The Seven Deadly Sins of Process Analyzer Applications

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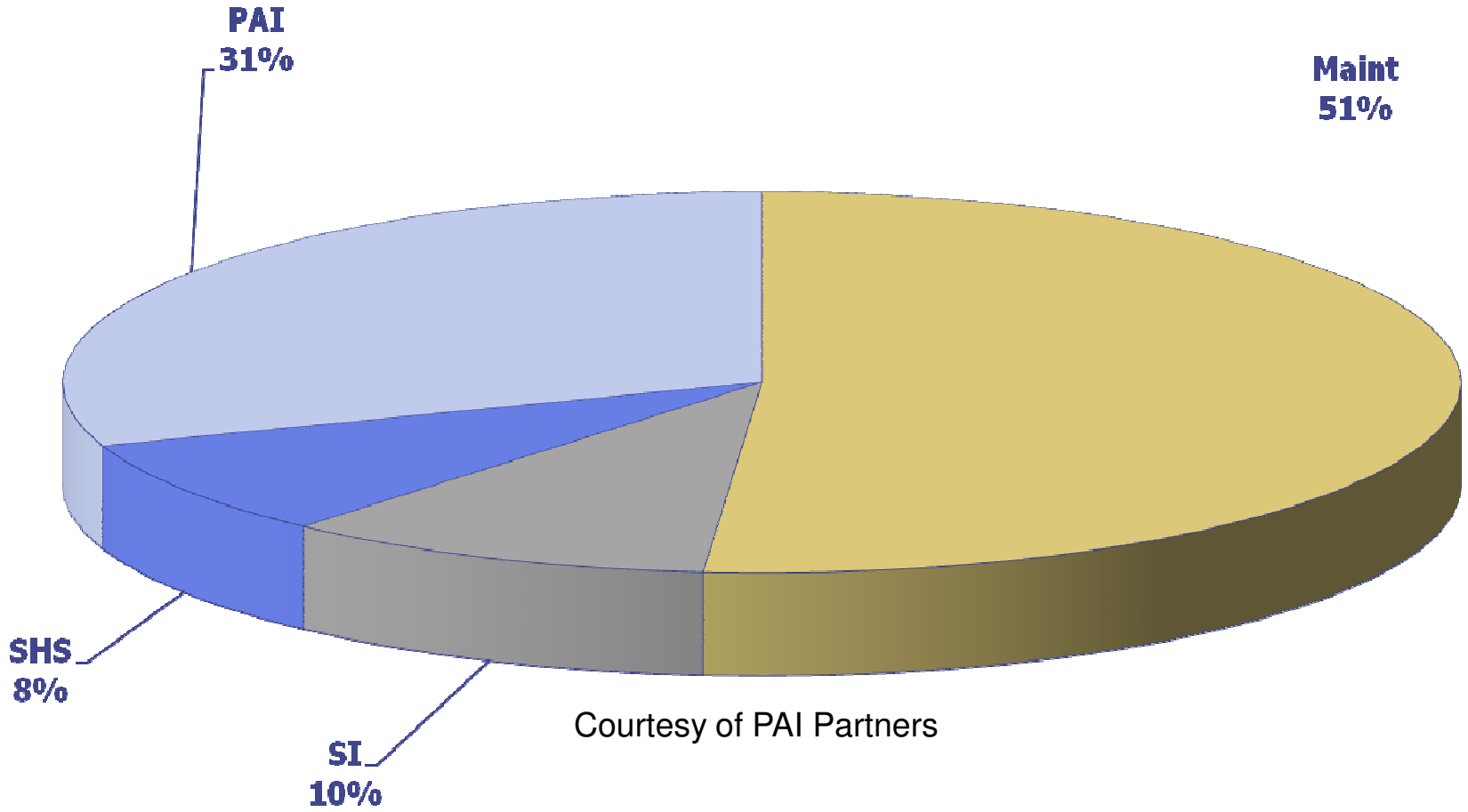
Introduction

