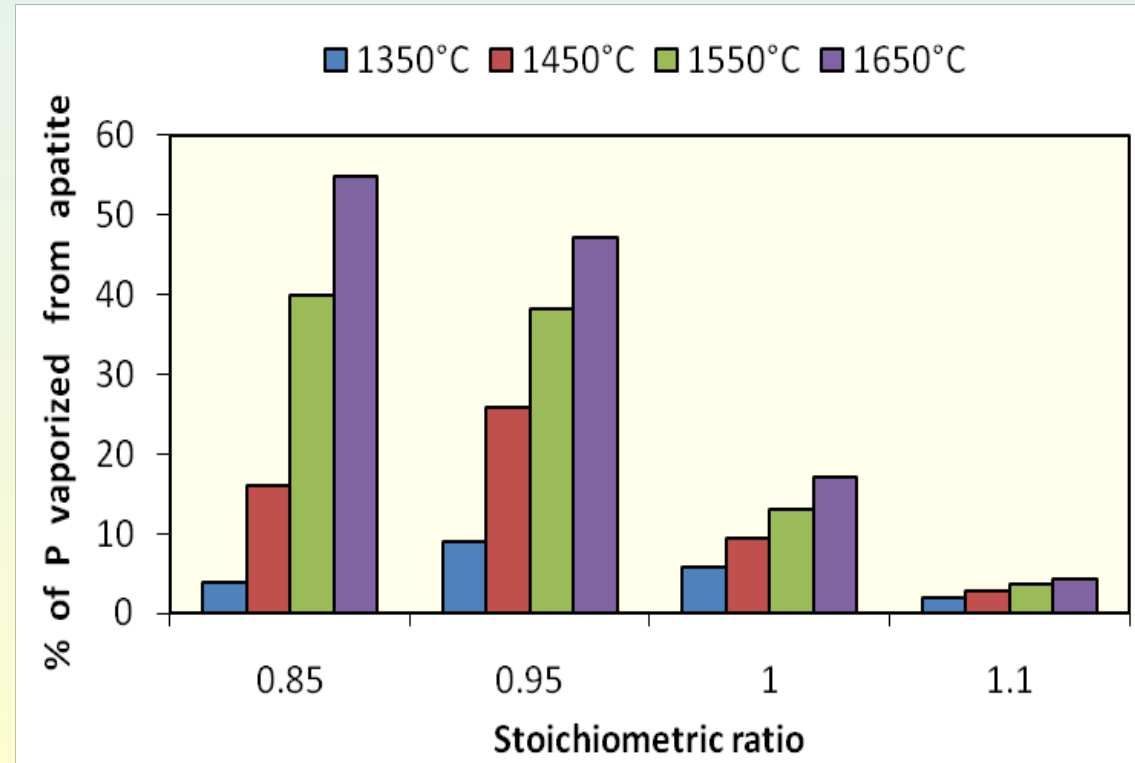


Niksa Energy Associates LLC

Relating the Deactivation Potential of SCR Catalysts to Fuel Properties and Firing Conditions

