Minataur gold refinery
The Minataur™ refining technology is a unique all hydrometallurgical route, based on solvent extraction, for refining gold to a purity of “five nines” (99.999 per cent).

Compared with conventional smelting and electro-refining technology, the Minataur process offers:
- Significantly reduced lock-up times of the gold;
- Easier operation and control; and,
- The ability to directly produce a high purity product on-site.

It is particularly attractive for feed materials containing significant quantities of base metals.

The process comprises oxidative leaching of the feed material in a chloride medium, followed by selective solvent extraction of the gold to reject impurities. The loaded organic phase is then stripped to produce a purified, concentrated gold solution, from which high-purity gold powder is precipitated by reduction. The leach and reduction are operated batchwise, while the solvent extraction is a continuous operation.

The gold content of the feed can range from about 20 per cent to 99 per cent. Suitable feeds include silver-refining anode slimes, gold electrowinning cathode sludge, zinc precipitation filtrates, doré bullion and jewellery scrap. Materials with variable gold contents can be handled.

Minataur plants with capacities up to 100 t/a have been installed in South Africa, Algeria, Italy, and Dubai.

Additional modules
Silver refinery
Impure silver anodes are produced from the Minataur leach residue using a pyrometallurgical method and refined electrochemically to produce 99.9 per cent pure silver. Any gold entrained in the feed is liberated by the process and returned to the gold refinery.

Gold potassium cyanide (GPC) plant
The starting point for GPC product ion is 99.99 per cent pure gold powder or granules. This is electrochemically dissolved, with the addition of potassium hydroxide and potassium cyanide in an ion-exchange membrane cell to form a solution of GPC. The solution is chilled to produce pure white crystalline GPC, which is used primarily for making up electrolytes for the gold electroplating industry.

“Five nines” plant
The “five nines” plant employs a highly selective precipitation technique to produce 99.999 per cent pure gold using a bleed from the loaded strip liquor from the Minataur refinery.

Continuous Bar Caster
The Continuous Bar Caster is a high-volume gold melting and setting machine for making ten-tola or 1 kg bars. The unit has a capacity of 200 ten-tola bars or 50 one-kilogram bars per hour. The heating of the crucibles, the melting and solidification of the gold, and the final cooling of the crucible take place under an inert nitrogen atmosphere. An optical pyrometer measures the temperature inside the induction furnace. Either the crucible temperature or the cycle timing can be used to determine the feed rate of the crucibles.

The feed material for the unit is granulated Good Delivery gold, which is weighed in a batch weigher to the required mass.

To ensure good quality bars, all the major parameters of the process can be controlled:
- Feeding cycle is determined by the optical pyrometer or timer;
- Furnace heating rate;
- Solidification zone levelling; and,
- Cooling water flowrates for the solidification zone and final cooling zone.

A Programmable Logic Controller (PLC) is interfaced with process interlocks to the induction furnace, inverter system, feeder and the cooling system to ensure safe and reliable operation.

Atomijet and Atomijet-S
The Atomijets were developed as cost-effective alternatives to conventional atomisers for preparing small batches (up to 50 kg) of finely divided gold and gold alloys for leaching and specialised purposes. Two or three high-pressure water
jets impact on a stream of molten metal, converting it to a fine powder. The units are supplied with a customised induction melt head, and each pour is automatically controlled for consistent results. Owing to the use of small high-pressure water nozzles, the amount of water that accumulates during a pour is limited.

A typical Atomijet allows a collection hopper to be discharged directly into a leaching vessel where the maximum throughput is about 20 minutes per batch (150 kg/h) if the unit runs continuously. Pours can be repeated immediately as there is no re-circulation of water.

Two models are currently available: the Atomijet for producing granules with a d50 less than 300 μm, and the Atomijet-S for producing granules with a d50 of less than 100 μm. Each unit is custom-designed for a batch operation of 10-50 kg depending on the pouring cup size that the client wishes to use.

