



## **Lowering Costs by Improving Efficiencies in Biomass Fueled Boilers: New Materials and Coatings to Reduce Corrosion**

*Edition: October 2019*

Dear Readers,

every 4 months a newsletter will be shared with all stakeholders and scientific community that are involved and or interested in the field of bioenergy, including plant developers, plant operators, and technology suppliers, as well as governmental bodies. Furthermore, members from the general public who are interested in one or more of the topics related to BELENUS, such as bioenergy and materials engineering, will also gain from our quaternary newsletters.

These newsletters will cover project progress, special topics, news, relevant information and where to meet us in person at important events. In this first edition of the newsletter, you will learn about BELENUS in general and the project members.

The best is yet to come! Enjoy reading!

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## Special Topic: Advance Special Systems

### Partners involved

[VAL](#), France  
[INTA](#), Spain  
[TEandM](#), Portugal  
[SMT](#), Sweden  
[UCM](#), Spain  
[UNIPER](#), United Kingdom  
[TUM](#), Germany

[DBL](#), United Kingdom  
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[VTT](#), Finland  
[EIFER](#), Germany

### Importance of topic

According to the Strategic Energy Target (SET) Plan<sup>1</sup>, biomass **conversion performance into heat and power** presents **some concerns in terms of technological development and energy efficiency**. *Severe corrosion is considered the most serious problem in biomass plants*<sup>2</sup> caused by alkali metals, chlorine and other corrosive elements, resulting in material wastage, tube failures and leakages, and a shorter boiler tubing lifetime (Figure 1). In worst-case scenarios, corrosion leads to emergency shutdown of boilers, bringing huge economic losses and safety repercussions. Severe corrosion limits maximum temperatures and steam pressures in energy production, which translates into lower overall efficiency and profitability.



Figure 1: Corrosion in biomass plants

### Current state of the art

The current materials (SS 310 and SS 347 HFG and Ni base alloys 625 and 800H), and coatings corrode very fast at metal temperatures above 550°C. This issue leads to material wastage, tube failure and a shorter boiler tubing lifetime. Typical boiler components and SH tubes operating in biomass fired power plants experience high corrosion rates mainly induced by the high amount of chlorine present in the fuel (gas) and/or the present of alkali and heavy metals in condensed deposits (Figure 2). Therefore, the lifetime of these components is significantly reduced, limiting the operating temperature and

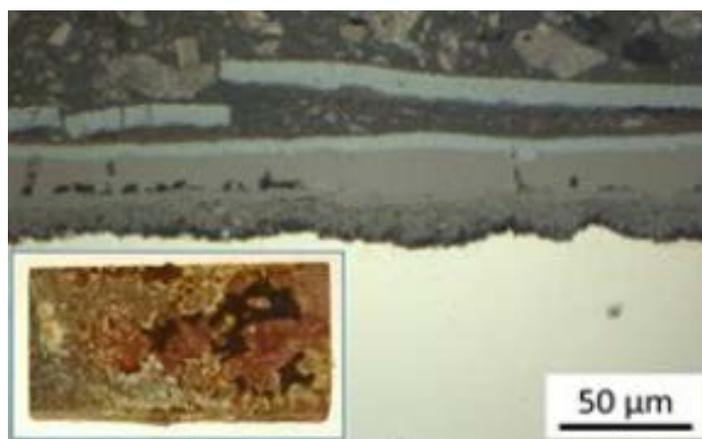


Figure 2: Biomass corrosion on base materials

thus

<sup>1</sup> SET-Plan – Declaration of Intent on "Strategic Targets for bioenergy and renewable fuels needed for sustainable transport solutions in the context of an Initiative for Global Leadership in Bioenergy

<sup>2</sup> [https://www.vgb.org/en/HT15\\_VGB\\_corrosion\\_workshop\\_2015.html](https://www.vgb.org/en/HT15_VGB_corrosion_workshop_2015.html)



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the efficiency of the biomass plant (electric efficiency from 25-37%), as well as significantly increasing the maintenance costs.

Many types of coating materials have been investigated and used, mostly based on weld overlays of Ni base alloys, including self-fluxing alloys (NiCrSiB) and composites incorporating ceramic materials such as SiC, Al<sub>2</sub>O<sub>3</sub>, Zr<sub>2</sub>O<sub>3</sub>, etc<sup>18</sup>. For instance, a cermet coating composed of TiO<sub>2</sub> and alloy 625 was estimated to last 27,000 h at a metal temperature of 448°C<sup>14</sup>. However, lifetimes at 550°C and higher are still insufficient and **most failures are related to coating defects such as pores and cracks, through which the corrosive species reach the substrate.**

In addition, welding is considered as the main technology for assembly and repair of boiler structures. Boiler fabrication procedures alter the microstructure of the base metal, mainly degrade coatings and affect properties either due to the forming and/or the thermal exposure.

