Assessing Health of Sensors Using Data Historians

Presented by: HALIT EREN

Curtin University

Electrical and Computer Engineering

Perth, Australia

Source:
http://img.alibaba.com/photo/11804820/Refined_Petroleum_Products_Fuel_Oil_D2_M100_Jet_Fuel.jpg

- Source: http://www.linde-le.de/images/Spezial-Pharma-Daenemark.jpg

- Source: http://automotiveauto.info/wp-content/uploads/2011/10/robots1.jpg

SUMMARY

This work investigates a method of determining the health of sensors using information stored in data historians.

Data historians are commonly used in process control applications.

This method aims the validation and reconciliation data coming from the sensors under normal operational conditions.

Method selected compares historical data with live data to assess status and health of any sensor anytime and every time.

Initial experiments are set up in a PLC/SCADA laboratory environment for testing live and historical data gives encouraging results.

PRESENTATION

Large-Scale Control Systems,

The Data Historian,

Use of Data Historians,

Theoretical Approach,

Set up and Implementation,

Initial Results,

Conclusions and Future Work.

LARGE SCALE CONTROL SYSTEMS

Industrial processes, manufacturing, automation, and other large-scale systems are intensively data-driven.

Thousands of sensors operate in a separate manner but in unison.

Hundreds of computers and embedded systems are used to synchronize signals for an effective control.

Processing large number of complex signals leads to time-controlled actions permitting optimum control.

Implementation of signals and resulting correct data is critical.

Data integrity obtained from all sensors bears ultimate importance.

Data historian implementations require:

- synchronous multiple devices,
- industry-standard hardware,
- Reliable data acquisition and resolution,
- Good network connectivity,
- Relevant software support,
- Large scale data management,
- Appropriate documentation.

DATA HISTORIAN

"Collection of software modules that gather, contextualize, correlate, aggregate, and store information."

Sensor outputs are directly logged into historians to calculate process variables or identify parameters (soft sensors).

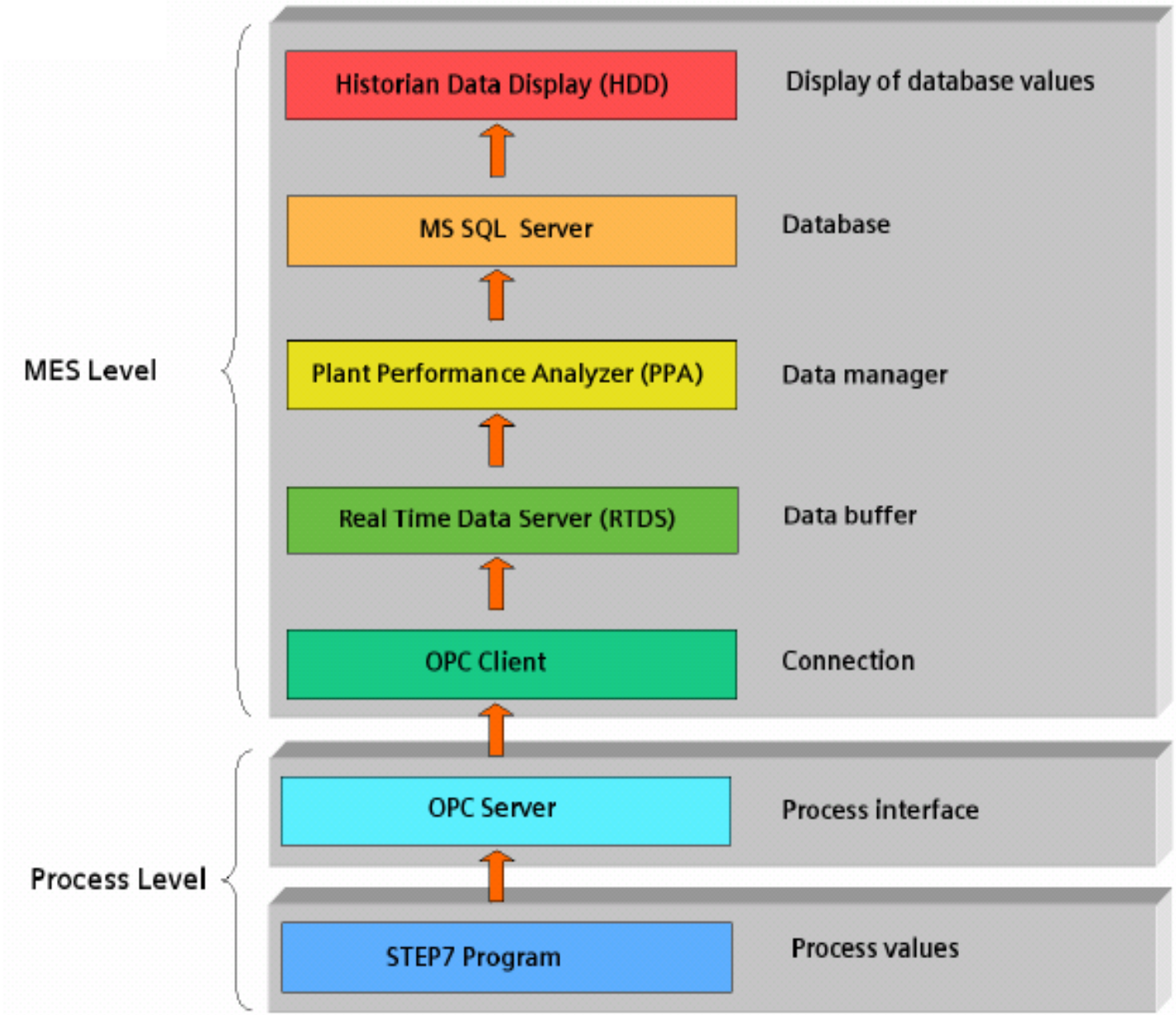
Data Historian helps parameter identification to monitor changes in operating conditions, such as the start-up, normal operations, emergencies, and shut-downs.

