VOSTEEN Consulting GmbH
Thermal Engineering and Environmental Protection

KNX™ and PRAVO® – a Perfect Duo for Mercury Capture

Recent Industrial Applications in Waste Incineration

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Track D9, No 4 – Full-Scale Demonstrations, Thursday 01/30/2008

German Licensees of Vosteen Consulting applying KNX™ and PRAVO® industrially

Karlsruhe

Town Karlsruhe – Wastewater Treatment Plant

2 Stationary Fluidized Bed Combustors for Sewage Sludge

applying NaBr and PRAVO® since 2007

Martin Maurer, Roland Milz

EMSCHER GENOSSENSCHAFT
LIPPE VERBAND

EGLV – Central Sludge Treatment Plant Bottrop

2 Stationary Fluidized Bed Combustors for Sewage Sludge

applying NaBr since 2004

Testing PRAVO® in 2004 and again in April 2008

Falko Lehrmann, Günter Schwabe

KNX™

is a registered trade mark of ALSTOM Power – ECS, standing for the bromine based mercury oxidation technology of Vosteen Consulting

PRAVO®

was developed in 2004 – 2007 and is applyed for a registered trade mark of Vosteen Consulting

Patents on the combined application are pending

PRAVO® is a proprietary anorganic polysulfide in different formulations (depending on the speciific application)

PRAVO® – Production, Laboratory R&D:

VOSTEEN Consulting GmbH

Thermal Engineering and Environmental Protection

PAN-CHEMIE Dr. G. Fülöp e.K.

Gabor Fülöp

Martin-Luther-Universität Halle-Wittenberg

Martin-Luther-University Halle-Wittenberg
Institute for Environmental Engineering

Heinz Köser, Jan Schütze

Application of KNX™ and PRAVO®

in the

Communal Waste Water Treatment Plant Karlsruhe-Neureuth

Karlsruhe

Karlsruhe has 285,000 inhabitants –
Wastewater Treatment Plant Neureut (875,000 PE)

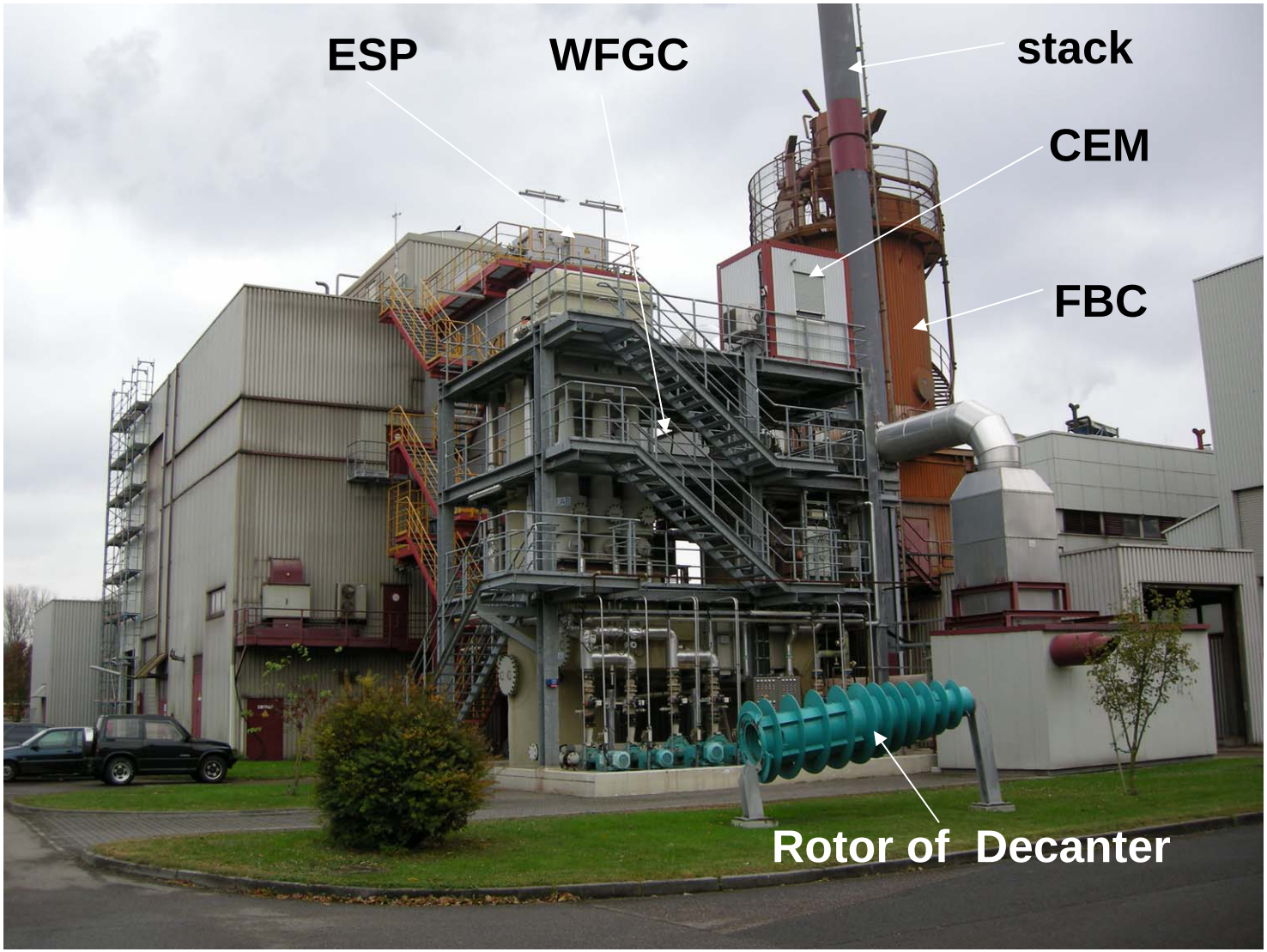
Wastewater Treatment Plant Karlsruhe-Neureut

