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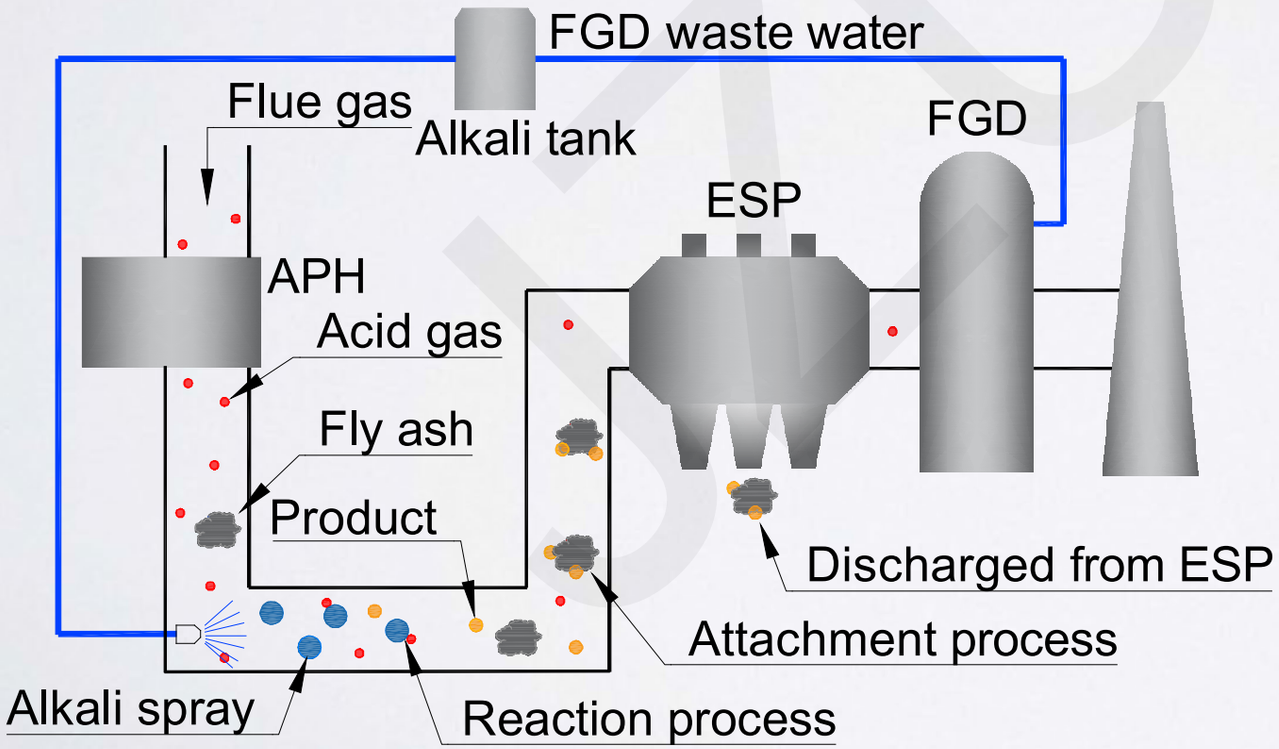
Chemical kinetics simulation of semi-dry dechlorination in coal-fired flue gas

