Contamination of the water-steam circuit at Herning Power Station with ECO wash water

SIAPWS, March 21st 2013, Monika Nielsen

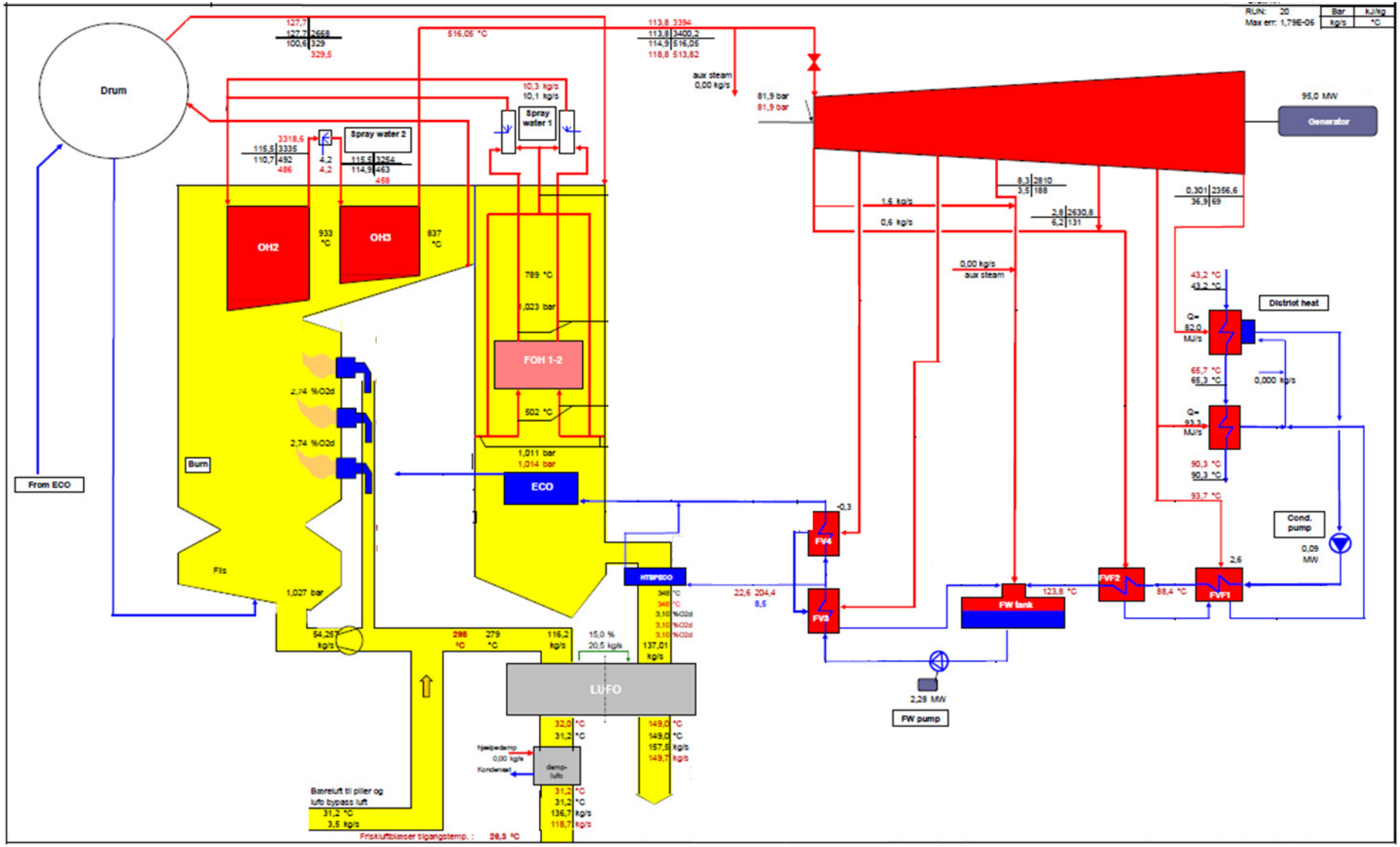
DONG energy

Herning Power Station

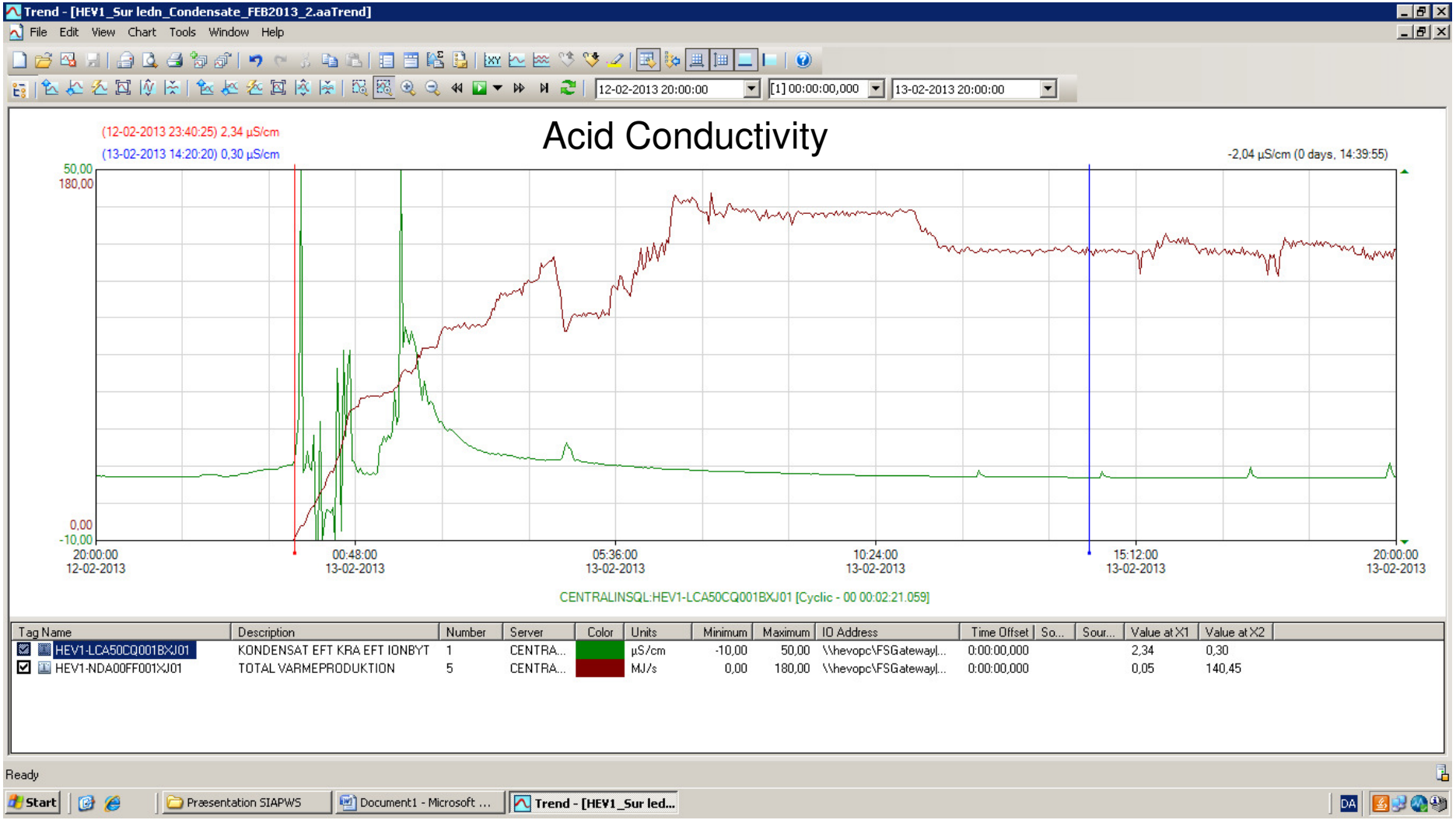
- Biomass fired combined heat and power plant
  - 70 % wood chips (approx. 280-300.000 ton per year)
  - 30 % wood pellets (approx. 60-70.000 ton per year)
  - Reserve fuel is natural gas
- 95 MW power
- 174 MJ/s heat
- Drum boiler (115 bar, 525 ˚C)
  - Boiler water treatment = CT (NaOH)
  - Feed water treatment = AVT (NH_3)
- Hanging superheaters
- Steam Turbine
- Heat exchangers
  - 2 primary exchangers
  - 1 by-pass exchanger
- Condensate polishing
  - Mechanical filter
- District heating
  - Water treatment = NH_3

