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HOW TO MAKE THE PLANTS OF TODAY COMPLY WITH THE REQUIREMENTS OF TOMORROW[1]

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Abstract
SMS Siemag expects the future to hold great potential for the field of energy and environmental technology. In the last two years, the company has brought different innovative concepts to market and has already been awarded orders for the corresponding technologies (e.g. energy recovery from EAF off-gas heat, hydrothermal regeneration of acids, waste water treatment systems, metal recovery solutions and a new generation of electric filters for primary BOF dedusting). We further reinforced our traditional dedication to energy-efficient and environment-friendly plants and equipment. Consequently, we extended our specialists team to offer an integrated solution how to use different energy sources available in a metallurgical plant complex most efficiently. Steelmaking processes generate a large range of gaseous byproducts like blast furnace gas, coke oven gas and converter gas that have a high energy content in the form of combustible components. Utilizing these gases as primary fuel in a firing plant contributes significantly to increased energy efficiency in steelworks, and therefore reduces the overall steel manufacturing costs and saves CO_2 emissions. For the systematic utilization of these gases to generate e.g. steam for production and/or to generate electricity in a complete power station process, SMS Siemag offers a wide range of part-standardized steam generators. The presentation will sum up the technologies introduced so far and give an outlook on the potentials of the new industrial power plants.
Key words: Environmental technology; Energy recovery; Energy efficiency; Acid regeneration; Water treatment; Electric filters; Metal recovery; Power plants.

COMO FAZER AS INSTALAÇÕES DE HOJE ATENDEREM AOS REQUISITOS DE AMANHÃ

Resumo
A SMS Siemag aposta no futuro potencial para as tecnologias ambientais e energéticas. Nos últimos dois anos a empresa trouxe conceitos inovadores para o mercado, sendo já contemplada com projetos nestas áreas (ex.: recuperação de energia térmica dos gases de processo em FEA, regeneração hidrotérmica de ácidos, sistemas de tratamento de água, soluções para recuperação de metais e a nossa geração de filtros elétricos para desempoeiramento primário em convertedores). Nós também reforçamos nossa tradicional dedicação em plantas e equipamentos eficientes energeticamente e ambientalmente corretos. Consequentemente nossos especialistas desenvolveram soluções integradas no uso eficiente de diferentes fontes energéticas disponíveis no processamento metalúrgico. Processos de aciarias geram diversos gases como sub-produtos: gás de alto forno, de coqueria e de convertedores, que possuem um conteúdo energético relevante em forma de combustível. A utilização destes gases em processos diretos contribui com a eficiência energética das aciarias, reduzindo custos operacionais e as emissões de CO_2. Para a utilização sistemática destes gases, seja na geração de vapor de processo ou destes para a geração de energia, a SMS Siemag disponibiliza de soluções inteligentes. Esta apresentação será baseada nas tecnologias introduzidas até então, bem como nas potenciais plantas industriais de geração.
Palavras-chave: Ambiental tecnologia; Recuperação de energia; Eficiência energética; Regeneração de ácido; Tratamento de água; Filtros elétricos; Recuperação de metais; Plantas de geração.

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1 ENERGY RECOVERY

The most important energy source in the steel industry is heat. Along the process chain from steelmaking plants to processing lines we can find several process steps where heat is required and waste heat is also generated.
Approximately 30 per cent of the energy spent in electric steelmaking leave with the hot off-gas (as sensible heat). Due to technical reasons, it is absolutely essential to cool down the primary off-gas from some 1,200°C to values below 250°C. Similar proportions also apply to the processes in the SAF, Conarc and BOF or AOD converter. Compared to a BOF converter, the thermal off-gas energy of an EAF is more than two times higher related to the liquid steel quantity.
Conventional off-gas ducts are cooled by water that circulates through welded tubes. The cooling water itself flows through a heat exchanger – the thermal energy remains unused.
In order to make use of this energy, SMS Siemag developed an energy recovery system that produces steam by means of an evaporation-cooled off-gas duct. The steam can be used for different technical purposes. Common applications are power generation in steam turbines, driving vacuum pumps or feeding the steam into an existing network. The extent of economic benefit depends on the individual plant.
For BOF melt shops, evaporation-cooled off-gas ducts are well-known. For other metallurgical smelting units, however, this is an innovative technology. Our customers have become aware of this opportunity to maximize energy utilization.