Drs. Balaji Krishnakumar and Stephen Niksa; NEA LLC & Alejandro Jimenez; EPRI

Phosphorus

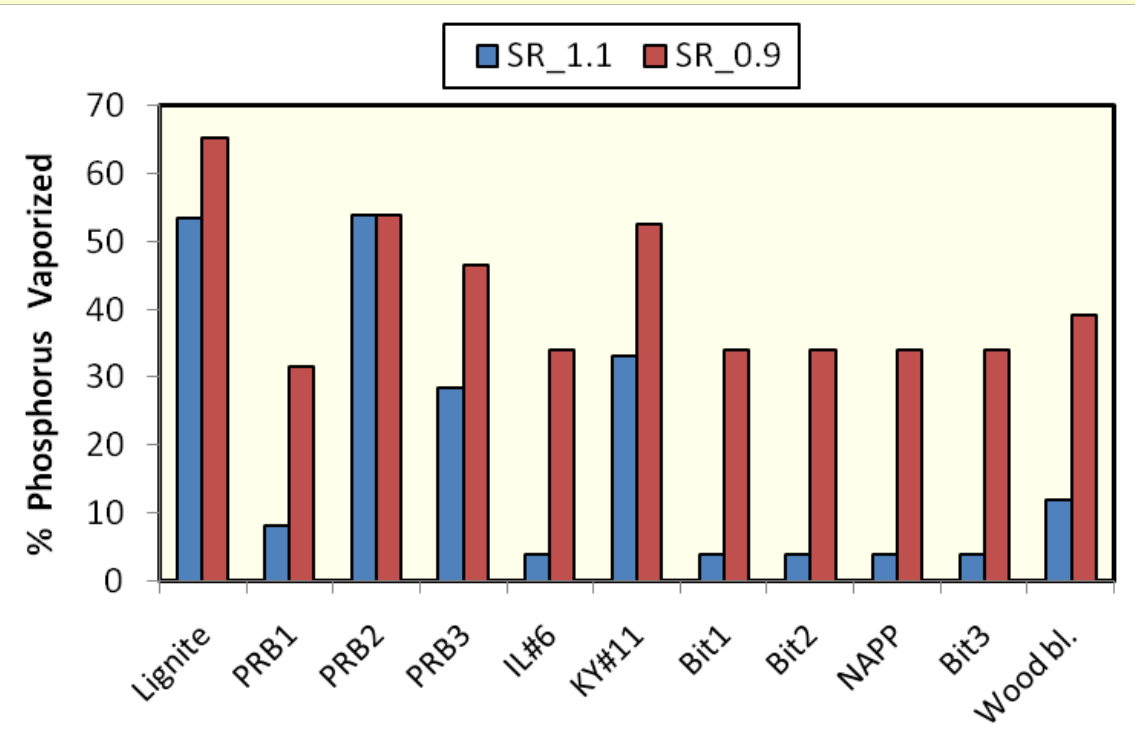


Mode of Occurrence

- Bituminous : Usually inorganic (apatite/phosphate)
- Lower rank : Mix of organic and inorganic
- Rank-specific MOO not clear

Release

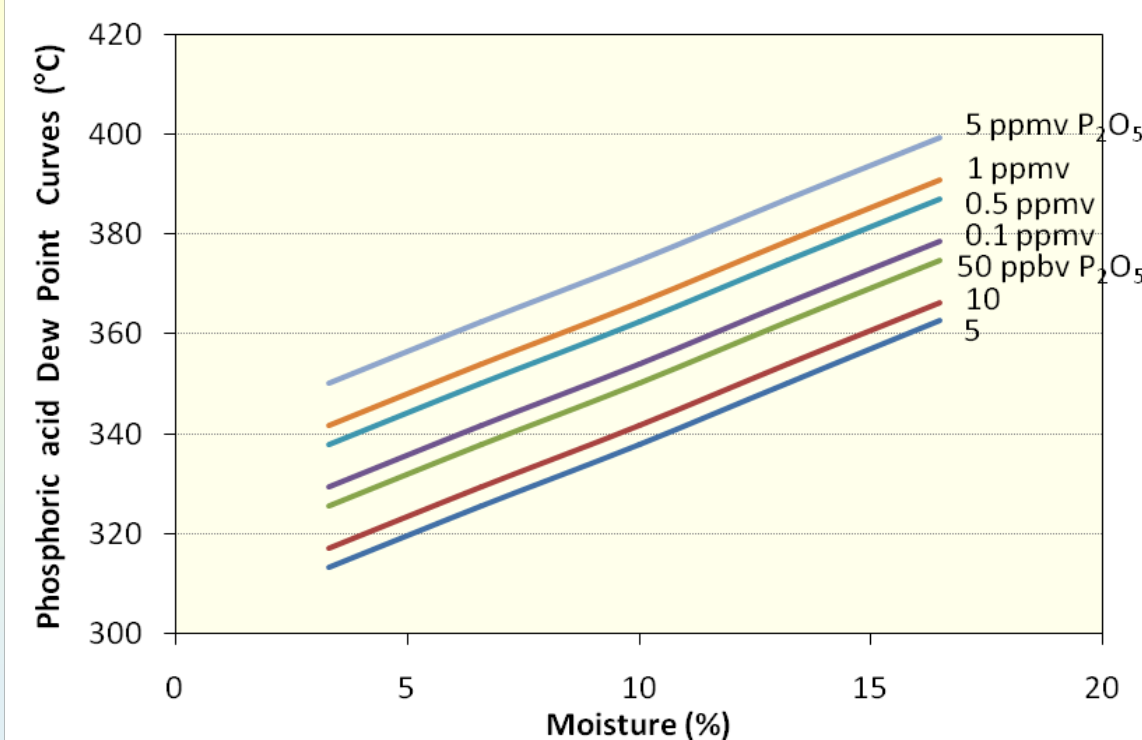
- Organic P : Mostly released
- Apatitic P : Released only at fuel-lean conditions & at higher temperatures



- KY#11 releases most P among bituminous coals.
- PRB1 releases least P among lower rank coals.
- Staged furnaces (lower S.R.) consistently release more P.
- MOO is crucial to determining P release.