- From the perspective of four diverse disciplines
  - The analyzer vendor
  - The Systems Integrator (“SI”)
  - The long term contract maintenance provider
  - Process testing contractor
- An introspective look from eminent analyzer professionals
  - “Stop Buying Analyzers”
  - ”Are There Dinosaurs Among Us?”
    - “The Stigma of Process Analytics”
    - “Myths and Mistakes That May Contribute to Our Extinction”

Worldwide Process Analytical Instrumentation Enterprise



Courtesy of PAI Partners

Process Analytical Spending by Category

The Big Picture

- Process control enterprise: USD 136 billion (per annum)
- Process Analyzers: USD 8.0 billion
- CPI Portion of Analyzers USD 5.6 billion
  - Maintenance USD 2.85 billion
  - Analyzers USD 1.75 billion
  - Integration USD 550 million
  - Sample Systems USD 450 million

The Big Picture - Outlook for Services &Support

- Maintenance continues as the largest expense component of the life-cycle cost equation
- Understaffed maintenance organizations are looking outside the analytical industry SI organizations for help
- PAI products will continue to incorporate advanced (remote) diagnostic functionality
- Challenge for maintenance organizations is to keep up with these technical advancements

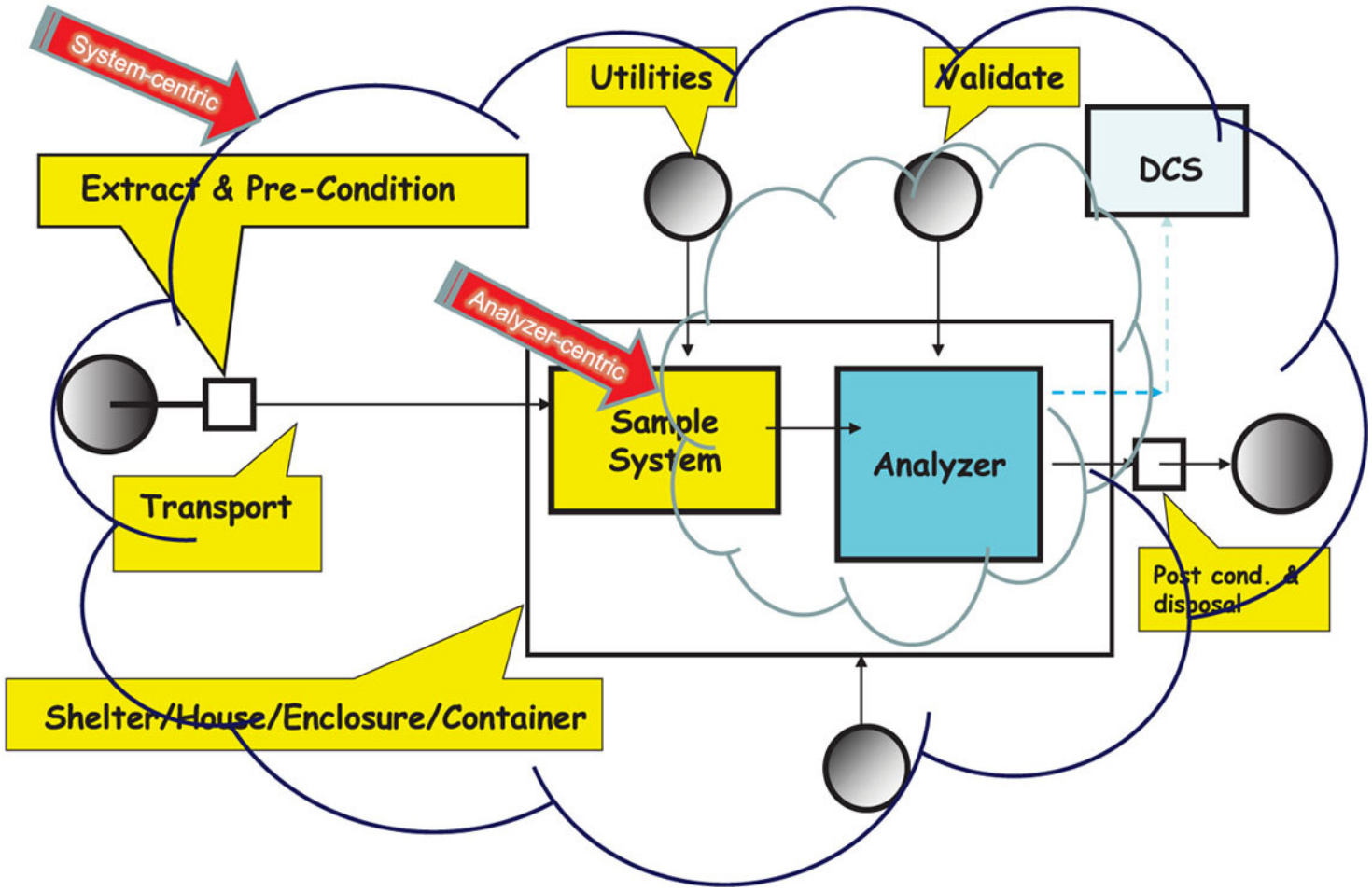
The Project Picture

- The Integration portion of a project is 55 – 70 % of the costs
  - Shelter, HVAC, sample handling system, engineering, design
- Analyzers represent 30 – 45 % of the cost
- A shelter for 8 gas chromatographs costs > than the 8 GCs
- The 15 year cost of ownership of an analyzer is ~equal to the purchase price

Trends & Generalizations

- Technology advances, a revolution in spectroscopy
  - Multi-component measurement capability competing with GCs.
- Analyzers close-coupled to the process requiring very little integration becoming common. Size and weight matter
- Full capability & features of an analyzer are rarely utilized
- The shelter + HVAC dominate the price of an analyzer system
  - It is uneconomical to supply a shelter for only 1 or 2 analyzers

Analyzer System Scope of Supply



1) Lack of Knowledgeable Analyzer Engineers at the FEED & EPC Stages

- Very difficult to manage the analyzer scope at the EPC level
