Application of LIOS Reactor Skin Temperature Monitoring Solution (RSTMS) for Kemper County Energy Facility Gasifier Vessels
Based on development work initiated by Felten & Guilleaume in 1995. NKT acquired F&G Kabelwerke in 1999 and founded LIOS Technology GmbH - headquartered in Cologne, Germany - in 2000. 1st branch outside of Germany - LIOS Technology Inc. - was founded in 2008 in Morganville, NJ (USA), with additional sales office established in Shanghai, China, in 2011.
Introduction - Reactor Skin Temperature Monitoring Solution (RSTMS)

- **Demand**
  - Gasifiers operate at very high temperatures and require thick reactor shells and refractory materials on the inside to operate efficiently and to reduce the heat reaching the reactor shell exterior. Failure of the refractory can result in excessive shell temperatures that can lead to significant damage to the reactor.
  - To maintain the integrity of the reactor vessel and to guarantee safe operation under process conditions.

- **Solution**
  - Traditional temperature monitoring based on infrared thermography and/or continuous thermocouples for point sensing using welding method making repairs and replacements (in case of a failure) as well as retrofit applications complicated.
  - Modern RSTMS based on **Distributed Temperature Sensing** (DTS) using **fiber optic sensing cables** allow for fully distributed/continuous monitoring of the whole reactor vessel surface temperature so companies can early identify - with high spatial, temporal and temperature resolution - possible refractory failure conditions and alert process operators to take necessary actions to better ensure safety, to reduce the potential for damage and to optimize overall process efficiency.

- **Purpose**
  - This presentation introduces the application, reliability/sensitivity and usage of LIOS Technology RSTMS at Southern Company World’s First IGCC (Integrated Gasification Combined Cycle) state-of-the-art commercial electric power production facility using TRIG (Transport Integrated Gasification) in Kemper County, MS (USA).
DTS technology has been proven to be successful in numerous critical applications such as:

**DE.TECT**

**Fire Detection**

Our technology has been successfully proven in critical applications like fire detection in road and rail tunnels, where our systems have been equipped in worldwide projects with more than 4400 km of sensor cable since 1997.

**WELL.DONE**

**Oil & Gas Exploration**

The Well.Done monitoring system is used to optimize the Oil production. Normally only around 30% of the Oil in a well can be produced with reasonable amount of technology. When the Oil price reaches a certain level, additional technologies -like DTS- are installed to enhance the Oil recovery.

**EN.SURE**

**Power Cable Monitoring**

The EN.SURE monitoring system enables the user to locate any cable hotspots before failure, to dynamically optimize the power load and ensure reliable supply of electricity.

**PRE.VENT**

**Industrial Applications**

The flexibility of the DTS and cables enables the customer to use it for many other applications like leakage detection in Pipelines, surface monitoring of vessels like gasifiers. Wherever you have a surface or a long asset to monitor the DTS technology provides a reliable and cost effective solution.
- LIOS has a unique experience with global references and leading track record of 4,000 permanent installations.

- August 2009. Fiber optic temperature measurement in LNG heat exchanger at the world’s first coil-wound heat exchanger completely made of stainless steel for LINDE in Stavanger, Norway.

- April 2003 - November 2003, Celanese I & II project. Gasifier temperature monitoring in EX zone “Zero” for ABB in Oberhausen, Germany.

- April 2009. Industrial process measurement for SMS Siemag in Düsseldorf, Germany.

- May 2005, Formosa project. Reactor skin temperature monitoring for BP Chemical Corp. in Mai Liao, Taiwan.

- August 2009. Fiber optic temperature measurement in LNG heat exchanger at the world’s first coil-wound heat exchanger completely made of stainless steel for LINDE in Stavanger, Norway.


- July 2013. External wall temperature monitoring of high temperatures/pressure gasification reactors at Southern Company energy facility in Kemper County, MS (USA).
Scope/Overview

In conjunction with Mississippi Power Company, Southern Company Services is constructing an IGCC commercial electric power production facility. As part of this facility, synthesis gas (Syngas) will be produced from lignite coal using the KBR air blown TRIG technology. Two (2) specially designed reactors are being installed at this facility and the gasification reactors are key to this process.