Condensation

- Dew point curves for P_2O_5 condensation determined using equilibrium.
- Dew point depends on $[P_2O_5]$ and moisture.
- Condensation takes place within the operating range of temperatures of commercial SCRs.
- Gas phase P and condensed aerosols on catalyst surface contribute to deactivation.



Arsenic

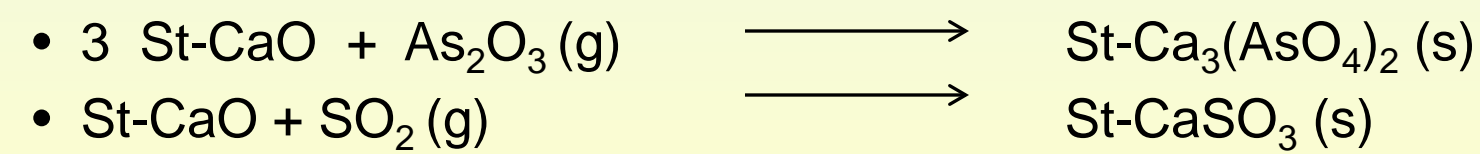
Mode of Occurrence

- Bituminous : Strongly pyrite
- Lower rank : Strongly organic

Release

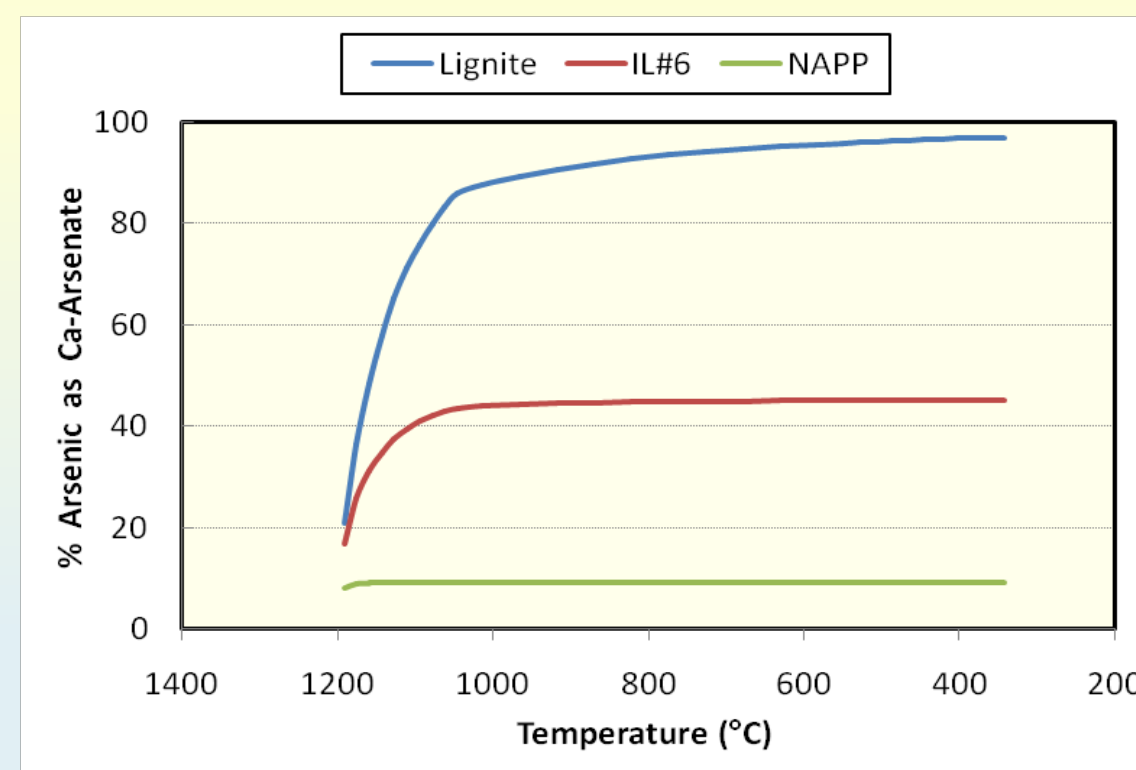
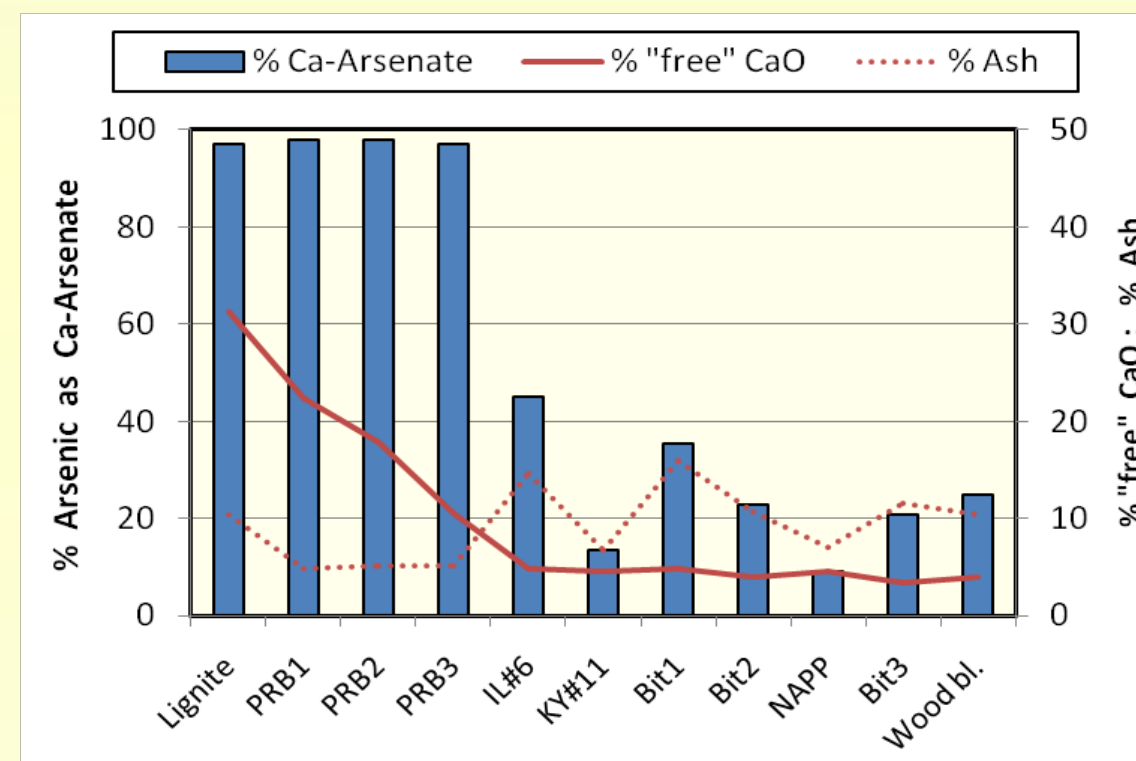
- Generally both MOO of Arsenic vaporize during combustion
- Present as As_2O_3 (g)

