Issue 1 - AUGUST 2011

Newsletter

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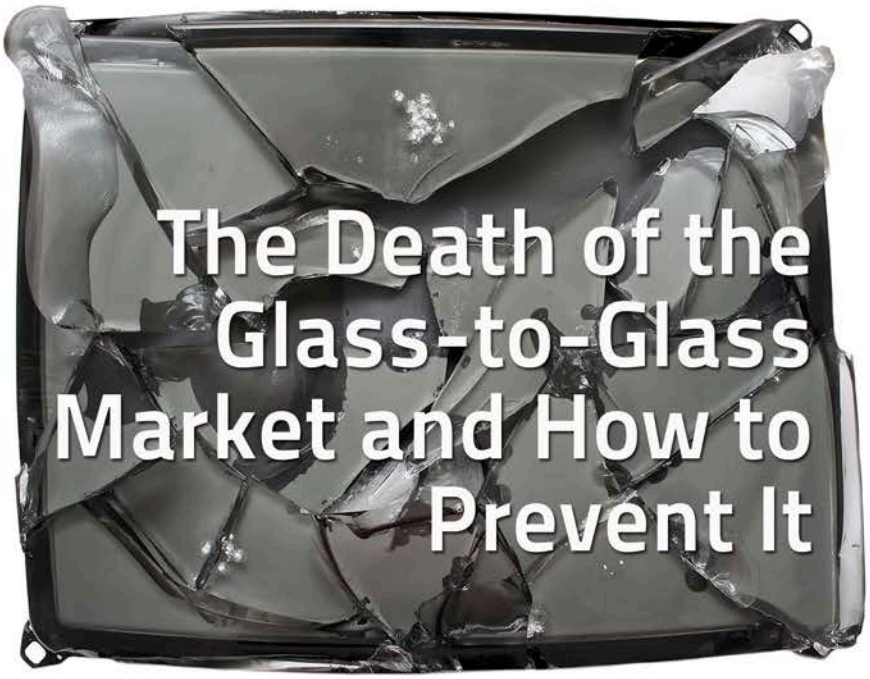
CLOSED LOOP
REFINING + RECOVERY



The Death of the Glass-to-Glass Market and How to Prevent It

Of all the items that end up in our landfills, few post as great a risk to our environment and our health as the cathode-ray tube, or CRT. Since the birth of television in the 1930s, CRT technology has been at the heart of every one of the billions of televisions and computer monitors that have been produced worldwide over the last 80 years.

The introduction of flat-panel displays in the late 90s rendered the large, bulky, inefficient CRT obsolete, almost overnight; CRT sales have disappeared in the U.S., with the developing world remaining as the only true source of CRT demand. Most businesses and government agencies have already made the switch to flat panels as well, due to the panel's smaller footprint and lower operating costs. This has resulted in a tidal wave of e-waste as tens of millions of old or non-functioning CRT TVs and monitors are set at the curb or staged in warehouses awaiting disposal.

Unfortunately, every one of those televisions or monitors contains at least several pounds of lead, a known toxin and pollutant. The majority of this lead is blended into the funnel glass that make up the sides of each CRT. When sealed inside an intact CRT tube, this lead poses no threat to people or the environment, even years after the CRTs useful life. But in the event than the leaded funnel glass is ground down through compacting or other means, it then becomes Hazardous Waste, according to the EPA. So what can we do to avoid having millions of CRTs ending up in landfills, where they have the potential to pose environmental harm?

The partial solution in the past had been to send these CRTs to glass furnaces, delivering two byproducts: panel cullet, which was free of any lead, and funnel cullet, which still had some lead contained within it. This glass was sold back to manufacturers as raw material, along with the ferrous and non-ferrous metals harvested from circuit boards and other essential electronics. Much of this glass still had trace amounts of lead in it, which prevented it from being used for most consumer glass applications. But it was perfect for one use in particular: the manufacture of new CRT displays.

Historically, this 'glass to glass" market has absorbed all the available recycled clean glass, since it was cheaper than purchasing primary glass or raw materials. But as demand for CRT-based displays has slowed to a trickle, so too has the demand for recycled glass cullet. This dropoff is happening at exactly the wrong time: a paper published in 2009 for the Institute of Electrical and Electronics Engineers showed that the supply of recycled CRT glass will exceed demand as early as 2014* – right about when the volume of CRTs in need of recycling starts to take off.