  - Many of the tie-in points fall into other disciplines, many types of engineering required and most are not familiar with analyzers
- Instrument data sheets that are out of date
- No provision for recent advances in process analytics
  - The GC is over applied as the default device

The Cost: 10 to 30% of the SI budget

The Remedy: Retain, nurture, grow a cadre of analyzer engineers

2) Piping Engineering; Mistakes Designed In at the FEED & EPC Stages

- Process piping design is not optimized for analyzer systems
- Access to analyzer sample taps is usually problematic.
- How do we establish standard analyzer design specifications
  - Properly implemented by process instrumentation and piping designers

The Cost: Compromised sample location, HS&E problems

The Remedy: Bring in vendors & specialists at the design phase

"You will have no problem accessing the sample point"

3) Award of the Systems Integration Contract; Compromises at an Early Stage

- Reluctance to purchase specialized sample handling from the analyzer vendor or to retain vendor for start up assistance
- Over design, over spending, over focus on the HVAC portion
- Analyzer selection dominated by field instrument protocol
- Thin margins, a culture of change orders, lingering hand over

The Cost: Change orders, replacing analyzers after handover

The Remedy: Qualified analyzer engineer at EPC, vendor start up

4) Lack of a Comprehensive Plan to Staff for Start-up, Training & Maintenance

- Most end users understaffed starting at the handover point
- The analyzer industry is short-handed at all levels
- Maintenance continues as the largest expense component of the life-cycle cost equation.

The Cost: Everything; reliability is at risk if confidence is lacking

The Remedy: Recognize analyzers are distinct from I&E, staff to proper levels

Grouping of Analyzer Categories for Maintenance Purposes

Complexity Factor		Type of Analyzer	Estimated Man-hours/month Maintenance
1~5	Simple	pH, conductivity, gas detection, O_2	2
6~8	Physical Property	Boiling point, flash point, freeze point, RVP, viscosity, etc	3
9	Environmental	CEMs , SO_2, CO, H_2S, Opacity,	2.5
10~15	Complex	Tail gas, GC, NIR, FTIR, Mass Spec	4

