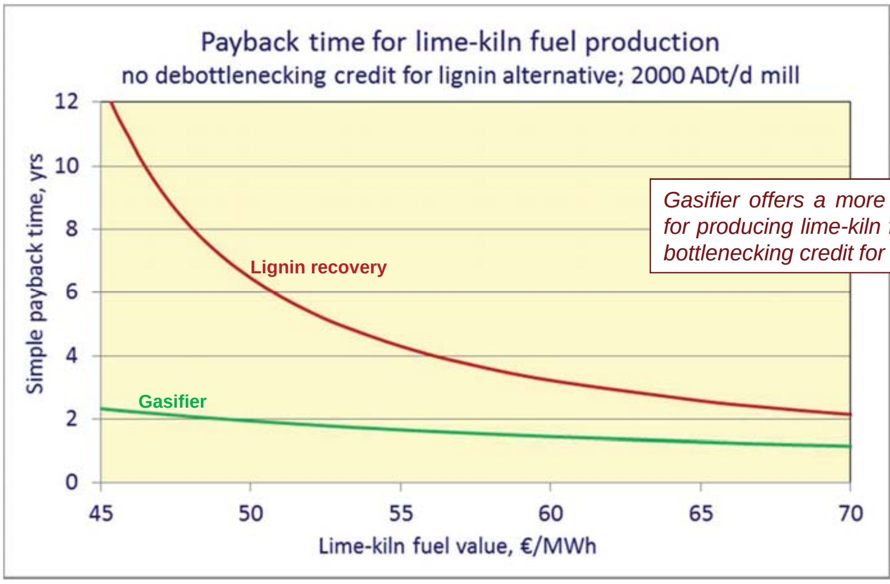
Our pre-studies: competitiveness vs. existing products

Lignin recovery vs. biomass gasifier for **lime-kiln fuel**; example results



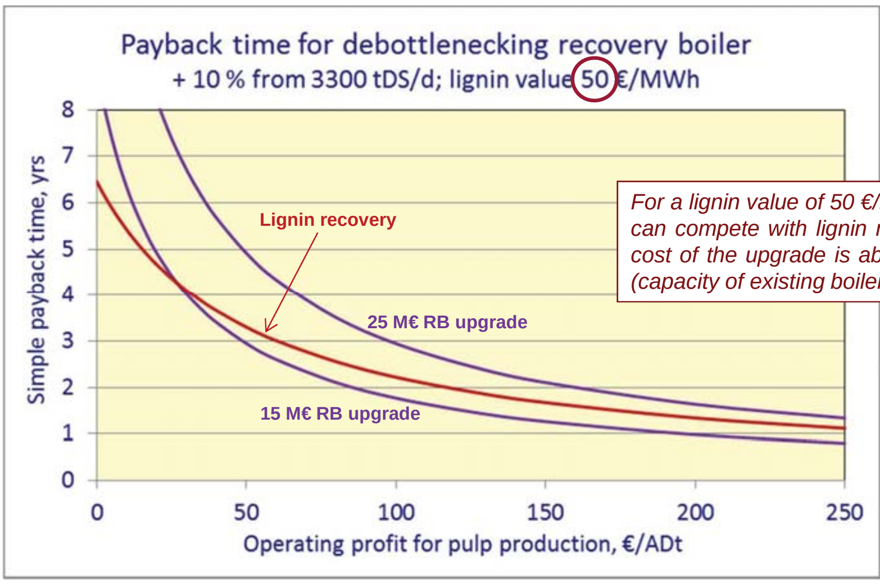
Gasifier offers a more economic route for producing lime-kiln fuel (with no de-bottlenecking credit for lignin recovery).

Key assumptions for lignin-recovery process: (1) investment with lignin dryer 23 M€, (2) all added S in added H_2SO_4 purged via ash dumping; Case 1, (3) CO_2 price 125 €/t, (4) H_2SO_4 price 100 €/t, (5) NaOH price 350 €/t, (6) value of lost black liquor 16 €/MWh (LHV), (7) electricity price 50 €/MWh.

Key assumptions for gasifier process: (1) investment 20 M€, (2) price of biomass fuel 16 €/MWh (LHV), (3) additional limestone purge 5 %, (4) electricity price 50 €/MWh.

Our pre-studies: competitiveness vs. existing products

Lignin recovery vs. recovery-boiler upgrade for **de-bottlenecking**; example results



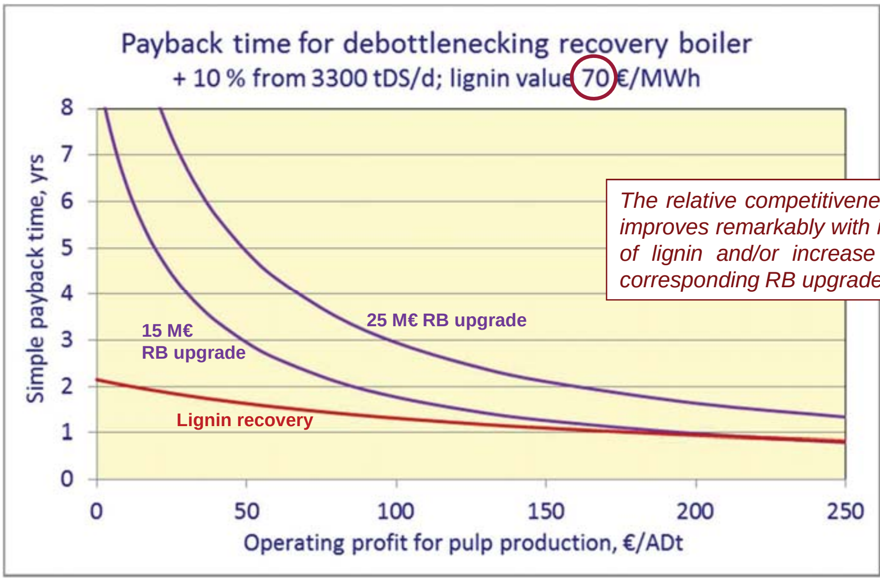
For a lignin value of 50 €/MWh, RB upgrade can compete with lignin recovery when the cost of the upgrade is about 20 M€ or less (capacity of existing boiler 3300 tDS/d).

Key assumptions for lignin-recovery process: (1) investment with lignin dryer 23 M€, (2) all added S in added H_2SO_4 purged via ash dumping; Case 1, (3) CO_2 price 125 €/t, (4) H_2SO_4 price 100 €/t, (5) NaOH price 350 €/t, (6) value of lost black liquor 16 €/MWh (LHV), (7) electricity price 50 €/MWh.

Key assumptions for recovery-boiler upgrade: (1) value of black liquor 16 €/MWh (LHV), (2) corresponding value of recovery-boiler output energy 25 €/MWh, (3) upgrade cost includes cost of extra mill downtime ~4 M€.

Our pre-studies: competitiveness vs. existing products

Lignin recovery vs. recovery-boiler upgrade for **de-bottlenecking**; example results



The relative competitiveness of lignin recovery improves remarkably with increase in the value of lignin and/or increase in the cost of the corresponding RB upgrade.

Key assumptions for lignin-recovery process: (1) investment with lignin dryer 23 M€, (2) all added S in added H_2SO_4 purged via ash dumping; Case 1, (3) CO_2 price 125 €/t, (4) H_2SO_4 price 100 €/t, (5) NaOH price 350 €/t, (6) value of lost black liquor 16 €/MWh (LHV), (7) electricity price 50 €/MWh.

Key assumptions for recovery-boiler upgrade: (1) value of black liquor 16 €/MWh (LHV), (2) corresponding value of recovery-boiler output energy 25 €/MWh, (3) upgrade cost includes cost of extra mill downtime ~4 M€.

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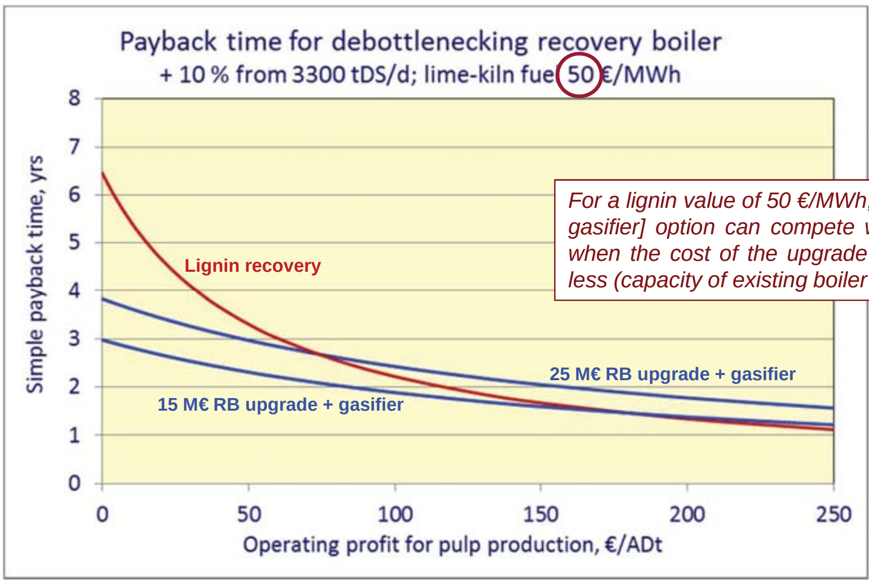
Our pre-studies: competitiveness vs. existing products

Lignin recovery vs. [recovery-boiler upgrade + lime-kiln gasifier] for [**de-bottlenecking + lime-kiln fuel**] ; example results



For a lignin value of 50 €/MWh, the [RB upgrade + gasifier] option can compete with lignin recovery when the cost of the upgrade is about 25 M€ or less (capacity of existing boiler 3300 tDS/d).

Key assumptions for lignin-recovery process: (1) investment with lignin dryer 23 M€, (2) all added S in added H_2SO_4 purged via ash dumping; Case 1, (3) CO_2 price 125 €/t, (4) H_2SO_4 price 100 €/t, (5) NaOH price 350 €/t, (6) value of lost black liquor 16 €/MWh (LHV), (7) electricity price 50 €/MWh.

Key assumptions for recovery-boiler upgrade: (1) value of black liquor 16 €/MWh (LHV), (2) corresponding value of recovery-boiler output energy 25 €/MWh, (3) upgrade cost includes cost of extra mill downtime ~4 M€.

Key assumptions for gasifier process: (1) investment 20 M€, (2) price of biomass fuel 16 €/MWh (LHV), (3) additional limestone purge 5 %, (4) electricity price 50 €/MWh.

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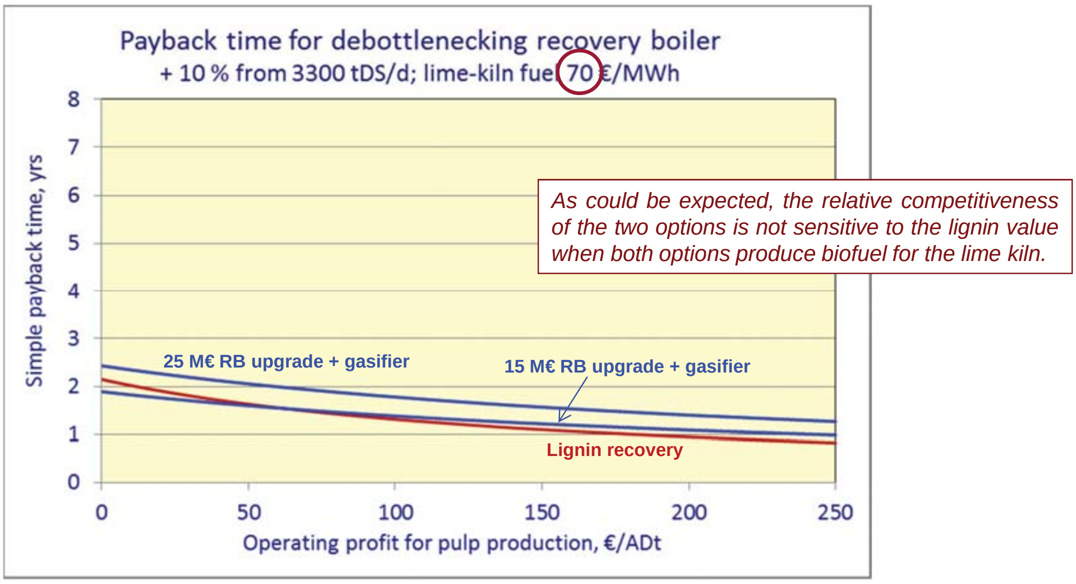
Our pre-studies: competitiveness vs. existing products

Lignin recovery vs. [recovery-boiler upgrade + lime-kiln gasifier] for [de-bottlenecking + lime-kiln fuel] ; example results



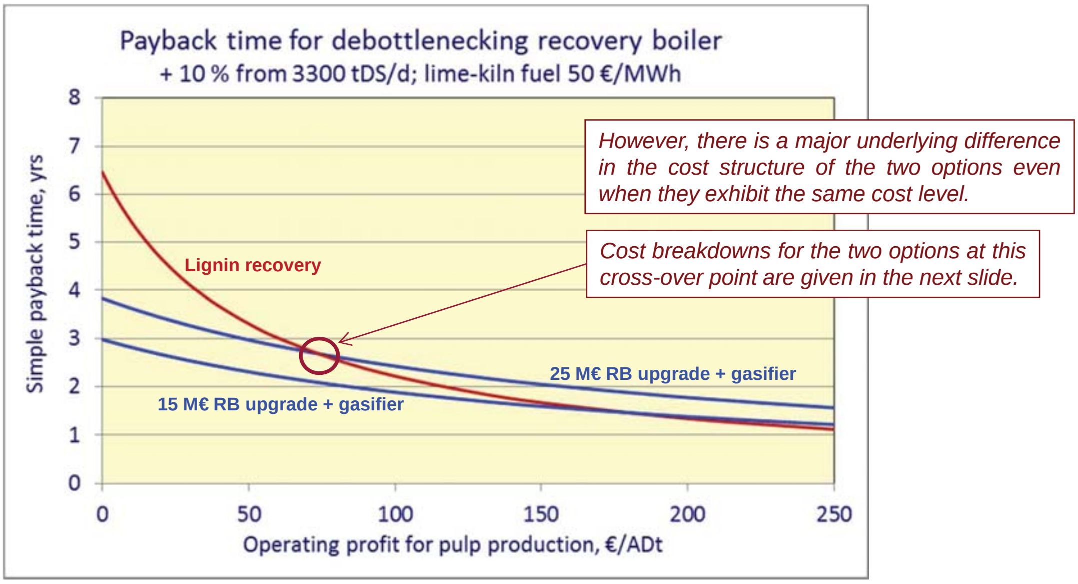
Key assumptions for lignin-recovery process: (1) investment with lignin dryer 23 M€, (2) all added S in added H_2SO_4 purged via ash dumping; Case 1, (3) CO_2 price 125 €/t, (4) H_2SO_4 price 100 €/t, (5) NaOH price 350 €/t, (6) value of lost black liquor 16 €/MWh (LHV), (7) electricity price 50 €/MWh.

