

Mercury Management in Practice: Case Studies with Miners in East Africa



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Contents

1. Background.....	1
2. Managing Exposure and Behavioural Sensitisation: Personal Protective Equipment	3
Gloves	3
Masks.....	4
Sensitising Miner Behaviour	4
3. Reducing Emissions: Mercury Vapour Capture with a Retort	5
Mercury Retort Cost-Benefit Analysis	6
Blogs and Videos on Mercury Retorts	7
4. Reducing Mercury Use through Improved Concentration Techniques.....	8
Gold Kacha Technology	9
Comparison Test Between Gold Kacha and Classical Sluicing.....	9
5. Miner Mercury Training Sessions	11
Mercury Training in Kakamega.....	11
Mercury Training in Migori.....	11
6. Lessons Learnt	12
Improved Mercury Handling by PPE Sensitisation	12
Mercury Vapour Capture using Retorts	12
Mercury Reduction through Improved Concentration Techniques	12
Appendix I: Mercury Management Equipment Profiles.....	13
Retort.....	13
Centrifugal Concentrators	14
Gravity Concentrators (Shaking Table).....	16
Appendix II: Case Study – Installing Improved Gold Processing Equipment in Busia, Uganda	18
Appendix III: Case Study – Invoice for Gold Kacha and Shaking Table	19
Appendix IV: Mercury Retort Pledge and Recognition of Value	20
Appendix V: Additional Resources	21

1. Background

The signature of the Minamata Convention on Mercury in 2013 was a major milestone in global efforts to mitigate the negative impacts of mercury, with more than 120 signatories to date. As part of this treaty governments have committed to phasing out and reducing the use of mercury as part of a greater transition to reduce the dependency of a range of different sectors on this useful but harmful metal. The artisanal and small-scale gold mining (ASGM) sector, besides being a livelihood for more people than almost any other sector, is one of the largest consumers of mercury. Despite growing awareness within the ASGM community of the toxic nature of this material, the lack of practical, viable alternatives means that many miners are forced to discount long-term health risks in return for short-term financial gain to make ends meet.

Mercury Use by ASGM

Artisanal gold mining is known to contribute heavily to the application of mercury as it is used during an intermediary stage in the gold refining process. Liquid mercury is mixed with partially concentrated gold-bearing material, with the resulting mixture subsequently being heated to liberate a purer form of gold 'sponge', causing mercury to evaporate in the process. In addition to the harm that this gaseous form of mercury can cause to both human health, this pollutes the environment, most notably water bodies in nearby communities as well as contributing to the illegal trade of mercury. The lack of a substitute for mercury that is effective, convenient, available and affordable has necessitated the development of management processes to mitigate the dangers of mercury use in artisanal and small-scale mines. Furthermore, mercury is traditionally used in ASGM in combination with a technique known as sluicing, which is discussed in more depth in this report, however despite the benefits of the simplicity of this method, it is inefficient as it only captures 40% - 60% of gold, which points to economic advantages that can be gained from finding alternative to mercury.

Alternatives to Mercury

In addition to using mercury, some artisanal miners have adopted the use of other chemical processes, most prominently the practice of cyanide leaching. During this process, mined material with lower gold content is typically used – known as tailings, that has been separated from the more gold-rich material, can be treated with a cyanide solution in order to extract a portion of the gold that still remains in the material. In principle, cyanide could be used to treat not only tailings, but primary material extracted from the ground, which would forego the need for mercury. Cyanide leaching has the potential to be a clean alternative to mercury when managed appropriately, however, it poses an environmental risk when used in conjunction with mercury as this can mean that the tailings are contaminated with mercury, creating another route for the poisonous metal to enter into soil and water.

Managing, Reducing and Eliminating Mercury Use Over Time

There are a range of approaches to mitigate the damage caused by mercury, which when used in concert can encourage the gradual reduction in mercury use by addressing the issue from multiple perspectives. This report discusses the various approaches to mercury management as falling into one of three broad categories:

- Managing Exposure and Behavioural Sensitisation
One group of techniques is to alter the ways in which mercury is currently used to help reduce harmful emissions and minimise human exposure, this can be achieved either through the use of a device known as a mercury retort that prevents mercury emissions into the air by capturing fumes and turning them back into liquid for, allowing miners to re-use mercury after the captured material is re-activated, or with personal protective equipment (PPE) to safeguard operators.

