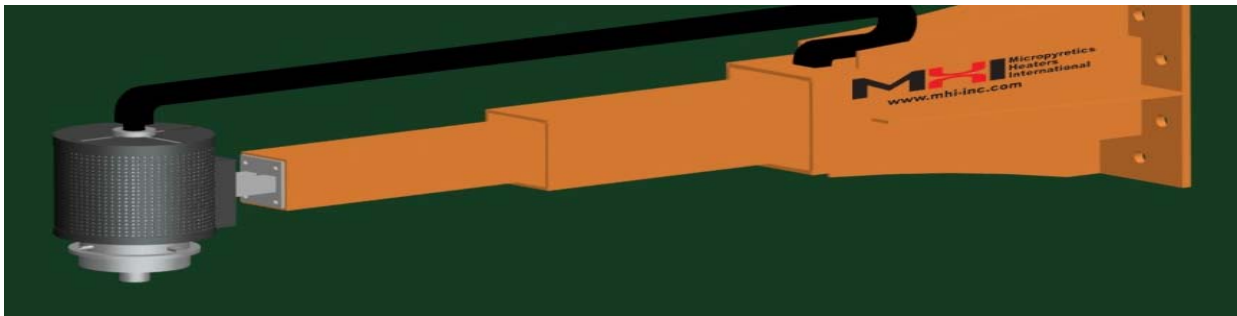


DRO CASCADE e-ION

Aluminum and Silver Processing



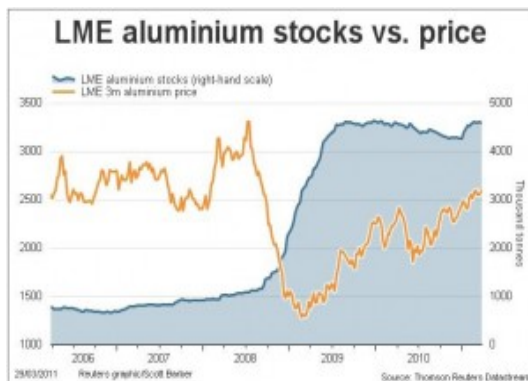
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Technology for a *DRO Ionic* Atmosphere Cover for Aluminum and Silver Containing Alloys
(see also www.oneatmosphereplasma.com)

- Save gross loss in existing and new furnaces
- Cleaner metal
- Close to 100% energy conversion for ion units
- High environment impact
- Competitiveness with patents and trade secrets
- @\$3000 /ton and 33 million tons production annually. Annual savings with 1% gross (metal content) reduction (note in reality gross loss is 5-15%) are **\$990 million. Add to this savings from nitrogen use, energy savings and improved metal quality!**

Graphs show aluminum prices are increasing and silver prices are high.

Aluminum and Silver Prices



Primary Sources Believed to be: Reuters and Stockchart.com

The aluminum industry is one of the most energy intensive industries in the world. Compared with other competing materials such as steel, copper, wood, glass, and plastics, etc., aluminum has the highest energy content. The availability of the DRO cascade e-Ion for aluminum melting/casting and heat-treating will certainly improve the competitive position of aluminum vs. other materials. The DRO machines are aimed at reducing oxide and mixed oxide formation during the liquid metal phase of processing.

Reduced energy consumption will be the number one payoff. In 1996, U.S. primary aluminum production was about 3.6 million tons while secondary aluminum recovery was about 3.3 million tons in 2010. The average energy consumption for producing primary aluminum is about 16,500 kWh/ton, in which 5.5% (~908 kWh/ton) is consumed for melting/casting. On the other hand, the average total energy consumption for producing secondary aluminum is about 6% of that required for primary aluminum. Therefore aluminum holding furnaces are plentiful. Aluminum is also transported as a liquid where considerable shaking can increase oxide formation unless a proper non-toxic cover is used.

