

Circumix ash handling technology with HX-Factor

Making a brown business go green



Ash handling with HX-Factor

The HX-Factor is our promise and stands for our unique expertise in Heat Exchange (HX = **H**eat E**x**change). It marks all our services and products. GEA Circumix Dense Slurry Technology with process automation is a customized and world-wide unique ash handling system with a long life time, sustainability and eco-friendliness.

Competence for sustainable ash handling

A reliable and safe disposal technology for coal combustion by-products and effluents

GEA Heat Exchangers: leading worldwide in heat exchange

GEA Heat Exchangers consolidates all the activities in the area of heat exchange and offers the probably largest portfolio worldwide in this field. Heat exchange with HX-Factor: that means customized, reliable, and sustainable solutions conforming to the signs of the times. The GEA Circumix Dense Slurry System (DSS) is an impressive proof of this quality and innovative strength.

GEA Circumix Dense Slurry System (DSS)

Waste management is an issue of high importance in every coal fired power station. Different processes related to the electricity generation produce several effluents and solid by-products. Those by-products can be fly ash from the flue gas purification, bottom or bed ash from the furnace, gypsum and effluents from the desulphurization process or blow-down from wet cooling towers.

All these kinds of pollution generated by a coal fired power station are subject to very strict emission standards, frequent monitoring, hence efficient and state-of-the-art cleaning and disposing technologies are required. Current management techniques involve disposal with either lean (wet) or dry technologies: the first one raises problems with excessive water usage and effluent emission while the latter involves dusting and stress posed by trucks. Bottom ash, for instance, is nearly always handled with a lean slurry technology and gypsum – if not marketable – is simply piled up onsite in dry form.

While most facilities thus maintain several different treatment and disposal technologies to deal with all the streams of materials, the Circumix DSS handles and disposes them of all in one single process. And if that is not enough, the Circumix DSS works in line with environmental, ecological as well as sustainable aspects.

The GEA Circumix mixer primarily works with fly ash and process water as the solidification of the final product is ensured by the chemical composition of the fly ash. Additionally, the system can receive and process bottom ash or bed ash as well as gypsum and wastewaters of different kinds. So it unites the positive advantages of both lean and dry technologies while dismissing all the negative aspects.





Our competence center for sustainable ash handling in Hungary: GEA EGI Contracting/Engineering Co. Ltd.



The GEA Circumix mixers: reliable and simple to operate with optimal water usage and low power consumption

Protecting our environment

HX-Factor for environmental friendliness

The Circumix DSS uniquely combines ecological aspects with a reliable ash handling system. The disposed end-product forms a solid surface which is resistant to wind erosion; hence no fugitive dust occurs on the landfill. Most of the water mixed with the ash is consumed by the hydration processes and mineral transformations resulting in very small quantities of free liquids. Any small amount of free liquid that may be present is lost to evaporation or bound by capillary forces in the cured product.

The low hydraulic conductivity (measured 10^{-4} to 10^{-9} cm/sec) provides for enhanced ground water and soil protection. The leachate rates are low and, moreover, the leachate is rather clean. Due to the solid nature of the final product there is no risk of catastrophic releases associated with dike failure.

The material can be deposited in tiered, multi-level disposal sites. Once a tier is filled and the surface is solidified, the next-level dike which will contain the discharged slurry can be constructed of the same final product. After its closure the so-constructed disposal site is then easily to cover with green vegetation.

