

Hydroprocessing Reactor Control – Key to Long & Optimized Runs

with Advanced Temperature Measurement Systems



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Director – Technology & Business Development

Daily Thermetrics

a division of Daily Instruments Corp.



Temperature Measurement Solutions



DAILY THERMETRICS

Advanced Process Control for the Process Industry

A MORE EFFICIENT REACTION...

DECREASES COSTS

INCREASES PROFITABILITY

MAXIMIZES SAFETY

**HOW CAN TEMPERATURE MEASUREMENT
SYSTEMS HURT OR HELP PERFORMANCE
& ROI OF HYDROPROCESSING
REACTORS?**

DAILY THERMETRICS

Advanced Process Control for the Process Industry

WHO IS DAILY THERMETRICS?

Specialists in Process Control Equipment for:

Hydroprocessing Fixed-Bed Reactors

Reforming (CCR, Semi-Continuous Regen, Cyclic Regen)

Hydrogen / Ammonia / Syngas Plants

Ebulating-Bed / Slurry Reactors

Heaters/Furnaces

World Headquarters, Design, Engineering & Manufacturing

Houston, Texas, USA

Established

1973

DAILY THERMETRICS

Product Offerings, Advanced Solutions

REACTOR THERMOMETRY



HEATERS & FURNACES



Field Engineering Services

Thermowells & Sensors



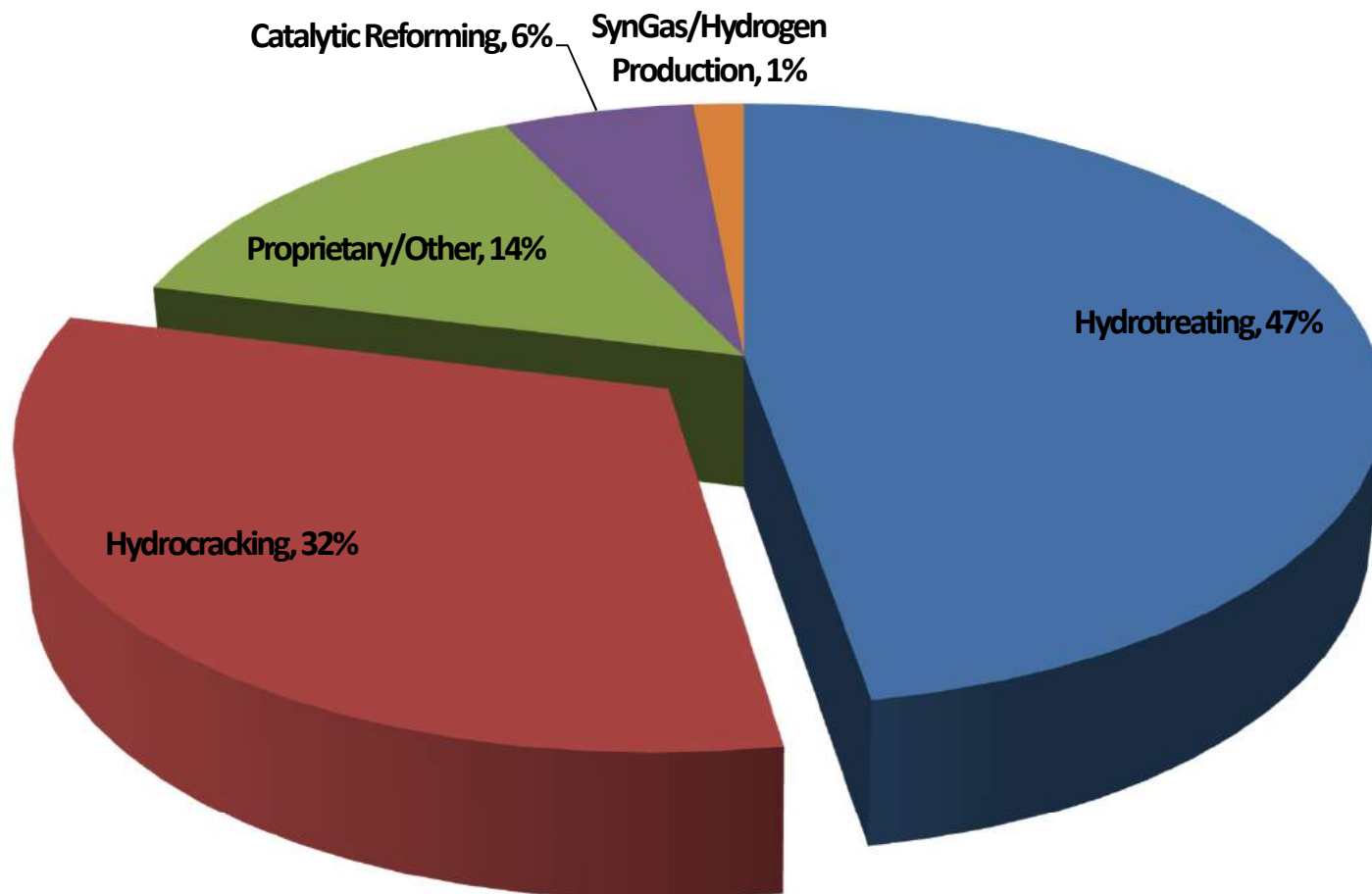
Vessel Skin Sensors™

Temperature Measurement Solutions



GLOBAL EXPERIENCE – CatTracker®

Snapshot as of Sep 2013



Over 700 reactors and 30,000+ sensing points
100+ Hydrocrackers, 300+ Hydrotreaters & 30 CCR/Oleflex

PATENT # US 6,550,963 & 6,599,011 / CANADA 2,449,074 / EU PATENT PENDING

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PROCESS LICENSOR RECOGNITION

Which **PROCESS LICENSORS** recognize Daily Thermetrics as specialists in reactor thermometry?



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IDENTIFYING REACTOR ASSETS

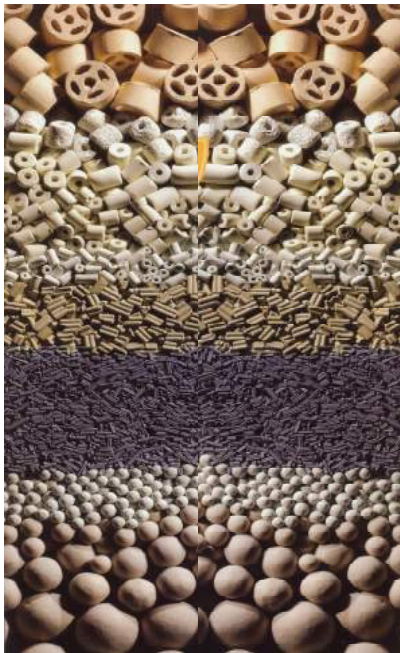
Catalytic Processing Units: Key Investments



