Perma Pure LLC

Dry Extractive Measurements for Low HCl Levels

EPRI CEMS User Conference

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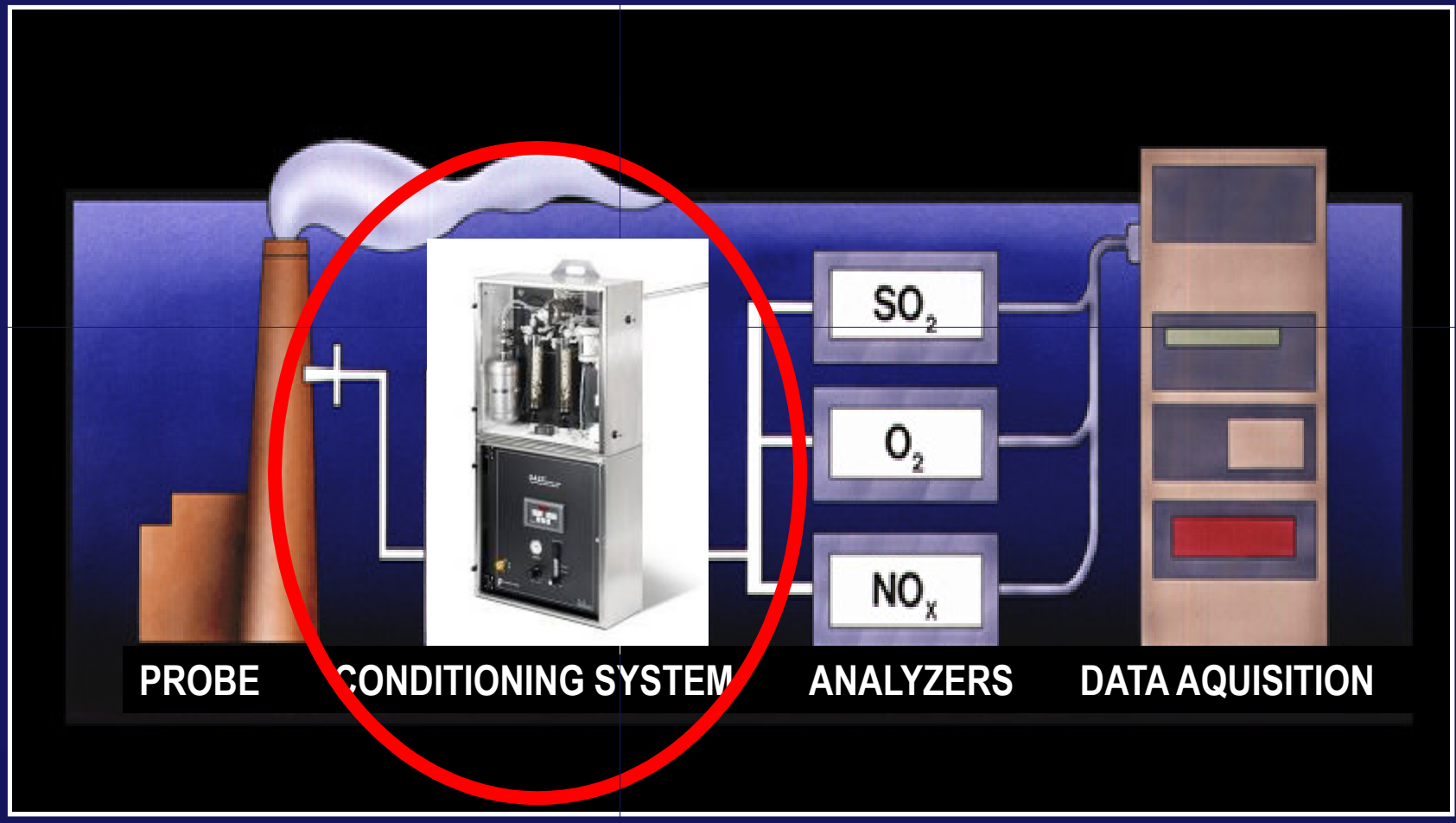
Sample Handling – Critical Path for CEMS



Perma Pure – Gas Sample Handling

3 Technologies:

- Dilution Probes
  - Wet measurement
- Baldwin™ Thermoelectric Coolers
  - Water removal through flash condensation
- Nafion® permeation dryers and systems
  - Water removal at the stack through unique membrane dryer technology
- Plus probes, filters, scrubbers, accessories

Utility MACT

- Proposed rule March 2011, final rule Nov 2011
- HCl, as a surrogate for acid gasses, reduced average of 91%. Target of 0.30 lb per GWh.
- Continuous HCl measurement now required.
- Option to measure SO_2 if wet scrubbers installed, but then you have to meet the SO_2 standard of 0.40 lb per MWh.
- Approx. 45% of coal fleet does not have SCR or FGD technologies installed.

