Supplementary File

Collaborative Effect of In-Plasma Catalysis with Sequential Na2SO3 Wet Scrubbing on Co-Elimination of NOx and VOCs from Simulated Sinter Flue Gas

Juexiu Li [1,*], Rui Zhao [1], Maiqi Sun [2], Qixu Shi [1], Mingzhu Zhao [1], Junmei Zhang [1], Yue Liu [1], Jinping Jia [3]

[1] School of Energy and Environment, Zhongyuan University of Technology, Zhengzhou 450007, China

[2] International Education College, Henan Agricultural University, Zhengzhou 450002, China

[3] School of Environmental Science and Engineering, Shanghai Jiao Tong University, Shanghai 200240, China

* Correspondence: 6858@zut.edu.cn; Tel.: +86-0371-62506813

Text S1. Description of DBD reactor

The self-manufactured DBD reactor was coaxial type with tubular quartz tube as the discharge barrier, and with total length of 300 mm and inner diameter of 20 mm. The designed wedged stainless-steel rod with a diameter of 14 mm was end-fixed along the axis of the cylinder and acted as a high-voltage electrode. The 3mm thickness CuO foam was filled in the discharge gap to enhance the plasma energy and synergistic effect comparing with sole NTP process. Detailed illustration and photograph of the wedged high electrode was shown in **Figure S1**.

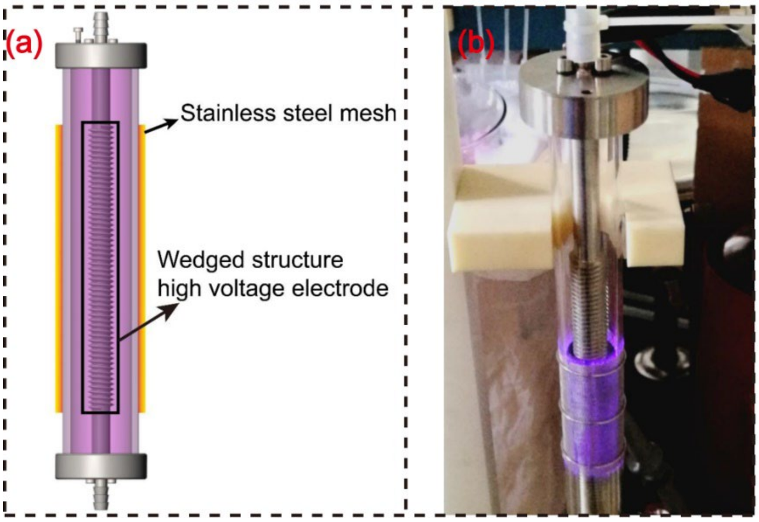

Figure S1. DBD reactor with wedged high-voltage electrode: figure illustration (a) and photograph (b).

Text S2. Detailed plasma status detection

Detailed schematic diagram of plasma status detection setup was shown in **Figure S2**. The plasma was generated by using a high-voltage alternating current (AC) power supply (CTP-2000K, Nanjing Suman Electronics Corp., Nanjing, China) equipped with an amplifier, which can adjust the employed peak voltage of gas discharge. The maximum voltage of the power supply was 30 kV. The frequency can be adjusted between 1 kHz and 100 kHz. A high voltage probe (Tektronix 6015A, 1000:1, Shanghai, China) and a voltage probe (PVP2150, RIGOL, Beijing, China) were used to record the applied voltage and voltage across the external capacitor, respectively. Both voltage signals were monitored using an oscilloscope (DS5062MA, RIGOL, Beijing, China).

A capacitor (1 μF) was connected between the DBD reactor and the ground to measure the amount of transferred charge so that the power consumption of the discharge could be calculated.

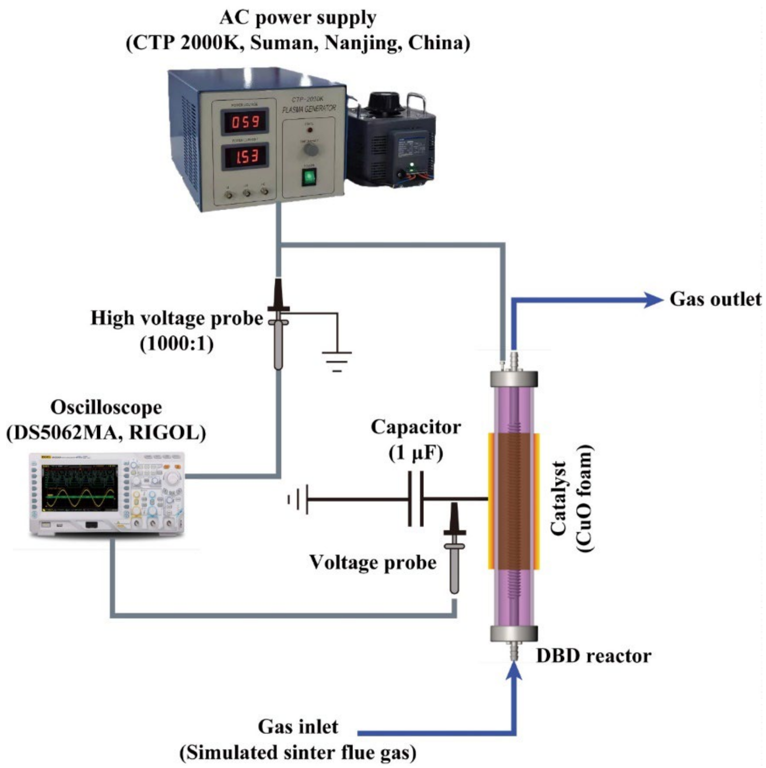

Figure S2. Schematic diagram of experimental setup for plasma status detection

Text S3. Discharge power calculation

The discharge power can be controlled by varying the applied voltage across the plasma reactor, which was calculated using the standard Q-U Lissajous method based on the following equations.

