History and Development of Slag and Dross Pressing

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Abstract

The hot dross pressing technology was first invented for the lead industry in 1896. This early patent was later followed by the hot pressing of zinc slag. The first commercially marketed pressing systems using this 1896 patent as a reference for aluminum, were available in the early 1980's and manufactured by Pechiney in France and Showa Aluminum in Japan. In the mid 1980's Anaconda Aluminum also developed a dross press system internally that was used in several of its operations. The first commercially successful dross presses were developed and marketed by Altek International in the early 1990's. Since that time there have been many commercial manufactures and home made versions of the dross press found around the world. Some have been successful performing the process and some have not been successful. Dross pressing is the most widely used system for hot dross processing used through out the aluminum industry today. The original developing industries of lead and zinc do not widely use this process to recover liquid metals from their slags.

Lead and Lemons

There were two technical breakthroughs that occurred in 1896 that were the dawn of todays technology. First, Mr. W. H. Howard of Pueblo, Colorado was a visionary when it came to processing slag. The device he invented used a flat plate to contact the lead slag in a cylindrical container. The device put pressure on the lead slag mass and let the molten lead flow back into the lead kettle. The patent covered a simple mechanical system and an early hydraulic system to provide the squeeze pressure.

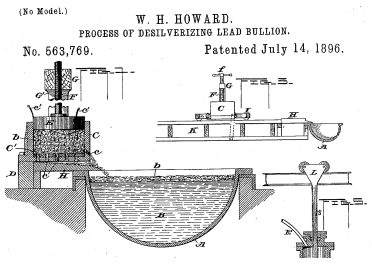

Figure 1 - The 1896 Lead Bullion

The next big advance, the significance of which no one really knew at the time, was invented by Mr. J. T. White of New York, New York. He developed a mechanical advantage device that used a pressing head and container with holes to separate a liquid that was contained in a solid. The lemon squeezer was born. These two ideas were the foundation of all the patents that were to follow.

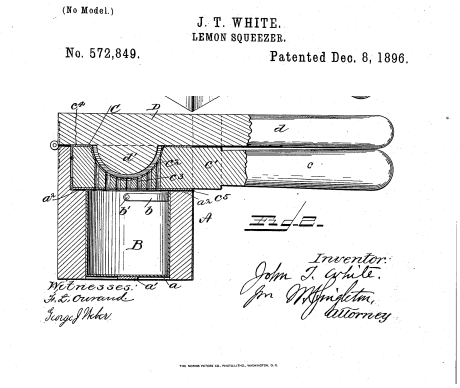

Figure 2 -The 1896 Lemon Squeezer

The Basic Process

The process of hot slag/dross pressing is based on the observation that when a solid matrix, that has a trapped liquid within it, is placed under pressure, the liquid will separate from the solid and flow to the area of highest concentrated pressure (the head and pan surfaces, aluminum escaping thru the drain hole locations). The basic press system consists of a press head and skim container/sow mold set, where compression forces are exerted either by gravity, a mechanical advantage or a hydraulic unit. All of these systems have been used successfully over the past 120 years of the press development. Systems developed over the past 10 years have focused more around the ancillary equipment such as safety doors, spray coating systems and pollution control units. All gadgets that are really nonessential to the basic process, but can make operation simpler, safer and appear environmentally more acceptable.

The Development of the Modern Press

There were three very important patents that lead to today's successful aluminum dross press.

The first was invented by Mr. G. P. Ross and Mr. J. L. Bedortha of National Steel Corporation in 1977 for the separation of molten zinc from zinc slag. This was the first patent in slag pressing that really took into consideration the importance of matching the compression head contours to the collection pan contours. This was a another breakthrough idea for understanding the type of pressure forces required to get the liquid metal separation at low enough values to be commercially practical. It was the understanding of this idea that made the next two patents possible.