To anticipate failures and manage risks equipment for corrosion detection would be a solution. iciparse There were few attempts in the past to monitor high temperature corrosion in power plants and none has been successful due to low durability, not enough accurate signals, etc.<sup>3,4,5</sup>

### The BELENUS approach

**BELENUS will avoid the use of expensive alloys (Ni-base) by developing highly-corrosion resistant coatings** combined with ferritic/martensitic and/or austenitic steels, that will be able to operate at >580°C, reaching higher efficiencies, and increasing their lifetime. Coatings of different compositions deposited by a range of techniques will be studied, potentially combining different methods appropriate to coat large and complex geometries found in boilers. **The coatings must be flexible in terms of being resistant to different types of biomass.**

In parallel, optimized joining strategies will be made available. An innovative element will be the determination of **critical peak temperatures to the coating system using thermo-physical forming and welding** simulation and transfer of this knowledge into manufacturing.

The **electrochemical ceramic-based composite sensor** proposed in BELENUS based on electrochemical reactions between materials and corrosive species present in combustion gases and ash deposits, it is not only t capable to measure the corrosion rate in mm/year (linear polarization resistance), but also detecting the corrosion mechanism (generalized or local corrosion attack). When localized attack starts (detected by electrochemical

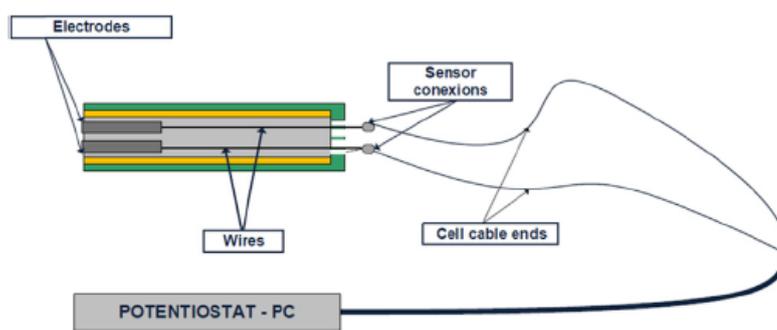


Figure 3: Sketch of the experimental setup for corrosion monitoring

noise) the sensor (Figure 3) should warn weeks before a critical failure happens, preventing unplanned shut-downs or accidents. The system will be designed and tested at laboratory scale to achieve reliable measurements up to 8,000 hours. Furthermore, it will be implemented in a real boiler and measures will be

<sup>3</sup> A. Stephan et al, Energy Procedia 120, 2017, 309-316

<sup>4</sup> B. Livingston, Ash Related Issues in Biomass. European Commission 2006

<sup>5</sup> Japanese patent JP2003346791 "Cooling electrochemical devices for measuring high temperature corrosion"



taken during 2,000 operational hours to evaluate their response, accuracy and validity. Thus, this sensor will optimize the programmed maintenance stops with more accuracy and anticipate failures.

Possible impact

The components lifetime of a biomass plant is highly affected by corrosion significantly reducing the plant lifetime. **The plant lifetime (currently 20 years) will be increased by 5 years and the annual operation from 8000 h to an average of 8400 h.**

In short, BELENUS brings innovations that will result in achieving CAPEX and OPEX reduction by about 1.03 and 40 % respectively.

