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MultiMelter© – The new generation of aluminium melting furnaces

Dr.-Ing. Björn Henning, Jasper GmbH, Borstel-Hohenraden (Germany)
Dipl.-Ing. Robert Jasper, Jasper GmbH, Geseke (Germany)

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Editor: Dipl.-Ing. Stephan Schalm, Tel. +49 (0) 201/82002-12, E-Mail: s.schalm@vulkan-verlag.de

MultiMelter© – The new generation of aluminium melting furnaces

In particular the secondary aluminium industry is in Europe at enormous cost pressure. In order to work against the rising costs, on the one hand energy-saving processes and on the other hand a minimization of the metal losses are necessary. This will be more difficult due to more contaminated scrap, which arrives into the cycle of the remelting processes. Here is a process engineering demanded, which fulfil the extreme operating conditions of recasting by specific environmental and financial aspects. The MultiMelter© – an advancement of the multi-chamber furnace combined with the newest technologies – is to be introduced in this article.

Dr.-Ing. Björn Henning
Jasper GmbH, Borstel-Hohenraden (Germany)
Tel. +49 (0)4101 / 801-150
Email:
b.henning@jasper-gmbh.de

Dipl.-Ing. Robert Jasper
Jasper GmbH, Geseke (Germany)
Tel. +49 (0)2942 / 9747-14
Email:
r.jasper@jasper-gmbh.de

Introduction

In principle construction units from aluminium can often be melted for the production of new products. At present in Europe is approximately 35 % for the total requirement of aluminium available by recasting. The increased demand for aluminium products and the political and economic orientation to the recycling economy requires the advancement of the remelting processes, since more and more scraps (contaminated aluminium scrap) arrive in this cycle. These contaminated aluminium scrap comes predominantly from the recycling, e.g. aluminium windows with foam core, aluminium profiles with bonded seals from plastic, composite sections from aluminium and plastic. These scraps are not to be separated at justifiable expenditure so far and will be melted as a mixture of different scraps with a tremendous effort of energy connected with high environmental impact [3]. In the rotary furnace contaminated aluminium scrap is melted by covering the melt with salt (NaCl and CaCL), in order to prevent the oxidation of aluminium. The dross of salt which originates in the furnace is very complex to recycle. The Closed Well Furnace or two-chamber melting furnace is suitable for melting thin-walled and easily to medium contaminated scrap. A fixed partition wall divides the furnace into Heating Chamber and Pyrolysis Chamber. The Heating Chamber is suitable for melting clean and blank scrap. The homogenisation of the bath and good melting capacities are reached by a circulation pump. However, the partial highly loaded exhaust gas from the Pyrolysis Chamber makes a cleaning process necessary. A part of the exhaust gas flow can be supplied to the gas burners. The same effect can be obtained by a TNV (Thermal Post Combustion), in order to cool down the flue gases by a water shower for decontamination. Fixed particles are separated in the following filter system.

Dioxins and Furans originate unintentionally during recasting of contaminated aluminium scrap in presence of plastics (chlorine, bromine) under participation of chlorine donors, e.g. carbon, potassium and copper. The dioxins are formed up to 600 °C and disintegrate at furnace temperatures by 1200 °C into their molecular structures. But with the cooling of the flue gas, a new formation synthesis (de novo synthesis) begins as an unintentional cycle process up to approximately 300 °C.

