BEST AVAILABLE TECHNIQUES TO CONTROL EMISSIONS IN SECONDARY METALLURGICAL PLANTS[1]

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Abstract

International laws, rules and regulations for protection of the environment especially regarding emissions is coming more and more into the focus during technical discussions. The paper presents technologies developed from these demands as well as results achieved. SMS MEVAC GmbH, a 100% subsidiary of SMS SIEMAG AG, is covering the secondary metallurgical activities, and its vast experience is backed-up by a close cooperation with leading international steel producers. The saving of resources, reduction of energy consumption and emissions into the environment has become more and more important. This article reports about the different available techniques to handle environmental emissions of secondary metallurgical plants. Even though gas and dust emissions occur in secondary metallurgical plants at lower levels than in case of BOF converters or electric arc furnaces, measures are shown how to reduce CO-gas emissions and dust in a secondary metallurgical plants. Different techniques for cleaning gases and dust will be highlighted based on examples of plants installed in the last few years. Finally an outlook on future technologies in regard to emission control is given.

Key words: Secondary metallurgy; Emission control; Environmental technology.

AS MELHORES TECNOLOGIAS DISPONÍVEIS PARA O CONTROLE DE EMISSÕES NO REFINO SECUNDÁRIO DAS ACIARIAS

Resumo

Leis, normas e regulamentações internacionais para proteção ao ambiente, especialmente em relação às emissões, estão se tornando cada vez mais um grande foco nas discussões técnicas. Este trabalho apresenta tecnologias desenvolvidas a partir destas demandas ambientais, bem como os resultados alcançados. A SMS MEVAC GmbH, subsidiária 100% da empresa SMS SIEMAG AG, está acompanhando os desenvolvimentos de projetos na área de metalurgia secundária, acumulando vasta experiência através da cooperação de longa data com empresas internacionais líderes na produção de aço. A economia de recursos, redução do consumo de energia e emissões para o meio ambiente têm se tornado cada vez mais importante. A apresentação aborda técnicas de manuseio e controle de emissões para o ambiente, provenientes de plantas de metalurgia secundária. Apesar de as emissões decorrentes do refino secundário serem em níveis inferiores àquelas decorrentes do refino primário em convertedores BOF ou fornos elétricos a arco, medidas são apresentadas para redução de emissão de CO e pó em plantas de metalurgia secundária. Diferentes técnicas para limpeza de gases e desempoeiramento serão abordadas com base em exemplos de plantas instaladas recentemente. Finalmente, tecnologias futuras para controle de emissões serão resumidamente apresentadas.

Palavras-chave: Metalurgia secundária; Controle de emissões; Tecnologia ambiental.

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1 INTRODUCTION

SMS MEVAC GmbH, a 100% subsidiary of SMS SIEMAG AG, is covering secondary metallurgical activities within the SMS Group.
SMS MEVAC's vast experience is backed up by a close cooperation with leading international steel producers.
The saving of resources, reduction of energy consumption and emissions into the environment is becoming increasingly important. This process is driven on one side by international agreements, rules and regulations for the protection of the environment. On the other side, it is driven by the necessity to reflect the increasing costs for energy, material disposal and emissions in the overall production cost considerations.
This article reports about the different by-products generated during a treatment in a secondary metallurgical plant and innovative techniques to reduce both their formation and their emission to the environment. Beyond that measures how to lower the media consumption are shown.
Standard systems like filter units, waste gas post combustion burners, gas washers and dust collection and disposal units are not particularly mentioned here since these solutions are state of the art in many installations built by SMS Mevac

2 LADLE AND SECONDARY METALLURGY

The development of secondary metallurgy was driven by the market requirements for high-quality steel products at a reasonable price level. These processes cover the hot metal treatment prior to BOF as well as secondary metallurgical treatments between primary melting aggregate and casting facility.
The primary step of the steelmaking process concentrates on the production of a basic melt in either EAF or BOF. After primary melting and refining the crude steel is tapped into a ladle. Secondary metallurgy takes place exclusively in the ladle and comprises all further measures required to produce a high grade steel. This division increases the throughput of the steel plant in an economic way and allows to optimize each metallurgical treatment step by using a dedicated equipment for it.
An overview of typical secondary metallurgical treatment stations is shown in Figure 1.
Various processes under vacuum as well as atmospheric treatments are nowadays standard in a modern plant, with different emphasis on the metallurgical tasks to be fulfilled such as heating, decarburization, degassing, desulphurization, alloying and so on.