IDENTIFYING REACTOR ASSETS

Catalyst Investment

CATALYST



REOCCURRING INVESTMENT
Significant Consumable Investment

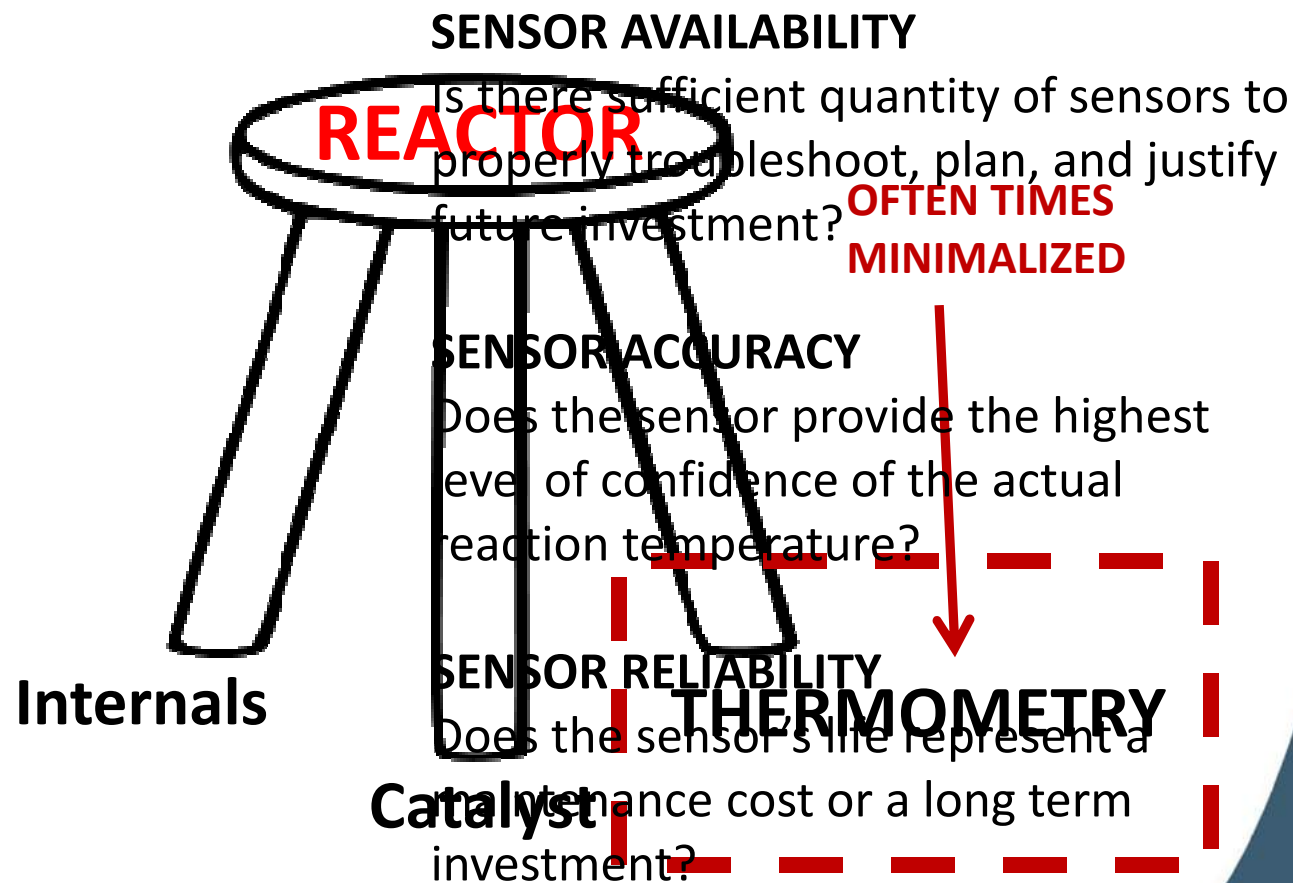
PRODUCTION
Reduce / Increase Production
depending on Utilization and Condition