In anticipation of this dropoff in demand, the primary furnaces that recycle CRT glass are shutting down left and right. Six years ago, there were roughly 20 facilities in the world recycling CRT glass. Today there are only two furnaces that accept CRT glass from North America; both of those facilities are expected to cease operations by 2013. That will effectively end the traditional glass-to-glass market for the largest e-waste producing country in the world.

Unless a new source of demand can be found for recycled glass cullet derived from CRTs, it will be cheaper to simply push old – and potentially hazardous – CRTs into the landfill by the millions. ▸

*The Digital Dump" : http://visual.ly/digital-dump

The hurdle that is preventing new uses for clean glass cullet comes down to the trace amounts of lead that remain in the recycled glass. The EPA's test for lead in any substance is called the Toxicity Characteristic Leaching Procedure (TCLP), referred to as 'T-Clip". EPA standards currently accept 5 mg/L of lead in any product being disposed.

Unfortunately, this rigid standard eliminates nearly all current uses for the recycled glass cullet, leaving a fast-growing supply and close to zero demand. Simply put, new applications must be developed that take advantage of this growing supply of secondary glass. Without the ability for the furnaces to offset costs by selling clean panel and funnel glass cullet, the average cost per ton of glass processed would be higher than the alternative: simply dumping the CRTs into a landfill.

The commitment to create new markets or uses must be done quickly. Such demand sources and markets don't develop overnight; they take several years to introduce, pass regulatory hurdles, go through research and development cycles, and ramp up production. Any policy or regulatory seeds planted tomorrow will take years to bear fruit in the marketplace.

One potential industry that might create enough demand to offset the growing potential quantities of secondary glass cullet available over the next few decades would be road construction. Glass cullet could be used as a cheap, durable aggregate to be included in the road bed mix. It could also be used to manufacture the durable, highly reflective dots that are placed every few feet on major roadways in the U.S. and abroad.

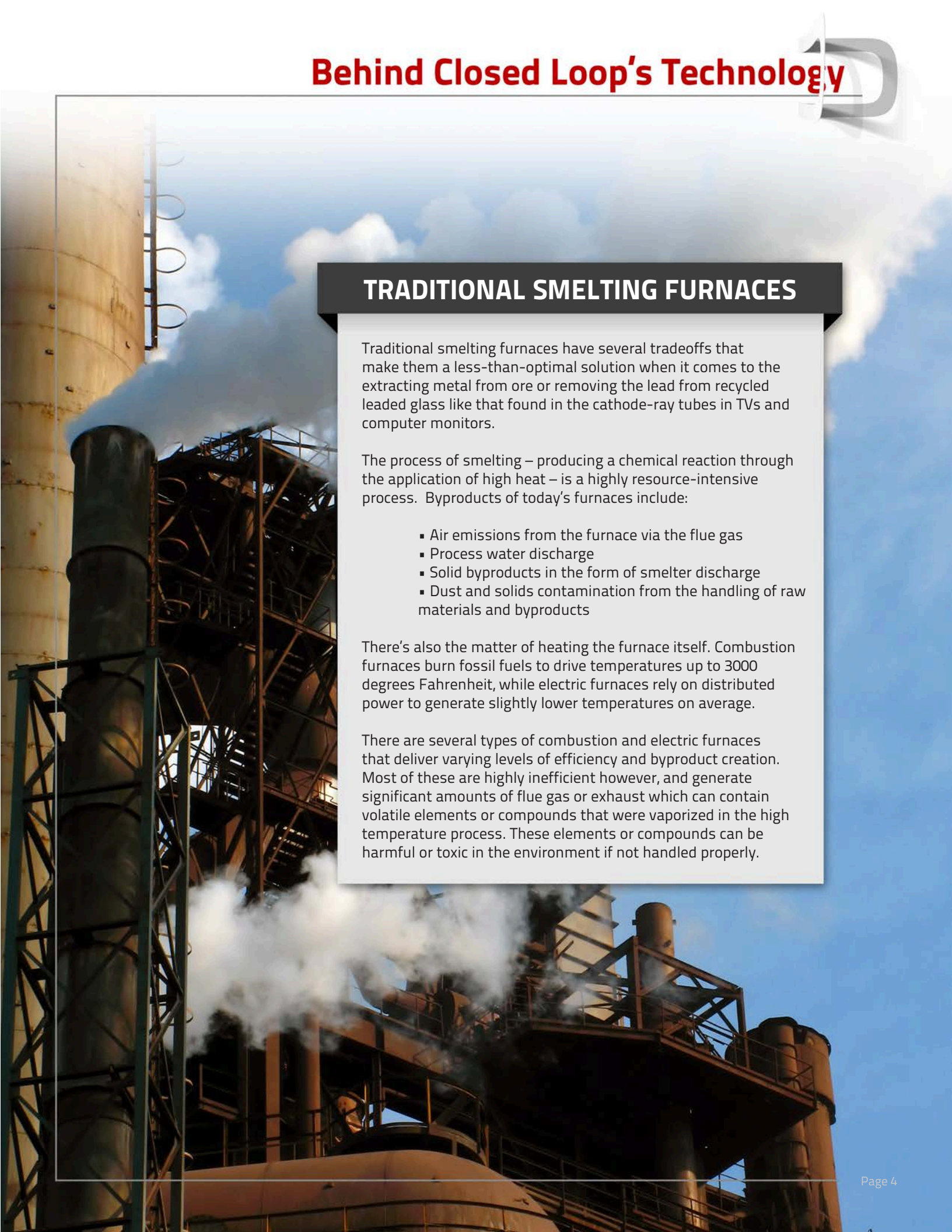
However, the EPA won't allow such uses today, due to the potential for the secondary glass products to degrade over time, releasing dust with trace amounts of lead into the environment. This regulation is simply shortsighted. As noted above, the cullet is very durable with minute traces of lead in it – lead that is inert within the glass, just as it is in leaded crystal and drinkware.