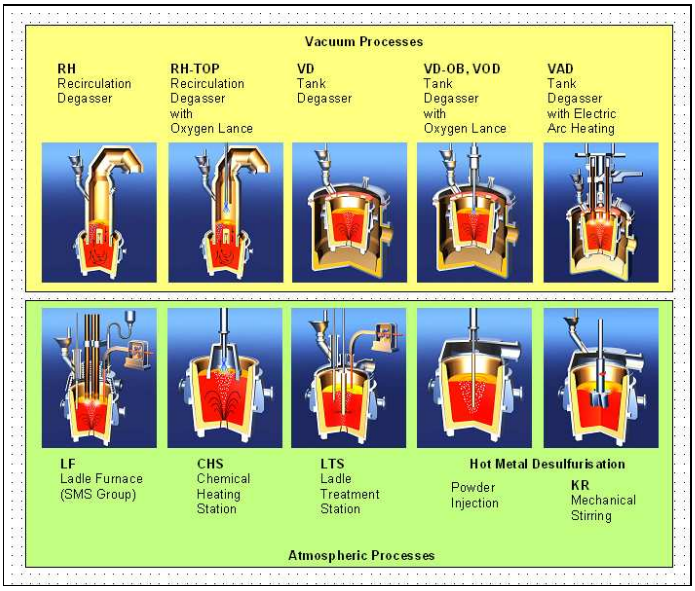

Figure 1. Ladle metallurgical processes.

All metallurgical processes consume resources - matter and/or energy – and convert them into products and wastes. This includes secondary metallurgical treatments as well.

Figure 2 shows a summary of the typical material flows (in and out) observed. Note that not all items mentioned are present in each case. For example, the processes under atmospheric pressure do not require a vacuum pump, steam and condenser cooling water.

