Fire Refined Copper Rod Production –

Environment Protection Aspects

Recycling old copper – a precious and limited metal – into new rod and wire for an unlimited number of times is the only hope of sufficient supply of such commodities in the decades ahead.

Presently about 15 million mt of primary copper is produced worldwide from mines while 5 million mt of semis are generated from scrap. Energy savings is about 85% when using recycled copper.

The renowned **La Farga – Properzi Process** for direct transformation of low quality copper scrap to copper wire rod is much shorter than the traditional approach through anode production: scrap is melted and refined and then continuously cast and rolled into rod. Compared to the traditional process mentioned above, there is a savings of approximately 2.000.000 kCal per mt, above and beyond the totality of the energy required for electrolysis. The environmental impact associated with such a reduction in energy consumption is obvious.

At the same time, the industry's awareness of the pollution problems (environmental impact) gave birth to a vast choice of technical options designed to render all possible copper scrap pollution sources environmentally friendly. Today, we can state that recycling of copper scrap is not one of the most difficult pollution sources to manage. In fact, the pollution management process has been simplified and is also relatively inexpensive.

The La Farga – Properzi Technology permits the production of FRHC (Fire Refined High Conductivity) rod directly from low quality copper scrap. This can be realized through two distinct processes: The Batch Process that is based on reverberatory technology through a special refining furnace, and the Continuous Process obtained by the Cosmelt Furnace System. We are going to make a distinction between the fumes relevant to each of the two processes:

Batch Process Fumes	Cosmelt Process Fumes
High exit temperature	Low exit temperature
Variable flow rate	Constant flow rate
Variable fumes composition	Relative constant fumes composition

All the above fumes emitted by these processes contain dust, metals and acid components. However, the formation of dioxin and VOCs (Volatile Organic Components) is also possible due to the presence of small amounts of chlorine (oil and plastic) present in the scrap. The high exit temperatures present in the batch process result in very limited VOCs concentration. However, as a result of the low exit temperatures in the Cosmelt process, the exhaust gases must be re-heated to render any VOCs as simple non-toxic components.

Due to the variety of plant sizes and types of scrap utilized in the process, each installation has its own requirements and must also be in accordance with local laws and regulations that can continually change in order to better safe-guard the environment. For instance, the European Commission is continuously updating the Reference Document on Best Available Techniques in the Non Ferrous Metals Industries – Integrated Pollution Prevention and Control (I.P.P.C.).

POLLUTION CONTROL DEVICES AND MEANS

Bag House:
A Bag House consists of a series of cloth filters (bags) up to 10 m long made in different materials like Polyester, Teflon, Glass or sintered metal that can withstand temperatures up to 900°C. Available bag houses today are fully automatic and can provide dust filtration efficiencies in excess of 99.9 %.

Candle Filter:
In recent years candle filters have proven to be a very effective form of air filtration. The candles work by forcing the flow of fumes through a filtering mesh of porous silicon carbide.

Wet Scrubber:
The wet scrubber removes dust particles by capturing them in water droplets and removes pollutant gases by dissolving or absorbing them into the water. Particularly efficient are the Venturi scrubbers. However, wet scrubbers imply the disposal of contaminated waters.

After Burner:
Reduction of CO, VOCs and dioxin is based on pyrolysis; high temperature that provides the transformation of CO into CO_2 and of VOCs and dioxin into simple elements like HCL – CO_2 – H_2O.

Regenerative Thermal Oxidizer:
This can replace the After Burner Process. The gas flow enters one stoneware chamber, which pre-heats the process stream where it is oxidized, releasing energy in the second stoneware chamber, thereby reducing any auxiliary fuel requirement. If the exhaust gas to be processed contains enough VOCs and CO, the energy released from their combustion allows almost self-sustained operation.

Additives:
Corrosive gases such as SO_2 – HCL – H_2S and others can be treated with alkali such as lime, magnesium hydroxide, sodium hydroxide, sodium or aluminium sulphate in both dry and wet systems.

As a reference, below is the summary of the abatement methods for components within the fumes (off-gases) produced in the different process stages (European Commission Reference Document on Best Available Techniques in the Non Ferrous Metals Industries, 2001 – Integrated Pollution Prevention and Control, IPPC):

Process stage	Component in fumes (off-gases)	Abatement option
Scrap Handling	Dust and metals	Correct storage, handling and transfer. Dust collection and fabric filter.
Scrap Charging	Dust and metals Organic material* and carbon monoxide	Correct pre-treatment. Gas collection and fabric filter Process operation, after-burning and correct gas cooling.
Scrap Smelting	Dust and metals Organic material* and carbon monoxide Sulphur dioxide **	Process operation and gas collection, cooling and cleaning by fabric filter Process operation, after-burning if necessary and correct gas cooling. Scrubbing if necessary.
Fire Refining	Dust and metals Organic material * carbon monoxide *** Sulphur dioxide**	Process operation and gas collection, cooling and cleaning by fabric filter or scrubber. Process operation, afterburning (if necessary during poling) and correct gas cooling. Scrubbing if necessary.

Note:

* Organic materials include VOC reported as total carbon (excluding CO) and dioxins, the exact content depends on the raw materials used.

** Sulphur dioxide may be present if sulphur containing raw materials or fuels are used. Carbon monoxide may be produced by poor combustion, by the presence of organic material or may be produced deliberately to minimise oxygen content.

