Science and Technology of the Mechanical/Thermal Dewatering

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Summary

In the work at hand basic experimental results are presented for the mechanical/thermal dewatering (MTE, German abbreviation for 'Mechanisch/Thermische Entwässerung', also used for 'mechanical/thermal expression' in English), during which lignites or other moisture containing materials are dewatered by the combined application of heat and mechanical forces. Models are developed for the description of the kinetics during the dewatering of the different materials based on soil-mechanical fundamentals, rheology and rate-process-theory.

Using mercury intrusion porosimetry (MIP), helium pycnometry, CO_2 adsorption and other techniques, it is investigated, how MTE process conditions, such as temperature and pressure, affect the physical properties pore size distribution and pore diameters, specific surface area, skeletal and 'true' density, hardening, compressibility and shrinkage behaviour of low rank coals from Australia, Greece and Germany.

The results provide a detailed insight in process kinetics and mechanism, in coal structure and structural changes during the dewatering process. Additionally re-hydration and combustibility of MTE products as well as the removal of minerals from lignites during the MTE process is investigated. Results from the mechanical/thermal dewatering and water leaching tests are compared, which prove, that the MTE process is a powerful technique for the removal of both water and alkali components from lignite and younger biomass fuels like straw. Reductions of the concentration of sodium in lignite and potassium in straw between 70 and 85 % are obtained. The results thus demonstrate, that the MTE process is also suitable for the upgrading of lignites and biomass fuels to prevent corrosion and slagging in power plants.

The development of the plant and process engineering for the dewatering of lignite and for the combined leaching and dewatering of biomass fuels is presented and technological modifications required for the dewatering of waste materials and suspensions like galvanising sludge are described. The technical implementation is demonstrated based on the laboratory and technical scale dewatering units at the University of Dortmund and the pilot and demonstration plants located in Frechen and at the power plant Niederaußem.

Efficiencies for different dry lignite fired power plant concepts with integrated mechanical/thermal lignite dewatering are calculated and compared to the results obtained for other drying and dewatering processes. Depending on the origin and water content of the lignite, power plant efficiencies can be increased by up to 20 percent and specific CO_2 emissions can be reduced by the same amount by the implementation of the MTE process in technical scale power plants. The results prove, that the MTE process is a remarkable advance compared to the existing methods.