with 2 Fluidized Bed Combustors (FBC) for sewage sludge

„No mercury into the air“

„No mercury into the neighbouring river Rhine“

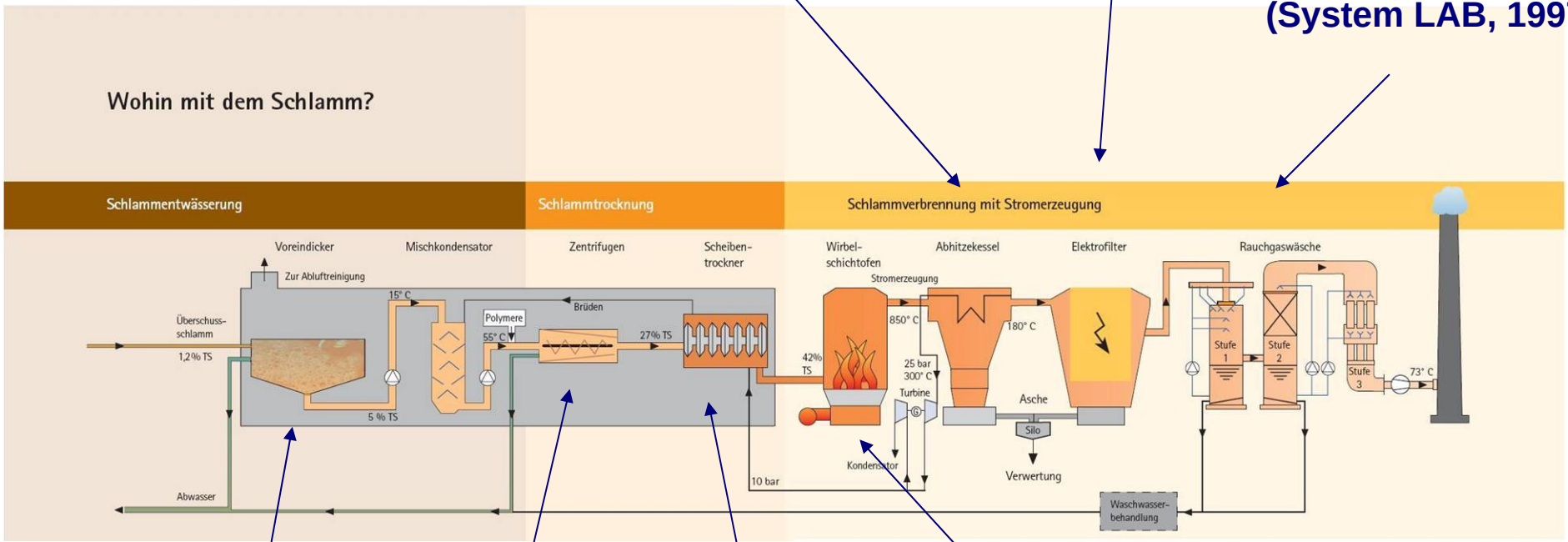
FBC Unit 2



Heat Recovery Boiler (25 bar, 300 °C)

ESP (170 °C)

WFGC 2 stages + wet Venturi (System LAB, 1997)



Sludge Sedimentation (4 – 5 % dry matter)

Thermal Contact-Drying (43 % dry matter)

PE-Sludge Conditioning Mechanical Dewatering Centripress (25 % dry matter)

Fluidized Bed Combustion (900 °C)

$NaClO_2$ to be substituted by NaBr (40 %) and TMT15® to be substituted by PRAVO®100

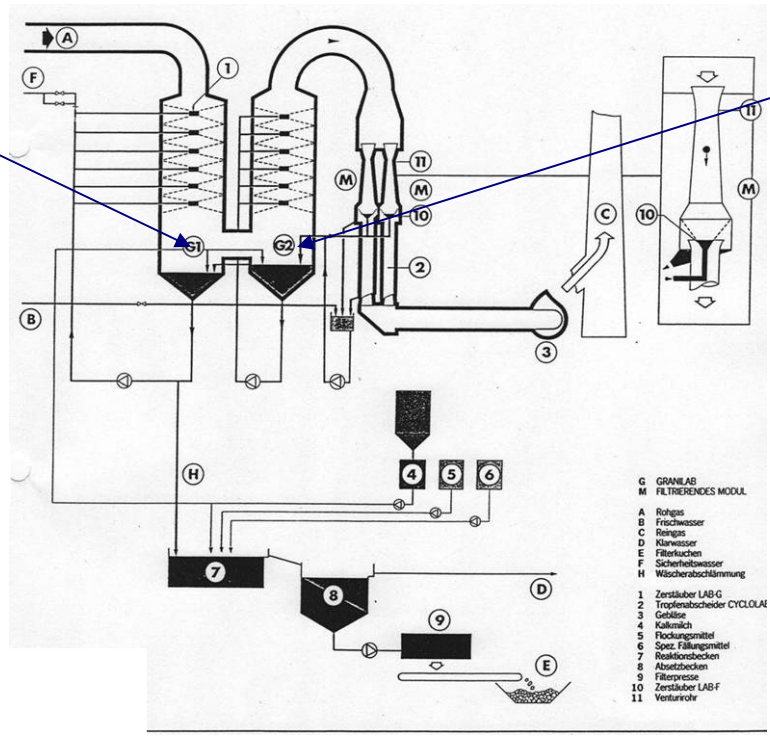
70 °C

First stage:

pH = 0,5 … 1

2 m³,
0.1 m³/hour

-> t_{R1} = 20 hours



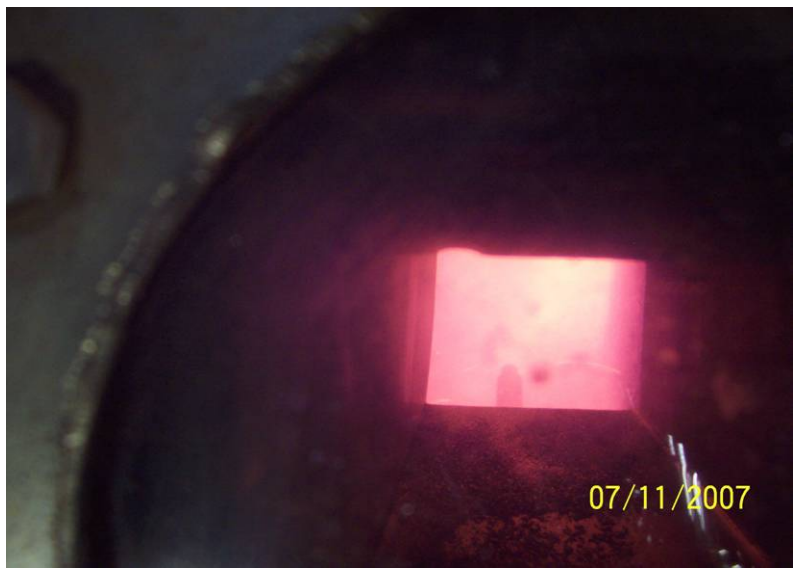
Second stage:

pH = 7.2

4 m³
0.75 m³/hour

-> t_{R2} = 5.3 hours

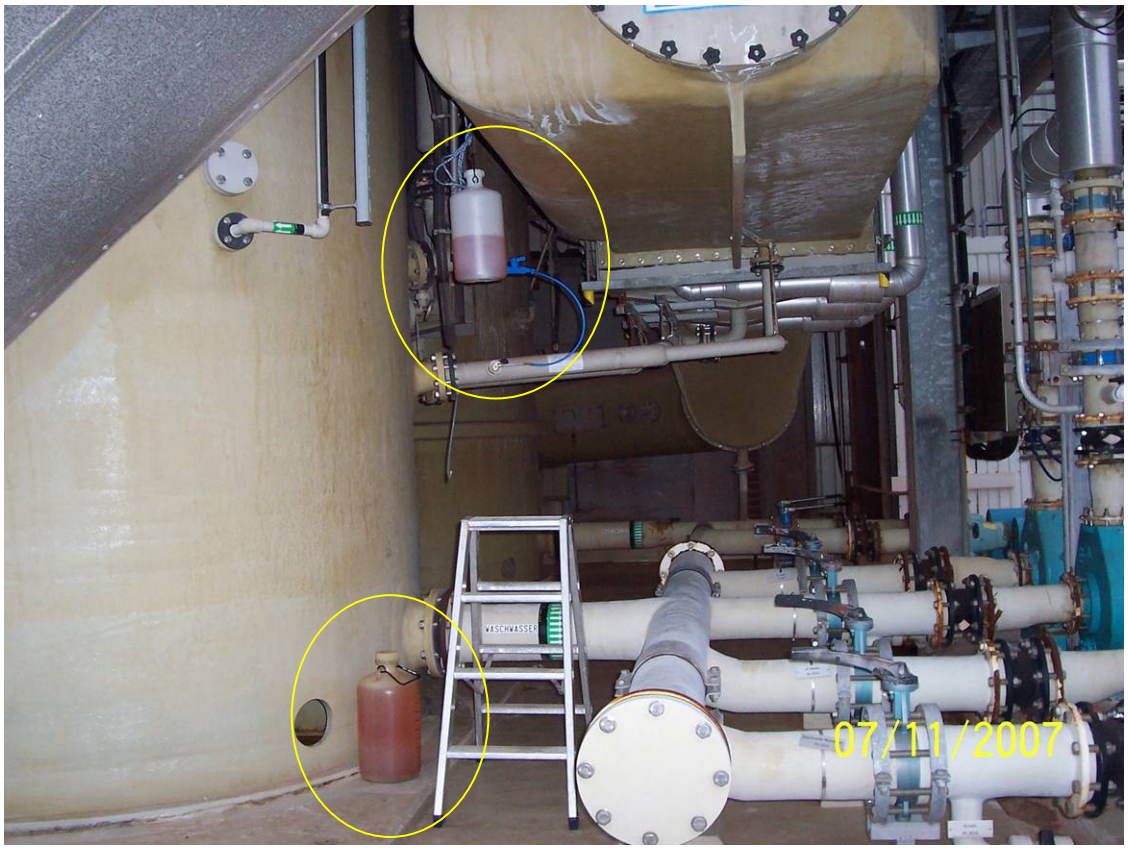
Injection of diluted NaBr into FBC-Freeboard with 3 lances