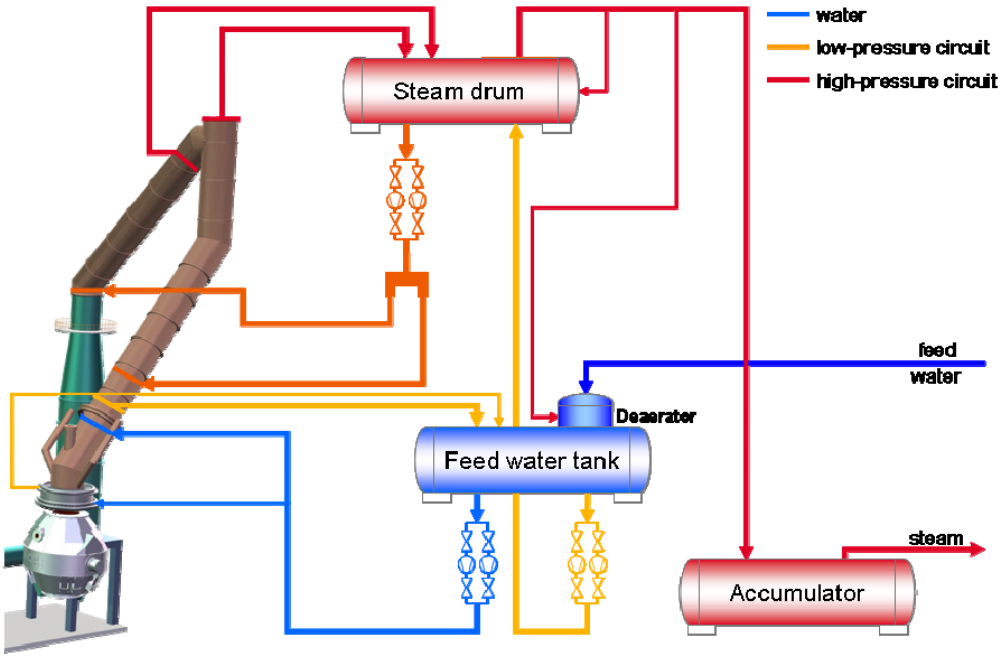


Figure 1. Evaporation cooling at BOF converter.

This is why ETI KROM, a ferrochrome producer from Turkey, ordered such an energy recovery plant that will be connected to two SAFs and supplies the steam to a 5-megawatt turbine. ETI KROM expects an amortization period of less than four years.

Fuxin Special Steel has placed an order with us for the engineering and supply of a steam generation plant that uses the off-gas heat at AOD converter and EAF – the world first installation of this kind.
One of the most interesting points is the steelmaking process in a basic oxygen furnace or electric arc furnace. Therefore, several technologies for energy recovery are being developed by SMS Siemag.
With these concepts, part of the waste heat energy is transformed into steam by evaporation-cooled off-gas ducts. At the BOF converter this technology is state-of-the-art.
Figure 2 shows a typical temperature profile of an EAF. The hot off-gas downstream the EAF can be used from approx. 1,250°C down to 250°C. The gas cooling equipment is the swivel duct, the post-combustion chamber and off-gas duct.