DAILY THERMETRICS

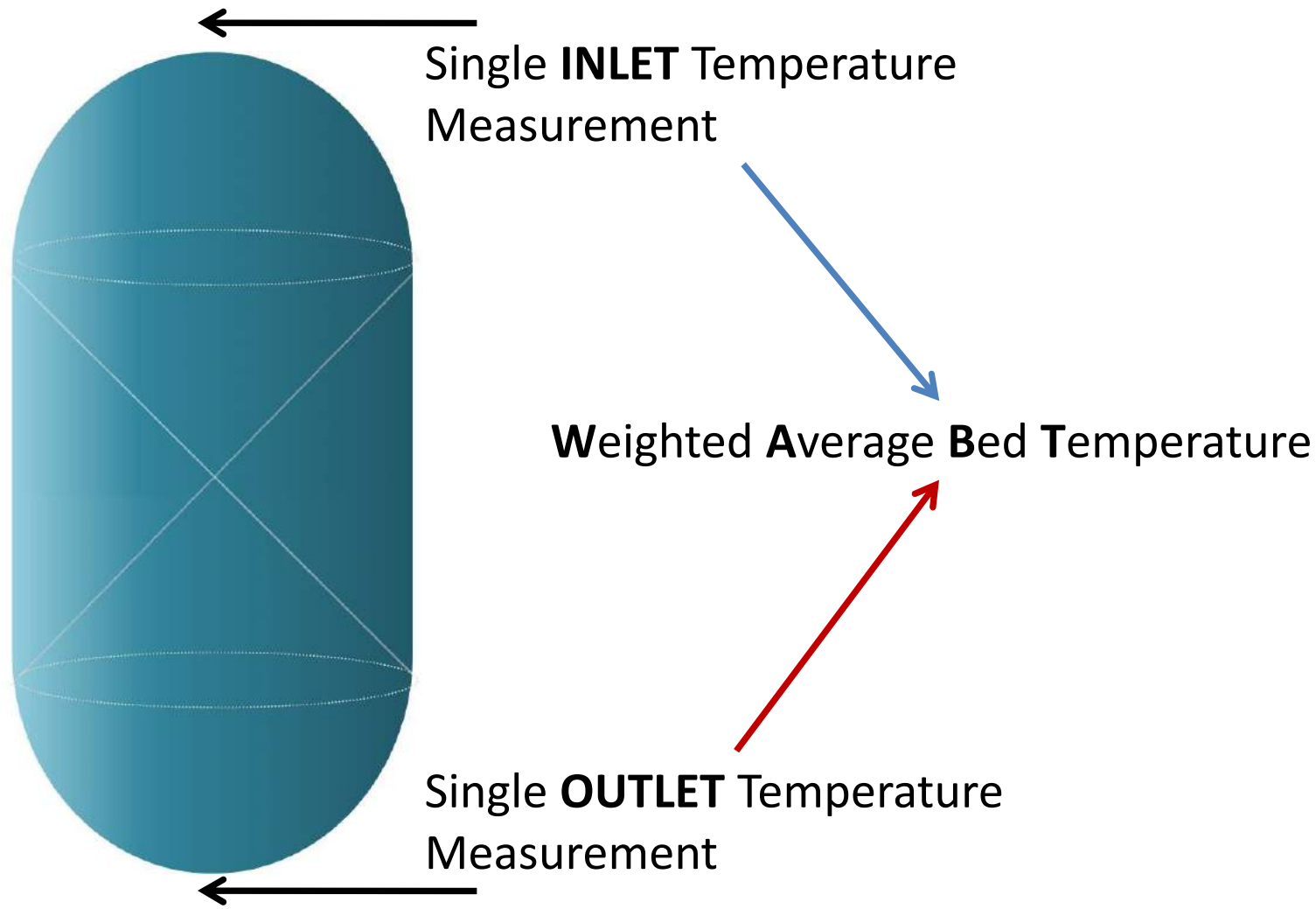
Reactor Components

3 Critical Components for HIGH PERFORMANCE Reactors



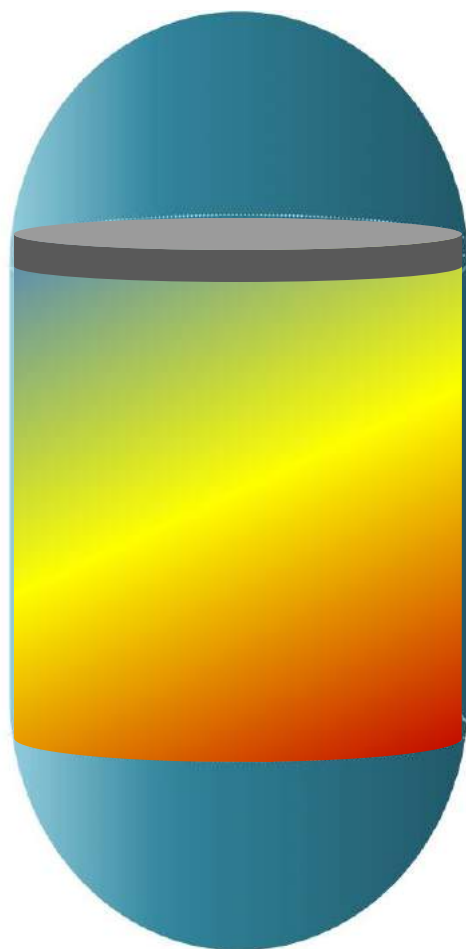
EVOLUTION: REACTOR THERMOMETRY

MEASUREMENT: **INLET, OUTLET, & WABT**



EVOLUTION: REACTOR THERMOMETRY

MEASUREMENT: **INLET, OUTLET, & WABT**



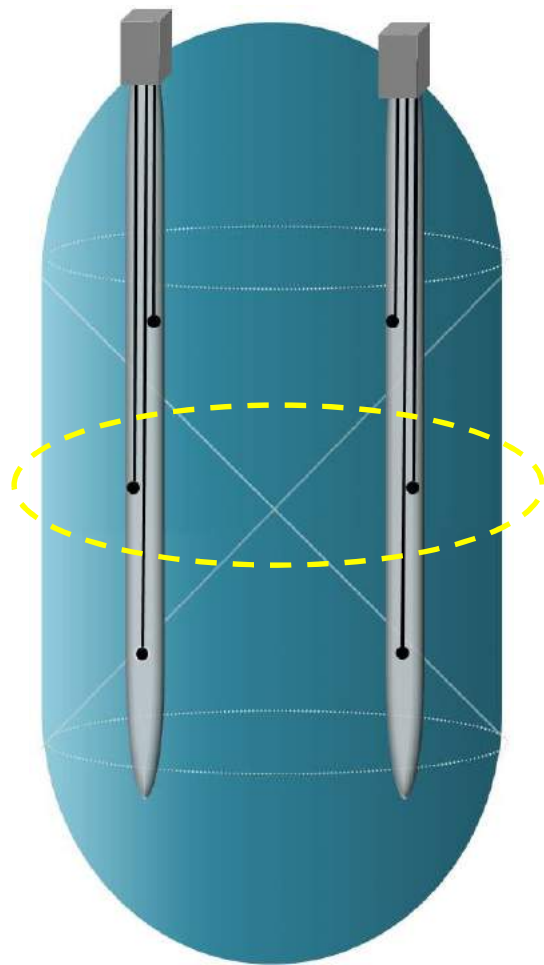
Weighted **A**verage **B**ed **T**emperature
WABT = SINGLE VALUE FOR CATALYST

CAN NOT EFFECTIVELY DETECT:

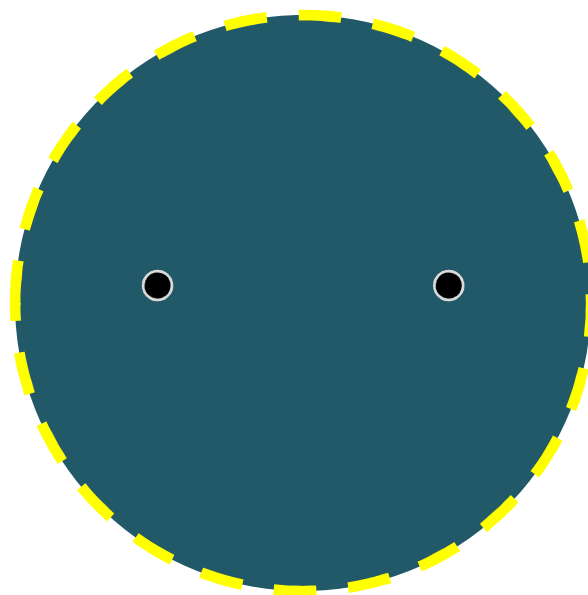
PROCESS FLOW & CHANNELING ISSUES
TEMPERATURE EXCURSIONS & HOT SPOTS
PROCESS MAL-DISTRIBUTION
DISTRIBUTOR / TRAY FOULING