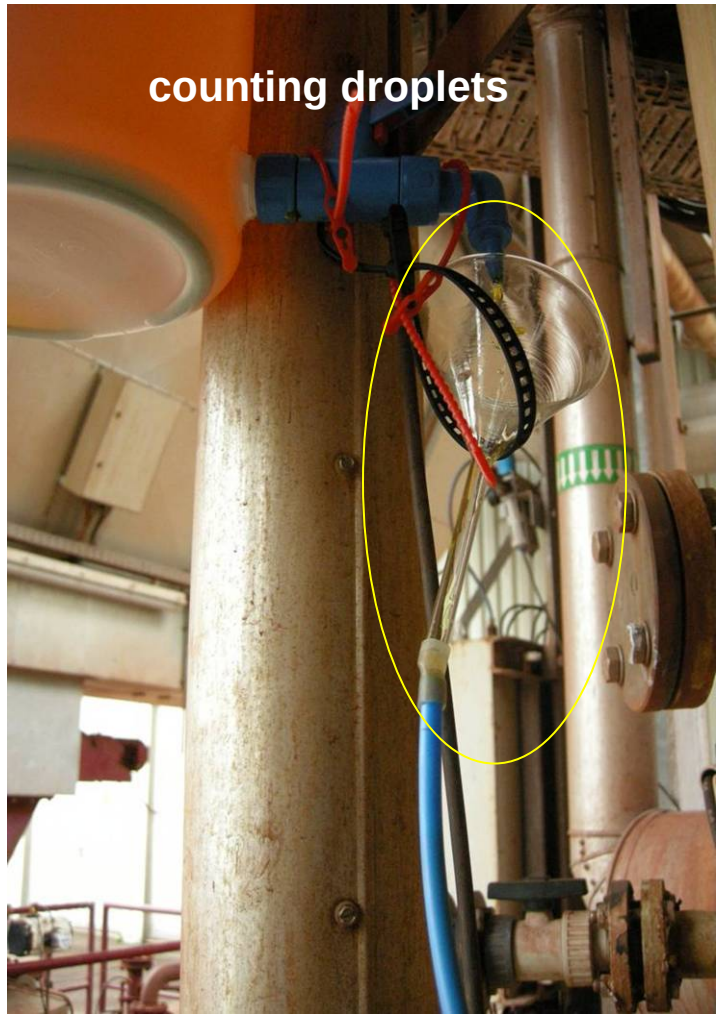


Most advanced German High Tech

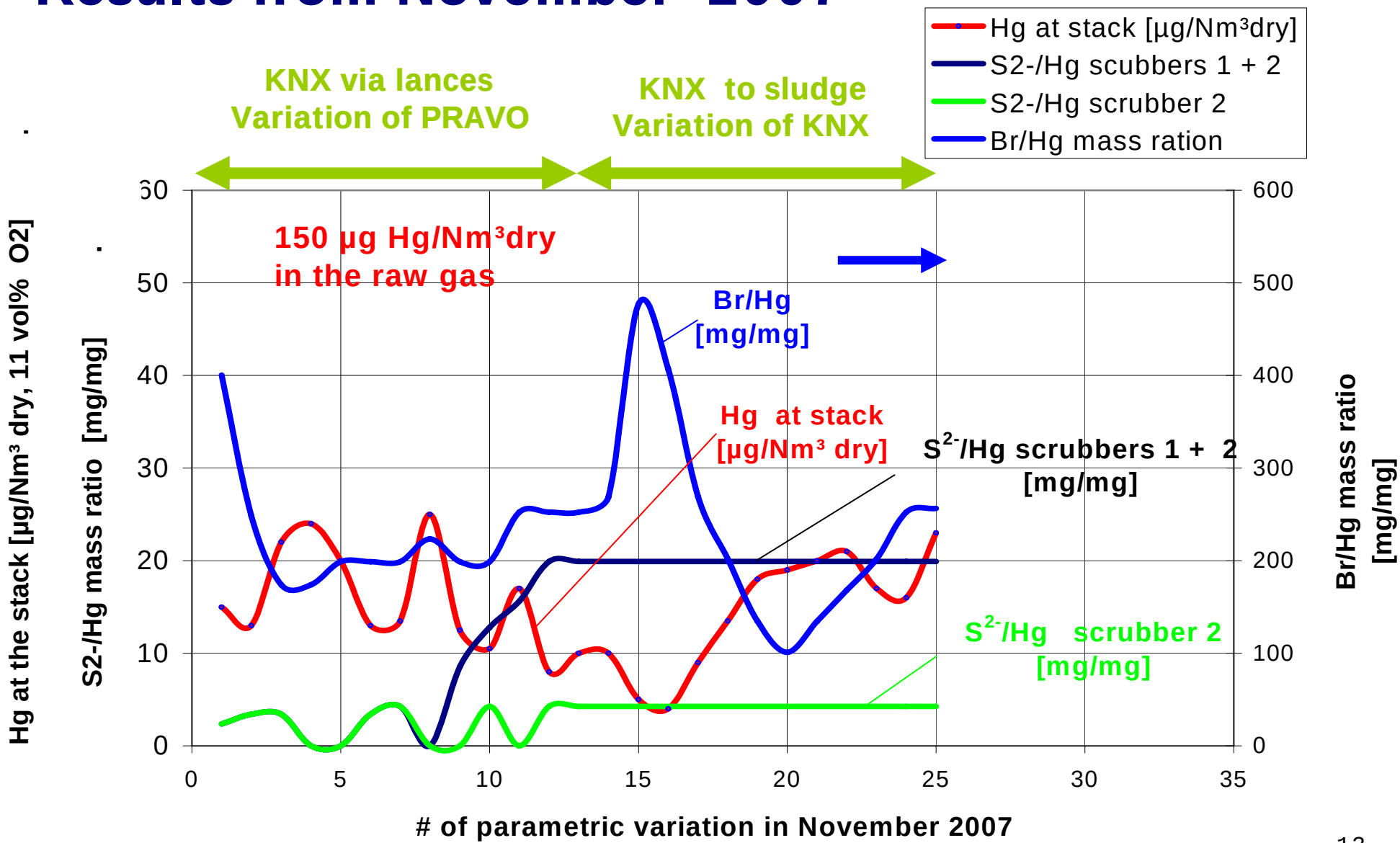
emptying plastic bottles

filled with diluted PRAVO (no Rhine wine)