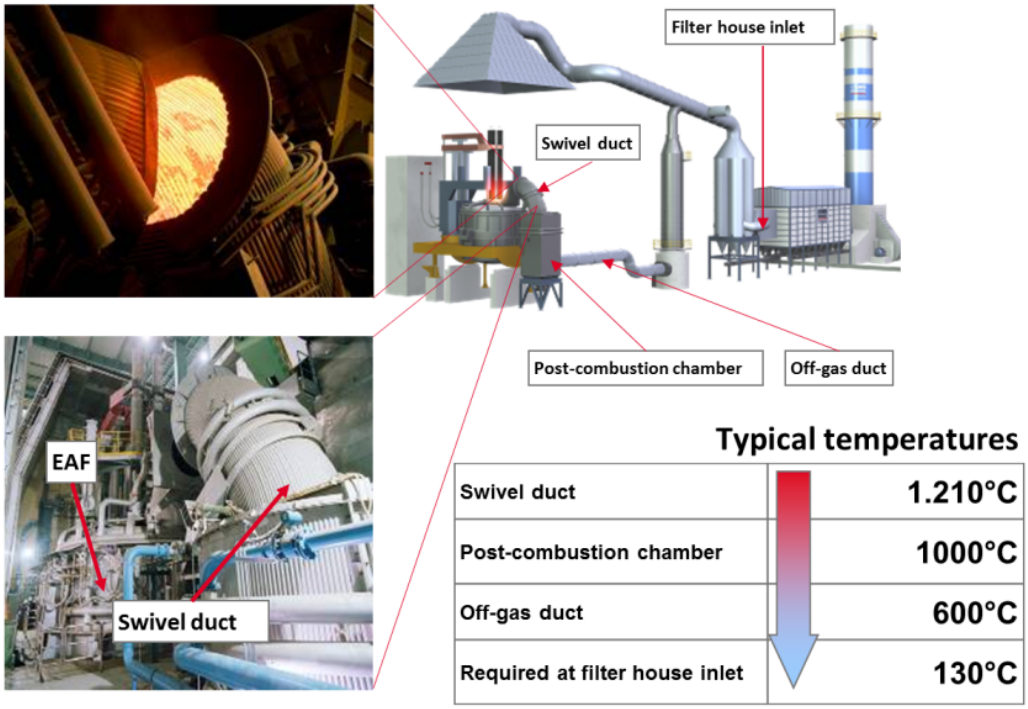


Figure 2. Typical temperatures in an EAF.

In a low-pressure circuit the feed water is heated up to approx. 130°C by cooling the movable off-gas elbow of the gas duct. This heat is used for deaerating the feed water. Then the water coming from the feed-water tank is pressurized and pumped into the steam drum. The boiling water is circulated by pumps through the cooling surfaces of the off-gas system and partly evaporated.
This water-steam mixture is routed back to the steam drum and separated there. The discontinuous amount of steam generated in the EAF batch process is temporarily buffered in accumulators and delivered to the consuming units. In comparison with a 150-ton BOF with 12 tons to 14 tons of generated steam per heat, a typical EAF with the same tapping weight will generate an average steam flow of 25 tons per heat at a gauge pressure of 25 bar. Steam generated in this way is always saturated steam.

Due to rising energy costs, this proven technology depending on steam utilization, generates a low amortization time.

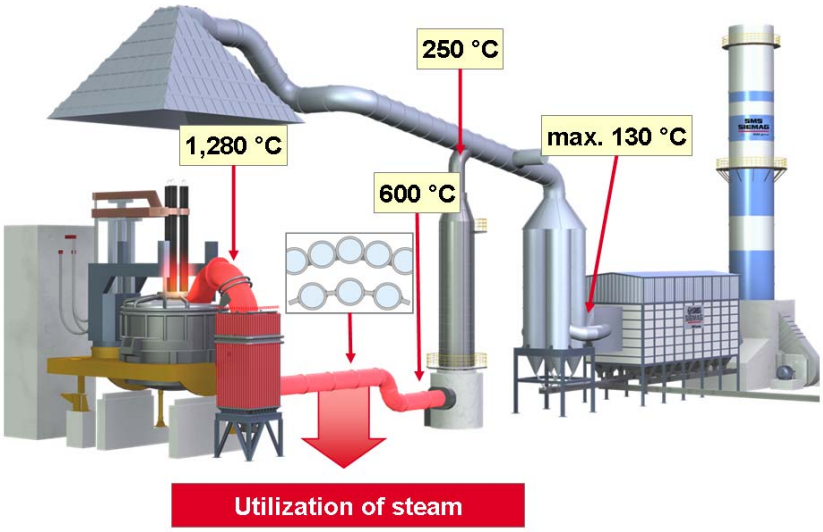


Figure 3. Evaporation cooling of an EAF.

2 POWER PLANT

The large range of gaseous byproducts as furnace gas, coke furnace gas and converter gas have a high energy content in terms of combustible components. Utilizing these gases as primary fuel in an industrial power plant contributes significantly to increased energy efficiency in steelworks and therefore reduces the overall steel manufacturing costs and saves CO_2 emissions.

