DEMEAU Workshop June 2015

Zweckverband
Landeswasserversorgung

Intelligent process control by use of artificial neural networks & genetic algorithms during treatment of Danube river water

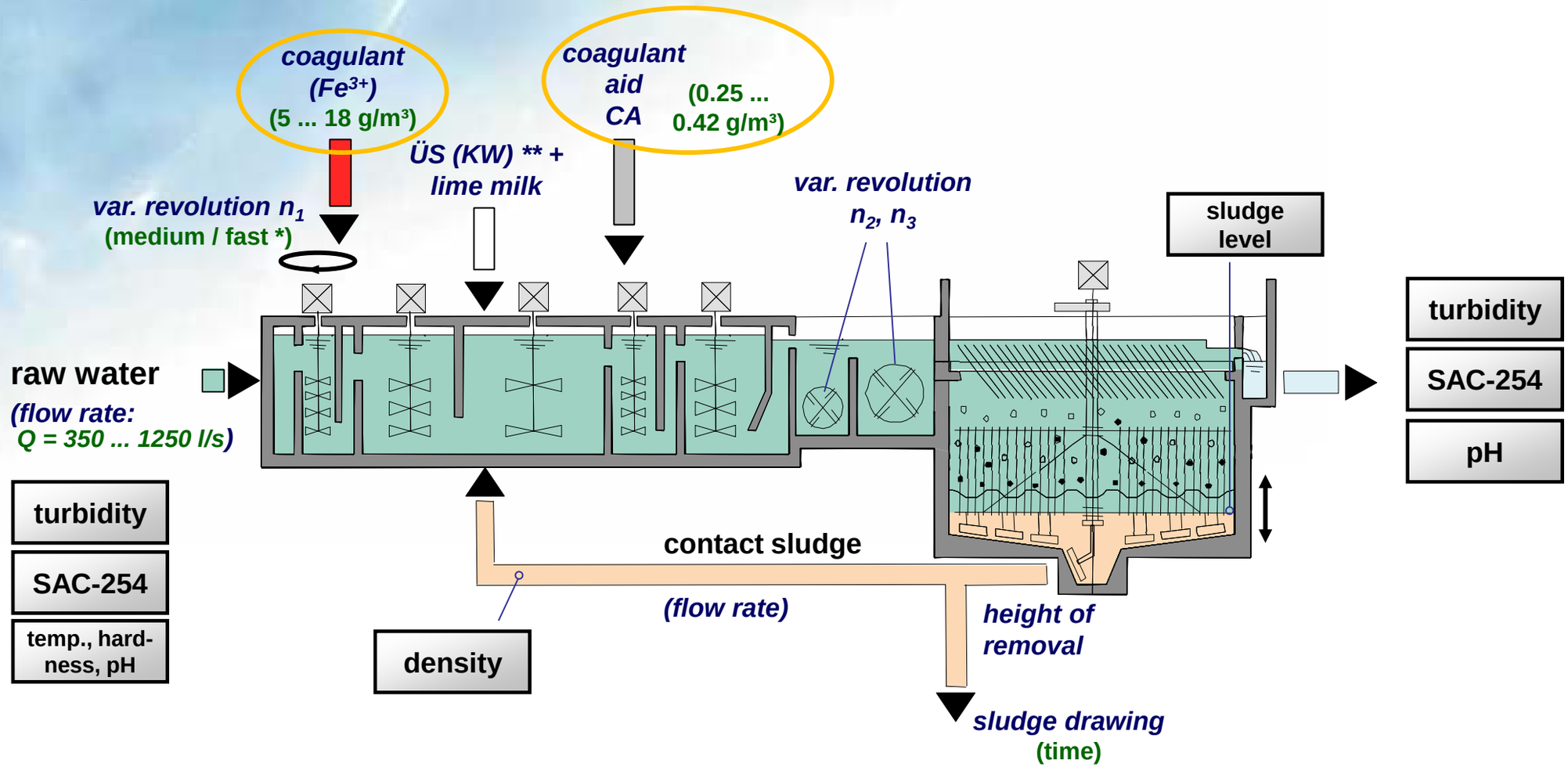
Thoralf Volquardsen[1]
Rudi Winzenbacher[1]
Jörg Gebhardt[2]
Silke Müller[2]