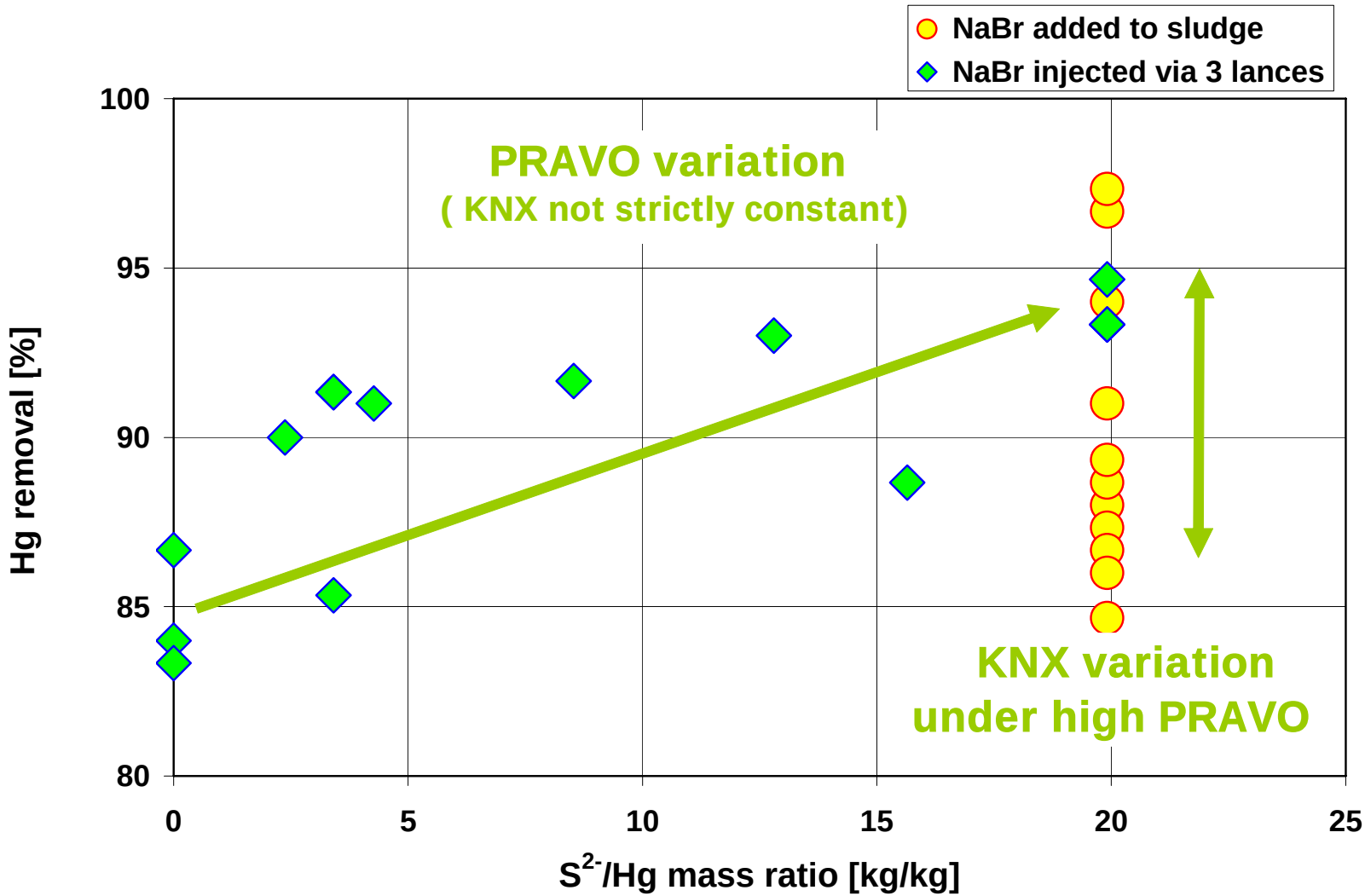




Results from November 2007

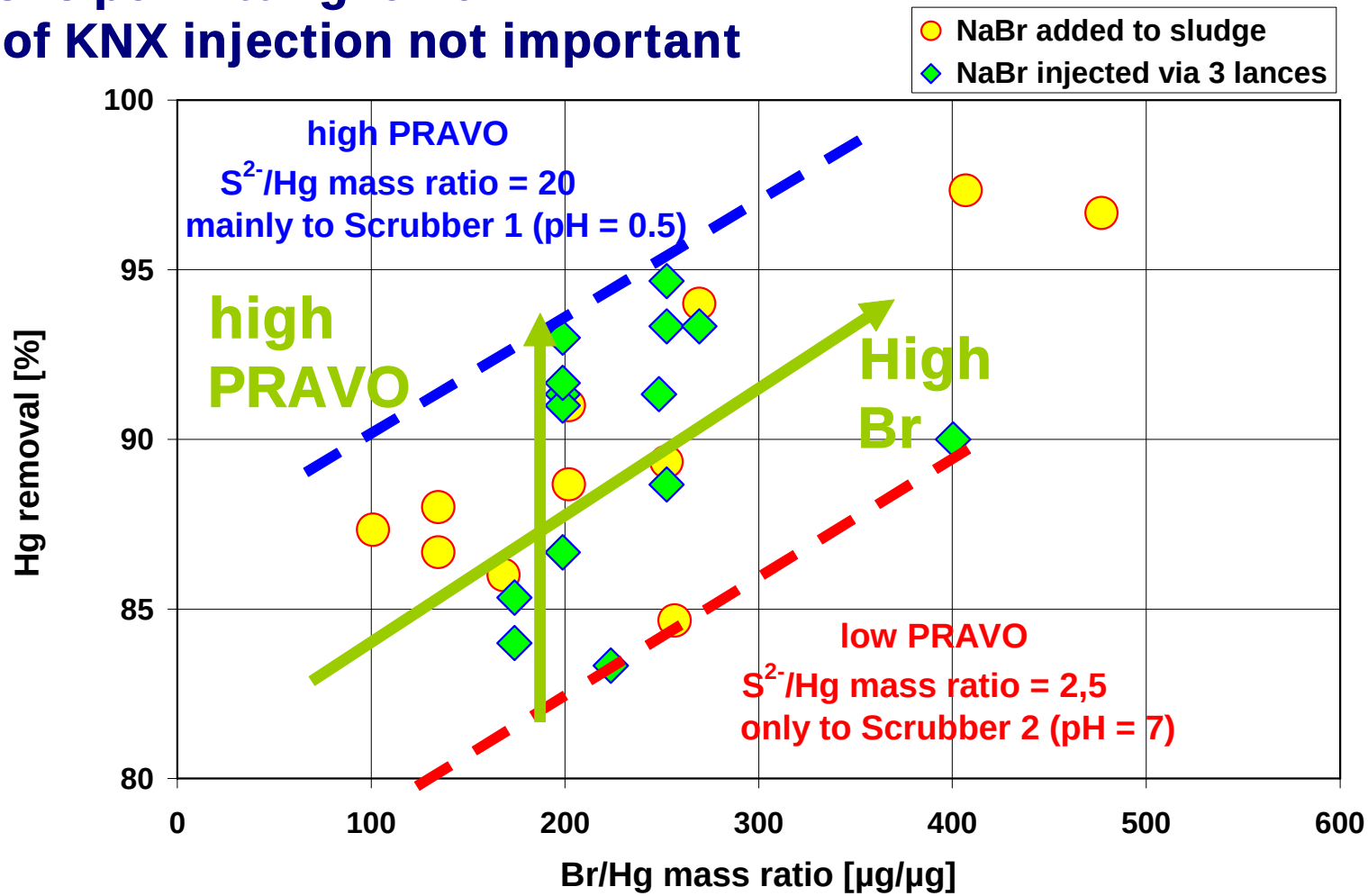