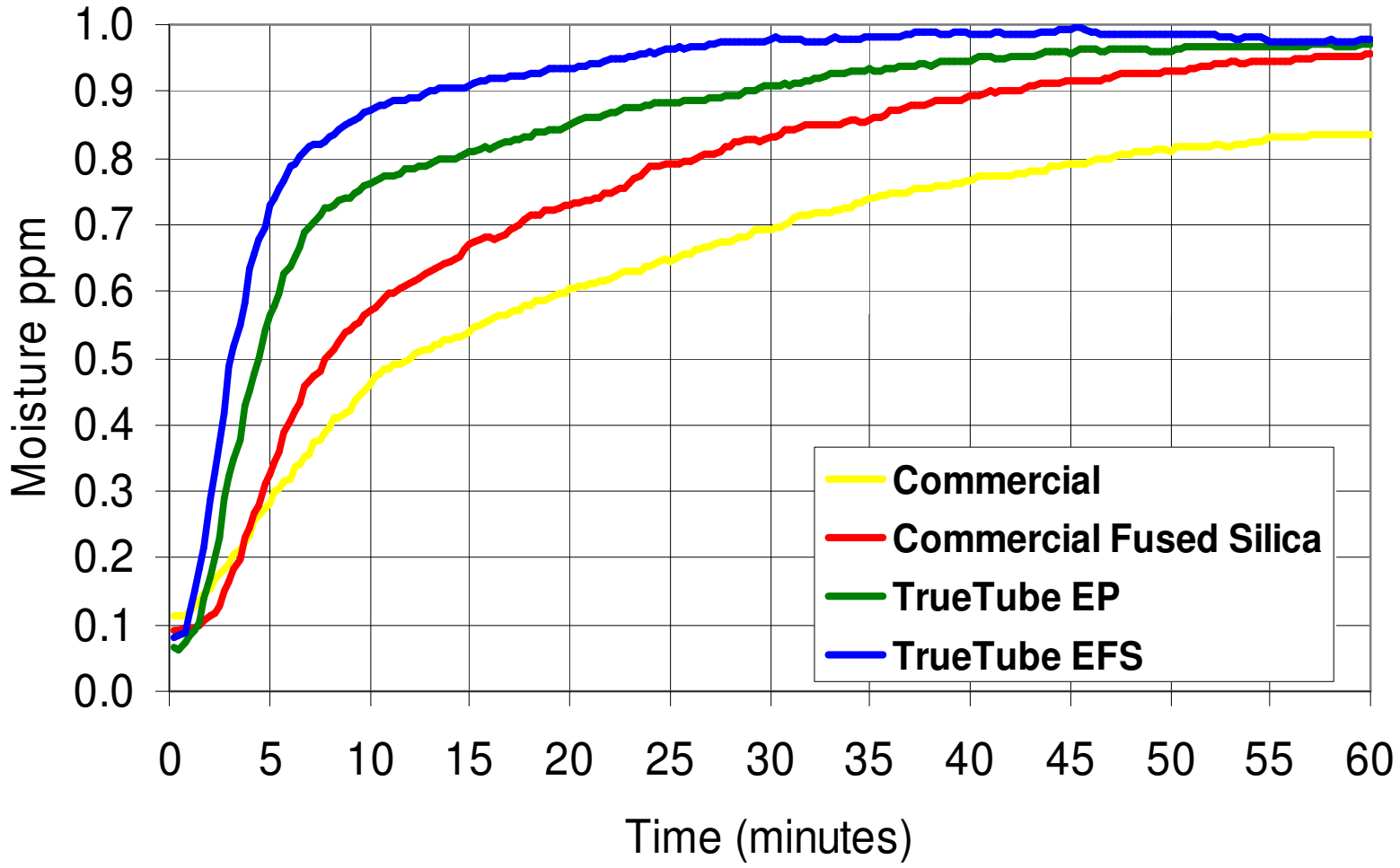
5) Sample Transport Mistakes

- Consolidating several tags in a building for economy of scale
- Sample transport, the least understood area in our industry
  - The impact of proper sample transport tubing design on analytical measurement performance is not well-understood or well-defined
  - Heat-traced tubing systems for process analyzer systems are now one of the most significant costs for the sample system