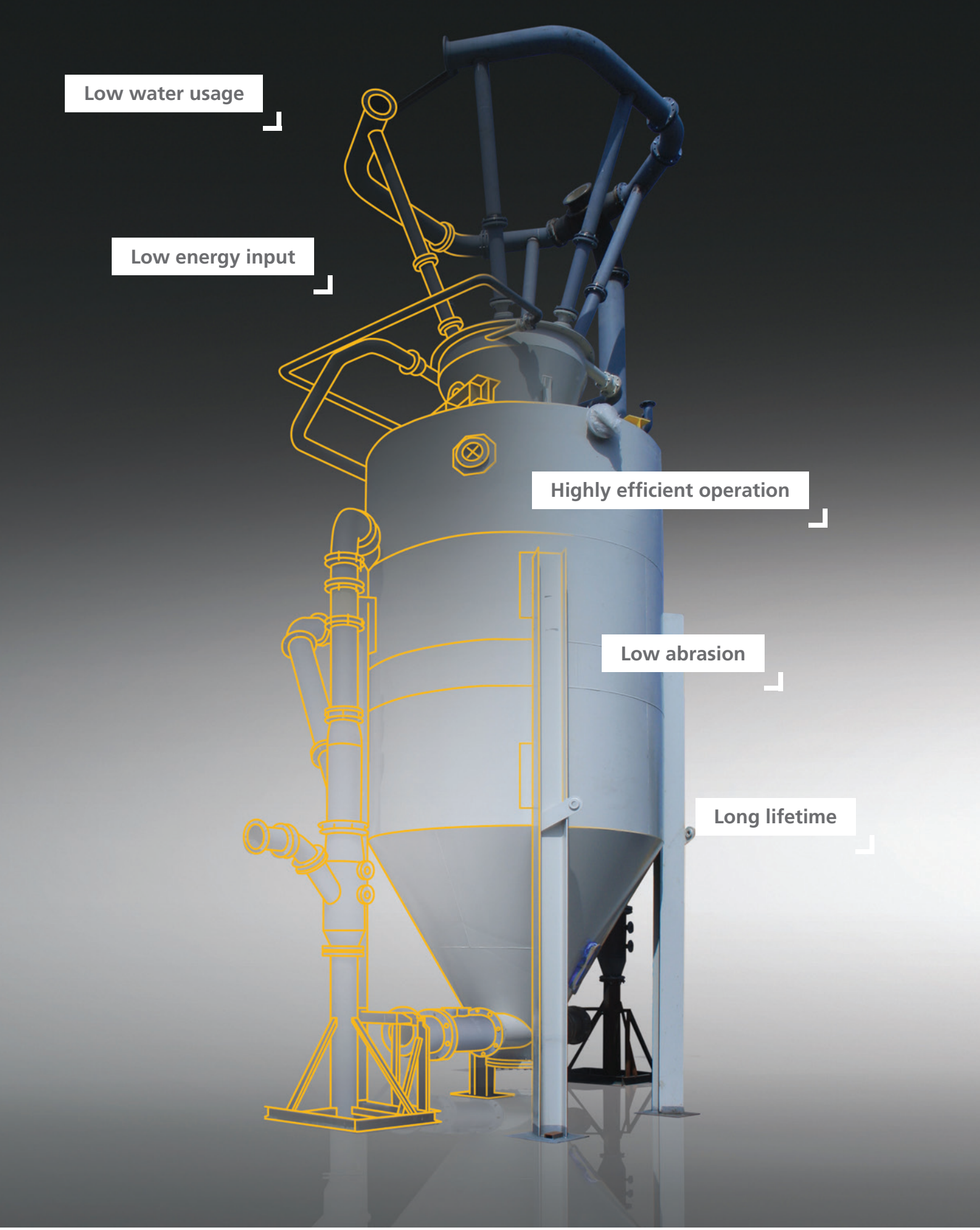


Operational and maintenance benefits

Efficient operation protects environment

The Circumix DSS is not only focused on environmental advantages, the Circumix system is also highly economic to run. There are hardly any moving parts and the abrasive particles are kept in suspension within the slurry. That is the reason why the wear and tear of the equipment is so low. This results in long lifetime and low maintenance costs.
Those few parts that are exposed to erosion are lined with ceramic chips. The key maintenance items are the volutes and impellers of the pumps; they only need to be replaced after the long operation time of 5,000-10,000 hours.

Moreover, the Circumix technology uses the very optimal amount of water: enough for the chemical reactions and mineral transformation, yet not too much to unreasonably increase the transported volume. This way both water consumption and electricity demand are kept very low and, therefore, it is resulting in moderate operational costs. Furthermore, due to the high level of automation and the simple distribution system both the operation and the landfill management require a minimal effort from operators.