Company wishes to early identify possible refractory failure conditions and alert process operators to take necessary actions. Then, a decision had been made to have identical systems to measure external reactor wall (skin) temperatures and send this temperature data to Company’s Distributed (Process) Control System (DCS) for logic processing and generation of alarms in the event that certain skin temperature conditions occur.

Technical Considerations

To provide temperature signals to enable the DCS:

- To monitor for hot spots, with temperatures and locations transmitted to the DCS.
- To develop reactor skin temperature profiles in each reactor zone.

The gasification reactor external skin temperatures are expected to range from 200°F to 400°F.

Measurement range shall be 0°F to 800°F with expected accuracy to be within ±2°F from 200°F to 500°F.
- **DTS Raman measurement principle**

The principle of the Raman effect

The Stokes and anti-Stokes scattering is called Raman scattering. While the signal of the Stokes scattering is only slightly influenced by temperature, the intensity of the anti-Stokes increases with increasing local temperature of the light waveguide clearly. The temperature can thus be determined by comparing the two signals Stoke and anti-Stoke determined.
DTS (II) - The Solution For Reactor Skin Temperature Monitoring

- DTS hardware & FO accessories
- DTS monitors the temperature along a fiber optic sensor cable (Fiber In Metal Tube - FIMT) designed for permanent high temperatures (up to 600°F during normal operations) and mounted onto the reactor using high temperature magnets (480°F) to avoid stud/TIG-welding.
- DTS has multiple channels connected to different fibers. Each cable has two (2) fibers measured by two (2) separate DTS and measured from both ends in order to achieve full redundancy (cable fiber break, DTS failure).
DTS (III) - The Solution For Reactor Skin Temperature Monitoring

- **DTS flexibility**

  Single ended:

  ![Single ended](image)
  up to 40km

  Single ended two directions:

  ![Single ended two directions](image)
  up to 80km

  Loop redundancy:

  ![Loop redundancy](image)
  up to 20km

  Flexible (meander shape) design:

  ![Flexible (meander shape) design](image)

  Redundancy (meander shape) design:

  ![Redundancy (meander shape) design](image)
DTS (IV) - The Solution For Reactor Skin Temperature Monitoring

- **DTS installation & precision**

- 50cm (i.e. 1.5ft) sampling intervals to ensure full coverage of the reactor. *DTS can allow for 10cm minimum sampling intervals.*

- Temperature accuracy better than 1°C.

- In-house designed installation tools to ensure proper routing of the FO sensing cable.
DTS (V) - The Solution For Reactor Skin Temperature Monitoring

- **DTS data, software program & visualization**

- Temperature data is processed in real-time using a zone concept with up to 1,000 zones per channel. Each zone can trigger pre-alarms and alarms based on maximum temperature, rate-of-rise, zone differential and deviations from normal operation temperature criteria. The zone/alarm data is transmitted to the DCS using a specific communication protocol.
Eight (8) PRE.VENT controllers monitor approximately 14,000 locations along more than seven (7) km of FO cable mounted in a meander shape onto two (2) seventy (70) meters high coal gasifiers for a total skin monitoring area of approximately 7,000 square meters.
The locations on each reactor are grouped into ten (10) zones for alarm processing.

The DTS triggers pre-alarms and alarms according to the alarm parameters assigned to each of the zones. Zone/location alarms are both communicated to the DCS via Ethernet using a fieldbus protocol.
Hot spots - to ensure the precision of the fiber location in a zone - are generated along the entire FO cable using a 30°C heating tape.

Hot spot illustration using a redundancy (meander shape) design:

Final RSTMS commissioning for both gasifier vessels scheduled for Q4 2015.
DTS RSTMS is a **powerful** tool for monitoring large numbers of locations on a hot & large surface. Monitoring of thousands of locations along a single sensor cable makes networking of large numbers point detectors obsolete.

**Highly reliable & flexible** industrial design with MTBF>33 years. **Field proven** and **maintenance-free**.

**Direct connection** to management systems such as DCS, SCADA etc.

**Turnkey solution** from engineering design to installation/commissioning.

THANK YOU... Questions/Comments?