



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

Edition: February 2021

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 impacts and information and where to meet us in person at important events. In this 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: Exposure of Corrosion Probes under Real Plant Conditions.

Partners involved

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

[CHAL](#), Sweden
[EIFER](#), Germany
[EDF](#), France
[UCM](#), Spain

Importance of the topic

While coal fired units operate at steam temperatures up to 650°C, the steam temperature in biomass fired boilers is limited to approximately 550°C. The reason is linked to problems of gaseous corrosion attack by $\text{HCl}_{(g)}$, as well as the build-up of alkali chloride deposits (mainly NaCl and KCl), which lowers the heat transfer and causing accelerated fireside corrosion, in particular in the upper part of the boiler, where the superheater (SH) tubes are located. The SH tubes are the heat exchangers, raising the steam circulating inside to its live operating temperature with heat transfer by convection and radiation of the hot combustion gas (850–900°C). Consequently, the corrosion problems limit the efficiency of the boiler and causes high maintenance, replacement and outage costs.



Figure 1: Superheater probe specimen string post exposure

In order to make biomass power plants a competitive source of energy compared to other renewable energies, the boiler steam conditions (pressure and temperature) of the SH tubes should be maximised to improve conversion efficiency. However, fireside corrosion testing is not a standardised process, especially when testing in operational boilers.

Current state of the art

The most well-established and longest-used method in industry to measure corrosion rates is the exposure of coupons of the materials of interest, because of its simple working principle, easy operation, and versatility. These coupons are assembled into a corrosion probe which is installed into a boiler and exposed to the corrosive environment for a period ranging from a few hundred to several thousand hours. Following exposure the probe is retrieved for post exposure assessment comprising metal loss measurement (weight change or coupon thickness), optical microscopy and Scanning Electron Microscopy (SEM), x-ray elemental / diffraction on the corroded coupons.



Figure 2: Corrosion probe with coupons prior to installation and exposure in operational boiler.

Specifically, corrosion probe exposures in operational boilers enables the collection of data at temperatures greater than that seen by the SH tubing operating within the host boiler and the exposure of alternative



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tubing alloys or corrosion protection systems can be undertaken without interfering with the normal boiler operation. It is still held as the gold standard to evaluate corrosion rates compared to a variety of corrosion monitoring technologies. However, this methodology is limited, requiring relatively long-term exposures to provide meaningful data and average corrosion rate information can only be gathered once the damage has been done, i.e. it does not offer an on-line or near real-time access to corrosion rate data. Real time data offers the possibility of linking plant operational changes or fuel changes to instantaneous corrosion rates.

The BELENUS approach

New improved or alternative coatings, with proven long-term performance in actual boiler environments to reduce corrosion at future anticipated operating trends and cost reduction in the mid-term will be developed in BELENUS.

The current materials and coatings can corrode at an unacceptable, very fast rate at metal temperatures above 550°C, leading to tube wall thinning, failure and un-economically short boiler tubing operating lifetime. BELENUS will avoid the use of expensive alloys (Ni-base) by developing highly-corrosion resistant coatings combined with ferritic/martensitic and/or austenitic steels.

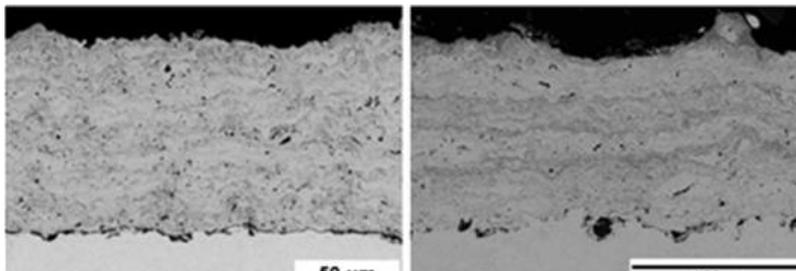


Figure 3: HVOF sprayed Fe50Cr50: a) before; and b) after 600 hours at 550°C under KCl and K₂SO₄ deposits.

Some of these new materials systems together with existing coatings systems and un-protected alloy tubes as reference, will be assembled in to air-cooled corrosion probes and inserted into the hot gas path of operating biomass boilers for extended periods. Thermocouples will be positioned along the probes to record surface metal temperatures and allow control the coupon temperatures. It is therefore possible to have coupons exposed to wide temperature ranges along the probes and thus have the ability to expose coupons at higher temperatures than the plant final SH temperature. In addition, fuel, ash and flue gas samples will be gathered and analysed to evaluate biomass quality and correlate with the corrosion behaviour and with the pilot plants results. Field testing is an important step in validating BELENUS coating-materials system solutions and fireside testing protocol. Finally, efforts to correlate the lab fireside corrosion results with those obtained in pilot plants and industrial plants (corrosion probes) will be done to provide recommendations seeking to create a biomass corrosion testing standard. Finally, some BELENUS partners are members of the ISO-WG13 International Committee and they will seek to introduce the new standards to the technical community.

