
Fluorescent Light bulb Recycling at Teck Trail Operations

Overview

Teck

Why Recycling Fluorescent Light bulbs is the right thing to do

Fluorescent light bulbs are touted for their ability to save energy over incandescent light bulbs which is true but brings another environmental issue to the forefront. All fluorescent lighting uses mercury to start the series of reactions that ultimately generate light. In order to make a positive effect on our environment, changing to fluorescent lighting is a first step to saving energy but a second step to handle fluorescent lighting after it has reached the end of its useful life is equally crucial.

Rather than dispose of fluorescent lighting into the waste stream, the contained mercury should be recaptured and reused responsibly. Recycling to recover metals, minimizes the need to produce new metal and lengthens the lifetime of our finite natural resources. Mercury can cause harm to humanity and the environment when not controlled and dealt with properly. However it is a useful metal that can be managed, controlled and put to good use for the benefit of society.

Teck Thermal Treatment Processes

Fluorescent lighting is collected by waste management companies and collection programs and consolidated with bulb crushing devices. These devices generate a mixed glass and end cap/ socket crushed material while separating out the mercury-bearing phosphor dust into a filter bag. The material would arrive at Teck in barrels after this initial stage of separation.

Processing this material will be fairly simple; the dust-filled filter bags can simply be removed and placed in a container for transportation; the mixed glass and end cap/ socket crushed material would require further crushing to size separate out the glass. Once separated into three streams, these will be sent to the three different plants at Teck for processing as outlined below.

In terms of material flow, the majority of lighting is comprised of glass with less than 1% being mercury-bearing dust.

