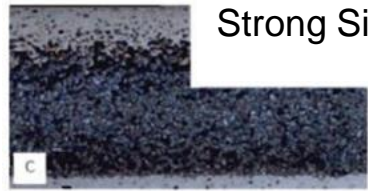# Experimental investigations of coal ashes for the VerSi Project

Matthias Dohrn

Institute for Energy and Climate Research, IEK-2

Subdivision Thermochemistry

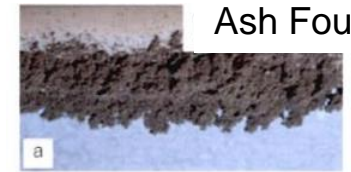GTT Usermeeting, 29.06.2016, Herzogenrath

Types of Deposits

Normal Sintering

Strong Sintering

Ash Fouling
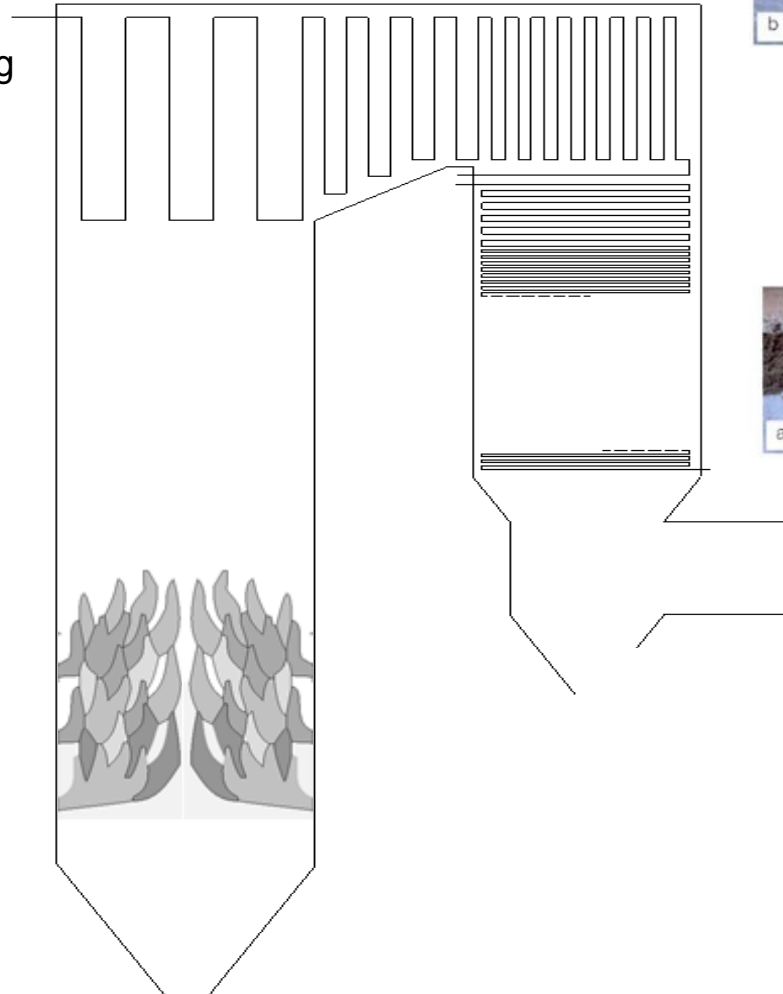
Molten slag

Overview

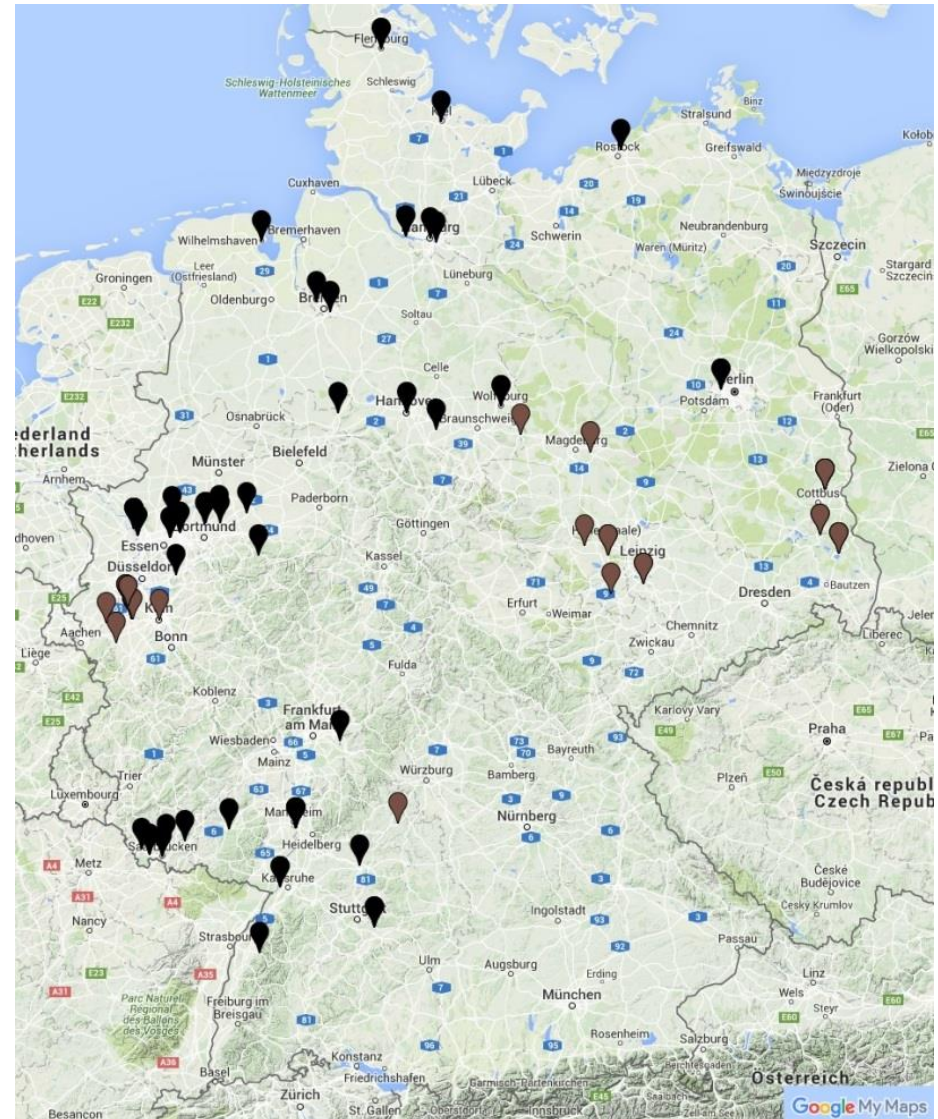59 lignite boilers at 19 locations with 19.8 GW net capacity

82 hard coal boilers at 41 locations with 26.7 GW net capacity

Operators:
- Uniper, EnBW, RWE, STEAG, Vattenfall
- 38.5 GW von 46.5 GW

More load changes due to privileged infeed of renewable energies into power supply

Potential risk of boiler shutdown due to corrosion and deposit buildup

Project

VerSi-EM

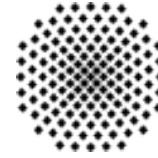Prediction of Deposit Formation via Thermochemical Modelling and CFD Modelling

–

Basic Experiments and

Thermochemical Modelling

Projectpartner

Research Institutes

SME

Industry

Schedule IEK-2/GTT

First simple SimuSage model

Analysis of hard coal

Analysis of lignites

Analysis of biomass and blends

Load change experiments

Final extended SimuSage model
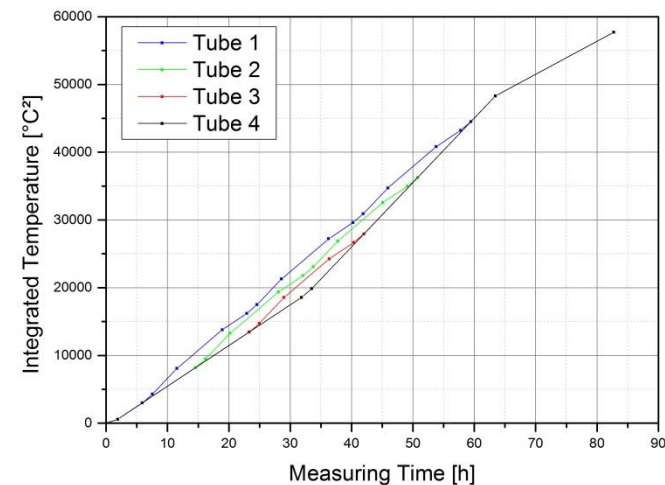
Experimental setup