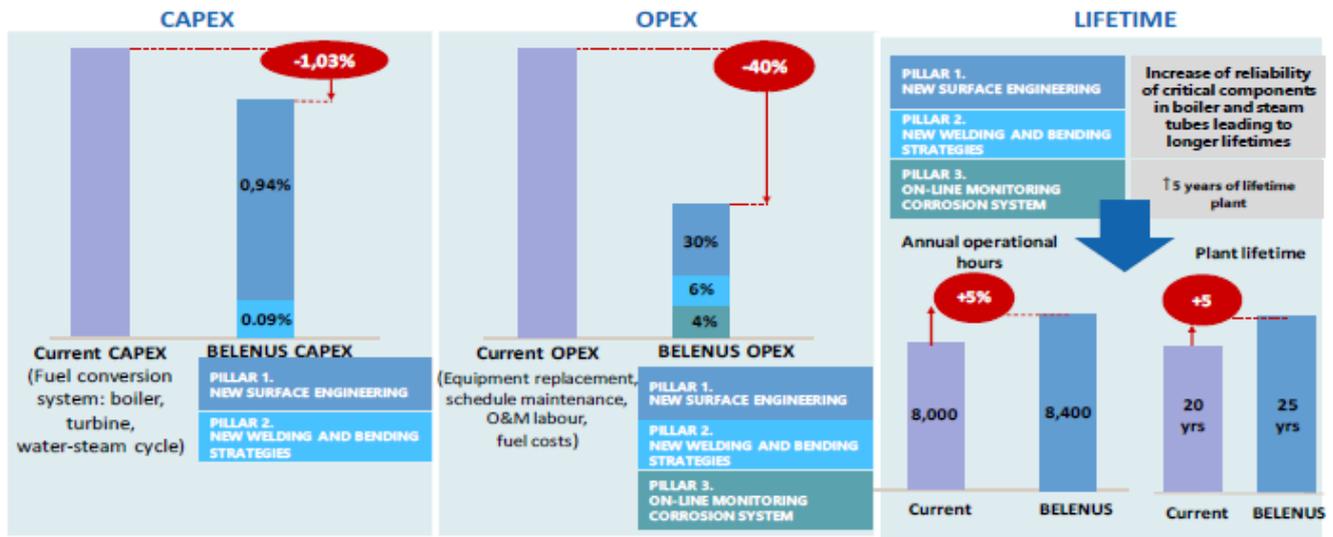


Figure 4: CAPEX, OPEX and Plant Lifetime total gains.

**Consortium meeting**

TEandM hosted the first consortium meeting in Coimbra, Portugal

On 29 - 30<sup>th</sup> of October 2019, TEandM hosted the 2<sup>nd</sup> GA meeting in Portugal.



Figure 5: Partners picture in Coimbra.



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As part of the meeting agenda, a visit of TEandM headquarters and industrial area was arranged. Partners saw the engineering processes and high technology used to protect materials in detail.

TEandM is regarded as a leader in supplying all the industrial applications of advanced materials for thick films (thermal spraying) and thin films (PVD). Therefore, it is one of their core values developing solutions for our customers based on the use of new materials and coating technologies and a very prompt service and on short notice, advanced shaping of materials.



Figure 6: Partners visit to TEandM facilities in Coimbra, Portugal.

## Sectorial Breaking News

Date	Headline	Source
3 June 2019	<a href="#"><u>Meeting Net-Zero GHG not possible without bioenergy</u></a>	Bioenergy Insight
17 July 2019	<a href="#"><u>Canadian Government invests in Indigenous biomass district heating system</u></a>	Bioenergy Insight
6 August 2019	<a href="#"><u>Drinks giant Diageo to invest in biomass boilers at African breweries</u></a>	Bioenergy Insight
2 October 2019	<a href="#"><u>German company RWE plans €1.5 billion renewables investment</u></a>	Bioenergy Insight
2 October 2019	<a href="#"><u>Atlantic Power signs energy supply contract for 66-MW biomass plant in Canada</u></a>	Renewables Now
17 October 2019	<a href="#"><u>Drax appoints independent advisory board and promises 'stronger' biomass sourcing policy</u></a>	BusinessGreen
25 October 2019	<a href="#"><u>Finnish firm to provide biomass boiler plant for Danone NZ facility</u></a>	Bioenergy Insight

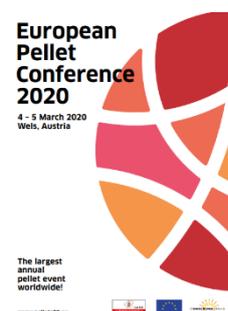


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## Remarkable Upcoming Events.

### 1. European Pellet Conference 2020

With more than 450 participants each year, it is the largest annual pellet event worldwide. This meeting place for the global pellet community offers a great opportunity to get informed about current trends in the pellet and bioenergy world. In just 2.5 days, the event offers delegates: a series of sessions delivering the latest news about markets, technologies and policies a full-day of technical site visits on fuels, equipment and exemplary installations a major tradeshow on renewable energy with over 100 pellet-related exhibitors



### 2. Biomass Power ON

Take an In-depth look into biomass to power supply, production and applications on this 2 day event filled with presentations from industry end-users and running projects case studies. Hear experts focus on new regulatory framework, fast paced market situation and more. Network and exchange ideas with colleagues from the energy industry.



### 3. International Conference on Bioenergy and Biodiesel Production

International Conference on Bioenergy and Biodiesel Production aims to bring together leading academic scientists, researchers and research scholars to exchange and share their experiences and research results on all aspects of Bioenergy and Biodiesel Production. It also provides a premier interdisciplinary platform for researchers, practitioners and educators to present and discuss the most recent innovations, trends, and concerns as well as practical challenges encountered and solutions adopted in the fields of Bioenergy and Biodiesel Production

ICBBP 2020: 14. International Conference on Bioenergy and Biodiesel Production  
May 14-15, 2020 In Paris, France



## Stay in contact with us. Visit our website

BELENUS website [www.belenus-project.eu](http://www.belenus-project.eu) is available since the early beginning of the project. It is the relevant source to show the scope and objectives of the project up and outstanding results. Find out more interesting information about the project and the impact of the results achieved, including all dissemination activities carried out.

If you have any questions feel free to drop us a line at [contact@belenus-project.eu](mailto:contact@belenus-project.eu) and remember you can follow us on *Twitter*  & *LinkedIn* .



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