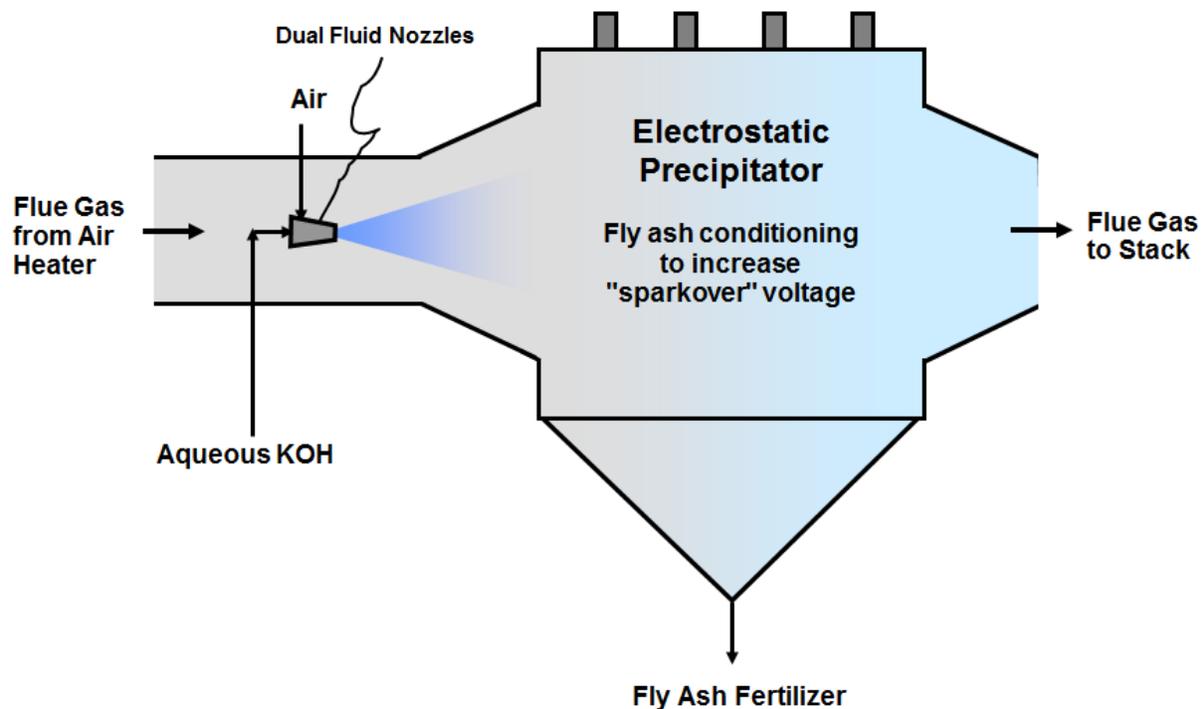


ClearStack Power, LLC



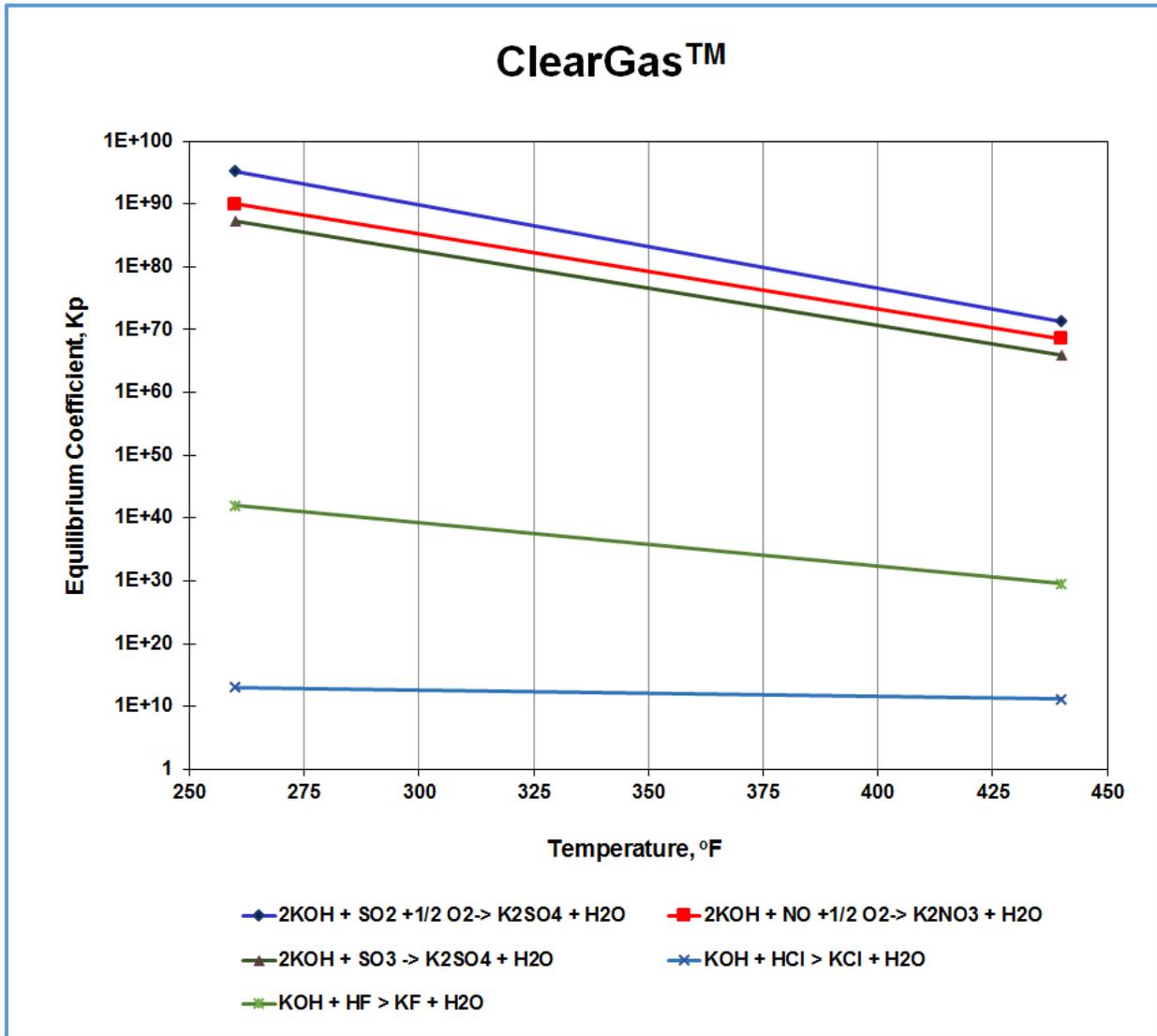
ClearGas™ Dry Scrubber Technology Description