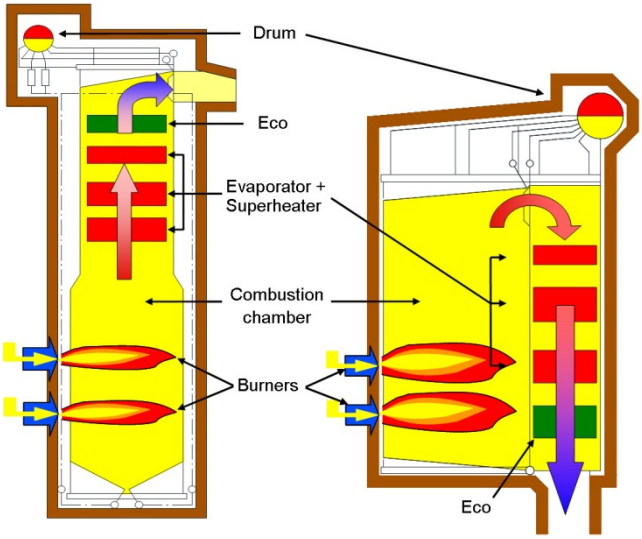


Figure 4. Single-pass and two-pass steam generator.

For the systematic utilization of these gases, e.g. to generate steam for production and/or to generate electricity in a complete power station process, SMS Siemag offers a wide range of part-standardized steam generators (Figure 4).

In this context SMS Siemag focuses on taking into account the many demands that influence the choice of steam generator type. Examples for these requirements are:

- low hazardous substance emissions;
- the option of using different fuels;
- compact design;
- fast starting capability;
- flexible operation modes, suitability for variable and fixed-pressure mode as well as dailystarting and stopping;
- high availability;
- high cost-effectiveness.

The SMS Siemag range comprises suspended or self-supporting natural-circulation steam generators with high to top outputs:

- fresh steam pressures up to 160 bar;
- fresh steam temperatures up to 540°C.

We supply single or multi-pass types that can be adjusted to a wide variety of tasks.

3 HARP (HYDROTHERMAL ACID REGENERATION PLANT)

Carbon steel pickling lines generate large quantities of spent, iron-enriched hydrochloric acid. With hydrothermal acid regeneration, SMS Siemag has developed a process for acid regeneration that has significant ecological and economic advantages over conventional processes (fluidized bed and spray roaster processes). This closed process takes place at temperatures of between 70°C and 170°C, cutting energy consumption by as much as 40% – 60%. What's more, the regenerated products are of higher quality and much more attractive on the market.
Hydrochloric pickling lines not only give the steel plates a better quality surface, they also allow for a closed pickling agent circuit. That is because spent hydrochloric acid can be completely reconditioned in acid regeneration plants, stripped of iron, and fed back into the pickling process.

Figure 5. Hydrothermal acid regeneration plant.

Another drawback of conventional regeneration systems is that they can only operate in very limited capacity windows (70% – 100%) and have to be switched on and off

when capacity utilization of the pickling plant fluctuates. That burns up a lot of energy. Hydrothermal regeneration can be continuously used at between 10% and 100% utilization of nominal capacity without affecting energy efficiency or byproduct quality. Because the regeneration takes place entirely in the fluid phase and at relatively low temperatures (170°C, compared with 700°C to 900°C in conventional plants), wear on the plant parts and therefore maintenance costs are much lower than they are for conventional processes with high burner temperatures.

