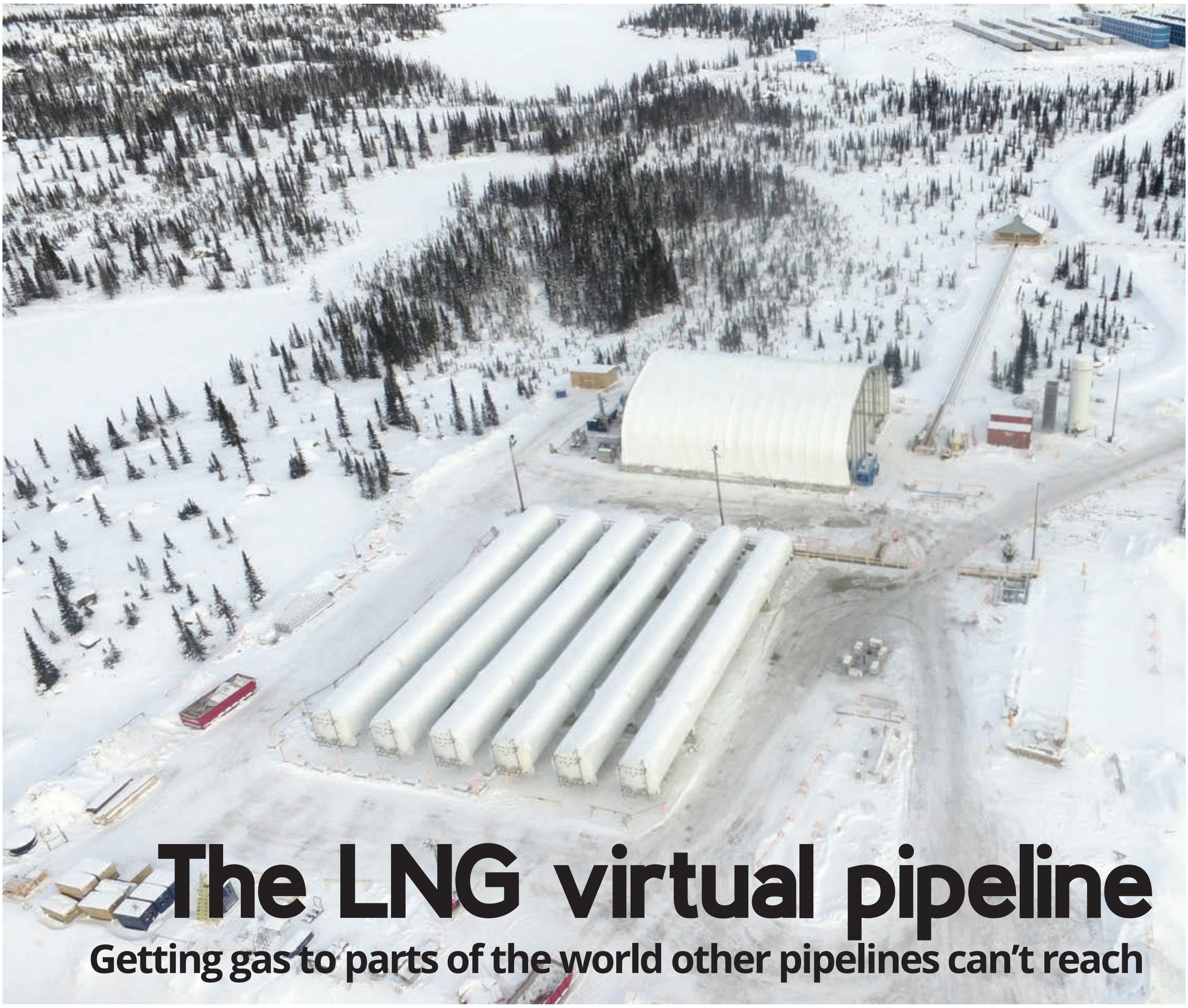
MPS
modern power systems



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Magaldi MAP shows the route to a more efficient lignite future

Higher efficiency and lower emissions have been achieved at the Işalniţa lignite fired plant in Romania as a result of a wet-to-dry bottom ash conversion and introduction of post-combustion for unburnt residues of the bottom ash handling system

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In the 1980s Magaldi invented a dry bottom ash handling (DBAH) technology known as MAC®, Magaldi Ash Cooler. It is a system for dry extraction, air cooling and mechanical handling of bottom ash from pulverised coal-fired (PCF) boilers. The DBAH technology recovers energy from the bottom ash produced in coal-fired power plants thus improving the boiler efficiency, compared to a conventional "wet" system.