DONG energy

Herning Power Plant



Contamination of the water-steam circuit on February 13th 2013



DONG energy

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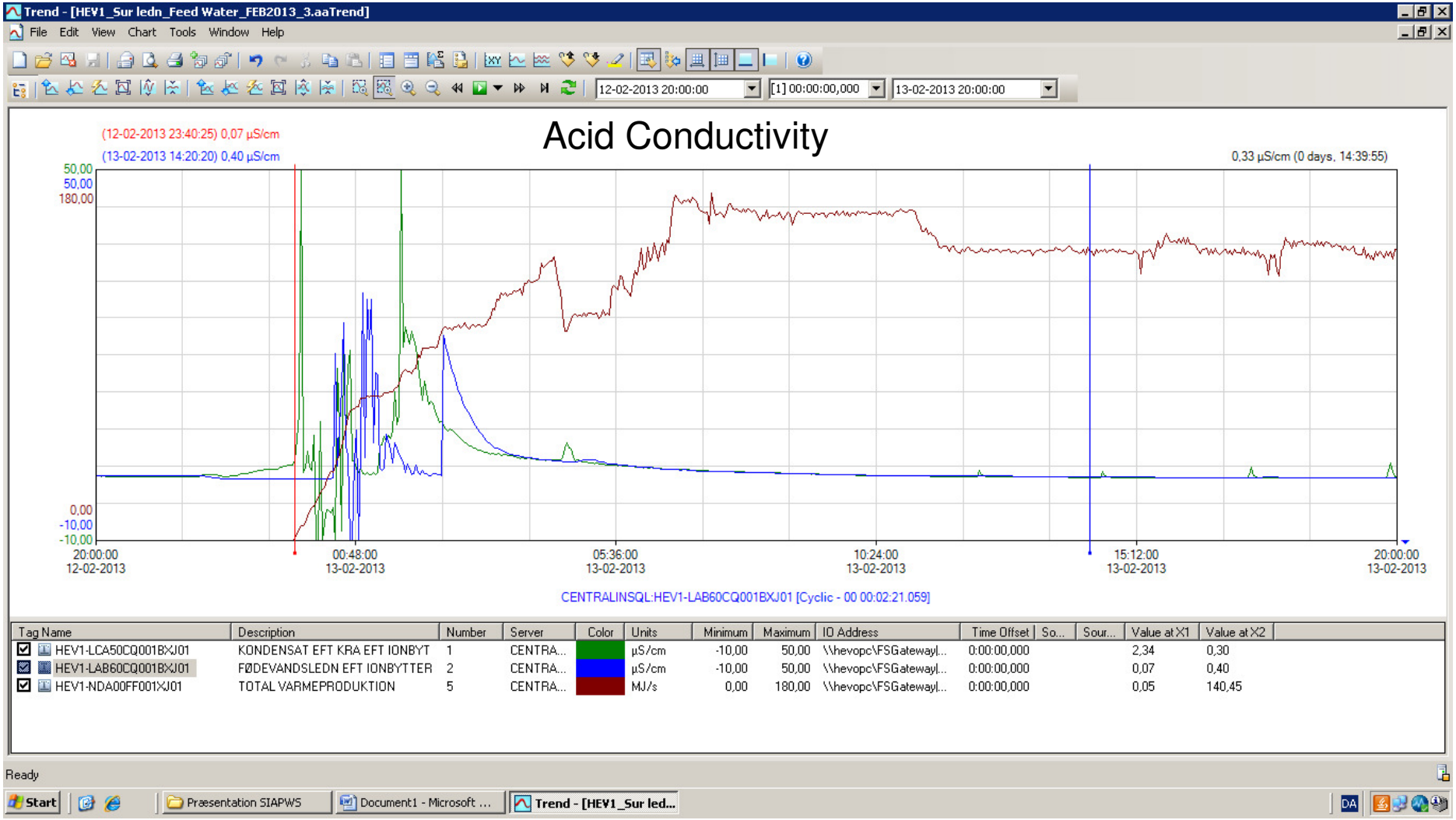

