DROSS Engineering

RECYCLING ALUMINIUM CASTINGS WITH 'CAST-IN' CAST IRON INSERTS

(The experience of PSA [Peugeot SA])

Fabrication rejects cost money and every foundry puts in place systems designed to reduce them. When dealing with components with 'cast-in' cast iron inserts and sleeves, an additional problem has to be overcome: separate out the iron without polluting the aluminium.
Even though such rejects represent a small percentage of overall production they exist and are a source of metal to be exploited. Recycling such components internally raises a number of issues that require resolving: choice of technique and installation running costs. This paper presents the different techniques on the market today and examines the reasons for the choice made by a major European automobile company (PSA) who opted for a system based around a tilting 'converter' furnace designed and built by Dross Engineering. We present the equipment itself and the results experienced by the PSA foundry division.

Introduction:

The Peugeot SA (PSA) high-pressure aluminium foundry is part of the Mulhouse fabrication complex. It is located in the eastern most part of France, in Southern Alsace, on the frontier with Germany and Switzerland. Part of the PSA group (Peugeot – Citroen), the integrated foundry facility employs some 290 people and produces daily 84 tonnes of engine blocks for the group's 4 cylinder diesel and petrol engines. The components are produced using the 'cast-in' insert technique. The foundry consumes 90 tonnes of aluminium per day either melted on site or bought-in in liquid form. The HP foundry is equipped with 8 x 2500t and 5 x 2000t diecasting presses.

The problem

Process rejects, although a small percentage of overall production remain an inevitable part of the fabrication process. Several years ago, as part of their forward planning, the foundry management gave themselves the objective of processing the reject parts in-house rather than continue the practice of selling the rejects to a secondary smelter, particularly as they were sold at a loss mainly due to transport costs. The brief, issued by the management team, placed a strong emphasis on:

- **Ergonomics** - minimal material handling
- **Versatility** - the ability to process a range of feedstock including:
  - Parts with and without cast-in inserts
  - Ingot
  - Chips and swarf
  - Dross
  - Runners & risers and general production scrap

They looked at a number of alternatives including:

- **Classic dry-hearth furnaces** or tower/shaft melting furnaces. (Eliminated due to intensive manpower requirements)
- **Crushing and separation** followed by melting in a reverb furnace with pump. (Eliminated due to high equipment costs, quality and safety issues)

They then looked at a new type of furnace that had been developed by the Anglo-French company, Dross Engineering:

- **The tilting rotary (TRF)** or converter furnace.

The Converter furnace

The concept of the TRF or converter furnace is simple: it is in fact, a rotating closed well, combining the advantages of rotary furnaces, reverbs and dry hearths in a single unit.

- Classic fixed axis rotary: Heat transfer – Homogeneous Melt
- Reverb: can be energy efficient & provide a controlled atmosphere
- Dry Hearth: melts irony scrap

All these combined in the TRF.

PSA's installation

Before proceeding with the project, PSA carried out melt trials at an existing plant equipped with a Dross 80 converter furnace. The trials were conclusive and the project was given the 'green light'.
. Dross engineering size their furnaces according to the 'useful capacity' of the furnace i.e the volume of liquid metal contained in the chamber. A Dross 100 furnace = 1m3 (35ft3) useful volume, a Dross 200 = 2m3 (70ft3) etc…PSA designed their recycling plant around a 2m3 (70 ft3) converter furnace, Dross Engineering's Dross 200 model. The furnace receives its charge via a dedicated charge machine, also supplied by Dross engineering. Liquid metal is transferred to a 35 tonne (77000 lb) bulk holding furnace via transfer ladles. PSA opted for ladle transfer as opposed to launder transfer for reasons of versatility and the ability to transfer metal to any of their other melting furnaces or directly to their machine holding furnaces. The installation is equipped with an efficient ladle preheat station that has enabled PSA to reduce pour temperature and to increase savings. Off-gas from the furnace is extracted via a cyclone and filter baghouse.

The equipment was commissioned in 2002 and PSA have carefully monitored the success of the installation. Methods department engineers have collected a wealth of information that confirms the original findings of the trials.

Production figures

Data from 174 melts has been collated and the following averages immerge:

- Production rate: 1493 kg/hour (3290lbs/hour) (Spot melt rate ~3 tonnes/hour [6 615lb/hour])
- Melt cycle time: 64 minutes including: Charging (2 charges per melt), melting, pouring and insert removal (actual melt time is ~ 30 minutes)
- Pour temperature: 655°C (1180°F) (process range 630 – 690°C / 1140°F – 1280°F)
- Iron pick-up: 0.09%
- Metal recovery > 97%
- The furnace is operated by one man per shift who is responsible for all the furnace operations including charging, pouring and cleaning.
- The furnace is fitted with a cyclone and baghouse filter rated at 16 500 m3/h @ 200°C. The following particulate emissions have been recorded: 0.41 mg/m3. The European standard calls for 40 mg/m3.
- The cast-in sleeves are recovered and sold on locally

