Metso:Outotec

Roasting Solutions

Benefits

- Suitable for concentrate and ore processing
- Low operating costs and waste generation
- High plant availability
- Cut power costs by using heat recovery for electricity generation
- Increase recovery levels at the leaching stage
- Profit from sulfuric acid generated during roasting
- Full range of lifecycle services

Metso Outotec roasting solutions are based on our decades of experience in developing processing technologies for concentrates and ores. Safe, easy, and cost-efficient to operate, they offer low waste generation and high availability. They also make it possible to profit from the production of useful by-products such as steam and sulfuric acid. Our bubbling fluidized bed and circulating fluidized bed technologies are the industry standard for roasting.

Technologies for the full range of feed materials and processes

We offer roasting solutions for zinc, copper, pyrite, gold, and precious metals concentrates, as well as whole ores — regardless of chemical and physical composition. Our solutions maximize heat recovery by using fluidized bed cooling coils with a specially designed waste-heat boiler. We have a strong track record in designing and implementing high-capacity plant installations with throughputs ranging from 100—5,000 metric tons per day.

Our roasting processes are highly effective at removing impurities such as chlorine, fluorine, arsenic, and mercury from concentrates, and they feature high combustion velocity with low residual sulfur in the calcine.

Roasting process offerings

- Dead roasting
- Partial roasting
- Sulfating roasting
- Two-stage roasting
- Sulfate decomposition

World-leading R&D capabilities

Our technologies are continuously developed using the capabilities of our world-leading in-house R&D centers, which boast multiple fluidized bed units of different sizes.

These facilities have a long record of successful fluidized bed technology developments, and are equipped with state-of-the-art laboratories and pilot plants for the most demanding testing applications. Our R&D center in Germany focuses on fluidized bed and sulfuric acid/ off-gas technologies. We can test different feed materials to demonstrate the performance of a particular application or raw material. Process simulations (steady state and dynamic calculations) and mathematical modeling are also key parts of our process development.

A lifetime of support

Metso Outotec is committed to supporting your operations throughout the plant lifecycle, helping you achieve and maintain peak performance levels and guaranteeing the best long-term return on your investment. Our global network of service and competence centers provides lifecycle services for both brownfield and greenfield roasting plants, covering everything from spare parts and technical services to modernizations, operations and maintenance agreements, shutdown services, training, and advisory services.

A complete solution for a wide range of applications

Our solution combines the core roasting process with in-house heat recovery and gas cleaning, as well as sulfuric acid and effluent treatment solutions. Our versatile fluidized bed technology allows reaction parameters to be optimized for a wide range of different minerals and metals processing applications.

Heat recovery

The waste-heat boiler is an integral part of the Metso Outotec roasting process. Our fluidized bed reactors feature internal tube bundles that ensure an even heat balance.

The high-pressure steam generated in the process can be used for electricity generation, thereby helping to reduce the plant's overall power consumption.

Impurity treatment

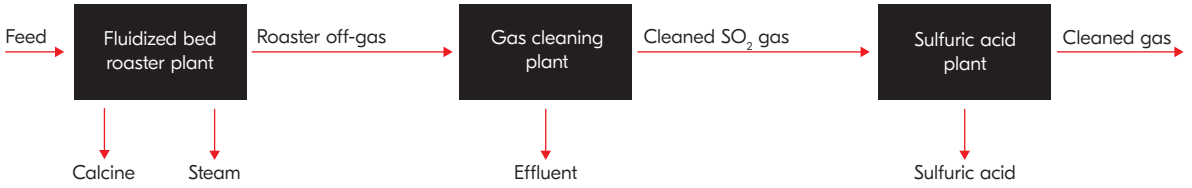
We offer several options for treatment of sulfur dioxide gas, with the production of sulfuric acid — a valuable by-product that can be sold for other uses — being the most cost-effective. The most appropriate method for the specific application depends primarily on the gas flow rate and the SO2 gas concentration.

The Metso Outotec ferric arsenate process is a reliable solution for managing toxic arsenic in process and effluent streams. It consists of a ferric arsenate precipitation stage followed by neutralization using lime milk, and is based on easy and robust precipitation. We are a pioneer in the development of mercury removal processes for smelter off-gases. Our technology is the most advanced on the market and is also suitable for use in other applications, such as geothermal power plants.