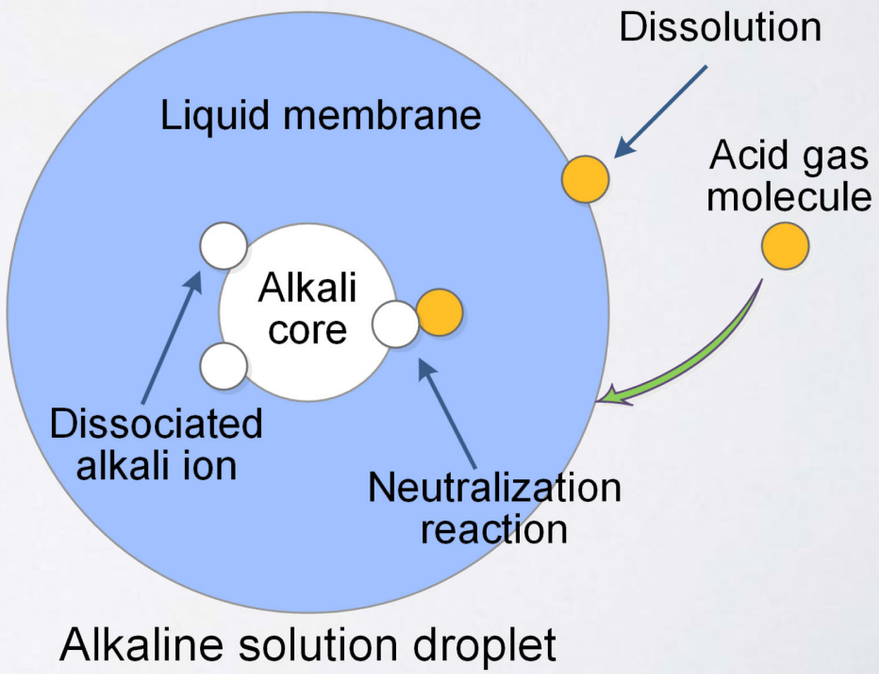
Key words:

coal-fired flue gas; semi-dry dechlorination; chemical kinetics; competition relationship; Na/Cl; CHEMKIN

The idea of the dechlorination system

- Objective: Zero discharge of waste water of FGD
- Through spraying alkaline solution into flue gas after APH, HCl can be removed by neutralization reactions and the final products would be discharged in ESP.
- When HCl and other acid gases is largely removed, the quantity of waste water of FGD would be greatly reduced.
- The significantly reduced waste water would be used as solvent of alkali circularly sprayed in the flue.