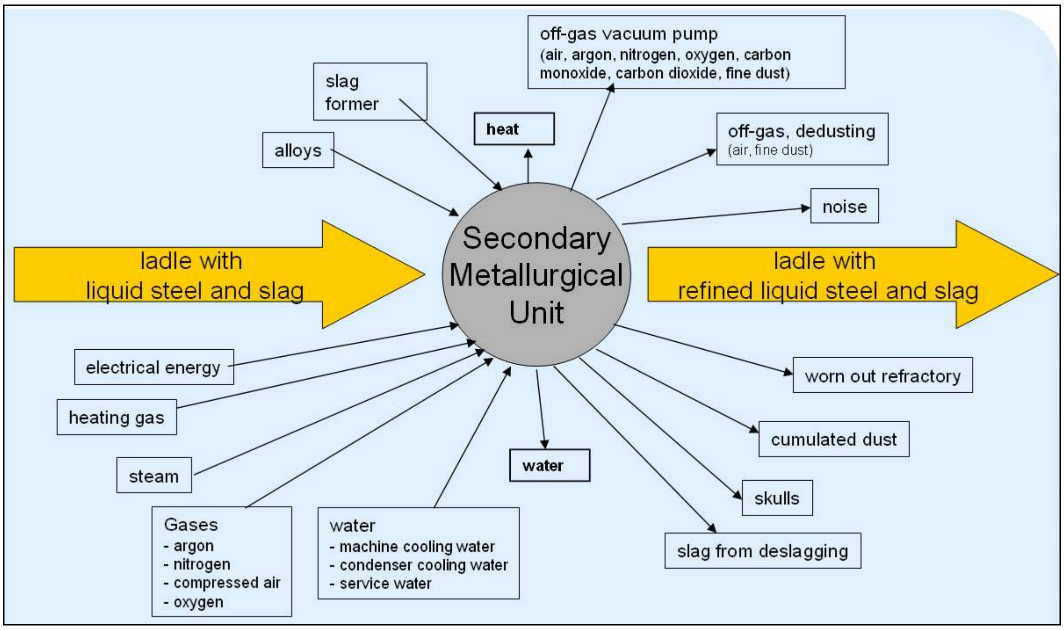

Figure 2. Material and energy flow (schematic).

In general, waste products such as slag, gas, dust, worn out refractories or skulls and the release of heat and noise are necessarily attached to these processes and can not be completely avoided. Reduction of the waste impact on the environment means to reduce the amount of wastes generated and/or to increase their environmental sustain-ability. Lower amounts of wastes or the creation of more environmental-friendly wastes create less cost in either material disposal or recycling procedures.

This aim is achievable either by changing the treatment practice appropriately or by using equipment optimized for that purpose or by using a combination of both. This shall be substantiated in the following by some examples.

3 PRIMARY ENERGY

The importance of secondary metallurgical processes in relation with measures to improve the efficiency of energy consumption or the direct saving of energy can be seen as well when having a closer look at well introduced and common processes.
Secondary metallurgical heating processes – either electrical (LF) or chemical (Al-heating both under vacuum or atmospheric pressure) – enable the reduction of safety margins of the tapping temperature; i.e. the tapping temperature of the primary melting aggregate can be lowered, since the liquid steel can be heated up – if necessary – at a later stage.
For example assuming a tapping temperature lowered by 10° C the energy saving is about 2,5 KWh/t or 900 KJ/t.
In case of an EAF steelshop the input of electrical energy can be directly reduced by the a.m. value and the tap-to-tap time shortened accordingly. In case of a BOF steelshop the scrap rate can be increased accordingly – at a given hot metal temperature. In return the consumption of oxygen and lime can be reduced resulting in both lower emissions and shorter tap-to-tap times.

Lowering of Tapping Temperature :	**10**	**°C**
Energy Saving :	**2,5**	**KWh/t**

Figure 3. Effect of lowered tapping temperature.

In order to make this figure more understandable it can be stated that the energy saving at an annual production of 2.5 million tons equals the annual electrical power consumption of 3000 average European households.

4 REDUCTION OF DUST GENERATION, SKULL FORMATION AND REFRACTORY WEAR

Advanced technologies can contribute to reduce the emissions of production processes. An appropriated example is the RH-SC® process of SMS Mevac available for RH recirculation degassers.
What does RH-SC® mean?
SC is an abbreviation of **S**plash **C**ontrol. The splashing of steel inside of the vacuum vessel is controlled in order to avoid significant skull build-up on the inner surface. RH-SC® controls splashes during rapid decarburization treatments by means of advanced vacuum pressure and lift gas flow control techniques.

