Energy Harvesting Applications

Anything is possible…
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Presenters

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Agenda

- What it means to generate electricity with thermoelectric energy harvesting

- How Power Puck energy harvesters work with Rosemount wireless
  - Benefits
  - Installation scenarios

- Customer Proven Solutions

- Remote power for wired instrumentation with Power Tiles
Overcoming Battery Limits is Valuable

- Many wireless users:
  - Are concerned about battery life
  - Have waited to adopt wireless because of battery concerns
- Ideally, we want:
  - A self-sustaining system
  - The ability to capture data to meet business requirements without thinking about the impact to battery life
Power Pucks Overcome the Power Hurdle

Power Pucks®

Wireless products are designed to last

But battery limits → Create a gap

0 5 10+ years

Power Pucks fill this gap
How Thermoelectric Power Pucks Work

- Electricity from temperature differences between heat sources and the surrounding air.

- Similar to a solar cell in concept, but with energy generated from temperature differences instead of light.

- Heat applied to “n” and “p” semiconductor materials creates high densities of carriers which diffuse to lower density areas. The carrier diffusion results in voltage and current generation.

- Without moving parts or chemical reactions – NASA has used thermoelectric technology for >50 years without a single failure.
How Much Temperature Difference is Needed?

- Power from equipment or pipes
- 40°C temperature difference: full power for any update rate
- 20°C temperature difference: doubles battery life at 2- and 4-second rates; full power for 8-second update rates

Sample Scenario

<table>
<thead>
<tr>
<th></th>
<th>Celsius</th>
<th>Fahrenheit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Source</td>
<td>52°C</td>
<td>126°F</td>
</tr>
<tr>
<td>Ambient</td>
<td>22°C</td>
<td>72°F</td>
</tr>
<tr>
<td>Temperature Difference</td>
<td>30°C</td>
<td>54°F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Battery Only</th>
<th>Energy Harvesting (ΔT = Temp. Difference)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No EH (Years)</td>
<td>ΔT °C</td>
</tr>
<tr>
<td>2 sec.</td>
<td>1.30</td>
</tr>
<tr>
<td>4 sec.</td>
<td>2.20</td>
</tr>
<tr>
<td>8 sec.</td>
<td>3.70</td>
</tr>
</tbody>
</table>
Power Pucks for Rosemount Transmitters
Benefits of Energy Harvesting

- Update rate flexibility without battery life impact
- Power for the life of the transmitter
- Fewer battery replacements lower maintenance costs & decrease time in hazardous areas
- Works anywhere a temperature difference exists, with heat sources ranging from -45°C to 450°C
- Backup power from Intelligent Power Module batteries
Temperature Differences From Many Sources

Pumps & Motors
Compressors
Machine Casings
Holding Tanks
Steam Lines
Warm Process Fluids
Oil Production Lines
Boilers
Certified for Hazardous Area Operation

USA - Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1; Class I, Zone 0, AEx ia IIC T4

Canada - Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1; Class I, Zone 0, Ex ia IIC T4

ATEX – II1G Ex ia IIC T4 II1D Ex ia IIIC T135°C

IECEx – Ex ia IIC T4 Ga Ex ia IIIC T135°C Da

EMC, RoHS and IP67 certified

**Application: Upstream Oil – Steam Injection**

- **Challenge:** Reduce maintenance costs at remote well heads, while enjoying the cost and installation time benefits of wireless transmitter deployments.
- **Solution:** Power Pucks using the heat from steam injection lines.
- **Results:** With high heat sources, Power Pucks are able to drive multiple wireless transmitters. 3:1 installations operating successfully in San Joaquin Valley.
**Application: Upstream Oil – Production Oil**

- **Challenge:** Reduce maintenance costs at remote well heads, while enjoying the cost and installation time benefits of wireless transmitter deployments.

- **Solution:** Power Pucks using the heat from production pipes in cold environments.

- **Results:** Depending upon the specifics of the installation, Power Pucks can significantly improve or eliminate battery replacements while enabling faster update rates. Bakken and Alaska results very positive.
Application: Specialty Chemicals

**Challenge:** Monitoring steam flow using differential pressure measurements in very hot, difficult to access chemical facility locations. Pipes not configured in long straight runs.

**Solution:** Special Emerson top-mounted 3051S wireless differential pressure transmitters and Power Puck energy harvesters.

**Results:** In use since November 2014, top-mounted 3051S transmitters address the temperature and configuration challenges of the process environment. 260°C steam line easily allows Power Pucks to support 4 seconds or higher update rates and eliminates the need for battery maintenance.
Application: Steel Manufacturing

- **Challenge:** Operate CSI 9420 transmitters at update rate of 20 minutes or faster minimizing battery replacement expenses.

- **Solution:** Power Pucks using the heat from the rotating equipment the 9420’s are monitoring.

- **Results:** The ~150°F (~65°C) surface temperatures provide excellent ΔT even in warm conditions of pump motor rooms.

Note: 9420 solution is for non-hazardous locations only
For More Information on Power Pucks

Product Data Sheet link:
http://www2.emersonprocess.com/siteadmincenter/pm%20rosemount%20documents/00813-0100-4404.pdf

Quick Start Guide link:
http://www2.emersonprocess.com/siteadmincenter/pm%20rosemount%20documents/00825-0100-4404.pdf

Additional Information on Emerson Sales Portal as well as Perpetua Power’s website:
http://www.perpetuapower.com/emerson.htm
Energy Harvester Portfolio

**Power Pucks®**
For Wireless transmitters

**Power Tiles®**
For wired 4-20mA, 24VDC transmitters
Higher Power Applications

- Power wired 24VDC 4-20 mA instrumentation in steam environments where line power isn’t accessible, and/or wireless infrastructure not deployed.

- Energy harvesting lowers deployment costs
  - 20-80% of deployment cost is in installation
  - Installation, (labor + material) cost estimated at >$3K
  - Installation, site remediation (e.g. asbestos) $$
  - Decreased time to commission

- Turn a wired solution into a wireless with a Thumb adapter
Perpetua Power Tile Features

- ~100°C ΔT powers most devices; less ΔT if outdoors
- Integrated design for quick installations
- Rugged construction and maintenance-free operation
- Options for an integrated multi-day battery backup and/or external port for long-life backup power
- IP67 and RoHS compliant
- Standard mounting on 2- or 3-inch NPS diameter pipes
- Currently a ordinary location product
Steam generation increasing due to the benefits of co-generation – greater energy efficiency with combined heat and power generation than with either

- Monitoring steam distribution with Vortex flow meters such as the 8800D is particularly attractive
- Coupled with a THUM adapter turns this into a wireless configuration
Challenge: Transition manual monitoring of analog flow gauges in an underground infrastructure to digital devices. Wireless is essential due to the high cost of wiring.

Solution: Flow meters powered by Perpetua Power Tiles using the steam being monitored as the heat source transitions wired nodes to wireless.

Results: Lower cost, safer, and more reliable measurements insure that customer billing data will be fast, accurate and secured at the lowest cost.
Continuous, Reliable, Co-located Power

Fully powering Vortex Flow meters, HART communication back to RTU install site. Environment is very hot room with numerous steam leaks.

Steam Pipe Temperature
Power Tile Base Temperature
Ambient Temperature
Power Tile Output Voltage
Summary

- Power Pucks will provide power for Emerson wireless for the life of the transmitter.
- Eliminating battery maintenance lowers costs and provides update configuration flexibility.
- Energy harvesting is not just for wireless. Perpetua offers solutions for 24V, 4-20mA devices that convert wired to wireless.

- Questions?
Thank You for Attending!

Enjoy the rest of the conference.