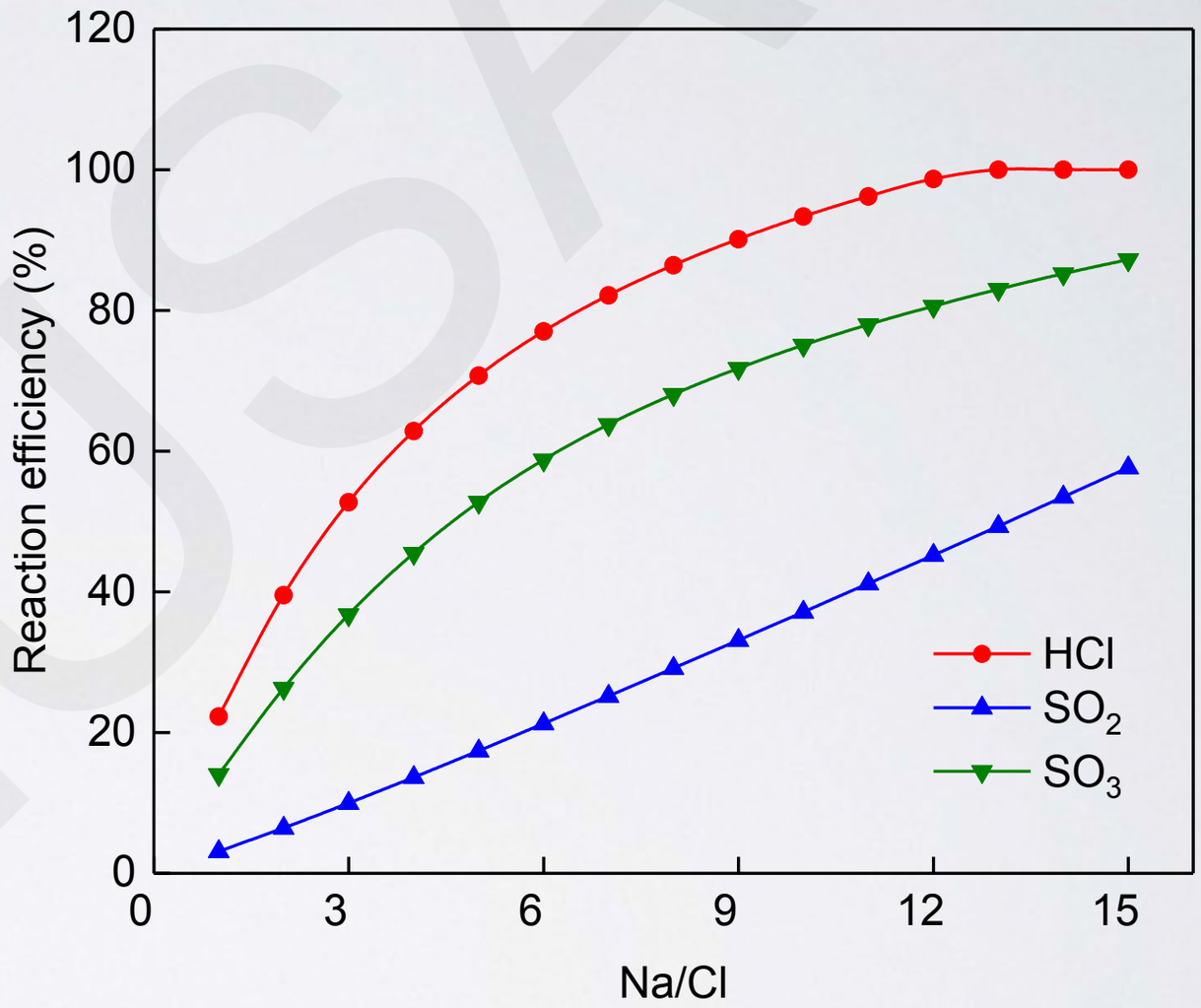
Research methods

- Simulated with CHEMKIN
- Composition of flue gas was measured on a 660MW boiler
- The simulated flue gas: HCl, SO_2, SO_3 & N_2
- Alkali: NaOH

Component	CO_2 (%, v/v)	H_2O (%, v/v)	O_2 (%, v/v)	SO_2 (mg/Nm^3)	SO_3 (mg/Nm^3)	HCl (mg/Nm^3)	HF (mg/Nm^3)	N_2 (%, v/v)
Concentration	14.00	7.50	3.00	2285.71	32.14	54.59	25.36	75.46