- Reducing Mercury Use with More Efficient Techniques
Secondly, by adopting more advanced gold processing methods such that less mercury is required by virtue of applying mercury only to gold concentrates, for example by using equipment such as centrifugal separators.
- Mercury Alternatives
Ultimately desirable to entirely replace the need for mercury by adopting techniques that make mercury obsolete. Next to cyanidation, which is costly to establish and requires high production volumes, direct smelting is the most promising alternative, using a chemical agent called borax as a substitute for mercury; to pivot from mercury use to direct smelting, even higher-grade concentrates are needed, which can be achieved by using so called secondary concentrators such as shaking tables and magnets that allow gold to be concentrated gravitationally.

Using a range of mitigation strategies to progressively reduce risks related to mercury is key, achieving not only improved technical performance but also encouraging behavioural change, which are summarised below:



Since 2018, The Impact Facility has been looking for practical ways to manage, mitigate and eliminate mercury use in the artisanal and small-scale gold mining (ASGM) space. This report presents work carried out in mercury use sensitisation, with more than a dozen artisanal mining groups in Kenya, Uganda and Tanzania, reflecting on successes, challenges and failures experienced along the way.



Figure 1: An artisanal miner holding a bottle of mercury

2. Managing Exposure and Behavioural Sensitisation: Personal Protective Equipment

As a first approach, preventing human exposure to the direct health hazards of mercury is an important measure as the exposure to fumes and skin contact needs to be avoided. This can be achieved through the use of personal protective equipment (PPE), such as gloves or masks, but requires sustained effort to affect behavioural change.

Gloves

A number of gold processing techniques require the use of large amounts of water, which leads to the presence of washing ponds, where the runoff from such methods is allowed to collect, which often maintains salvageable concentrations of gold. Miners who work in washing ponds often run the risk of mercury exposure through cuts that form on their skin. The amalgamation process involves pouring mercury in a pan of concentrate the miners do so by estimating the amount of mercury to be used, (research shows that for every 1gm of Gold recovered 1.5gms of mercury is used) and thoroughly mixing the concentrate by hand. As miners carry out this panning process, in which they thoroughly mix gold concentrate with liquid mercury, they are running a significant risk of exposing their skin.



Figure 2: A mine worker wearing latex gloves while washing gold into a washing pond

Sluicing ponds are predominantly operated by women, where they often use their bare hands. As such, gloves will help prevent exposure of mercury to blood capillaries, which are the entry point for mercury into the body. To help ensure that miners adopt the use of gloves in washing ponds, ideally they should be quite flexible for use during the washing process, as in the past the gloves that were used were too rigid to allow workers to

nimbly wash materials, or conversely, very thin and thus easily get worn through during washing. Examples of different kinds of gloves can be seen in Figure 3.



Figure 3: 5 grams of gold amalgam held by a miner in Tanzania wearing a woven glove (left). A miner in Tanzania demonstrates the panning process with makeshift gloves (right)

Masks

At the stage of burning of amalgam, the risk of exposure to mercury fumes is most imminent. A proper mask could help mitigate toxic fumes from being inhaled, but mask use is basically unheard of. Despite a few miners being seen regularly wearing masks in the mines, it is more common that they are exposing themselves to harmful particles, oblivious of the real danger of mercury fumes in the mines and other particulate matter.

Sensitising Miner Behaviour

In principles, gloves and masks are relatively inexpensive and easy to use, however achieving widespread uptake of glove use at an artisanal or small-scale mine site often requires time and considering the human aspect of a mine. As with many workplaces, improving technical performance also requires certain psychological and behavioural considerations. Experience has shown that the following points are informative in encouraging the greater use of PPE:

1. Repeated, consistent training of the miners and demonstrating the use of PPE often.
2. Setting mine leaders as examples and holding them accountable.
3. Supporting the miners who need gloves or masks without simply handing them out for free to everyone, highlighting that safety is also an investment.