Originally developed to pre-condition gold for chloride leaching in Mintek’s Minataur gold-refining process, the Atomijet has proved to be the technology of choice for applications upstream for any gold leaching circuit, whatever the leaching method employed. The technology could also be used downstream of the refining step, where the fine particle size of the Atomijet product would enable high precision weighing of the feed to bar production.

Atomijet units have been installed in Italy, Dubai, India, and Algeria, as well as in South Africa.

Check weigher and marking press
The PLC-controlled check weigher and marking press is designed to automatically weigh and sort ten-tola gold bars to an accuracy within 10 mg.

The bars are fed by a conveyor belt into the marking press, where they are stamped with an insignia. The bars are then transferred to the check weighing section, where they are weighed and sorted into three categories:
- on-weight (116.64 - 116.65 g)
- over-weight (> 116.65 g)
- under-weight (< 116.64 g)

Since the equipment is custom-built, different-sized bars can also be catered for.

A Programmable Logic Controller (PLC) interfacing with process interlocks ensures smooth and trouble-free operation.

The on-weight bars can be shrink-wrapped for final packaging. Over-weight bars can be further processed through metal removal using a de-burring tool. The underweight bars can be re-melted and processed through the Granulator for recycling.

The unit can handle 200 ten-tola bars per hour.

Although the check weigher and marking press has been designed primarily to process ten-tola (3.746 ounce) bars, it can be retooled to handle bars up to 1 000 g.

Granule Caster
The Granulator is designed to melt and to granulate a gold charge of 12.5 kg or 50 kg, depending on the crucible size. The feed to the melting crucible will typically consist of dried precipitated gold (sponge) or reject ten-tola bars, but may also include powder, granules, or bars. The gold is melted by induction heating in a custom melt-head. A pneumatically operated plunger is activated to discharge the stream of molten gold into the Granulator tank, where it is granulated by a single low-pressure water jet. The granulated gold and water are retained in the Granulator tank until they are separated in the drain pot and the granulated product removed.

The typical processing time (melting and casting) for a 50 kg batch of gold is between about 30 and 40 minutes, depending on the nature of the feed material. The typical size of the product of the Granulator is on average 3 mm in diameter, with a wide size range from less than 300 mm to as large as 5 mm.

Power at 380 V and 240 V is required. The inverter is rated at 380 V – 50 kW, and requires a water flowrate of 25 l/min from a cooling tower for cooling the induction coils. Compressed air at 500 kPa is required, together with nitrogen at 100 kPa for the crucible. De-ionised water for filling the granulator tank is required.

Vibratory Feeder Dryer
The vibratory feeder is designed to dry wet granulated gold granules from the Granule Caster in 50 kg batches, and to screen the dried granules into two size fractions.

A baffle plate at the inlet of the vibrator distributes the gold granules evenly over the tray of the vibratory feeder. The speed of the vibrator can be fine adjusted manually. The water is vapourised from the granulated gold by six 200 W infrared lights situated over the tray. A screen at the discharge end of the tray separates granules into size fractions greater than 300 μm and smaller than 300 μm.

A 220 V AC power supply is required.

Batch weigher
The microprocessor-controlled batch weigher is designed to automatically weigh particulate gold or any other high-value product to an accuracy of 10 mg. It is typically used to weigh the product from the granulator for production of ten-tola bars.

Coarse and fine material are fed separately. The unit is programmed to feed the coarse fraction at a high feed rate until 90 per cent of the target mass is reached, then at a reduced rate up to 99 per cent of target. The fine fraction is then fed via the dribble feeder to the correct final mass.

The target setpoint is entered into the controller via a keypad. The system incorporates in-flight compensation, as well as auto-tare of the container that the product is weighed into.

The unit can handle one batch of up to 120 g approximately every 16 seconds. This time will increase as the target mass increases.

The Batch Weigher can be customised to weigh up to 1 000 g, and can also incorporate an indexing unit to feed product automatically into a multi-cavity crucible.

An optional extra is available for entering setpoints via a SCADA system, and to log the weight deviation from setpoint for record keeping.

The Batch Weigher requires 220 V AC power and a compressed air supply.

Specialist
Marthie Kotze - Consultant