The total energy consumed for melting/casting aluminum (both primary and secondary) in the U. S. per year is thus approximately $(3.6 \times 10^6 \text{ tons} \times 908 \text{ kWh/ton} + 3.3 \times 10^6 \text{ tons} \times 990 \text{ kWh/ton}) = 6.5 \times 10^9 \text{ kWh} (22.3 \times 10^{12} \text{ Btu})$.

A small saving of even 1-2 % from dross can yield close to US\$1 Billion Dollar Revenue depending on the price of aluminum.

The new technology disclosed in this document will save you significant dollars. Read on...



Oxidation and dross

The Creation of Dross

Dross is the layer formed on surface metal when molten aluminum is exposed to oxygen at high temperatures. This layer of oxidized metal is a nuisance to the industry; it has no value. Around 5-15% of Aluminum is consumed by dross per year. Due to the current high energy prices, this is a big loss.

Several traditional techniques are used to reduce dross and prevent metal loss: **gas cover** and **toxic fluxes**. New Ionic covers discussed in this document are a clean replacement as the only input used is air, which is ionized to provide protective ionic

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covers.

TRADITIONAL WAYS TO REDUCE DROSS

Gas Cover: Nitrogen and Argon gases are introduced into a furnace chamber to reduce the presence of oxygen and lower the rate of dross formation.

Pros: Effectively this reduces dross in the melting process.

Cons: Requires large quantities of gases on site. Cool gasses can quench the metal surface. This increases the power required to maintain the melt state. You pay for gasses!

Chemical Fluxes (could be toxic): Fluxes are used to reduce dross.

Pros: Insures dross level will be low.

Cons: Bad flux use contaminates the metal thus lowering the metal grade; creates pollution. You pay for chemicals!

NEW METHOD TO REDUCE DROSS

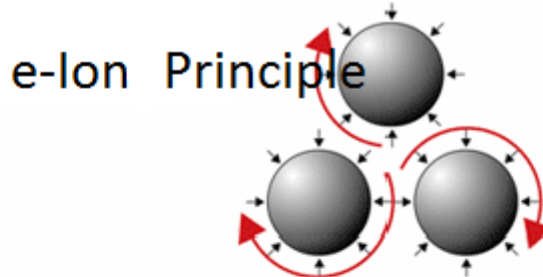
*The **DRO cascade e-Ion** system often eliminates the need for expensive gasses or chemical fluxes.*

This new technology will eliminate consumption of fluxes and costly gases. Read on...

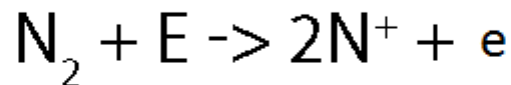
The basics of plasma heating and nitrogen cover are discussed next..

New *DRO Cascade e-Ion* Device - Principle

When you immerse in an e-Ion CleanElectricFlame™

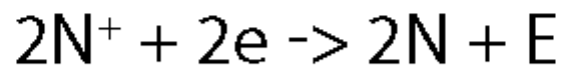


Example of Plasma Formation



E stands for energy

Example of Plasma Recombination



Possible species include O₂, N₂, O₂⁺, N₂⁺, N, O, N⁺, O⁺, e⁻, in e-Ion Plasma of air

Possible species include N₂, N₂⁺, N⁺, e⁻, in e-Ion Plasma of nitrogen.

Many elemental or molecular gases/species can be ionized including Ar, Xe, H₂O and others.

How does it work? Read on...