Furnace with four tubes

➢ Cyclic load change

➢ Different temperature profiles

➢ Same integrated temperature

➢ Same flue gas atmosphere

Temperature Profiles Four Tubes Furnace
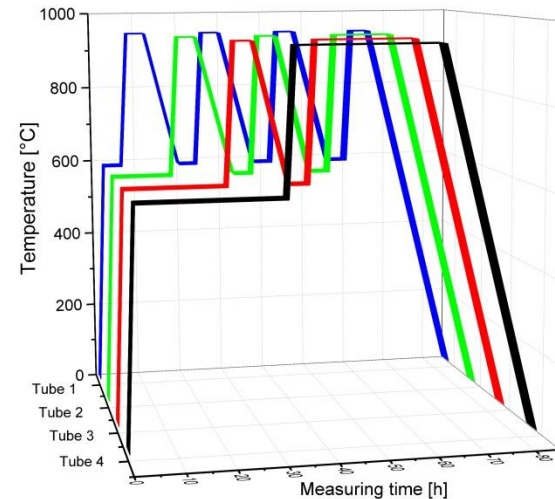
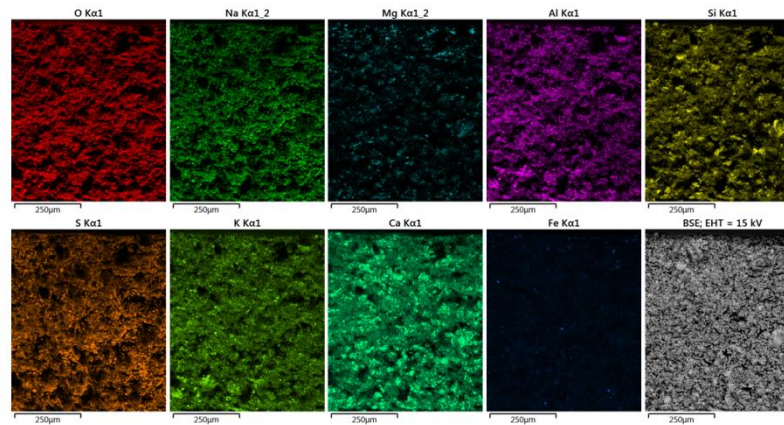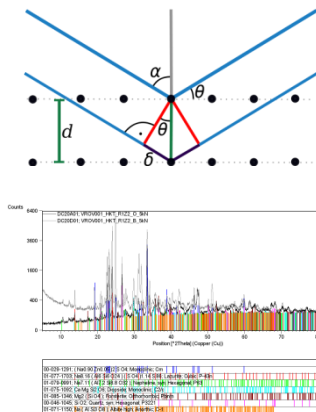Integrated Temperature Profiles of all Tubes
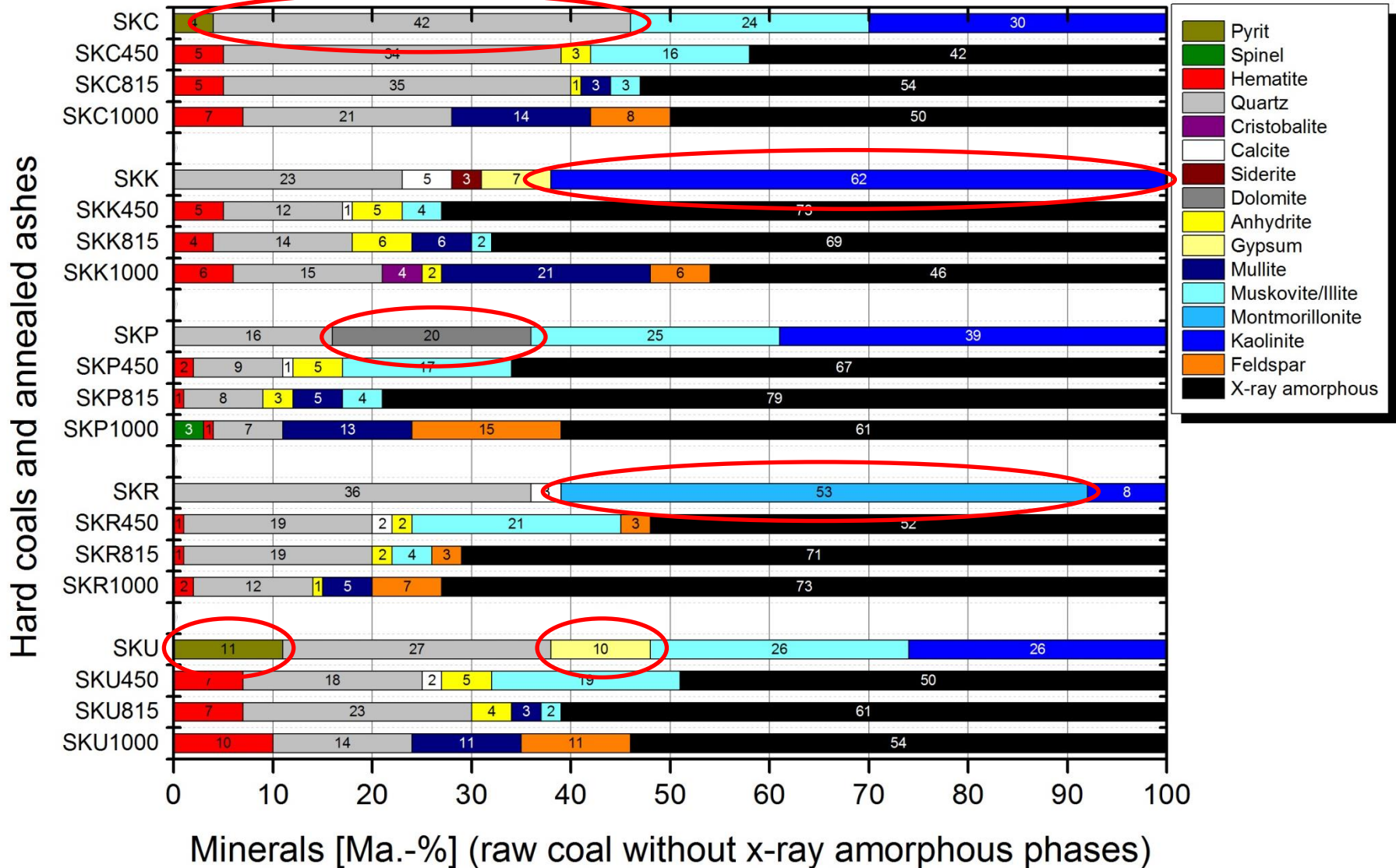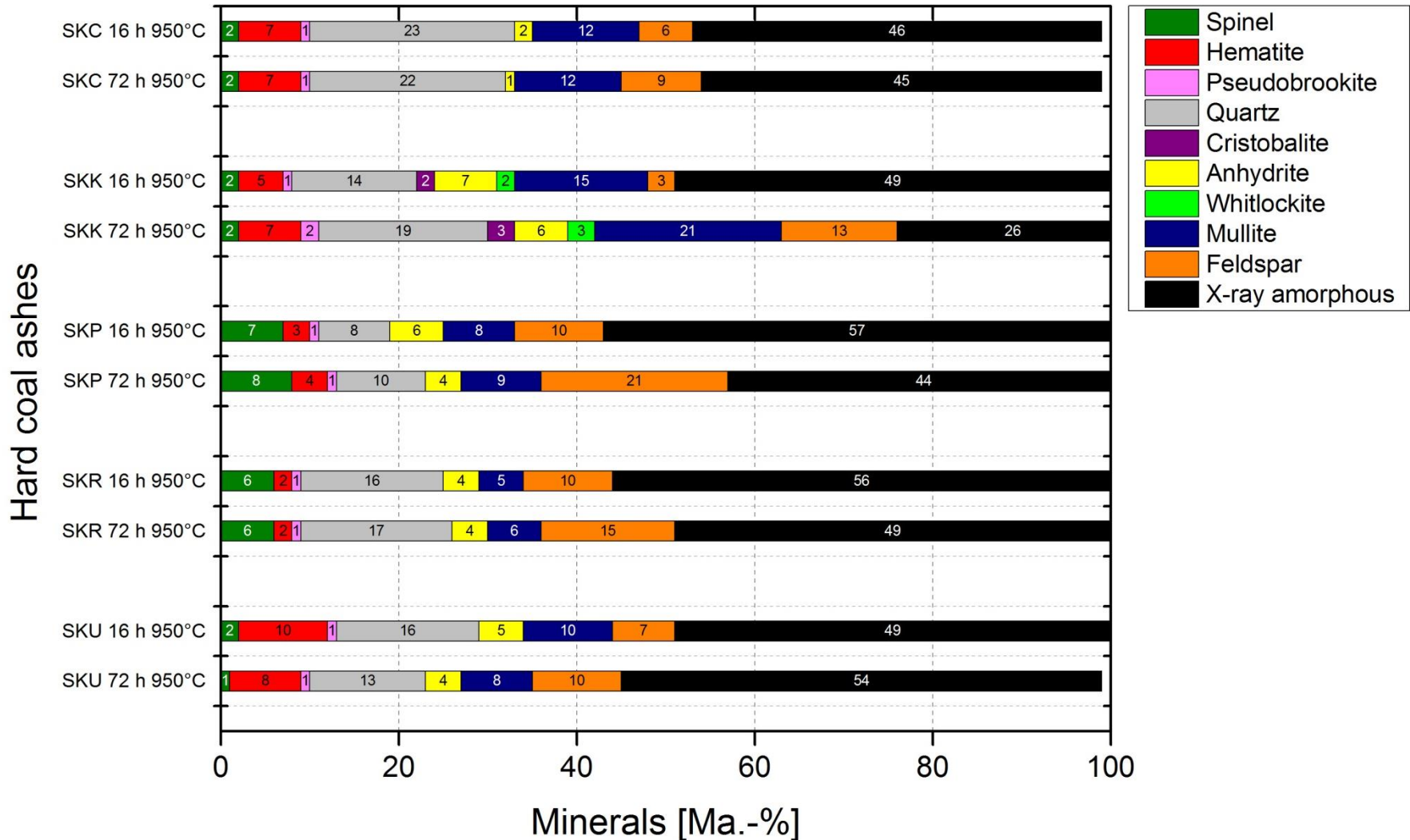
Experimental setup