Key assumptions for recovery-boiler upgrade: (1) value of black liquor 16 €/MWh (LHV), (2) corresponding value of recovery-boiler output energy 25 €/MWh, (3) upgrade cost includes cost of extra mill downtime ~4 M€.

Key assumptions for gasifier process: (1) investment 20 M€, (2) price of biomass fuel 16 €/MWh (LHV), (3) additional limestone purge 5 %, (4) electricity price 50 €/MWh.

Our pre-studies: competitiveness vs. existing products

Lignin recovery vs. [recovery-boiler upgrade + lime-kiln gasifier] for [de-bottlenecking + lime-kiln fuel] ; example results



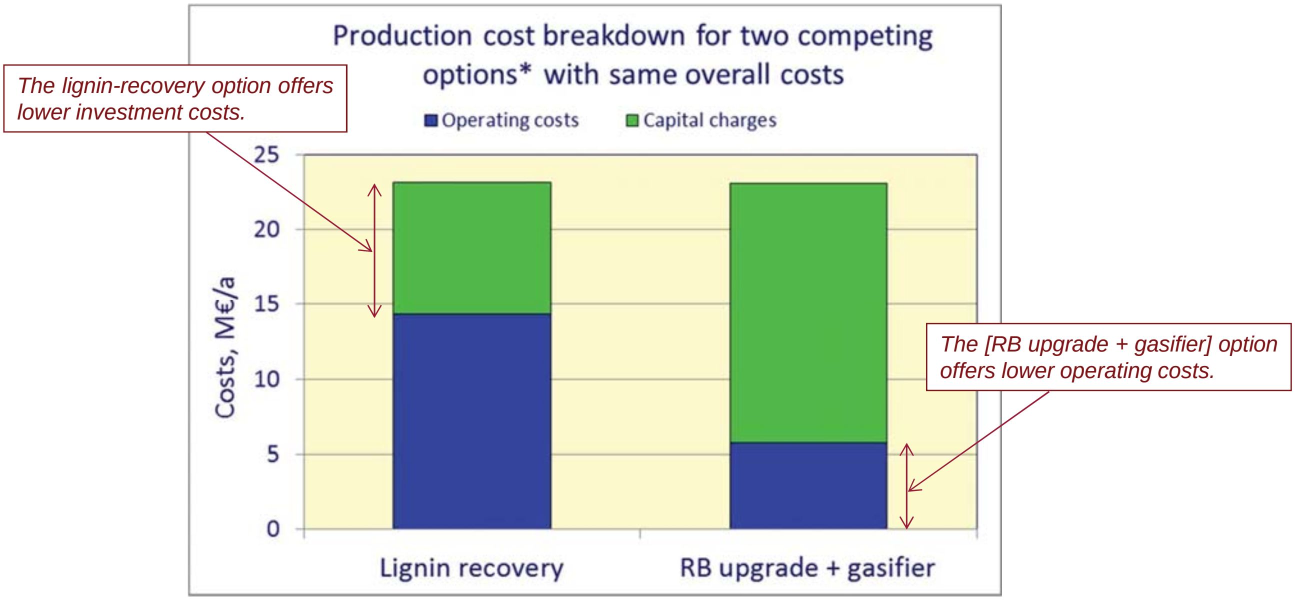
Key assumptions for lignin-recovery process: (1) investment with lignin dryer 23 M€, (2) all added S in added H_2SO_4 purged via ash dumping; Case 1, (3) CO_2 price 125 €/t, (4) H_2SO_4 price 100 €/t, (5) NaOH price 350 €/t, (6) value of lost black liquor 16 €/MWh (LHV), (7) electricity price 50 €/MWh.

Key assumptions for recovery-boiler upgrade: (1) value of black liquor 16 €/MWh (LHV), (2) corresponding value of recovery-boiler output energy 25 €/MWh, (3) upgrade cost includes cost of extra mill downtime ~4 M€.

Key assumptions for gasifier process: (1) investment 20 M€, (2) price of biomass fuel 16 €/MWh (LHV), (3) additional limestone purge 5 %, (4) electricity price 50 €/MWh.

Our pre-studies: competitiveness vs. existing products

Lignin recovery vs. [recovery-boiler upgrade + lime-kiln gasifier]
for [de-bottlenecking + lime-kiln fuel]



* Options correspond to cases from previous slide: payback time 2.6 yrs; 25 M€ RB upgrade.

Conclusions and outcome of our pre-studies

- In the short term, lignin recovery is a promising technology for simultaneously de-bottlenecking a recovery boiler and producing biofuel for the lime kiln.
- For this application, lignin-recovery technology represents a low-investment option compared to what we could otherwise offer our customers. Furthermore, in some cases, upgrading the recovery boiler is not an economically feasible de-bottlenecking option under any circumstances.
- The downside of the lignin-recovery option is relatively high operating costs, in particular those due to H_2SO_4 utilization.
- Higher-value applications for lignin are expected in the longer term and these would remarkably improve the competitiveness of lignin recovery.
- Our overall conclusion: We should have the capability to offer our customers competitive lignin-recovery technology and, preferably, our technology would consume less H_2SO_4 than processes already available on the market.
- Outcome: a decision was made to instigate a development program.

Lignin recovery – Andritz's evaluations and development work

Part 2. Development work

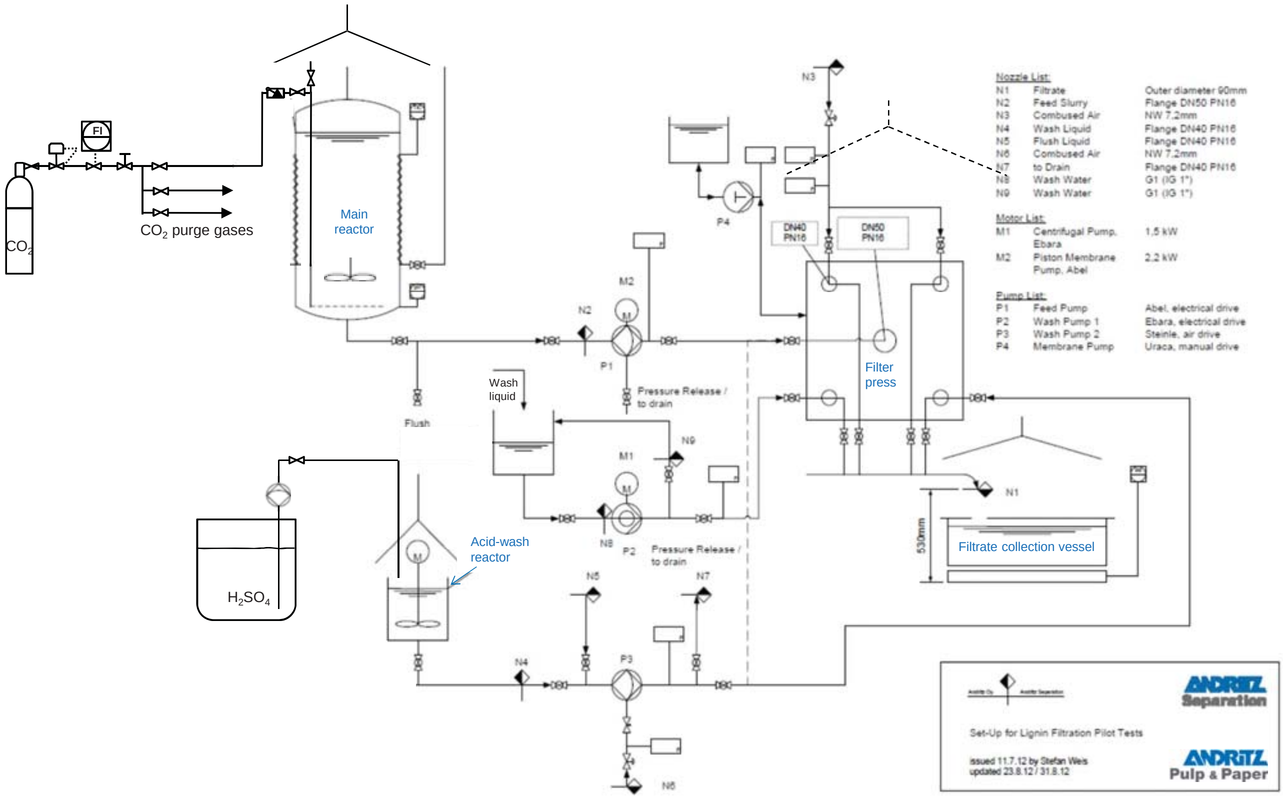
- Experimental program
- Process concepts under development
- Updated cost estimates based on experimental results
- Concluding remarks and future plans

Experimental program

Outline of program:

- conducted in co-operation with a pulp producing company at a Nordic pulp mill
- laboratory-scale experimental program from September 2011 till August 2012:
  - screening of novel approaches
  - process-concept development.
- on-going experimental program on a pilot plant (P&I sketch in next slide) from September 2012 till December 2013:
  - verification of techno-economic feasibility of several process concepts
  - generation of data necessary for the design of an industrial-scale demonstration plant.

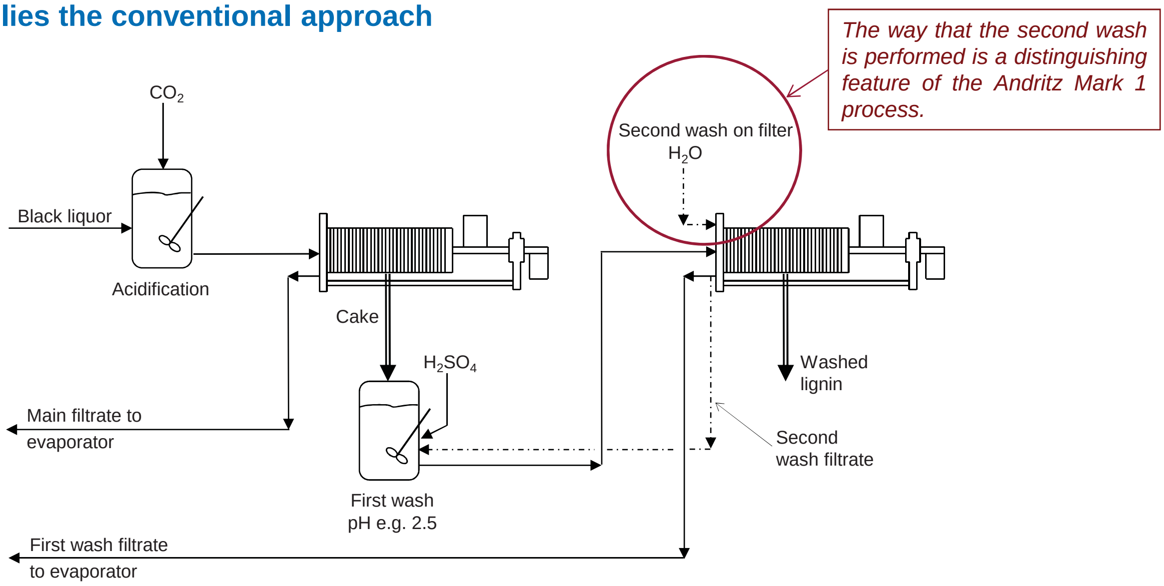
P&I sketch of the pilot plant



Process concepts under development

The Andritz Mark 1 lignin-recovery process

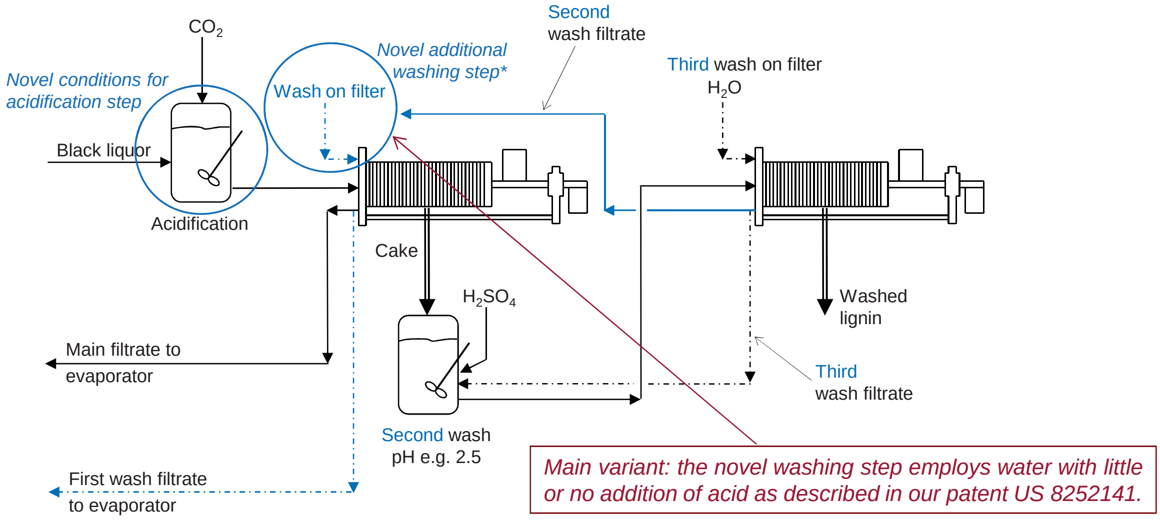
- applies the conventional approach



Process concepts under development

The Andritz Mark 2 lignin-recovery process

- potential to reduce costs of chemicals by 30 – 40 % compared to Mark 1 process

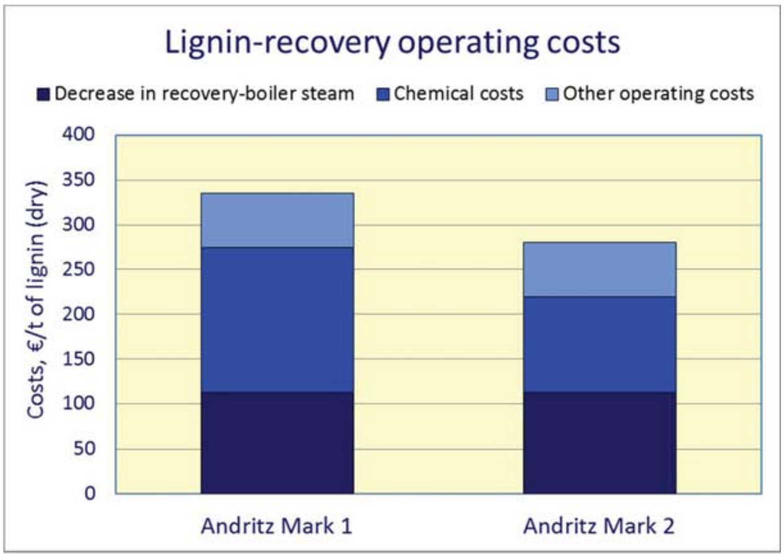


** This additional washing step may also be performed as a re-slurry wash with concomitant additional filtration step.*

Updated cost estimates based on experimental results

Operating costs: Mark 1 process vs. Mark 2 process

Considerable savings in chemical costs are potentially attainable with the Mark 2 process.



