Smelting furnace SCF 4

Recycling and assessing precious metals

Global demand for precious metals continues to soar, whether for jewellery or for use in industrial applications. While gold and silver have been used for thousands of years in jewellery, more recently precious metals are performing useful and specialist functions in chemical processes, electronics manufacturing, aerospace and automotive systems, eg catalytic converters. CARBOLITE equipment is used throughout the world both for recycling these relatively rare commodities and for assessing their purity. Two key processes in the precious metals market are smelting and cupellation.

Smelting

Smelting is the separation of precious metal from non-metallic impurities. When bulk ores are involved, very large installations are required, using heat and chemical reducing agents to decompose the ore, drive off other elements such as gases or slag and leave only the metal behind. When the process involves pre-used materials – for example, catalytic converters or jewellery – the equipment is smaller in scale but involves the same principles in order to ensure a high-quality end material.

Precious metals recovery is a typical use of smelting. In a catalytic converter, exhaust gases pass through a ceramic honeycomb which is coated with a fine layer of palladium group metals (PGMs). This contains platinum ore, typically two to three orders of magnitude richer than the mined ore. During the recycling process, the honeycomb ceramic is crushed into a powder and fed into the furnace. Up to 98 % of PGMs may be recovered.

For recycling purposes, the raw material to be assayed is typically ground into powder form before being placed in crucibles where it is melted with lead oxide and a suitable flux at 1200 ºC. In its molten state the lead combines with the precious metal and the impurities form a slag, which can be easily removed when the sample cools. A cupellation furnace is then used to remove the lead, leading to further treatment to ascertain the precious metal content.

CARBOLITE's SCF furnaces are specifically designed to provide the temperatures required for smelting, while withstanding the gases given off by the process. High-performance silicon carbide elements are fitted, which allow continuous operation up to 1350 ºC. In addition, furnace chambers are lined with silicon carbide tiles which protect the elements and the insulation, with hard-wearing insulating brick providing a solid hearth.

Material is processed in ceramic crucibles of various sizes, and **the SCF range includes five models to suit different customers' requirements.** The smallest model is a single-chamber unit, while the other four have twin chambers. The hinged chamber lids keep the hot face insulation away from the operator and also incorporate chimneys to vent fumes. Furnace temperature is regulated by a three-term microprocessor-based controller, and a 24-hour seven-day time switch allows the equipment to be switched on automatically without an operator being present.

Assaying

Accurate analysis is routinely carried out to determine the precious metal content in a wide variety of different materials. This is particularly important for fineness determination for the hallmarking of precious metals for jewellery use. The precious metal concentration in different materials can vary widely from amounts measured in parts per million (ppm) for car catalysts or powdered ore samples to almost 100 % in jewellery alloys or bullion bars.

Determining the precious metal content of gold, silver and platinum is fundamental to the jewellery industry and is particularly important for those valuing, buying or selling scrap gold or second-hand material. While X-ray fluorescence (XRF) spectrometry is more accurate than in the past and can provide reliable results, there remains a number of drawbacks including the initial purchasing expense. **For gold and silver the most accurate and preferred method still remains the traditional cupellation process.**

The cupellation of gold is a refining process in which all other elements are eradicated, leaving only pure gold. For assaying gold by cupellation, small samples are accurately weighed and wrapped in lead with a pre-determined quantity of silver to assist with the collection of gold and the removal of base metals. The wrapped samples are placed on porous blocks, known as cupels, and heated to 1100 ºC in a furnace, resulting in the cupels absorbing the lead and any base metals as oxides.

A pure gold and silver bead is left behind, which is then boiled in nitric acid, dissolving the silver and leaving a residue of fine gold. When the weight of the residue is compared with the original sample the gold content by weight can be calculated.

The assay of gold alloys by cupellation is the standard method used by the UK Assay Offices and a reference method laid down by the International Hallmarking Convention in accordance with ISO 11426 : 1997 and ASTM E1335 – 08. **The CARBOLITE furnaces designed for this process have a reputation for close temperature uniformity, low heat loss and maximum fume control.**

FEATURES

Smelting furnaces

- Specifically designed for smelting of precious metals
- Four models available including single and multiple crucible options
- Maximum operating temperature of 1400°C
- Each chamber lid is vented by a 50 mm diameter chimney
- Silicon carbide heating elements protected by silicon carbide tiles

Cupellation furnaces

- Three models are available with a continuous operating temperature of 1200ºC
- Silicon carbide elements above and below the chamber provide even heating and long-life
- Controlled variable air-flow is pre-heated by passing over the lower elements ensuring good temperature uniformity
- Refractory brick insulation and silicon carbide tiles withstand the corrosive lead fumes created by the process and protect the heating elements
- Fumes are extracted through an insulated exhaust duct, with lead condensates being safely collected in a removable container
- Removable brick spy hole plug allows easy viewing of samples during heating