Furnace details

The TRF or converter furnace is a 'dedicated melting furnace', that can melt a wide range of feed stock and is equally at home processing aluminium, zinc, lead, tin etc…Because the furnace operates as a batch melter, metal pollution by trace elements in the charge (free iron for example) is greatly diminished or even eliminated making it an ideal 'de-ironing' unit. The rotary action facilitates charge mixing and promotes melt homogeneity, heat transfer and also promotes self-cleaning. The furnace melts 2 to 3 times faster than equivalent rated static furnaces and offers extremely efficient energy returns. The PSA furnace is fitted with a 2000 kW burner set at 1200 kW, during commissioning, returns of less than 400 kW/t (619 Btu/lb) melted were recorded. Furnace movements are remote controlled by radio link providing a safe, operator friendly working environment.

The furnace is designed more like a 'machine tool' than a furnace. The movements and stresses, even for smaller models, are unforgiving and punish any misalignment. They demand a level of precision during assembly that is normally reserved for machine tools.

The drive mechanism:

For the first furnaces of this type built, Dross Engineering chose to power the rotation via a hydraulic motor. The results were satisfactory but not without problems. This initiated design work that resulted in the adoption of an innovative drive system that is both direct and reliable and that guarantees a positive movement in both directions. The system is compact and ensures a smooth start to rotation under charge; it withstands a wide variation of load at temperature and all the aggression of a foundry environment with a minimum amount of maintenance. The mechanism is patented and grants to Dross Engineering's furnaces a drive system that is unique for this application.

Furnace design

Efforts created by the movement under load and at temperature require a furnace structure that is both robust and precise. Dross Engineering uses the finite element method to provide accurate predictions and evaluations of component response when subjected to thermal and structural loads. Particular attention is paid to assembly tolerances and a large number of components are machined. Guide bands, or tyres, traditionally mounted 'floating', are welded to the shell and machined insitu to tight tolerances and run on 'elastic' rollers assembled to a high level of precision. This 'elastic roller' system is also covered by a recent patent.

Rotary seal

A rotary seal system linking the hygiene hood with the base of the stack promotes efficient extraction and enables combustion products and fume to be 'captured' at source and channelled to an independent cyclone and filter unit or to the plant' filtration system.

The drive mechanism guarantees a wide range of rotation speeds, facilitates change of direction and stoppages – these can be programmed in individual 'recipes' according to the type of product processed and lead to a major reduction of particulate in the off-gas stream.

Vari-gas burner

In itself, the concept of the converter furnace with its enclosed well allows both the furnace atmosphere and furnace pressure to be adjusted to give optimum stoichiometry and to avoid ingress of parasite air, thus promoting reduced energy consumption and minimal metal losses and the possibility of running completely salt free or with greatly reduced quantities of fluxing agents.

To achieve good metal yields the normal practice is to adjust the burner to give an atmosphere inside the furnace that is slightly 'reducing' (gas rich). This adjustment usually takes place once and for all during furnace commissioning or during a regular service and is carried out by a qualified technician who manually sets the air and gas control valves after analysis of combustion products. However, certain products and feedstocks would benefit from being able to vary the air/gas ratio at different times during the melt cycle to create an atmosphere in the furnace that is either 'air-rich' (oxidizing) or 'gas-rich' (reducing) to obtain even higher yields, to optimise production or for metallurgical reasons. Such operational flexibility was not available to foundrymen until now. Completely programmable, the 'Vari-gas' system splits the melt cycle into segments that can either be air-rich or gas rich depending on the charge and offers foundrymen and refiners alike real operational flexibility.

The fixed chassis of Dross Engineering's converter furnaces is designed to house the control panel and the hydraulic power pack all of which are wired and piped in their fabrication shops. The refractory lining that is either in brick, castable or pre-cast blocks or even a combination of all three, is also carried out in the fabrication shop. Working this way Dross Engineering can ship furnaces that are completely finished (up to the Dross 700 - 7m3 furnace size), tried and tested in house and so limiting intervention and disruption at the customer's plant. Normally, from delivery, only 10 - 15 days are required to install and commission the furnace, including refractory drying time. It is almost a 'plug and play' furnace! For the furnace operator all the movements of the furnace are remote controlled by radio link. Rotation speed and direction, furnace tilt, door opening and charge machine movements are all controlled remotely for operator safety and ease of use.

Conclusion

With the Dross Engineering converter furnace PSA have an installation that is:

- Highly versatile, melting a wide range of feed stock from furnace dross to ingot and foundry returns with cast-in inserts.
- Ergonomically efficient requiring minimal manpower
- And that provides quality metal economically

Dross Engineering has the vocation to provide foundries worldwide with innovative solutions to their molten metal problems and in addition to their Converter Furnaces offer a range of equipment that includes Dross Presses and holding furnaces and specially developed melting furnaces for aluminium powder production using immersion heater technology.