It is also advisable to select one lead miner who can be a role model to the rest of the washing team that uses gloves at all times during washing, which is intended to slowly influence the rest of the miners in the washing ponds to do likewise.

3. Reducing Emissions: Mercury Vapour Capture with a Retort

In January 2020, just prior to the outbreak of COVID-19, The Impact Facility was able to take an important step in ASM mercury management by providing mercury retorts to mining organisations in Kenya, which served as

a reminder that the hazard of mercury, like COVID-19, is very present.

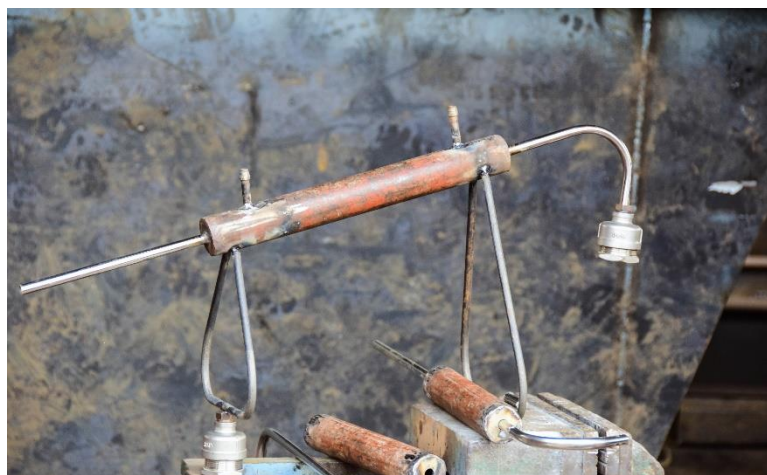


Figure 4: Fully fabricated mercury retort in a workshop in Nairobi

A mercury retort (see Figure 4) is a small device designed to safely burn mercury-gold amalgam such that mercury does not evaporate in the open air – this not only prevents harmful exposure to those people nearby, but also prevents the passage of mercury into the natural environment.

The retorts were fabricated in Kenya and were supplemented by a guide instructing other stakeholders how they could

manufacture retorts themselves. Additionally, training materials were prepared to be administered at the mine sites to ensure adequate on-site demonstration.

Capturing and recycling mercury can be an effective first step on the journey towards mercury-free processing. The Impact Facility, together with a third-party service provider, Maxius Engineering, was able to create a design where the components, assembly process and design, as well as the materials for the retort, were considerably and unanimously agreed upon. The next step was to design a blueprint for fabricating a mercury retort, which was then created in a workshop in Nairobi, resulting in the fabrication of eight mercury retort systems, with a spare to be kept for future use in demonstrations and training.



Figure 5: Ingughu miner demonstrate to the rest of the miners on how to operate a retort after training conducted by The Impact Facility

Mercury Retort Cost-Benefit Analysis

A schematic of a mercury retort is shown in Figure 6, which details the individual components that comprise its design. The small number of parts and simplistic design of the retort mean that it is simple and cheap to produce, which means that it is affordable for even smaller ASGM operations with low profits.