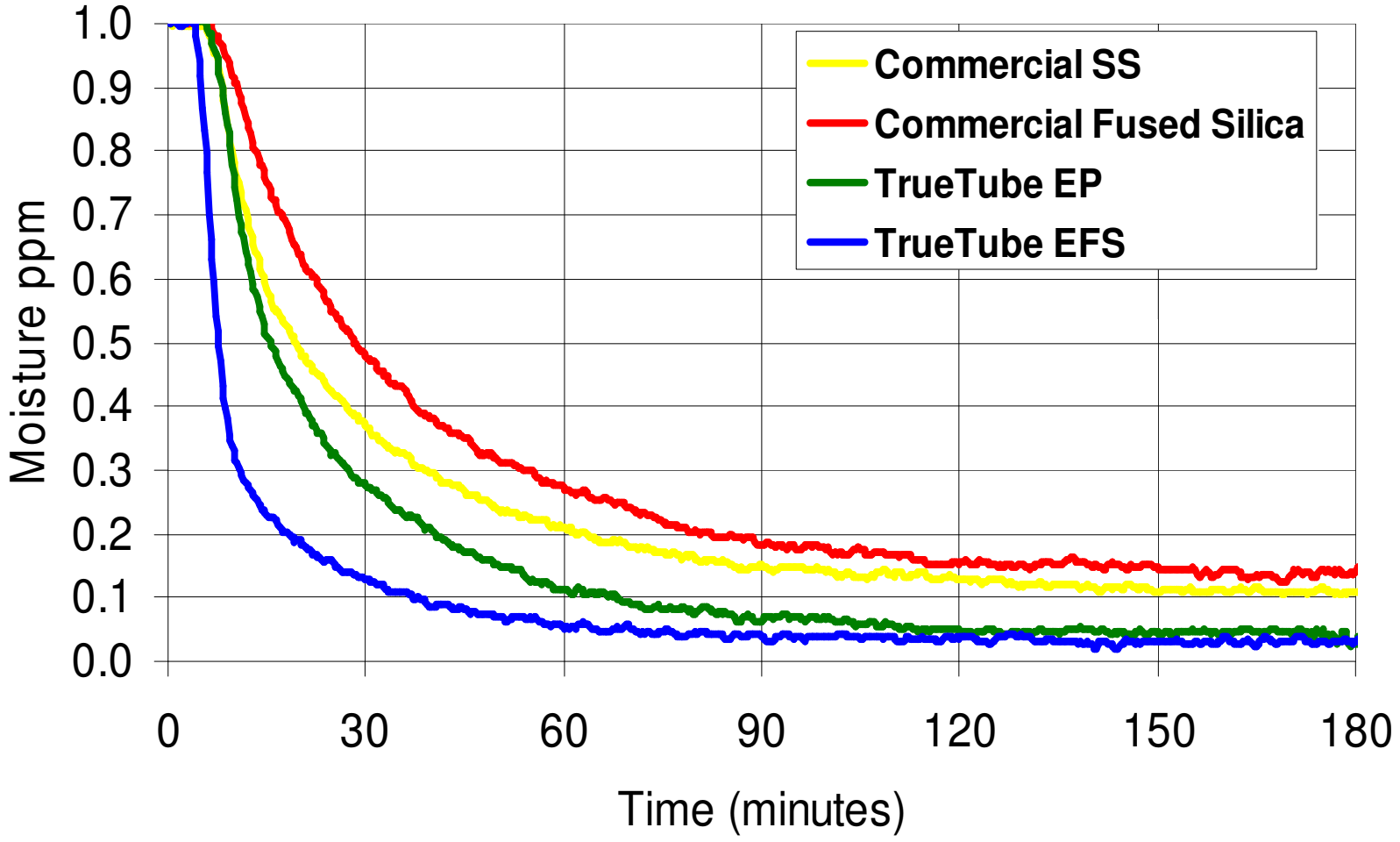
The Cost: False economy, compromises analytical measurement

The Remedy: Engage vendor & SI in before signing off on design

Moisture Transport ("Wet-Up")



Moisture Tests ("Dry-Down")



Sample Systems as an Art Form

- We have detailed specifications for shelters' analyzers etc but not much of the PIP sheets describe sample systems
- Treated as Art Form, designed & handled differently by everyone
- You can leave the physics alone but the physics won't leave you alone (*"Physics is the only real science, the rest is just stamp collecting"….*Ernest Rutherford)
- Fundamentally, the same physical & chemical laws apply to each system….as well as some real world laws

What kind of laws are we talking about?