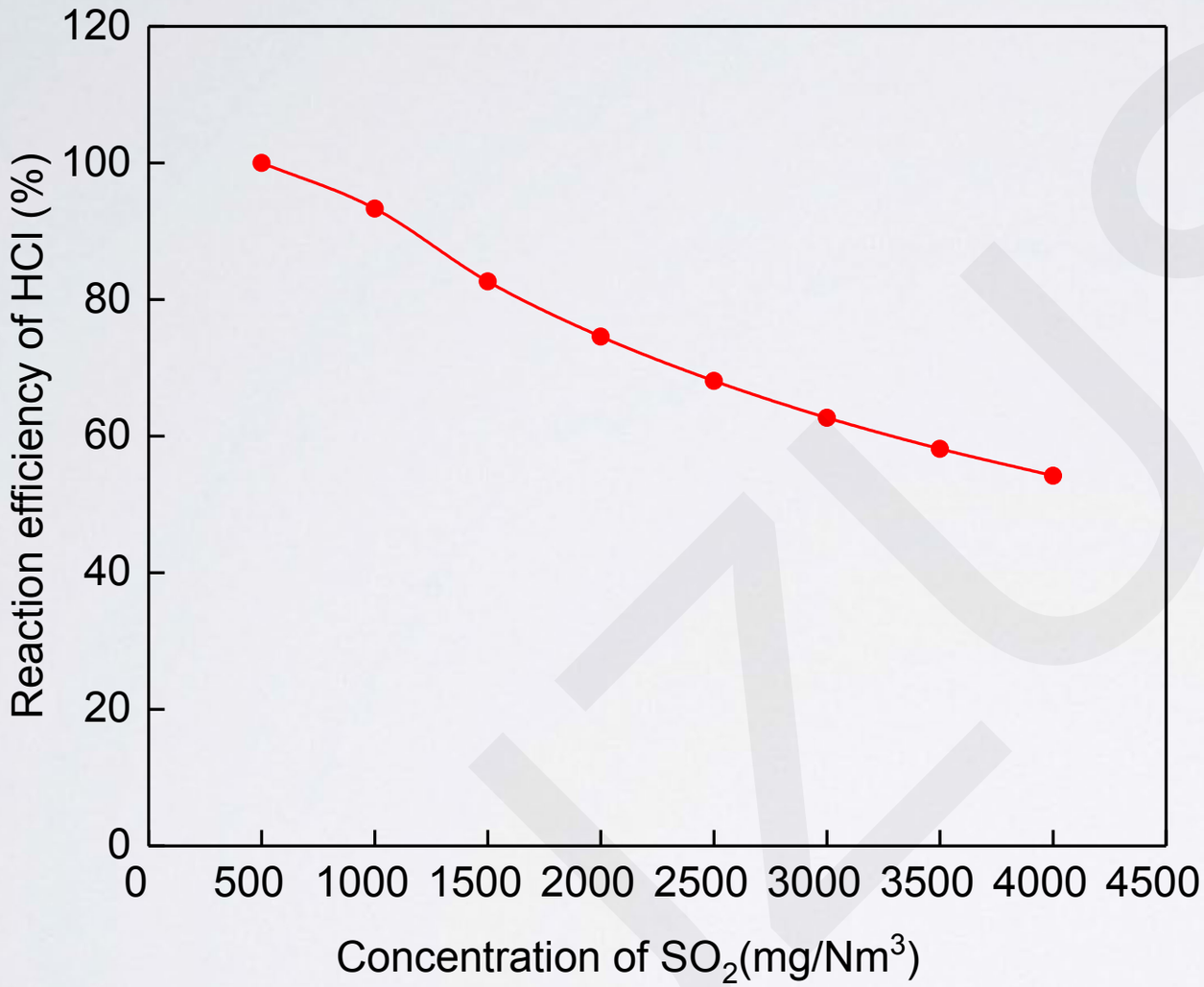
Influence of Na/Cl on reaction efficiency of HCl

- Reaction efficiencies of HCl, SO_2 and SO_3 are positively correlated with Na/Cl.
- The high concentration of SO_2 in flue gas has great influence on the semi-dry dechlorination process. However, the reaction efficiency of HCl is still significant.
- When Na/Cl is 5, the reaction efficiency of HCl & SO_3 reach 70.71% & 52.72%.



