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aufbereitung / recycling / prüftechnik
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Summary: Rotary Drum Furnace Alumonte GmbH

While carrying out technical pilot trials with the support and collaboration of the Montanuniversität, Leoben / Austria (particularly with the Institute for Non-Ferrous Metals), the key points in the process – such as yield, salt-free remelting and energy consumption – were thoroughly investigated. The results are summarised below. Further attention was also focused on the emissions involved in the process, with the support of the ÖSBS, the Austrian Dust and Silicosis Prevention Unit.

1. Metal recovery/yield

It is of decisive importance for the economic viability of a melting or remelting plant to minimise the amount of metal loss due to oxidation when storing, transporting and transferring, particularly when melting, holding at high temperature and casting. The extent of oxidation also depends on the composition of the melt, especially for alloys containing magnesium, and on the temperature and time. This dependence on temperature and time must always be taken into consideration when melting and holding at high temperature, since oxidation significantly increases at high temperatures.

During the separate experimental trials a range of different scrap materials, from slightly to very contaminated, were used. Some experimental results are shown in Table 1 below.

1.1. Table 1: Summary of some experimental results

Experimental results			Standard	
Material used	Degree of Contamination	Melting loss %	Alumont prior data melting loss %	Industrial practice actual melting loss %
Al scrap sl. contam.	<1%	1.2	<1	1.5-3
Al scrap sl. contam.	<1%	0.9	<1	1.5-3
Al scrap v. contam.	10-15%	6.4	4-6	8-12
Al scrap v. contam.	10-15%	3.6	4-6	8-12
Al scrap v. contam.	10-15%	6.2	4-6	8-12
Al scrap v. contam.	5-10%	2.1	4-6	8-12
Al scrap v. contam.	5-10%	2.9	4-6	8-12

As can be seen from the table above, the results show that aluminium loss varies between 3 and 7% for highly contaminated scrap and around 1% when slightly contaminated scrap is used.

Compared to the values found in industrial practice, a significant improvement in metal yield can be expected.

2. Salt-free melting of aluminium scrap

Due to its high affinity for oxygen, a layer of aluminium oxide measuring from a few nm to a few μm forms on the surface of solid aluminium and impedes further oxidation. Liquid aluminium displays an even greater tendency to oxidation and for this reason salts are added to cover contaminated and small-sized material and reduce further oxidation in the liquid state, while also enabling aluminium oxide to be separated from the liquid aluminium. In general up to 500kg of melting salt is used per tonne of manufactured secondary aluminium, depending on the degree of contamination of the initial material and the technology used. The processing of the resulting salt slag and its subsequent disposal has high costs and significant environmental impact.

No salt was used for any of the experiments. This was in accordance with the high standards fixed by Alumonte.

3. Energy consumption

The Kipp rotary drum furnace used in this process is operated using a natural gas/air/oxygen burner. The different stages of the process can be divided into charging, roasting, melting and pouring. Since the pouring stage is not comparable with the situation used in industry and the speed of pouring did not meet requirements due to construction factors at the periphery, the same ratio of total energy consumption was allocated to the pouring process as found in industry.

Average energy consumption was 40-45 Nm^3 natural gas/t Al scrap. Some experiments indicated however that process optimisation can further reduce energy consumption to 35-40 Nm^3 natural gas/t Al scrap.

Comparable processes used in the secondary aluminium industry show an average consumption of 50-100 Nm^3 natural gas/t Al scrap. Improved energy consumption is mainly due to the recirculation of roasting gases as a result of an internal recuperative system and the omission of added salt, which means no additional energy is required to heat and melt the salt.

4. Emissions

In collaboration with the technical department of the ÖSBS, the Austrian Dust and Silicosis Prevention Unit, a subsidiary of the AUVA, the Austrian National Accident Insurance Organisation, the experiments were also

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examined for their emissions. The basis for the measurements was the Austrian Federal Law Gazette BGBl. No. 1/1998 "Regulations on the restriction of air pollutants from plants producing non-ferrous metals" . The concentrations of the following substances in raw gas were determined: (comparable with the IPPL guidelines of EU 1996)

- Dust
- Particulate and filter passing metals, semimetals and their compounds
- NO_x, SO_2, CO, CO_2, O_2, HCl and HF
- Dioxins and furans (PCDD/DF)
- Polycyclic aromatic hydrocarbons (PAH)
- Total carbon (org. C)

Determination of chlorine is not required with this process and it is operated without using salt, thus achieving a significant advantage compared to previous melting process.

The concentrations measured in the raw gas without exception complied with the NF metal regulation. The measurement regime provided greater process transparency and as a consequence enabled significant optimisation of the operating process. As part of EU requirements reference is made to the IPPC guidelines (official title: Directive 96/61/EG of the Council dated 24 September 1996 on the Integrated Prevention and Reduction of Environmental Pollution). This aims to achieve the integrated prevention/reduction of emissions from industrial plants, in particular through the use of "Best Available Technology" (BAT)

5. Large-scale production

The rotary drum furnace is constructed in modular form as a furnace body, internal recuperative system, burner module and control unit, where in addition to the furnace unit, an integrated system is also provided with the innovative feature of an internal recuperative system.

The success of this process lies in the combination and coordination of the separate components. From a machine engineering viewpoint, the process can be considered ready for regular production. Due to the modular construction it is possible to adapt it to the individual requirements of the customer.

6. Summary

Pilot trials have shown that this process can offer significant potential savings compared to conventional technology, both through higher yields of recovered metal and through lower energy consumption. The process does not use salt as a melting aid, thereby providing additional economic and environmental benefits. It can be expected that further optimisation and improvements to the process can be achieved.

7. ARP Testing Institute

ARP GesmbH – Processing, Recycling, Test methods, is a private state-accredited (EN ISO/IEC 17025) research and development testing agency with a focus on metallurgy, process technology, building materials testing, mineralogy and chemistry. Some reference projects are cited below:

- Co-development of the HSR (Holderbank melt redox) process
- Ceramization of filter dusts
- Regeneration of desulphurisation slag from the steel industry
- Process development foam slag ABB
- UNIDO Model Steel Works Program
- Expert knowledge of rotary drum furnaces
- Different projects with rotary furnaces of own production
- etc.

Further information can be found at http://www.arp.at .

Sources:

- ARP Expert's Report (Nov. 2001) and Third Milestone Test of ARP Process (Sept. 2003)
- Test report ÖSBS (March 2004)
- Montanuniversität Leoben degree dissertation (Nov. 2003)

Leoben, 22.03.2004