Data sources:

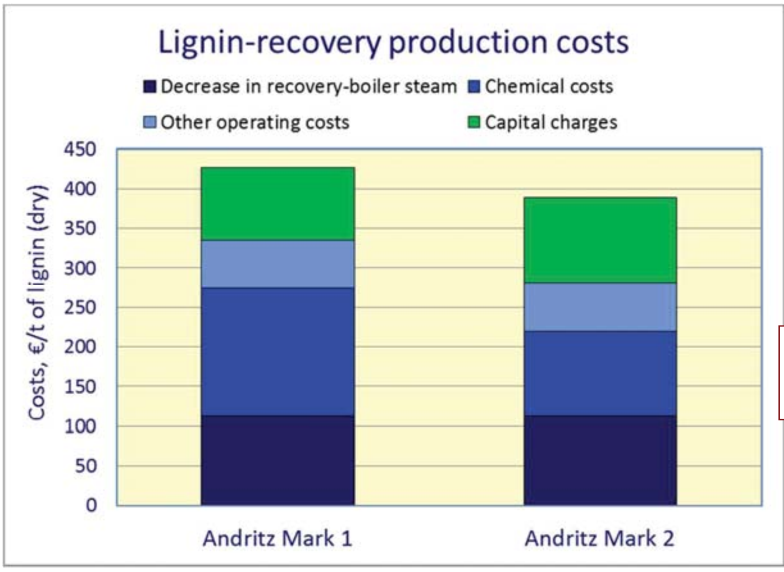
- For Mark 1 process: from pilot-plant trials
- For Mark 2 process: from earlier laboratory trials; not yet confirmed on pilot plant

Key cost bases: (1) all added S in added H_2SO_4 purged via ash dumping; Case 1, (2) CO_2 price 125 €/t, (3) H_2SO_4 price 100 €/t, (4) NaOH price 350 €/t, (5) value of lost black liquor 16 €/MWh (LHV), (6) electricity price 50 €/MWh.

Updated cost estimates based on experimental results

Production costs = operating costs + capital-related charges

Bases of estimate of capital-related charges: (1) capacity of plant: 50 000 t/a lignin dry matter, (2) estimated cost of Mark 1 plant 23 M€, (3) capital-charges factor 20 % p.a., covering also overheads, insurances, etc.**



Data sources:

- For Mark 1 process: from pilot-plant trials
- For Mark 2 process: from earlier laboratory trials; not yet confirmed on pilot plant

Estimated investment costs are somewhat higher for the Mark 2 process.

Key cost bases: (1) all added S in added H_2SO_4 purged via ash dumping; Case 1, (2) CO_2 price 125 €/t, (3) H_2SO_4 price 100 €/t, (4) NaOH price 350 €/t, (5) value of lost black liquor 16 €/MWh (LHV), (6) electricity price 50 €/MWh.

** Includes dryer; assumes existing evaporator can handle increased evaporation demand

Concluding remarks and future plans

- Two process concepts have been investigated at the pilot-plant scale. The base concept (Mark 1) is based on the conventional approach and has been fully verified on the pilot plant. The second process concept (Mark 2), which aims at significantly lower chemical costs, is still under investigation.
- On the basis of the design data generated in the pilot-plant program, a pre-engineering study of a full-scale lignin-recovery plant has been initiated.
- An industrial-scale demonstration plant is envisaged as the next step. Negotiations with pulp-producing companies have been initiated. In all probability the demonstration plant will be based upon the Mark 1 process but will, in addition, incorporate the capability to further develop the Mark 2 process on the industrial scale.

SUOMEN SOODAKATTILAYHDISTYKSEN KUULUMISET

Markus Nieminen
Suomen Soodakattilayhdistys ry

YHTEENVETO SOODAKATTILAYHDISTYKSEN TOIMINNASTA VUONNA 2013

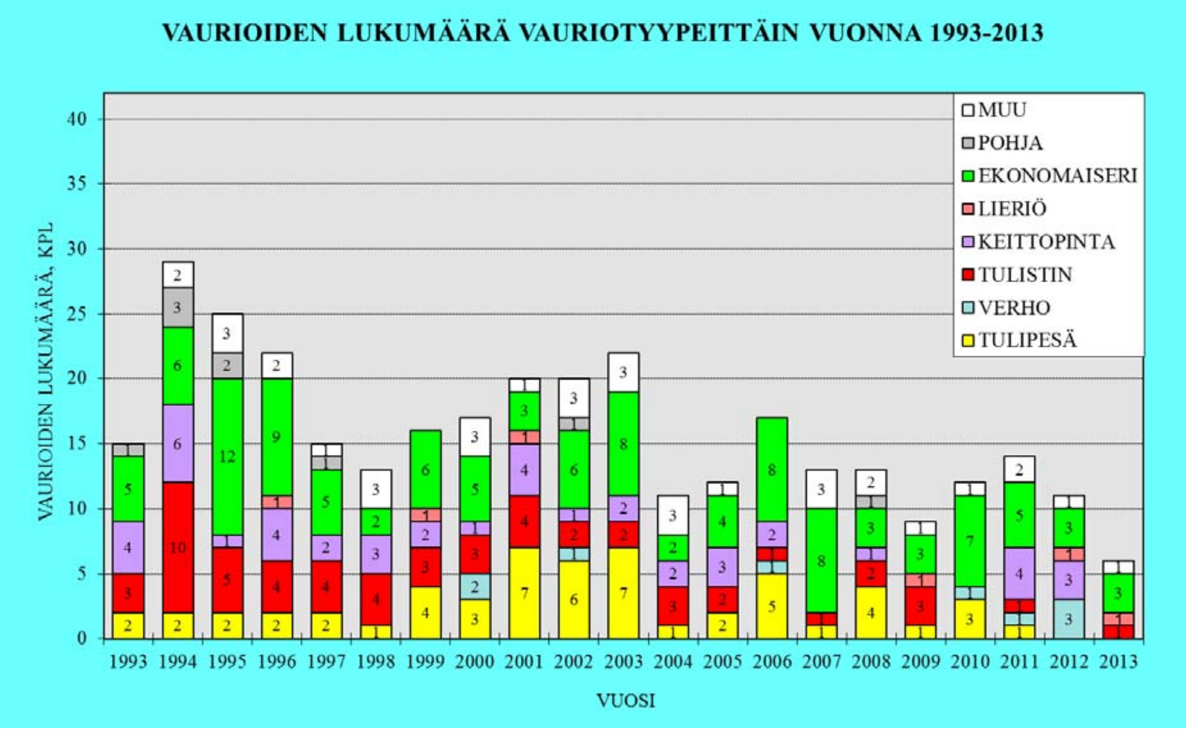
1 JÄSENET

Tällä hetkellä Soodakattilayhdistykseen kuuluu 23 varsinaista jäsentä, joista 15 on sellutehtaita, sekä 4 ulkojäsentä.

Suomen soodakattiloiden keskimääräinen koko on 2400 tonnia kuiva-ainetta päivässä ja keskimääräinen ikä 25 vuotta.

2 SOODAKATTILAVAURIOT 2013

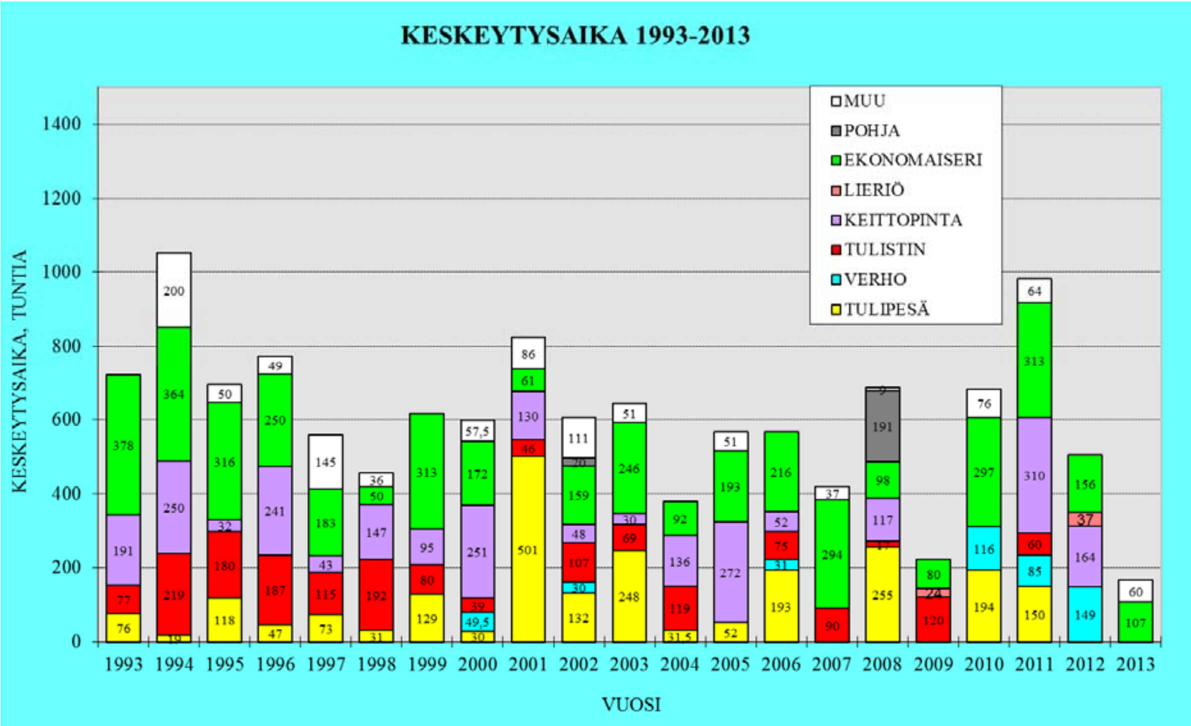
Soodakattilayhdistyksen vauriotietokantaan on raportoitu lokakuun 2013 alkuun mennessä yhteensä 6 vauriota. Vaurioiden lukumäärä vuosina 1993 – 2013 vaurion esiintymisalueen mukaan on esitetty kuvassa 2-1.



Kuva *2-1* Vaurioiden lukumäärä vauriotyypeittäin vuosina 1993 – 2013.

Raportoiduista vaurioista yksi havaittiin tulistimessa, yksi keittopinnalla sekä kolme ekonomaiserissa. Yksi raportoitu vaurio oli sulavuoto primäärikanavistoon. Tulistin sekä keittopintavaurio havaittiin seisokin aikaisessa tarkastuksessa, muut normaalissa ajossa. Näissä tapauksissa alasajo suoritettiin normaalisti.

Yhteenlaskettu mustalipeänpolton keskeytysaika on lokakuuhun mennessä vain 167 tuntia, joka on huomattavasti keskiarvoa (606 tuntia) alhaisempi. Keskeytysaika vuosina 1993 – 2013 vaurion esiintymisalueen mukaan on esitetty kuvassa 2-2.



Kuva *2-2*. Vaurioiden aiheuttama lipeänpolton keskeytysaika vuosina 1993 - 2013

3 PROJEKTIT 2013

Soodakattilayhdistyksen toiminta on jaettu viiteen työryhmään: kestoisuustyöryhmä, lipeätyöryhmä, ympäristötyöryhmä, automaatiotyöryhmä ja ohjelmatyöryhmä. Jokaisella työryhmällä on oma vastuualueensa, jonka piirissä työryhmät toteuttavat tutkimusprojekteja.

3.1 Työryhmien projekteja

3.1.1 Ohje soodakattilalaitoksen varmennetun jännitejakelun periaatteeksi

Selvityksen tarkoitus on suositella mahdollisimman varmaa UPS verkon rakennetta syöttämään soodakattilan varmennettuja kuormia. Dieselin osalta käsitellään dieselistä syötettäväksi suositeltavat kuormat.

Ohje ei yritä pakottaa valmistajia ja käyttäjiä samanlaisiin laitteisiin ja ohjausratkaisuihin, vaan ohjeessa pyritään esittämään malliratkaisuja luotettavasta UPS verkon rakenteesta, suunnittelusta sekä varmennetusta verkosta syötettävistä kuormista. Lisäksi on annettu suosituksia laitevalintaan, testauksiin ja huoltoon liittyen. Selvityksen loppuun on kerätty kuvauksia tehtailla tapahtuneista UPS-jakelun häiriöistä.

Projektin taustalla on Ruotsissa sattunut UPS-vika (staattinen vaihtokytkin hajosi ja valvomon kaikki näyttöpäätteet sammuivat ja kattila oli ilman ohjausta 30 minuuttia). Tavoitteena on laatia ohje, miten UPS-kytkentä tulisi tehdä, jotta vastaava tilanne ei tapahtuisi.

3.1.2 Polttoperäisten päästöjen ja nano-hiukkasten haitallisuuden määrittäminen uudella tutkimusmenetelmällä (POPE), TEKES

Soodakattilayhdistys osallistuu Itä-Suomen yliopiston TEKES-hankkeeseen jossa tutkitaan soodakattilan, meesauunin, hakevoimalaitoksen, pienpolton (tulisija ja arinakattila) päästöjä ja jälkikäsittelytekniikoiden vaikutusta dieselajoneuvon päästöihin sekä päästöjen fysikaalis-kemiallisia ja toksikologisia ominaisuuksia. Lisäksi tutkitaan teollisten nanohiukkasten vastaavia ominaisuuksia.