Sulfur dioxide treatment

Metso Outotec is a world leader in sulfuric acid plant design. For maximum sulfur-conversion efficiency, we can design and implement a complete turnkey plant solution, incorporating treatment of wastewater, dust, slag, and heavy metals, as well as scrubbing acid equipment.

Metso Outotec roasting process



Zinc concentrate
The zinc roasting process has played a key role in the development of our bubbling fluidized bed technology. Continuous process improvements have increased throughput capacities, and plant operations are now safer and more environmentally friendly than ever. The process uses dead roasting for concentrates, where sulfides are completely transformed into oxides. The high-pressure steam and sulfuric acid produced are used in the hydrometallurgical section of the plant.

Pyrite concentrate
Dead roasting is recommended when the pyrites have no trace of arsenic and when high metal recovery is critical. Iron sulfides are transformed into iron oxides, with the production of sulfuric acid being an important output of this process in terms of ensuring its economic viability. In a typical pyrite roasting plant gas temperatures can be over 800°C at the inlet of the waste-heat boiler, which is suitable for high-pressure steam production.

Gold-bearing feed
When processing concentrate that contains gold, the highest recoveries are obtained within rather narrow ranges of roasting temperature and oxygen partial pressure of the roaster gas. Our circulating fluidized bed technology enables the necessary fine control over these parameters. To avoid losses in the leaching plant, it is recommended that whole ores are treated with a gold-roasting step. Due to the low specific heat value of whole ore, it is generally necessary to add fuel to the reactor.

A two-stage roasting process combines partial roasting in the first stage with dead roasting in the second stage. The first stage is used as a de-arsenifying process step in an oxygen-deficient roasting atmosphere, while the second stage operates in an oxidizing atmosphere to fully transform metals into their oxide form and to eliminate sulfur and organic carbon.

Copper concentrate
Our partial roasting process is used for removing impurities from feed material. In this process the sulfur is only partially roasted, with the quantity depending on the concentrate analysis and the desired calcine grade. In some cases, partial roasting is used to remove almost all unwanted elements — such as arsenic and antimony — before further treating the calcine. Special equipment is used for cooling and precipitating arsenic trioxide, which can be produced to a very high purity.

Most of our sulfating roasting plants are used for copper/cobalt concentrate applications in combination with electrowinning. The copper sulfide is transformed into water-soluble copper sulfate and the iron sulfide into insoluble iron oxide. Standard sulfating roasters run with a slurry feed and do not require a waste-heat boiler system in the off-gas stream.

Metal sulfates
Our sulfate decomposition process is used to reduce the amount of tailings and for the recovery of valuable metals such as manganese sulfate and magnesium sulfate. Ferrous sulfate is a by-product primarily associated with titanium dioxide production. Ferrous sulfate heptahydrate is decomposed to iron oxide and SO_2 in an endothermic process. The required heat can be provided by adding sulfur, pyrite, oil, coal, alternative fuels, renewable fuels, or by using pre-heated air. The iron oxide has low sulfur levels and is suitable for further processing in a steel mill.

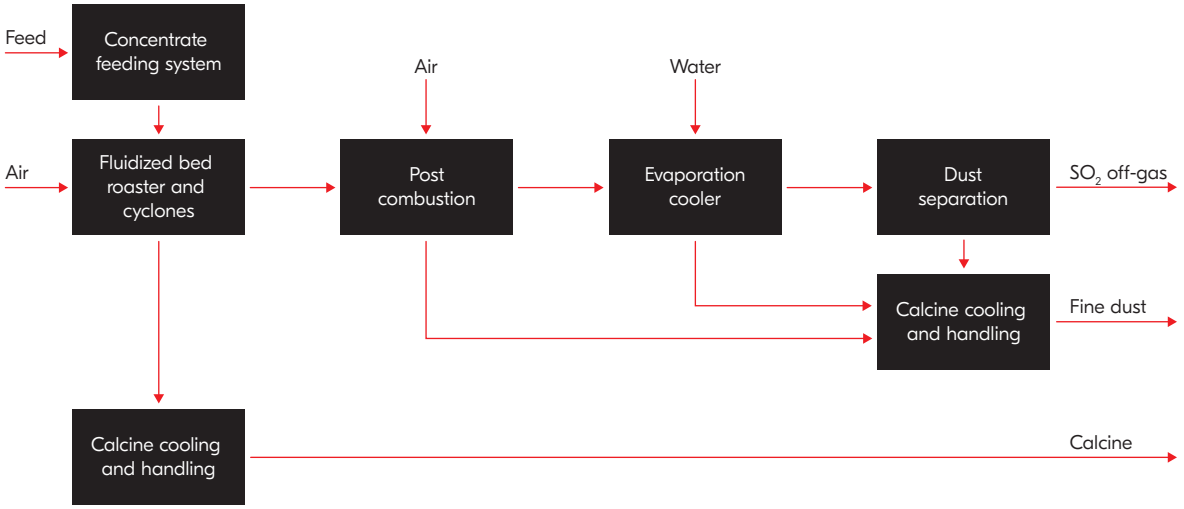
Metso Outotec roasting process offerings

