Leveraging New Intrinsically-Safe Digital CANbus Technology for Simultaneous, Multi-Analyzer Sample Conditioning Using a “Single System Methodology” for Moisture and GC Analysis

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Agenda

- End user value propositions
- Challenges with the application
- Integrated system design, installation and attributes
- System technology
- Benefits and challenges with Gen2 Bus
- Summary & Questions
End-user Value Propositions

• Continuous sample validation
  • Capturing the credits/opportunity from the analytical system depends upon the integrity of the sample condition
  • Requirement is for continuous feedback on sample system parameters and variables

• Early warning diagnostics / preventative maintenance prediction
  • Implementation shall include warnings to facilitate efficient and effective maintenance activities
    • “Traffic light”
      • Green – all is good and sample is valid
      • Yellow – caution, sample valid but attention recommended
      • Red – sample is not valid (alarm/fault status), attention required
End-user Value Propositions

• **Notification outputs**
  - Effective alarms & validity feedback provided via discrete contacts
  - Validation feedback needed to be “compatible” with standard DCS methodology (i.e. validity communicated via the individual analyzer loop/interface)

• **Electrical hazardous area certification**
  - Compliance and certification by FM or CSA required (compliance)
  - Interior of “enclosed” sample system deemed Class 1, Division 1 T3 Groups C,D

• **Cost effective and expandability**
  - Leverage system capacities for future expansion in “Brown Field” scenario
  - Leverage development work (PLC code, architecture, design, etc.) for future systems
End-user Value Propositions

• **System Interface Features**
  • Straight forward and easy to understand (traffic light, touch panel, efficient graphics)
  • Secure & robust
  • Provision for remote access – desire for reduced cost of ownership (optimize trips to the field)

• **Reliability**
  • This additional hardware and software shall not contribute increased cost of ownership
  • Analyzers shall be able to run with or without the “smart system” (i.e. if the smarts fail, the sample system continues to function)

• **Automation and advanced model capabilities**
  • Future applications may utilized advance control features
  • Dynamic flow, pressure and temperature controls
End-user Challenges

• **Challenges with this application**
  
  • Analysis of low level (low ppm) contaminants in a liquid hydrocarbon feed stream
    • Substrate question – is SP76 okay and then, which SP76
  
  • Analysis required more than one analyzer technology
    • Utilized...
      • GC with FID for hydrocarbon analysis
      • Moisture probe (aluminum oxide) in the liquid state sample
      • Quartz crystal for moisture in a vaporized sample
    
    • All three need continuous sample validation
  
  • Desire for “local” interface to sample system including custom interface to moisture analyzer
  
  • Need for controlled vaporization section with interlock required to prevent liquid in vapor analyzer
  
  • “Smart” alarms from system
Integrated System as Designed
Installed System

• **Features:**
  
  • Tri-fold swing out door for HMI to locally view system status and perform diagnostics both with and without sample cabinet being open
  
  • Two zone system, one upper heated system with interlock, one lower system, non heated
  
  • Modular SP76 technology enables space savings to fit 3 independent sample systems into one system footprint on shelter
    • Common “stick” design methodology allows for easy visualization and troubleshooting
    • Both visual and electronic pressure and flow sensors available in case of loss of power or bus communications
  
  • ProfiNET™ enabled PLC manages:
    • Gathering data from both moisture analyzers (one analog, one Modbus input/output)
    • Gathering data and alarms from digital bus conditioning components
    • Sensing digital relays from GC and controlling system valves
    • HMI commands/visualization and alarms/data to DCS system
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System Design Attributes

- **Vaporization Loop**
  - Using finned tube heater as heat source and 1/8” tubing coil to create heat transfer and convection circulation loop
  - Liquid flows up 1/8” line inside the heat exchanger, pre-heated with the warmed liquid by-pass flow. A small fraction of the pre-heated sample is vaporized with a standard regulator
  - Both inlet pressure and backpressures are regulated to adjust residence time, vapor pressure desired
  - Multi-variable flow meter in the heated loop can use various pressures and temperature to calculate whether it is vapor or liquid phase via inferential thermodynamics
System Design Attributes

- Common stick concept
  - Each analyzer has the exact same sample conditioning schematic and hardware
  - Only difference is the range (and phase) of flow meter calibration
  - Enables quick troubleshooting and repair with a common spare on hand, swap out spare in the field and troubleshoot in a safe area
  - Flow meter can be both digitally and mechanically re-ranged so there is flow meter commonality between sticks as well
  - “Standard” graphic shows up on the HMI screen including data and alarm set points when selected on the master view screen