EVOLUTION: REACTOR THERMOMETRY

MEASUREMENT: **PIPE WELL/THERMOBAR MULTI-POINT**

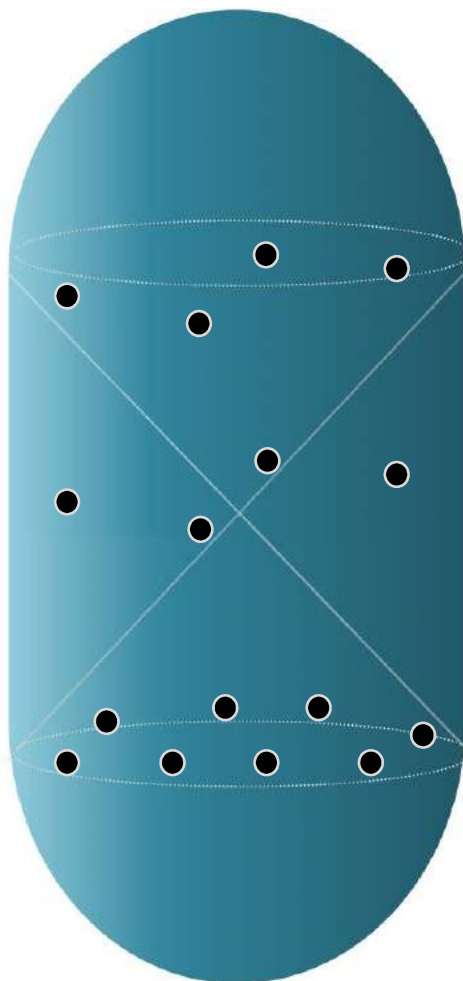


**TEMPERATURE VISIBILITY
at Measurement Elevations**



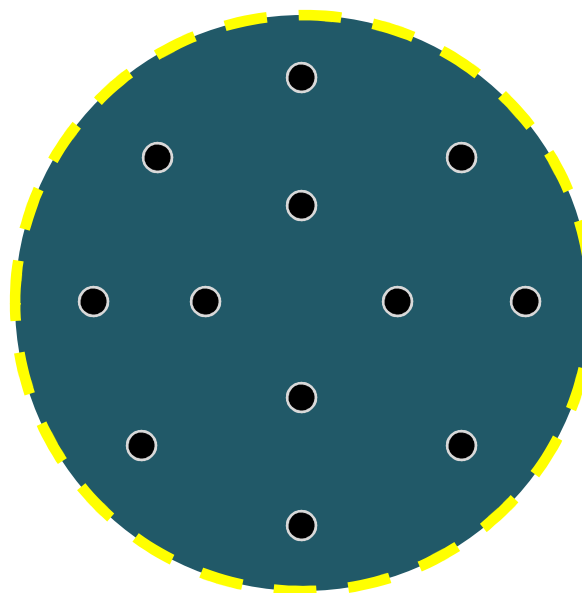
EVOLUTION: REACTOR THERMOMETRY

MEASUREMENT: **RADIAL PROFILING**



RADIAL TEMPERATURE PROFILING

Process Licenser Specifications
for **NEW** Reactors



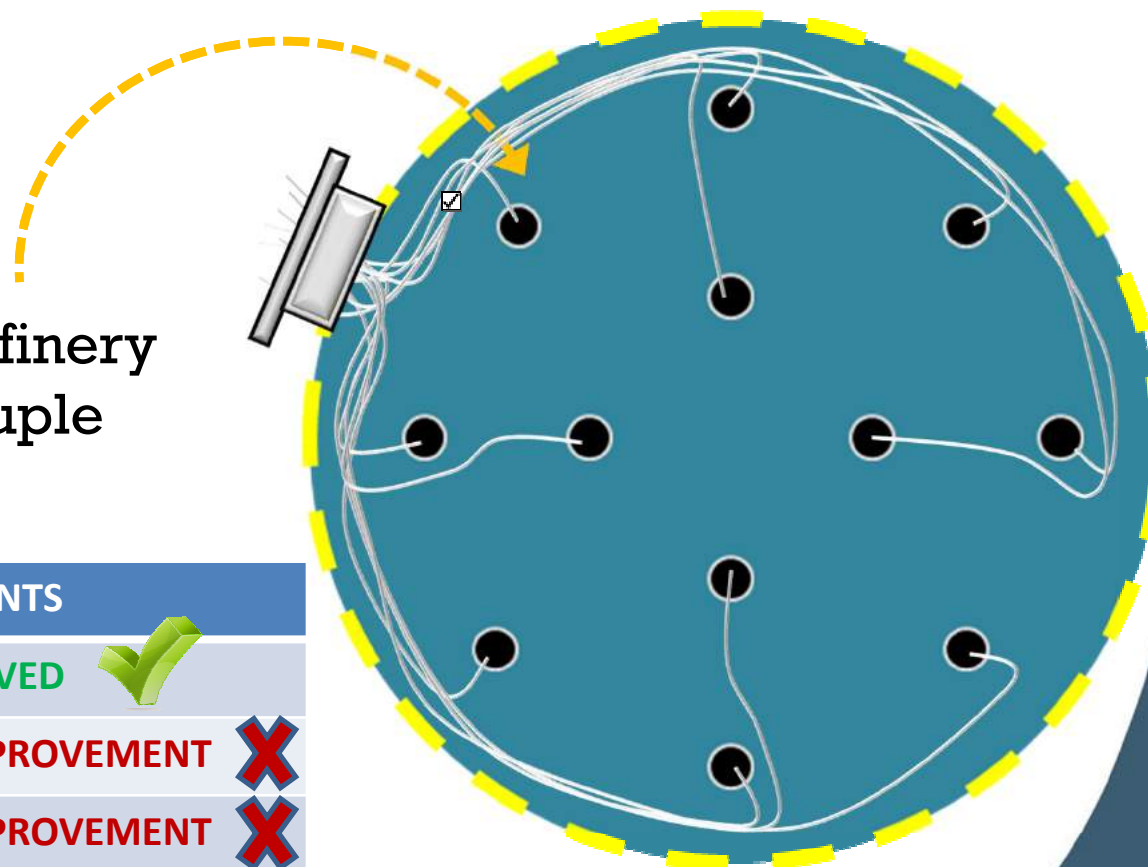
EVOLUTION: REACTOR THERMOMETRY

MEASUREMENT: 1st GENERATION RADIAL PROFILING

1st GENERATION FLEXIBLE SENSORS

YEAR 1987: MEETING RADIAL SPECIFICATIONS

Industrial Refinery
Thermocouple



IMPROVEMENTS	
AVAILABILITY	IMPROVED ✓
ACCURACY	NO IMPROVEMENT ✗
RELIABILITY	NO IMPROVEMENT ✗

1st GENERATION RADIAL PROFILING

TECHNOLOGY LIMITATIONS: SIGNIFICANT HARDWARE

1st GENERATION FLEXIBLE SENSORS

YEAR 1987: MEETING RADIAL SPECIFICATIONS

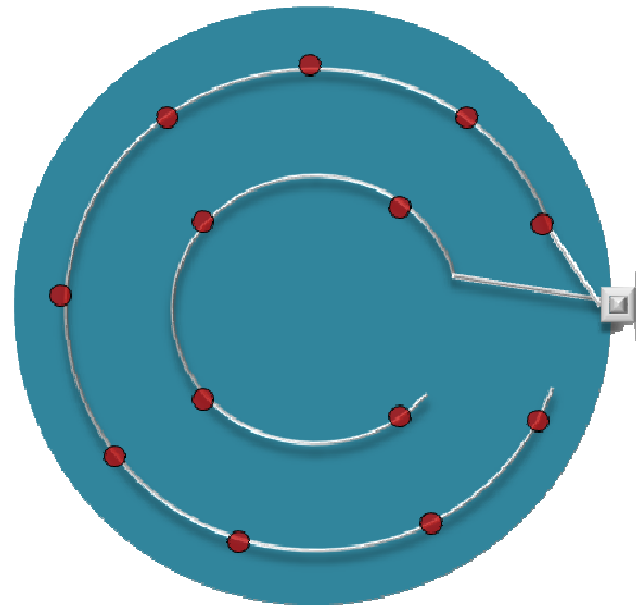
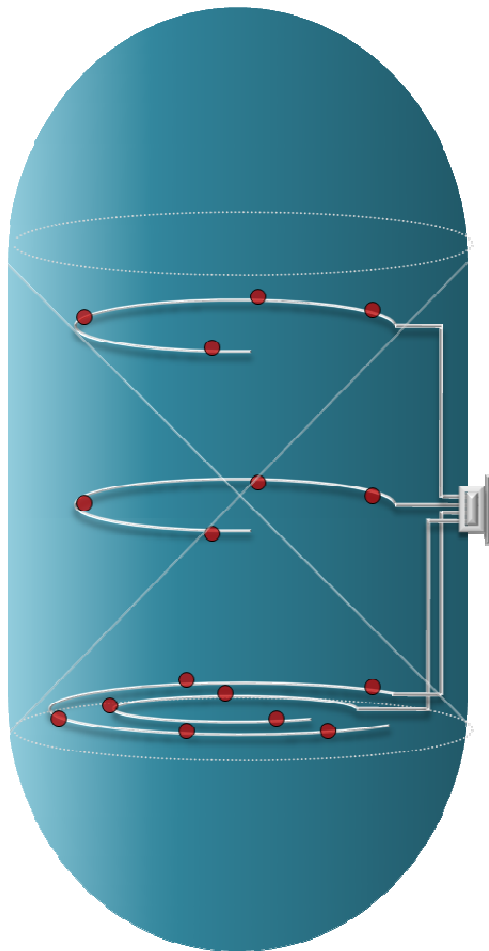