ClearStack Power, LLC is developing a dry scrubber called ClearGas™ that uses potassium hydroxide (KOH) to remove sulfur oxides, nitrogen oxides, hydrochloric and hydrofluoric acids from flue gases. Removal of sulfur trioxide (SO₃) also reduces flue gas opacity. The presence of potassium salts on a downstream electrostatic precipitator (ESP) increases the “spark over” voltage and improves ESP performance even though SO₃, a fly ash conditioning agent, is removed in the process. The process produces a byproduct of salable potassium nitrate-potassium sulfate-fly ash fertilizer. In 2001, a US patent was allowed for this technology, U.S. Patent 6,363,869 "Potassium Hydroxide Flue Gas Injection Technique to Reduce Acid Gas Emissions and Improve Electrostatic Precipitator Performance".



Aqueous potassium hydroxide (KOH) is spray dried into the flue gas using in-duct injection or a dry scrubber. The KOH reacts with SO₂ to form K₂SO₄, with NO and NO₂ to form KNO₃, with HCL to form KCL and with HF to form KF. See thermochemical coefficients for all four reactions below, all are highly favored. All four salts are captured and removed with the fly ash from a downstream electrostatic precipitator (ESP) or baghouse.

The presence of potassium salts in an ESP, decreases the resistivity and increases the “spark over” voltage to improve particulate removal performance even though SO₃, a fly ash conditioning agent, is removed in the process. The process produces a byproduct of fly ash-fertilizer.



Economics show that this dry scrubber technology is a low cost technique to bring coal-fired stokers into environmental compliance. It is less costly than a stoker replacement with a natural gas-fired boiler system or a conversion to a coal-fired fluidized bed system. It will also be evaluated for niche market use on large coal-fired electric utility boilers. A 100 scfm pilot unit has been built but has not been operated yet.

A preliminary economic analysis was completed for a stoker coal fired boiler at St. Joseph's College in Rennsalaer, Indiana, see table below. They may have the opportunity of the scrubber paying for itself over time.

ClearGas Dry Scrubber for St. Joseph College

12.5 Million Btu/hr of Coal Fired

Total Plant Investment (Dry Scrubber) \$650,000

Projected Annual Operating Costs
[190 days per year of operation]

	Annual Use	Cost/Unit	Cost/ Yr	Cost/10 ⁶ Btu
Raw Material:				
KOH (based on 40%KOH liquid)	685.0 tons	\$327 /ton	\$224,182	\$3.93
Utilities:				
Electricity	169,841 kWhr	\$0.10 /kWhr	\$16,984	\$0.30
Fixed Charge Rate			\$0	\$0.00
Labor:				
Operator (one on days)	1,520 mnhrs	\$15 /mnhr	\$22,800	\$0.40
Maintenance @ 60% of 2% of TPI			\$7,800	\$0.14
Supervision @ 20% of O & M labor			\$6,120	\$0.11
Supplies:				
Maintenance @ 40% of 2% of TPI			\$6,500	\$0.11
Admin. and Gen. Ovhd. (30% of total labor):			\$4,176	\$0.07
Insurance and Taxes (2.7% of TPI):			\$17,550	\$0.31
Total Gross Operating Costs			\$306,112	\$5.37
Fertilizer Product Sales (KNO ₃ & K ₂ SO ₄)	494.2 tons	\$776 /ton	(\$383,394)	(\$8.15)
Total Net Operating Costs			(\$77,282)	(\$2.78)

Projected emissions, 99% reduction in SO₂ and 98% reduction in NO_x in flue gas