In order to avoid the dumping of tens of millions of leaking CRTs into U.S. landfills over the next decade, the federal government must act quickly, but not rashly.

The recycled CRT glass is also many times more durable than the tires travelling on it – tires which a 2009 EPA study* indicate introduce zinc, lead, and other hazardous compounds into the environment as they break down. Yet those tires today are not only driven on, but also ground up and used in rubberized road coatings, playground surfaces, and as cushioning at the base of the newest artificial turf fields.

In order to avoid the dumping of tens of millions of leaking CRTs into U.S. landfills over the next decade, the federal government must act quickly, but not rashly. It must review existing policies when it comes to usage of recycled glass cullet in applications that do not include regular or prolonged human contact. It must also encourage – likely through subsidies – the development of new applications of glass cullet that abide by existing usage regulations. These new products will take time to develop, and when it comes to the demise of the glass-to-glass market, the clock is already ticking. ▪

*http://hdl.handle.net/1721.1/59351



TRADITIONAL SMELTING FURNACES

Traditional smelting furnaces have several tradeoffs that make them a less-than-optimal solution when it comes to the extracting metal from ore or removing the lead from recycled leaded glass like that found in the cathode-ray tubes in TVs and computer monitors.

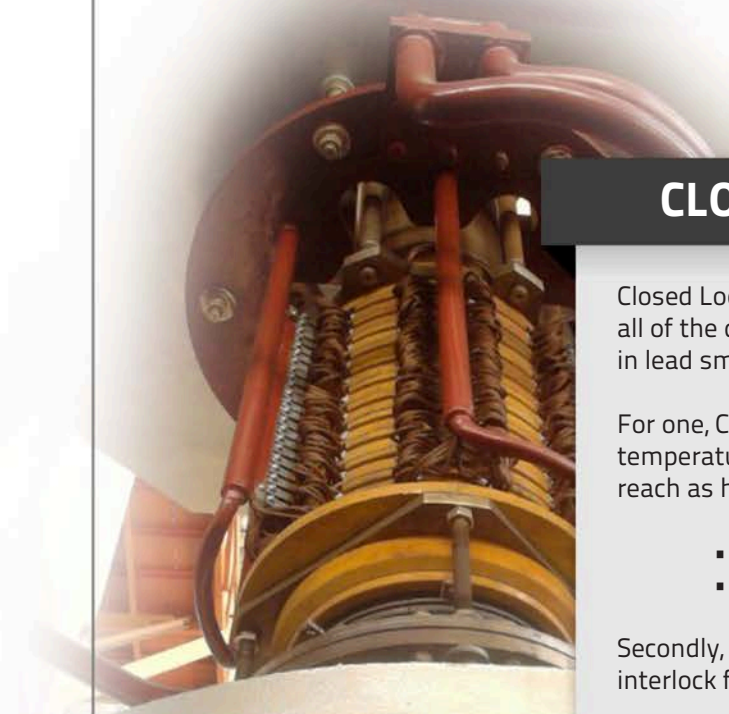
The process of smelting – producing a chemical reaction through the application of high heat – is a highly resource-intensive process. Byproducts of today's furnaces include:

- Air emissions from the furnace via the flue gas
- Process water discharge
- Solid byproducts in the form of smelter discharge
- Dust and solids contamination from the handling of raw materials and byproducts

There's also the matter of heating the furnace itself. Combustion furnaces burn fossil fuels to drive temperatures up to 3000 degrees Fahrenheit, while electric furnaces rely on distributed power to generate slightly lower temperatures on average.

There are several types of combustion and electric furnaces that deliver varying levels of efficiency and byproduct creation. Most of these are highly inefficient however, and generate significant amounts of flue gas or exhaust which can contain volatile elements or compounds that were vaporized in the high temperature process. These elements or compounds can be harmful or toxic in the environment if not handled properly.

Behind Closed Loop's Technology



CLOSED LOOP'S GLASS FURNACE

Closed Loop's new glass furnace technology reduces or eliminates all of the drawbacks associated with current CRT glass processing in lead smelters.

For one, Closed Loop's furnace is able to operate at much lower temperatures; 1900 F whereas hot zones in traditional furnaces reach as high as 2800 F. This offers several benefits, including:

- Lower operating costs
- Fewer volatilized compounds and elements

Secondly, Closed Loop's furnace is completely sealed, with interlock feeding of process materials. This system delivers:

- No slags or byproducts that are hazardous to the environment
- Far less contact between metal and air, greatly reducing the risk of fugitive emissions

Traditional smelters have evolved over the years, but most are still highly inefficient, resource-intensive, and have a significant negative impact on the environment. Closed Loop's Glass Furnace represents a great leap forward in furnace technology, delivering:

- Greater energy efficiency
- Greater cost efficiency
- Minimized emissions
- No hazardous slags or byproducts

Leading the evolution: Why yesterday's smelting technology can't meet today's needs

By Brian LaPoint, Co-Founder OF Dantig, Inc.

The art and science of smelting – extracting metals out of ore using high heat – has evolved over many years as new opportunities have developed and solutions were created to take advantage of them.

But there's one market opportunity that even the latest smelting furnace technology hasn't been able to fully address: extracting lead from the leaded glass found in the cathode-ray tubes (CRTs) used for decades in televisions and computer monitors. ▶

Every CRT manufactured over the last 80 years or so contains a significant amount of lead in the 'funnel glass" and 'neck glass", which make up the tapered sides that connect the electron gun in the back to the screen glass on the front where the image is projected. This lead is used to absorb radiation inside the CRT, and it's embedded in the matrix of the glass rather than applied as a coating to the inside. This makes it much safer for humans but ultimately makes removing the lead from the glass more difficult when the CRT reaches its end of life.

On average, the neck or funnel glass of a standard CRT contains about 25% lead. For a CRT tube in a big-screen TV (over 35" diagonally) this translates to 11 pounds of lead alone.

As flat-panel displays have almost entirely replaced CRT technology in recent years, a wave of old TVs and monitors have started ending up on curbs or in warehouses for disposal. This wave won't crest for some time. In the U.S. alone, 22.8 million CRTs are expected to enter the waste stream by 2020 – and that's only if 60% of them are collected properly.

Due to the high toxicity of lead, funnel and neck glass has very little application outside of their use in CRTs. But there is significant demand for standard recycled soda-lime glass. If the lead could be extracted from the glass somehow, the resulting low-lead or lead-free glass could be used in a wide variety of consumer and industrial applications just like other common recycled glass. As an added bonus, the extracted lead could also be reused as a raw material in manufacturing, significantly reducing the amount of waste that goes in the landfill.