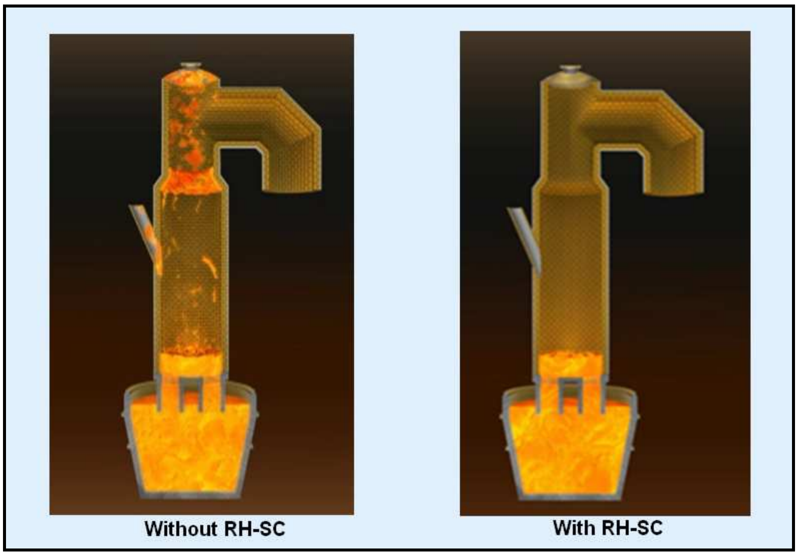

Figure 4. Splashing during RH-process with and without Splash Control .

Less splashing is directly related to less dust formation during the vacuum process. On the one hand due to a reduced number of particles able to be sucked off by the vacuum system, on the other hand due to less metal surface directly exposed to the vacuum conditions such limiting the evaporation of elements like Manganese. Since dust generation is reduced, the condenser cooling water is less contaminated. The load on the water treatment plant is decreased accordingly.
Less splashes cause less skull formation inside of the vacuum vessel. In return less effort is needed to cope with skull handling such as skull cutting by use of hydrocarbon fuels and/or oxygen applied through burner lances. Beyond the direct saving of resources the handling, recycling or disposal of skulls is minimized.
Since less skull cutting is required the negative impact on the vessel lining is reduced and the refractory lifetime increased. In return the amount of worn out refractories to be dumped and/or recycled is decreased.
The a.m. examples clearly demonstrate the close relation between emission and cost control enabled by the application of advanced process technology.

5 REDUCTION OF MEDIA AND ENERGY CONSUMPTION OF VACUUM SYSTEMS

New technologies and considerations introduced to the SMS Mevac steam ejector vacuum pump systems have led to a significant reduction of both steam and cooling water consumption.

5.1 Steam

A unique feature of the SMS Mevac vacuum systems is the suction capacity control of the steam ejectors by means of steam flow control. The standard practice still is to run vacuum pumps at full capacity and to introduce an additional gas load to control the pressure. Although the main objective is to improve the pressure control during pump down phase a positive side effect is the saving of steam as propellant of the pump.
To make it more understandable we like give following example:
"*Imagine a car that runs always under full throttle and you have to use the brake for speed control. This is not very smart in terms of fuel consumption. Our car can throttle up and down as you expect it.*"

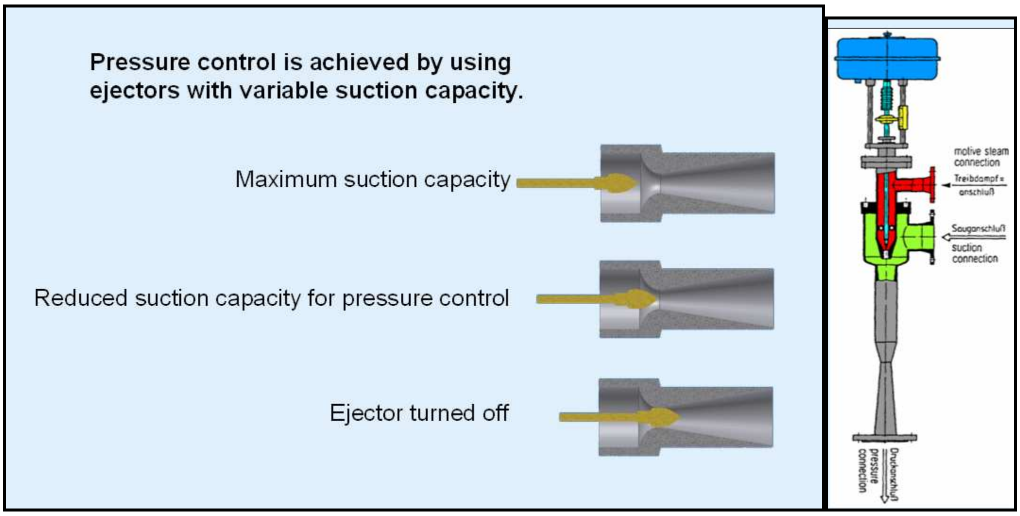

Figure 5. Pressure control by variable suction capacity.

