# MODERN FURNACES FOR ALUMINUM SCRAP RECYCLING

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There are a number of furnace types that can be used for melting of aluminum scrap. The decision regarding which type of furnace a melting operation will use is based on type of scrap, quantity of scrap, physical condition of the scrap, and the end product of the operation. The information presented in this paper is intended to assist in the determination of a suitable furnace design.

**Tilting Barrel Furnace**

The first furnace type to be discussed is the Tilting Barrel Furnace (Photo 1). Since this furnace was developed, over 250 have been placed in operation.


Photo 1: Tilting Barrel Furnace

***Type of Scrap Processed***

The tilting barrel furnace has been used for melting of scrap die castings, foundry castings, and the trimmings from the casting process. This type of scrap has a relatively high density to surface area ratio that helps the material sink beneath the surface of the bath when it is charged. There is typically some residue on the surface of the scrap, such as die lubricant, which will burn off during the charging activity, so getting the metal away from oxygen is essential to minimize dross formation.

***Features of the Furnace***

The tilting barrel furnace features an external well for charging scrap. The well is separated from the main chamber by a submerged arch or vertical lifting door. Opposite the well, a dry hearth ledge can be included for preheating of ingot or sows (Photo 2).

Photo 2: Dry Hearth Charging of Sow

Photo 3: Tilting about the long axis

Metal is removed from the furnace by rolling the furnace over about the long axis of the unit (Photo3), or by tilting the furnace about the pour spout axis (Photo4). This method of tapping eliminates the need for tap plugs and cones. The tilting controls are located away from the metal flow for increased safety of the operator.

Photo 4: Tilting about the pour spout

The refractory lining consists of hi-alumina brick in the metal contact area and high strength brick in the upper portion of the furnace. The brick is arch shaped to produce a self-supporting lining when the furnace is cold. As the furnace heats, the brick expand to form a very tight joint system that prevents penetration of molten aluminum. This allows the furnace to be cooled down without the concern for damage that is common to a straight walled furnace when shut down. The furnace can be heated with gas, oil, or radiant electric elements.

***Applications***

The tilting Barrel Furnace is available in capacities ranging from 5 MT to 10 MT, and melt rates of 0.5 MT/hour to 1.5 MT/hour. These sizes are ideal for the operation running different alloys that may require frequent metal changes within the furnace. The circular shell and refractory design make batch melting possible without undue damage to the furnace.

Suitable operations for this furnace include die-casting and foundries, particularly for automotive parts, processing their own in-house scrap, and secondary smelters producing a variety of different remelt ingot specifications.

**Scrap Manager™ Rotary Furnace**
The second type of furnace to be discussed is the Scrap Manager™ Rotary Furnace. This furnace is similar to the barrel furnace in overall shape, but rotates completely about the center axis. This furnace was first supplied in the late 1970's and has undergone significant updates since that time (Photo 5).

Photo 5: Scrap Manager™ Tilting Rotary Furnaces

***Type of Scrap Processed***
The Scrap Manager™ Rotary furnace has been used for melting of scrap castings, extrusion scrap, UBC, and dross processing. This type of scrap has a relatively low density to surface area ratio. This characteristic requires that the material be melted quickly so the thin cross section material does not burn up.

***Features of Furnace***
The rotating action of the furnace results in the load being heated from above by flame radiation and from below by the heated refractory. The rotation assures even wear on the lining because there is not a fixed metal line for the aluminum to attack.

The furnace consists of a single ended steel drum in a rigid support cradle including alignment trunnion systems, tilt bearings and drive sprocket (Photo 6). The 25mm thick steel drum has greater stiffness, providing stability to the refractory lining and reducing bearing problems in the trunnion and thrust rollers. The hydraulic tilting system maximizes charge volume with a 10 degree back tilt and provides controlled pouring with a 42 degree up tilt. The furnace utilizes an electric rotation drive that can be varied between 0 and 9 rpm and can be rotated throughout the full range of tilt angles.

Photo 6: Scrap Manager™ Tilting Rotary Furnace

Photo 7: Burner Door Assembly

The burner and flue door are designed to move vertically away from the shell to provide access (Photo 7). The heating system incorporates a double pass firing scheme that maximizes efficiency from the combustion system. The furnace can be fired with oil or natural gas, cold air, preheated air, or an Oxygas combustion system.

