Incinerator Bottom Ash (IBA) is the residue of municipal and industrial waste incineration whereby energy is produced in the form of heat or electricity and from which valuable metals can be recycled. IBA consists mainly of inorganic (mineral or glassy) matter, organic (unburnt) matter and metals. Incineration is performed in grate, rotary kiln or fluidised bed incinerators and in most cases IBA is discharged through a wet cooling quench subsequent to incineration. It is advantageous from an urban mining perspective that the waste stream is reduced in mass by more than 60% resulting in a metal concentration of more than 10% in the IBA. (1 Bunge, 2015)

Modern IBA processing facilities are targeting the recovery of metals from coarse (+2mm or coarser) fractions, with Ferrous, Aluminum, Copper, Stainless Steel and Zinc being the main contributors. Valuable metals in the fine particle sizes (0-2mm, and especially 0-1mm) were previously considered unrecoverable with conventional dry technology. (1 Bunge, 2015)

Sepro’s FSTP (Fine Slag Treatment Plant) module can add a precious metals dimension. Fine IBA contains Gold (0.2 – 1 ppm), Silver (5 – 20 ppm) as well as Platinum group metals (in minor amounts). With today’s 1st world throw-away societies, increasing amounts of precious metals are found in fine IBA, tracing back to mainly electronics and jewelry.
There are principally two technological routes for coarse IBA (+2mm or coarser) treatment:

1. **Conventional dry processing plants** utilize eddie current separators to recover non-ferrous metals.
   - IBA has to age for about 4-6 weeks before it can be processed
   - There is no meaningful metal revenue from the fine size fractions
   - The adaptation of a fine IBA treatment module (FSTP) is possible (requires a process water circuit)
   - Conventional dry systems generate a metal revenue of 20-30 EUR per ton of IBA (without FSTP)

2. **Wet process plants** utilize a Jig to recover heavy non-ferrous metals and eddie current separator for light non-ferrous metals.
   - Incorporates a process water circuit
   - Fresh IBA and aged IBA can be treated; metal recovery rates are higher when treating fresh IBA
   - Dust emmissions are eliminated when treating fresh IBA
   - The aging period (4-6 weeks) and associated storage space for wet discharged IBA required before treatment in a conventional dry process can be eliminated
   - Metal concentrates can directly be sold to smelters or upgraded further
   - IBA residues can be used as construction aggregates in accordance with local regulations, leachable contaminants are isolated in decanter sludge / filter cake
   - Straightforward adaptation of a fine IBA treatment module (FSTP)
   - Wet systems generate a higher metal revenue per ton of IBA compared to dry systems

![Figure 1: Wet BWS process plant (left), Heavy non-ferrous jig concentrate (2-50mm) (center), Clean aluminum concentrate from EC - separator following the jig (2-50mm) (right)](image)

Brantner Oesterreich GmbH’s BWS process (Brantner Wet Slag) produces a ferrous concentrate (by magentic separation), a heavy NF (non-ferrous) concentrate (copper, brass, stainless steel, zinc by jiggling) and a light NF concentrate (aluminum by EC- (eddie current) separation) from a single modular plant. Rejects are kept as three separate fractions: bottom ash aggregates, fine sludge (from process water treatment); and floats (wood, etc.). Process water used to operate
the jig is entirely recirculated. An industrial plant with a capacity of 35,000 - 50,000 t/a IBA (single shift) is in operation since 2013. (Stockinger, 2017)

Since 2017, Brantner Oesterreich GmbH operates a Sepro fine IBA treatment module (FSTP) in conjunction with the existing wet process plant (BWS) enabling it to recover ferrous, non-ferrous and precious metals in particle size ranges between 100 micron to 50 mm.

Approx. 20-30% of the IBA feed material is found in the fine size fraction (0-2mm) and fed to the fine IBA treatment module. The recovery of precious metals and base metals dominates the economy of this process:

10,000 t/a of fine bottom ash (0-2mm) are processed through the FSTP module and about 0.3% of the mass is extracted in form of a clean heavy metal concentrate (30 t/a), which is sold directly to copper smelters. The process has a precious metal recovery rate of up to 70%. Besides the pay metals (Au, Ag, Cu), the process also reduces the Lead (Pb), Arsenic (As), Antimony (Sb) contents from the IBA - an environmental consideration important for construction aggregate applications.

Figure 2: Sepro’s modular FSTP for fine IBA treatment

It is understood that physical density separation is most appropriate for precious metal recovery from IBA because of the low investment and operating cost. Chemical processes (such as leaching) are economically and ecologically not applicable to IBA due to the complex chemical composition of the material.
The physical separation characteristics of metals in IBA differ from that of metals in natural / mineral occurrence: The comparison of various density separation methods indicates that shape factors of target metals are highly influential on physical separation: Particle shapes range from 1-dimensional (wires) over 2-dimensional (flat shaped) to 3-dimensional (fragmented/bulky vs. round sintered beads).

Figure 3: FSTP Concentrate from fine IBA (0-2mm) in rotor bowl (left); Microscope view of clean FSTP concentrate (0-2mm) (center), in comparison with „fine“ concentrate that a conventional dry process is able to produce (<3mm) (right)

Testwork at UMTEC / HSR Rapperwil University (Switzerland) and at Met-Solve Laboratories (Canada) showed that the FALCON centrifugal concentrator is effective for the recovery of fine precious metals occurring in various particle shapes. 3-dimensional, fragmented/bulky particles are typically considered favourable for density separation. In contrast, it was found that odd particle shapes (such as wires as well as round, sintered shapes) conflict with the separation principle of i.e. Humphrey spirals. (1 Bunge, 2015)

Sepro’s modular plant for fine IBA treatment relies on a wet process incorporating a low intensity wet drum magnetic separator (LIMS, 0.1 Tesla) and Falcon centrifugal gravity concentrators followed by a wet shaking table for final upgrading. Products can either be marketed directly or further upgraded. Metal particles down to about 100 micron are recovered effectively. Conventional dry processes rely entirely on EC- (eddy current) separators and lack in recovering valuable metals below at least 1mm in size (see Fig. 3).

Industry outlook suggests that wet process solutions will gain importance over conventional dry processes due to higher resource recovery, lower footprint, minimized dust emissions and the ability to produce washed construction aggregates from the remaining IBA rejects. Sepro’s fine IBA treatment module (FSTP) can be adapted to both dry and wet IBA treatment plants. The Brantner BWS process in combination with Sepro’s FSTP process is the industry benchmark wet process for urban metals mining from incinerator bottom ash.
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Reference list


2. Ing. Gerhard Stockinger, Brantner Oesterreich GmbH: Brantner Slag Processing for slag from waste incineration plants, 2017