MP Corrosion Innovation of the Year Awards Nomination Form for 2021

Additional Nominee's Name:

Job Title:

Organization:

Mailing Address:

City: State: ZIP/Postal Code: Country:

Telephone:

(If outside the United States and Canada, please include country code)

E-mail:

Is this the primary contact for the Award program? ☐ Yes ☐ No

Additional Nominee's Name:

Job Title:

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Mailing Address:

City: State: ZIP/Postal Code: Country:

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E-mail:

Is this the primary contact for the Award program? ☐ Yes ☐ No

NOTE: The above contact information will not be made public except the nominees' names, job titles, and organizations. However, all information submitted on the following pages will be submitted to the panel of corrosion experts and posted on the MP Corrosion Innovtion of the Year Awards web site.

2021 Award Nomination

Title of Innovation: **Belenus Condition Monitoring Sensor**
(insert title here—no more than five words)

Nominee(s): **Dr Dave Hughes, Novosound**
(insert Name[s] and Organization[s])

Web site: **www.novosound.net**

Summary Description:

Ultrasonic testing is the ideal technology for condition monitoring applications. There are, however, severe limitations with current ultrasound sensors for the use of asset integrity monitoring.

Most conventional ultrasound sensors cannot operate effectively when exposed to high temperature and extreme

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Full Description
(Please provide complete answers to the questions below. Graphs, charts, and photos can be inserted to support the answers.)

1. What is the innovation?

The innovation is a condition monitoring sensor, named the Belenus, which uses innovative, thin-film ultrasound technology to enable real-time, in-service monitoring of assets. With its compact size (1.97 x 1.26 x 0.79") and true flexibility, the Belenus can be fitted to a range of structures including pipes, storage tanks and pressure vessels, enabling 24/7 asset monitoring. Capable of continuous operation up to 400°C, the Belenus is suitable for fixed installation in both extreme and ambient environments.

2. How does the innovation work?

The Belenus utilises ultrasonic pulse-echo to monitor pipe wall thickness. It generates an ultrasonic signal into the pipe, and the time taken for a reflection to be detected allows for the calculation and visual display on a data acquisition unit, of the pipe wall thickness. A faster arrival time indicates that the pipe wall is thinning. The novel utilisation of ultrasonic thin-film material means that the Belenus has no intrinsic Curie temperature, unlike most standard sensors. This makes the Belenus the

3. Describe the corrosion problem or technological gap that sparked the development of the innovation. How does the innovation improve upon existing methods/technologies to address this corrosion problem or provide a new solution to bridge the technology gap?

Power stations, oil refineries, and nuclear plants all contain pipes which are subject to harsh environments, usually with high pressures and temperatures. Due to the harsh environment, the pipes tend to corrode over time and lose wall thickness which can lead to failure. In the interest of safety and to allow for timely and targeted maintenance, it is desirable to be able to monitor the condition of these pipes, preferably without costly equipment shut down.

4. Has the innovation been tested in the laboratory or in the field? If so, please describe any tests or field demonstrations and the results that support the capability and feasibility of the innovation.

Figure 1a) shows a photograph of a typical Belenus sensor, installed in a boiler. The utilisation of an ultrasonic thin-film has allowed for the creation of a simple, affordable device that can operate at >400°C. The thin-film sensor material is additively manufactured in-house making it cost-effective and repeatable. It does not need any coolant and can be compressed to the pipe surface due to its flexible nature. The entire sensor housing is 50 mm long, less than the size of a match-box, meaning it is

5. How can the innovation be incorporated into existing corrosion prevention and control activities and how does it benefit the industry/industries it serves (i.e., does it provide a cost and/or time savings; improve an inspection, testing, or data collection process; help to extend the service life of assets or corrosion-control systems, etc.)?

With the ability to continuously operate at high-temperatures >400°C, the Belenus allows for corrosion to be detected in pipes without the shutdown or cooling of assets, therefore greatly reducing maintenance costs and downtime. This also enhances safety as it limits staff exposure to high temperatures and hazardous environments. Additionally, without the need for a delay line when operating at high temperatures, there is no loss of signal between the sensor face and asset, therefore the Belenus

6. Is the innovation commercially available? If yes, how long has it been utilized? If not, what is the next step in making the innovation commercially available? What are the challenges, if any, that may affect further development or use of this innovation and how could they be overcome?

The Belenus sensor is commercially available and has been adopted by a BlueChip Energy Company based in the UK for Permanent Corrosion Monitoring inside a boiler. The Belenus is installed and has been successfully operating inside the boiler environment since the summer of 2020. When completing installation, there was restricted access to the burner and tight working spaces. This can be seen in figure 1, where the Belenus has limited space around the inspection pipe, and is

7. Are there any patents related to this work? If yes, please provide the patent title, number, and inventor.

Ultrasound Device, GB2582562A, Daniel Irving, David Hughes, Heather Trodden