***Applications***

The Scrap Manager™ Tilting Rotary Furnace is available in capacities ranging from 2 MT to 12 MT, and melt rates of 0.5 MT/hour to 4 MT/hour. The furnace is suited to the operation running different alloys that may require frequent metal changes and processes many different types of scrap. The furnace can process clean and dirty scrap with the appropriate pollution abatement equipment.

Suitable operations for this furnace include secondary smelters and primary processing facilities interested in processing their in-house scrap. This furnace has also been used for recycling of lead-acid automobile batteries.

**Reverb Melter**

The reverb melter has been the standard in the aluminum industry ever since the first slabs were cast. The variations in design are as numerous as the types of scrap available. Some of these variations are stationary, tilting, front loading, top charging, and multi-chamber designs. Each design has technical strengths and weaknesses.

***Front Loading Dry Hearth (Photo 8)*** – the front loading furnace features a full width door that provides complete access to the interior of the furnace. Loading is accomplished by forklift or more commonly by a dedicated charging machine. The advantages of this design include the ability to completely drain the furnace for batch operations and it can achieve a relatively high melt rate to holding capacity. The weakness of the furnace is that it typically requires more than one charge to fill due to the furnace geometry.

This furnace is suitable for medium to large processors and multiple alloy specifications.

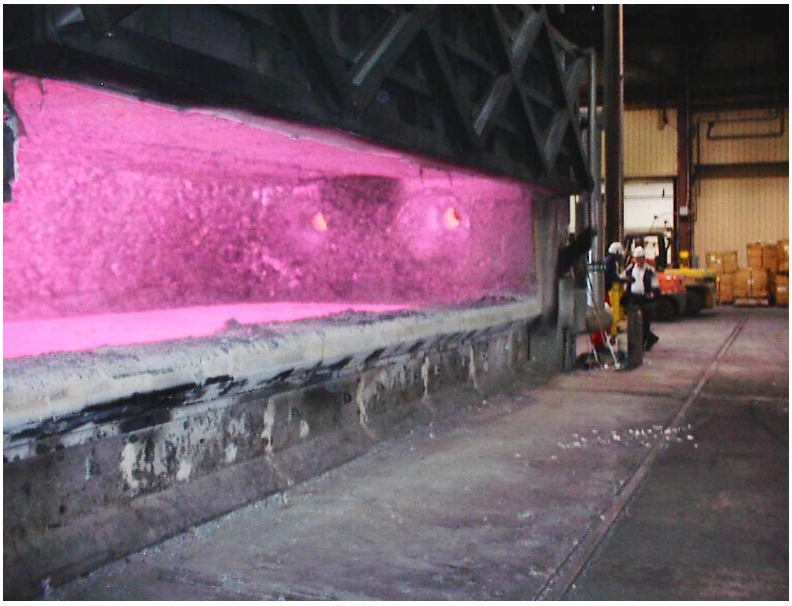


Photo 8: Front Loading Melter

***Top Charging (Photo 9)*** – the top charge furnace features a removable roof that provides full access to the interior of the furnace. Loading is accomplished by overhead crane and charge bucket. The advantage of this design is that it can be filled very quickly. The furnace is designed to be completely drained after each melt cycle allowing easy alloy changes. The weakness in this design is the heat loss that occurs when the roof is removed which demands the charge sequence and cycle time be tightly controlled.

This furnace is suitable for large processors with sufficient overhead clearance, processing a wide range of scrap types.