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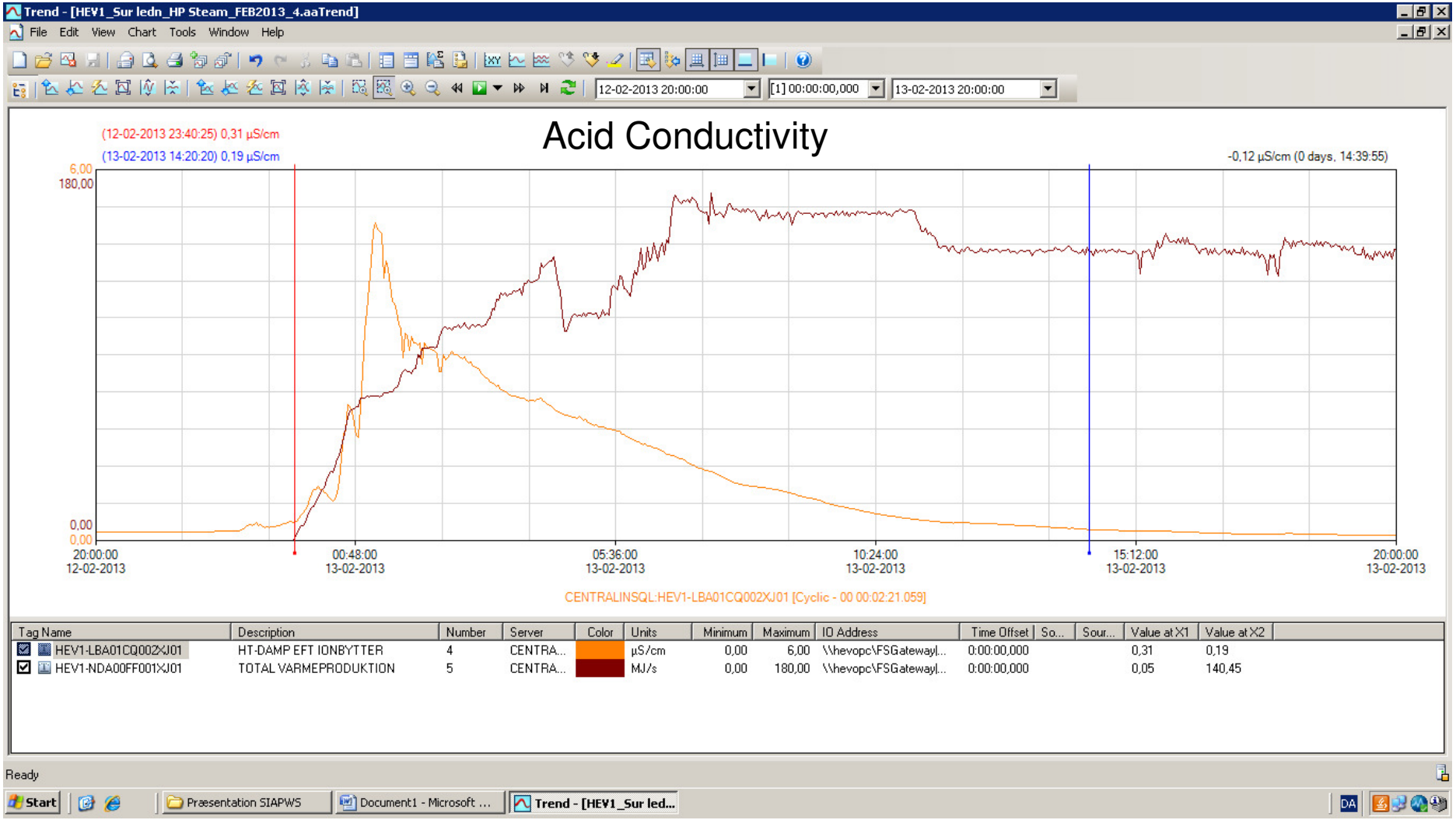

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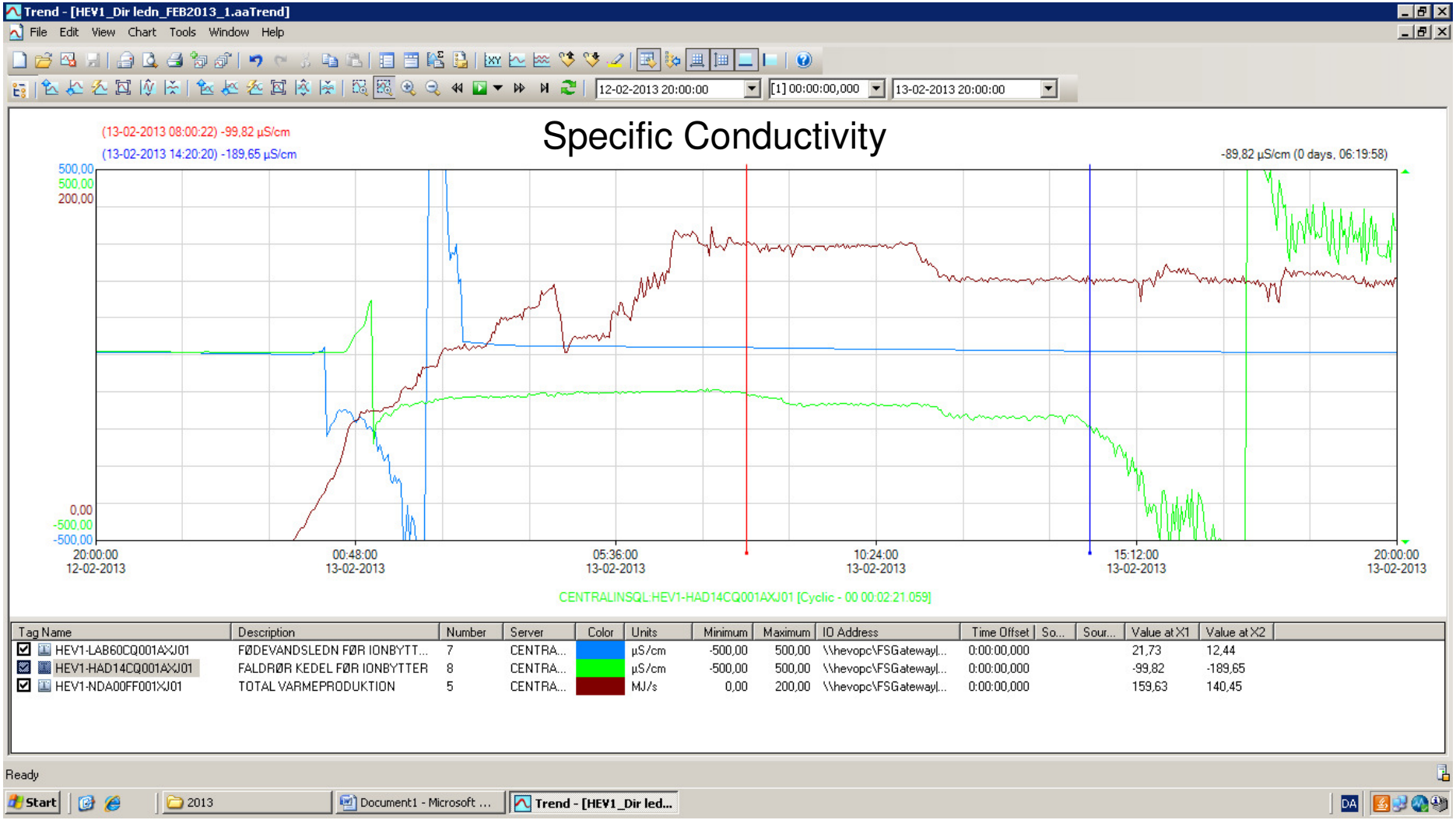