Projektin tuloksena syntyy uusi kokeellinen tutkimusmenetelmä, jonka avulla voidaan luotettavasti arvioida päästöjen haitallisuutta ja haitallisuuteen vaikuttavia tekijöitä perustuen niiden fysikaalisiin ja kemiallisiin sekä toksikologisiin ominaisuuksiin. Näitä tekijöitä ovat mm. polttoaineen laatu, polttolaitteen toiminta ja käyttötapa.

3.1.3 Sähkösuodintuhkan hyötykäyttömahdollisuudet

Projektin tavoitteena on löytää teknistaloudellinen ratkaisu sähkösuodintuhkan hyötykäytölle sellutehtaan sisällä tai ulkopuolella. Projektissa päivitetään aikaisemman suodintuhkan puhdistushankkeen tulokset nykyiseen markkina- ja hintatilanteeseen sekä arvioidaan sähkökemiallisen käsittelymenetelmän käyttökelpoisuus.

3.1.4 Hajukaasusuosituksen päivitys

Suositus on toinen päivitetty versio 30.5.2002 ilmestyneestä suosituksesta. Suositus on päivitetty viime vuosina tapahtuneiden hajukaasuräjähdysten opetuksilla sekä toteutettujen sellutehdasprojektien kokemusten perusteella. Päivitystyö aloitettiin loppuvuonna 2010 ja saatiin päätökseen syksyllä 2013.

3.1.5 Syöttövesipumppujen säätö ja mitoitus, syöttövesisäiliön koko - konseptitarkastelut

Työssä tehdään esiselvitys kolmen Soodakattilayhdistyksen valitseman soodakattilan syöttövesipumppauksen mahdollisuuksista säästää sähköä toteuttamalla pumppauksen säätö uudella tavalla. Samalla mietitään, miten suurella syöttövesisäiliöllä kukin soodakattila pärjäisi ja esitetään eri pumppujen lukumäärän ja syöttöveden tarpeen mukaisen mitoituksen investointikustannus ja energiankulutusarvot.

3.1.6 Mustalipeän ei-Newtonilaisuus ja pisaroituminen

Projektissa tutkitaan erilaisten lipeiden (lehtipuu-, havupuu-, seka- ja eukalyptuslipeä) ei-Newtonilaista käyttäytymistä sekä vaikutusta soodakattilan toimintaan, erityisesti mustalipeän ruiskutukseen. Samalla pyritään arvioimaan myös vaikutusta putkivirtauksiin, pumppuihin sekä haihduttamoon.

Mustalipeän viskositeetti on tärkeä soodakattiloiden ja haihdutinyksiköiden toimintaan vaikuttava suure. Viskositeettiin vaikuttavat lipeän koostumuksen lisäksi mm. lämpötila ja kuiva-aine. Pienellä leikkausnopeudella viskositeetti on erittäin suuri, mutta kun leikkausnopeus kasvaa, niin viskositeetti laskee vakiotasolle. Alhaisilla kuiva-aineilla ja alhaisissa lämpötiloissa tehdyt kokeet viittaavat siihen, että ei-Newtonilaisuutta esiintyy kuiva-aineen kohotessa yli 50-70%.

3.1.7 International Chemical Recovery Conference 2014 ja SKY 50-vuotisjuhla

Yhdistyksen juhlavuoden kunniaksi International Chemical Recovery Conference järjestetään Tampere-talossa kesäkuussa 2014 (9.-13.6.2014).

Konferenssin nettisivut: http://www.soodakattilayhdistys.fi/ICRC/ICRC_index.html

POHJOIS-AMERIKAN SOODAKATTILAYHDISTYKSEN KUULUMISET

Thomas J. Grant
American Forest & Paper Association

Finnish Recovery Boiler Conference

AF&PA Recovery Boiler Program Update

Thomas J. Grant
American Forest & Paper Association

Helsinki, Finland
October 3, 2013

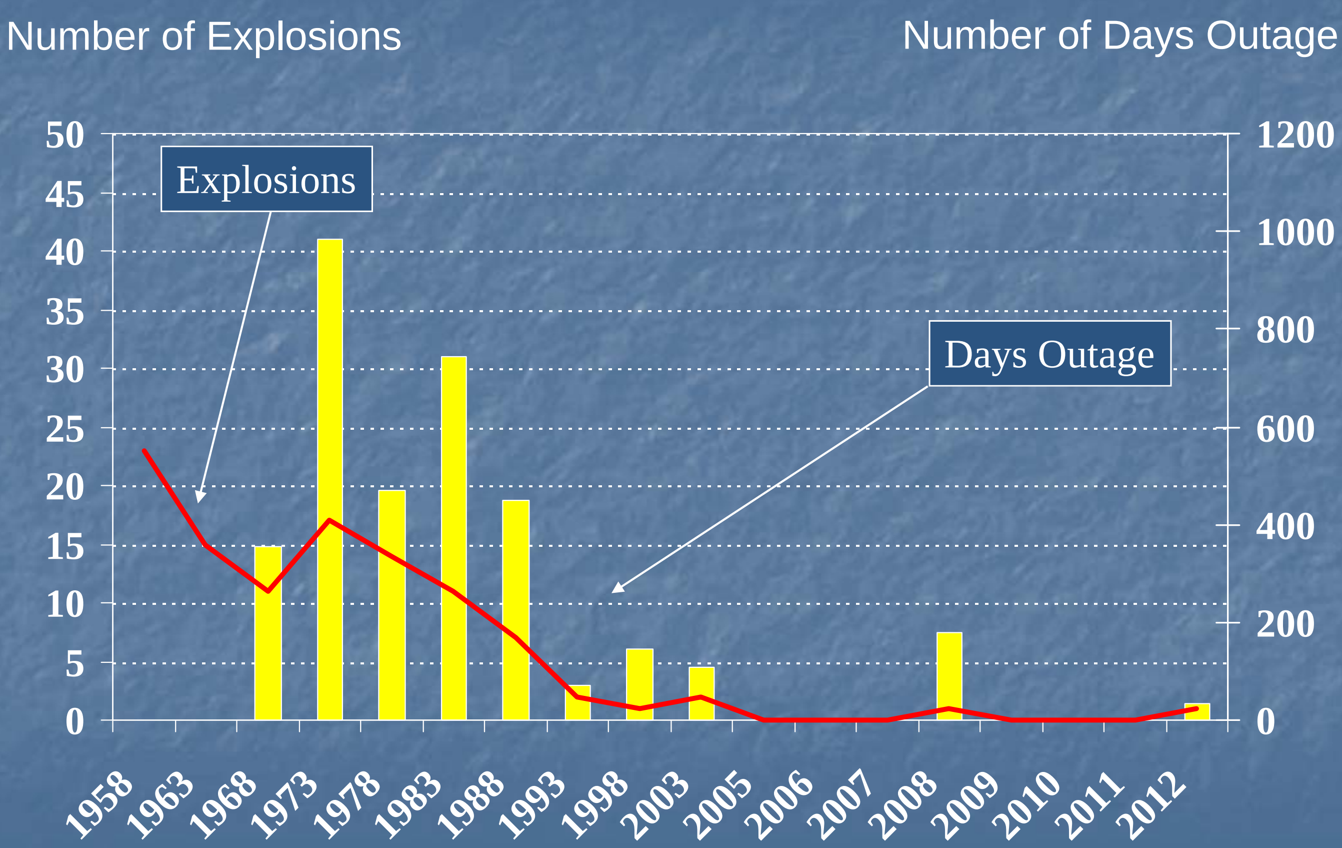
Recovery Boiler Program Update

- Formed in 1974 – currently 31 companies including 7 non-Assoc. members - Produce nearly 95% of black liquor in U.S.
- 111 mills operate 169 recovery boilers - produce nearly 40% of total energy used by U.S. p & p –average age of boilers about 30 years – 67% installed prior to 1979
- Mission: To produce greater awareness in safe practices, improve operation, maintenance and efficiency of boilers
- Emphasis on training, maintenance and supervision
- Two subcommittees: R&D and O & M work closely with BLRBAC
- All operating companies gain directly from program

Recovery Boiler Explosions

- Reduced explosion frequency by 10-fold - Chart shows five year periods 1958 – 2012
- From 1948 thru May 2012 reported
  - 161 explosions (last one May, 2012)
  - averaged 3 to 4 explosions per year thru 1990's
- Decrease reflects improvement in training; More awareness of safety guidelines
- Dedication to operations and maintenance
- Management commitment
- Mills doing more operator "walk downs" of boilers find small upsets before bigger problems
- Increased critical incidents reported – near misses avoided

Recovery Boiler Explosions/Outages



Operator Safety Seminars

- Started in 1985 – held 3 per year – nearly 3,200 attended
- 2011: 71 attendees from 13 companies and 21 mills;
- 2012 – 136 attendees 17 companies, 32 mills
- 2013: 100 attendees from 12 companies, 23 mills
- Attendees benefit from dialogues with expert instructors and operators from other mills on review of actual explosions
- High evaluation from mills for seminars – 2 half days – Review actual case histories and BLRBAC and AF&PA guidelines and training
- Special topic seminars coordinate with BLRBAC
- Updating Reference Manuals & make electronically available
- Updating Recommendations; Guidelines and Audit Documents

R&D Subcommittee Current Activities

- Mitigation of Dissolving Tank Explosions Study
- Produce Economizer TAPPI TIP Sheet – possibly others
- Updating "Kraft Recovery Boilers" textbook
- Considering other research work – interaction of shatter jets with smelt flow; guidelines for designing smelt dissolving tanks; heavy smelt run-offs; methanol burning; ash hopper pluggage/level indication; tube cleaning; energizing precipitator prior to starting fans up; monitoring temperatures in superheaters at start-up.
-

R&D Subcommittee Sponsored Projects

- Dissolving Tank Explosions Study
  - Reviewed & analyzed incidents reported
  - Identified major causes of explosions
  - Excessive smelt runoff following upset conditions, e.g. boiler trip or chill & blow
  - Spout orientation relative to furnace arch
  - Large quantities of molten smelt in dissolving tank
  - Completed study of calculations of green liquor density (Baume) vs TTA as a function of composition in the smelt dissolving tank Establish guidelines for preferred test methods

R & D Subcommittee Sponsored Projects

- Survey for best practices for safe operation of dissolving tanks reports from mills to be analyzed
- Study of Materials and equipment available used for personnel protection around recovery boilers
- Study of Heavy Smelt Runoffs
- Study of Developing Procedures for Investigation of steam leaks

Other R & D Subcommittee Activities

- Updating “Kraft Recovery Boilers” textbook
- TAPPI Tip sheets developed from studies for Economizers – two published last year
- Possible TAPPI Tip Sheets developed from studies for
  - Floor Tubes
  - Behavior of Furnace Corners In Explosions
  - Superheaters

Annual Conference

- 52 attended the February 2013 conference, including representatives from operating companies, manufacturers, insurers, and vendors. Lower attendance a result of the economic environment
- Presentations included reports on current projects, subcommittee reports on their activities, reports from Sweden, Norway and Finland, and research planned
- Next conference will be held February 2014

BRASILIAN SOODAKATTILAYHDISTYKSEN KUULUMISET

Brazilian Recovery Boiler Safety Committee

BRAZILIAN CURRENT RECOVERY BOILER UPDATE

8th International Colloquium on Black Liquor
Belo Horizonte/MG – Brazil

CSCRB

ESP SUB COMMITTEE

CSCRB

Brazilian Recovery Boiler Safety Committee

- Since 2001 (next meeting July 4^{th} 2013 at Lwarcel)
- 4 sub committees:
  - Combustion
  - Safety
  - Maintenance
  - ESP

CSCRB – ESP SUB COMMITTE

ESP Sub Committee Activities

1- Brazilian Recovery Boiler database maintenance

2 - Exchange information with other international

Committees (BLRBAC, SNRBC, FRBC)

3 - Incident analysis

4 - Incident presentation

5 - Non ordinary issues

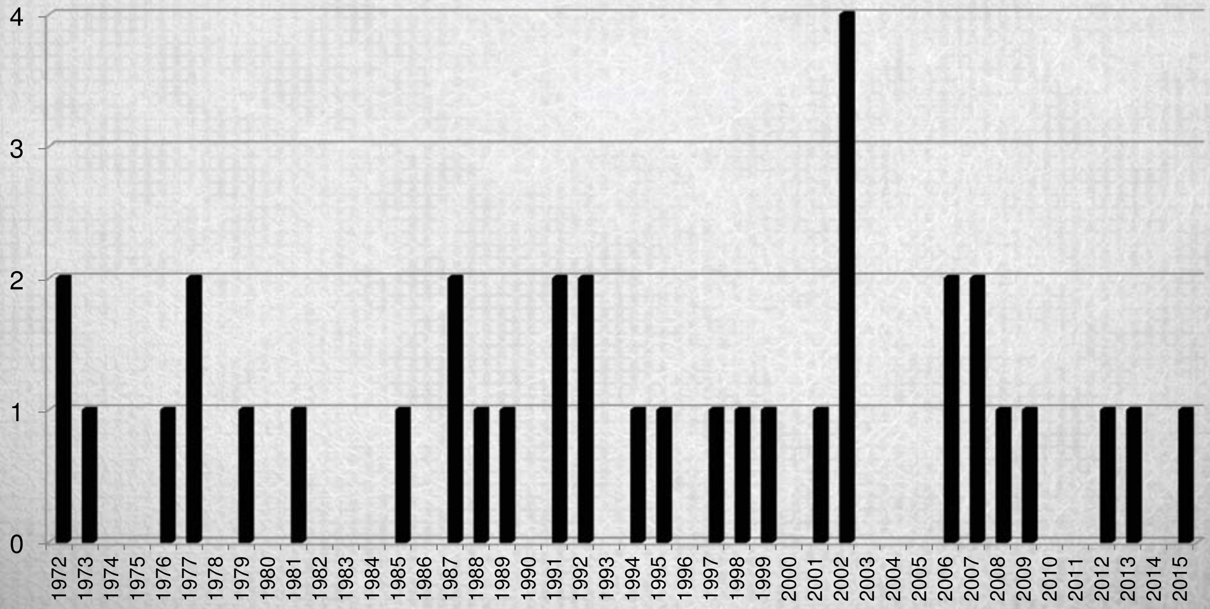
1

Data base maintenance

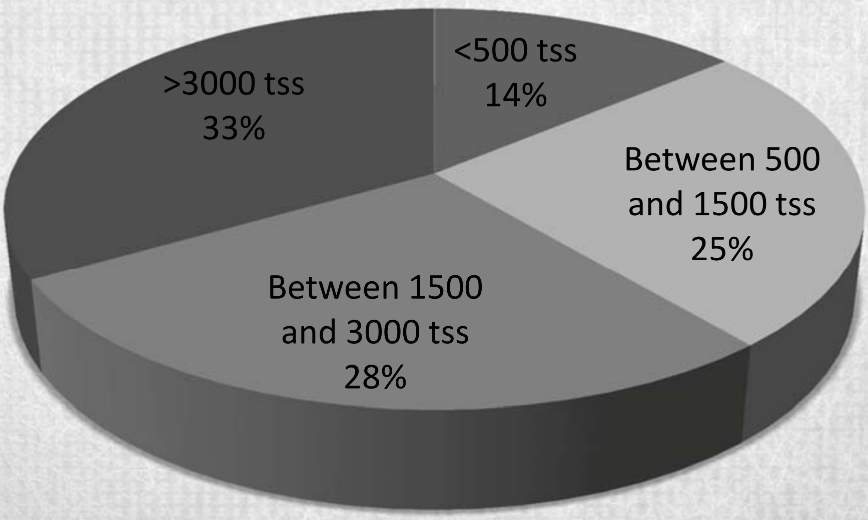
Current status

- 36 recovery boiler - 33 in operation
- 1 Hibernated
- 2 Under project (Suzano Imperatriz and CMPC)
- 17 Recovery boilers retrofits since 2000
- 14 New recovery boiler since 2000
- Typical age: 18 years
- Typical size: : 2220 tss/day