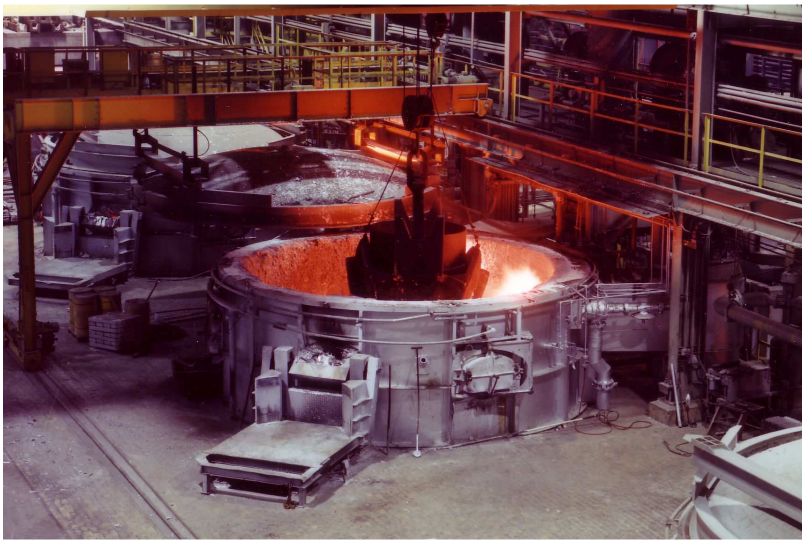


Photo 9: Top Charge Melter

***Multi-Chamber Furnace***

The multi-chamber furnace (Photo 10) features various chambers designed to address specific physical properties of the scrap being processed. Loading is accomplished in a number of ways including through a well and through a main door.

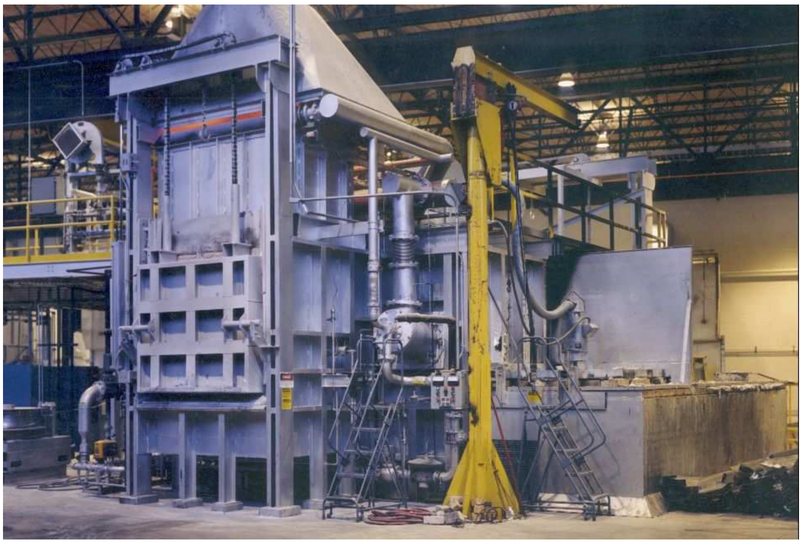


Photo 10: Multi-Chamber Melter

Well chamber melting employs an external well to accept the scrap charge. Typical charge materials include extrusion scrap, chips and turnings, baled material, and other material that has a small weight to surface area ratio. These materials require quick submergence beneath the bath surface to prevent oxidation and metal loss.

Auxiliary equipment used in conjunction with the well include mechanical pumps, fume collection hoods, submergence systems, and dividing walls. This equipment is included to move the hot metal from the heating chamber into and through the well, take the charge material below the surface of the bath, and collect any emissions caused by contaminant burn-off.

Dry hearth chamber melting employs a ledge inside the furnace to accept the charge material. Typical charge materials include long extrusion scrap, ingots, sows, T-bar, and baled material. The material sits on the ledge and is heated by the products of combustion before being pushed into the molten bath to complete melting.

Auxiliary equipment used in conjunction with the furnace includes electromagnetic or induction pumps to mix and homogenize the melt and fume collection systems to circulate charge off-gases to the burners for destruction, or to dedicated abatement equipment.

***Applications***

The Multi-Chamber Furnace is available in capacities ranging from 20 MT to 120 MT, and melt rates of 5 MT/hour to 30 MT/hour. These furnaces are recommended for operations producing a limited number of alloys using the same basic chemistry. This is due to of the issues associated with switching alloys in this type of furnace. A furnace design can include any combination of the chambers depending on what is to be processed and how much space a facility has available.

**Stationary versus Tilting**

The last question to answer involves whether the furnaces will be tilting or stationary. The major operational difference between the two is how the metal is removed from the furnace. Loading methods, combustion systems, fume treatment methods, and metal recirculation systems are basically the same for either design.

