

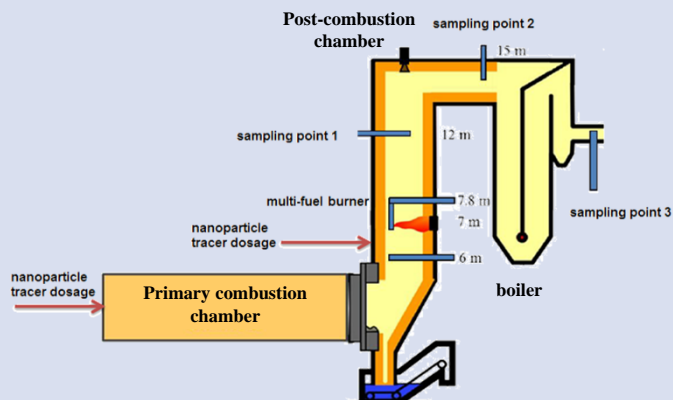
Investigation of the release of engineered nanoparticles in the pilot scale combustion chamber BRENDA

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Main goals

- Investigation of the release of nanoparticles in the pilot scale combustion chamber BRENDA
- Dosing of a cerium oxide NP suspension (1g/l) into the plant
- online and offline measurement
 - Measurement of particle size distribution in flue gas
 - Gravimetric analysis of particle mass concentration
 - Chemical analysis of filter samples (Cerium) with ICP-MS
 - Chemical analysis of ELPI+ filter stages (Cerium) with ICP-MS

Combustion chamber BRENDA



Chemical analysis of filter samples

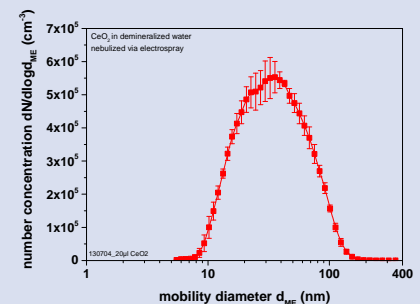
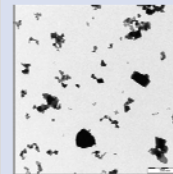
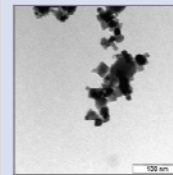
Experiment	Firing	Dosage	Post combustion chamber				After boiler				Stack			
			Theoretical Ce concentration		MS		MS		MS		Ce content	SD		
			$\mu\text{g}/\text{Nm}^3$	$\mu\text{g}/\text{Nm}^3$	$\mu\text{g}/\text{Nm}^3$	SD	$\mu\text{g}/\text{Nm}^3$	SD	$\mu\text{g}/\text{Nm}^3$	SD	$\mu\text{g}/\text{Nm}^3$	$\mu\text{g}/\text{Nm}^3$		
V1	Natural Gas	no dosage	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
09.03.13		10 th	2.500	59,21	59,5	0,00	0,00	0,01	0,015	0,01	0,01			
V2	Natural Gas	no dosage	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
17.03.13		10 th	4.400	11,9	1,4	88,6	58,0	0,081	0,08					
V3	Hard Coal	no dosage	70	36,7	0,8	49,9	1,1	0,090	0,00					
21.03.13		10 th	2.500	210,7	101	144,2	4,9	0,071	0,00					
V4	Hard Coal + Switch Grass	no dosage	70	28,6	3,5	28,2	2,3							
13.04.13		10 th	4.100	84,2	17,4	42,7	1,5							
		10 th	2.500	37,5	8,2	61,9	26,0							

Cerium oxide as Tracer



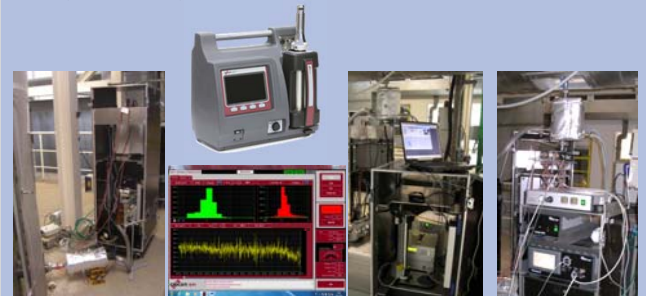
Nanoscale ceria

- Cerium(IV)-Oxide, Alfa Aesar
 - Commercially available suspension with 18 % CeO₂ in water
- Melting point
 - bulk-material 2.400°C
- Selection criterion
 - Low concentration in the system background



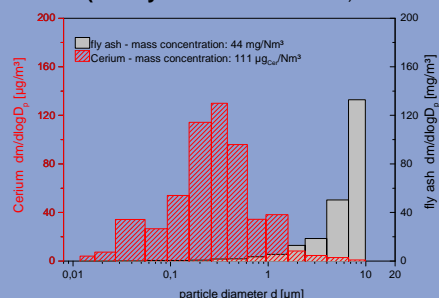
Measurement systems

- Measurement of the particle mass concentration according to VDI 2066 with 47 mm plane filter
- Measurement of the particle size distribution by:
 - Electrical Low Pressure Impactor ELPI, Dekati (6 nm – 10 µm)
 - Scanning mobility particle sizer SMPS, Grimm (11 – 1083 nm)
 - Light scattering analyser WELAS Promo 3000H, Palas (0.2 - 40 µm)

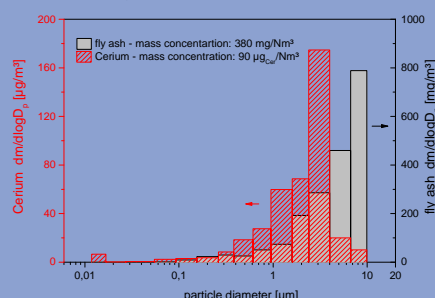


ELPI+ measurement behind boiler with cerium dosing

Fired with natural gas (low fly ash concentration)



Fired with a coal dust / switch grass mixture (high fly ash concentration)



Results

- Cerium oxide has a melting point of about 2400 °C. That is, in addition to the relatively rare occurrence and good detectability, a reason why it was chosen as a tracer substance for the release studies in the pilot combustion.
- Removal efficiency of cerium oxide in the flue gas cleaning of at least 99.9%.
- The comparison of the cerium distribution at gas firing and coal dust firing shows a shift in the distribution of 0.3 microns up to 3 microns.
- This shift indicates that the dosed Cerium oxide NP coagulates with the particles from the fly ash with a diameter of 3 µm.

References

Lang, Inge-Maria; Hauser, Manuela; Baumann, Werner; Mätzig, Hartmut; Paur, Hanns-Rudolf; Seifert, Helmut (2015): Untersuchungen zur Freisetzung von synthetischen Nanopartikeln bei der Abfallverbrennung. In: K. J. Thomé-Kozmiensky und Michael Beckmann (Hg.): Energie aus Abfall, Band 12. neue Ausg. Nietwerder: TK-Vlg, S. 347-370.