$$P=\frac{1}{T}\int_0^T VIdt=\frac{C_M}{T}\int_0^T \frac{dV_M}{dt}dt=fC_M\oint VdV_M$$

Where C_M represented the capacitor (1 μF), V and V_M were high-voltage and voltage across C_M, respectively. When connecting V and V_M to channels of the oscilloscope, the plasma discharge voltage waveform and Lissajous figure can be obtained (shown in **Figure S3**). The circle area A enclosed by the curve is directly proportional to the discharge energy. The discharge power P can be obtained as P = fA, and the specific input energy (SIE) of the DBD reactor is calculated as following equation:

$$SIE\ (J/L) = \frac{P}{Q} = \frac{Power\ (W)}{Gas\ flow\ rate\ (L/s)}$$

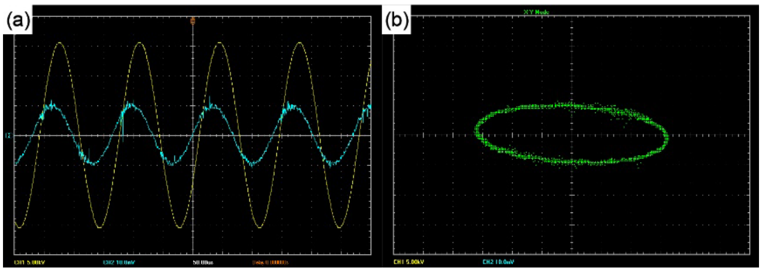

Figure S3. Output voltage signals of plasma discharge (a) and Lissajour figure (b) at 15 kV, 7.5 kHz

The discharge power employed on VOCs and NO conversion were valued by applied peak voltage and specific input energy (SIE, J/L). And the discharge power can be controlled by adjusting the applied voltage through the amplifier, with the input discharge power varying from 4.3 to 27 W corresponding to SIE varying from 31.6 to 633.2 J/L (shown in **Table S1.**).

Table S1. Specific input energy (SIE) with different input power and peak voltage.

Input power (W)	4.3	6.2	10	14	15	16.8	20	27
Peak voltage (kV)	5	6.5	8	12.8	13.6	14.5	15	20
SIE (J/L)	31.6	65.9	109.6	162.5	272.3	319.4	330	633.2

Text S4. Investigation on different treatment process on sinter flue gas TVOC removal

To further prove the effect of synergistic of plasma catalytic and sodium sulfite scrubbing process, different progress on the elimination of TVOC emissions from sinter flue gas was conducted (shown in **Figure S4**). To be noted, the sinter flue gas was provided by heating 10.0 g of practical sinter raw mix at 500 °C with air flow rate of 100 mL/min in a tubular furnace. It can be observed that scrubbing process has slight reduction effect on TVOC emission, indicating that certain amount soluble VOCs produced by sinter process. When combining with plasma catalytic pre-oxidation, the tail TVOC concentration showed obvious decrease, with the average removal efficiency of 81.3%. The above results have demonstrated the synergistic effect on VOCs treatment of plasma catalytic and sodium sulfite scrubbing process.

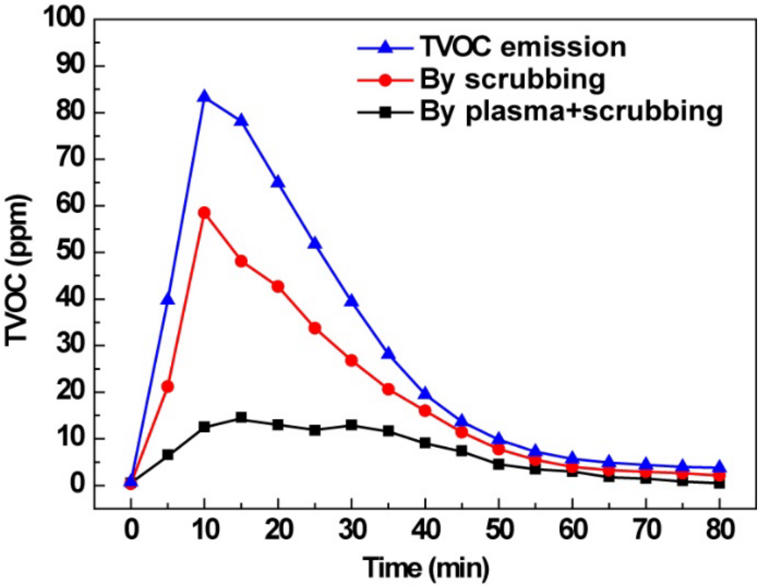

Figure S4. Comparison of different treatment process on sinter flue gas TVOC removal