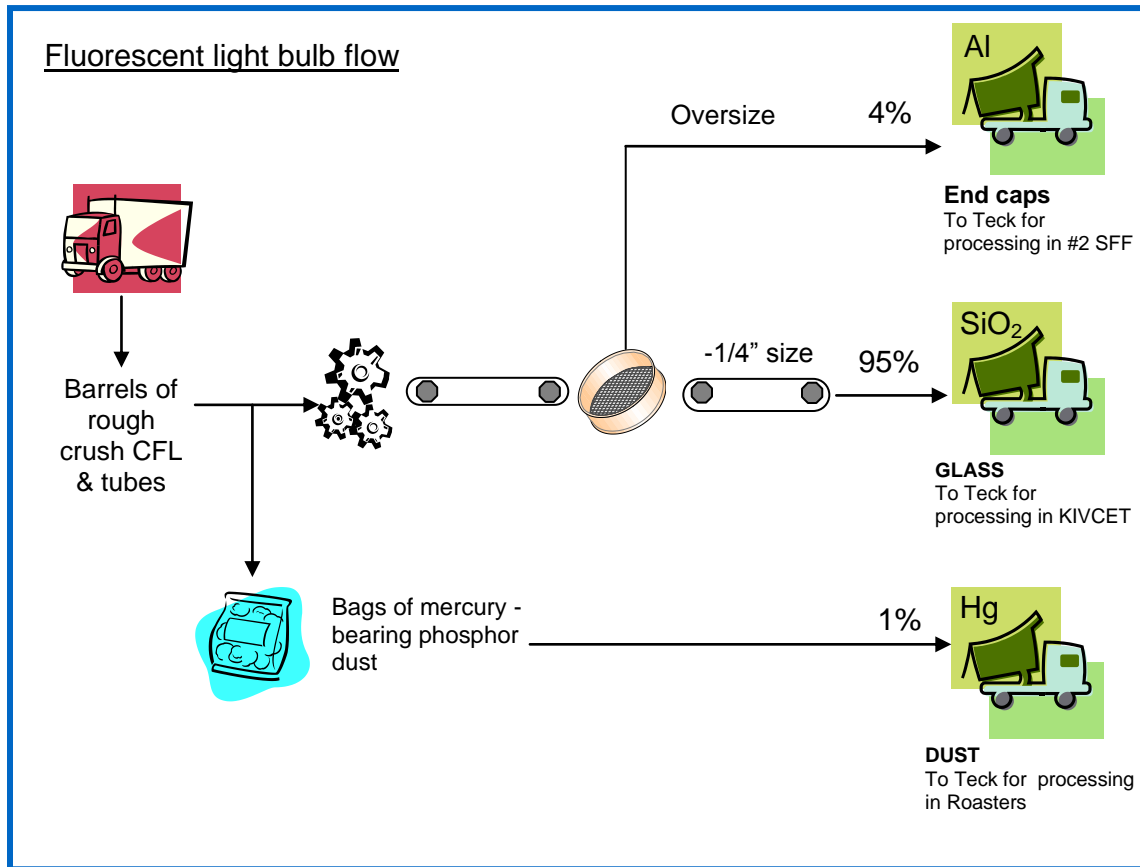


Figure 1: Flow of Crushed Fluorescent Light bulbs in the Teck Recycling Process

Dust Treatment

When a fluorescent light bulb reaches the end of its life, the mercury that originally made the light bulb operate binds to the dust inside the light bulb. This mercury-bearing dust is fed into one of two roasting units at Trail Operations. The Roasters are the starting point for zinc metal production at Trail.

Roasters use heat and minimal air to convert zinc sulphide to zinc oxide (called calcine), which is soluble in water and acid. This way the zinc metal value can be converted from the original mineral, then leached and recovered as pure zinc metal products.

After an initial heat up step, the zinc sulphide concentrate fuels the reaction within the Roasters. The feed material is fed into the middle of the 10m wide roaster by a high speed conveyor belt. The material within the roaster is a bed of particles that floats and moves on a continuous cushion of air. It is called a fluidized bed and creates excellent contact between solid particles and the hot air which is required for the conversion to calcine.

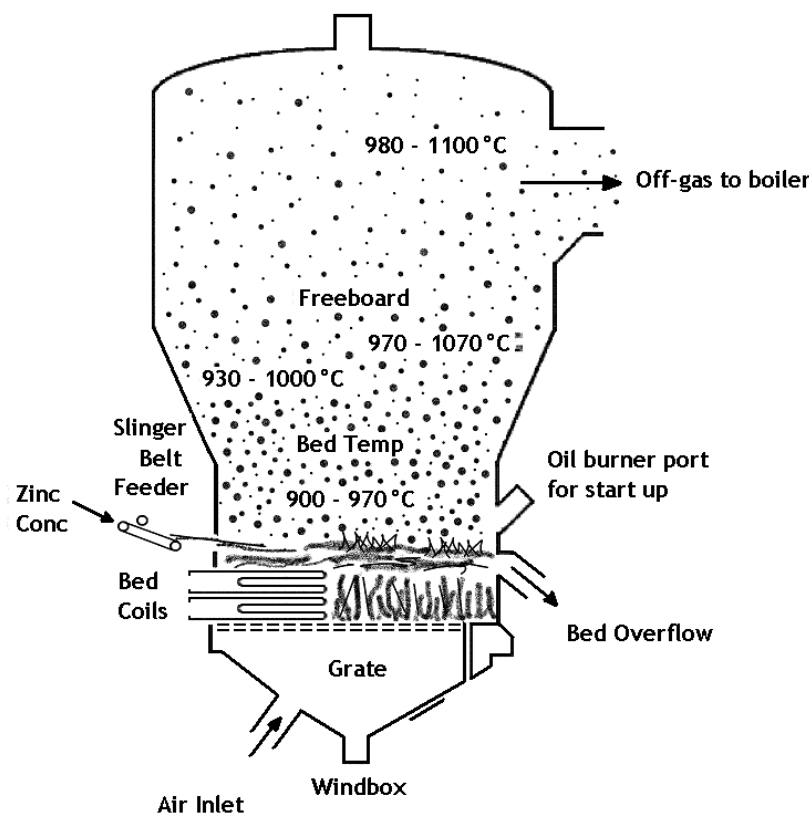


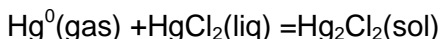
Figure 2 Schematic of Fluidized Bed Zinc Roaster

During the roasting process, any mercury present will be converted to a gas. As the air passes through the bed of material it carries the mercury to the Roaster Off-gas Cooling and Cleaning system, followed by the Mercury Removal system.

In the Roaster Off-gas Cooling and Cleaning system the gases are cooled and particulate is removed through a boiler, scrubber, cooling towers and mist treaters in series. Once the gaseous phase has been cleaned of particulate matter it can advance to the Mercury Removal system.