DONG energy

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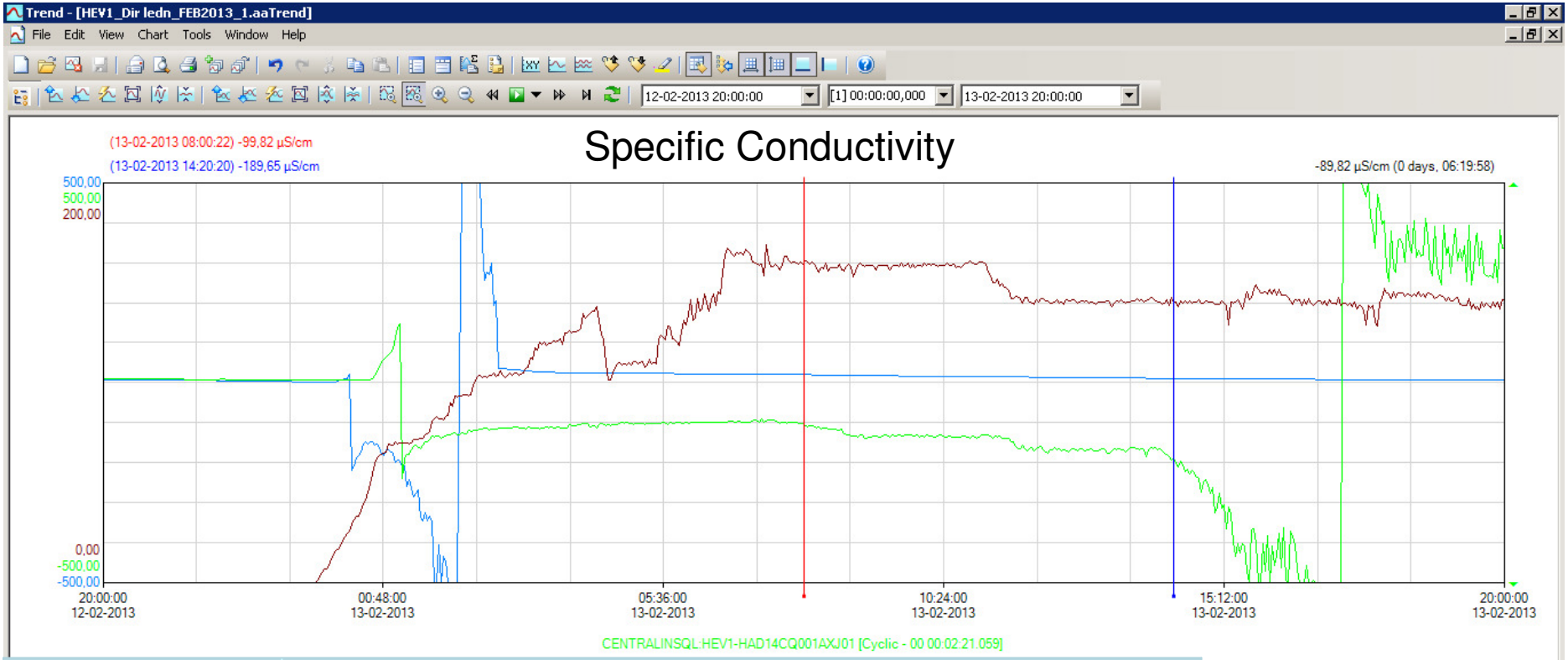
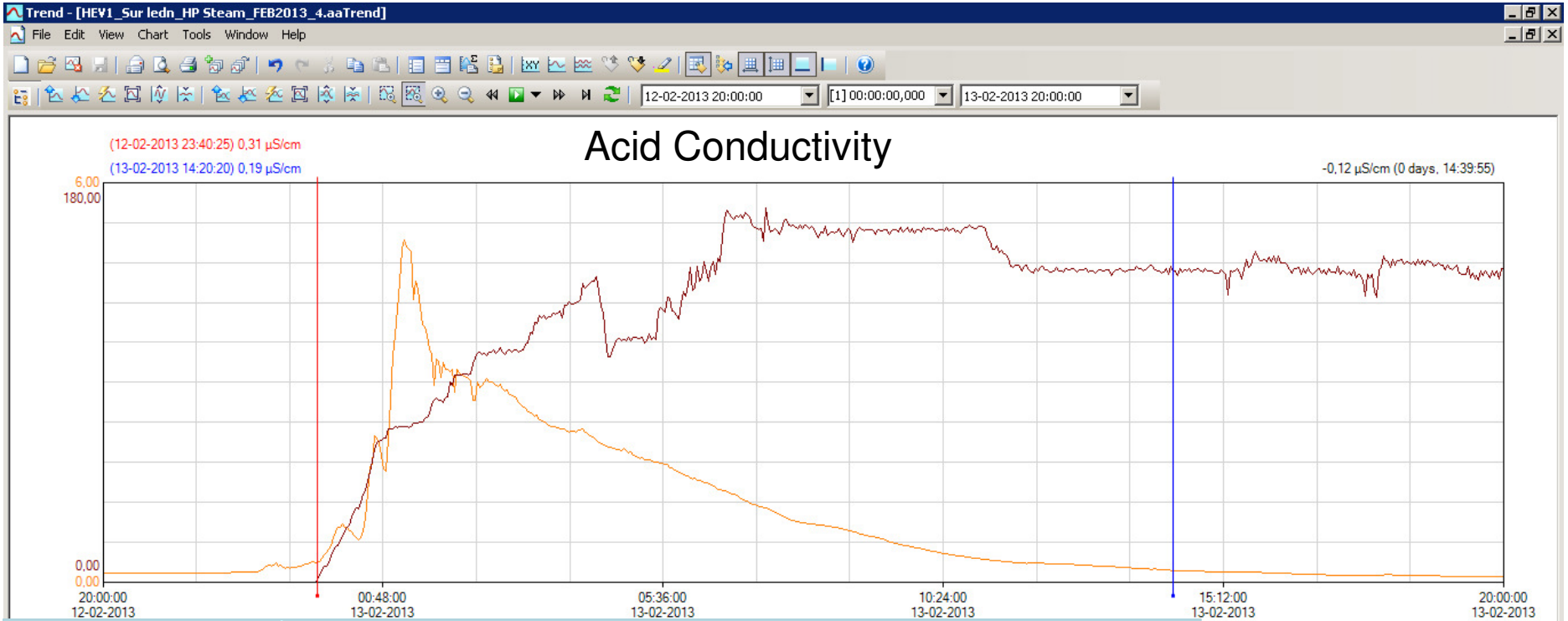