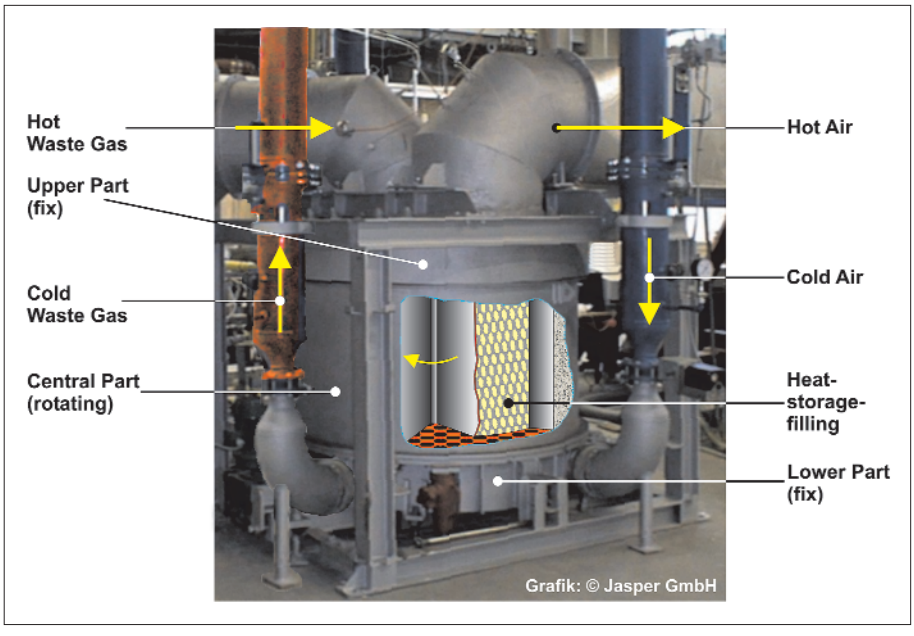

Fig. 1: ECOREG®-Regenerator

For these contaminated aluminium scrap are solutions in demand, which can help to reduce or eliminate this problematic environmental impact and allows an economic mode of operation.

State of art

The main focus for all melting processes is:

- to reduce the metal loss,
- to decrease the energy consumption,
- to prevent dioxins and furans and
- to decrease the CO_2-Emissions.

Since more than 20 years the Jasper GmbH is involved in the field of building plants and furnaces for an economic and environment friendly energy consumption. A consistent work in research and development led to products and procedures, which consider to these demands. In December 1997 a research project for a rotating regenerator was successfully finished, which was supported by the German Government. This rotating regenerator was patented by the product name EcoReg® Regenerator. The EcoReg®-Regenerator (**Fig. 1**) is used for a central heat recovery in powerful furnaces and replaces the classic recuperator. The air piping can be connected to an unlimited quantity of burners.

The flue gas temperature amounts between 1200 °C to 1400 °C. This results in an average combustion air temperature of approximately 1060 °C to 1275 °C (in the High Temperature version up to 1400 °C). The exhaust gas of the rotating regenerator (heat exchanger) has a temperature of 140 °C up to 210 °C, which is suitable as filter inlet temperature. The energy saving amounts up to 62 % in relation to a burner system for cool air with a flue gas temperature of about 1400 °C.

A continuously optimisation of this rotating regenerator system EcoReg® and a multitude practical applications in the aluminium and steel industry was the reason for further development concerning exhaust air purification. In frame of a research project in 1998 the exhaust air purification was successfully proven concerning dioxin (quenching of dioxin). This outstanding effect of the dioxin reduction during simultaneous high heat recovery is an environment friendly and financially attractive solution for the use in melting furnaces.

This combination – a multi-chamber furnace, in which dirty and contaminated scrap can be used, with EcoReg® and an internal pyrolysis gas burning – resulted in the plan to the MultiMelter©.

Fig. 3: MultiMelter© BAGR Aluminiumverwertung GmbH in Berlin, Germany

MultiMelter© furnace and application

The MultiMelter© is a three chamber furnace with an integrated pyrolysis process. The field of application is the economical and ecological melting of Aluminium Scrap heavily contaminated with organic coatings and inlets (**Fig. 2**). The operation of this furnace is without salt.

The newest MultiMelter© (**Fig. 3**) with a capacity of 120 t/day with a bath content of 60 t was built for BAGR Aluminiumverwertung in Berlin this year [2]. Jasper GmbH got the order on the Therm-process Fair 2003 in Düsseldorf. The whole plant was done as a Turn-Key Job by Jasper GmbH. This job needs from order to the first production only 9 month. The task was to reach a good melting process for dirty and contaminated scrap with minimal metal loss and the highest possible energy saving through a consequently use of the newest available technology.

The technical data of this plant are as follows:

- Melting Capacity : 5 to/h
- Bath Content: 60 to
- Energy Consumption: < 650 kWh/to aluminium
- Used Aluminium Scrap: blank an polished srap, painted and de-contaminated scrap, turnings
- Yield: > 98 % for clean scrap
- Yield: > 90 % for dirty and de-contaminated scrap
- Run Time: 550 h per month
- Temperature of Air Preheating: up to 1000 °C
- Flue Gas Temperature behind ECOREG®: < 220°C