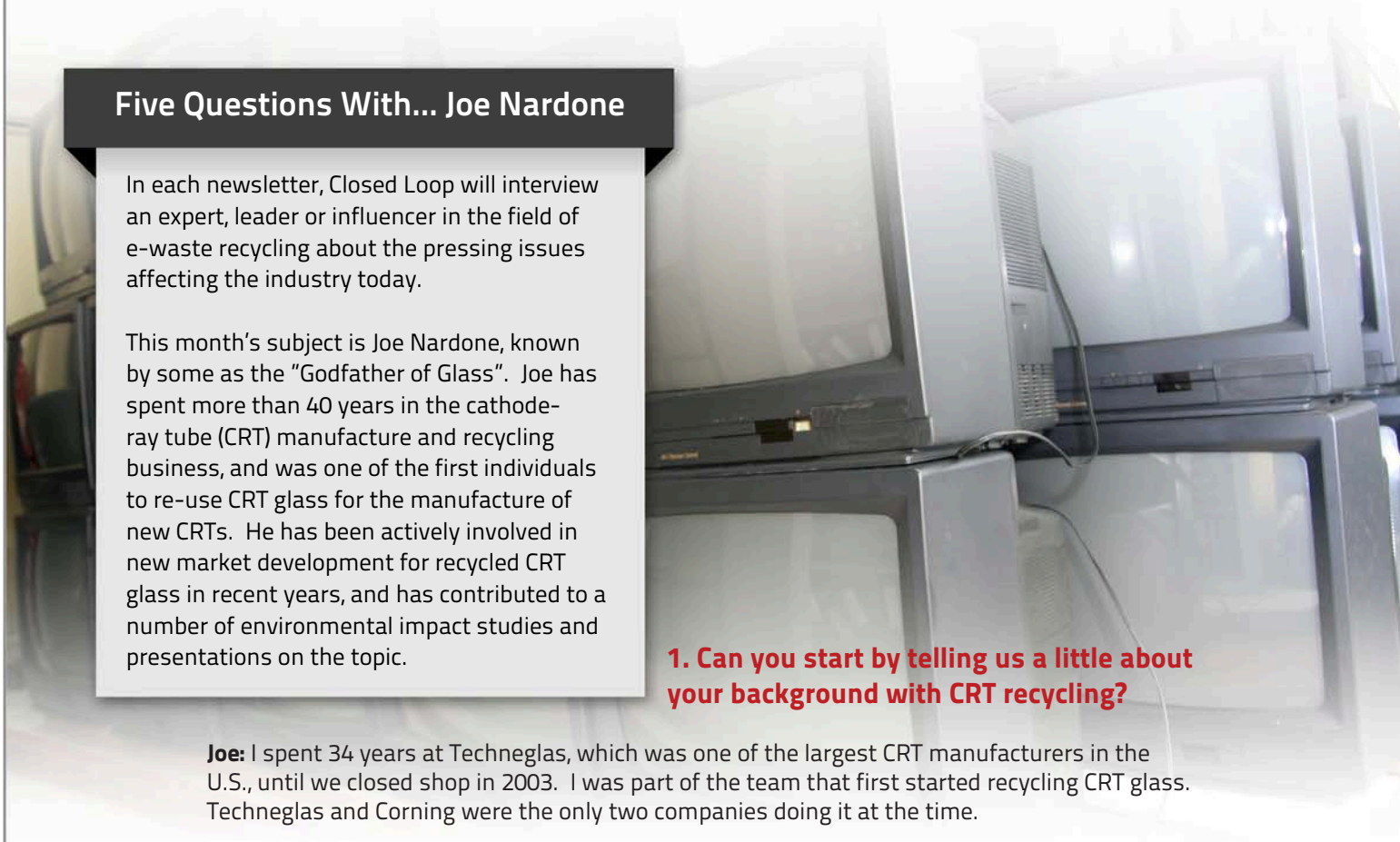
Unfortunately, lead (along with a few other trace elements) vaporizes in the high temperatures traditional smelting furnaces need to melt the CRT glass, a process known as volatilizing. Volatilized elements can create a significant environmental and health hazard if not cooled, collected, and filtered properly. A traditional furnace burns at 2,600 – 3,300 degrees Fahrenheit, well above the point at which lead becomes volatile. Using today's smelting furnaces, there's simply no way to cost-effectively heat glass to that temperature then cool the vapor to the point where the lead can be captured safely and effectively.