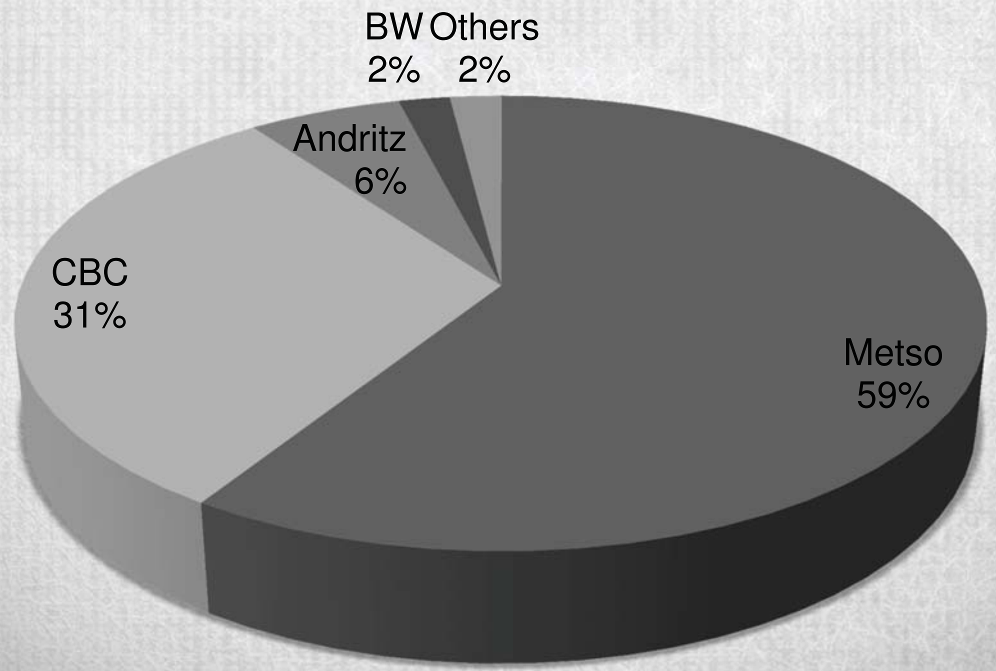
Recovery boilers start-up year



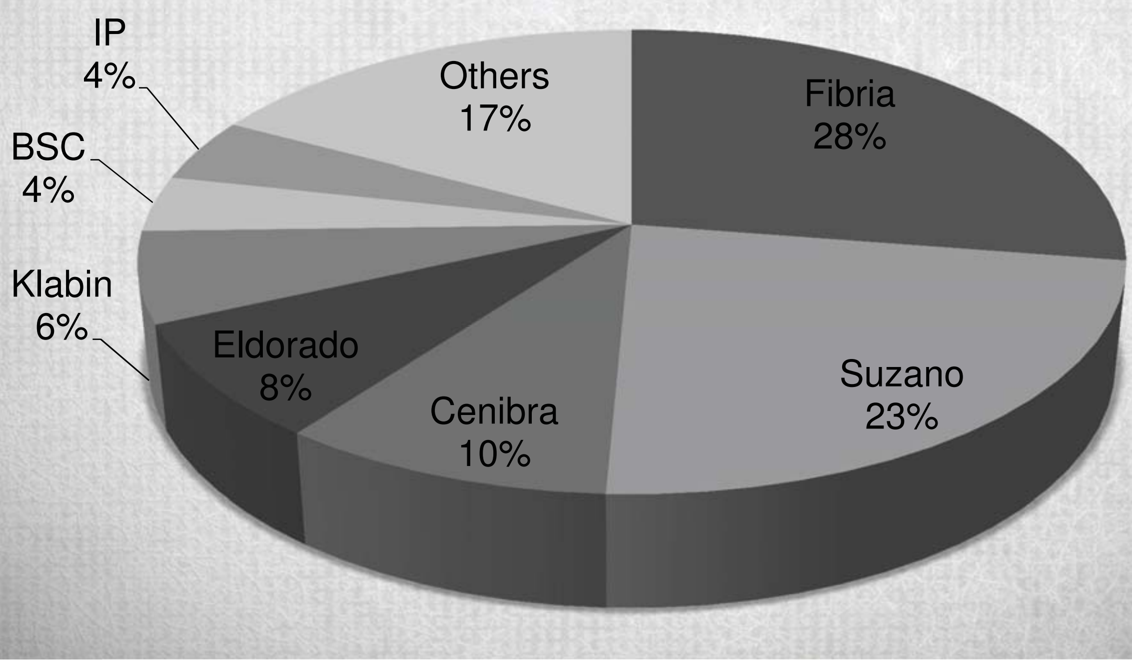
Boilers by size



Boilers by suppliers



Boilers by producers



#	Empresa	Status	Start up (ano)	Reforma (ano)	Idade (anos)	Capacidade Original (tss virgem/dia)	Capacidade Real (tss virgem/dia)	Pressao (barg)	Temp(C)	Vapor p/ processo (t/h)	Area (m2)	Ratio (tss/m2xdia)	Responsavel
1	BSC	Em operacao	2008		5	3000	3300	85	490	494	149.2	22.1	Sandro Yosmini <sandro_yosmini@bahiaspeccell.com>
2	CENIBRA	Em operação	1977	2003	36	1440	1800	65	450	250	93.86	19.2	Virgílio Procópio <virgilio.procopio@cenibra.com.br>
3	CENIBRA	Em operação	1992	2004	21	2050	2700	65	450	422	138.13	19.5	Virgílio Procópio <virgilio.procopio@cenibra.com.br>
4	CENIBRA	Em operação	2006		7	3500	3500	66/86	450	524/515	189	18.5	Virgílio Procópio <virgilio.procopio@cenibra.com.br>
5	CMPC	Em operação	2002		11	1950	1950	64	465	300	125	15.6	Humberto Batista <HLBatista@cmpcrs.com.br>
6	CMPC	Em projeto	2015		0	6200	6200	95	490	1075	271	22.9	Humberto Batista <HLBatista@cmpcrs.com.br>
7	COCELPA	Em operação	1988	2010	25	160	270	45	425	30	12	22.5	Aldionir de Liz<aldionir.liz@cocelpa.com.br>
8	Eldorado	Em operação	2012		1	6800	6800	85	485	1116	293	23.2	Murilo Sanches<murilo.sanches@eldoradobrasil.com.br>
9	Fibria Aracruz CR-A	Em operação	2001		12	3440	3440	64	450	524	156.7	22.0	Ronaldo Schuster <ronaldo.schuster@fibria.com.br>
10	Fibria Aracruz CR-B	Em operação	1991	2002	22	2200	3600	64	450	524	165.7	21.7	Ronaldo Schuster <ronaldo.schuster@fibria.com.br>
11	Fibria Aracruz CR-C	Em operação	1997	2000	16	2200	3300	64	455	433	130.8	25.2	Ronaldo Schuster <ronaldo.schuster@fibria.com.br>
12	Fibria Jacarei	Em operação	1994		19	1430	1990	90	470	240	101	19.7	Julio Cezar Macedo <julio.macedo@fibria.com.br>
13	Fibria Jacarei	Em operação	2002		11	2500	2990	93	480	360	149	20.1	Julio Cezar Macedo <julio.macedo@fibria.com.br>
14	Fibria Tres Lagoas	Em operação	2009		4	5300	5500	86	487	822	242	22.7	Fernando Raasch<fernando.pereira@fibria.com.br>
15	Iguacu	Em operação	1972		41	320	320	12	190	24	18.92	16.9	Wilson Lopes <wilsonlopes@iguacucelulose.com.br>
16	IP - Luiz Antonio	Em operação	1991	2005	22	890	1850	64	450	245	66	28.0	Edivaldo Verdile <edivaldo.verdile@ipaperbr.com>
17	IP- Mogi Guaçu	Em operação	1976		37	187	320	29	350	28	14.04	22.8	Geraldo Ferreira <Geraldo.Ferreira@ipaperbr.com>
18	IP - Mogi Guaçu	Em operação	1985	2006	28	950	1144	27.6	340	120	51.85	22.1	Geraldo Ferreira <Geraldo.Ferreira@ipaperbr.com>
19	Orsa IP	Em operacao	2006		7	400	400	42	400	74	26	15.4	Yoshiro Nagao<ynagao@orsaip.com.br>
20	Jari Monte Dourado	Hibernada	1979	1988	34	1360	1750	59	450	276.12	89	19.7	José Cogui <jcmoreira@jari.com.br>
21	Klabin-Correa Pinto	Em operação	1987	1992	26	580	750	85	480	110	49	15.3	Edson Maestri<elbmaestri@klabin.com.br>
22	Klabin Telemaco	Em operação	1977	2000	36	1100	1850	46	430	250	92.5	20.0	Bruno Peres <bhperes@klabin.com.br>
23	Klabin Telemaco	Em operação	2007		6	1700	1700	106	503	243	79.6	21.4	Bruno Peres <bhperes@klabin.com.br>
24	Klabin-Otacílio Costa	Em operação	1998		15	1100	1050	89	483	170.2	69.1	15.2	Edson Maestri<elbmaestri@klabin.com.br>
25	Lwarcel	Em operação	2002	2008	11	700	826	85	480	120	44	18.8	Cesar Anfe <canfe@lwarcel.com.br>
26	Rigesa	Em operação	1999		14	850	600	64	460	126	47.4	12.7	Fernando Wessler <fernando.wessler@mwv.com>
27	Suzano Imperatriz	Em projeto	2013		0	7000	7000	95	492	1207	323.2	21.7	Nelson Fuzikava<nfuzikava@suzano.com.br>
28	Suzano Limeira	Em operação	1972		41	270	510	42	380	65	24.11	21.2	Antonio Carlos Andrella<acarlosandrella@suzano.com.br>
29	Suzano Limeira	Em operação	1981	2000	32	270	510	42	380	65	24.11	21.2	Antonio Carlos Andrella<acarlosandrella@suzano.com.br>
30	Suzano Limeira	Em operação	2002	2007	11	1100	1700	46	400	180	69	24.6	Antonio Carlos Andrella<acarlosandrella@suzano.com.br>
31	Suzano Mucurí	Em operação	1992	2007	21	1750	3000	85	480	420	144	20.8	Hildomar Raimondi <hildomar.raimondi@suzano.com.br>
32	Suzano Mucurí	Em operação	2007		6	4700	4700	85	480	738	251	18.7	Hildomar Raimondi <hildomar.raimondi@suzano.com.br>
33	Suzano Suzano	Em operação	1973	2004	40	670	811	50	380	110	49	16.6	Heverton Dias<hevertondias@suzano.com.br>
34	Suzano Suzano	Em operação	1987	2002	26	800	1400	50	420	218	64.1	21.8	Heverton Dias<hevertondias@suzano.com.br>
35	Trombini	Em operação	1989	2000	24	140	180	21	420	30	10	18.0	Alceu Scramocin <AScramocin@fbo.trombini.com.br>
36	Veracel Celulose	Em operação	2005	2011	8	4000	4800	93.6	490	630	210	22.9	Estanislau Zutautas<estanislau.zutautas@veracel.com.br>

Highlights

Company	Capacity (tss/d)	Pressure (barg)	Temp (C)	Area (m2)	Ratio (tss/m2.d)
IP-LA	1700	64	450	66	25,8
Suzano Imperatriz	7000	95	492	323,2	21,7
Klabin TB	1700	106	503	79,6	21,4
Eldorado	6800	85	480	293	23,2

2 Exchanged information

Boilers comparisons

	Brasil	Canada	USA	Finland	Sweden
Recovery boilers	36	43	158	17	27
Age	18 y	35 y	39 y	24 y	29 y
Oldest	41 y	73 y	60 y	55 y	52 y
Biggest	7000 tDS/d (2013)	3300 tDS/d (1990)	3325 tDS/d (1995)	4500 tDS/d (2003)	4000 tDS/d (1996)
Youngest	2015 (6200 tDS/d)	2007 (2400 tDS/d)	2008 (3000 tDS/d)	2008 (3600 tDS/d)	2012 (2400 tDS/d)

Boiler comparisons

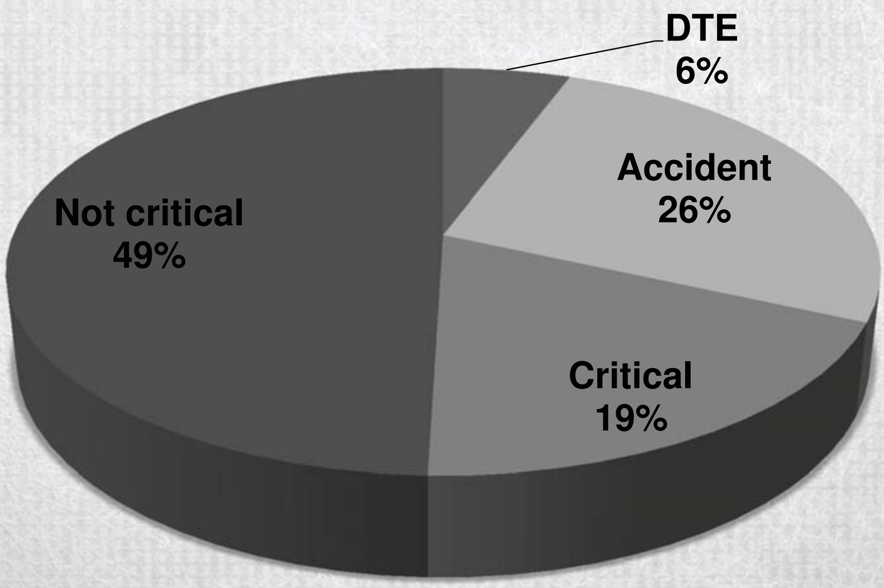
- Previous slide presented us the enormous challenge we are facing.
- We must keep our boilers with highest availability, allways considering its total life cycle