A new challenge in recent years has been the application of DBAH technology to PCF boilers producing bottom ash with a high unburned content. This condition can be encountered in PCF boilers that are burning solid fuels that present milling difficulties, for example lignite, RDF (refuse derived fuel) or biomass, and the consequent incomplete combustion.

In that case, the DBAH system provides the opportunity to continue the combustion of unburned residues, thus significantly increasing the positive impact on boiler efficiency thanks to the significant chemical energy content of these residues.

However, the significant heat generated from this "post-combustion" requires design modifications to accommodate higher temperatures and implementation of accurate process control in order to ensure safe and dependable operation. That need led to the design of a new product: MAP® – the Magaldi Ash Postcombustor – a development of the MAC® system that enhances and controls the post-combustion of unburned particles.

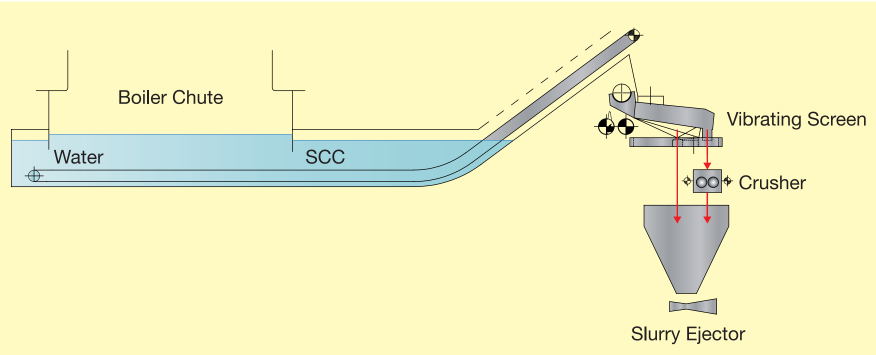

Figure 1. Wet system configuration prior to the MAP system installation

Experience with MAP® was gained in European power plants where coal is co-fired with RDF and/or biomass, and subsequently Magaldi designed, installed and successfully commissioned two MAP systems for extraction and post-combustion of bottom ash produced by lignite fired boilers at the Işalniţa power plant in Romania. They were installed on boilers 7A and 7B, which serve a common 315 MWe steam turbine.

This article summarises results achieved by the wet-to-dry conversion of the bottom ash handling system at the plant. On each unit the MAP system, commissioned in October 2017, performs both the dry bottom ash extraction and the afterburning process.

Table 1. Işalniţa power plant, unit 7 main design data

Steam generators	7A and 7B
Power unit capacity	325 MW
Steam generator capacity (each)	510 t/h
Lignite rate for each steam generator	220 t/h
Lignite low heating value	1600 – 2000 kcal/kg
Lignite carbon content	19 – 25%
Lignite humidity	40 – 46%
Natural gas (CH_4) thermal contribution	Max. 10%, ~ 4500 Nm³/h, Avg. 2000 Nm³/h
Normal bottom ash production (per boiler)	3 t/h
Maximum bottom ash production (per boiler)	6 t/h
Economiser ash production (discharged in B.A. system in emergency conditions)	3 t/h
Superheater ash rate (discharged in B.A. system in emergency conditions)	1.2 t/h
Unburned content in bottom ash	Min 25%, Max 55%, Avg. 40%

Coal and RFD co-firing post-combustion experience

Magaldi had already had the opportunity to test and analyse the bottom ash post-combustion process at the Fusina power plant in Italy. In 1993 the MAC system was installed on units 3 and 4 there, each 320 MWe. In 2004 the plant owner started to co-fire RDF with coal, at a rate of up to 5% of the thermal input to the boiler. The co-firing of RDF increased the unburned carbon content (UBC) in the bottom ash and some upgrades were introduced by Magaldi on the MAC systems. Over the years Magaldi carried out several test runs and experimental results were collected and analysed: the feasibility of afterburning carbon residues in the bottom ash and promoting and controlling the post-combustion process was thoroughly analysed.

Gaining from the experience and the results gained at Fusina, in 2011 Magaldi replaced the existing wet system with a dry MAP system at the hard-coal-fired Gersteinwerk unit K in Germany.