[1] Zweckverband Landeswasserversorgung, Langenau, Germany
[2] aquatune – Dr. gebhardt & Co GmbH, Aarbergen, Germany

Pre-treatment of Danube river water at Langenau Waterworks

Zweckverband
Landeswasserversorgung

Coagulation-sedimentation plant (compact flocculation unit „FS 1“):



italic - **process control parameters**

- **treatment of 30 million m³/a**
- **11 control parameters**

* stirrer revolution chamber Ia: medium / fast = 100 / 150 rpm

** alkaline $Mg(OH)_2$-excess sludge from lime water preparation

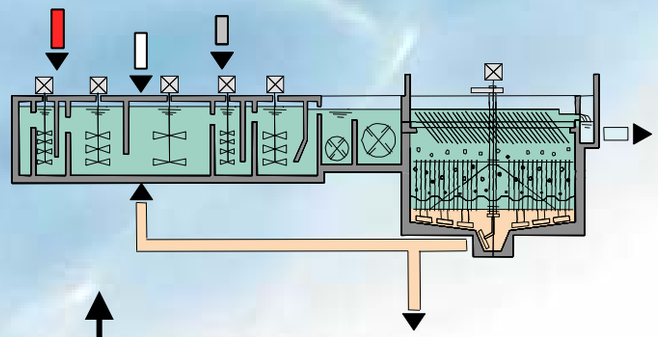
Conventional control of the coagulation-sedimentation step
(until 2009) ...

Zweckverband
Landeswasserversorgung

online-readings:

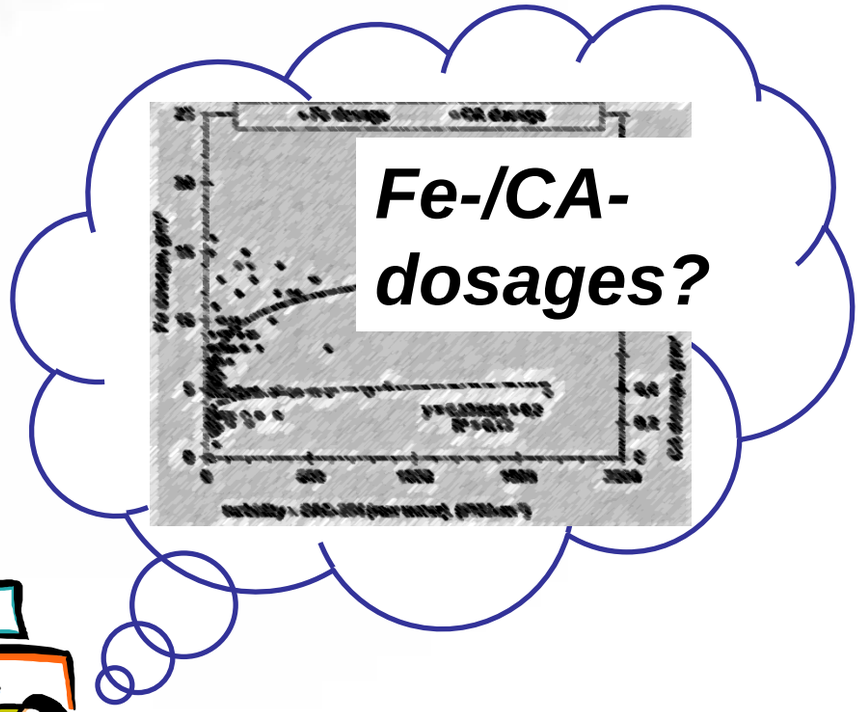
turbidity

SAC-254



turbidity

SAC-254



operation center:

treatment additives:

Fe dosage

CA dosage

(CA = coagulant aid)

set points

disadvantages:

- excess consumption of treatment additives
- burden on the operation crew

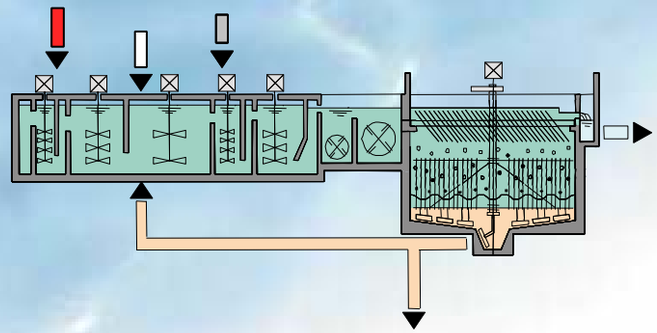
… and new intelligent control system

(since 2011)

Zweckverband Landeswasserversorgung

online-readings:

- turbidity
- SAC-254
- temp.
- flow rate
- …



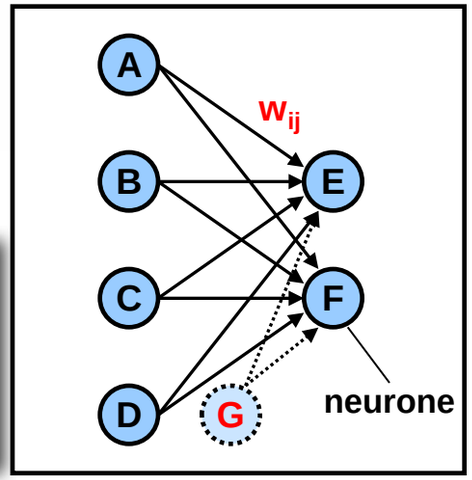
- turbidity
- SAC-254

modelling layer (software)

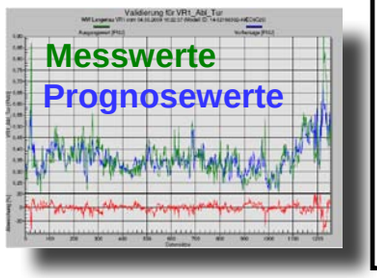
control system layer

artificial neural network (ANN)

online-readings „LSX_Export.csv“

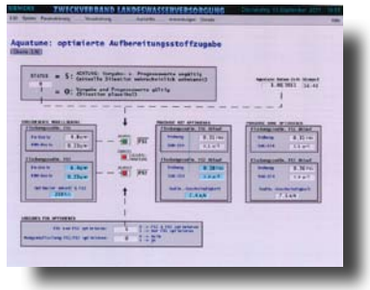


forecast/control:



„Main.BSY“ (APC), „Langenau…online.opt“ (GenOpt)

forecast values, optimization proposal „LSX_Import.csv“



treatment additives

- Fe dosage
- CA dosage

(CA = coagulant aid)