The Mercury Removal system is a wet scrubbing system that contacts the gaseous elemental mercury with mercuric chloride to seed the system. This environmental pollution control equipment cleans the gas stream prior to treatment through the acid plants for sulphur dioxide (SO_2) removal. Generally the mercury level in the product acid is $<1\text{ppm}$. After the SO_2 has been removed the cleaned gases are released via the Zinc Stack.

Within the mercury removal tower (the wet scrubber) elemental vaporous mercury from the gas is mixed with a liquid solution of mercuric chloride HgCl_2 . This causes the mercury in vapour form to oxidize, while the mercury in solution reduces and both atoms of mercury end up as mercurous Hg^{1+} . This allows the formation and collection of the mercury as insoluble calomel Hg_2Cl_2 .



The calomel product is sold to a company which purifies through quadruple distillation to extremely high quality mercury. This mercury is sold back to lighting manufacturers, closing the production loop.

In the future, mercury will eventually be phased out of products. This mercury distillation company also has a solution to turn mercury back into its naturally occurring form, commonly known as cinnabar HgS . This effectively pulls the excess mercury back out of the ecosphere and returns it to the earth, in its naturally occurring form, where it originally came from.

End caps and socket bases Treatment

Finely sized glass is separated out leaving behind any larger sized pieces. These are typically the end caps from fluorescent tubes, and socket bases from compact fluorescent lightbulbs. This material would contain mainly aluminum and ceramics and would be processed in a smelting unit called the #2 Slag Fuming Furnace (#2 SFF).

The purpose of the #2 SFF is to recover the last possible amount of metals from the cold slag feed (a black sand-like material) left over from previous smelting steps. In this way overall metal recoveries are maximized. The end caps and sockets are added with the cold slag which acts as an insulating shroud as the materials enter the furnace and drop roughly 20ft into the molten bath.

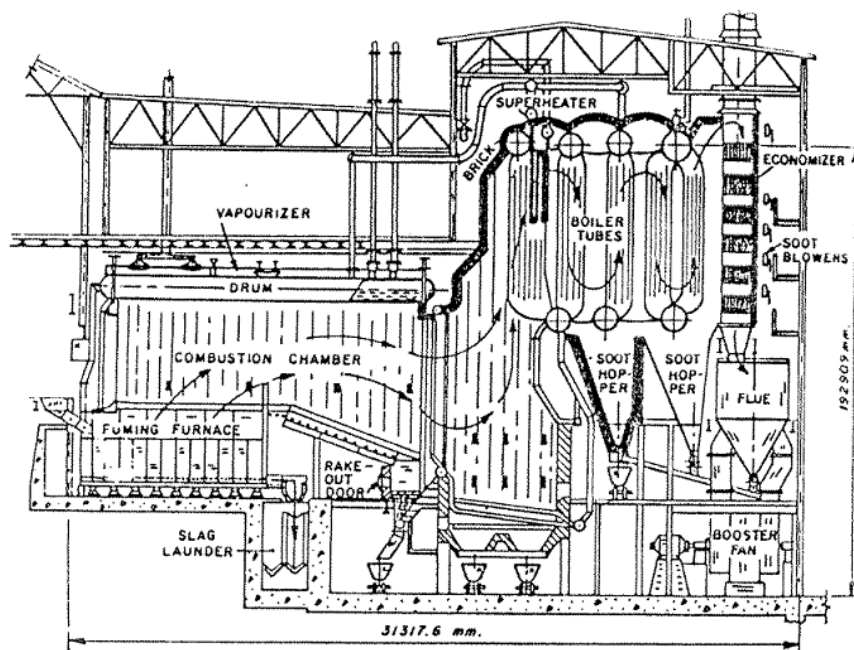


Figure 3 Schematic of #2 Slag Fuming Furnace

The fuming cycle begins once the feed is loaded into the furnace. This is when reducing conditions are created within the furnace with the addition of coal and oxygen-enriched air. Metals such as lead and zinc are reduced to a metallic particle which exits the process in the gas stream. This metal is captured in the baghouse as fume and sent to adjoining plants for further processing and recovery of the metal values.