IMPROVEMENTS	
AVAILABILITY	IMPROVED ✓
ACCURACY	NO IMPROVEMENT ✗
RELIABILITY	NO IMPROVEMENT ✗

EVOLUTION: REACTOR THERMOMETRY

MEASUREMENT: 2nd GENERATION RADIAL PROFILING

LATEST GENERATION FLEXIBLE SENSORS
YEAR 2001: MEETING RADIAL SPECIFICATIONS

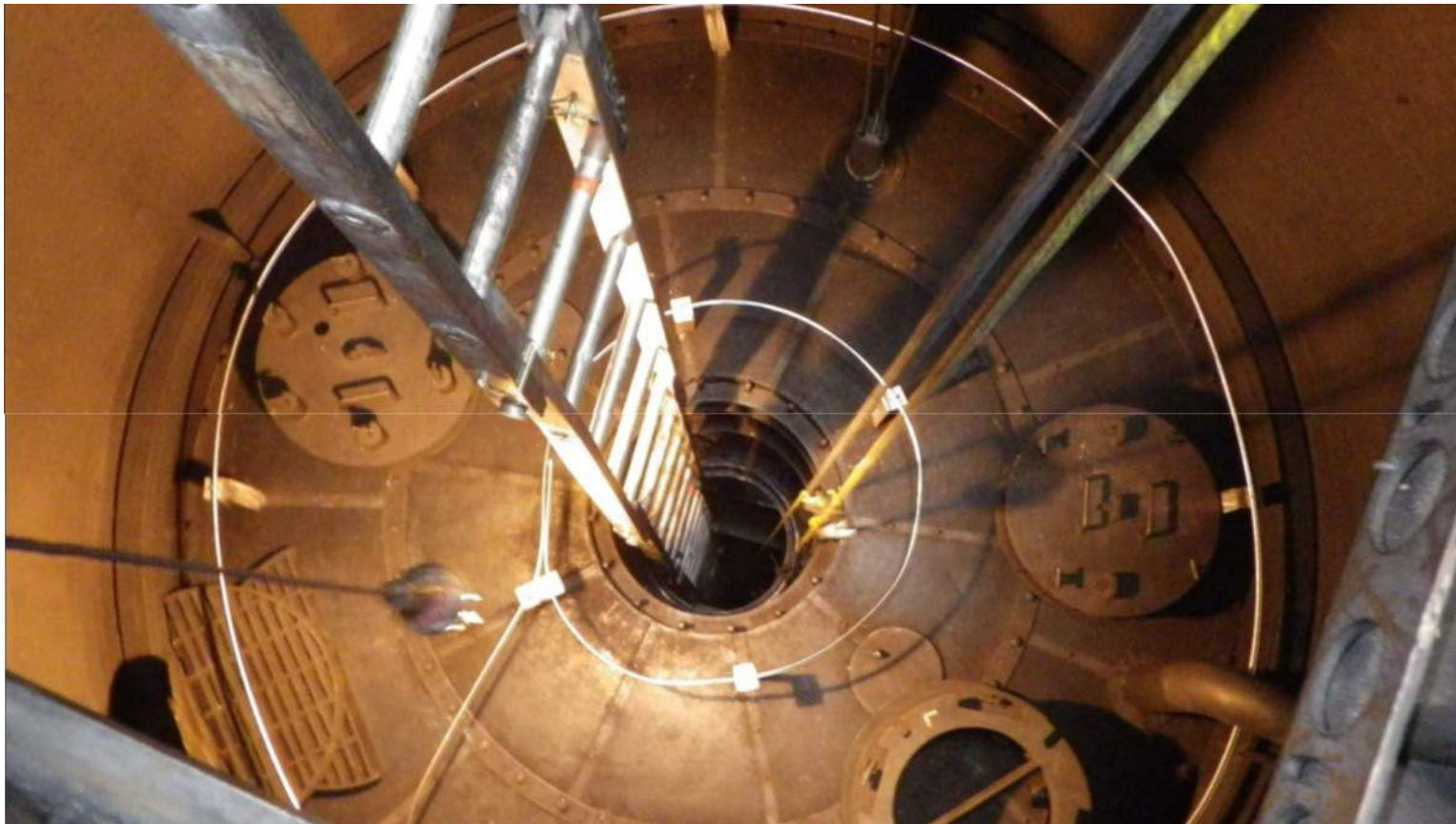


IMPROVEMENTS	
AVAILABILITY	MAXIMIZED ✓✓✓
ACCURACY	IMPROVED ✓✓
RELIABILITY	IMPROVED ✓

PATENT # 6,550,963 & 6,599,011 / CANADA PATENT # 2449074 & EU PATENT PENDING

2nd GENERATION RADIAL PROFILING

CatTracker® Catalyst Tracking Solutions



Temperature Measurement Solutions



PATENT # 6,550,963 & 6,599,011 / CANADA PATENT # 2449074 & EU PATENT PENDING



Standard CatTracker® Features

1. Ultra High Accuracy™
2. Ultra High Precision™
3. Maintenance-Free, Repair-Free Technology
4. Extended Life
5. Patented, aerospace-derived technology with up to sixteen (16) measurement locations along each sheath/probe
6. Helium Leak Test
7. Certified SIL 3 Capable (Q2 2014)



WHAT IS THE CATTRACKER®?