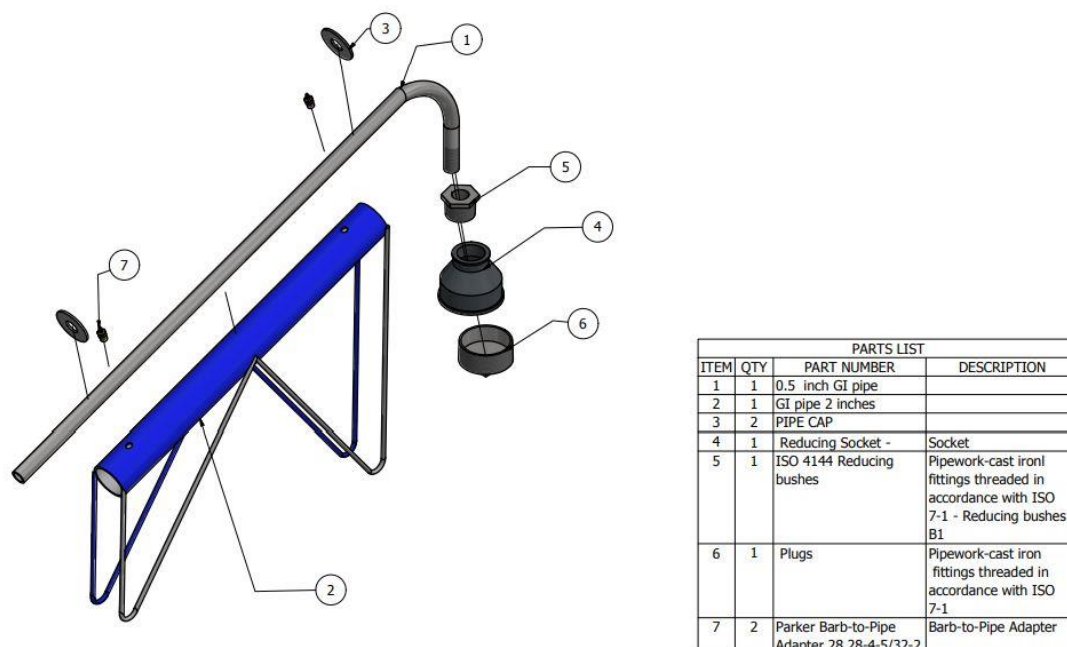


Figure 6: Extrapolated design for a retort, which is primarily made from stainless steel

Overall cost to get a full mercury retort system would be approximately \$100, with a breakdown of costs shown in Table 1. A large part of the cost due to the use of stainless-steel components, which ensure that gold amalgam does not react with the metal of the tubes or burning cap.

Description	Cost
Components: raw materials, mild steel tubes, non-corrosive stainless-steel tubes, burning caps	\$50
Gas cylinder (3 kg) and Bunsen burner system	\$30
Labour	\$20
TOTAL	\$100

Table 1: cost breakdown for fabricating a mercury retort in Nairobi

Advantages of Using Mercury Retorts

- Mercury emission is reduced by 90-95%. Based on the principle that a retort has a closed-loop mercury recycling system, capturing mercury fumes, and channelling them into cooler-water instead of emitting them into the air, they present a great way to prevent miners from inhaling the fumes and also from contaminating the environment.
- The retort ensures recovering mercury that would otherwise have been lost in the air, the miners operating costs are reduced as they do not have to buy nearly as much mercury.
- Mercury retort use is now becoming obligatory and miners who use the device have the benefits of getting more support from the government and organisations that support responsible mining.

- By using a mercury retort, miners are adopting a world-leading practice that supports the Minamata Convention – an international treaty signed in 2013 to eliminate the use of mercury.

Disadvantages of Using Mercury Retorts

- Upfront investment costs can be high for miners.
- The process is slower than the open burning process.
- Miners were sceptical that they cannot see the amalgam during the process as one has to cover it in a closed cap.
- Gas needs to periodically be replaced, creating the risk that miners stop when they finish the gas.

Blogs and Videos on Mercury Retorts

Cyrus Maina and David Sturmes of The Impact Facility have created a series of blogs and videos detailing their work relating to mercury risk management in the artisanal and small-scale gold mining sector.