X-ray diffraction
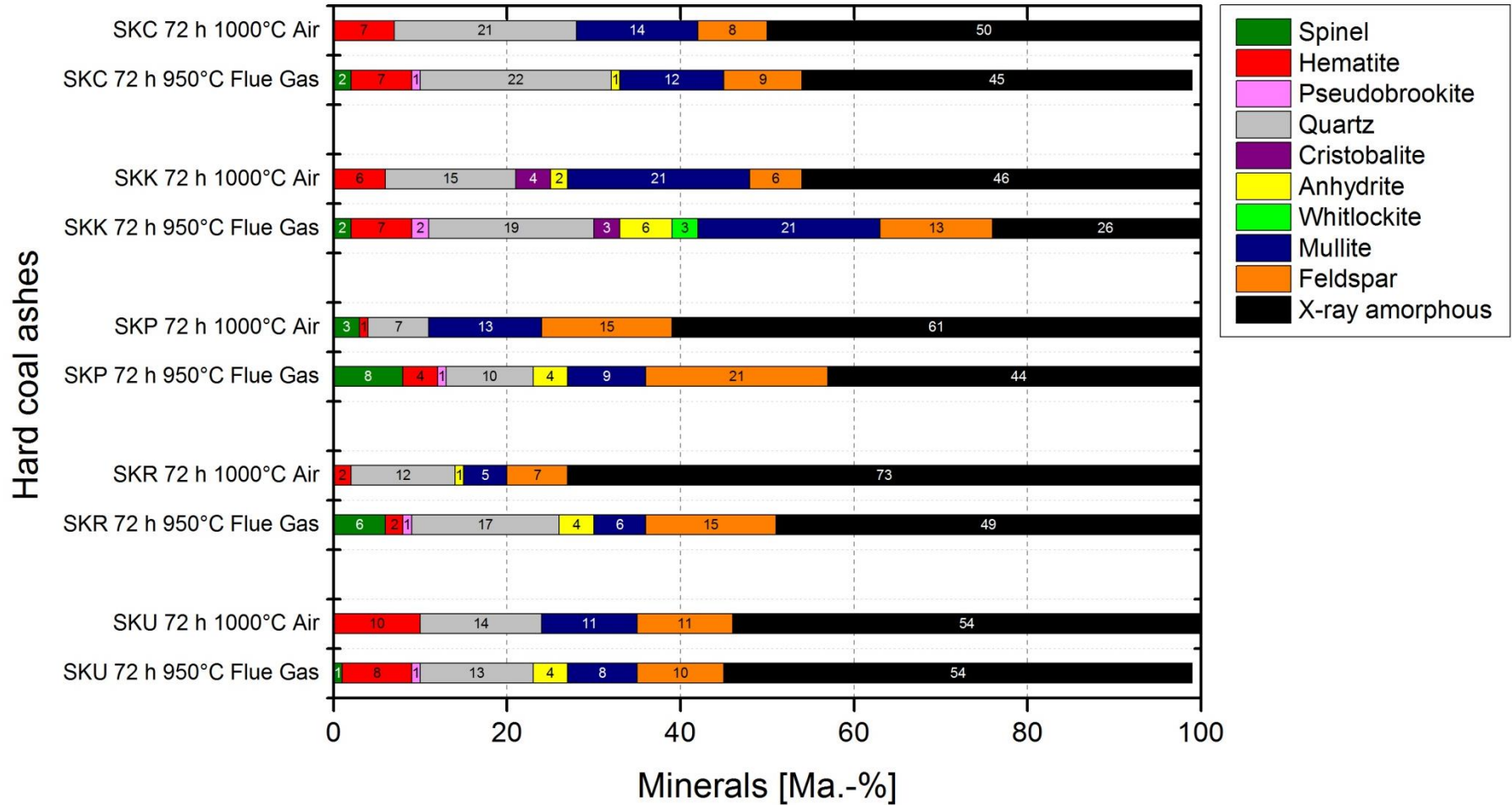
SEM/EDX

Compressive Strength Test

Hot Stage Microscopy
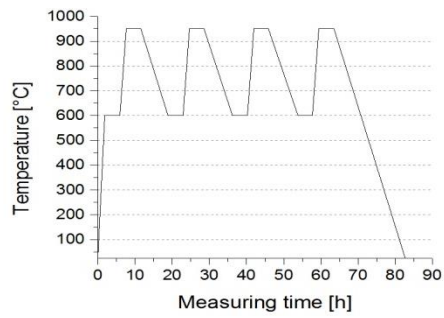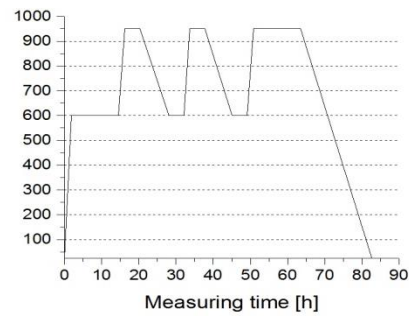
XRD Results

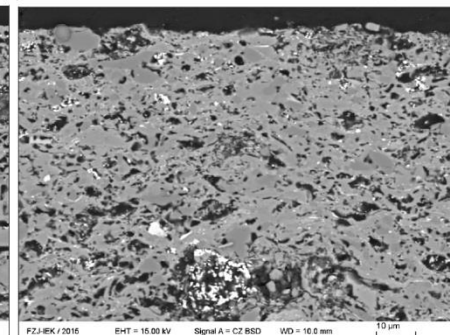Minerals [Ma.-%] (raw coal without x-ray amorphous phases)
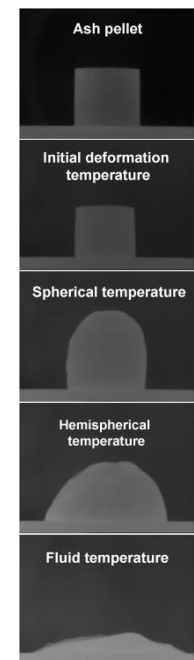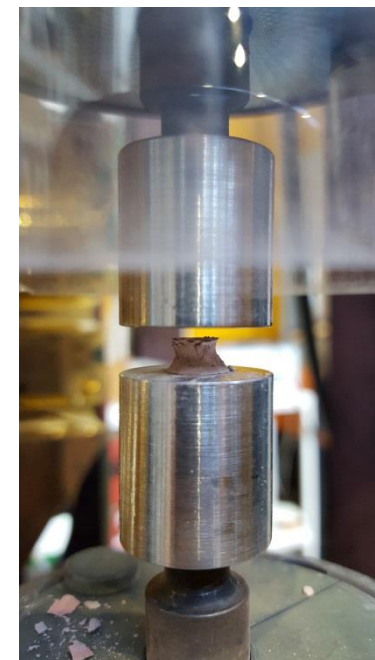
XRD Results