MEASUREMENT: 2nd GENERATION RADIAL PROFILING

Aerospace Technology



IMPROVEMENTS		
AVAILABILITY	MAXIMIZED	✓✓✓
ACCURACY	IMPROVED	✓✓
RELIABILITY	IMPROVED	✓

Number of Tubes Required: 45 Sensing Points

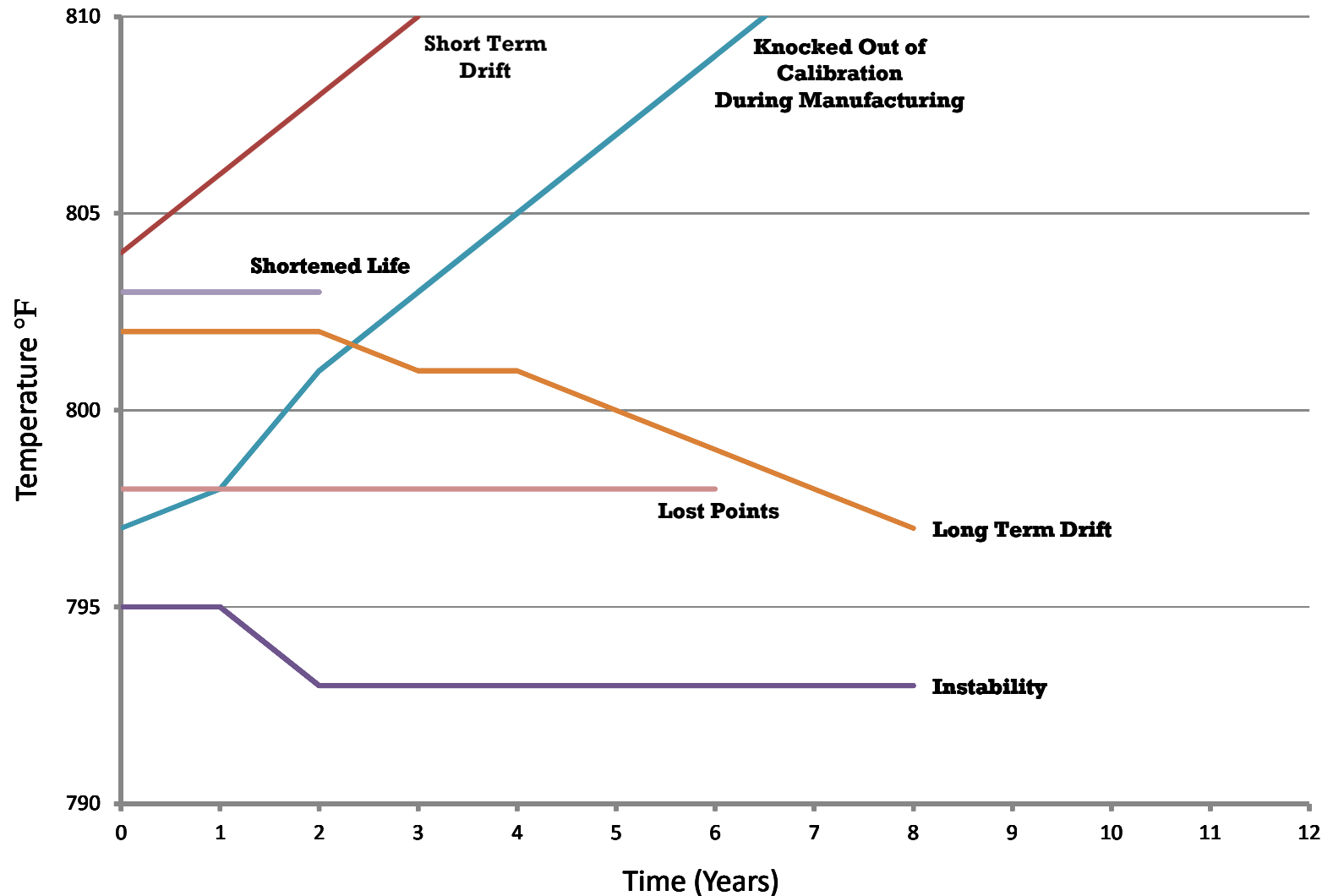


IMPROVEMENTS	
AVAILABILITY	MAXIMIZED
ACCURACY	IMPROVED
RELIABILITY	IMPROVED



1st GENERATION THERMOCOUPLES

LIMITATIONS OF CONVENTIONAL SENSORS



ADVANCED: Thermocouple Moisture

Understanding Thermocouple Performance

Moisture in contact with thermocouple wires and insulation cause:

WIRE CORROSION

Changes in composition of wire metallurgy also changes known voltage

Corroded Type K, E, and J wires do not carry the same temperature gradient/voltage at a given temperature as non-corroded clean thermocouple wire

GHOST JUNCTIONS & SHORTS

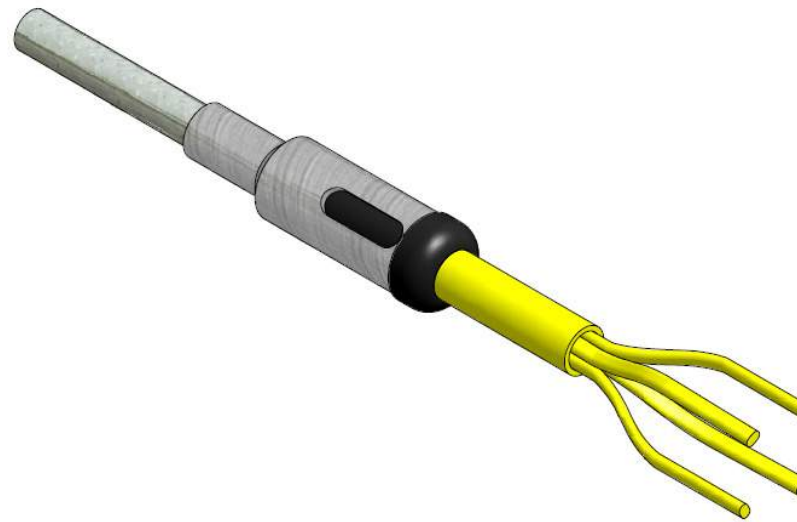
Moisture creates resistance drops and if localized, will short out a thermocouple or create multiple low output junctions

Resistance drops, especially between thermocouple wires between designated hot and cold junctions create unintended junctions that disrupt the EMF and output voltage resulting in poor measurement

Introduced in 2012

Ralexian™ Transition Design

- Developed and offered exclusively by Daily Thermetrics
- Moisture-tight Seal
- Multiple Epoxies with different curing temperatures used
- Function tested multiple times to ensure moisture resistance
- Water Submersion Test



IMPROVEMENTS		
AVAILABILITY	MAXIMIZED	✓✓✓
ACCURACY	IMPROVED	✓✓
RELIABILITY	IMPROVED	✓✓

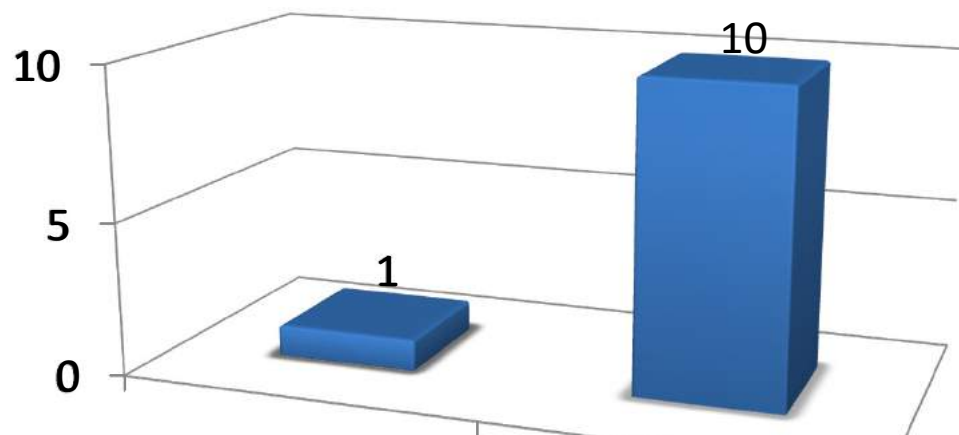
ADVANCED: Thermocouple Moisture

CatTracker® Sets a NEW World Standard

Measuring Moisture in Thermocouples: Insulation Resistance (IR) Test

This test is performed by testing the resistance between any single ungrounded thermocouple wire and the external thermocouple sheath.