Process	Type	Aim and process conditions	Feed materials	End products	Application
Partial roasting (exothermic)	BFB	Removal of As, sulfur is removed partially from 34% to 20% Temp: 550—700 °C Oxygen: < 1 vol%	As elimination in Cu-concentrate	"As-free" Cu-concentrate, Sulfuric acid	Copper roaster
Dead roasting (exothermic)	BFB/ CFB	Total sulfur elimination, product is pure oxide Temp: 550—950 °C Oxygen: 3—5 vol%	ZnS, FeS_2, CuS, MeS, Au	MeO, Sulfuric acid, Steam	Zinc, pyrite, gold, copper, nickel
Two-stage roasting (partial roasting + dead roasting)	BFB	Removal of As (partial roasting), Removal of S and C (dead roasting) Temp: same as partial/dead roasting, Oxygen: same as partial/dead roasting	As containing Au concentrate	"As-free" Au-concentrate, Sulfuric acid, Steam	Gold roaster
Sulfating roasting (exothermic)	BFB	Transformation of metal sulfides into metal sulfates Temp: 650—750 °C Oxygen: ~ 6 vol%	MeS-like Cu/Co-sulfide	$MeSO_4$, mainly $CuSO_4$/CoSO	Copper/cobalt roaster
Decomposition (endothermic)	CFB/ BFB	Removal of SO_4 from metal, Removal of chloride from metal Temp: 600—1000 °C Oxygen: 1—2 vol%	$MeSO_4$ (e.g. $FeSO_4$, $CaSO_4$) MeClx (e.g. $NiCl_2$, $AlCl_3$)	MeO, Sulfuric acid, Hydrochloric acid	Pigment industry, nickel, alumina

BFB = Bubbling Fluidized Bed CFB = Circulating Fluidized Bed

We offer lifecycle services for all roasting processes to help you optimize plant performance and maintain asset values.

Partial roasting for copper and arsenic



Our partial roasting process is used for removing impurities from feed material. In this process the sulfur is only partially roasted, with the quantity depending on the concentrate analysis and the desired calcine grade. In some cases, partial roasting is used to remove almost all unwanted elements — such as arsenic and antimony — before further treating the calcine. Special equipment is used for cooling and precipitating arsenic trioxide, which can be produced to a very high purity.

For copper concentrates, partial roasting is used as a pretreatment step prior to the flash smelting process.

Typical composition

	Concentrate	Calcine
Cu	30%	35%
Fe	21%	23%
S	35%	20%
As	4%	0.3%
Sb	1%	0.2%
Zn	0.4%	0.4%