BELENUS will study and test the following:

- ✓ Coating sections of tubes and pipes with the BELENUS coating-materials system solutions, as well as existing coatings systems and substrates as reference.
- ✓ Inserting air-cooled corrosion probes of the selected systems into the hot gas path of operating biomass boilers for extended periods and the subsequent post exposure assessment.
- ✓ Gathering and analysing fuel, ash and flue gas samples in order to evaluate biomass quality and correlate with the observed corrosion behaviour, including data routinely gathered by the plant operators.
- ✓ Seeking recommendations to create a biomass corrosion testing standard to the technical community

Possible Impact



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BELENUS will bring improvements regarding the current issues in biomass power plants: [1] Existing “standard” corrosion resistant coatings such as IN625 weld overlays, have reached the limits of application in terms of gas and boiler tubing metal temperatures. [2] In-situ repairs currently difficult, or impossible in close spaced tube banks. Extended outages required when large scale tubing replacements are needed to prevent failures in corroded tubing. [3] Many coatings are nickel based and subject to high and variable/uncertain costs due to fluctuations in the price of nickel.

BELENUS will also enhance the understanding and quantitative treatment of complex processes of degradation of protective high temperature coatings resulting from chemical and mechanical interaction, and their lifetime assessment, enabling a quantitative characterization of coating performance and degradation of component and plant operation at any given time. Moreover, the material systems developed in BELENUS have the potential to provide longer life alternatives to chemical, petrochemical, nuclear and even fossil fuels plants, in which high temperature corrosion from very aggressive atmospheres needs to be mitigated.

Sectorial Breaking News

Date	Headline	Source
4 th February 2021	Ørsted reports strong 2020 results	Bioenergy Insight
8 th February 2021	Drax to buy Canadian biomass producer Pinnacle in USD-580m deal	Renewables Now
10 th February 2021	Renewable power output in Argentina rises by 63% y/y in 2020	Renewables Now
12 th February 2021	Renova inks option to take lion's share in 75-MW biomass-fed plant in Japan	Renewables Now
18 th February 2021	New biomass tracking project will divert material from landfill, produce biochar	Bioenergy Insight

Remarkable Upcoming Events.

1. 29th European Biomass Conference & Exhibition, EUBCE 2021

On account of the Covid-19/coronavirus pandemic, this year’s European Biomass Conference and Exhibition will be held almost exclusively virtually from 26–29 April 2021.

Each year, EUBCE brings together the greatest minds and latest advancements in biomass, with the aim of accelerating research and market uptake across the globe. EUBCE has become the world’s leading event for all things biomass including its exhibition showcasing relevant and new technologies. In order to comply with WHO recommendations and travel regulations of European countries, this year’s e-EUBCE will be held virtually and online-only. More than 1500 delegates, 5000 visitors and authors from 80 countries are expected to attend the 29th European Biomass Conference and Exhibition.



2. European Pellet Conference 2021



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Different dates, but same high-relevance content! Boosting economic recovery with bioenergy – this is the focus of the 2021 conference. Learn and discuss how we can make a green recovery happen in practice and how the pellet sector can profit from this deep transformation.

This special edition of the annual conference will be held as a hybrid event: you can join in Wels/Austria or connect digitally from anywhere in the world. The new date is 21–25 June 2021.



World Sustainable Energy Days
New date: 21 - 25 June 2021, Wels/Austria

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. It offers a series of sessions presenting the latest trends about markets, policies and technologies.

3. Bio360 Expo

Combining the converging worlds of biogas, biomass, waste-to-x, carbon capture and utilisation, carbon sequestration, the bioeconomy. Bio360 Expo is an international exhibition providing a panoramic view of all things bio-derived.



Bio360 Open / Retiers, Brittany
30 June-01 Jul. 2021

Bio360 Expo attracts 7000 professionals and 450 exhibitors from across 35 countries and 5 continents. It's highly international character is further enhanced through a rich conference programme with simultaneous translation, a large panel of international speakers and international B2B business meetings, study tours to local sites of special interest, the innovation competition etc.

Stay in contact with us. Visit our website.

BELENUS website 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 and remember you can follow us on *LinkedIn* .



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