4 ESP - FILTER

To boost its activities in green technology, SMS Siemag joined forces with Elex AG to found SMS Elex AG, which is headquartered in Schwerzenbach near Zurich. SMS Elex produces and supplies new-generation dry and wet electric filters for converter steelworks, including the associated units such as conditioning towers and induced-draft blowers. The filters clean the CO-laden process gases effectively and cost-efficiently, meeting even the toughest safety and environment standards. They are capable of cleaning volume flows of 80,000 m³ to 300,000 m³.
Ideal for new converter steelworks are dry electric filters in combination with a conditioning tower. The low pressure loss, maintenance-friendly design, and long lifetime of the filter unit add up to low operating costs. The high efficiency and separation performance ensure low residual dust contents, making ambitious green standards attainable. The dust-laden gas generated during the converter process is captured above the converter opening and channeled into the cleaning and recovery plant. This gas is cooled in the conditioning tower before cleaning in the dry electric filter. Here, even the smallest dust particles are efficiently separated. These electric filters achieve a separation degree of well over 99.8%.recovery are being developed by SMS Siemag.
The converter process is highly dynamic. Therefore, the composition of the converter gas is subject to large variations – especially at the beginning and towards the end of the blowing phase. As a result of irregular process conditions or interruptions, a flammable mixture of oxygen and carbon monoxide may form in the system. Therefore, the primary-gas cleaning plants are equipped with pressure vent valves as a precautionary measure in the event of a flash fire. These valves efficiently prevent the components from being damaged. They limit the maximal pressure by opening at a defined overpressure and releasing the excessive pressure. When the system has returned to the correct pressure level, they close again, providing a gas-tight sealing.

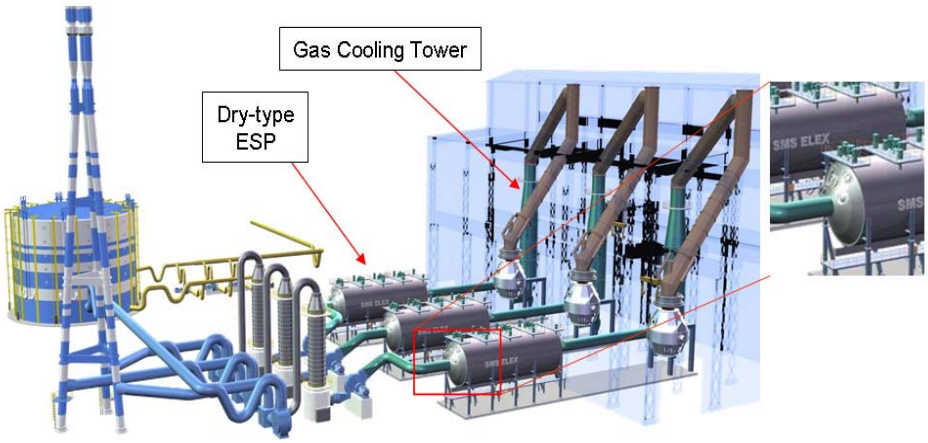


Figure 6. BOF plant off-gas system with dry-type ESP and pressure vent valve.

SMS Elex also offers a wet electric filter for steelworks with existing converter gas wet scrubbers. This globally unique innovation enables integration of an electric filter into the existing gas cleaning system, including the option of integrating an existing water management system. The main benefits of this solution are the low investment costs and advanced plant technology for a fast reaction to stricter environment protection regulations.
Our innovative hydro-hybrid-filter system is especially suitable for retrofitting into existing works so that they can comply with ever stricter environment protection regulations. The investment costs are much lower compared to new construction of a primary gas cleaning plant with dry ESP, and in most cases they reduce the operating costs for gas cleaning. A further benefit during installation in existing factories is the compact shape of the filter that fits into even tight spaces. The modernization strategy allows for later integration of a converter gas recovery plant that will increase cost-effectiveness even more.

- Clean gas dust content ≤ 10 mg/m³
- Very low investment cost
- Upgrade of almost every existing wet scrubber is possible
- Decrease of operating costs / energy consumption

Figure 7. Ideal for retrofitting: Hydro hybrid filter system.

Electric filters are an excellent solution for separating solid particles. Discharge electrodes charged with rectified negative high voltage transmit electrons. These migrate to the collecting electrodes, where they come into contact with gas molecules and dust particles. The dust particles become attached to the electrons and are negatively charged. Due to the electrical field, they are transported to and adhere to the grounded collecting electrodes.

5 CLOSED-LOOP SYSTEM FOR RISE WATER FROM STAINLESS STEEL PICKLING LINES

As a provider of integrated plant solutions, SMS Siemag's portfolio, of course, also includes the entire range of water supply and treatment systems – from the design to construction and commissioning of the process. This includes make-up water solutions e.g. by reverse osmosis as well as open and closed cooling cycles and waste water treatment systems like neutralization or microfiltration, including the return of treated water into the production process.