However, Closed Loop has the solution. Our engineering team worked closely with glass manufacturing veterans to create a proprietary, sealed Electro-Slag furnace technology that smelts glass at much lower temperatures, right around 1,900 degrees Fahrenheit. This way the lead can be safely isolated from the molten glass without it becoming vaporized, allowing for the safe extraction and capture of the lead from the funnel glass.

As this technology scales up, Closed Loop will be able to turn a waste stream of hundreds of millions of CRT tubes into raw soda-lime glass and lead for a fraction of the cost of manufacturing these same products from raw materials.

As this technology scales up, Closed Loop will be able to turn a waste stream of hundreds of millions of CRT tubes into raw soda-lime glass and lead for a fraction of the cost of manufacturing these same products from raw materials.

At the same time, millions of tons of leaded glass originally destined for the landfill will be repurposed into safe consumer and industrial applications. Every time an opportunity has evolved, smelting technology has evolved to meet the opportunity head on. When it comes to converting a leaded glass waste stream into a source stream for recycled products, Closed Loop is leading the evolution. ▪



Five Questions With... Joe Nardone

In each newsletter, Closed Loop will interview an expert, leader or influencer in the field of e-waste recycling about the pressing issues affecting the industry today.

This month's subject is Joe Nardone, known by some as the "Godfather of Glass". Joe has spent more than 40 years in the cathode-ray tube (CRT) manufacture and recycling business, and was one of the first individuals to re-use CRT glass for the manufacture of new CRTs. He has been actively involved in new market development for recycled CRT glass in recent years, and has contributed to a number of environmental impact studies and presentations on the topic.

1. Can you start by telling us a little about your background with CRT recycling?

Joe: I spent 34 years at Techneglas, which was one of the largest CRT manufacturers in the U.S., until we closed shop in 2003. I was part of the team that first started recycling CRT glass. Techneglas and Corning were the only two companies doing it at the time.

2. How did CRT recycling get its start?

Joe: We started by reusing our own generation of cullet, meaning glass that wasn't fit for customer use the first time due to physical imperfections rather than chemical imperfections. That is a common practice in any industry these days.

The next step for us at Techneglas was to take back our glass from the manufacturers we supplied that didn't meet quality standards for use in TVs and computer displays. A lot of that was due to physical imperfections within the glass parts we sold.

It was only toward the end of the CRT lifecycle that we started recycling CRTs that had already been in the marketplace and were being discarded. There were several state programs that started around then that accepted computer monitors and TVs, but it was mostly TVs obviously.

We'd send them to a recycler who would break the tube, separate it by its glass/cullet chemistry, clean it and send it to us so we could reuse the glass in our furnaces. This is referred to as EOL or end-of-life glass/cullet. That lasted through 2002 or 2003 when the Pacific Rim took over CRT production at a much lower cost than we could do it here in the U.S.

3. With CRTs nearly phased out globally, what do you see as some of the potential uses for all this recycled CRT glass?

Joe: I see a lot of potential reuses for EOL – CRT glass/cullet. On a global scale, the glass that's used to make fluorescent tubes – both standard and compact –has the potential to reuse the recycled glass overseas where all of the fluorescent tubing production is done. But shipping CRT glass/cullet from the U.S. to Asia may be too costly to be of use.

Domestically, CRT glass that has been ground, polished, sorted and had all of its coatings removed can be included in the mix of substrates used in concrete building blocks. Based on historical data, this addition appears to increase the strength of the block by 30 to 35 percent. It lasts longer, and it's perfect for marine use for bridges since it doesn't break down like concrete. No-lead glass/cullet or ground-up panel glass can also be used for sandblasting, coated drilling beads, silica fracturing materials, and different types of insulation.