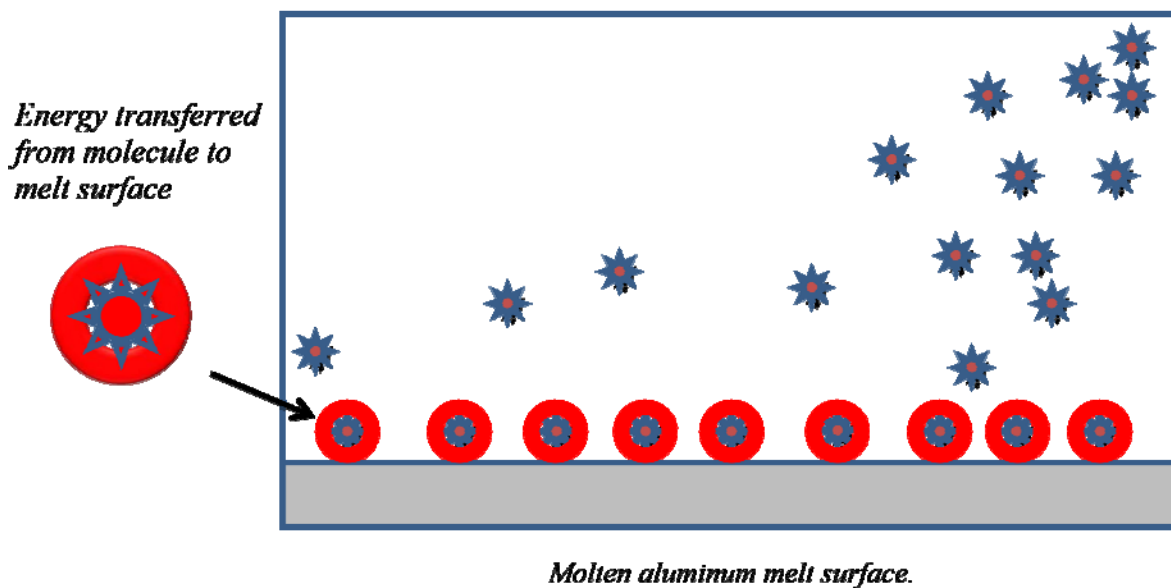
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Cascade e-Ion Cover

Applying a *Cascade e-Ion* Cover is a novel way to protect molten aluminum so that oxidation and dross are minimized. The ionized gas can also substantially eliminate the need for inert atmospheres or fluxes. Heat is also transferred from the molecule to the molten metal thus keeping the surface hot and ready to pour.



The ionized molecule gives off energy as it contacts the surface of the melting providing additional heat & excellent oxidation cover before exiting the chamber.

With a plasma cover you get the following benefits. Read on....

Benefits of a Plasma Cover

- Key to melting aluminum cleanly and efficiently
- Key to high productivity in the aluminum industry (highest melt rates)
- Dross is reduced. A 1% savings is a considerable savings
- **Energy efficiencies improve** although the DRO Cascade e Ion is primarily meant as an ionic gas cover
- Extremely small foot-prints
- **Quiet** (not like conventional plasmas which are very noisy). Improved worker acceptance.
- Close to 100% power transfer efficiency of plasma device- again compare with low efficiency conventional plasmas
- No need for nitrogen, argon or fluxes.



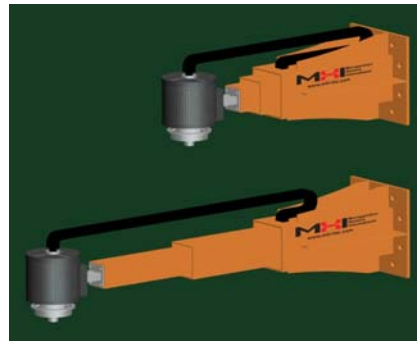
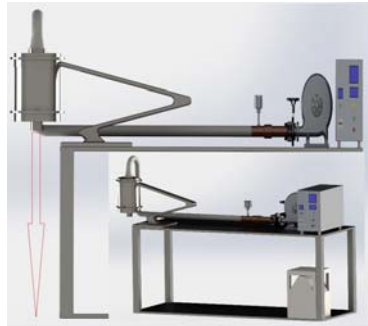
The benefit of a Cascade e-ion cover used during melting is shown above. The melt on the left does not show any signs of oxide compared to the melt on the right.

Like the benefits? Here are more ideas. Read on...



Retrofitting Cascade e-Ion System to Existing Aluminum Furnaces

The quiet DRO machine (except for noise of a blower) is easy to add to an existing holding furnace. The unit is best applied by allowing the cover to be downward firing. The DRO special pipes provided by MHI will introduce the ionic gas through the top of the furnace without being fixed to the furnace. See the illustration below.