Sample 08:00	SiO_2 [µg/L]	NH_3 [mg/L]	Na^+ [µg/L]	pH	L_{SC} [µS/cm]	L_{AC} [µS/cm]
Evaporator Water	1420	6,0	11000	11,3	460	-

Value at X1	Value at X2
21,73	12,44
-99,82	-189,65
159,63	140,45

DONG energy

Contamination of the water-steam circuit on February 13th 2013

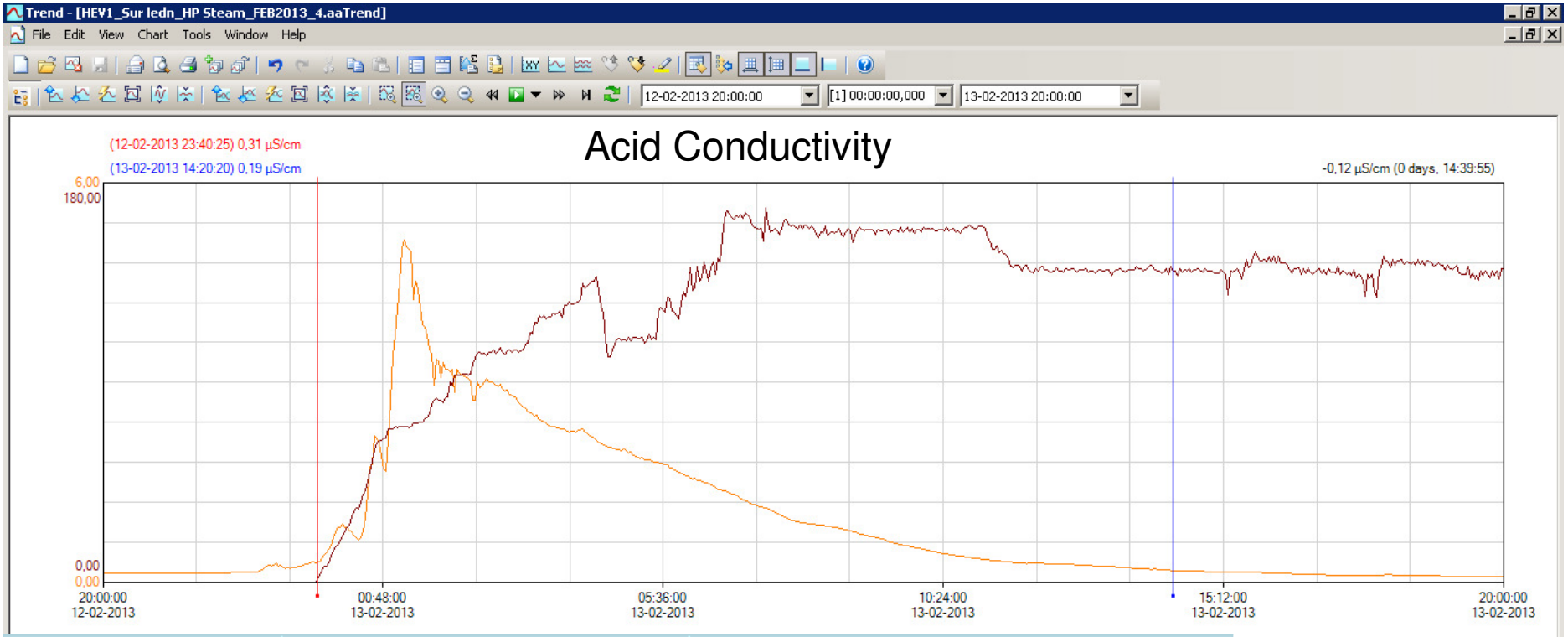


Sample 14:15	SiO_2 [µg/L]	NH_3 [mg/L]	Na^+ [µg/L]	pH	L_{SC} [µS/cm]	L_{AC} [µS/cm]
Feed Water	24	4,7	3	-	12,5	0,4
Evaporator Water	930	1,6	4000	10,9	174	118
HP Steam	13	-	3	-	14,8	0,3
Condensate	26	-	5	-	13,0	0,3