Reaction with "free" CaO



Model Predictions

- Chemical kinetic model to determine competitive As capture by CaO.
- Arsenic capture strongly dependent on "free" CaO.
- Low rank coals generally capture all Arsenic.
- 10 to 50 % capture in high rank coals examined.
- 20 % "free" CaO sufficient to completely capture Arsenic.
- Arsenic capture is complete by 1100°C.
- No competitive effect of SO_2 since As/Ca reaction window is at higher temperatures.
- Unreacted gas phase As_2O_3 poisons SCR catalysts.



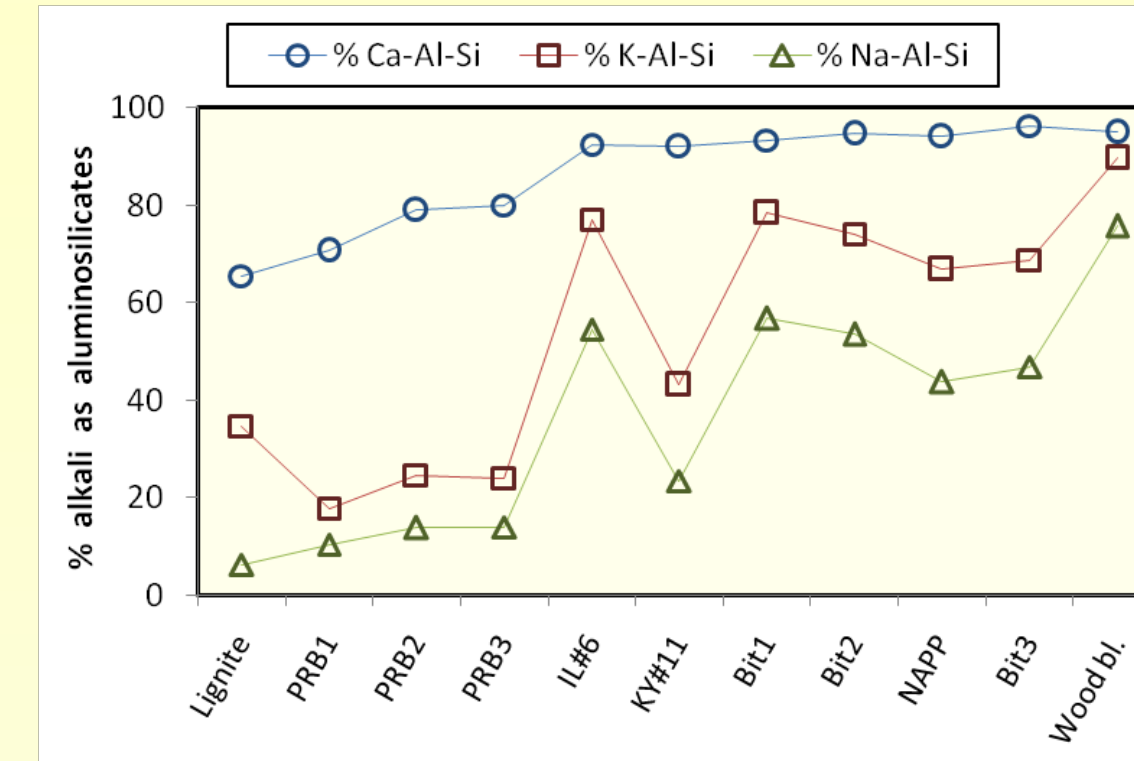
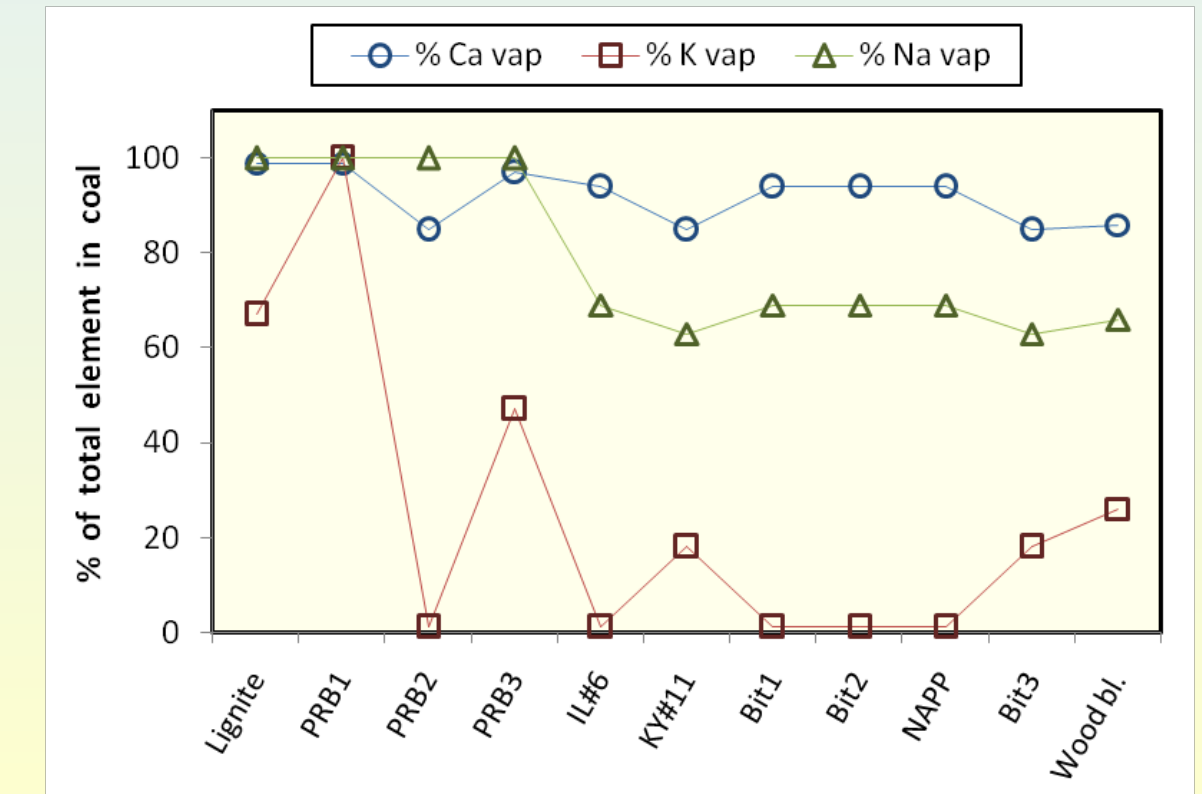
Alkali: Ca, K, Na