Low water usage
Low energy input
Highly efficient operation
Low abrasion
Long lifetime

Ash handling with HX-Factor

Technical details of the Circumix DSS

The Circumix DSS is based on a set of three natural chemical reactions between water and the reactive particles present in the ash: calcium-oxide, aluminates and sulfates, together forming calcium silicate hydrates and calcium aluminate hydrates. Under optimal conditions the ash-water mixture rapidly solidifies at the disposal site by pozzolanic reactions and ettringite formation. Those optimal conditions can be ensured by accurately adjusting the amount of water and applying a very intensive mixing.

The Circumix DSS is a high intensity mixing process which was especially designed to ensure these necessary circumstances with the least possible power input. The core component of the technology is the hydrodynamic mixer and a very accurate, state-of-the-art control system capable of adjusting the proper density as well as the required volume flow as boiler load changes.

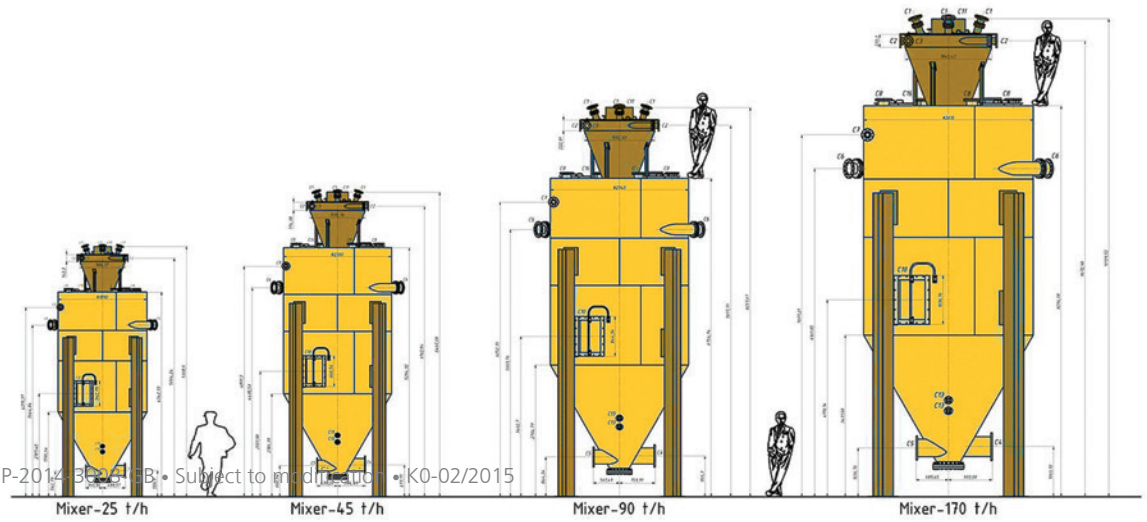
The Circumix technology applies a four-stage hydrodynamic mixing to produce a very homogenous ash-water slurry and, moreover, to avoid "dead", non-agitated zones and settling of particles. The intensive mixing process enables a very short residence time of the material in the mixer. Thanks to this short residence time a fast response control is possible. Depending on ash quality the water to solid ratio of the dense slurry is around 0.9 - 1.1 : 1. This is the secret of ensuring easy pumping while catering for the chemical reactions. The viscosity of the slurry is in an optimal status. It is low enough to allow the use of low-cost, simple centrifugal pumps but still sufficient to keep even the larger ash particles in suspension, thus minimizing the wear of the pipelines.

Once discharged on the disposal site, the slurry hardens within only 24 to 72 hours. When cured, the end-product exhibits low hydraulic conductivity, high compressional strength, little or no fugitive emissions nor sequestration of heavy metals and other pollutants.

The Circumix process is a unique method for handling coal combustion residues as it can not only handle fly ash, coarse ash and bottom ash within the same process, but if necessary also other by-products. Those other by-products might be FGD gypsum which may also be integrated and safely disposed, together with various wastewaters of the plant.

HX-Factor effects for ash handling

- Enhanced operational safety
- No risk of catastrophic releases
- Efficient land-use
- High compressional strength of end product
- Reduced noise level
- No fugitive dust emissions
- Low energy costs
- Reduced need for additional supporting services
- Simplified closure
- Reduced risk of groundwater pollution





Landfill area at Mátra Power Plant: Each tier means one year of disposal of dense slurry

Long-lasting experience with HX-Factor

The Circumix DSS is a mature technology

The Circumix technology is the result of continuous development in the past 25 years and a commercially mature as well as a proven solution. Numerous systems are in operation worldwide, with having over fifteen years of excellent operational history. In order to exploit the advantages in cost and maintenance, Circumix DSS usually employs centrifugal pumps to transport the slurry. But the system is flexible and can also accommodate piston-type pumps, if that is required.