These are the actual data after the first operation. Especially the energy

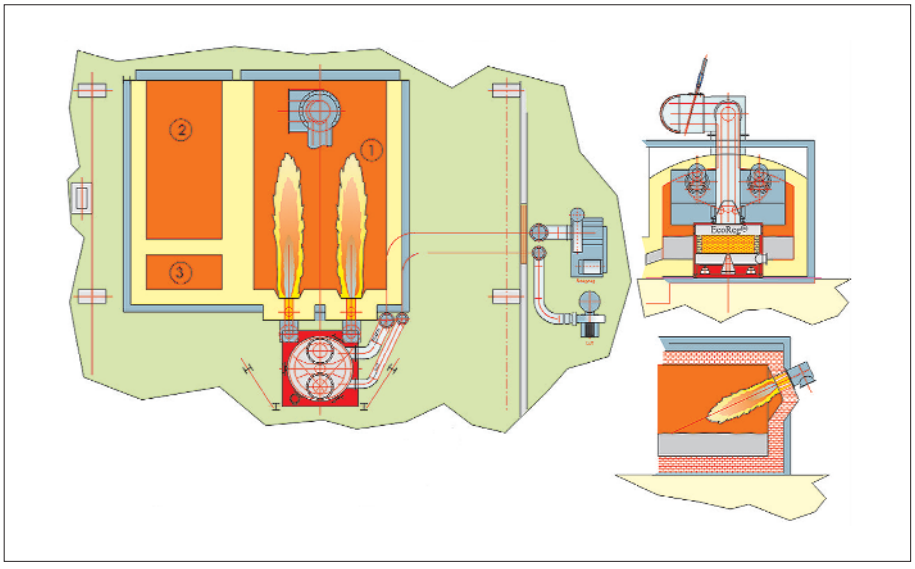

Fig. 2: MultiMelter© - Regenerator melting furnace

consumption and the metal loss shall be further minimised due to an optimised process operation.

The Multimelter© consists of:

- A Heating Chamber (1) to melt clean scrap, ingots etc. and to heat the bath of liquid aluminium.
- The Pyrolysis Chamber (2) to pyrolyse the organic components of the scrap into fuel gas and to melt the decontaminated scrap.
- The PreMelt Inc.– Pumping Chamber (3) with the function of circulating the bath of liquid aluminium and to melt turnings and chips.

The Heating Chamber (1) and the Pyrolysis Chamber (2) are equipped with Low NO_x Burners with SFI-Technology (Selective Fuel Injection). The SFI-burner technology, specially developed by Jasper GmbH allows the co-utilisation of the pyrolysis gas. In general, all burner systems of Jasper GmbH are delivered exclusively in "low emission" version. As a minimum standard all burners are built to the German "TA-Luft" requirements, with the following values: NO_x < 350 mg/Nm^3 and CO < 100 mg/Nm^3 (5 % O_2) [1]. The installation of a special burner type depends on the application of the melting process. The burner systems (gas or oil) are regulated by oxygen content. The pyrolysis-gas replaces to a part the main fuel in an efficient and economic way. Different ways are possible to use the pyrolysis gas as substituted fuel. On the one hand it can be directly burned in the heating chamber and on the other hand it can be completely burned with the natural gas within a special burner system.

The pyrolysis gas is formed in the Pyrolysis Chamber (2) (Scrap Chamber).

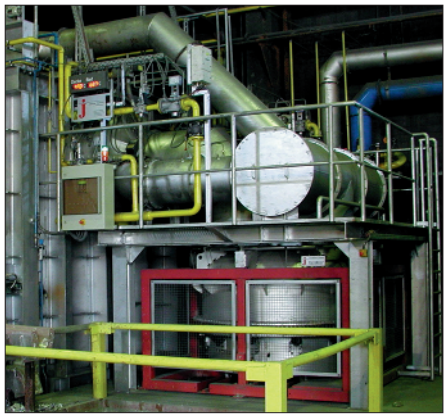

Fig. 4: ECOREG®-Regenerator BAGR Aluminiumverwertung GmbH in Berlin, Germany

After charging the scrap is lying on a bridge. The chamber is heated with a HiTAC-Burner High Temperature Air Combustion) and the convective heat transfer is responsible for the first thermal treatment of the scrap. The organic adhesions releases immediately with a temperature above of 350 °C during the heating process and the srap is preheated before it slides into the bath. The Scrap Chamber (Pyrolysis Chamber) is loaded several times per hour due to a uniform heating. Further, this thermal treatment has the effect of a decreasing metal loss due to a minimized oxidation of the aluminium scrap [4]. The volatiles release and the formed pyrolysis gas is transported into the Heating Chamber (1). It must be assured that all organic gaseous components completely burned in the Heating Chamber (1). The pyrolysis gas can substitute the main fuel (natural gas) up to 15 %.

A Regenerator System guarantees an effective heat recovery to preheat the combustion air (**Fig. 4**). Further, the regenerator substitutes the quench-cooler to suppress the De-Novo-Synthesis of dioxins and furans. The furnace is equipped with a PLC Siemens S7 System with a visualisation of all components, e.g. temperature, pressure, oxygen content etc.

Conclusion

The MultiMelter© reach high melting capacities with a minimum of melting losses. A extreme decrease of energy consumption is reached by an effective heat recovery and the substitution of natural gas through pyrolysis gas. The reducing of metal loss by the pyrolysis process and the energy saving through an effective heat recovery by the Regenerator results in a short time of a Return of Investment. The MultiMelter© is the profit generating melting furnace for secondary aluminium melters with respect to the environment.

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