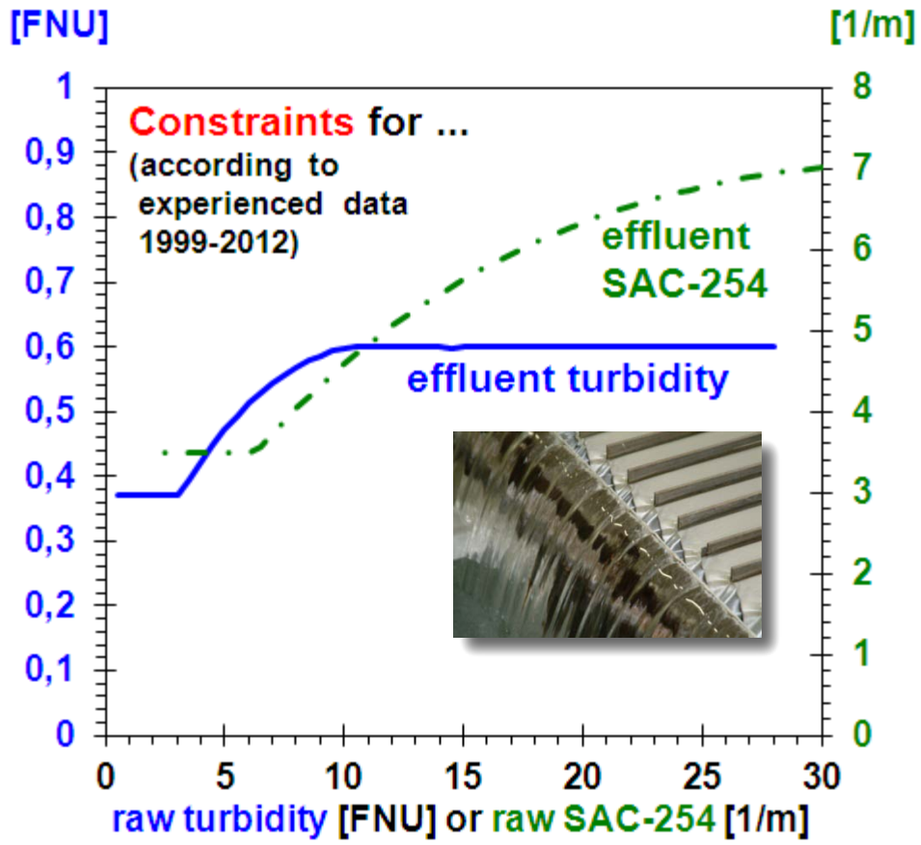
set points

The (long) way of implementation

Zweckverband
Landeswasserversorgung

Realization steps:

- Compilation and analysis of existing process data (2005-2008)
- Building, training and validation of ANN-models
- Formulation of the optimization task:
  - → target function
  - → variable constraints
- Analysis of crucial online-parameters
- Test phase with ANN-re-trainings and alterations for improved consideration of model uncertainties



Integration in our process control system “RITOP”

Zweckverband
Landeswasserversorgung

WWL Aquatune: optimierte Aufbereitungsstoffzugabe

Sammelalarm

MODELLIERUNGSSTATUS: 0

0 = Vorgabe-/Prognosewerte gültig (Situation plausibel)
5 = Vorgabe-/Prognosewerte ungültig (aktuelle Stiuation wahrscheinlich unbekannt)

Flockungs-sedimentation

FS1

Ablaufwerte FS 1

	Aktuell (gemessen)	Prognose mit Optimierer	Aufbereitungs-ziel
	MWA0052	CWA101	CWA102
SAK-254	3.1 1/m	6.06 1/m	5.18 1/m
	MWT101	CWT101	CWT102
Trübung	0.40 FNU	0.74 FNU	0.45 FNU

ASA001 Automatik FS1 H

MWX005 kritische Ablaufwerte FS1: 0
0 = unkritisch
5 = kritisch

GWA001 Gerätewartung H

Vorgabewert Modellierung

	CWF101
Fe-Dosis FS 1	0.0 g/m³
	CWP103
FHM-Dosis FS 1	0.00 g/m³

Ablaufwerte FS 2

	Aktuell (gemessen)	Prognose mit Optimierer	Aufbrereitungs-ziel
	MWA201	CWA201	CWA202
SAK-254	0.00 1/m	0.00 1/m	
	MWT201	CWT201	CWT202
Trübung	0.00 FNU	0.00 FNU	