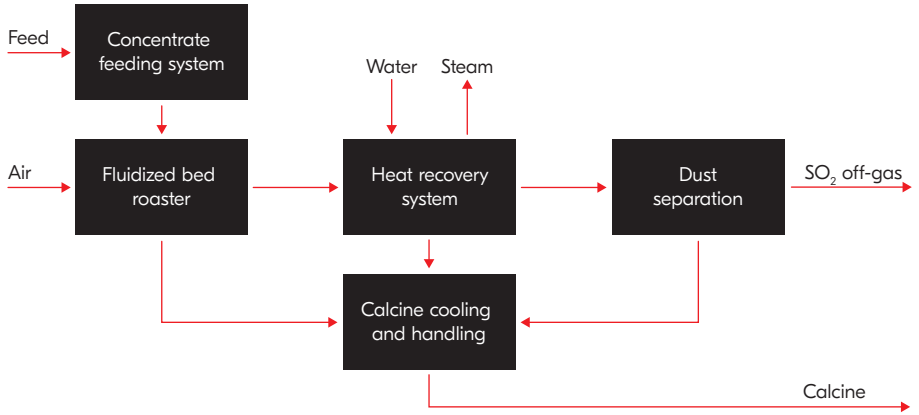
Features

- Arsenic elimination from concentrate: 12% to < 0.3%
- Antimony elimination from concentrate: 1.2% to < 0.2%
- Feed material capacity of up to 600,000 metric tons per annum

Benefits

- Sulfuric acid production
- Ability to process and upgrade lower-quality ores
- Recovery of valuable metals such as antimony

Dead roasting for zinc sulfide, pyrite, and gold-bearing SULFIDE minerals



Dead roasting is the most commonly used roasting process and is mainly applied in our zinc and pyrite roasters. When using a dead-roasting process for concentrates, the sulfides are completely transformed into oxides. The gas temperature in this type of plant is typically between 800 and 950°C. The hot gas generated in the process is used for heat recovery and is suitable for high-pressure steam production in a waste-heat boiler.

For gold-roasting applications, even low-sulfur and organic contents are removed efficiently, leading to increased gold recovery in the downstream leaching process.

Typical composition

	Concentrate (ZINC/PYRITE)	Calcine (ZINC/PYRITE)
Fe	8/46%	8.9/61%
S	32/48%	0.3/0.3%
Zn	52/0.2%	59/0.3%
Pb	1.8/0.1%	2/0.1%

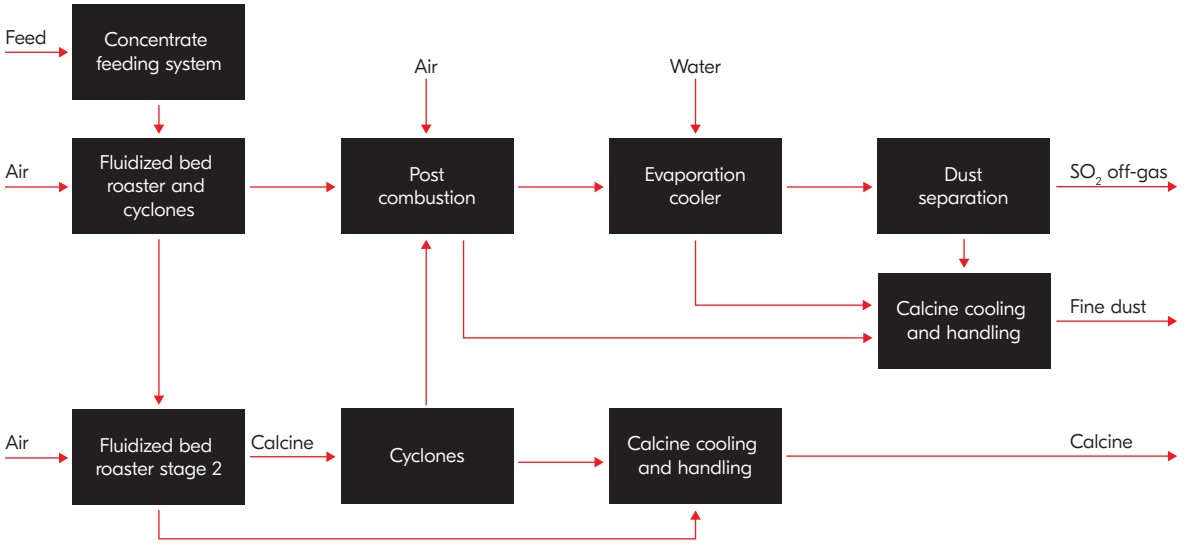
Features

- Direct dry feeding of the concentrate (moisture content 6-12%) to the roaster
- Suitable for roasting sulfidic concentrates with a wide range of chemical and physical compositions
- High-capacity plants with a whole-ore throughput of up to 5,000 metric tons per day
- High combustion velocity results in low residual sulfur in the calcine
- Maximized heat recovery in the fluidized bed in conjunction with an off-gas waste-heat boiler
- Chlorine and fluorine removed from concentrate during roasting