Silica, aluminum, and iron report to the ferrous granules which are sold to the cement industry for the manufacture of Portland Cement. In this way the endcaps and bases are downcycled into a new product and avoid being landfilled as waste.

Glass Treatment

The Lead Smelter employs the Russian-developed KIVCET flash smelting process to produce lead bullion from a two-stage furnace. Dry feed along with fluxing and fueling agents are injected at the top of the furnace with oxygen. Glass can be used as a fluxing agent, which means it helps to lower the temperature needed to smelt lead. This reduces the total energy consumption of the metal smelting process resulting in less greenhouse gas production. The CFL glass has the benefit of acting as a direct replacement for raw, mined silica, further conserving the earth's natural resources for the future.

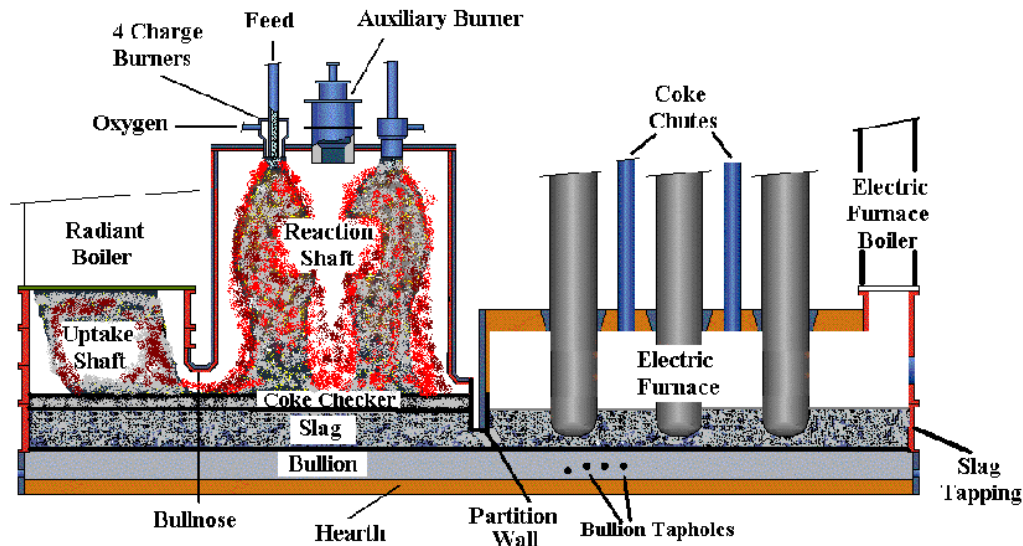


Figure 4 Schematic of KIVCET Flash Smelter

Through chemical reactions and settling, impure lead bullion and slag are formed and tapped separately from the furnace. The molten slag is transferred to a slag fuming furnace to remove zinc, mainly in the form of zinc oxide fume. The fume is processed in the Leaching Plants in Zinc Operations to extract more zinc. The remaining barren slag is sold to cement manufacturers.

The hot sulphur dioxide gas resulting from the process passes through a waste heat boiler to make steam, and then on to an electrostatic precipitator to remove dust particles before being sent to Zinc Operations for processing into saleable products, including sulphuric acid and liquid sulphur dioxide.

The lead bullion is processed through the Drossing Plant adjacent to the KIVCET furnace to remove copper and other impurities. The remaining bullion is purified in the Electrolytic Refinery, and cast into the finished product. By-products of the refining process include silver, gold, arsenic and antimony.

Conclusion

None of the products from fluorescent lighting go to waste. All are reused, recycled or downcycled – nothing goes to landfill.

Element	Operation	Phase	Trail End Product	End Use
Mercury	Roasters	Gas	Calomel	Fluorescent Lighting
Silicon	KIVCET	Slag	Ferrous Granules	Flux, Portland Cement
Lead	KIVCET	Bullion	Lead Metal	Car Batteries
Magnesium	KIVCET	Slag	Ferrous Granules	Portland Cement
Aluminum	#2 SFF	Slag	Ferrous Granules	Portland Cement

The Teck thermal recycling processes capture, recover and recycle the element of concern in fluorescent lighting; mercury. It is reused by light bulb manufacturers to complete the cradle-to-cradle cycle, recycling at it's best.