***Tilting Furnace***

The tilting furnace utilizes a set of two hydraulic cylinders to pivot the furnace about a set of trunnions mounted in line with a pour spout. Seco/Warwick supplies a proprietary no-leak rotary pour spout (Photo 11) for our designs. The pour spout is a refractory lined assembly that resists erosion from the passage of the molten aluminum.

Photo 11: Seco/Warwick Rotary Pour Spout

The tilt cylinders and hydraulic power pack can be controlled by level sensors that maintain a constant pour rate to a casting system or manually to a sow casting line. Proportioning valves are included in the hydraulic lines to allow automatic control by the level sensor. The furnace will automatically go from 0º tilt to 33º tilt at the speed required to maintain a constant flow through the launder to the caster. The control system ties together the sensor and the hydraulics (Photo 12).

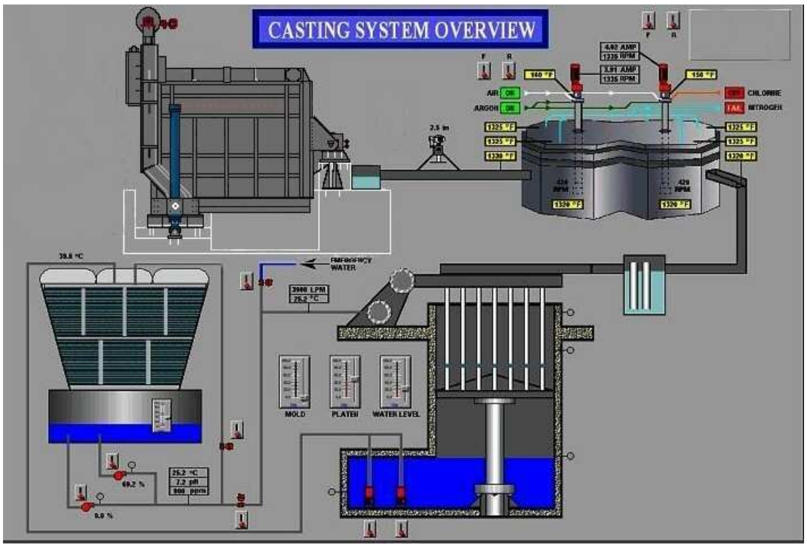
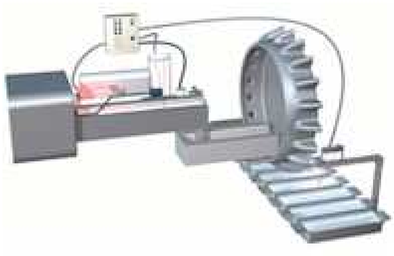



Photo 12: Automatic Tilt Control

The advantage of a tilting design is that the furnace can be completely emptied relatively easily. The geometry of the hearth and pour spout ramp is designed to drain the furnace without the need for secondary taps and plugs.

***Stationary Furnace***

The stationary furnace relies on head pressure to produce flow. The depth of metal above the tap hole creates this pressure. The hole is sealed with a cone shaped cast iron piece and a ceramic fiber gasket. The rate of flow from the tap can be controlled with a motorized device integrated with a level sensor mounted on the launder. Based on a signal from the level sensor the mechanism moves the cast iron tap plug into or out of the hole (Photo 13).



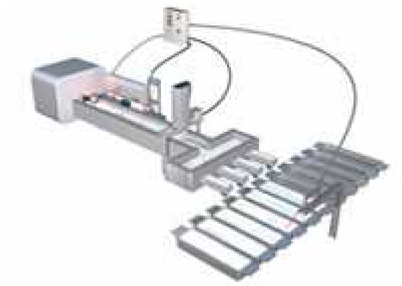


Photo 13: Precimeter Automatic Tap Actuator

The advantage of a stationary design is that the capitol cost of the equipment and foundation is typically less than a comparable tilting design.

**Summary**

In conclusion, the choices offered to an aluminum scrap processor are many and varied. The decision between a furnace dedicated for a specific type of scrap and a furnace with the flexibility to process many different types of scrap affects the overall design and cost of an installation. Many scrap processors can benefit from assistance in choosing a design that fits their needs. The manufacturer is there to provide this assistance.