Closed Loop and a few other entities are currently working to develop four new large consumer markets for no-lead cullet glass. Everybody involved in this industry understands that small boutique markets like art glass will not solve the glass-to-glass recycling consumer issue; the U.S. needs recycled glass consumers that need 15,000 to 20,000 tons per month of clean cullet to meet their market demands and offset the growing supply of CRT glass. In my experience, these markets can take years to develop.

4. It seems that road construction keeps coming up as a potential source of demand for the CRT glass supply. Would you agree?

Joe: Absolutely. Not in the top layer where the tires make contact – we learned this the hard way when it rained one day on our test strip and turned the whole road to something with the physical properties of ice! – but in the base of the road that the cars never touch. You'd have the same advantages as you would with building materials.

5. What's holding the road construction industry – or any industry for that matter – back from using what seems to be a cheap, plentiful and recycled resource?

Joe: The issue seems to be perception, both from the general public and from regulators. They want to make sure we're not putting leaded material on the roadway and into the environment. I think everybody involved in this process agree with that goal.

You also have state and federal Department of Transportation standards that need to be met, so if you're using it in a parking lot, it's easier: you just have to meet the state standards. When you have to meet a federal standard as well, which could differ on the formula of glass allowed, it gets more complicated. So there's a lot of work and a lot of testing, but it's worth it. It's what we want to do. We don't want this glass to go anywhere where it could impact anything in a way that wasn't expected. But we need to find somewhere safe for this massive amount of glass to go besides the landfills. ▪

Closed Loop's "Green Team"

Closed Loop Refining & Recovery is tackling some of the biggest challenges and opportunities in the e-waste industry, and we've assembled a team of industry veterans and game-changers to meet those opportunities head on. They include:

David J. Cauchi
Director, President & Chief Operations Officer

David has served as Closed Loop's President & Chief Operations Officer since inception. he brings over 26 years of experience in Electronics Recycling programs, including non-ferrous and ferrous metals, plastics and CRT commodity management.

Prior to joining Closed Loop, David founded Nxtcycle to manage e-waste recycling for clients like Sony Electronics, Panasonic, Sharp, Thomson, JVC, Hitachi, Bose and more. During his tenure there, David worked with the City of Los Angeles to establish the first municipal e-waste collection program in the U.S. He also oversaw the merger of NxtCycle with e-waste recycler ECO International.

Prior to Nxtcycle, David was a co-founder of Cypress Environmental, Inc. which was later acquired by Waste Management, Inc. While working with the WM Asset Recovery Group, David was a co-author of the Minnesota Office of Environmental Assistance 'Plug into Recycling" study and report. This study was one of the first to bring recyclers, manufacturers and municipalities together to evaluate the cost of recycled material compared to the values and benefits in recovering e-waste within the State of Minnesota. Over his career, David has worked for Noranda Minerals, Micro-Met, National Smelting and Refining, and Consolidated Resources, Inc., a non-ferrous and ferrous metals trading company.

David has been a national speaker for e-waste 'Best Practices" for the Institute Scrap Recycling Industries (ISRI) as well as the annual E-SCRAP Conference. He has also consulted on several state e-waste programs.

Brent A. Benham
Chairman and Chief Financial Officer

Brent has served as the Chairman and Chief Financial Officer for Closed Loop since inception. He is also the founder and Managing Director of Benham & Associates, LLC which for the past eight years has provided interim and crisis management consulting services for business workout, turnaround, and startup environments.

Prior to founding Benham & Associates, LLC, Brent spent eight years with the Phoenix office of Arthur Andersen LLP and the Chicago office of McGladrey & Pullen, LLP where he managed all aspects of audits and consulting engagements for private and public companies in a variety of industries including mining, manufacturing, retail, distribution, service, commercial real estate, and construction.

He is currently the Chief Financial Officer and a Director of Dantig, Inc. and OSA, Inc., a medical device development company. Brent also serves as the interim Chief Financial Officer of Pantheon Chemical, Inc., a chemical manufacturing company. Brent graduated from Hillsdale College with a B.A. degree in accounting and is a Certified Public Accountant in the State of Arizona.

Albert LaPoint
Co-Founder & Chief Science Officer of Dantig, Inc.

Co-Founder and Chief Science Officer of Dantig, Inc. a majority partner of Closed Loop Refining & Recovery. He brings over 39 years of experience in Lead Acid Battery Recycling programs, including non-ferrous and ferrous metals and commodity sciences.