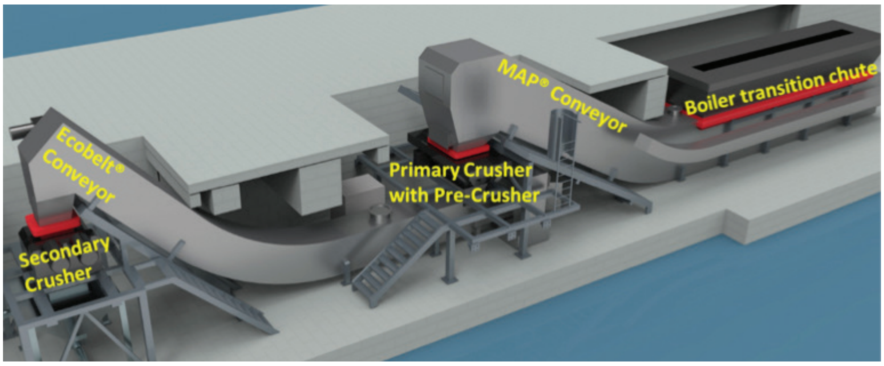

Figure 2. The MAP system configuration at Işalniţa

MAP system installation at Işalniţa

Building on the experience gained thus far, in September 2017 two MAP systems were installed under the two lignite fuelled boilers of Işalniţa unit 7, in place of the existing wet bottom ash handling systems (WBAHS, submerged chain conveyor SCC type).

The Işalniţa power plant is located in Dolj County, about 10 km north west of Craiova, Romania. It is owned by Societatea Complexul Energetic Oltenia SA (CEO).

Before the installation of the MAP system, natural gas was used as flame support fuel. The natural gas contribution was a maximum 10% of the total thermal input, corresponding to 4500 Nm^3/h.

In the wet bottom ash system, before MAP was installed, the bottom ash generated by the combustion process in the furnace fell into the water filled basin of the SCC conveyor, and was then transported to a vibrating screen. The screen separated out larger particles, which were processed by a crusher, and retained as smaller particles. All the ash was therefore discharged to the downstream slurry conveying line.

Prior to the MAP installation, the combustion process generated very high UBC content (up to 55%). The SCC was installed in a pit below the ground level, in a dirty and dangerous environment, where a mix of water and ash was permanently lying on the pit floor. High maintenance costs of the SCC were an issue, exacerbated by frequent breakdowns which caused boiler shutdowns.

Moreover, and above all, the large amount of natural gas, constantly used to help create a stable combustion process, significantly increased the unit costs of power generation.

Because of these factors, the owner decided to invest in refurbishment of the bottom ash handling systems at unit 7.

The main targets of the project are summarised below:

- reduction of operating and maintenance costs of the bottom ash handing system.;
- an increase in boiler efficiency and reduction of power plant fuel consumption by the post-combustion of unburned fuel in the bottom ash;
- a minimum 50% decrease in bottom ash unburned content;
- elimination or reduction of water used for bottom ash mechanical handling;
- improvement in availability of the bottom ash handling system;
- increase of the bottom ash handling system lifetime (to a minimum 15 years);
- reduction in the power plant's power consumption;
- improvements in the operational stability, safety and security of the bottom ash handling system;
- reduction of the hydrocarbon (natural gas) admixture in the combustion process from 4.5-5.5% to a maximum value of 1.5% following installation of the new MAP dry bottom ash handling system.

System configuration

The MAP system configuration at Işalniţa includes:

- MAP conveyor, connected to the existing boiler transition chute, to extract, and promote post-combustion of, bottom ash;
- pre-crusher and primary crusher installed to reduce the ash particle size down to 80 mm;
- Ecobelt® conveyor, installed downstream of the MAP conveyor, for further ash transportation and cooling;
- double roll secondary crusher to further reduce ash particle size to 14 mm, a suitable size for the downstream slurry and high concentration slurry disposal systems.

Figure 3. Post-combustion on the MAP conveyor steel belt ('Superbelt')

System performance

After installation and commissioning, MAP system performance at Işalniţa PS was measured during tests carried out by a third party company. The tests compared the unburned residues and the boiler efficiency before and after the wet-to-dry refurbishment works at different boiler loads (315, 275, 250 and 210 MWe).

The reduction in unburned residues and heat recovery levels achieved are shown in Table 2. The main benefit for the plant operator was a significant reduction in natural gas consumption due to heat recovery from the combustion of the UBC residues contained in the bottom ash. After the MAP installation the continuous use of natural gas was in fact eliminated. At 5000 operating hours for each boiler, the yearly saving of natural gas was calculated to be in the range 10 to 22.5 million of Nm^3.

Conclusions

The Magaldi MAP technology has been shown to contribute to an increase in boiler efficiency and a reduction of CO_2 emissions at Işalniţa. Because of the significant reduction in unburned residues, the MAP system recovers back to the boiler the chemical energy contained in the bottom ash, which in conventional wet systems is lost. As a result, based on the same power output, a significant reduction in fuel consumption is also achieved.

The MAP system installed below the steam generators 7A and 7B at Işalniţa power station has improved the boiler efficiency by 2–4% (depending on the operating conditions), and has eliminated the use of water as a cooling and transport medium from below the boiler throat to the downstream slurry disposal system.