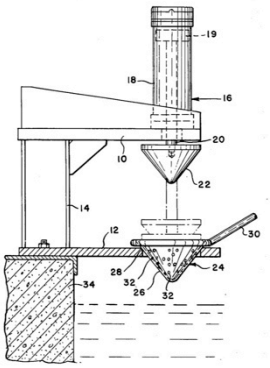

Figure 3 - 1977 Molten Metal From Dross

The second was invented by Mr. D. J. Roth, Mr. L. R. Culler and Mr. R. D. Heffner of the Anaconda Company in 1983 for the separation of molten aluminum from aluminum dross. This was the first patent in this area of aluminum dross pressing but others soon followed and used cylinders to contain the dross and flat plates to press the material. The pressures required to drive out the aluminum from the dross with these type of flat heads and cylindrical containers were extraordinary and made the units far too expensive and commercially unacceptable. Presses manufactured using the Anaconda couture head and pan technology were placed at several Anaconda plants. The short coming of this technology and the reason for the relatively short internal company use was due to deformation and cracking of the fabricated steel pans and the difficulty this caused in removal of the cold dross from these pans. The most important part of this development was the understanding of the aluminum plating process that occurred at the right pressures due to the matching of the contours of the head and container designs. This was the first major step in increasing the recovery of aluminum from dross from the 20% range, that was typical in the early 80's, to the 50 - 60% range that is typical in today's pressed dross.

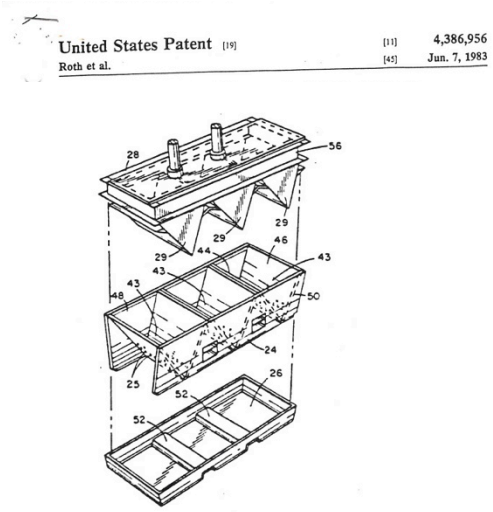

Figure 4 – 1983 Metal Recovery from Dross

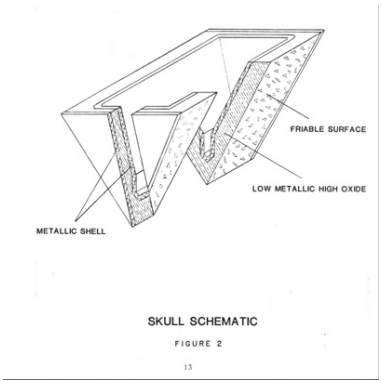

Figure 5 – Plating Action Under Pressure

The third major step was the invention by Mr. D. J. Roth of the Altek International Company in 1997. This patent talked of the use of ribs on the head that matched the contours of the pan. The genesis of this breakthrough idea came from old tests from the 1980's that were done in the Anaconda development period and the Remetal Rotary Cooler Systems. The Remetal use of cast steel skim pans was very unique at the time. By going away from the fabricated pans, the dross pressing process could now be commercially acceptable from the viewpoint of a long service life and a moderate sales price. The first press frames and hydraulic systems were modified scrap paper compactors. They were inexpensive but did the job. Today's standard commercial versions use the same pan and head concepts of the original designs but are built like tanks to last in the severe cast house environments. Fork truck and cast house operators seem to know only one speed, full ahead!

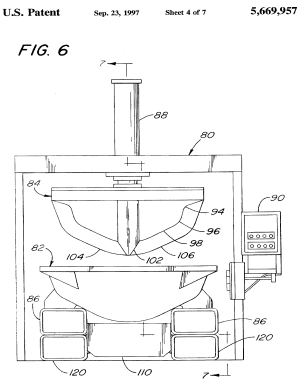

Figure 6 – 1997 Dross Compression Apparatus

There have now been more than 25 US and international patents in this technology area.

Dead Weight Pressing

The use of the press head only started in the Anaconda Company in the early 1980's. All the early test and designs used this strategy. This "dead" head technique, has been used by several other companies since the 1980's. The heavily weighted "dead" head would cool the material but it was not able to get the plating action that was so important to the high recovery values achievable from hydraulically pressed dross. However, for generators of small amounts of dross and when shallow dross pans can be used, this is a viable less expensive solution over the use of a hydraulic press. The overall recovery numbers will not be as good as a standard dross press.