XRD Results

V4 SKP 12kN R1   V4 SKP 12kN R2   V4 SKP 12kN R3   V4 SKP 12kN R4
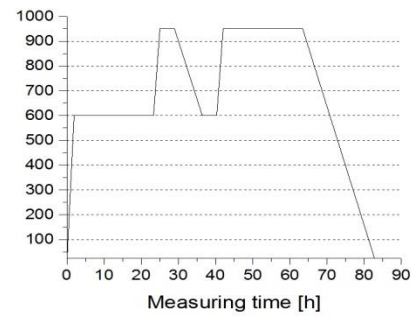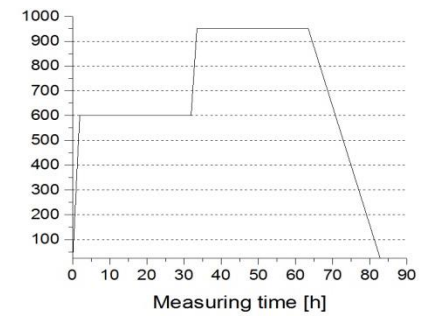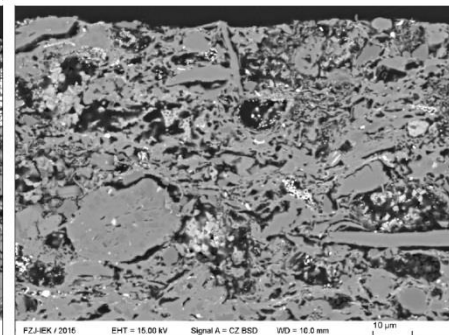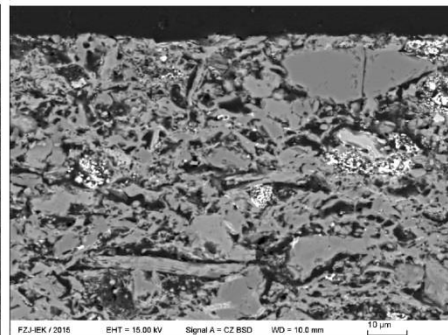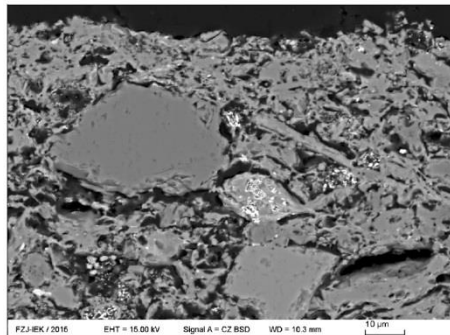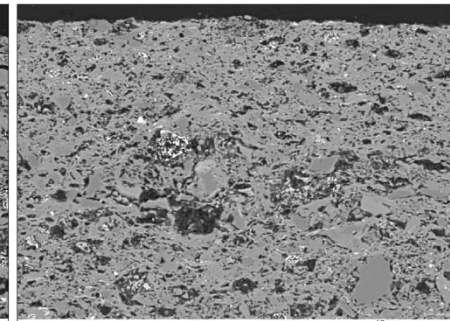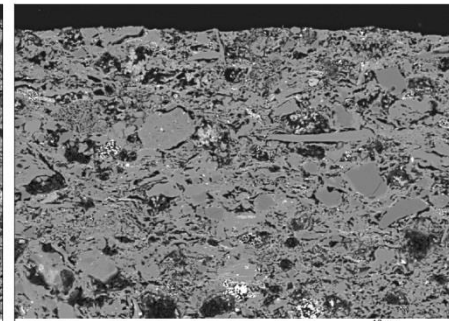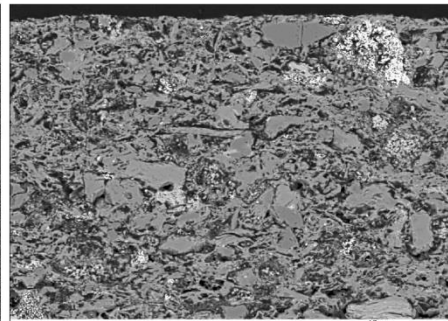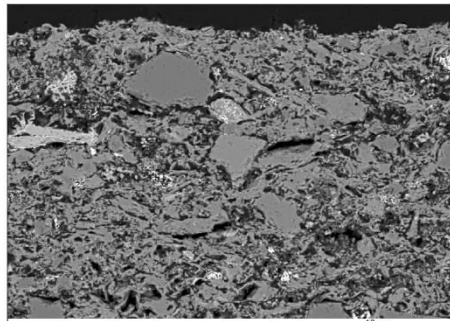
Weight change
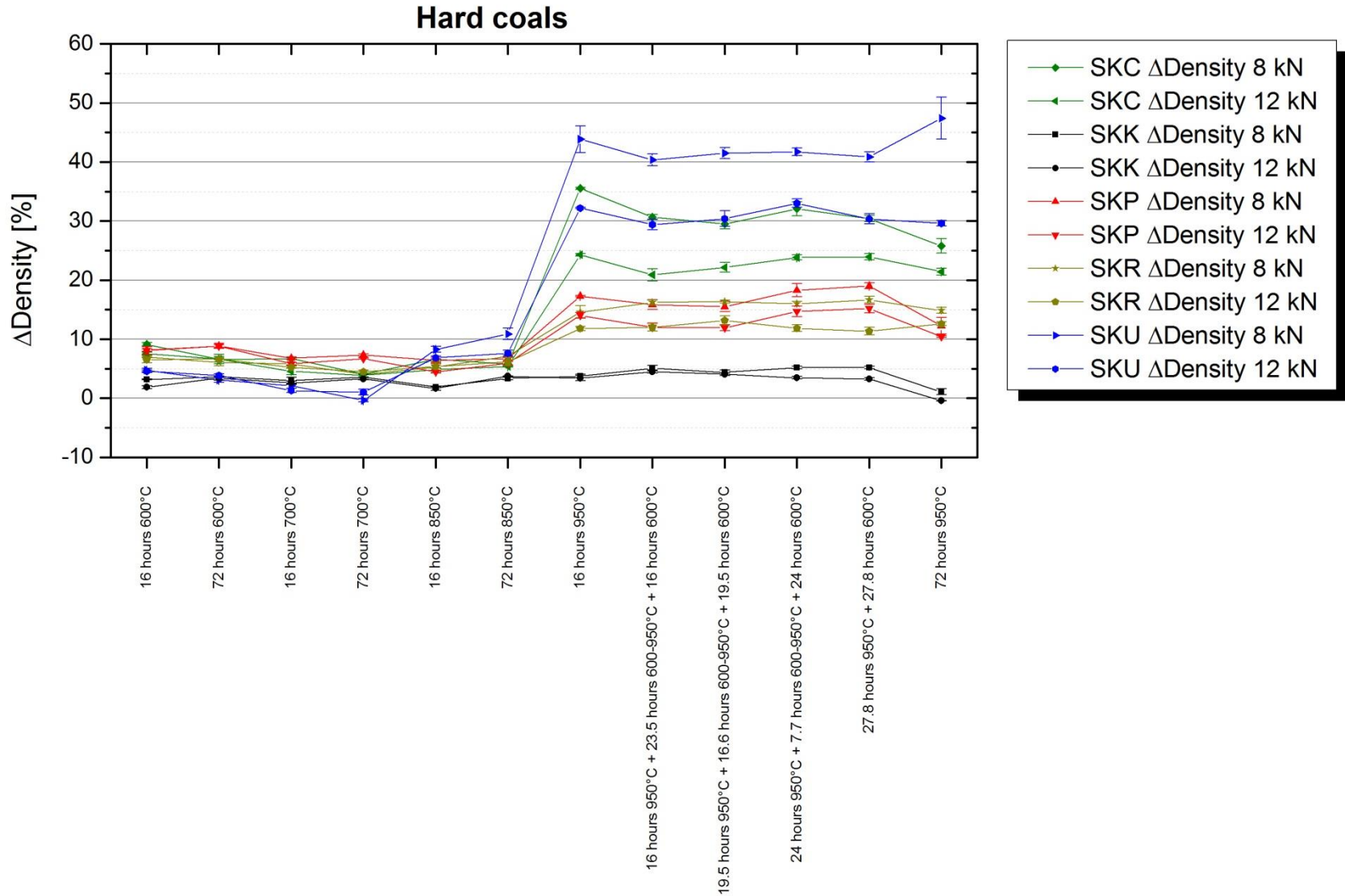
Hard coals