The latest developments took place in the recycling of used water. A new technology of microfiltration enables the recycling of 75% of rinse water at stainless pickling lines. The corresponding references, e.g. ThyssenKrupp Nirosta in Germany, point up to amortization periods of less than 6 months.

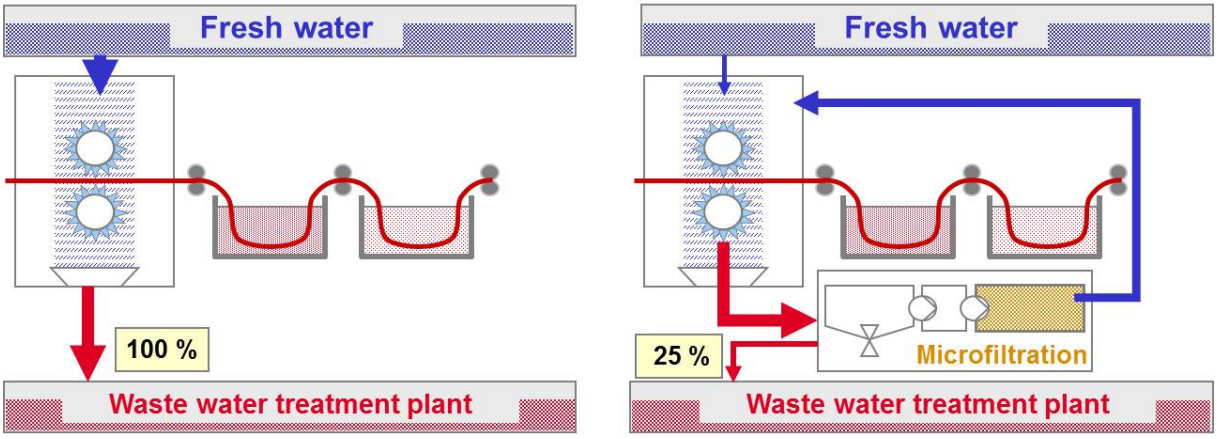
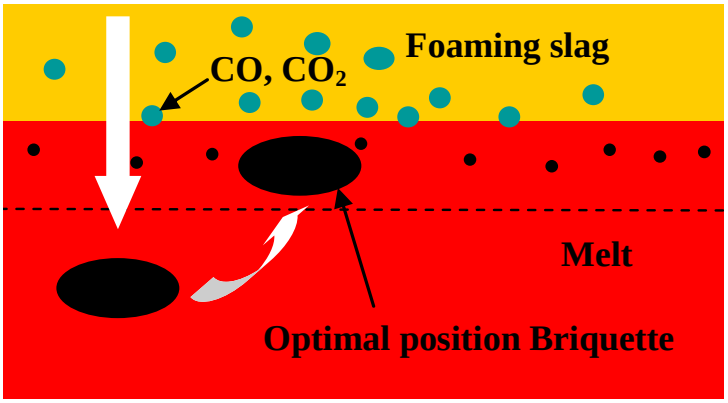


Figure 8. Conventional method: Usage of 100% fresh water (left) and innovation (right).

6 WASTE MATERIAL BRIQUETTES

For the manufacture of stainless steels in the electric arc furnace, the SMS Siemag has likewise developed a patented process involving so-called "foaming slag briquettes". These newly developed briquettes allow to generate a foamy slag like it is produced in a carbon steel EAF by injecting oxygen and pulverised coal. The briquettes largely consist of residues, e.g. EAF or AOD dusts, as well as carbon, ballast material and binding agents. They are charged into the EAF via the 5th hole in the roof. In the EAF, the briquettes float between the slag and the molten metal due to their specific density and they cause the slag to foam, provided that the slag has a suitable composition (Figure 9).



Advantages:

- Improved Metal yield (like Cr, Ni)
- Recycling of residues containing metal oxide allows landfill costs to be reduced
- Heightened productivity by shortened tap-to-tap time
- Higher service lives of the electrodes in the EAF

Figure 9. Illustration of the reaction.