Prior to his work at Dantig, Albert was a founder of Tech Metals, a company that developed battery recycling equipment. During that time he obtained patents on battery breaking and separating technology which are now considered the standard for all secondary lead smelters and battery breaking/separating facilities worldwide. His success led to a partnership with the larger recycling company Cal West Metals.

Since the sale of Tech Metals, Albert has performed independent consulting for large smelting operations such as CarpCo, Inc. in the U.S. and Dominion Metals and Preussag AG in Canada, as well as at numerous high-intensity magnetic and electrostatic separation facilities throughout the world.

Albert is a graduate of New Mexico Tech where he obtained a BS in Metallurgical Engineering and MS in Metallurgical Engineering / Chemistry. His Master's thesis was on lead-acid batteries and methods of recycling them.

Brian LaPoint
Co-Founder, Chief Executive Officer of Dantig, Inc.

Brian is a Co-Founder of Dantig, Inc., and has acted as Chief Executive Officer of the company for the past three years. Under the direction of his father, Albert, Brian developed many of Dantig's processes. With his integral knowledge of the necessary equipment and process capabilities, Brian has managed Dantig's budgets, timelines and business model.

Prior to co-founding Dantig, Brian worked as an engineer with OSI Systems and managed several smaller companies. He is a graduate of California State University at Long Beach with a B.S. in Chemical Engineering.

Larry Ploetz
Senior Technical Advisor

Larry has had an illustrious career in the glass industry for nearly 40 years. During that time he has held senior technical and executive-level positions for major companies such as Westinghouse Electric Corp, maker of fluorescent tubes; Zenith Radio Corp., CRT tube manufacturer; Owens Corning, maker of insulation glass; and others, including Kontes Glass and Makintech Corporation.

Larry has extensive experience in glass manufacturing, melting and refining, including the custom building of furnaces and process planning. His collective furnace design and glass manufacturing work over the last several years now processes over 1,300 metric tons of glass per day across 10 countries. He is currently the President of International Glass Melting Services and acts as an advisor to the world's leading companies in the glass industry.

Larry graduated with a Master's degree in Ceramic Science from Alfred University in 1974, and was previously a Captain with the U.S. Army Air Defense Artillery.

Clark Everhart
Logistics and Customer Service Manager

Clark Everhart has over 25 years of experience in the electronics industry, 24 years in the printed circuit board industry and more than five years in e-waste recycling. Prior to Closed Loop Refining, Clark was a senior manager for Nxtcycle and Amandi Services, now Eco-International. Prior to working in the e-waste recycling business, Clark was a member of the commercial leadership team for Isola Laminate Systems (formerly Honeywell). During Clark's tenure there he led the team that developed the new product development process that included environmental and product safety decision points early in the process. Clark is six sigma trained and greenbelt certified.

Joe Nardone
Vice President of Business Development

Joe is one of the true pioneers of the closed loop glass-to-glass CRT market, having been one of the first individuals to recycle CRT glass as an alternative to beginning with raw silica.

Prior to joining Closed Loop, Joe spent 32 years working in and managing the Corporate Environmental Affairs Department at Techneglas Inc., the largest CRT glass parts manufacturer in North America.

In his role at Techneglas, Joe was actively involved in numerous committees and conferences on CRT recycling and has been a frequent speaker and author on the subject of electronic recycling. He holds a Mechanical Engineering degree from Penn State University.

Dwight Clark
Principal Engineer/Environmental Division Manager for Ninyo & Moore

Dwight has more than 15 years of experience in the environmental field, performing and managing projects related to environmental compliance and remediation for a number of industries. During that time, he has conducted multi-media environmental compliance audits and due-diligence assessments at more than 100 facilities in the U.S., including complete ISO 14000 assessments.

Dwight's experience and understanding extends beyond federal environmental statutes and regulations to encompass state-level environmental regulations and programs as well. This includes environmental risk/liability assessment programs; preparing permit applications and Right-to-Know (RTK) reports; and development of contingency/emergency response plans such as Spill Prevention Control and Countermeasures (SPCC), Storm Water Pollution Prevention (SWPP), and RCRA Contingency Plans.