Mode of Occurrence

- Ca : Calcite & clays in bituminous, organic in lower rank
- K : Illite & clays in bituminous, organic in lower rank
- Na : Organic

Release

- K in illite is not vaporized, rest are released as -Cl, O and -OH to varying extents.

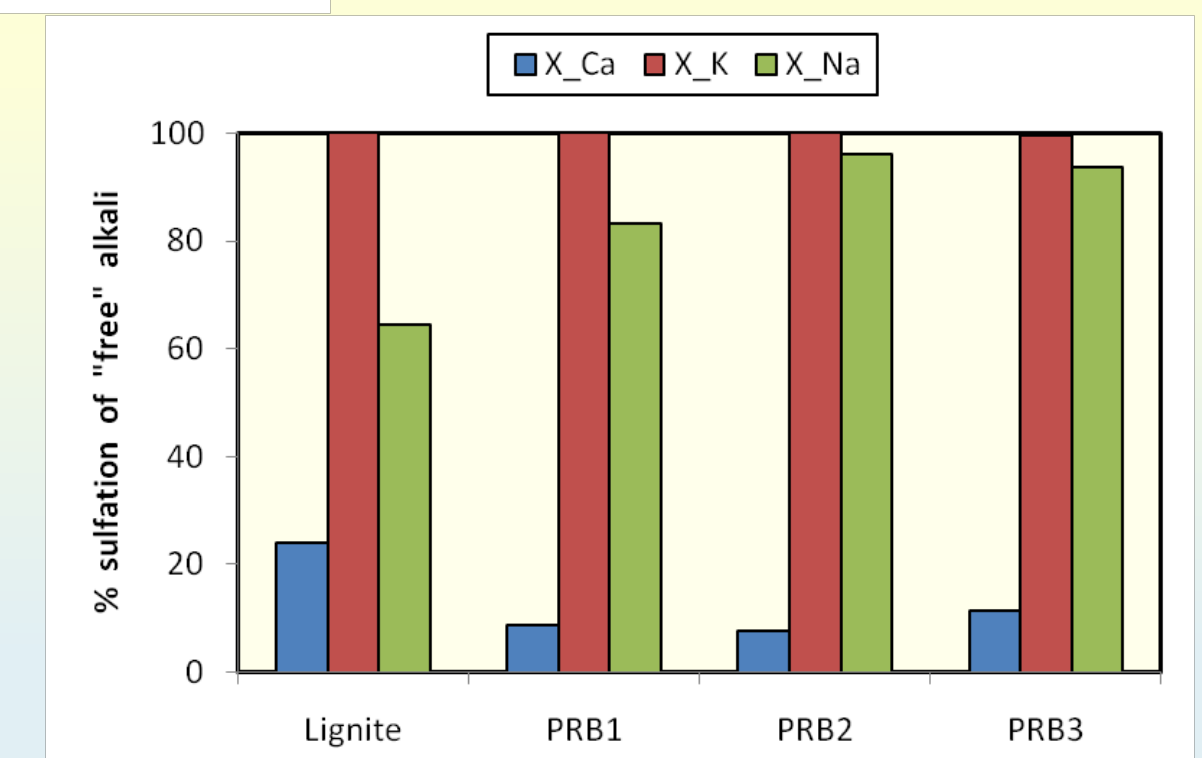


Aluminosilicate Scavenging

- Bituminous coals: All Ca is captured by Al-Si. 20–90 % of Na and K are captured.
- Low rank coals: Ca strongly competes with Na and K for Al-Si.

Sulfation

- Bituminous coals: K, Na, Ca are sulfated prior to SCR inlet.
- Low rank coals: Most K and Na are sulfated, ~20 % "free" CaO is sulfated before SCR inlet.
- Unsulfated CaO and NaOH aerosols responsible for pore plugging of SCR catalysts.



This work was sponsored by the Electric Power Research Institute under their project entitled "Equilibrium Characteristics of SCR Catalyst Poisons."