Density change

Hard coals

Compressive strength

Russian Coal

Compressive strength

Russian Coal

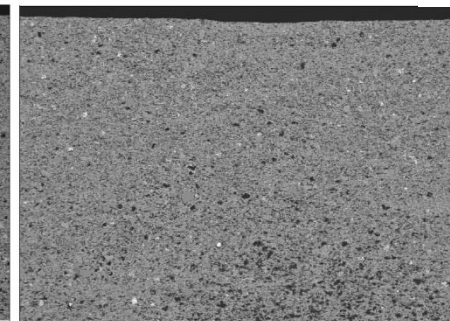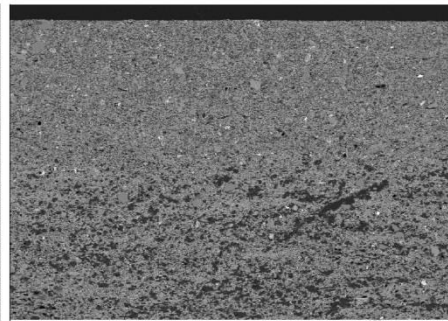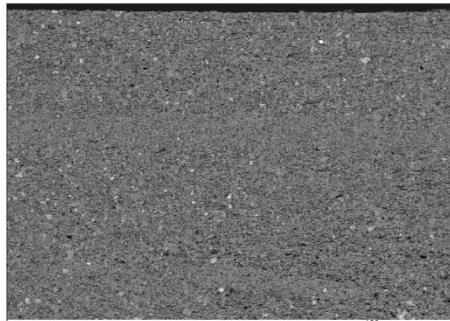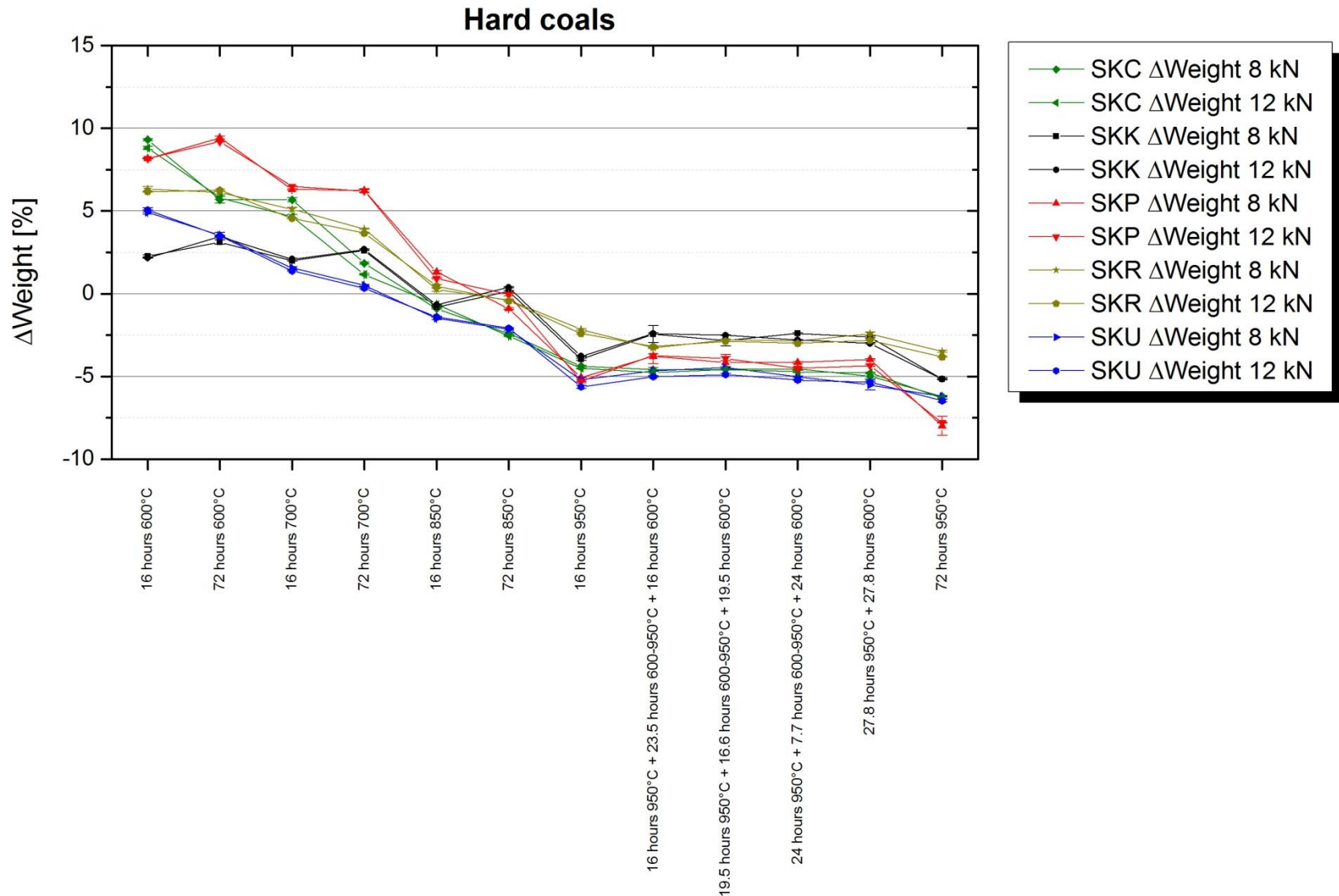# Compressive strength

Russian Coal

Compressive strength

Hard coals (8 kN pellets)