IR Pass/Fail Criteria



**Industry
Standard**

1 GΩ at 500V
at ambient temperature

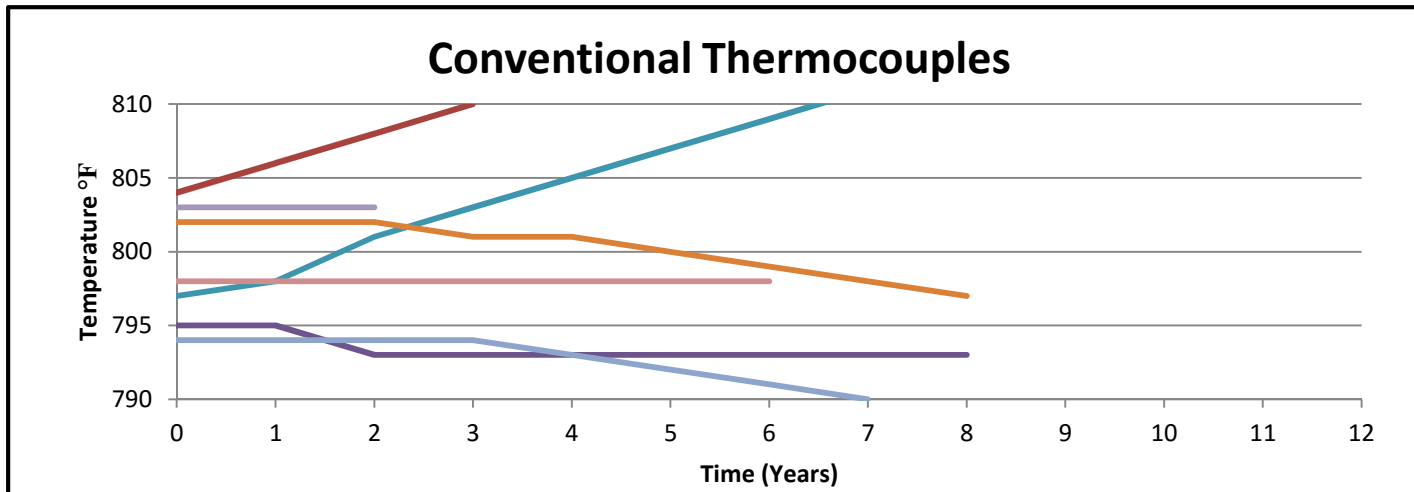
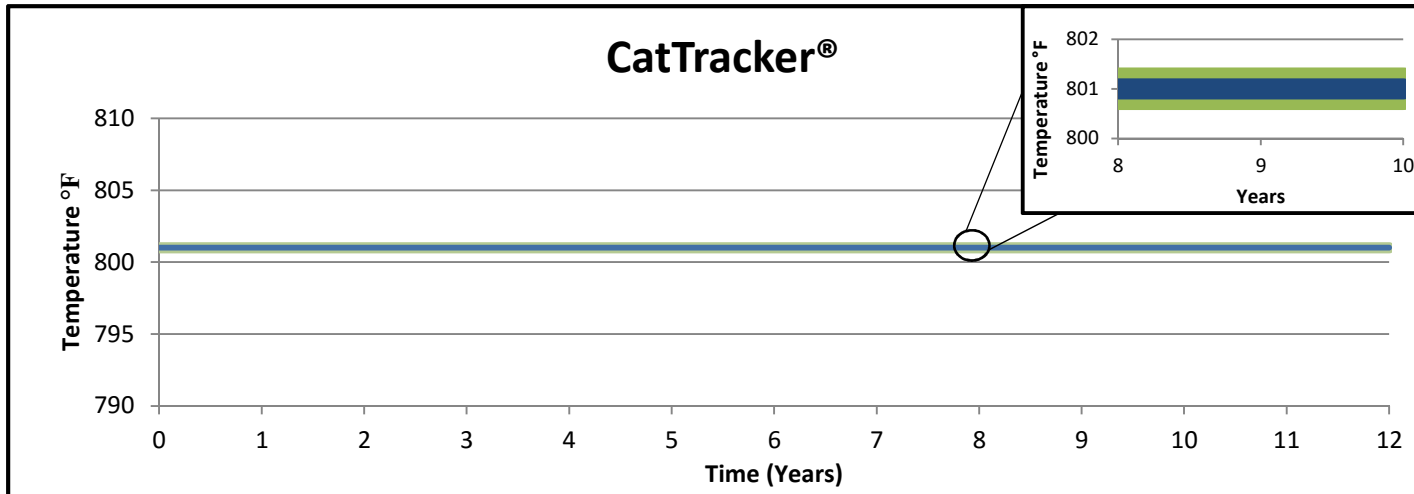
**Daily
Thermetrics**

10 GΩ at 500V at ambient temperature
AFTER a water submersion period of
10 minutes is performed

■ Gigaohms at
500V at ambient
temperature

IMPROVEMENTS	
AVAILABILITY	MAXIMIZED
ACCURACY	IMPROVED
RELIABILITY	IMPROVED

CatTracker® = Highest Stability and Extended Sensor Life



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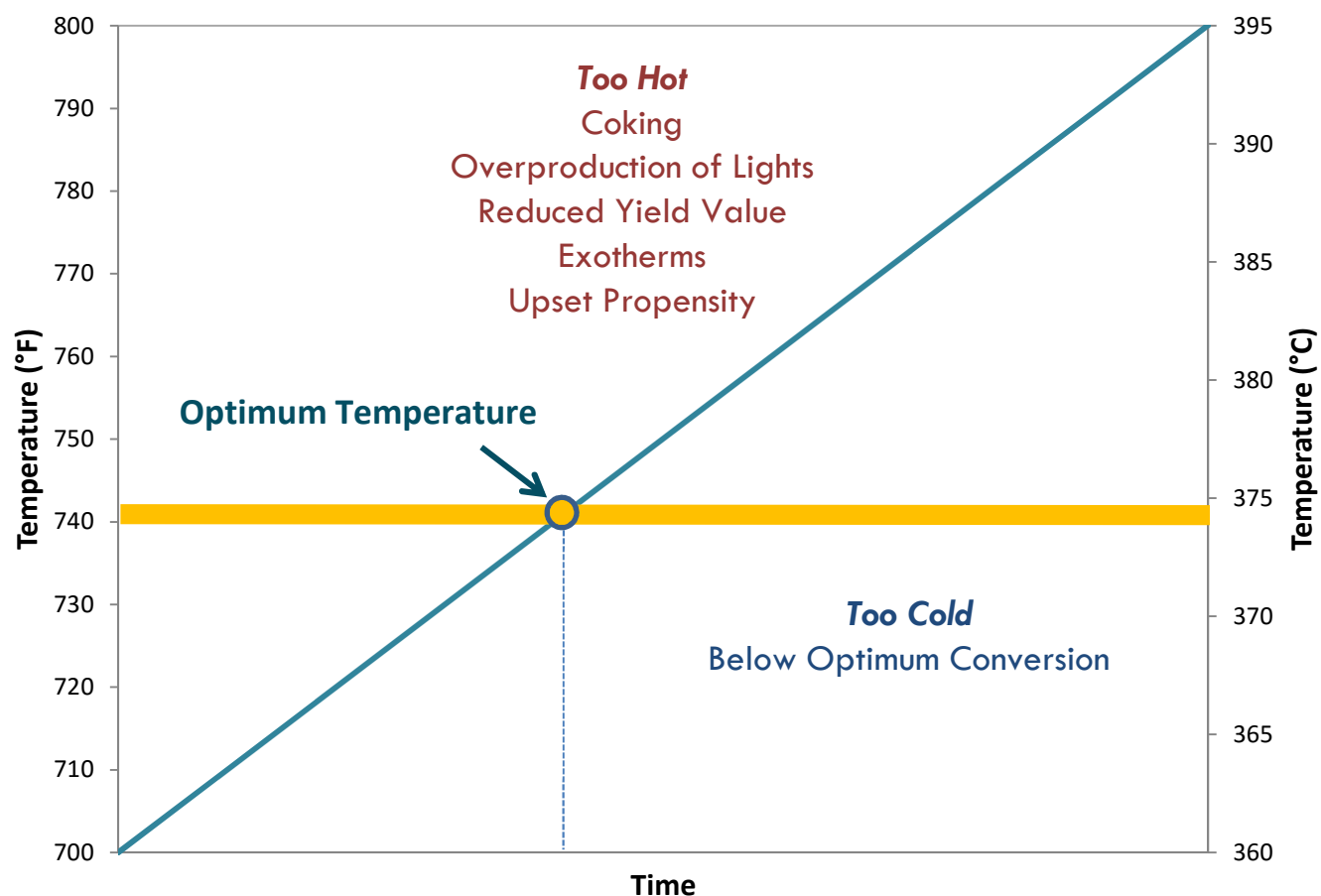


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THERMETRICS

REACTOR THERMOCOUPLES

What's the importance?