Experimental conditions: temperature, 393.15 K; reaction time, 1 second

Influence of SO_2 on reaction efficiency of HCl

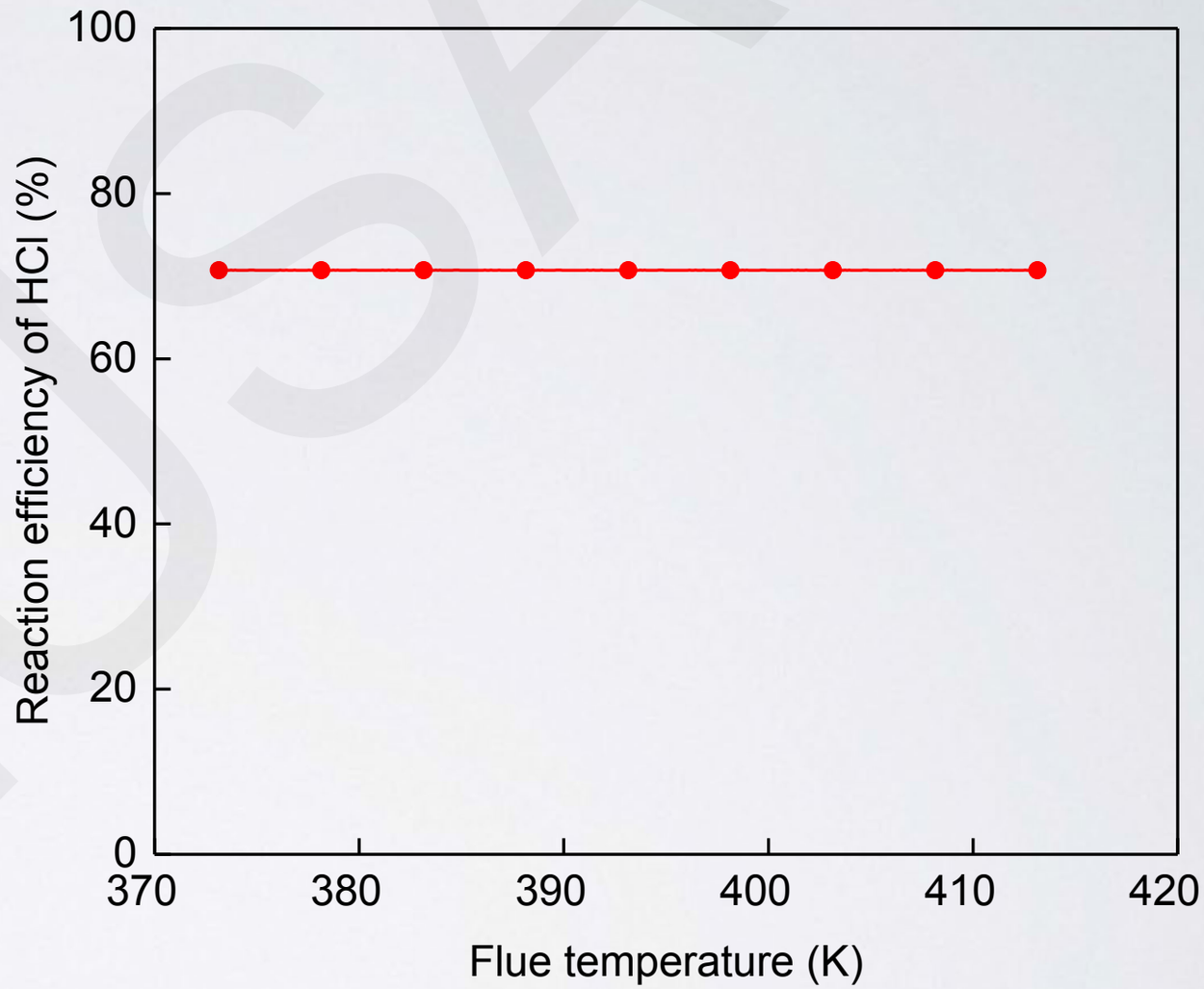


Experimental conditions: temperature, 393.15 K; reaction time, 1 second; Na/Cl, 5

- When the concentration of SO_2 changes in large measure, the reaction efficiency of HCl is greatly affected.
- When SO_2 concentration changes 1000 mg/Nm^3, the reaction efficiency of HCl changes about 13%.
- However, for a specific boiler, the burning coal is usually relatively, the reaction efficiency of HCl would not be greatly affected.