How to achieve 95 % mercury removal rate

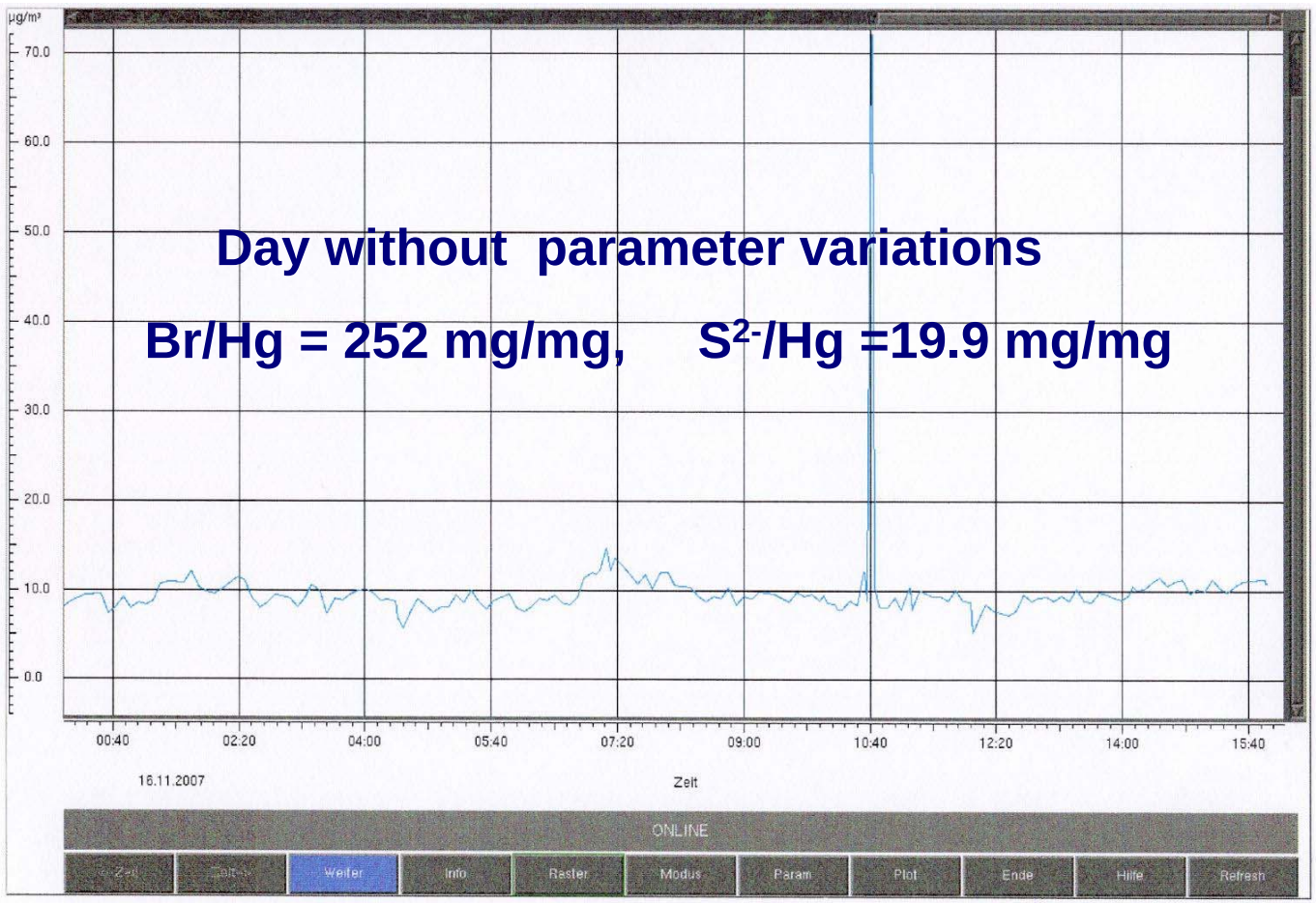


Variation of Br^- / Hg and S^{2-} / Hg mass ratio (1)