HCl Measurement Options: Not Good!

Method	Challenges
• Wet Chemistry	Not continuous or immediate
• FTIR	Expense, maintenance, low PPMs, all that data
• TDL	Expense, calibration
• Dilution	Below detectable limit
• Dry Extractive	HCl dissolves in water

HCl Measurement Options

Is there another approach for Dry Extractive?

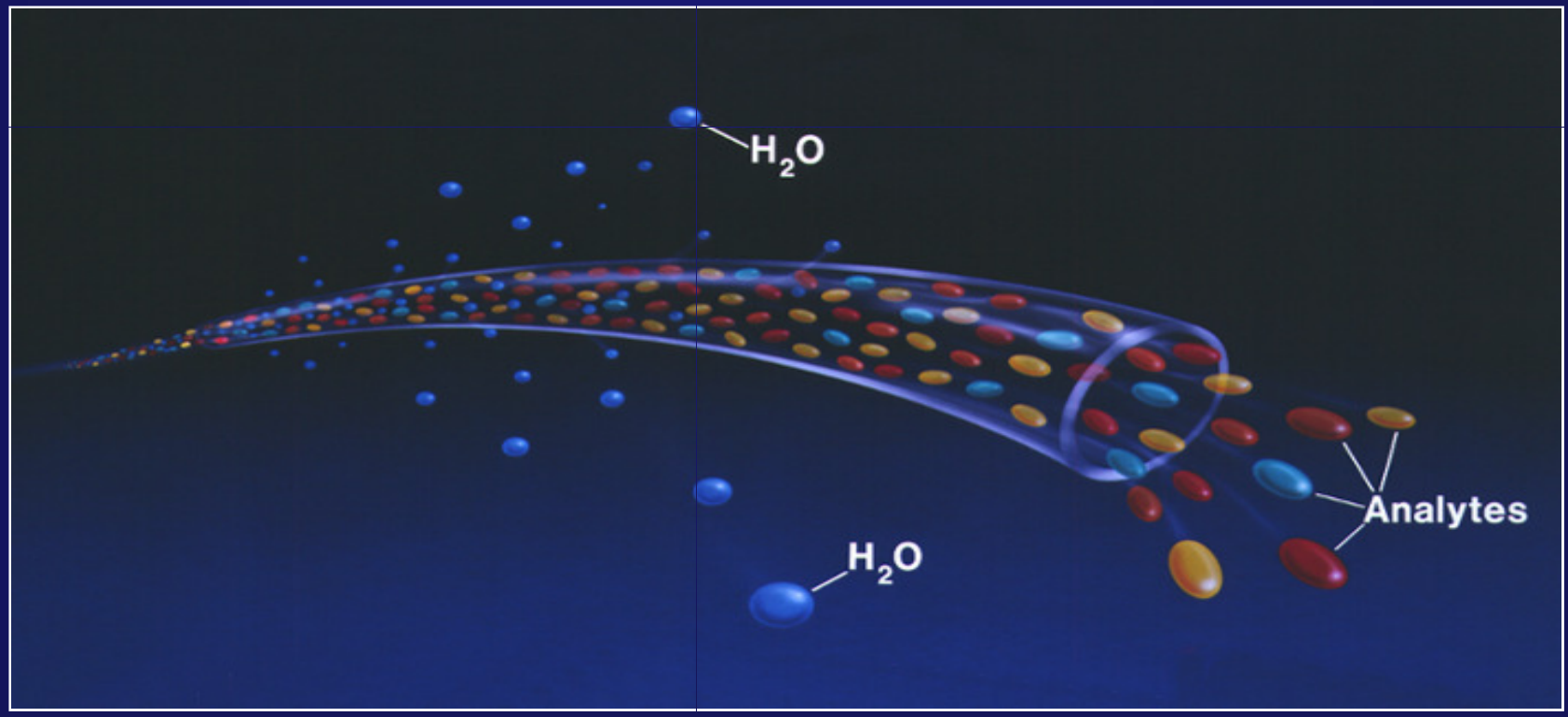
YES. They key is to remove water in VAPOR phase before HCl can dissolve.

How?

Nafion® is a Teflon®-derivative co-polymer that selectively and chemically removes water in vapor phase while retaining acid gases.