Value at X1	Value at X2
0,31	0,19
0,05	140,45

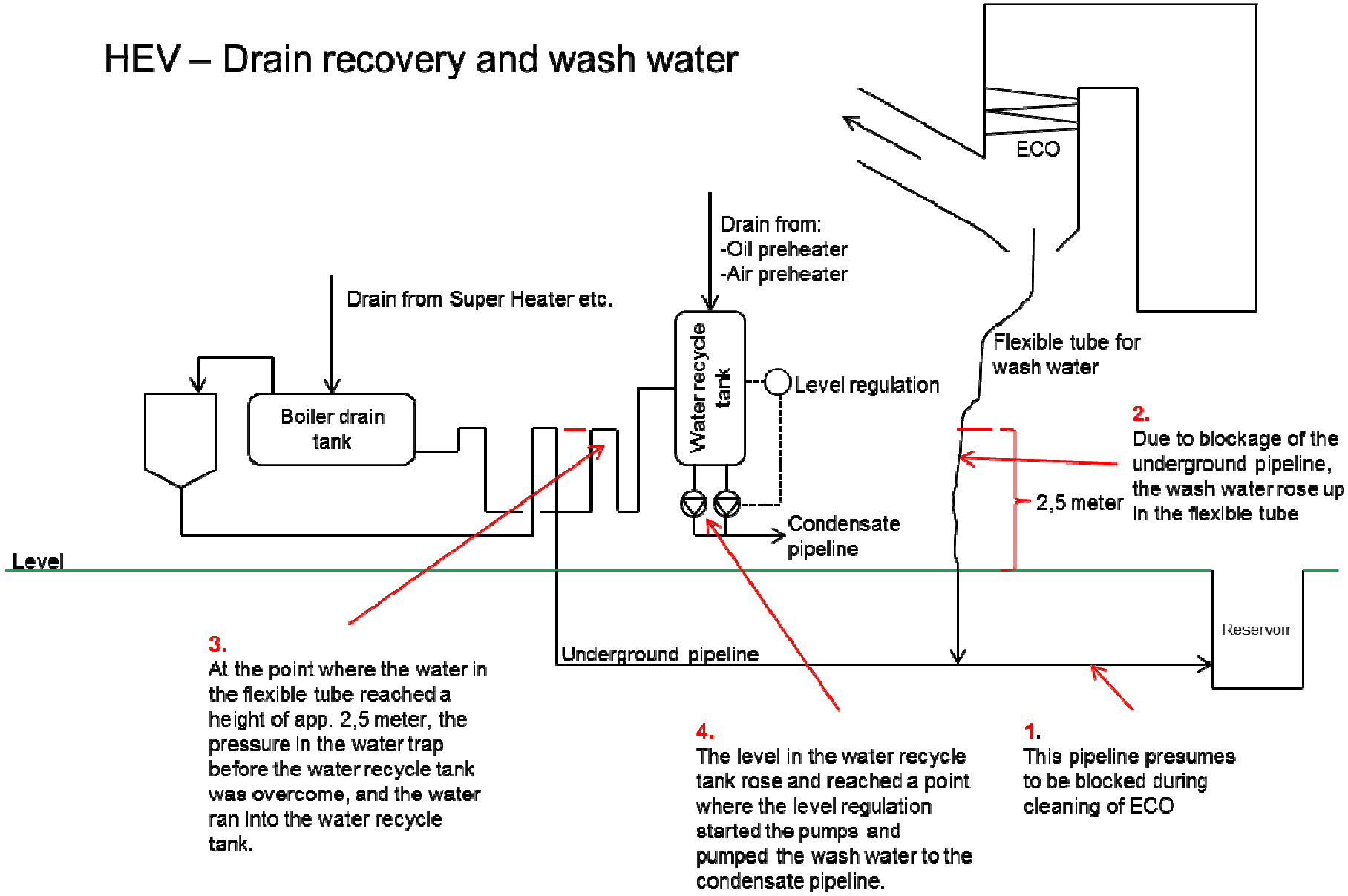
DONG energy

Contamination of the water-steam circuit on February 13th 2013



Sample 14.15	Cl^- [µg/L]	SO_4^{2-} [µg/L]	PO_4^{3-} [µg/L]	Na^+ [µg/L]	NH_4^+ [µg/L]	K^+ [µg/L]	Ca^{2+} [µg/L]
Feed Water	3	< 5	80	1	3900	20	40
Evaporator Water	8700	9000	< 5	4300	950	28000	60
HP Steam	< 2	< 5	< 5	< 1	3500	40	< 5
Condensate	120	25	20	70	3300	210	90