The Four Laws of Thermodynamics

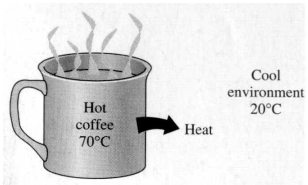
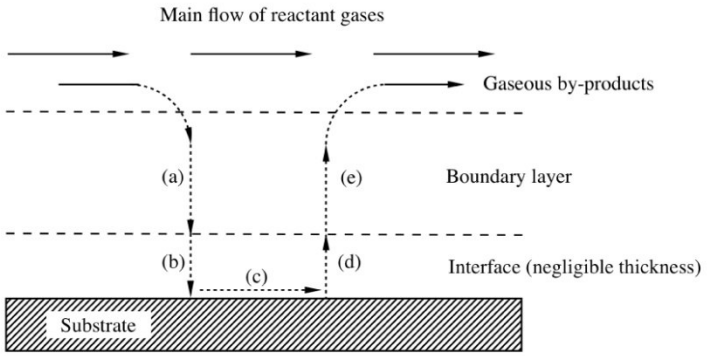


FIGURE 1–3
Heat flows in the direction of decreasing temperature.

Newton's Law of Gravitation

Ficks's Law of Diffusion
Langmuir Adsorption Isotherms
Henry's Law for fractional surface coverage



Real World Laws that Apply

Pareto

- Pareto's Law
- 20 % of the system will cause 80% of the problems

Murphy

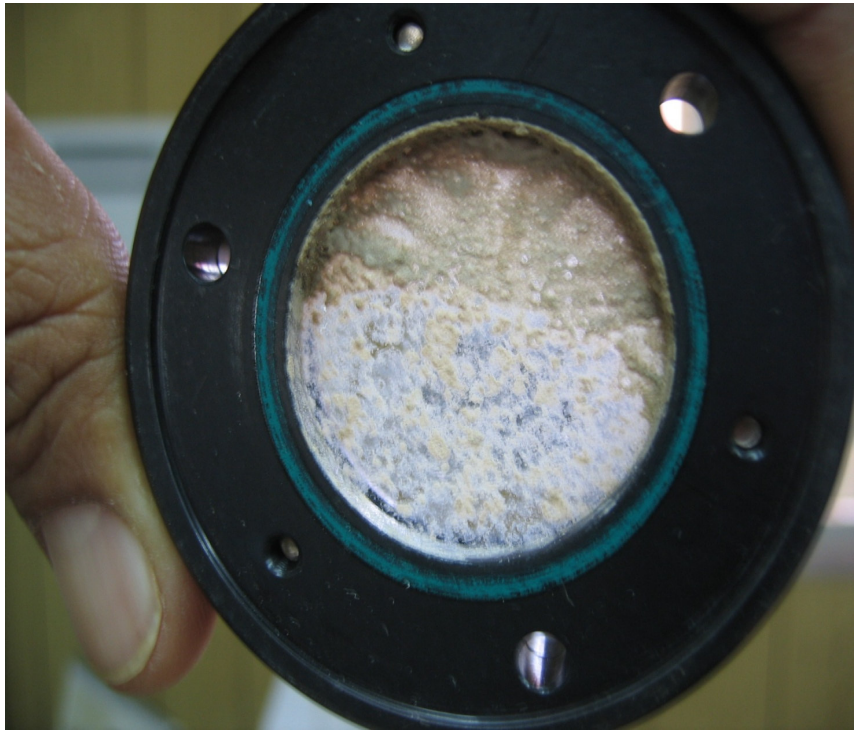
- Murphy's Law (and corollaries)
- Anything that can go wrong – will (at the worst possible time)
- Chaos always wins because it is better organized