Nafion® Drying Technology

Fast ● Selective ● Continuously Self-regenerating
Powerless ● No Moving Parts ● No Maintenance



Nafion® Selectivity

- Nafion permeation selectivity is based on chemical reactivity, not size
- Only compounds that chemically associate with sulfonic acid permeate through Nafion
- Water and bases associate with sulfonic acid and permeate through Nafion
- Very few bases are gases at typical operating temps, so very few compounds permeate

Nafion® Im-Permeability

Totally Retained in Sample

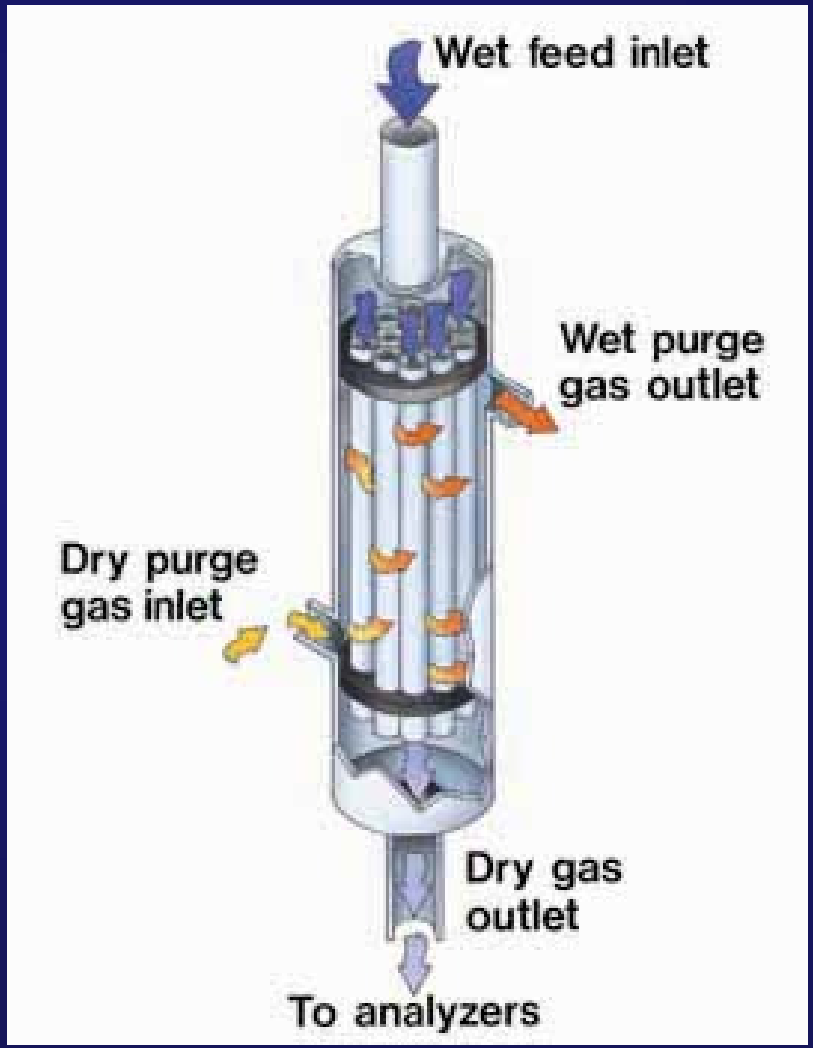
Atmospheric Gases	Ar He H_2 N_2 O_2 O_3
Halogens	Br_2 Cl_2 F_2 I_2
Hydrocarbons	Simple forms (alkanes)
Inorganic Acids	HCl HF HNO_3 H_2SO_4
Other Organics	Aromatics Esters Ethers
Oxides	CO CO_2 SO_X NO_X
Sulfur	COS H_2S Mercaptans
Toxic Gases	$COCl_2$ HCN NOCl

Typical Combustion Analytes

Nafion® Dryer Construction

Tube-in-shell, heat and moisture exchanger

To increase drying capacity, simply increase the surface area (wider, longer or more tubes)



GS-2040 Stack-Mounted Sample System

- Integrated probe & sample system
- Final dew point of -10°C to -45°C eliminates water condensation
- Non-corrosive wetted parts
- Dry sample lines
- Low maintenance and high reliability

GS-2040 Current Applications

- Used for 15 years in US refineries
- FCC, sulfur units, tailgas, process applications
- Biomass, incinerators
- Low SO_2 (under 2 PPM) and low NO_X applications
- Hundreds in use in US and around the world

HCl Future Tests and Studies

- Refused Derived Fuel (RDF) Facility, online February 2010, will publish 18 month HCl results at EUEC, February 2012
- New mountain states coal facility launched May 2011. Initial RATA this summer.
- Stack tests ongoing using portable MG-2812 Nafion®-based system.