ASA002 Automatik FS2 H

MWX006 kritische Ablaufwerte FS2: 0
0 = unkritisch
5 = kritisch

Vorgabewert Modellierung

	CWF201
Fe-Dosis FS 2	99999.0 g/m³
	CWP203
FHM-Dosis FS 2	99999.00 g/m³

LSX-Werte FS1

MWA0051	MPF151
8.6 1/m	1050 l/s
MWT01	MPD101
3.99 FNU	199 g/l

KOSTEN EINKAUF

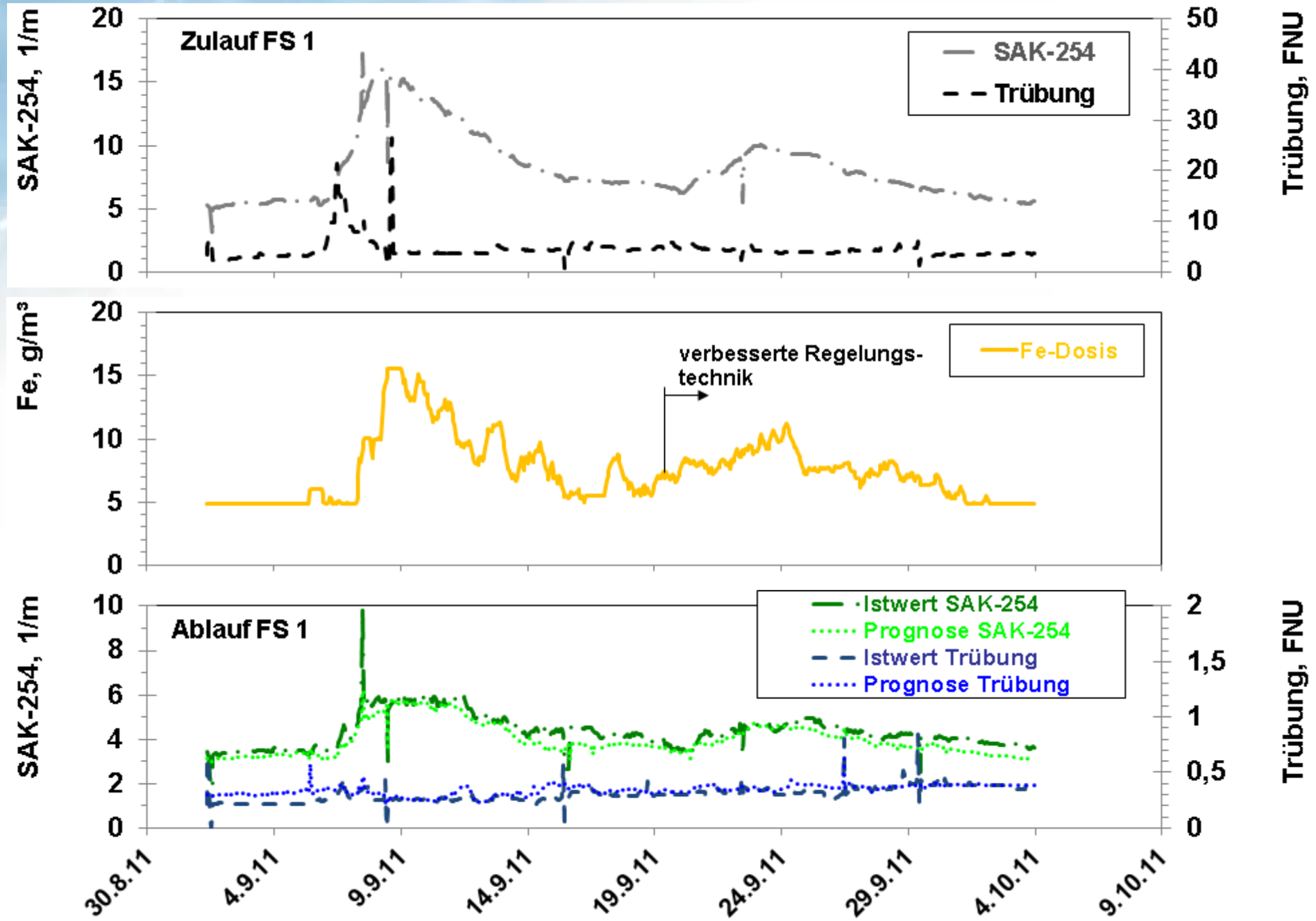
	CPX001
Fe	1036.59 EUR/t
	CPX002
FHM	2600.00 EUR/t
	CPX003
CaO	94.73 EUR/t

Aufbereitungskosten

	Fe	FHM	CaO
Fahrweise gemäß Orientierungswerten [1]	26.72 EUR/h	2.77 EUR/h	5.70 EUR/h
aktuelle Fahrweise	31.35 EUR/h	0.00 EUR/h	s.o.
Fahrweise gemäß Optimierung [2]	0.00 EUR/h	0.00 EUR/h	s.o.
-> Einsparung [1] - [2]	29.49 EUR/h	(Summe)	

intelligent control system of the coagulation-sedimentation: result

Zweckverband
Landeswasserversorgung



Zweckverband
Landeswasserversorgung

Thank you for Your attention!

Contact:
volquardsen.t@lw-online.de
winzenbacher.r@lw-online.de
s.mueller@aquatune.de