3 Incident analysis

Classifications

- **Critical**
- **Not critical**
- **Dissolving tank explosion**
- **Accident: When people or the recovery boiler itself were under risk, independent of leakages consideration – examples: HBL Tank failure; BFW contamination…**

Events by type



Events remarks

- Decreased Dissolving Tank events after deep procedure discussions (2006)
- Since 2001 we have only one injured person (DTE) on recovery boiler related events
- One minor explosion due waterwash a hotter furnace
- Three smelt-water contacts without explosion
- 0 ESP's from 2002 to 2007
- 9 ESP's since 2008 (all of those correctly evaluated by operators)

4 Incident presentation

Case

Incidents will be presented during ABTCP 2013 Congress

5

Non ordinary issues

Data base update

- Survey every five years. First on 2003, second at 2008, third under execution this year.
- Results will presented on ABTCP 2013 Congress

Major concerns

- Superheater life cycle
- Materials for lower furnace tubes
- BLRBAC guidelines for x-large boilers

SODAHUSKOMMITTÉN - RUOTSALAIS-NORJALAINEN SOODAKATTILAKOMITEA, VUOSIKATSAUS 2012

Peter Andersson
Sodahuskommittèn

Annual Report from the Swedish-Norwegian Recovery Boiler Committee 2013

Ragnar Stare, ÅF
Secretary of the Swedish-Norwegian Recovery Boiler Committee (SNRBC)

Topics

1. The organization of the SNRBC
2. How to work/be organized in the future?
3. State of the boiler park in Sweden and Norway
4. Reported incidents
5. Recommendations
6. Education and examination of operators
7. Standardization
8. Repair welding of composite tubes

1. The organization of the SNRBC

- The Board of the SNRBC
  Chairman: Per Utterström, BillerudKorsnäs Gävle
  Secretary: Urban Andersson/Ragnar Stare, ÅF
  16 members (12 voting)
  - Recommendations Subcommittee
    Lars Andersson, Secretary, ÅF
    Additional 3 members
  - Incidents Subcommittee
    David Good, Secretary, ÅF
    Additional 9 members
  - Education & Training Subcommittee
    Björn Lundgren, Inspecta
    Additional 5 members

2. How to adapt the committe to our members demands?

- The work load on the personnel in the mills has increased due to constant strive for increased efficiency. This means that the personnel in the mills have less time available for any issue outside what is considered core. For an operations engineer that could include *development* of safety work,for example within the framework of SNRBC.
- The annual fee from the mills to SNRBC has been more or less constant for many years or actually decreased in value due to inflation.
- Since mills have closed during the last five years, the SNRBC budget has been further reduced.

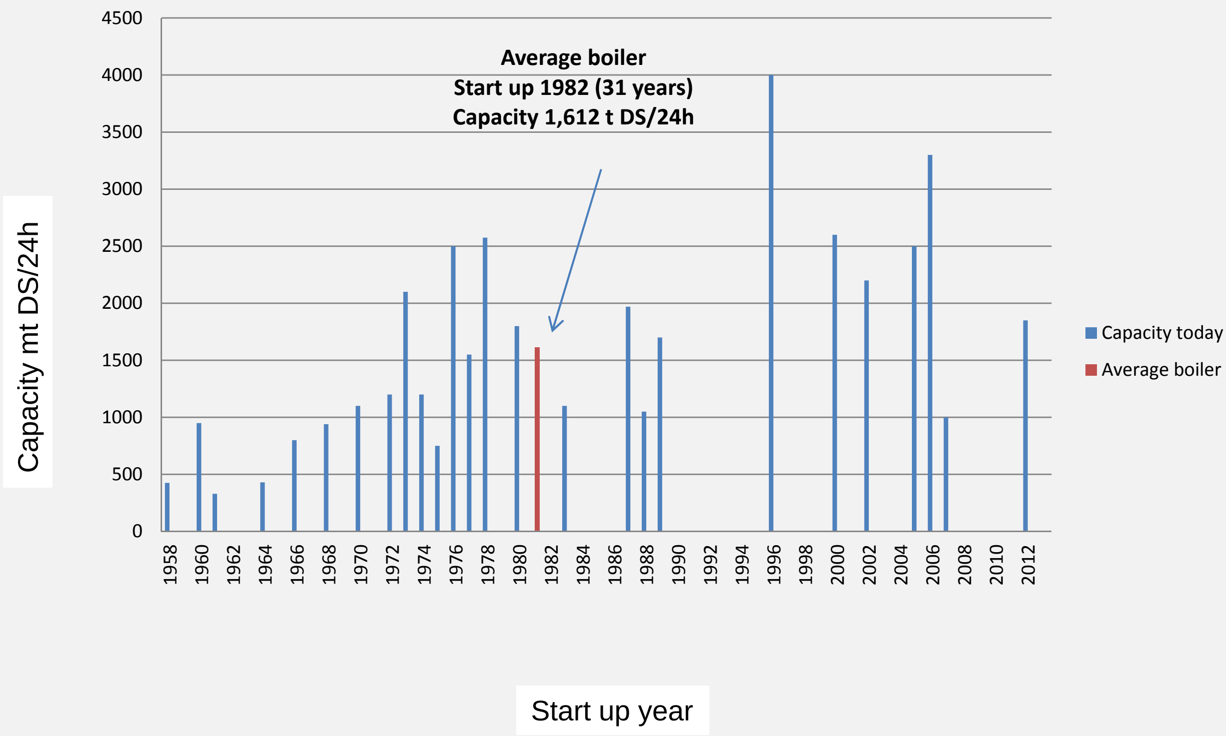
2. What to adapt and how?

- In spring 2013 a small workgroup was initiated to study alternatives.
- First of all SNRBC was considered to have a large value for maintaining the safety, and that value need to be taken care of and developed!
- The statues of the Committe was scrutinized and the core activities was preliminarily to include
  - Recommendations (based on…)
  - Incidents evaluation
  - Spreading of information – including the education of operators
- It is under discussion what is needed to be done to ensure that we do what the members need and to the right extent!
  - For example : The work determined to be needed that previously was done by mill personnel as a part of their daily work must be done by somebody else.
  - We can work different, web meeting to save travel & time, simplified evaluations of some types of incidents etc,
  - This and more will be further discussed in a workshop in November

3. Boiler park
Larger changes during the last years

- Autumn 2013: The boiler in SCA Munksund (start up 1960) was converted to single drum
- Autumn 2013: New evaporator line in BillerudKorsnäs Skärblacka
- August 2013: Closure of Södra cell Tofte – Norway
- Summer 2012: Start up of a new boiler in Iggesund (the 2 old boilers were shut)
- Spring 2012: Closure of Peterson Moss - Norway
- Autumn 2011: The boiler in Smurfit Kappa Kraftliner Piteå (start up 1973) was transformed to single drum
- Autumn 2009: Metsäboard Husum closed one of their 3 boilers. Increased capacity in the two remaining.

3. The boiler park in Sweden and (Norway)



Sodahuskommittén
The Swedish Norwegian Recovery Boiler Committee

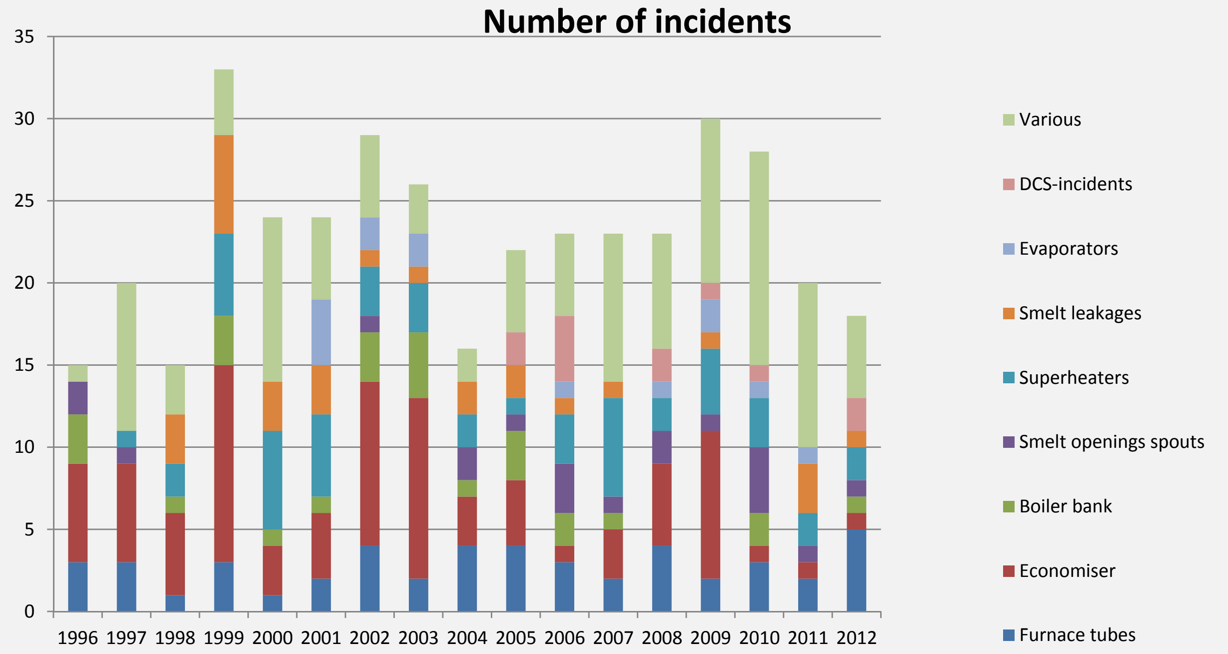
4. Incidents

A total number of 18 incidents were reported for 2012

No.	Incident headline	Down time	No.	Incident headline	Down time
2012-01	Tube leakage in primary 1B superheater	72 h	2012-10	Fire during start up at smelt spout level	48 h
2012-02	Leakage in warm economiser	19 h	2012-11	Boiler explosion (not defined if it was smelt/water explosion or gas explosion)	140 h
2012-03	Leaking T-joint in economiser / air heater circulation system	10 h	2012-12	Local tube thinning in furnace	0 h
2012-04	Leak in generating bank	51 h	2012-13	”black” screens for control system	8 h
2012-05	Leak at the upper part of nose/grid	36 h	2012-14	Leaking smelt at floor corner	96 h
2012-06	Tube leakage inside nose cavity	36 h	2012-15	Lack of agitation in dissolving tank	20 h
2012-07	Broken primary supeheater tube at roof penetration	89 h	2012-16	Cracks in tubes and membranes at ports	0 h
2012-08	Corroded tubes at smelt openings	51 h	2012-17	Cracks in pipe for black liqour	0 h
2012-09	Cracks at stretcher opening	0 h	2012-18	DCS incident	15 h