- [Spotlight on Mercury](https://www.theimpactfacility.com/spotlight-on-mercury/) - blog article by David Sturmes on the place mercury has in the ASGM space, then further elaborating on the dynamics of retorts to mitigate mercury use: <https://www.theimpactfacility.com/spotlight-on-mercury/>
- [How to Make your own Mercury Retort](https://www.theimpactfacility.com/blueprint-to-fabricate-your-own-mercury-retort/): - Cyrus Maina discusses how mercury retorts are designed and how they can be made with limited equipment: <https://www.theimpactfacility.com/blueprint-to-fabricate-your-own-mercury-retort/>
- [Mercury Retort Training in Kakamega County, Kenya](https://www.theimpactfacility.com/retort-training-in-kakamega-keeping-safe-from-covid-19-and-mercury/) – Cyrus Maina details his work with four ASGM groups in Kakamega to demonstrate and train miners how to use a mercury retort in 2020: <https://www.theimpactfacility.com/retort-training-in-kakamega-keeping-safe-from-covid-19-and-mercury/>
- [Miner Testimonial](https://vimeo.com/468909851/21595eac4d) – a woman from a gold mine from Mwangaza Mining Group in Kakamega County, Kenya speaks about how her experience learning how to use a mercury retort and the benefit that it brings: <https://vimeo.com/468909851/21595eac4d>
- [Artisanal Miners Explain Their Work](https://vimeo.com/431378864) – artisanal miners from Kenya explain the different stages of the gold mining process: <https://vimeo.com/431378864>

4. Reducing Mercury Use through Improved Concentration Techniques

Taking mitigation a step further, moving beyond the need for mercury entirely can provide better health and environmental outcomes than managing its use more responsibly. A range of equipment can be used to increase the rate at which miners can recover gold from gold-bearing material to the point where the use of mercury is no longer necessary, with in-depth information on some items of equipment provided in Appendix I.

The Impact Facility has showcased and provided access to this technology to artisanal miners which allowed them to process their ore without the use of mercury. Specifically, a centrifugal concentrator (one popular model is known as the “Gold Kacha”), a sluice mat and a shaking table were provided to a mine group in Kenya, a hub of mines in Uganda (see Figures 7 and 8) and three mine groups in Tanzania. On top of this, efforts were made with the mining groups in Uganda to trial the use of shared processing facilities.



Figure 7: Gold Kacha without a sluice box located in Busia, Uganda, installed and operated by The Impact Facility throughout 2019 and 2020)

The initial cost for any of these sets of equipment started at USD 55,000, including installation and training the miners. The equipment comprised of a Gold Kacha, a shaking table, a water pump, 1000 L plastic tank and a 30 kVA generator. These technological improvements were expected to achieve processing efficiencies that allowed for up to 90% recovery rate in perfect conditions, which is a significant increase compared to the conventional methods in place prior to installation, which typically only yielded a 40% recovery rate. A detailed cost analysis of the installation, miner training and operation of the system in this case study is given in Appendix II.

The initial plan was to establish a processing hub where miners would easily process their ore within the shortest time possible, particularly in that it would allow for smelting, which would circumvent the need for mercury use.

Gold Kacha Technology

The Gold Kacha system consists of a centrifugal machine, inside of which is a ribbed bowl that rotates such that increased centrifugal force casts lighter concentrates off to the side, leaving heavier gold concentrate remaining in the bowl for further processing. Beneath the end of the Gold Kacha, a sluice mat table traps the concentrates which escape from the machine to ensure that any heavy gold particulate matter is captured before it finds its way to the waste ponds.



Figure 8: Busia Miners gathers with project partners to compare efficiency of the gold Kacha and classical sluicing, Busia Uganda

Advantages of a Gold Kacha

- A 95% gold recovery rate, which is much higher than the classical sluicing method, which only achieves around 40% recovery.
- Gold Kacha is significantly faster than sluicing.
- Bulk processing that enables faster, less cumbersome gold processing.

Disadvantages of a Gold Kacha

- Lack of support to ASGM operations for the equipment supplied by manufacturers, without which it is hard for miners to achieve full benefit for the equipment.
- Upfront investment costs are high, which can only be justified by high-capacity operations that mine higher grade ores.

Comparison Test Between Gold Kacha and Classical Sluicing

A Gold Kacha was installed in a mining community in Busia, Uganda on 11th March 2020 as part of a trial to assure the miners that the technology would work better than the conventional sluicing method used there. Equal amounts of ore taken from the same roof were fed into the sluice and the Gold Kacha to ensure an objective test, with the gold recovered from each system weighed in order to compare their gold recovery efficiency.

From 45 kg of gold ore, the Gold Kacha yielded 3.26 g of gold and 2.76 g was produced from the traditional method in the nearby sluicing pond – a difference of 0.5 g (18%), with the former only requiring 20 minutes to complete processing. This was an effective demonstration of not only the superior recovery efficiency of the new method, but that the reduced amount of mercury subsequently required to amalgamate the gold concentrate after this processing stage.