The very first, then intermittently operated Circumix system was installed in 1990 in Hungary, followed by the first continuous operation mixer in 1992. The first real large-scale system was installed in the Mátra Power Station in 1998, and has been working trouble-freely since. Mátra was also the first power station where, after a major upgrade in 2000, FGD by-products were also handled by the Circumix DSS. The first overseas project was commissioned in 2003 in the Jacksonville North Side Generating Station, in the USA in Florida. By today the Circumix systems serve over 6,000 MW_e coal fired power plant capacity and have safely processed and deposited more than 60 million cubic meters of dense slurry.



All projects are tailor-made

Different ash qualities require customizing

Ensuring the high quality and environmental performance of the deposited material requires very careful and accurate design. Therefore, careful testing of the combustion residues and water is required to determine the optimum “recipe” for stabilizing combustion products with wastewater from a power plant. These tests provide the basic input for design and, moreover, they include the identification of physical properties; the chemical and mineral analysis and the rheological features of the ashes and slurry. If more material for testing is available it is possible to make slurry samples. After a proper curing time of approximately 90 days they can be tested for hydraulic conductivity, leach performance and compressional strength in order to predict landfill behavior.



GEA EGI Pilot Mobile Circumix Plant

Although most of these tests can be done in laboratories, semi-industrial scale testing on-site is also possible with the GEA EGI’s Pilot Mobile Circumix Plant (PMCP). This small-scale mixer system fits in a standard-size container but its working principle and design is identical to the industrial size equipment. Testing with this equipment has the advantage that exactly those materials are used in the tests that are generated in the plant. Furthermore, the plant operators can have a hands-on experience with the system and also important experience is gained for equipment design.



Geotextile for covering
The bottom lining prevents ground-water pollution

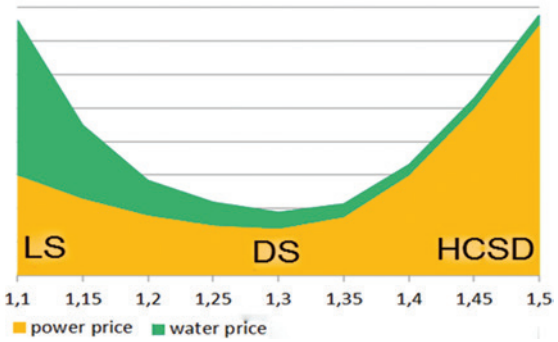


Ash stone
The solid surface of the end product eliminates dusting and air pollution

Maximal Pros with the HX-Factor

Circumix DSS advantages at a glance

The Circumix system works at optimum conditions which enabe a highly economic operation.



Lean slurry (LS) systems have higher water demand which raises water price and pumping demand while high concentration slurry disposal systems (HCSD) work with high pressure and hence big power consumption. The total cost of discharge is the lowest with dense slurry technology (DS): The Circumix DSS is at the optimum point where discharge volume is moderate and pumping demand is kept low thanks to low discharge pressure. The Circumix DSS is a future-oriented technology with maximal benefits for the environment while combining the Pros of both systems and eliminating the Cons:

Overview - wet ash management Pros	Cons
Relatively low capital costs	High water use
Ease of ash transport	Waste water management
Easy to operate	Risk of flow if released
	Stringent inspection and maintenance
	Risk of ground water contamination
	Will become airborne if dry
	Process water leachate
	Complex closure requirements

Overview - dry ash management Pros	Cons
Low water use	Relatively high capital operating costs
Reduced waste water	High risk of fugitive dust
Product will not flow	Multiple handling for transport
Lower risk of ground water contamination	Increased safety risk from trucks
Easier closure requirements	Heavy equipment required for lanfill management
Eased inspection and maintenance	


No ground water pollution
No dusting on surface
No need for protection zone
No risk of spill
Landfill fits in landscape

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