In the case of 100% lignite firing or biomass/RDF co-firing with coal, the application of air cooled ash removal, with simultaneous and controlled post-combustion of unburned residues on the conveyor belt, effectively enlarges the furnace and improves combustion efficiency over a range of fuel qualities. The dry conveyor increases the dwell time of unburned particles below the boiler. The unburned particles fall from the furnace onto the conveyor belt and persist below the boiler for a few minutes since the conveyor runs very slowly (< 2 cm/s). The technology was confirmed as able to render conventional coal plants more flexible and efficient. ■

Table 2. Unburned residues and heat recovered by MAP

Unburned residues, SCC system	32–58%
Unburned residues, MAP system	7–15%
Heat recovered	7.8 – 21.1 MWt

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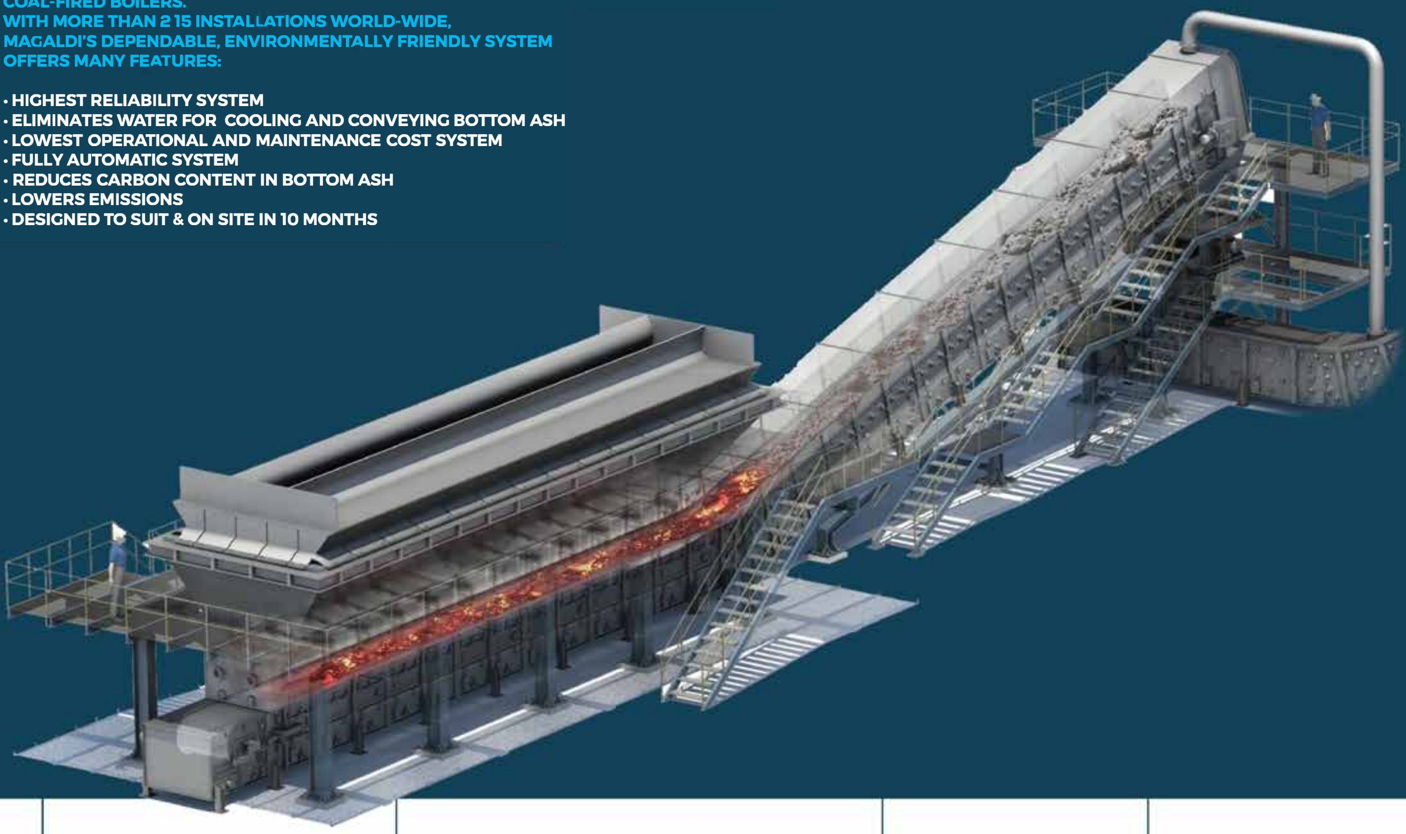
- FULLY AUTOMATIC SYSTEM
- REDUCES CARBON CONTENT IN BOTTOM ASH
- LOWERS EMISSIONS
- DESIGNED TO SUIT & ON SITE IN 10 MONTHS



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