Heinlein

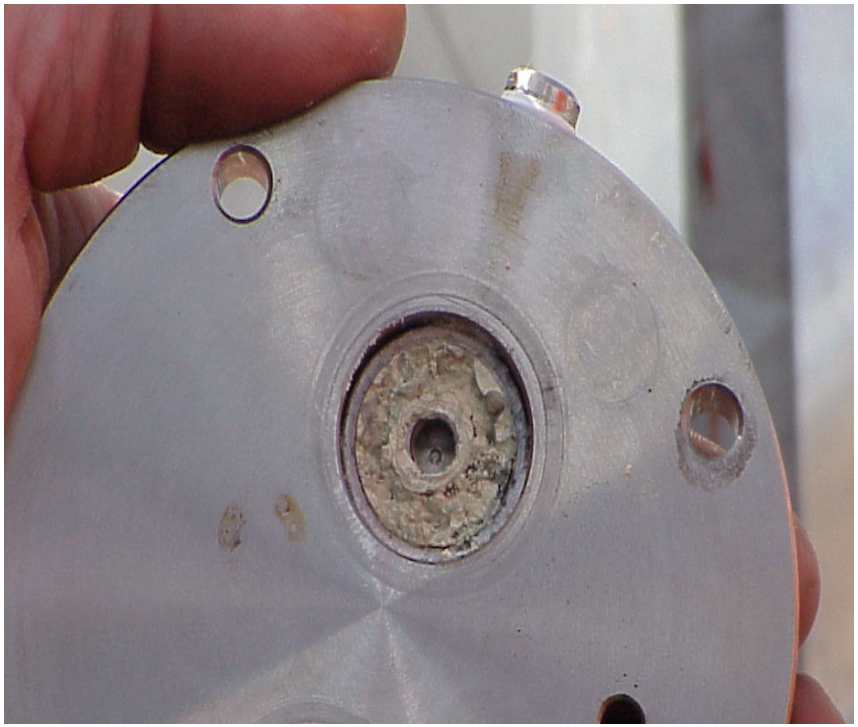
- Heinlein's Law (paraphrased)
- Never ascribe to bad design what can be explained by stupidity, but don't rule out bad design