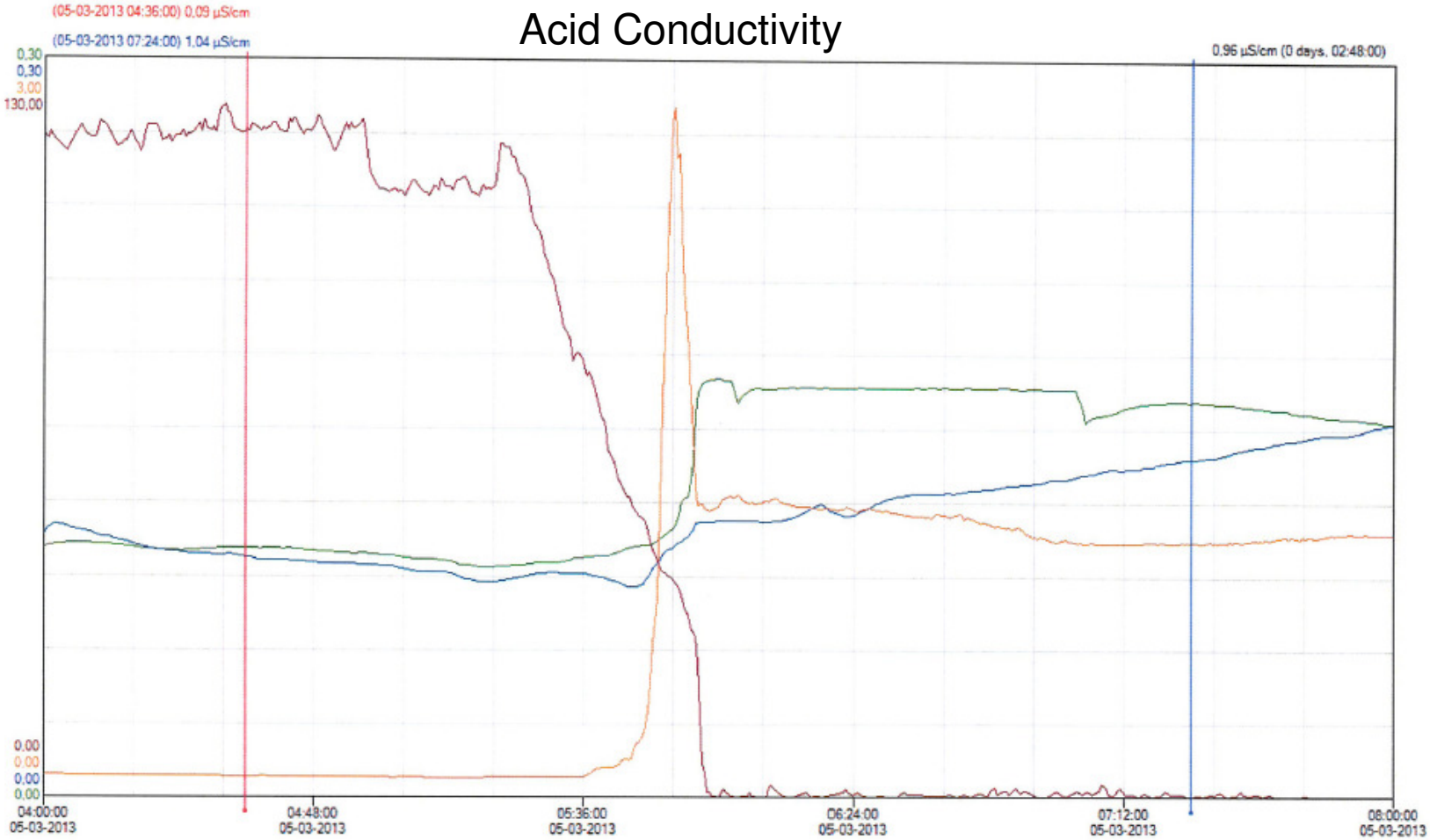
HEV – Drain recovery and wash water



DONG energy

Superheater rupture on March 5th 2013

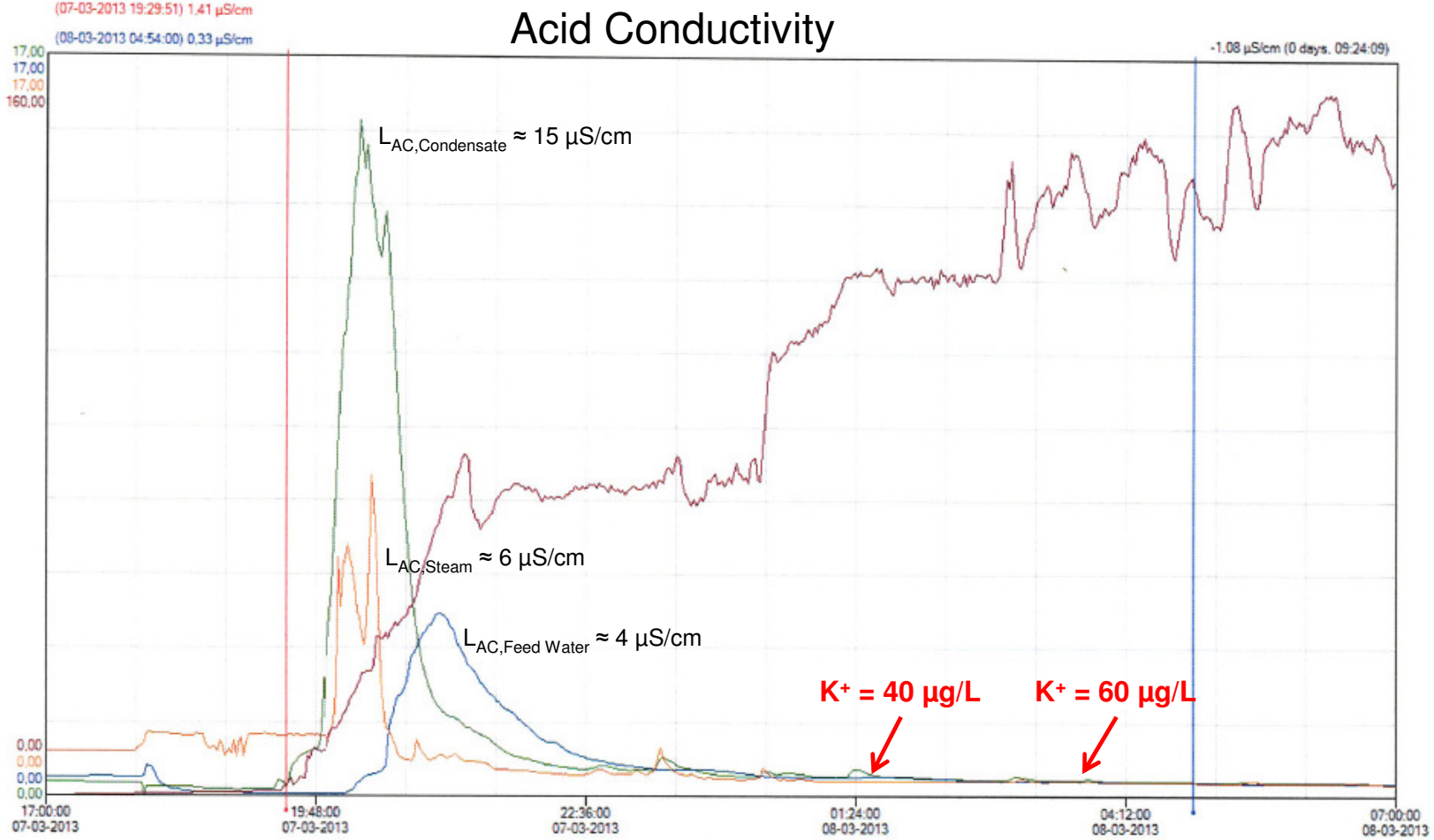
Acid Conductivity



Tag Name	Description	Number	Server	Color	Units	Minimum	Maximum	IO Address	Time Offset	So...	Sour...	Value at X1	Value at X2
HEV1-LCA50CQ001BXJ01	KONDENSAT EFT KRA EFT IONBYT	1	CENTRA...		µS/cm	0,00	0,30	\\hevopc\FSGateway(...	0:00:00,000			0,10	0,16
HEV1-LAB60CQ001BXJ01	FØDEVANDSLEDN EFT IONBYTTER	2	CENTRA...		µS/cm	0,00	0,30	\\hevopc\FSGateway(...	0:00:00,000			0,10	0,14
HEV1-LBA01CQ002XJ01	HT-DAMP EFT IONBYTTER	4	CENTRA...		µS/cm	0,00	3,00	\\hevopc\FSGateway(...	0:00:00,000			0,09	1,04
HEV1-NDA00FF001XJ01	TOTAL VARMEPRODUKTION	5	CENTRA...		MJ/s	0,00	130,00	\\hevopc\FSGateway(...	0:00:00,000			117,24	0,17