Live signals and multiple historians are used with techniques such as Fourier, wavelet transforms, fuzzy systems to improve the signal accuracy and repeatability. This reduces the maintenance and eliminates the need for off-line calibrations.

USE OF DATA HISTORIAN

Historians are used for:

- Parameter calculations
- Quality assurance
- Process reports
- Statistical analysis
- Performance monitoring
- Trace and track
- Archiving
- Soft sensing
- Accuracy and repeatability
- Key Performance Indexes (KPIs)
- Management tools such as MES
- Plant maintenance.


MES Level
Historian Data Display (HDD)
Display of database values
MS SQL Server
Database
Plant Performance Analyzer (PPA)
Data manager
Real Time Data Server (RTDS)
Data buffer
OPC Client
Connection
Process Level
OPC Server
Process interface
STEP7 Program
Process values

THEORETICAL APPROACH

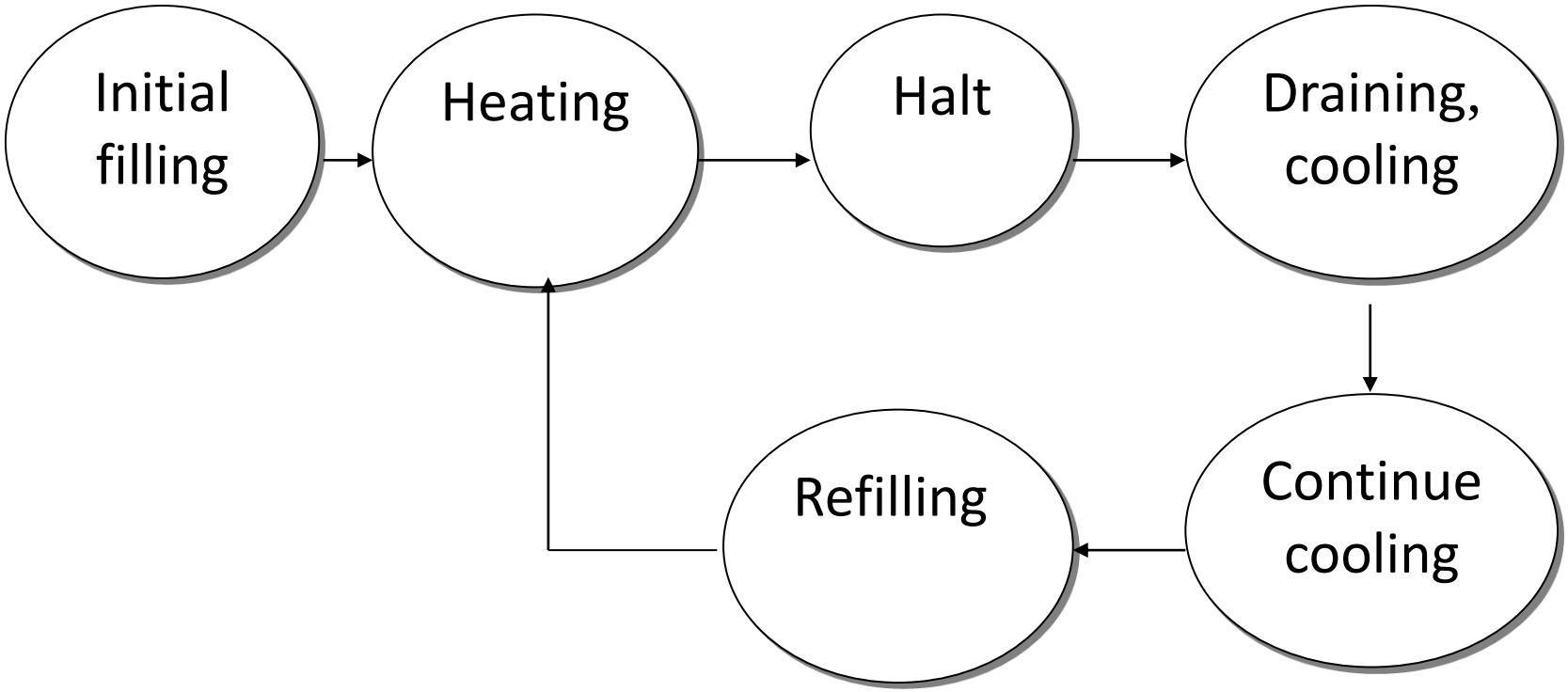
Software methods available for assessment of senor health:

- Artificial intelligence
- Data mining
- Statistical methods
- Signal processing techniques
- TelegraphCQ streaming query processor
- FastBit to correlate current behavior with historical trends
- Pattern Correlation Queries (PCQs)
- Data stream management by Stream Query Language, SQL
- DISC - Data-Intensive Similarity Measure for Categorical Data
- Spatial Overlapping based Hierarchical Clustering method SOHC
- Multi-sensor multimedia monitoring system
- Offline correlation methods.

SET UP AND IMPLEMENTATION

PLC/SCADA Lab set-up (Omron PLC/Citect SCADA):

The semi-simulated process has 6 stages: 1) Initial Filling, 2) Heating, 3) Halt, 4) Draining and Cooling, 5) Tank Cooling, and 6) Refill.



Tank	Fill	Heat	Halt	Drain & Cool	Cool	Refill
Tank Level	0 → 39	40	40	39 → 1	0	0 → 39
Temp. (°C)	50	51 → 99	100	99 → 61	60 → 51	50
Waiting Time (s))	0	0	1 → 4	5 (= 0)	0	0
Valve Filling	TRUE	FALSE	FALSE	FALSE	FALSE	TRUE
Valve Drain	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE
Limit Filling	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE
Tank Halted	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE
Tank Empty	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE
Temp. Reduce	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE
Temp. Start	TRUE	FALSE	FALSE	FALSE	FALSE	TRUE
New Filling	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE

Methods:

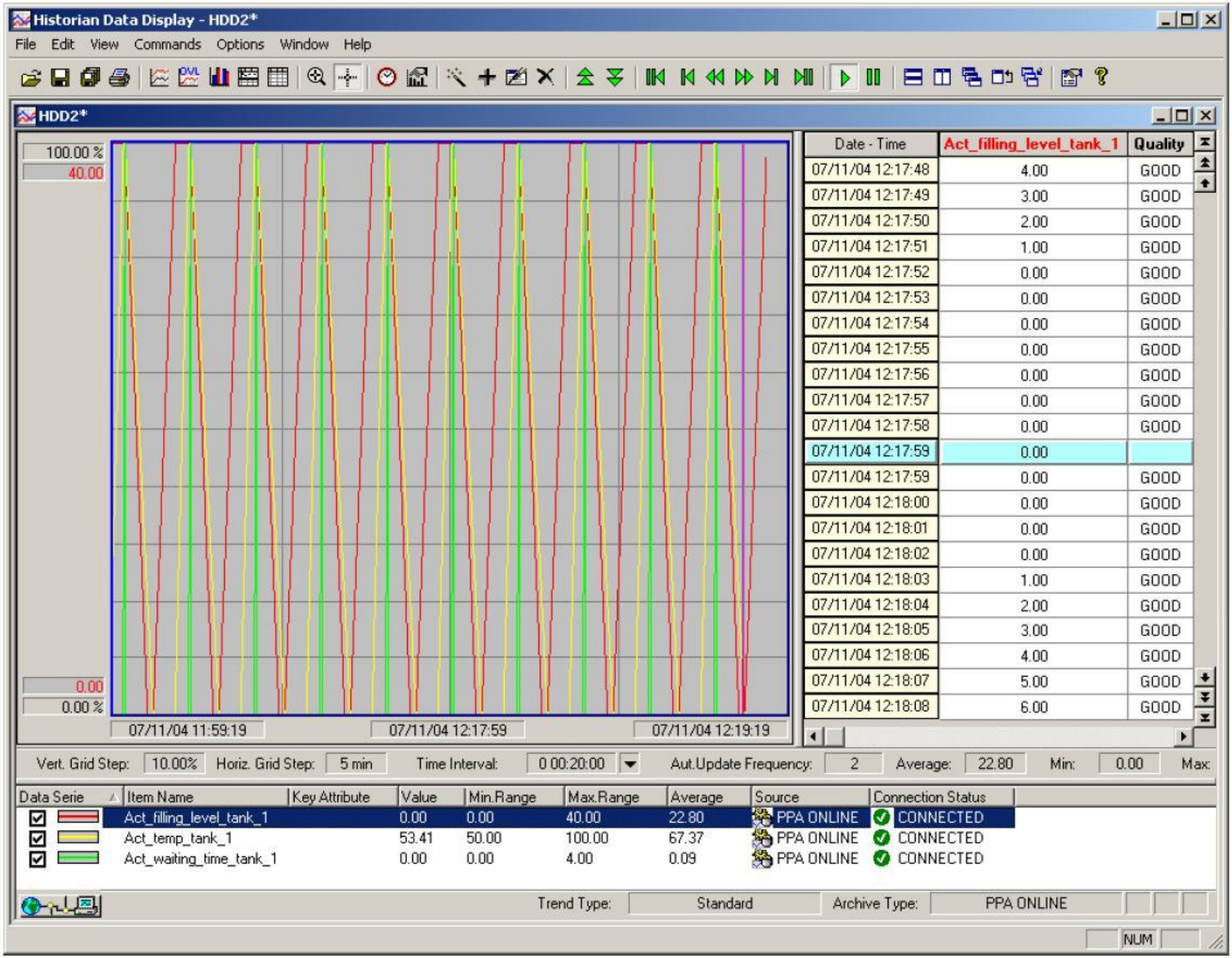
A program is generated for the continuous process of filling, heating, draining and cooling of water tank in historian software.