Unexpected Contamination in “HAG” Probes

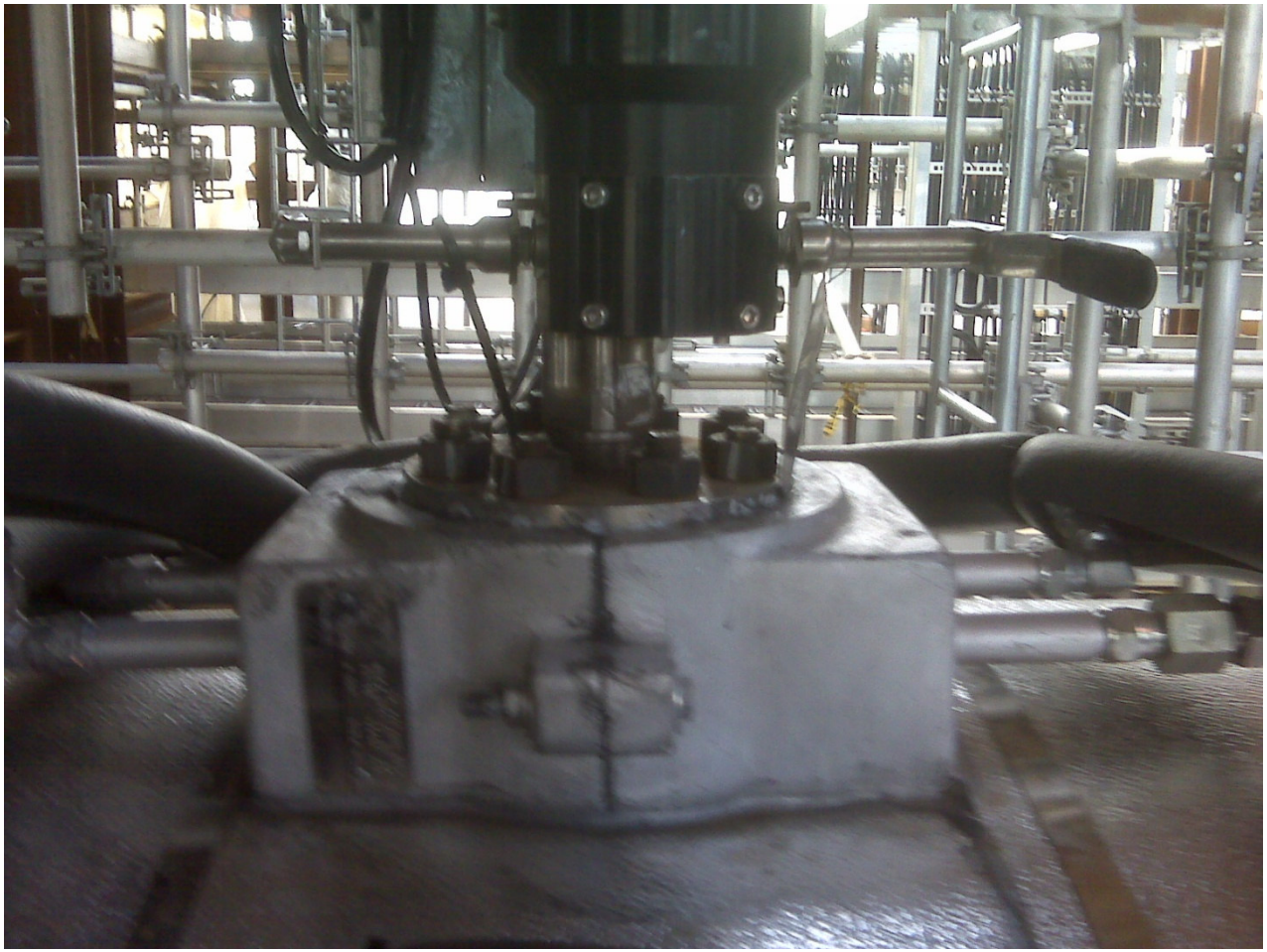
Ammonia salts in amine acid gas



Heat stable salts in TGTU absorber overhead



“CSI” Steam Jacket on ASR Probe Process Connection



6) Validation; Test Results vs. Analyzer & Analyzer vs. Lab

- The method (or device) that reads low is the 1st one to suspect
- When comparing lab results be sure to correct for dry vs. wet
- Span gases can be wrong (10% of the time, when fresh !)
  - Stain tubes are accurate +/- 25% (~ mine canary)
- An analyzer tech can say with confidence “the analyzer is right”

The Cost: Time & resources, “suspect” analyzers abandoned

The Remedy: Use all resources, contact vendor for explanation

7) Analyzer Industry Not Forthcoming with Information (Mis-application, Interferences, Contamination)

- Industry doesn't provide information to evaluate technologies for component interference & potential contamination
- Budget constraints at EPC often means only major GC manufacturers can effectively bid for huge analyzer projects
  - They understand their own products very well however they have much less knowledge of other analyzer sub suppliers.

The Cost: Not having the best available technology

The Remedy: Due diligence at FEED and EPC level, stay current

Conclusions & Recommendations

- The credits delivered by analyzers far outweigh the costs
- Minimum cost leads to poor availability, high cost of ownership
- Retain career analyzer professionals at FEED & EPC level
- Rationalize spending on HVAC & use of long sample lines
- Let an analyzer engineer sign off on the piping design
- Move analyzers closer to the pipe.
  - If a closed shelter is required, use cabinets when possible
  - Utilize analyzers houses when necessary.

Process Analyzer Profession Resources

- ISA Analysis Division
  - www.ADSymposium.org
  - An essential organization for your organization
  - Annual Symposium, 900 professionals, contact network
- Analyzer Technician Opportunities Project (ATOP)
  - www.analyzertech.org
  - Distance learning program developed by 2 Houston colleges
  - The necessary education to grow a lifetime skill set