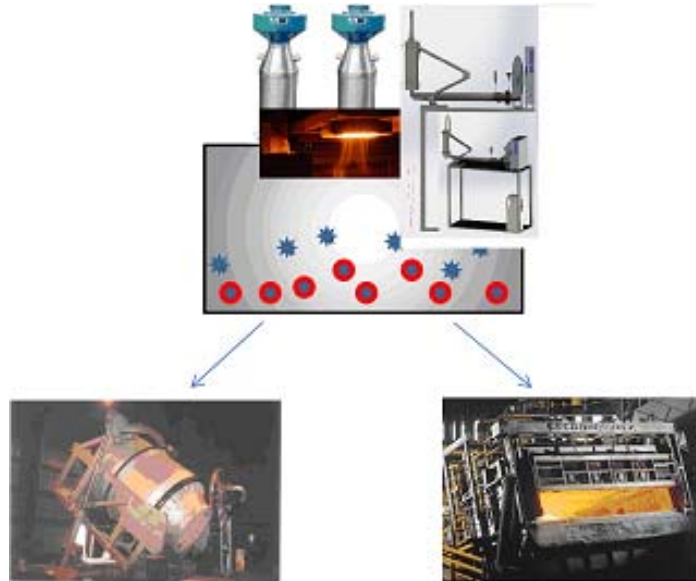
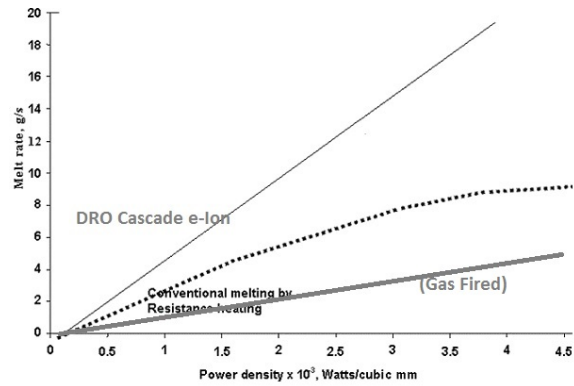


Special Tools: MHI provides the plume inlet flex tube to connect the plume to the furnace interior.

Performance Comparison

Conventional furnaces are unable to create heat on the charge without loss and their efficiency falls off often with size. Plasma assisted furnaces automatically have high power densities and heat transfers directly to the melt. DRO Cascade machines are to be primarily used for ionic covers. Although melting is affected only as a ratio of the DRO compared to the original power, an increase in the melt rate is impacted when the melting furnace original power is small compared to the DRO machine.

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{ Want to compare furnaces? Read on... }

DRO machines are not for aluminum melting but for ionic covers that can improve melts. The graph shown above is not to be extrapolated for melting when furnace power greatly exceeds the Cascade e-Ion power.

See the furnace comparison in attached article. Read on...

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Summary

Over the years, the aluminum casting industry has been looking for an energy efficient non-toxic melt enhancer with reduced losses from oxidation and contamination. To accomplish these goals combined with energy efficiency, the furnace design must incorporate systems which allow directing highly concentrated heat on the aluminum ingots, sprues or molten scrap.

The new *Cascade e-Ion* technology with the DRO machines is able to alleviate several of the current negatives encountered for aluminum and silver alloy melting. The net result is:

- Save dross loss in existing and new furnaces
- Cleaner metal
- Close to 100% conversion into heat and ions
- High environment impact
- Competitiveness with patents and trade secrets

Save money \$\$\$\$\$

Use the *Cascade e-Ion* technology starting today.

For more information, please contact a MHI Representative:

513-772-0404 or sales@mhi-inc.com

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Supplementary Articles/Data.

(Links)

1. [Energy Savings, Environmental Benefit and Increased Productivity](#)
2. [Heat Transfer Enhancement](#)
3. [Technical Article for Aluminum Processing](#) (Enhancement of Heat Transfer Due to Plasma Flow in Material Processing Applications)

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