- 250 sccm
- 35 psig
- 70 °F
System Design Attributes

- Other system attributes
  - Diaphragm double-block-and-bleed valve stream switch module
  - Nitrogen purge to vent configured in each sub-system for maintenance
  - Differential pressure is sensed across every filter
  - Both visual and electronic pressure/flow monitoring for redundant operation and visualization in case of loss of power
  - Temperature Interlock on sample vaporization loop to prevent accidental liquid injection into moisture analyzer
Latest Sample System Monitoring and Control Technology

• NeSSI™ Gen2 Intrinsically Safe CANbus Technology
  • Multi-variable Flow Meters
    • Upstream Pressure
    • Downstream Pressure
    • Mass and Volumetric Flow Rates
    • Fluid Temperature
    • High and Low Alarms on all variables (sent down from HMI to CANbus device memory)
    • Local health and alarm status on CANbus devices

• 4-channel 9.5V Intrinsically Safe Power supply
  • 4 output channels with 9.5V@1A available for each channel, each channel is triple redundant with redundant AC inputs as well
  • Only 4% of available power is used on this supply but is supporting 3 separate analyzer conditioning system sensor arrays
  • Therefore, the existing system can be upgraded to include closed loop flow/pressure, heat control, and pilot valve control on the currently used channel
  • Power supply was centrally located in shelter so that many other systems can use same power supply with remaining 3 channels
Latest Sample System Monitoring and Control Technology

- CANbus Interface Manager
  - Forms galvanic barrier between Class 1, Division 1 zone and Class 1 Division 2
  - No special needed except for 24VDC on Division 2 side, 9.5V on Division 1 side, two polarized connections
  - Acquires analog signals from traditional 4-20mA pressure sensors and moisture probe (4 available)
  - Manages inventory of CANbus devices and analog signals
  - No network configuration required, give one command and system configures itself
  - FIFO (first in, first out) memory buffer of last 10 system and device level alarms uploaded to PLC alarm master
  - High speed interface with Industrial Ethernet interface to PLC (ProfiNET™)
Benefits with Gen2 Bus Integration (Lessons Learned)

• Small space footprint of modular and multi-variable sensors combined (5 different sensing points in a 1.5” x 3.0” footprint)

• Graphical outputs from Visio Design Tool provided all the GUI graphics for the PLC HMI

• Simple cabling scheme
  • No IS barriers
  • Connections are keyed, no polarity issues
  • No wire stripping, wire tagging

• Digital flow meter alarming structure fit with “red-yellow-green” mentality
  • High-high and low-low alarms (RED) (operating out of factory max spec)
  • High and low alarms (operating out of user defined high/low alarm points) (YELLOW)
  • No alarms (GREEN)

• Ease of Initial Integration with PLC
  • Plug and play with defined PLC ProﬁNET (“virtual I/O” points seen by PLC)
  • No engineering unit conversion required (voltage/current to pressure, temp or flow units)

• Lower Cost of Design, Components, Integration, Assembly, Installation (with caveats discussed on next slide)
Challenges with Gen2 Bus Integration (Lessons Learned)

• Scope of system included three analyzers with different sample conditioning requirements
  • Sample system “crosstalk” due to common inlet and outlets
  • Liquid delivery and vaporization required in same sample system
  • Different flow rates and pressure requirements

• Lack of familiarity with new concepts/ installation by technicians, contractors, vendors
  • Digital scope, PLC, and thermodynamic/ fluid mechanic design scope combined was a tall order using new digital components

• Unforeseen obstacles
  • Operating system in “full handshake” mode (i.e. sharing electronic data sheet data and alarms) between all digital devices and PLC resulted in 3 sec update cycles for the system
    • Converted the digital data into “streaming mode” where all data is read by PLC (30 floating point and integer values from the entire system are now read in less than 1 second)
  • Digital device addressing schemes got mixed up between vendor, PLC integrator/programmer, and end user and caused some confusion. In future, will opt for automatic (software) addressing.
  • During troubleshooting, some mechanical design system issues were attributed to digital device or bus communication issues (need to establish trust in the new digital devices)
  • If analog/ mechanical sensors/ gauges differ from higher accuracy digital ones, which one do you believe?
Summary

• NeSSI™ Gen2 bus is live and operational in the field

• Compact system and multivariate sensors allow for multiple sample conditioning systems in one traditional system shelter footprint

• A minimal combination of PLC automation, industrial Ethernet and digital bus communications allow for preventative maintenance and continuous validation, alarming, and local visualization and control for three sample conditioning systems
  • Lower capital cost than pure analog/PLC system
  • Lower assembly/install cost
  • Lower cost of ownership
  • Lower cost of “future expansion”

• A “Keeping it Simple” mantra and building some uninterrupted field time will be paramount in controlling the perception of new digital bus devices and helping to expand their use with field technicians