Supporting Information (SI)

Migration and emission characteristics of ammonia/ammonium through flue gas cleaning devices in coal-fired power plants of China

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Table S1. Parameters and Components of Flue Gas at Each Sampling Points and Key Operation Parameters of APCDs

		PP1			PP2			PP3			PP4		
Sampling points		#a*	#b*	#c*	#a	#b	#c	#a	#b	#c	#a	#b	#c
SO_2	mg/Nm^3	-	5269	13	-	1468	14	-	1785	19	-	1554	6
NO_x	mg/Nm^3	43	-	-	39	-	-	33	-	-	34	-	-
O_2	%		5.9	5.8	4.5	6	7.5	3.7	8.4	8.4	4.9	7	7
T		368	108	49	155	134	48	327	137	48	342	152	49
W	%	-	6.5	7	-	4.5	7.5	-	5.5	11	-	4.5	10
Denitrification process													
Denitrification efficiency	%	93.9			-			93.3			94.3		
Number of Catalyst layers		4			-			3			3		
Ammonia consumption	kg/h	263			20			38			68		
Ammonia slip(online measurement)	mg/Nm^3	0.49			ND*			ND			ND		
Desulfurization process													
Number of desulfurization tower		2			1			1			1		
Number of spraying layers		4+3			5			3			3		
Desulfurization sorbent		Limestone			Limestone			Aqueous ammonia			Liquefied ammonia		
Desulfurization absorbent consumption	kg/h	20510			416			991			234		
Desulfurization efficiency	%	99.8			99			98.9			99.6		

*#a: denitrification outlet, #b: desulfurization inlet, #c: final outlet, ND: not detected.

Table S2. Comparison of NH_3/NH_4^+ average concentration in flue gas from our study with other published results

	After denitrification devices		After dedusting devices		Final outlet	
	NH_3	NH_4^+	NH_3	NH_4^+	NH_3	NH_4^+
PP1	0.54±0.01	21.35±1.57	0.17±0.007	0.34±0.14	0.14±0.01	0.21±0.11
PP2	0.15±0.008	15.08±0.48	0.18±0.002	0.18±0.32	0.16±0.03	0.22±0.05
PP3	0.44±0.11	4.98±0.11	0.49±0.03	0.42±0.20	0.44±0.20	1.07±0.09
PP4	0.41±0.05	6.85±1.00	0.28±0.06	0.05±0.007	4.07±0.30	6.27±1.87
Li et al.[1]					0.26	0.15 ($PM_{2.5}$)
Cheng et al.[2]	0.53	1.19 ($PM_{2.5}$)*	0.35	0.32 ($PM_{2.5}$)	0.04	0.41 ($PM_{2.5}$)
Ruan et al.[3]		0.32 (PM_{10})*		0.05 (PM_{10})		0.005(PM_{10})
		0.19 ($PM_{2.5}$)*		0.03 ($PM_{2.5}$)		0.005($PM_{2.5}$)
		0.17 (PM_1)*		0.03 (PM_1)		0.004 (PM_1)

*The PM_{10}, $PM_{2.5}$ and PM_1 in brackets means the NH_4^+ concentration in the three diameters.