*** CO only when not after-burning

EXAMPLES OF SOLUTIONS:

Cosmelt process:
The Cosmelt Furnace System is composed of three different types of furnaces:

- One melting furnace, with constant fumes emission of 11.500 Nm³/h
- Two refining furnaces, with 12.000 Nm³/h emission during refining process
- One holding furnace that is considered as non-pollutant

The pollutants measured in the flue gas are: PM_{10}, CO, NOx, SO_2, VOC, HCl, Cu.

If the gas stream contains both particle matter and gases, wet scrubbers are generally the only single air pollution control device that can remove both pollutants.

When wet air cleaning techniques are applied, the contaminated liquid effluent requires additional treatment; for instance, by precipitation and/or sedimentation for solid-liquid separation. Sometimes specific treatment measures like ion exchange are used to remove very harmful or valuable metal compounds. The primary "end-of-pipe" techniques for this purpose are:

- **Chemical precipitation:** Chemical precipitation is primarily used to remove the soluble metal ions from the liquid effluent.

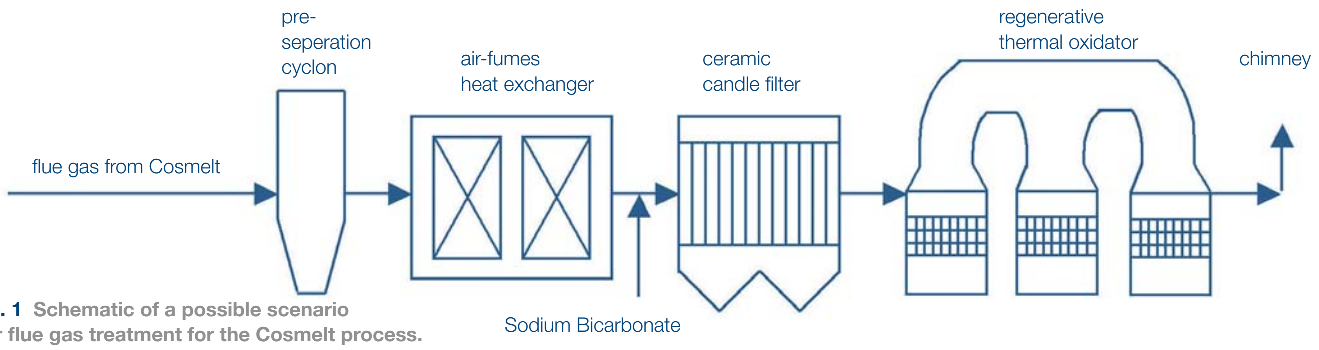
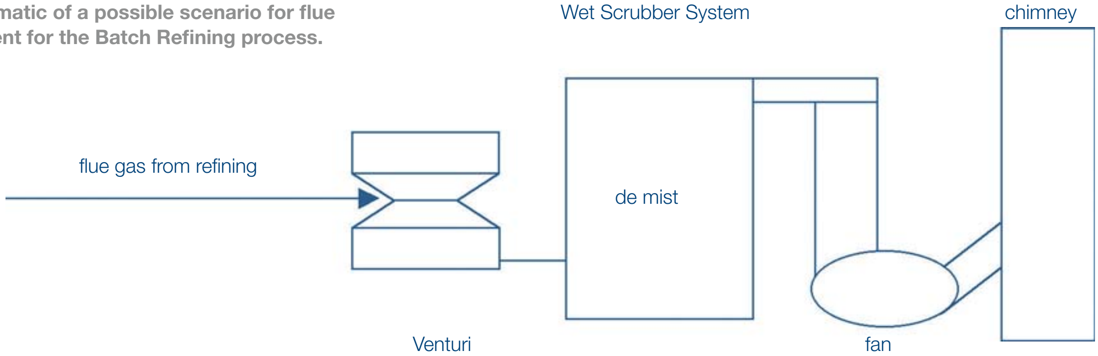


fig. 1 Schematic of a possible scenario for flue gas treatment for the Cosmelt process.

fig. 2 Schematic of a possible scenario for flue gas treatment for the Batch Refining process.



Batch Refining Furnace:
The Refining process is composed of three different steps:

- Charging + Melting process, which is the most important in terms of pollution emissions and has a fume emission of about 20.000 Nm³/h in the case of a 100t furnace
- Oxidation + Reduction process, with a fume emission of about 15.000 Nm³/h
- Casting process, with a fume emission of about 10.000 Nm³/h (practically non-polluting)

The pollutants measured in the flues gas are: particles, CO, NOx, SO_2, H_2S, Cl^-, Zn, Al, Sr, As, Sb, Cu, Fe, Pb. In Fig. 2 a simplified schematic of the possible emission treatment plant is reported.

- **Sedimentation:** Sedimentation is a solid/liquid separation technique that utilizes gravity to separate the solid particles from the liquid effluent.

- **Filtration:** Filtration techniques are normally used for solid/liquid separation and as a final clarification step in a waste-water treatment process.

With the vast experience obtained through existing operations and with the present state of the art in Environment Protection technologies, modern plants for Copper scrap recycling can assure a clean operation in an environmentally friendly and economically viable manner. The confirmation of this fact is that the cost of pollution control has reasonable levels even when recycling less "precious" scrap like paper, iron or plastics. For example, in Italy alone, over 20 million tons of steel scrap is recycled each year with obviously justified profitability. *by Vladimir Djukic*