PRAVO is permitting lower KNX
Mode of KNX injection not important



Constantly achieved:
Hg = 10 µg Hg / Nm³ dry, 11 % O2 at stack

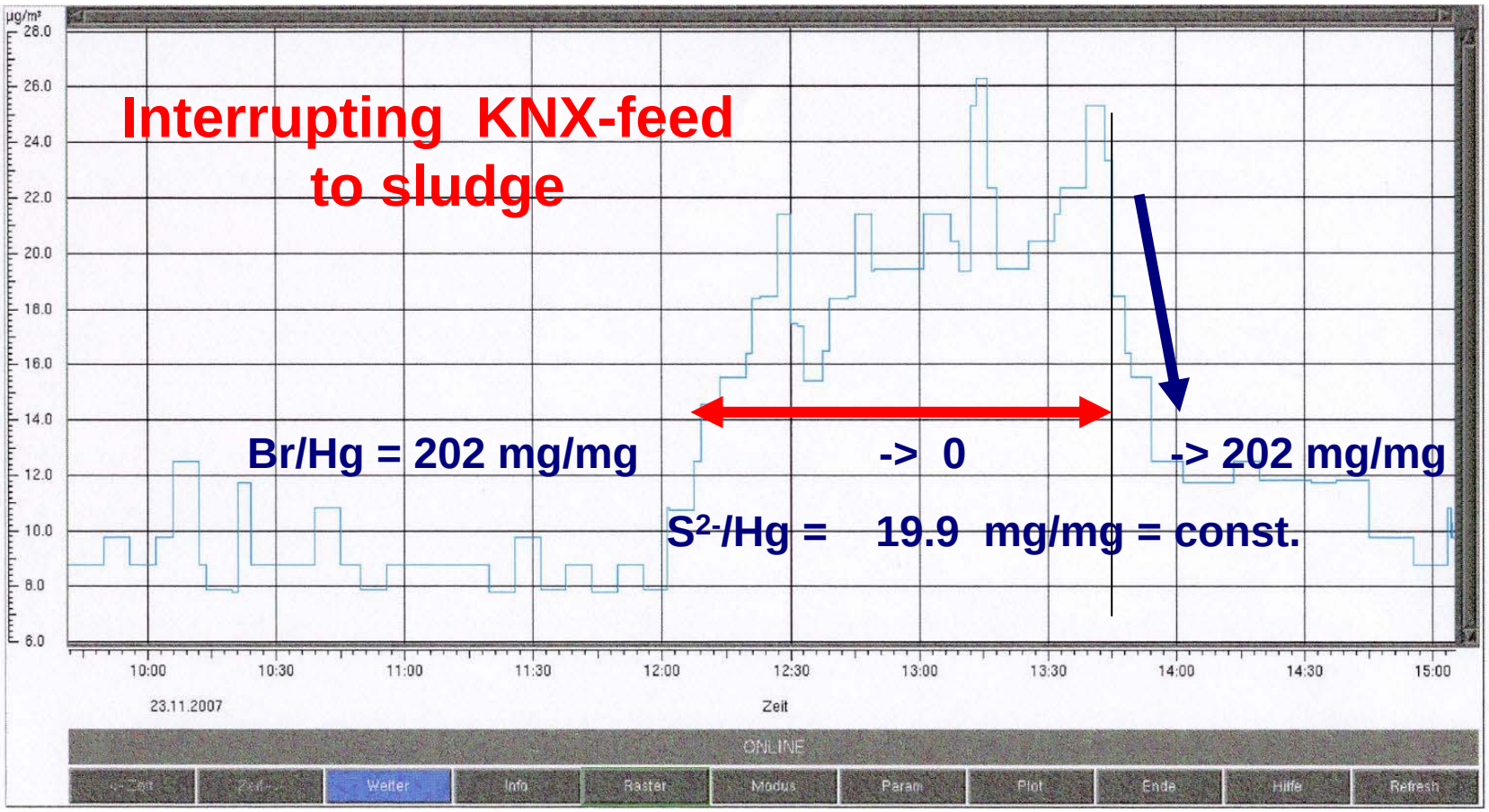


Day without parameter variations

Br/Hg = 252 mg/mg, S^{2-}/Hg =19.9 mg/mg

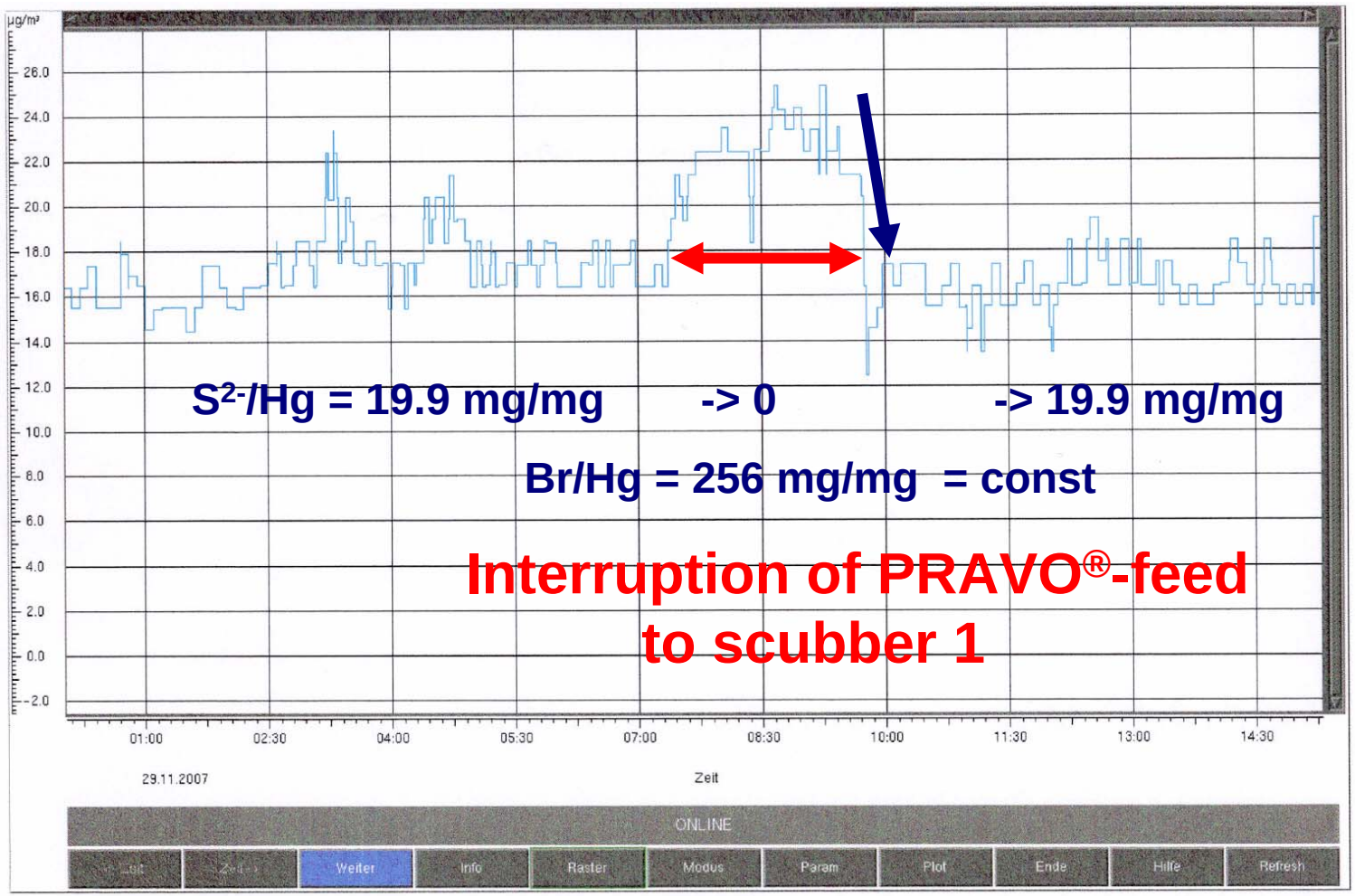
Hg = 8 … 25 µg Hg / Nm³ dry, 11 % O_2 at stack –