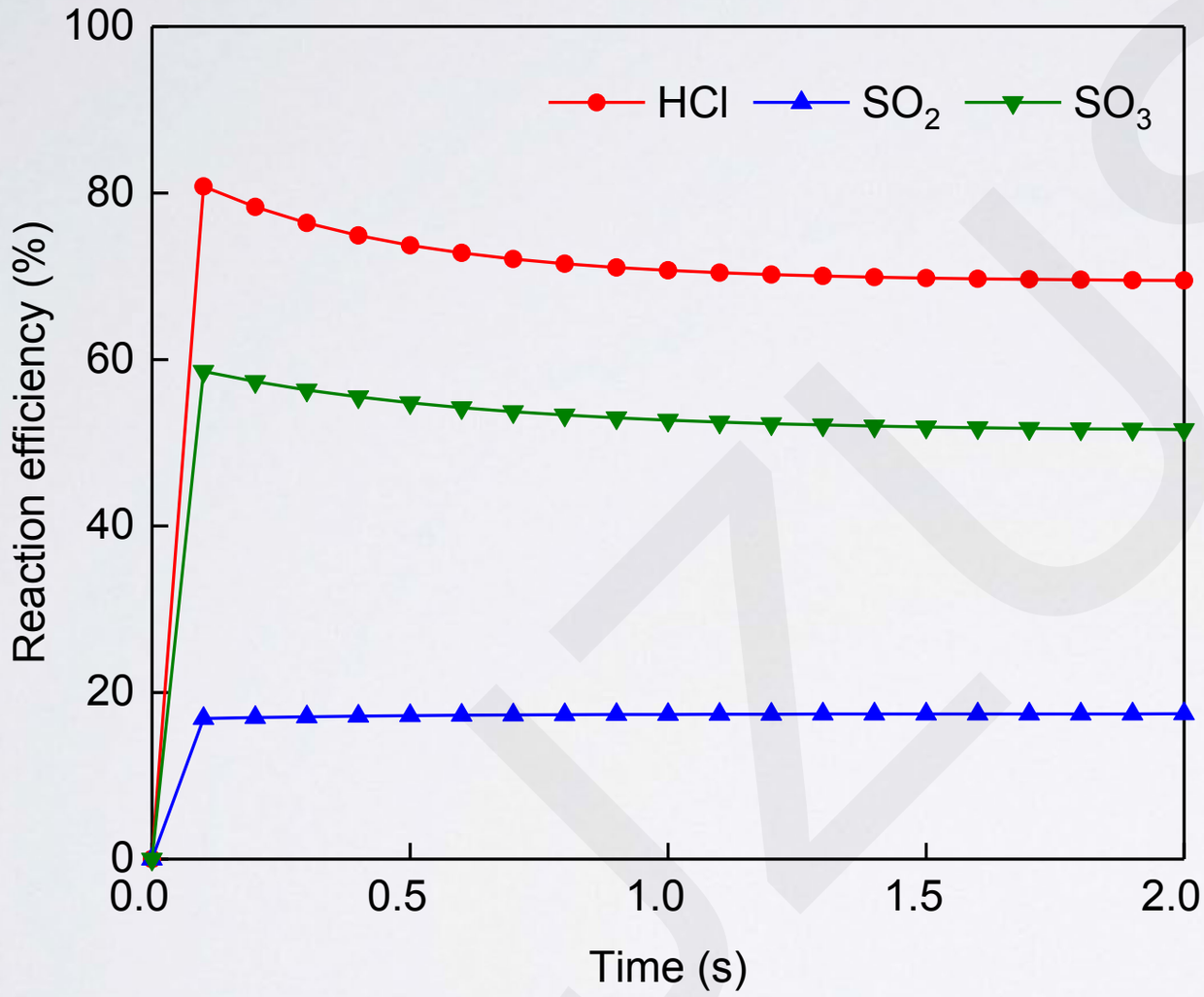
Influence of flue temperature on the reaction efficiency of HCl

- The simulated result showed that the reaction efficiency of HCl is not sensitive to the flue temperature.
- However, in practice, the flue temperature may significantly affect the persistence of liquid drops, and this would affect the process of semi-dry dechlorination.
- So the effect of flue temperature on HCl reaction efficiency still needs further study.



Experimental conditions: temperature, 393.15 K; reaction time, 1 second; Na/Cl, 5

Influence of reaction time on reaction efficiency of HCl



- The reactions among acid gases in flue gas with NaOH mainly finish within 0.1 second and reach equilibrium after 1 second.
- It is important in practice to select an appropriate position to spray alkali solution after air preheater to control reaction time.

Experimental conditions: temperature, 393.15 K; Na/Cl, 5