Accurate Measurement allows for
Accurate Inlet Temperature Control Decisions



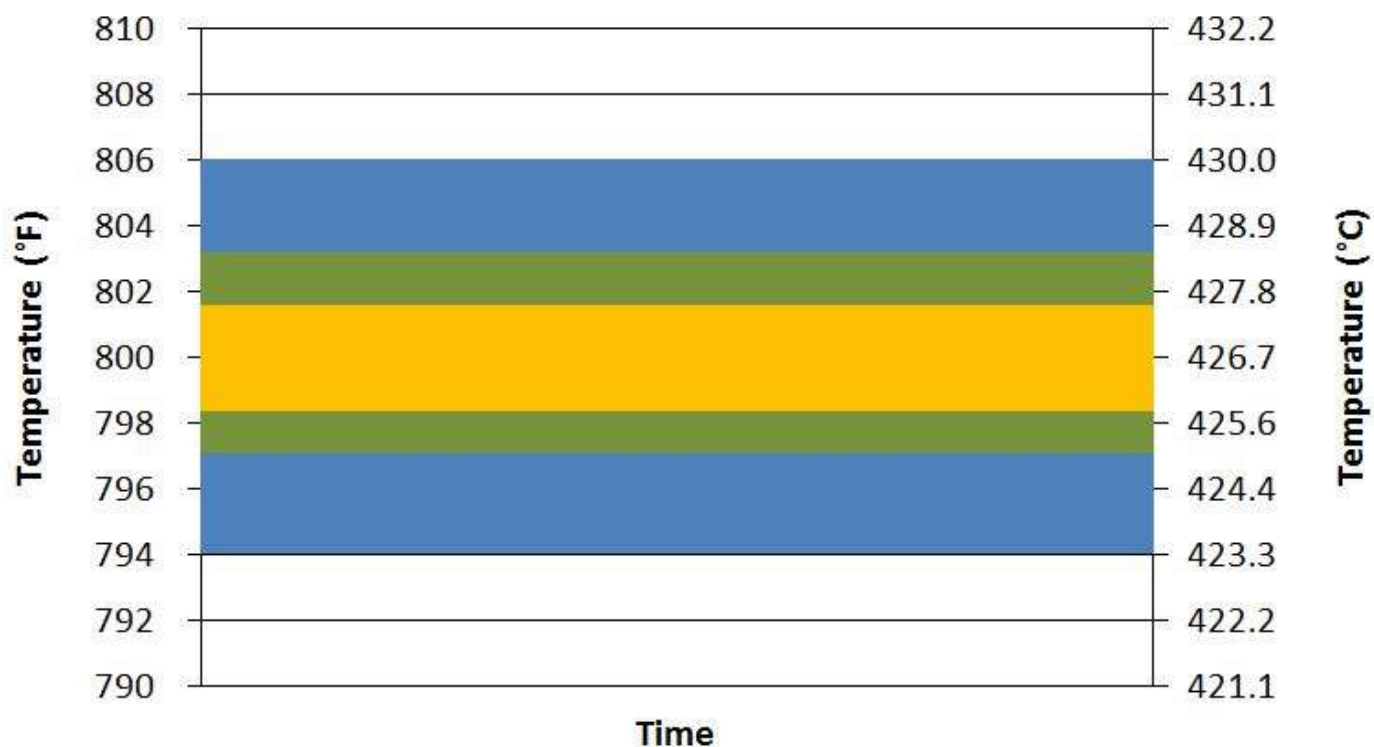
ULTRA HIGH ACCURACY™

Daily Thermetrics Corporation (EXCLUSIVE OFFERING)

Daily Special Accuracy

$\pm 0.01^\circ\text{C}$ at 427°C

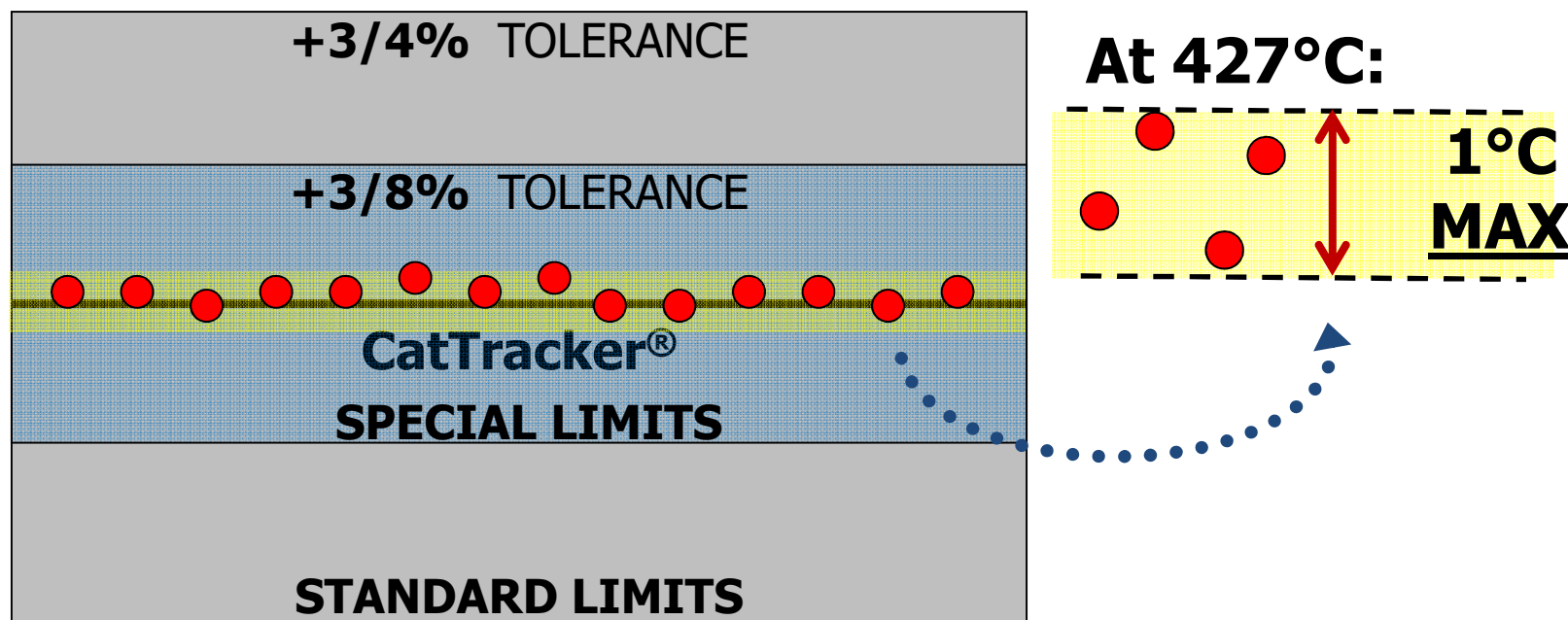
Up to 4X MORE ACCURATE than
previous generation sensors



ULTRA HIGH PRECISION™

Daily Thermetrics Corporation (EXCLUSIVE OFFERING)

Guarantee: Every sensor in the entire reactor is designed and manufactured to achieve a **1°C** maximum delta-T at 427°C



Temperature Measurement Solutions



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DAILY THERMETRICS

Revisited: Reactor Thermometry Components

3 Critical Criteria for REACTOR THERMOMETRY

THERMOMETRY

2ND GEN. CatTracker® OFFERS:

SENSOR AVAILABILITY

As many as **SIXTEEN TIMES (16X)**
Is there an efficient quantity of sensors
to properly troubleshoot, plan, and
justify future investment?
1ST GENERATION systems.

SENSOR ACCURACY

Up to **FOUR TIMES (4X) MORE**
Does the sensor provide the highest
level of confidence of the actual
reaction temperature?
1ST GENERATION systems.

SENSOR RELIABILITY

REPAIR-FREE, maintenance-free
Does the sensor's life represent a
maintenance cost or a long term
investment?
leading warranty (up to 10 years)
plus SIL3 Certification in Q2 2014.

Temperature Measurement Solutions




Conclusion: Precise Temperature Management

Reactor Thermometry

CatTracker® Offers Process Managers Maximum:

IMPROVEMENTS	
AVAILABILITY	MAXIMIZED
ACCURACY	IMPROVED
RELIABILITY	IMPROVED



Which results in:

INCREASED ROI

when compared to process units monitored by older systems.