Sodahuskommittén
The Swedish Norwegian Recovery Boiler Committee

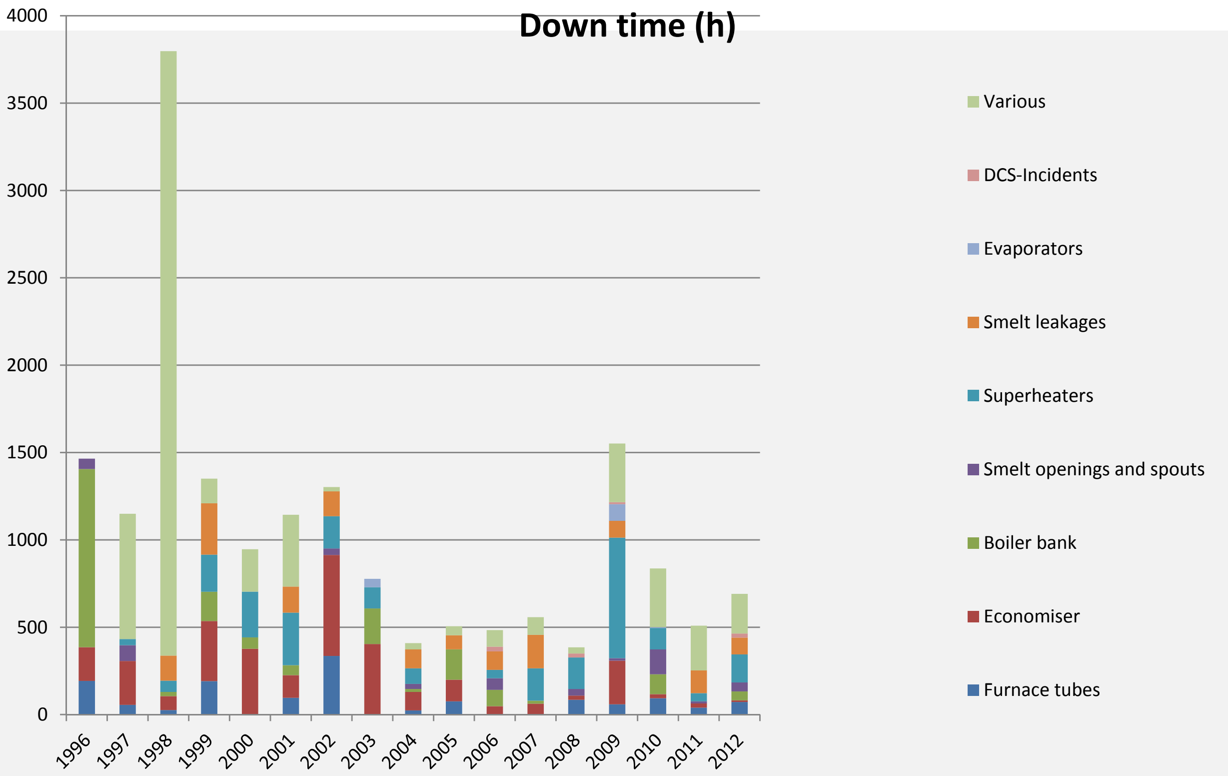
4. Number of reported incidents



Sodahuskommittén

The Swedish Norwegian Recovery Boiler Committee

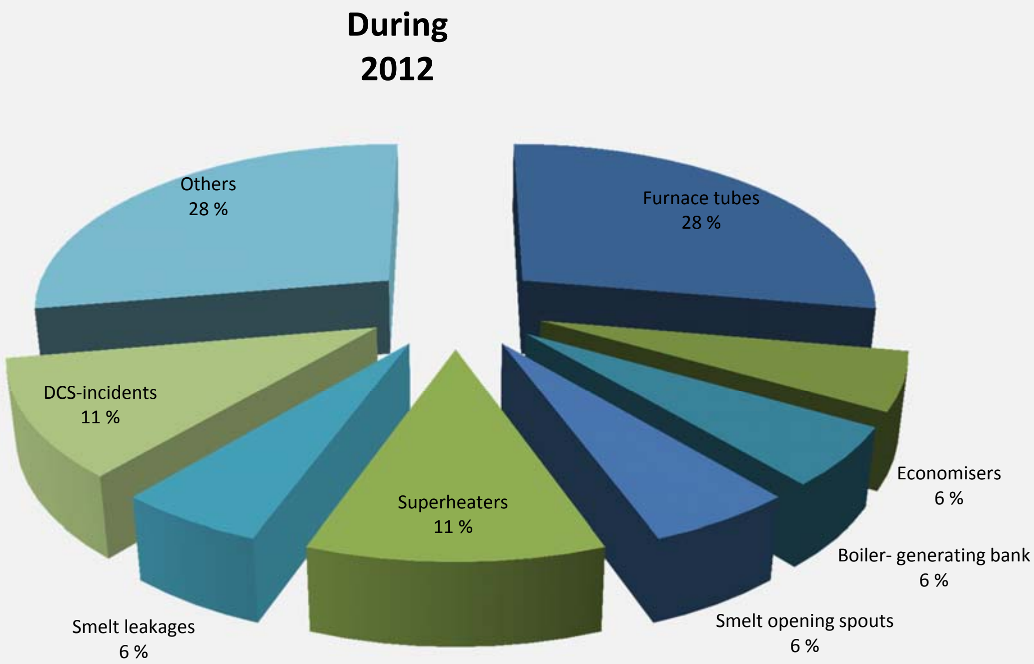
4. Down time due to reported incidents



Sodahuskommittén

The Swedish Norwegian Recovery Boiler Committee

4. Incidents per area 2012



Sodahuskommittén

The Swedish Norwegian Recovery Boiler Committee

5. Recommendations

A – Nomenclature (Facktermer och begrepp)

B – Design and equipment (Konstruktion och utrustning)

C – Production (Drift och driftstörningar)

D – Inspections and maintenance (Inspektion och underhåll)

E – Education (Utbildning av personal)

F – Safety (Säkerhetsbetingelser)

Sodahuskommittén

The Swedish Norwegian Recovery Boiler Committee

5. Recommendations

During the last year 4 recommendations have been approved:

D1: Water washing of flue gas side in boilers
(Vattentvättning av sodapannors gassida)

D3: Minimum accepted thickness of furnace tubes
(Minsta godstjocklek hos vattenförande tuber i sodapannor)

D4: Advices regarding welding repairs in recovery boilers
(Reparation och underhållssvetsning i sodapannor)

E1: Education and examination of operators
(Utbildning och behörighetscertifiering av sodahusoperatörer)

Recommendations

For consideration by members

B – Design and equipment (Konstruktion och utrustning)

Eight recommendations out for consideration

C – Production (Drift och driftstörningar)

Four recommendations out for consideration

D – Inspections and maintenance (Inspektion och underhåll)

One recommendation out for consideration

Sodahuskommittén
The Swedish Norwegian Recovery Boiler Committee

Recommendations

For consideration by members

B1:	Sodapannors konstruktion och utrustning
B6:	Utrustning och tillsyn av utrustning för nivåövervakning i sodapannor
B8:	Tekniska anordningar för nödnedeldning och snabbtömning av sodapannor
B10:	Vattencirkulation och materialtemperaturer i sodapannor
B15:	Förebyggande av inläckage av jonbytesmassa till pannvatten
B16:	Riktlinjer angående utrustning för destruktionseldning i sodapannor
B17:	Utformning och drift av lutsystemet indunstning-sodahus
B19:	Utrustning för luteldning i sodapannor
C4:	Kvalitet på spädvatten kondensat matarvatten pannvatten och ånga
C5:	Förebyggande åtgärder och övervakning för att skapa en beläggningshämmande pannvattenbuffert
C6:	Förebyggande åtgärder vid låga pH-värden samt vid förekomst av svartlut eller olja I pannvatten
C9:	Destruktion av starka luktgaser, metanol och terpentin i sodapannor
D2:	Besiktning, egenbesiktning och fortlöpande tillsyn i sodahus

5. Recommendations

The aim of the recommendation sub committee is to check/update each recommendation every third year.

Extra efforts have been put made to revise ”B12 Auxiliary power supply (Reservkraft i sodahus)” due to the fact that several mills have experienced that the displays for the control system suddenly have turned black

6. Education and examination

During 2013 the education of operators was updated

The education will take place during three occasions, one week each, totally 120 h (Earlier 108 h)

The first education phase will be the same for personnel working within

- Recovery boilers
- Evaporators
- Recausticizing

The education will contain more automation compared to the old education

All participants will perform a project work at their home mill. The projects are decided by the participants and their home mills.

Example of projects/issues are:

More stable reduction rate, ash leakinging, continous blow down, water washing of the boiler…

6. Education and examination

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

All certificates need to be updated/re-newed each 7th year

The "examination test" will be web-based and divided into three main parts:

- Recovery boiler design (funktion och konstruktion)
- Combustion optimization (Förbränningsteknik)
- Safety (Säkerhet)

7. Standardization

SWEDISH STANDARDS INSTITUTE

SVENSK STANDARD
SS-EN 12952-1

Fastställd 2002-01-11
Utgåva 1

Vattenrörspannor och hjälpinstallationer –
Del 1: Allmänt

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

ICS 27.040
Språk: engelska
Tryckt i februari 2002

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 12952-1

December 2001

ICS 27.040

English version

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

Chaudières à tubes d'eau et installations auxiliaires - Partie 1: Généralités

Wasserrohrkessel und Anlagenkomponenten - Teil 1: Allgemeines

This European Standard was approved by CEN on 10 March 2000.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 12952-1:2001 E

or
ecove

7. 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”.

- Today the standard comprises 18 separate parts, from Materials, Design, Fabrication, Testing to Operating Instructions and Flue gas cleaning systems.

- We inform our mills about new editions and how to use the standard for Maintenance etc.

7. Standardization

- Last standard finished this year is the second edition of EN 12952-7, Equipment.

- There is also a proposal for a new edition of the Pressure Directive, 97/23/EC, on the table.

- Swedish standards for the fabrication of all kinds of pressure vessels and boilers under the PED are nowadays identical to the European standards, i.e. they can be used within the whole EU.

8. Repair welding of compound tubes

- A working group with the aim helping to specify when overlay welding is acceptable on composite furnace tubes has been initiated.

- Members from:

Metso Power, Andritz, Inspecta, Dekra and ÅF

- Main work will be carried out during 2014

Sodahuskommittén
The Swedish Norwegian Recovery Boiler Committee

SOODAKATTILAYHDISTYKSEN OPINNÄYTETYÖPALKINNON ESITTELY: MULTI-OBJECTIVE OPTIMIZATION OF RECOVERY BOILER DIMENSIONS USING COMPUTATIONAL FLUID DYNAMICS

Viljami Maakala
Aalto-yliopisto/ Andritz Oy

Multi-Objective Optimization of Recovery Boiler Dimensions Using Computational Fluid Dynamics

Viljami Maakala
Aalto University / ANDRITZ Oy

Supervisor: Professor Timo Siikonen, Aalto University
Instructor: Pasi Miikkulainen, D.Sc. (Tech.), ANDRITZ Oy

Soodakattilapäivä, 31.10.2013

Background

- Furnace designs of large capacity recovery boilers have not been optimized.
- Mostly based on semi-heuristic rules and experience with smaller boilers.

Background

- Computational fluid dynamics (CFD) models can be used to study and compare new designs.
- A trial and error comparison process does not guarantee an improved design (or the best).

Solution

CFD-optimization

A CFD model is combined with an optimization method.

- An optimization method finds the best design using information from CFD simulations.
- The best possible design is found according to the objectives given.

Contents

Introduction
CFD in Recovery Boiler Modeling
Multi-Objective Optimization
Outline of the Work

Methods
Furnace Geometry Optimization Problem
CFD-Optimization Program

Results
Furnace Geometry Optimization

Conclusion

CFD in Recovery Boiler Modeling

- Fluid flow, heat transfer, liquor spraying, chemical reactions, etc. in the boiler are solved using a CFD model.
- Steady state (time averaged) modeling is used.

CFD in Recovery Boiler Modeling

- There are uncertainties (errors) present in CFD modeling and their effects should be estimated.
- Regardless, when boiler features or operation mode are changed, changes in performance are predicted realistically.
- CFD models can be used for design optimization.

Multi-Objective Optimization

Optimization

Finding a solution which makes the inspected system as good as possible in some defined sense.

- A multi-objective optimization problem has more than one objective.
- When the objectives are conflicting there is a set of optimal points (Pareto set).
- Choosing a final solution involves making trade-offs (decision maker).

Outline of the Work

Goals of the work:

- Estimating errors of the used CFD solutions
- Developing and verifying a CFD-optimization program
- Solving a multi-objective optimization problem: Find the best furnace dimensions for a large capacity (7000 tds/d) recovery boiler

Introduction

CFD in Recovery Boiler Modeling

Multi-Objective Optimization

Outline of the Work

Methods

Furnace Geometry Optimization Problem

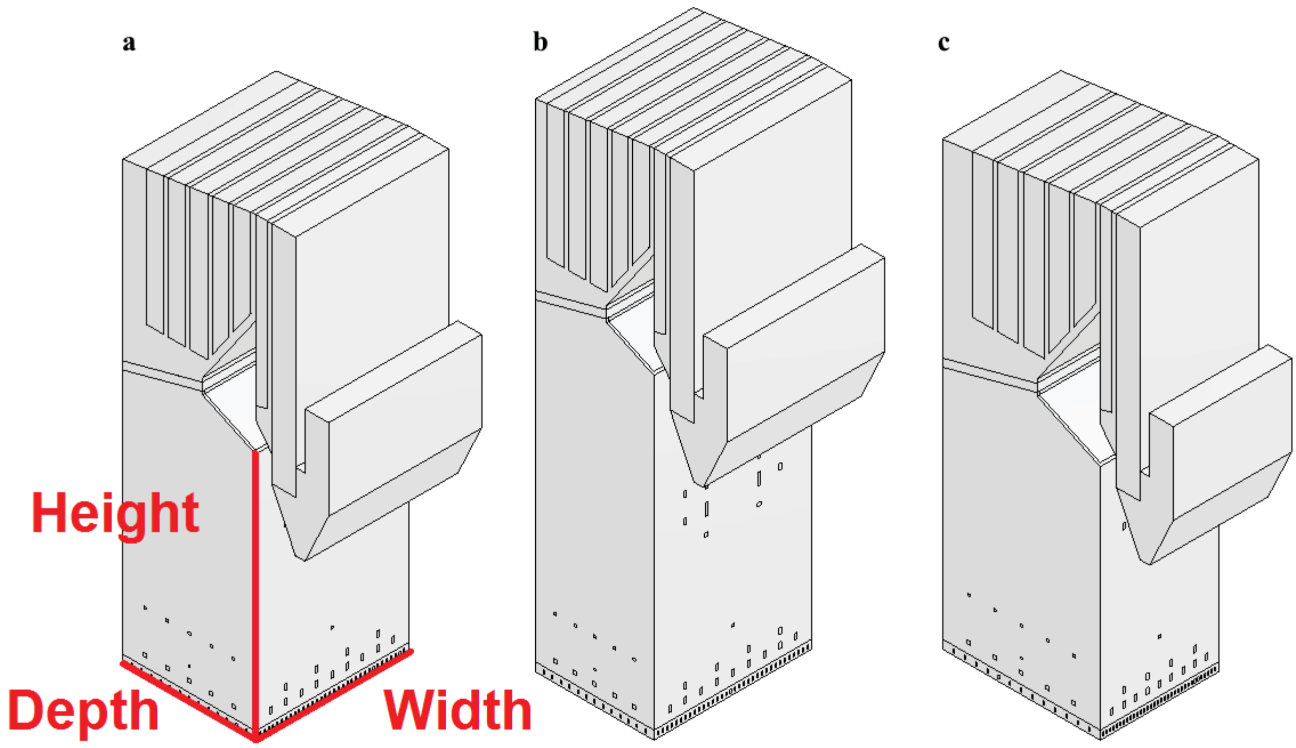
CFD-Optimization Program

Results

Furnace Geometry Optimization

Conclusion

Furnace Geometry Optimization Problem



a) Base design. b) and c) Other designs.