Correlations

Simulation
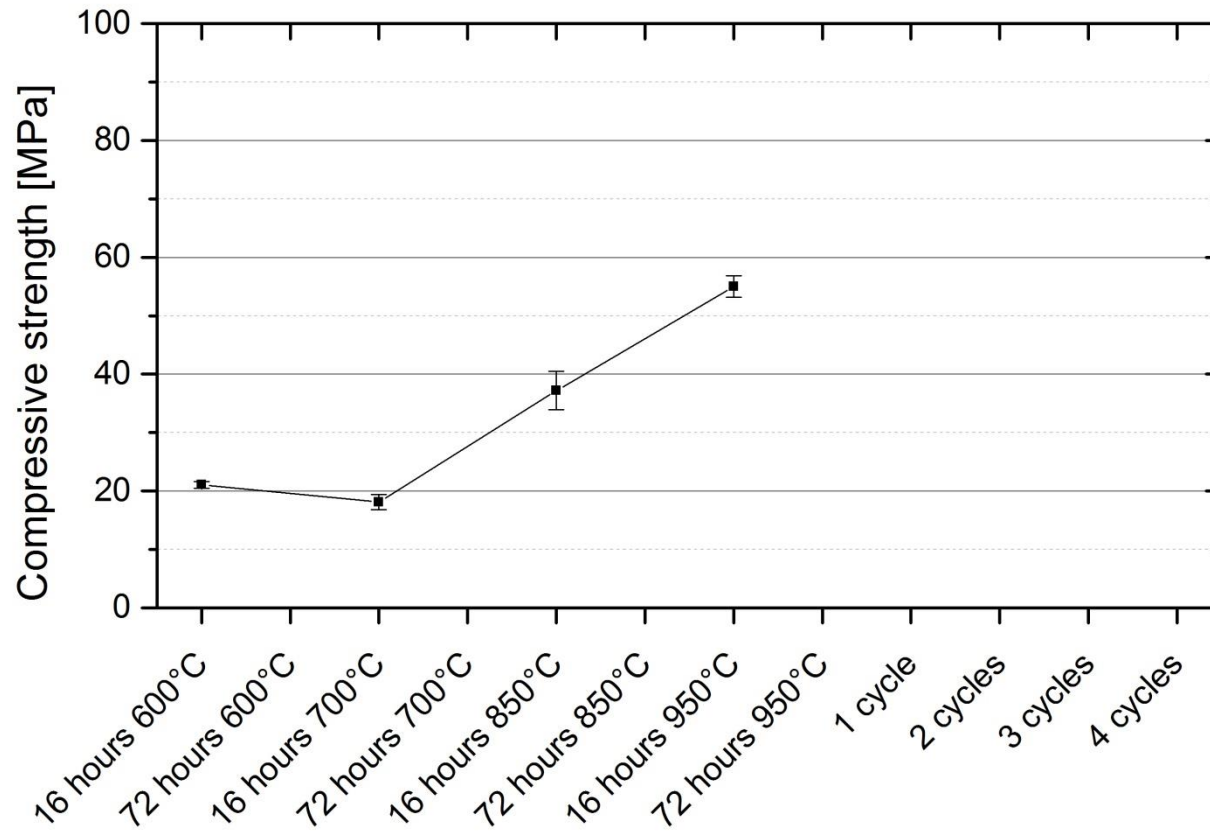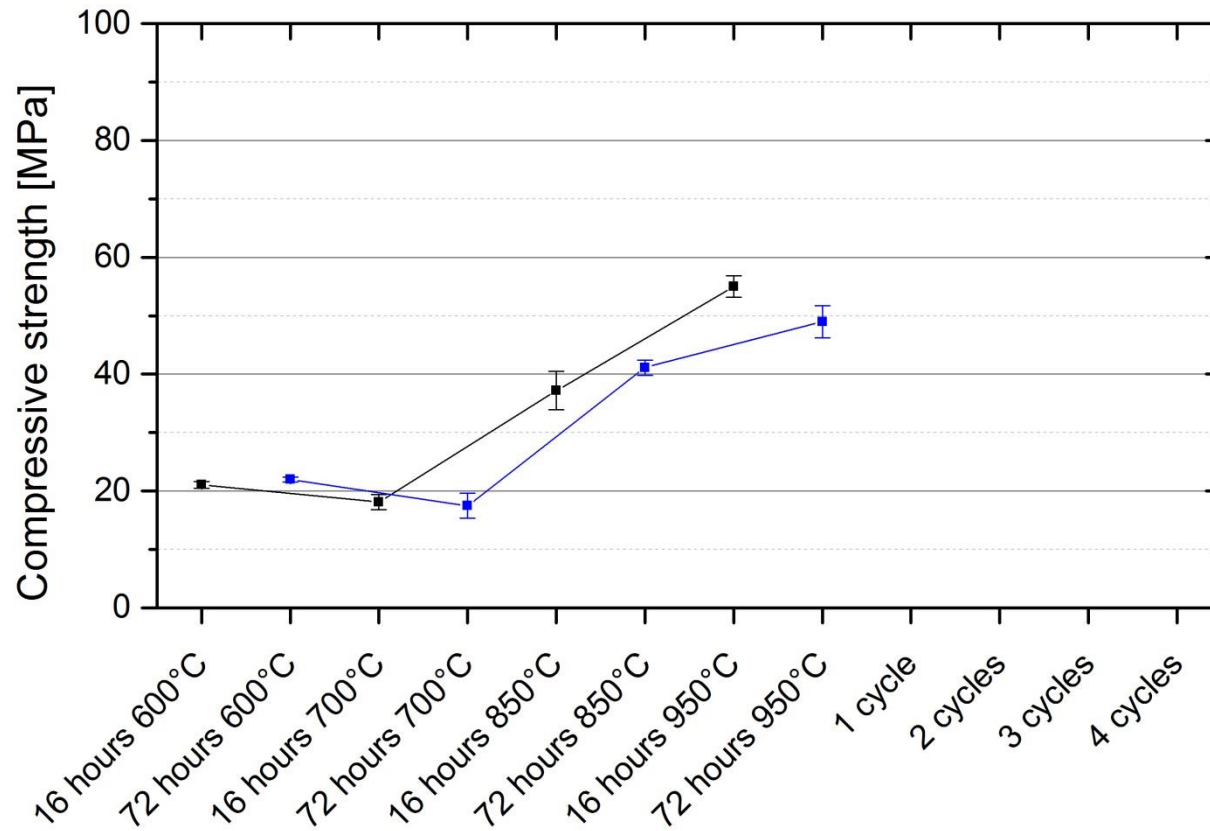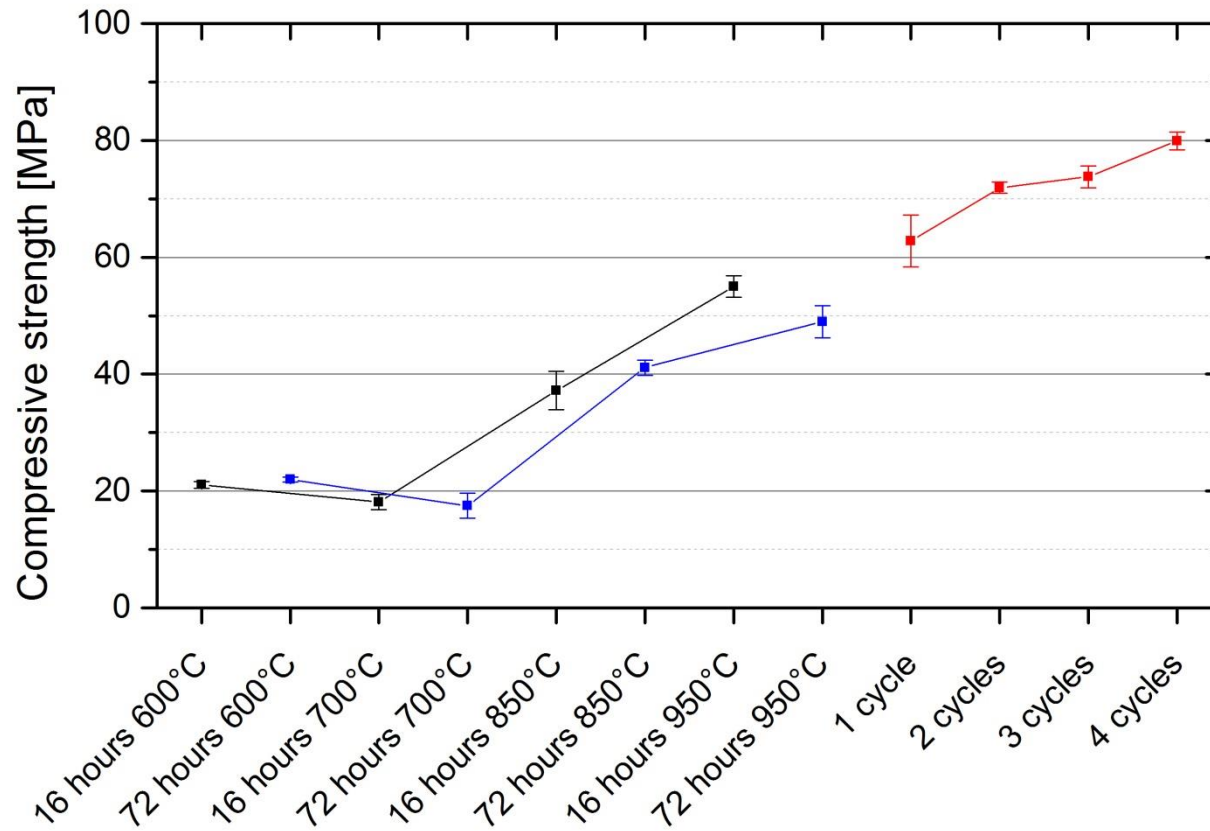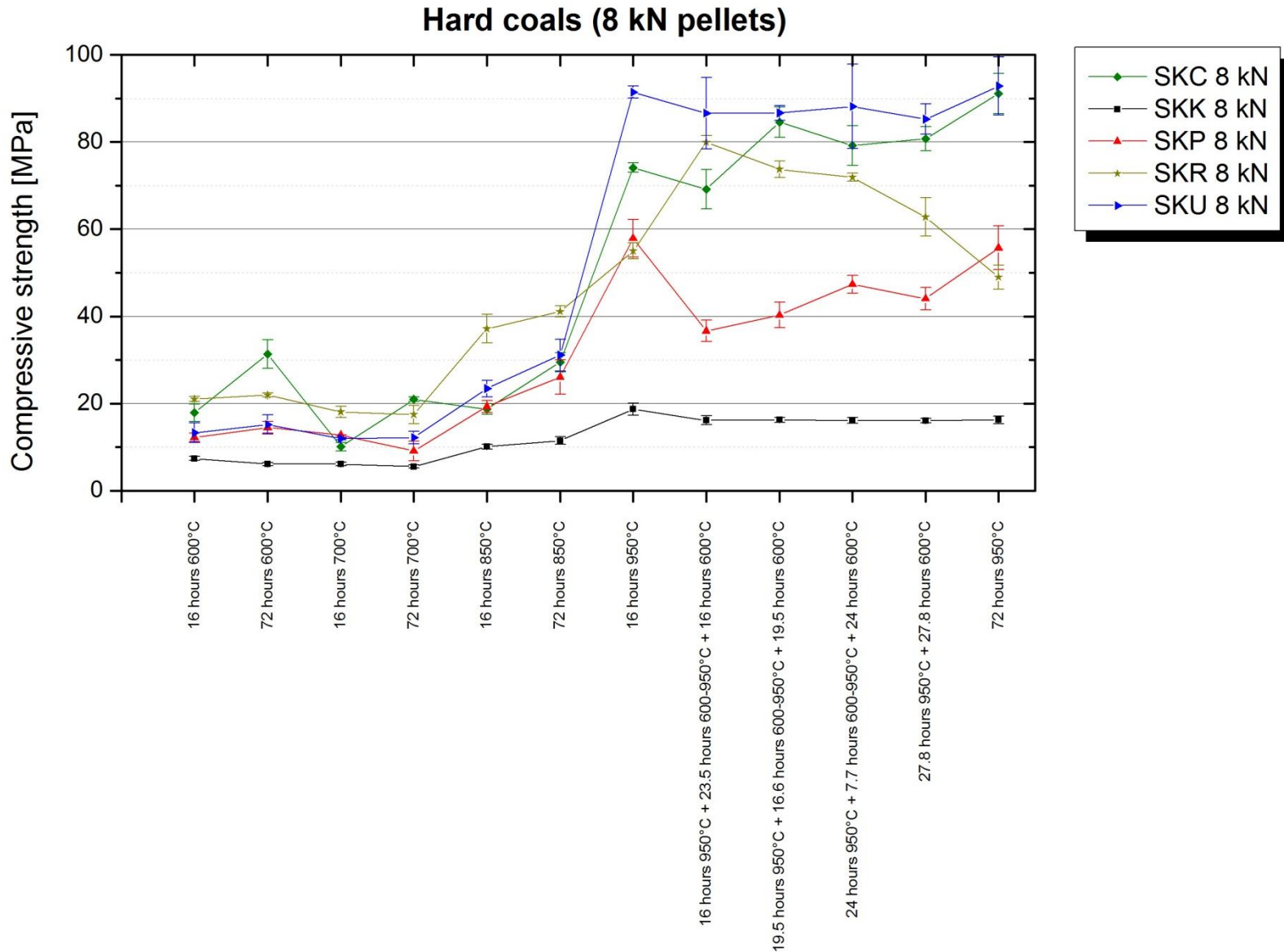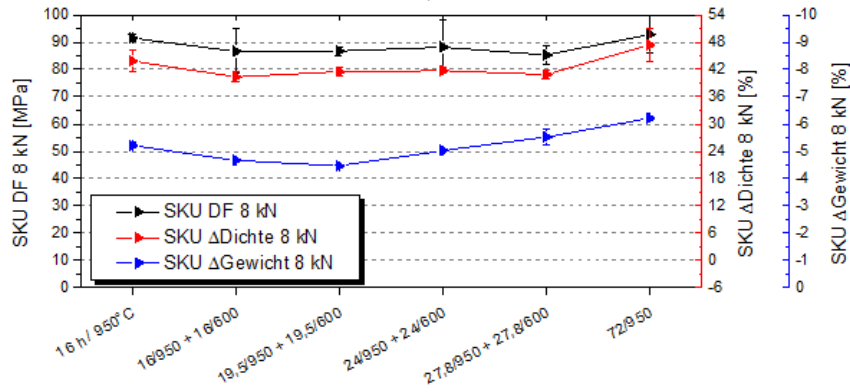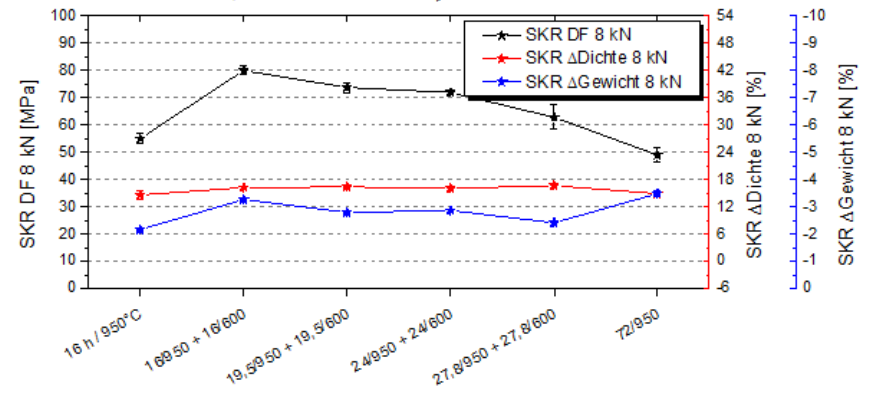