DONG energy

Start-up on March 7th 2013

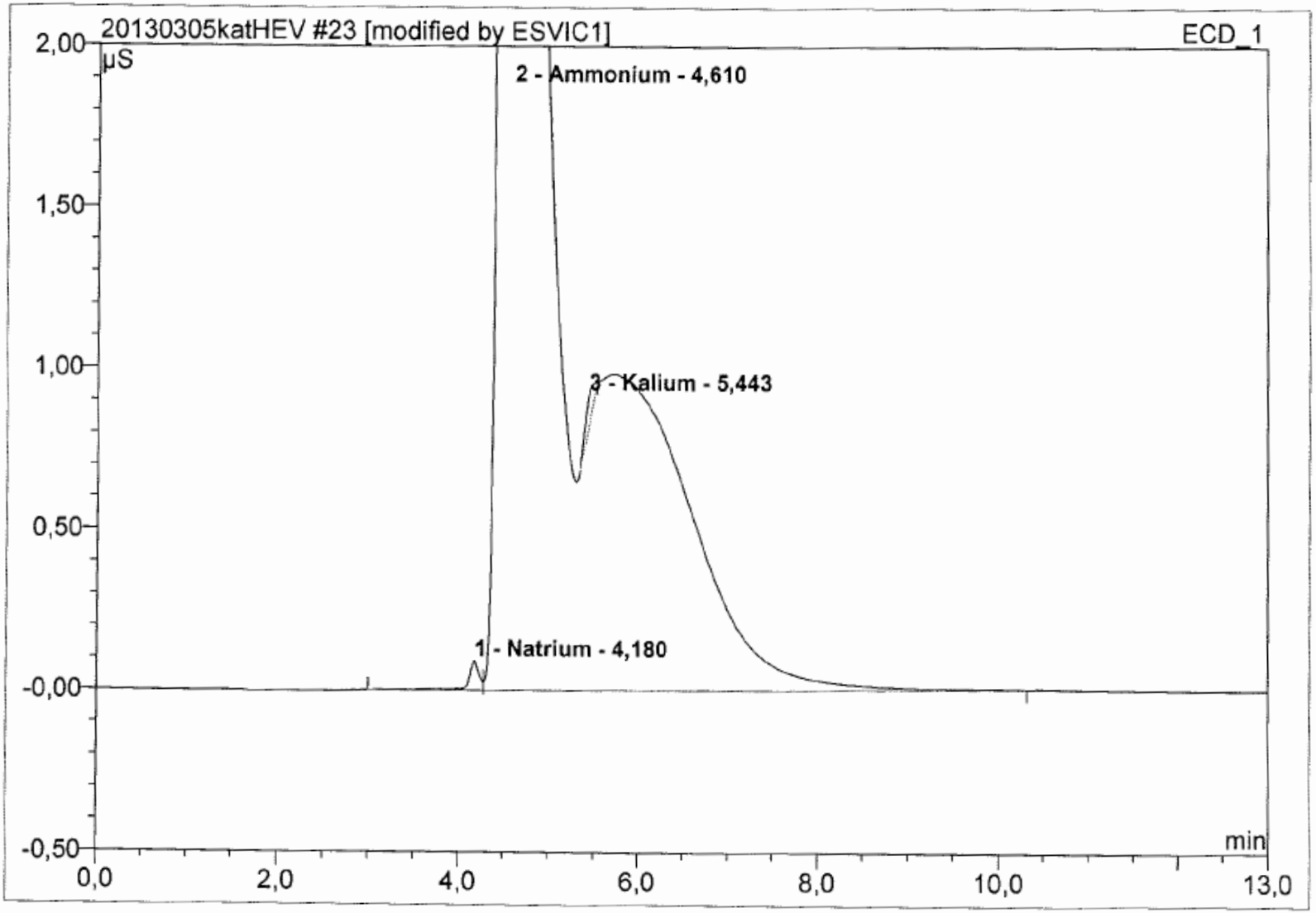


CENTRALINSQL:HEV1-LBA01CQ002XJ01 [Cyclic - 00:00:01:28.339]

Tag Name	Description	Number	Server	Color	Units	Minimum	Maximum	IO Address	Time Offset	So...	Sour...	Value at X1	Value at X2
HEV1-LCA50CQ001BXJ01	KONDENSAT EFT KRA EFT IONBYT	1	CENTRA...		µS/cm	0,00	17,00	\\hevopc\FSGateway\...	0:00:00,000			0,35	0,36
HEV1-LAB60CQ001BXJ01	FØDEVANDSLEDN EFT IONBYTTER	2	CENTRA...		µS/cm	0,00	17,00	\\hevopc\FSGateway\...	0:00:00,000			0,07	0,33
HEV1-LBA01CQ002XJ01	HT-DAMP EFT IONBYTTER	4	CENTRA...		µS/cm	0,00	17,00	\\hevopc\FSGateway\...	0:00:00,000			1,41	0,33
HEV1-NDA00FF001XJ01	TOTAL VARMEPRODUKTION	5	CENTRA...		MJ/s	0,00	160,00	\\hevopc\FSGateway\...	0:00:00,000			2,26	134,46

DONG energy

Start-up on March 7th 2013



DONG energy

Start-up on March 7th 2013

HP Steam	19:40	20:40	21:40	22:40	23:25	00:30	03:30	8/3 11:55	9/3 08:50
L_{AC} [µS/cm]	> 6	0,99	0,65	0,58	0,72	0,45	0,36	0,25	0,24
Cl^- [µg/L]	< 2	20	10	5	< 2	< 2	3	< 2	< 2
SO_4^{2-} [µg/L]	720	60	20	40	25	10	< 5	< 5	< 5
Acetate [µg/L]	500	12	20	20	15	< 2	< 2	< 2	< 2
Na^+ [µg/L]	3	4	3	< 2	< 2	< 2	30	< 2	< 1
K^+ [µg/L]	400	25	12	9	< 2	< 2	25	4	< 2
Ca^{++} [µg/L]	60	< 10	< 10	< 5	< 5	< 10	< 5	< 5	< 5

Feed Water	20:40	21:40	22:40	11:55
L_{AC} [µS/cm]	2,31	2,27	0,86	0,24
Cl^- [µg/L]	65	30	12	< 2
SO_4^{2-} [µg/L]	550	220	70	< 5
Acetate [µg/L]	50	30	20	12
Na^+ [µg/L]	12	10	6	< 2
K^+ [µg/L]	320	100	40	0
Ca^{++} [µg/L]	160	55	< 25	< 5

Steam to turbine at a normal start-up

DONG energy

Recommendations for the coming period

- At every start-up before the overhaul we need to measure the potassium content before the steam is sent to the turbine
- Before the stop for the upcoming overhaul the superheaters will be washed with saturated steam
- Take pipe samples of the superheaters to estimate the condition of the parts that will remain after the overhaul
- Acid clean the part of the superheaters that will remain after the overhaul
- The possibility to take a pipe sample of the evaporator will be examined
- The turbine will be examined during the overhaul (cracks and salt deposits)

DONG energy

Unfortunate actions during the incident

- The re-use water is sent to the condensate pipeline in stead of to the make-up water treatment plant
- The operating personnel did not respond to the very high acid conductivities
- The first 4 hours of a start up the conductivity alarms are disconnected
- There is no laboratory on site, and we had to wait several hours/days before we had any results
- The experience of such incidents is little, and we rely on external consultants

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