Figure 7 - "Dead Head" Pressing

The Key to a Successful Dross Press

Dross press technology is really not about the press but about good skim pan and head designs. High grade steel castings, which allow for optimal pressing configurations have made the process what it is today. The skim pot has holes to allow for the maximum natural drain and pressed drain. Good casting designs also promote dross cooling and newer designs optimize skull sizing for downstream processing.

The process starts when dross is skimmed into the skim pot set. The most important free metal drain starts here. When projecting the process total drain the rule of thumb is that 2/3 of the total drain will come from the free drain while skimming and 1/3 will come from the pressing action. After skimming, the skim pot sets are brought to the press by fork truck, where the press head is pressed into the dross. This pressure forces additional molten aluminum out of the dross and into the sow mold. The more important action however is the coalescing the fine particles of liquid aluminum into large solid plates of aluminum within the dross matrix. This action is the key behind increased recoveries and cooling of the pressed dross. The mode of the press cylinder cycle is very important to get the separation of the aluminum from the oxides for down stream processing. The plates of aluminum formed by the high head pressures recover at a much higher melt recovery than the typical – ¼" (6mm) aluminum particles that you see in non-pressed dross. A properly pressed dross will have 70 - 80% of the solid aluminum above + 6 mm (1/4"). A non-pressed or poorly pressed dross will have 50 – 60% under 6 mm (1/4"). The size of these aluminum particles plays a major role in their overall recovery.

Figure 8 - Pressed Dross

The in-house drain metal recovery will range from 0 - 10% on black dross and salt cake where cooling and metal coalescing is more important than draining. The free drain can run 15 - 40% on white dross alloys. Secondary recovery ranges the entire spectrum depending on the type of dross or salt cake pressed.

Although the hot dross pressing process is by far the most acceptable and best method commercially put forward to date for cooling and increasing the overall recovery of dross, it is not useful for all materials.

Cold skimmed dross will not press and this practice is the preferred skimming method for some companies. Wildly thermiting dross will press but with poor results and potentially significant damage to the press and pans. Pressed thermiting dross typically continues to burn and fume after pressing.

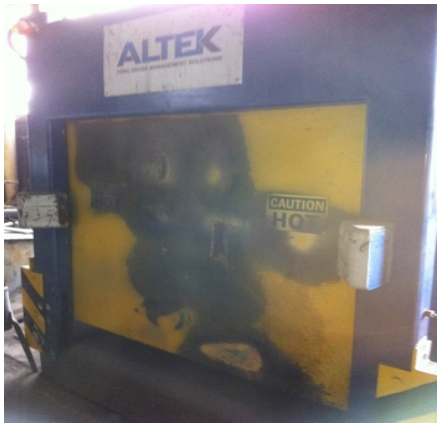

Figure 9 – Press Damaged by Thermiting Dross

Future Dross Presses

Those of us who work in this area of dross recycling have to continually ask ourselves how can we make things better. What could we do to be even more effective in dross pressing and handling, saving energy units, aluminum units and minimizing our industries landfill and CO_2 generation.

GPS - Global Solutions is working on a press system to minimize the amount of metal pulled out of the furnaces with the dross. The goal is to cut the amount removed in half from the current averages. Imagine cutting the plants dross generation in half by the use of a unique in furnace dross press / skimming machine. A significant amount of the dross removed from the furnace is aluminum that should have remained in the furnace. The development of this process has the opportunity to significantly reduce melt losses, energy consumption from remelting metallic concentrates and cause a significant contribution to real landfill and CO_2 reductions in the area where dross is processed and handled.

Summary

There is an industry need to keep moving forward in its dross processing technology development. The first step is keeping as much aluminum as possible inside the melting furnace. The next step is keeping as much recycled aluminum in house for use in the facility that generates it and producing dross pressed skulls that are easily recyclable by non-thermal means. The dross press developed over the past 120 years has added significantly to where we are today. We have continuously moved forward over the past 50 years and we still have the momentum for change and improvement. Our industry understands the value of the aluminum and the oxide products and the value of efforts to preserving both.

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