Improved technologies to decrease the air leakage of the vacuum plant lead to a considerably lower load on the vacuum system. In conventional installations the portion of air leakage is about 10-20% of the total mass flow of gas to be sucked off by the vacuum pump at a low pressure. This percentage can be lowered due to tighter installations which in return results in a drop of 5-10% of steam consumption.

Considering that a very low level of vacuum pressure is not necessarily needed to achieve excellent metallurgical results, the steam consumption can be further reduced by approx. 15% in case the aimed minimum pressure is 1 mbar instead of 0.67 mbar.

In case the concept of the vacuum plant considers the available optimization potential by application of both engineering and technological know how the steam consumption of the vacuum system can be lowered by up to 35 % compared to conventional systems on the market (see Figure 6).

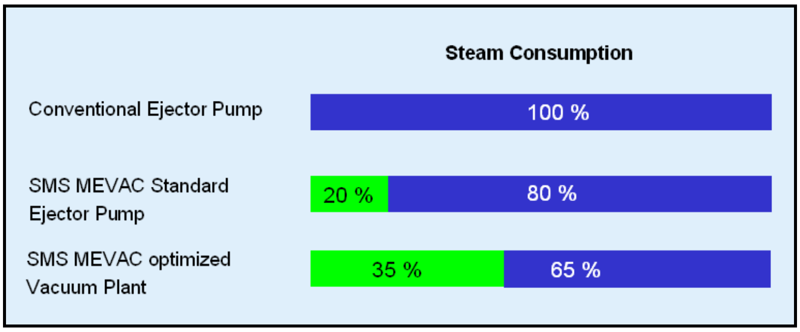

Figure 6. Potential of Steam Saving.

5.2 Cooling Water

In order to minimize the load on the downstream ejector stages of the vacuum system, the steam to drive the upstream stages has to be removed from the system, as soon as possible. This is to limit the required suction capacity and is performed via steam condensation by means of cooling water sprayed into the steam condensers. The condensed steam and the cooling water are collected in a sealed tank and pumped to the water treatment plant.

Usually the condensers are supplied with water directly from the water treatment plant. This configuration results in a maximum condenser cooling water (CCW) consumption.

In order to reduce the CCW consumption SMS Mevacs vacuum systems are featuring a different concept – the SSS-system – which stands for **S**uper **S**aving **S**ystem. The main difference is to be seen in the partial reuse of water from the sealed tank instead of water from the water treatment plant.

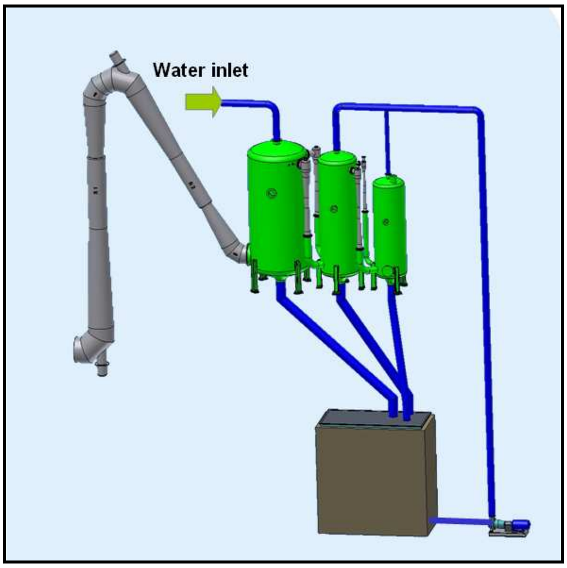

Figure 7. Triple-S Condenser Cooling Water Distribution.