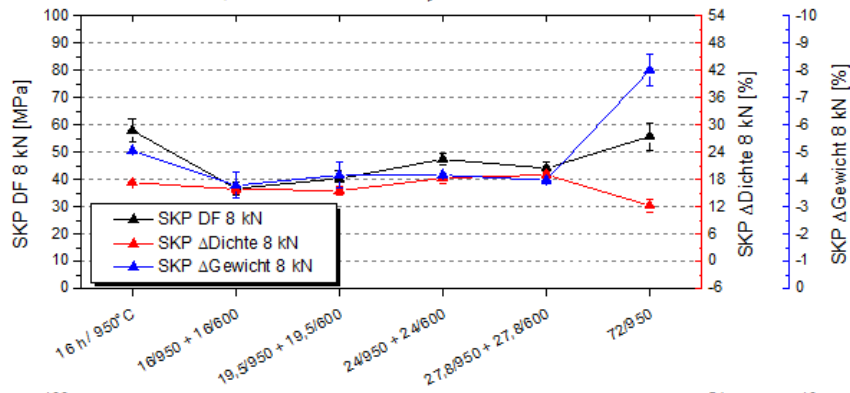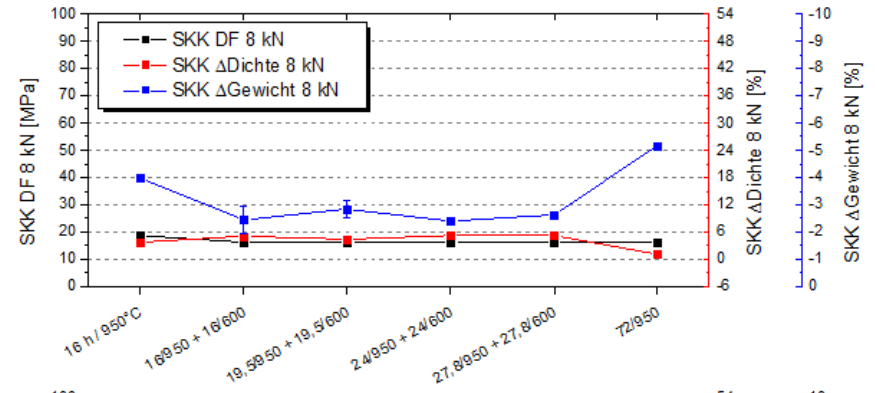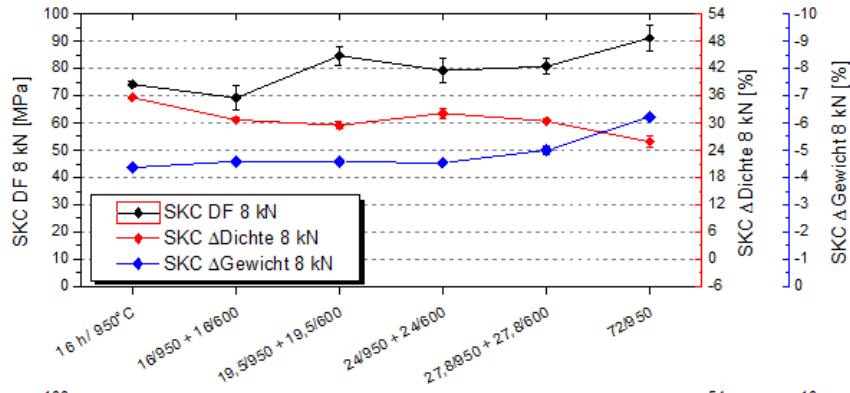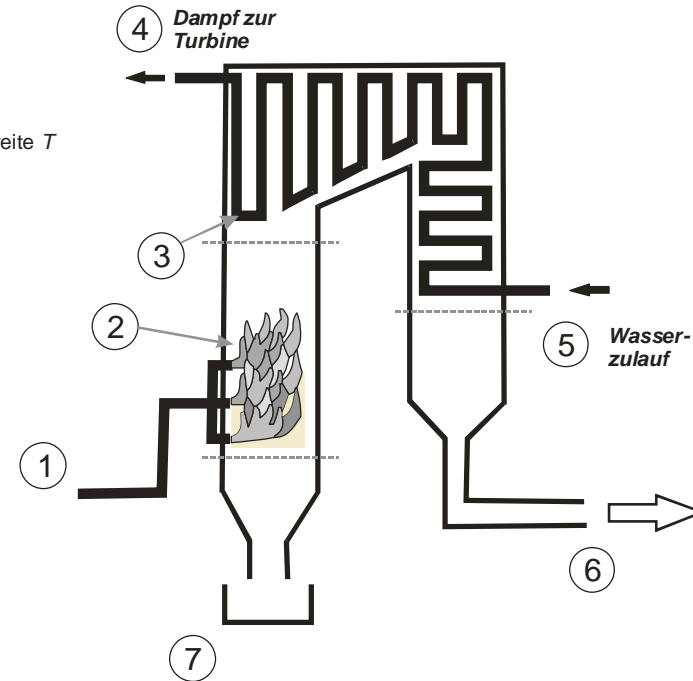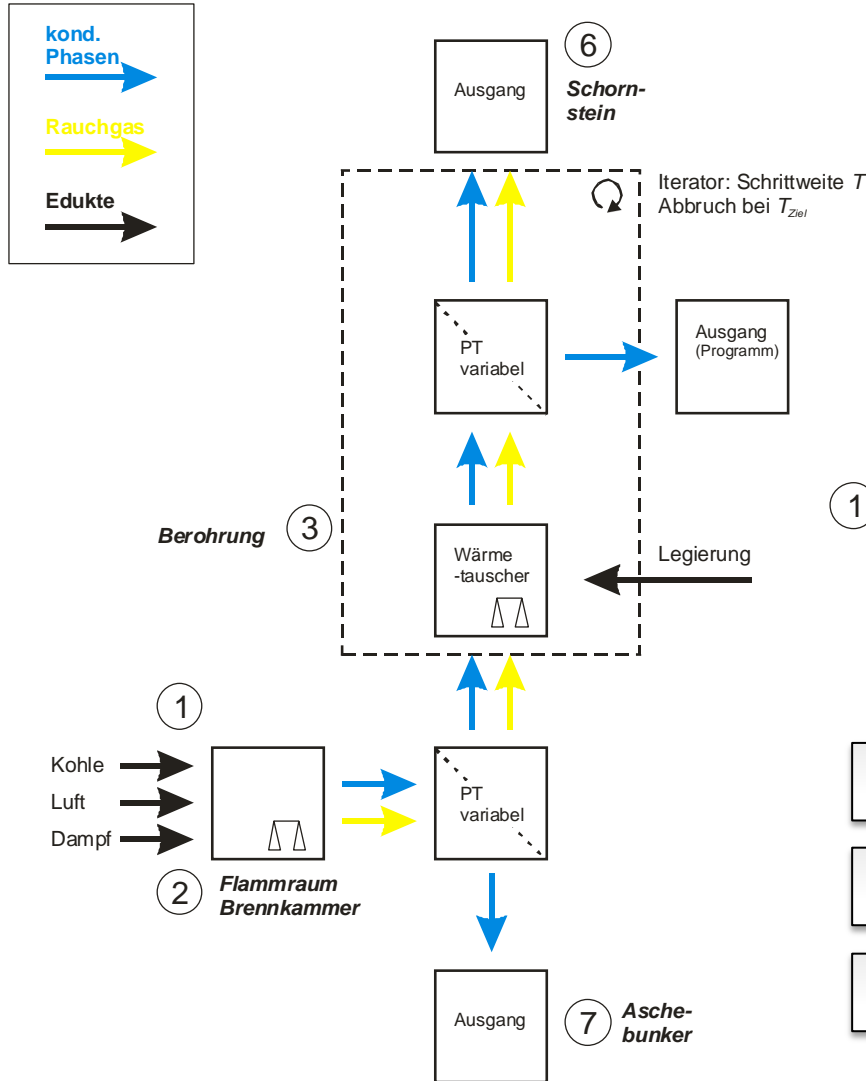
Development of a new model