„Only high PRAVO is not enough“



Hg = 15 → 25 µg Hg / Nm³ dry, 11 % O_2 at stack

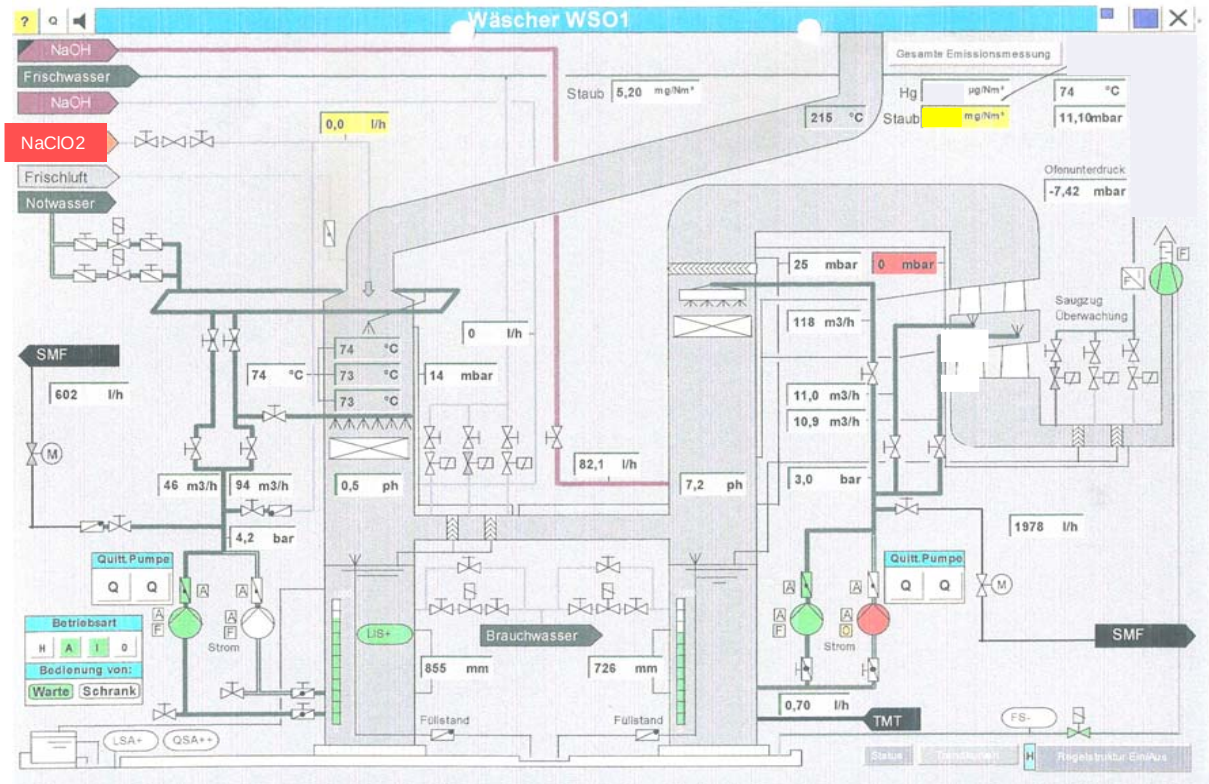
„Only low KNX is not enough“



Wastewater Treatment Plant Bottrop and Central SludgeTreatment Plant Bottrop

$NaClO_2$ substituted by NaBr since August 2004

> 90 % mercury capture



PRAVO® already tested in 2004

Bottrop Project Team (Dezember 2003 und July 2004)

Bernhard Vosteen

Günter Schwabe

Operations Manager

Yearly savings in Bottrop: 300,000 €

Ecotoxicological Assessment of the Waste Water Treatment with PRAVO®100

Preliminary results, under revision
testing PRAVO®100, density: 1,28 g/l (at 20 °C)

Marine Algal Growth not inhibited
(tests according to DIN ISO 10253-L45)

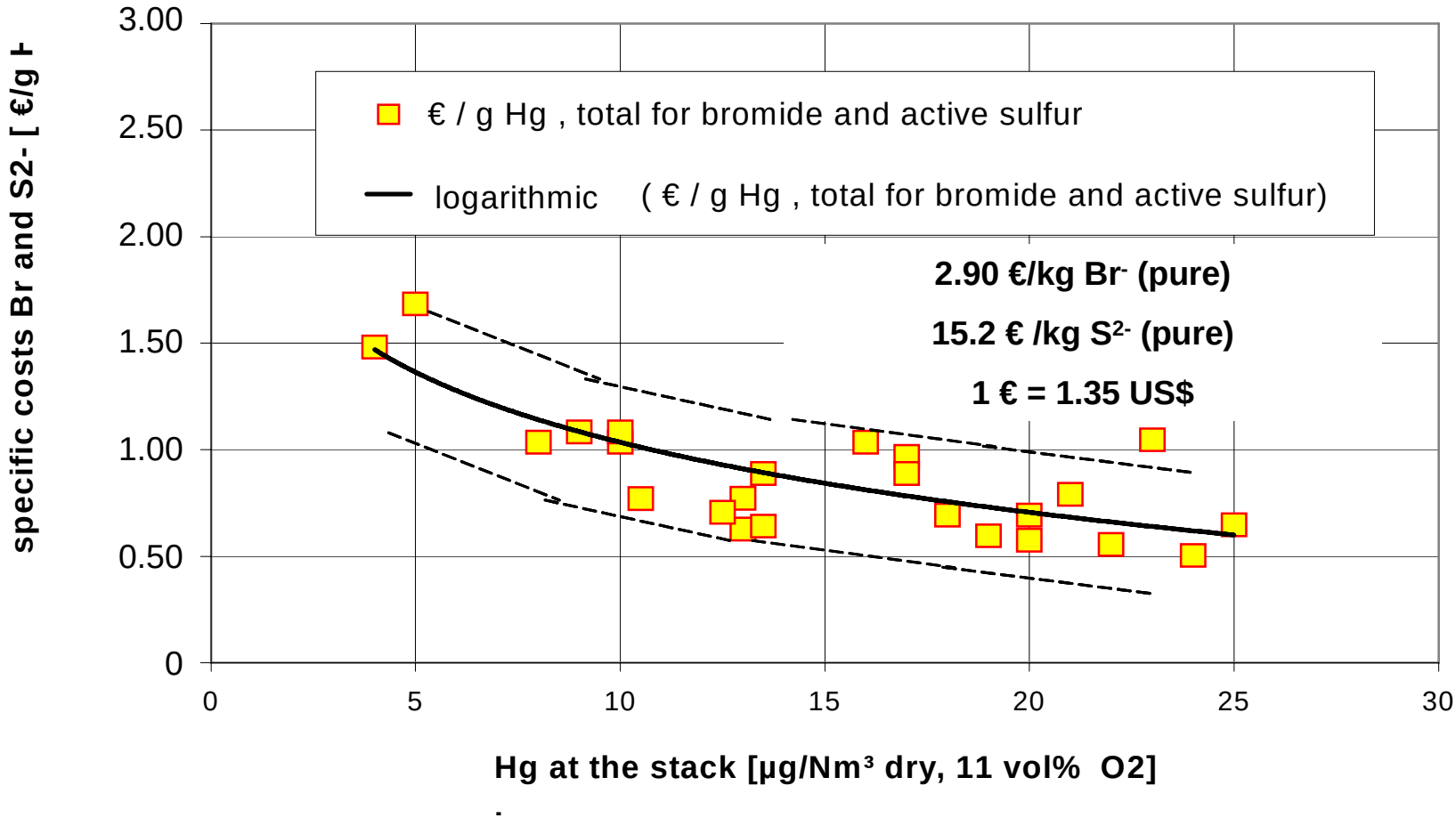
Aquatic Toxicity of PRAVO®100
(tests according to OECD)

LC_0:	640 mg/l	(dilution 1 : 2,000)	
LC_{50}:	2660 mg/l	(dilution 1: 500)	
LC_{100}:	5120 mg/l	(dilution 1: 250)	(

Diluted PRAVO®100 safe to handle

dissociation products: S, SO_4^{2-}
limited H_2S-formation (even at pH < 1)

Specific additive costs much < 100 US $/gHg



KNX™ and PRAVO® – a perfect duo indeed

Conclusions

1. KNX™ highly effective in wet and dry mercury capture
2. PRAVO® enhancing wet mercury capture
3. KNX™ + PRAVO® make sure > 90 % removal rate
4. PRAVO® in WFGD alone less effective than KNX alone
5. PRAVO® most effective in presence of Br^-
6. PRAVO® lowers need of KNX™ (cost optimisation)

Patents pending

Thanks for Your attention

Questions?