Benefits

- Steam or power generation without CO_2 emissions
- Sulfuric acid production
- Recovery of valuable metals such as gold, zinc, copper, and cobalt

Two-stage roasting for gold-bearing sulfide minerals containing arsenic



Our two-stage roasting plants are mainly used for treating double-refractory gold concentrates. A two-stage roasting process combines partial roasting in the first stage with dead roasting in the second stage. The first stage is used as a de-arsenifying process step in an oxygen-deficient roasting atmosphere, while the second stage operates in an oxidizing atmosphere to fully transform the metals into their oxide form.

When roasting sulfur-bearing minerals, their iron content can form hematite (Fe_2O_3) or magnetite (Fe_3O_4), depending on the partial pressure of the oxygen in the roaster gas. In the first roasting stage, pyrites with a grain size of up to 6 mm are roasted in a fluidized bed of iron sulfide, where the arsenic is volatized. The partly roasted solids are then transferred to the second stage and dead roasted. De-arsenifying roasting can also be applied when processing gold-bearing concentrates or ores, or copper concentrates.

Typical composition

	Concentrate	Calcine
Fe	38%	42%
S	30%	0.3%
As	3%	0.3%

Features

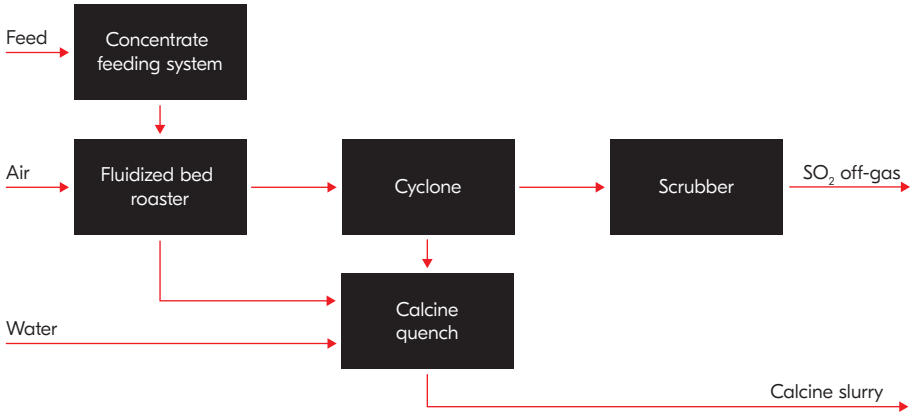
- Elimination of impurities such as arsenic and antimony
- Substantially arsenic-free calcine
- Autothermic process

Benefits

- Increased gold recovery
- Significantly lower CAPEX
- Sulfuric acid production

Sulfating roasting for copper and cobalT

Sulfating roasting is generally used for processing copper concentrates in combination with electrowinning. The copper sulfide is transformed into water-soluble copper sulfate and the iron sulfide into insoluble iron oxide. Standard sulfating roasters run with a slurry feed and do not require a waste-heat boiler system in the
off-gas stream.



Typical composition

	Concentrate	Calcine
Cu	33%	25%
Co	5%	4%
Fe	5%	4%
S	25%	
SO_4-S		14%

Features

- Proven technology for cobalt and copper production
- Optimized for small and medium-size plants (annual copper production of 30,000—50,000 metric tons)
- Autothermic process operating at medium temperatures
- Insensitive to various concentrate impurities
- Roaster concept based on dry or slurry feed to achieve autothermal conditions

Benefits

- Process optimized for cobalt recovery
- No additional fuel required even with low sulfide levels in the concentrate
- Works with ambient air, with no need for an oxygen plant
- Can be integrated into existing sulfuric acid plant
- Increased profitability for small and medium-sized plants

Metso Outotec Corporation, PO Box 1220, FI-00101 Helsinki, Finland
tel. +358 20 484 100, fax +358 20 484 101
mogroup.com

Partner for positive change