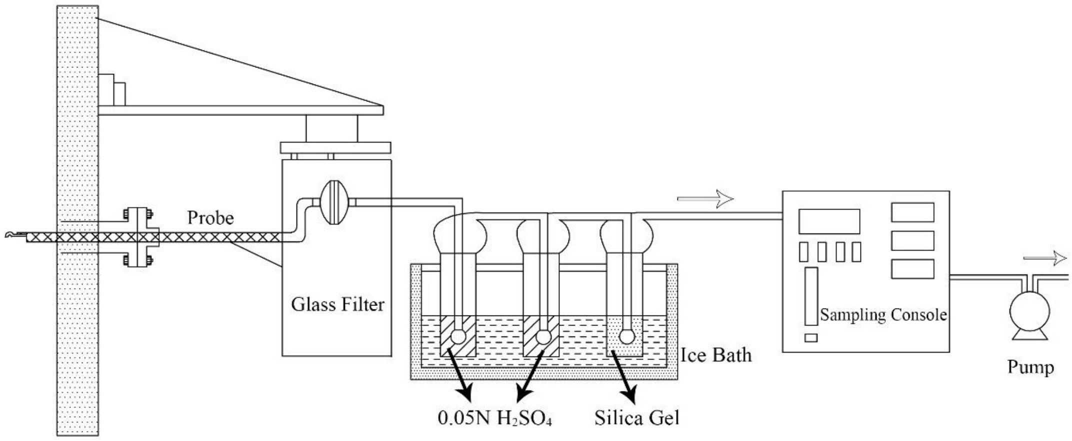


Figure S1 Schematic of the Ammonia/Ammonium Sampling system

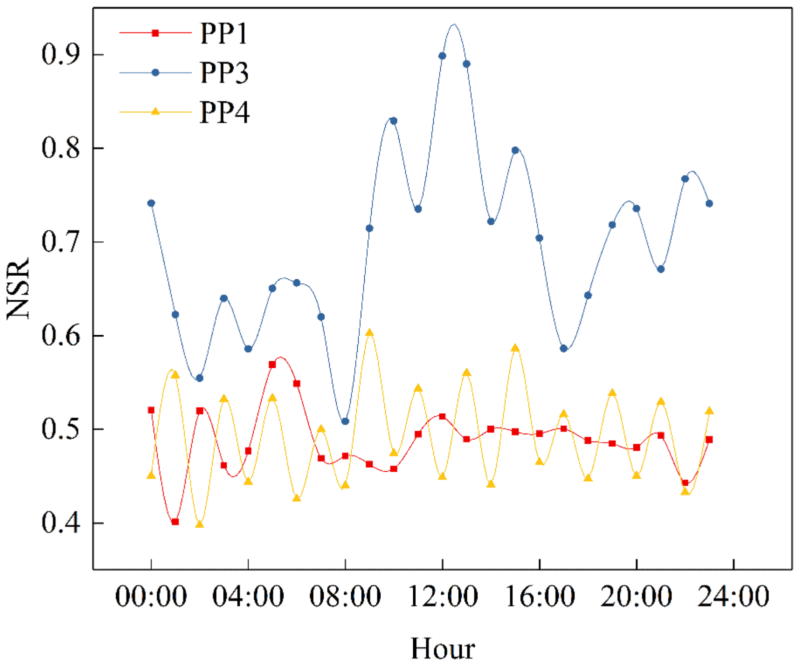


Figure S2. The hourly variations of NH_3/NO_x normalized stoichiometric ratio (NSR) in three tested plants