The operating system executes the Organization Block (OB) periodically in a repetitive manner.

Within this OB, for system integration a CALL Function to call upon the other function blocks.

Function blocks also integrate functions from the historians.

The live operational information obtained by suitable algorithms and the data is displayed side-by-side with those from the historian


Historian Data Display - HDD2*
File Edit View Commands Options Window Help
HDD2*
100.00 %
40.00
0.00
0.00 %
07/11/04 11:59:19
07/11/04 12:17:59
07/11/04 12:19:19
Date - Time
Act_filling_level_tank_1
Quality
07/11/04 12:17:48 4.00 GOOD
07/11/04 12:17:49 3.00 GOOD
07/11/04 12:17:50 2.00 GOOD
07/11/04 12:17:51 1.00 GOOD
07/11/04 12:17:52 0.00 GOOD
07/11/04 12:17:53 0.00 GOOD
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07/11/04 12:17:59 0.00 GOOD
07/11/04 12:18:00 0.00 GOOD
07/11/04 12:18:01 0.00 GOOD
07/11/04 12:18:02 0.00 GOOD
07/11/04 12:18:03 1.00 GOOD
07/11/04 12:18:04 2.00 GOOD
07/11/04 12:18:05 3.00 GOOD
07/11/04 12:18:06 4.00 GOOD
07/11/04 12:18:07 5.00 GOOD
07/11/04 12:18:08 6.00 GOOD
Vert. Grid Step: 10.00% Horiz. Grid Step: 5 min Time Interval: 0 00:20:00 Aut.Update Frequency: 2 Average: 22.80 Min: 0.00 Max:
Data Serie Item Name Key Attribute Value Min.Range Max.Range Average Source Connection Status
Act_filling_level_tank_1 0.00 0.00 40.00 22.80 PPA ONLINE CONNECTED
Act_temp_tank_1 53.41 50.00 100.00 67.37 PPA ONLINE CONNECTED
Act_waiting_time_tank_1 0.00 0.00 4.00 0.09 PPA ONLINE CONNECTED
Trend Type: Standard Archive Type: PPA ONLINE
NUM

CONCLUSION AND FUTURE WORK

Data historians in process environment gathers vast amount of information on the process over a long period of times.

Gathering of the information from a process includes data logging; control, simulation, and database connectivity.

This large amount of information is generally used as a management tool for decision making.

This new approach is investigated to make use of the historical information as a tool to assess the health of sensors employed in processes.

This case study aims to establish algorithms that data generated in process can be used to assess health of any and every sensor.

In the case of failure of sensors the associated causes can be identified and to determine the remedial measures.

FUTURE WORK

A long way to go but could yield extremely good outcomes leading to efficiency and cost cutting.

Various data comparisons methods needs to be tried.

Different sensors and process variables need to be considered.

Suitable designed sensor disagreement methods may enhance the concept.

Thank You