Furnace Geometry Optimization Problem

By changing furnace width, depth and height

minimize	7 objectives
maximize	1 objective
subject to	2 constraint functions
	contraints on furnace dimensions

Furnace Geometry Optimization Problem

Constraints:

- CO content at nose level (less than 200 ppmw)
- Temperature at nose level (near 1000 °C)

Maximize:

- Lower furnace temperature (below liquor guns)

Furnace Geometry Optimization Problem

Minimize:

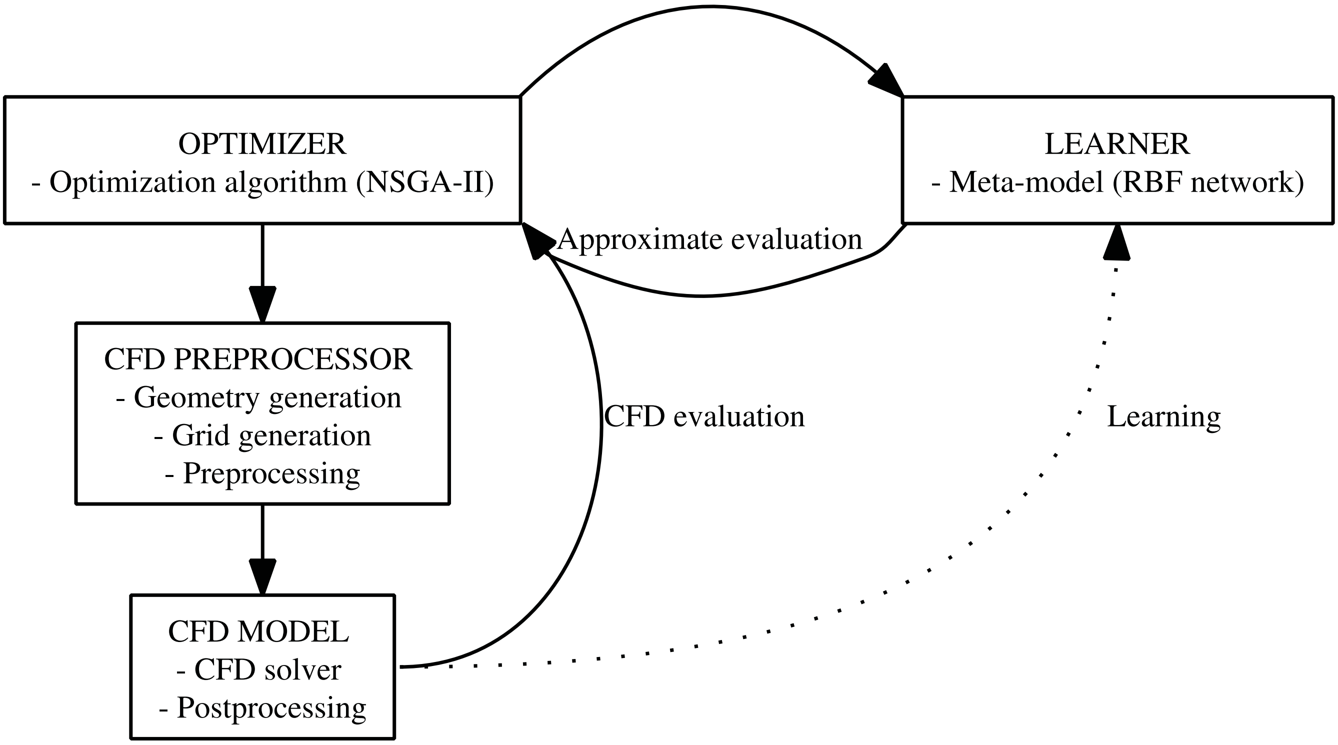
- Carryover at nose level
- Amount of liquor particles landing on walls
- CO content at nose level
- CO spikes at nose level
- Upward velocity standard deviation at nose level
- Temperature standard deviation at nose level
- O_2 content at nose level

CFD-Optimization Program

The program includes:

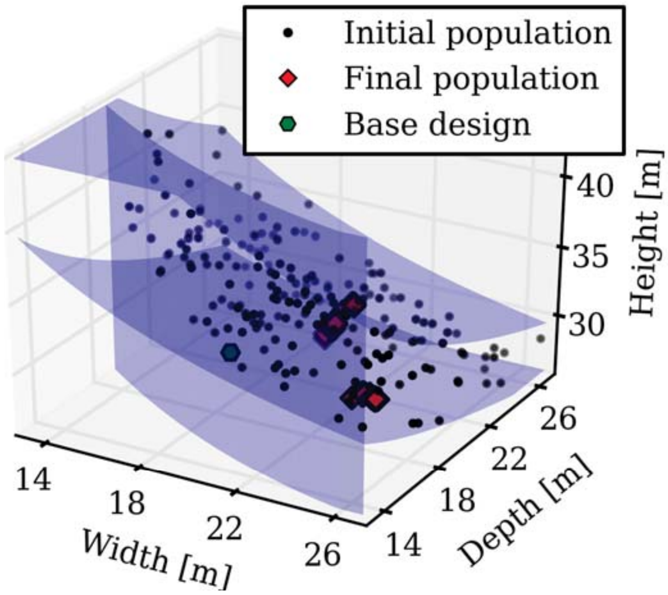
- A recovery boiler CFD model.
- An optimization method based on a genetic algorithm.
- A learner based on a radial basis function network (used for approximate evaluations).

CFD-Optimization Program



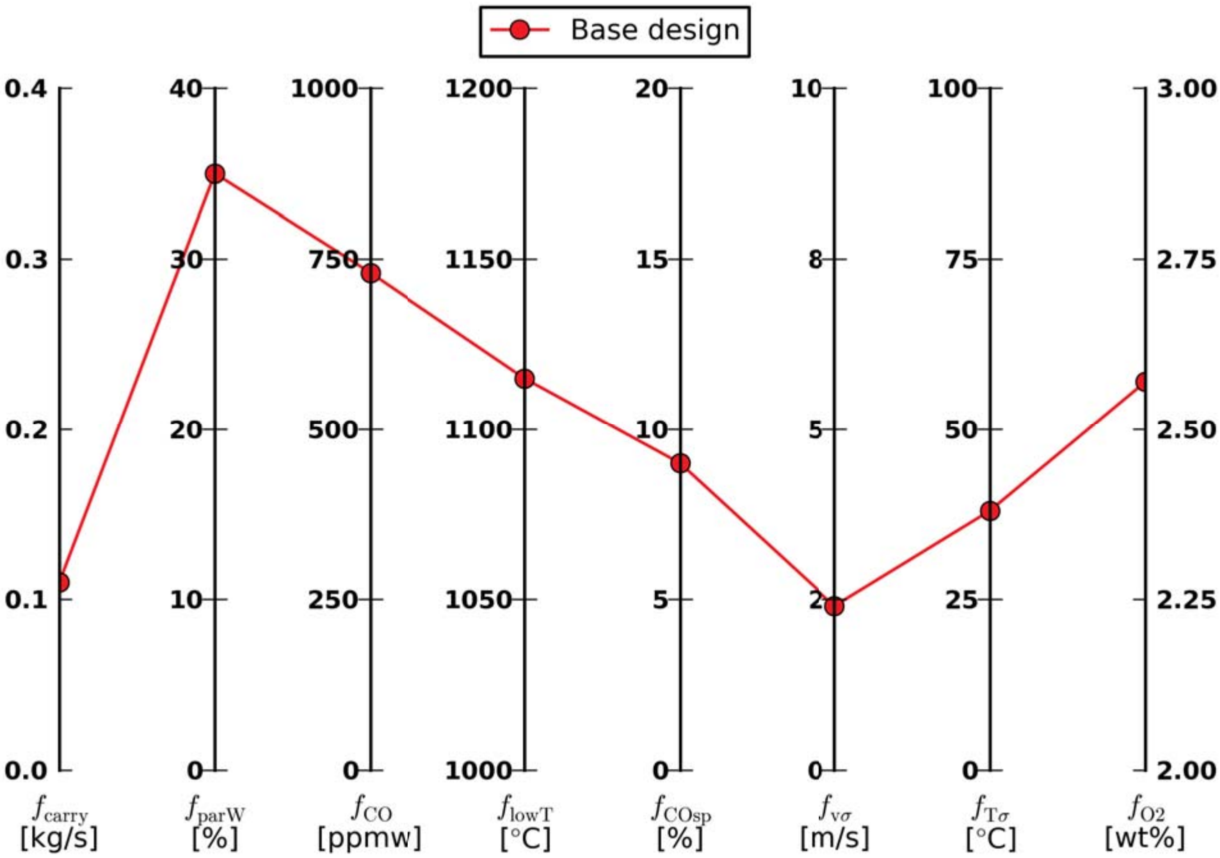
Furnace Geometry Optimization

- The program was run for 40 generations (1 month)
- Optimization was converged (ready) at this point
- Iteration errors in solved CO values affect the results.

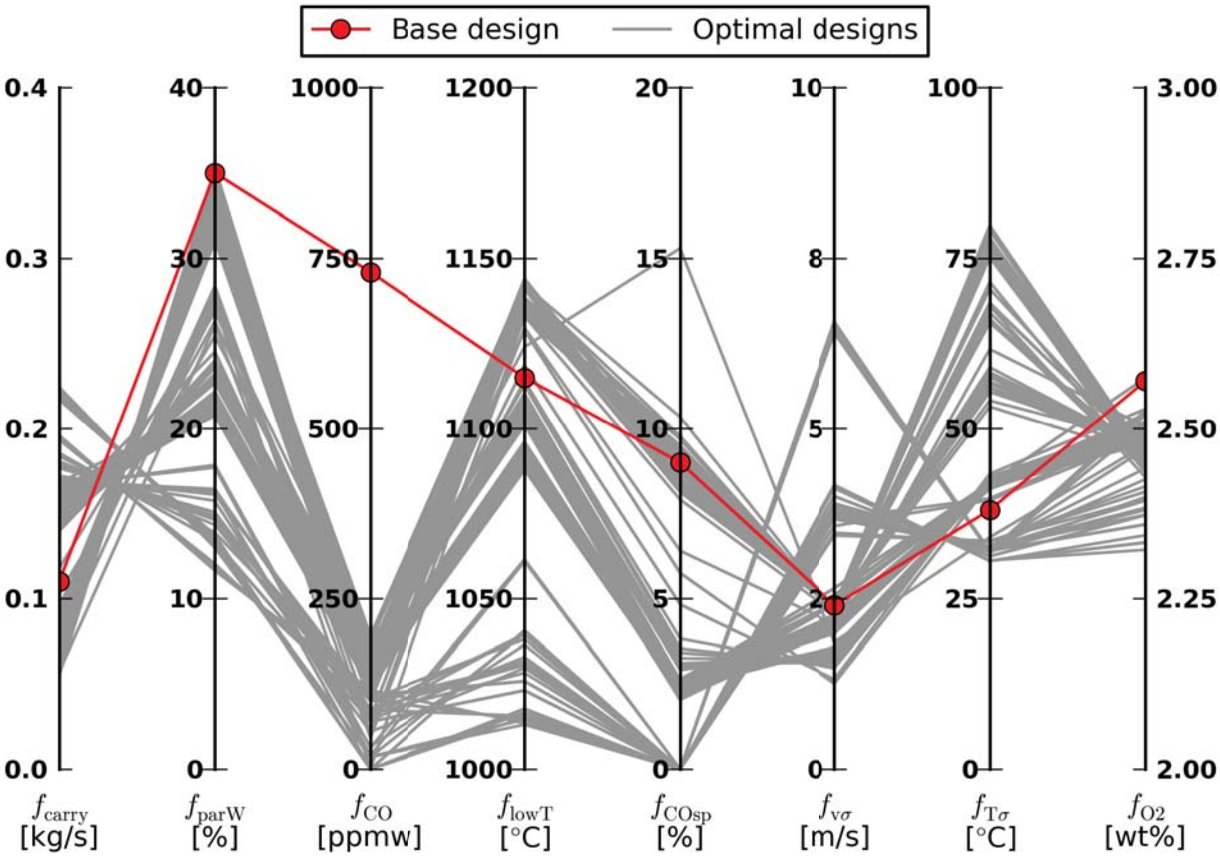


Final population (200 points)

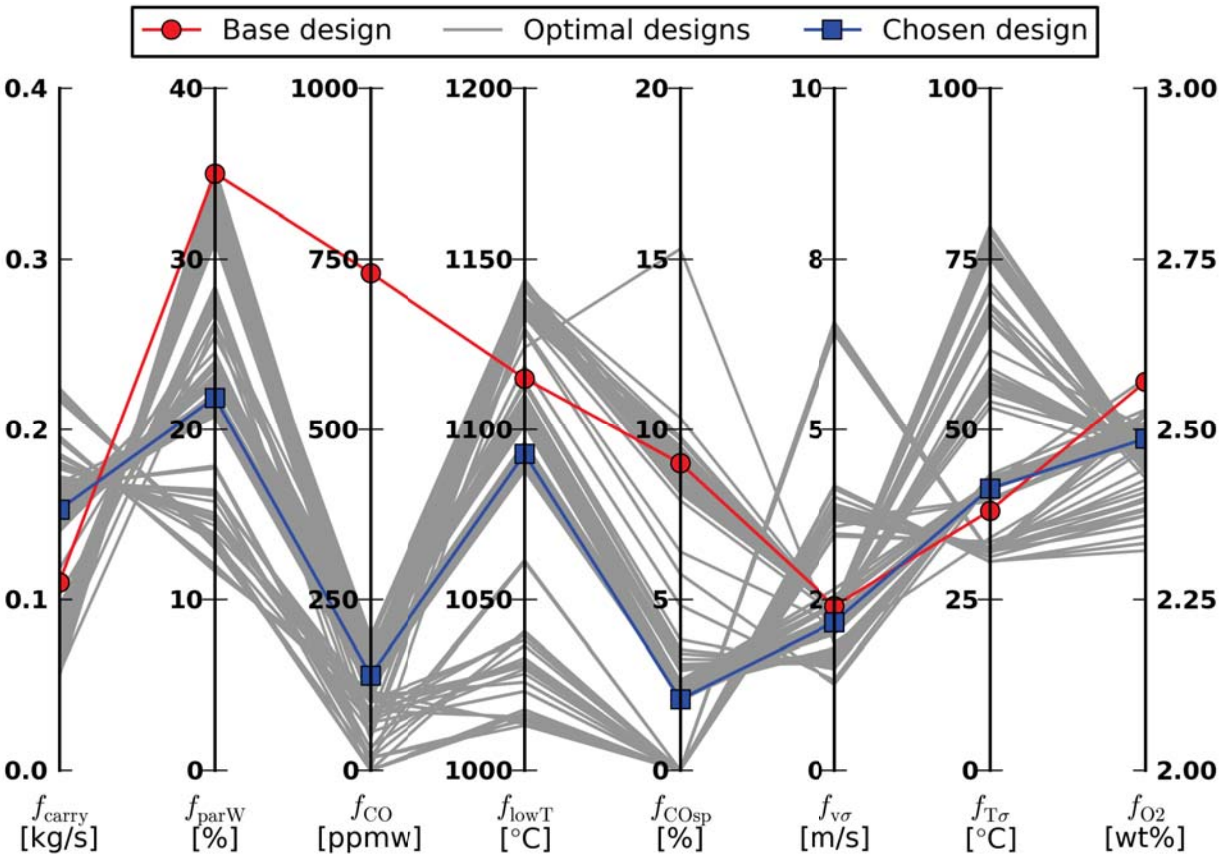
Furnace Geometry Optimization



Furnace Geometry Optimization



Furnace Geometry Optimization



Conclusion

- By optimizing the furnace design, performance of the recovery boiler can be significantly improved.
- CFD-optimization can be used effectively in recovery boiler design.

Conclusion

Future work:

- The optimization program can be used for all kinds of design problems.
- We can optimize placements of openings, spraying, model parameters, ...
- The possibilities are endless!

Acknowledgements

- This work was done at and funded by ANDRITZ Oy.

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