Consideration of load change

Identification of key properties

Simulation
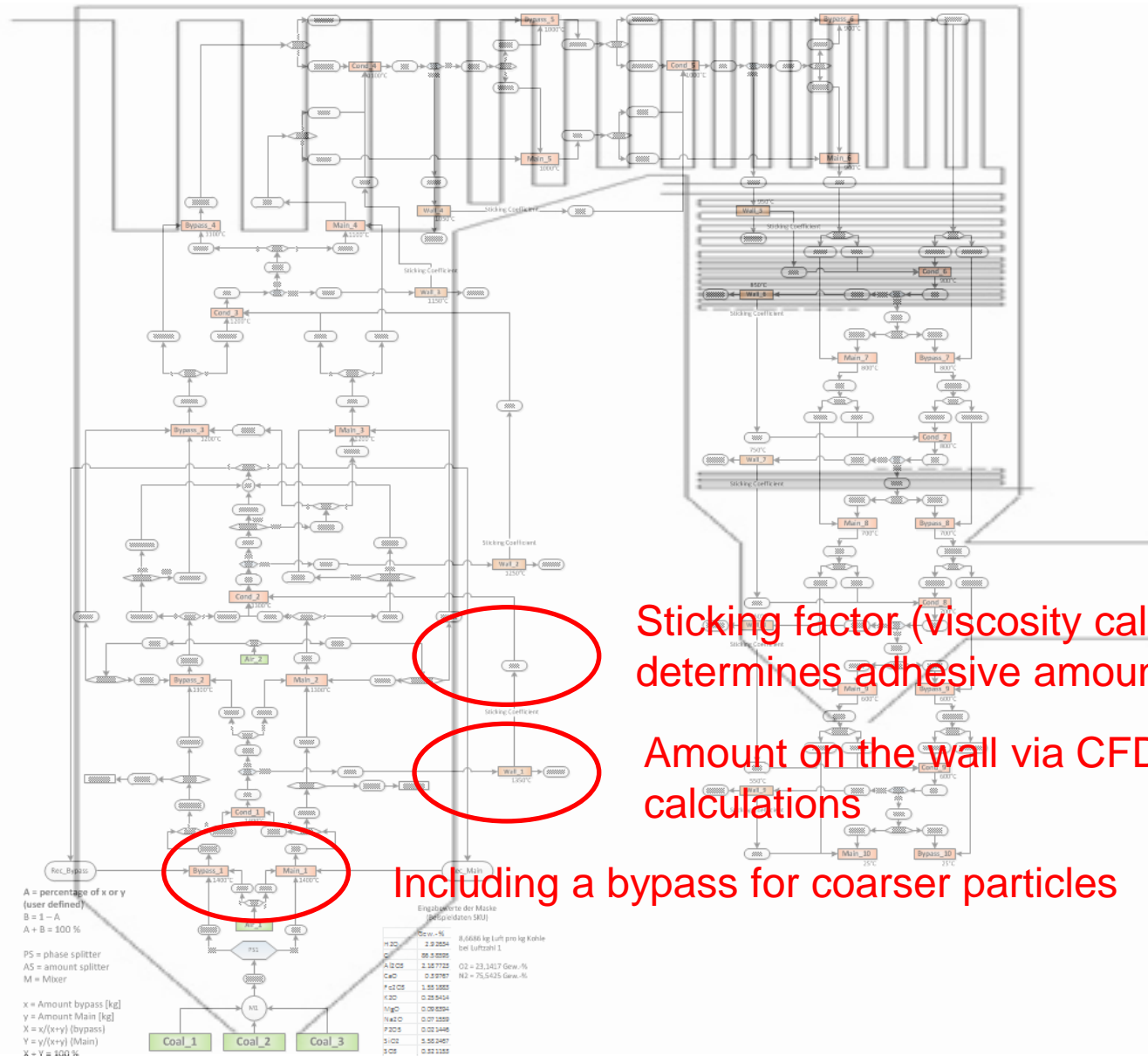
Sticking factor (viscosity calculation) determines adhesive amount

Amount on the wall via CFD calculations

Including a bypass for coarser particles

Summary

- ➢ Intensive analysis of five important hard coals

- ➢ Different key minerals

- ➢ Flue gas catalyses crystallisation

- ➢ Peak temperature of importance

- ➢ Load change sensitivity demonstrated

- ➢ Concept model for solid fuel combustion includes a kinetic bypass, CFD, and viscosity calculations

References

Slide 2 Pictures: Neuroth, M., Lokay, P., Saigge, M. (2012). *Kraftwerksinternes Dokument: Kohlequalitätskolloquium Kraftwerk Niederaußem, 2.2.2012.* Bergheim: RWE

Slide 3: Bundesnetzagentur, www.bundesnetzagentur.de, Dezember 2015, [Online], Available: http://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/Versorgungssicherheit/Erzeugungskapazitaeten/Kraftwerksliste/kraftwerksliste-node.html. [Zugriff am 01.12.2015]

Slide 20: F. Lüttschwager and L. Singheiser, *Rauchgasseitige Korrosion von Nickelbasislegierungen für zukünftige 700C-Dampfkraftwerke*: Germany, Europe Publikationsserver der RWTH Aachen University, 2011., 2011.