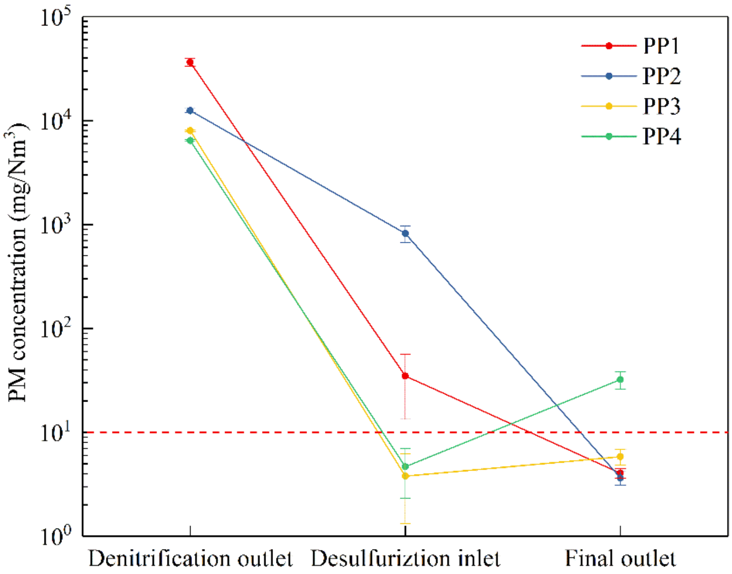
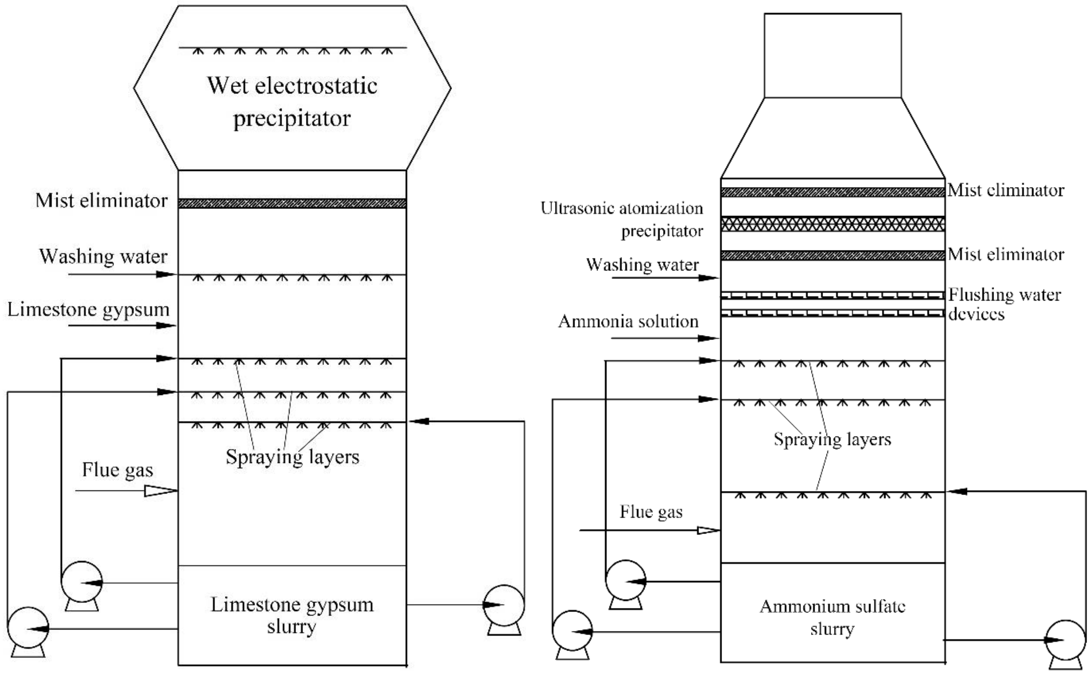


Figure S3. Average PM concentration with standard deviation at sampling points of four tested plants



(a) (b)

Figure S4. The Schematic of Desulfurization tower (a) Limestone-based WFGD, (b) Ammonia-based WFGD