In Figure 7 is shown, that only the first condenser is directly supplied from the water treatment plant. The downstream condensers reuse the water from the sealed tank.
This concept generates a significant CCW saving of about 35%, which is in line with the aimed reduction of media consumption (Figure 8).

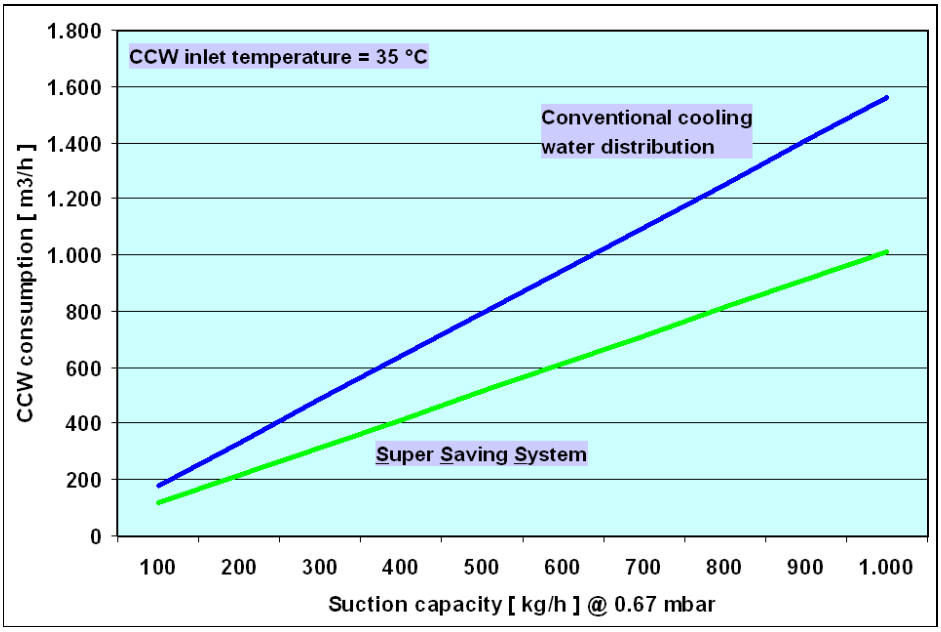

Figure 8. CCW Saving as a Function of Suction Capacity

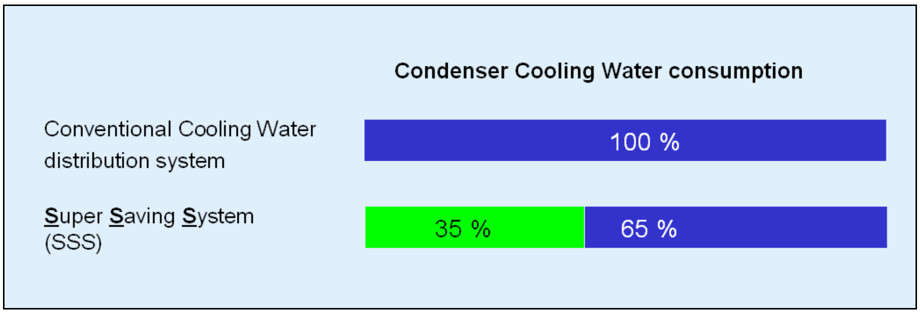

Figure 9. Potential of CCW Saving

As a side effect less electrical power is consumed by the condenser cooling water pumps. Depending on the pump performance installed the saving is up to 0.5 MWh per year or 0.2 KWh/t.

6 CONCLUSION

This article reports about environmental aspects of the application of advanced technologies in the field of secondary metallurgical plants.
New challenges like

- increased costs of energy and media
- lower admissible emissions
- international agreements for CO2 reduction
- increased awareness of our responsibility to protect the environment now and for future generations

are met by SMS Mevac with innovative technologies.

These are developed in close cooperation between SMS Mevac and steel producers. They do not necessarily lead to a cost increase in production. Moreover, their introduction will create a more positive image of the steel industry in our societies.