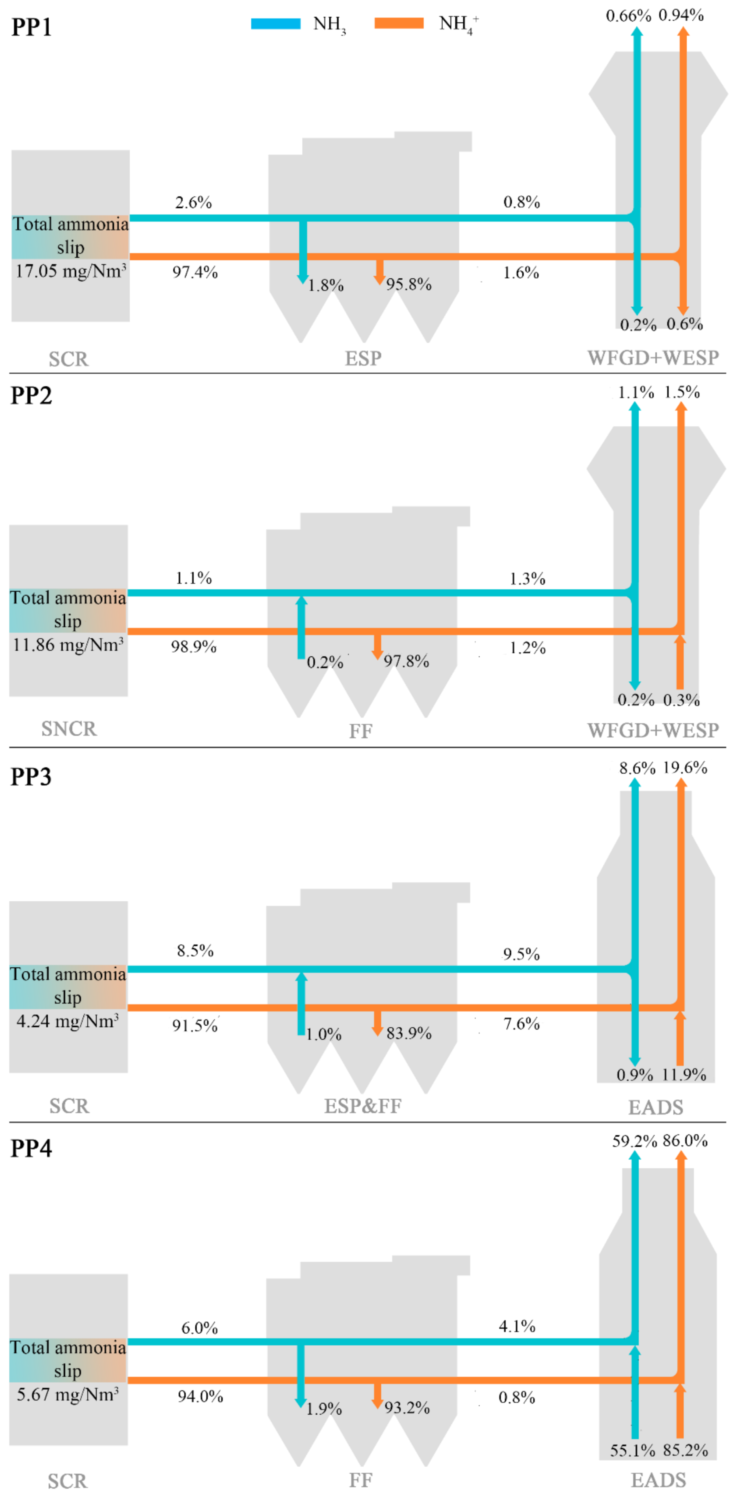


Figure S5. Quantitative migration and transformation laws of NH_3 in flue gas and particle-bound NH_4^+ for the four tested plants

Equation S1

Because there are no proper sampling conditions before the SCR, hourly NO_x concentration of SCR inlet and the amount of injecting ammonia were derived from the denitrification flue gas continuous emission monitoring system, and used to calculate the NSR based on the following equation[4]:

$$\mathrm{NSR} = \mathrm{W}/(\frac{V_q \times C_{NO} \times 17}{30 \times 10^6} + \frac{V_q \times C_{NO2} \times 34}{46 \times 10^6}) \quad \text{(eq S1)}$$

Where W is the ammonia consumption per hour in the denitrification system, Vq is the flux of the flue gas at the inlet of SCR reactor, C_{NO} and C_{NO2} are the NO and NO_2 concentration at the inlet of SCR reactor, "17" and "34" are determined based on the reaction molar ratio of NO/NH_3 and NO_2/NH_3, respectively.

References

(1) Li, Z.; Jiang, J. K.; Ma, Z. Z.; Fajardo, O. A.; Deng, J. G.; Duan, L. Influence of flue gas desulfurization (FGD) installations on emission characteristics of $PM_{2.5}$ from coal-fired power plants equipped with selective catalytic reduction (SCR). *Environ. Pollut.* **2017,** *230*, 655-662.

(2) Cheng, T.; Zheng, C. Q.; Yang, L. J.; Wu, H.; Fan, H. M. Effect of selective catalytic reduction denitrification on fine particulate matter emission characteristics. *Fuel.* **2019,** *238*, 18-25.

(3) Ruan, R. H.; Xu, X. W.; Tan, H. Z.; Zhang, S. C.; Lu, X. C.; Zhang, P.; Han, R. W.; Xiong, X. H. Emission Characteristics of Particulate Matter from Two Ultralow-Emission Coal-Fired Industrial Boilers in Xi'an, China. *Energy Fuels.* **2019,** *33*, (3), 1944-1954.

(4) China Power Engineering Consulting Corporation (CPEC). Design Technology Guide for Denitration system of Fossil Fuel Power Plant (Q/DG 1-J004-2010) (in chinese).