A blog and video has been produced documenting this comparison test, with credit to Magali Rochat:

Kacha vs. Sluice – blog about the competition between centrifugal and sluice gold processing techniques to demonstrate the value of a Gold Kacha, with a \$100 prize for the winner provided by the Netherlands Enterprise Energy [RVO]: <https://www.theimpactfacility.com/busia-gold-ore-processing-competition/>

Gold Processing Competition in Uganda – an up-close look at how the comparison between the Gold Kacha and sluice was set up: <https://vimeo.com/434051478>

Advantages of Gold Kacha Over Traditional Sluicing

- Yields a higher amount of gold from the same quantity of ore concentrate.
- The small volume of concentrate remaining in the Gold Kacha helps minimise the amount of mercury used to amalgamate when compared with sluicing.

5. Miner Mercury Training Sessions

Mercury Training in Kakamega

Due to movement restrictions in counties around the country, in response to the onset of the Coronavirus pandemic, it was not possible to move to the mines until after lockdowns were lifted. Training sessions began later in the year, with at least 30 miners from four mine groups in Kakamega County, Kenya receiving training.

A benefit of the mercury retort is that one can test and demonstrate its effectiveness on the spot. During the first retort training session performed in Mwangaza mine, Kakamega, miners were able to witness exactly how gold amalgam changes colour from silver to dark brown, which signifies that mercury has been liberated from the amalgam.

Significance of Kakamega Training

- It was evident that miners in this area had limited access to mercury retorts, as gold traders routinely requested this equipment for their daily operations.
- The retorts were a perfect reminder to the miners that, even with the pandemic, their health was crucial! It was indeed important to ensure that their bodily health was not affected by exposure to mercury.
- The miners' testimony on the effectiveness of the retort was encouraging, with an individual from Mwangaza mine gladly reporting that she had not anticipated her amalgam to come out with such a perfect yellow colour after burning with a retort.

Mercury Training in Migori

In November 2020, Cyrus Maina from The Impact Facility headed out to mines in Migori County, in order to distribute retorts to four mining groups. Not only did they benefit from acquiring new equipment, but they were also trained on how to use and maintain the retorts.

At least 35 miners from four mining in the region benefited from this project, with emphasis put on continual and consistent use throughout the lifetime of a mine. As part of the process of handing over the retorts, The Impact Facility made sure that the miners signed a document acknowledging their commitment to use the retort and recognition of how they can benefit from it. A sample of this document can be found at the end of this report.

In order to encourage uptake of the mercury retort and to provide formal recognition of its purpose, mining organisations signed a document created by The Impact Facility formally recognising their value, which in addition includes a pledge to use the mercury retorts at all times when burning gold amalgam. A template for this document can be found in Appendix IV.

6. Lessons Learnt

Addressing the issue of mercury can be a sensitive topic given its significant role in artisanal and small-scale gold mining, and even with the existence of mitigation strategies and substitutes, it is difficult to motivate people to change their habits – not only specific to mercury, but in all aspects of mining operations. Initiatives to improve mercury management are larger than any one mining group and the entity that is pushing to change practice, in this case The Impact Facility, must hold the burden of creating sustained changes in behaviour.

Financial commitments with conditions relating to improved mine management are a compelling way to do this, but performing pilot training sessions to showcase the potential of improved equipment also has value and can be a catalyst for future change and even sectoral shift. One example of this is The Impact Facility's work with the Nsangano gold mine in Nyarugusu, Tanzania which received processing equipment but due to lack of confidence in the use of the equipment, they have remained inactive. Hopefully by doing more trial tests it can help gain the miners' faith in change over time.

Reflecting on our experience with mining organisations across the three broad areas of managing exposure, vapour capture and improve concentration techniques, we have summarised some important take-away points that should be taken into consideration in future work:

Improved Mercury Handling by PPE Sensitisation

- Facilitate the procurement of appropriate PPE for mines without necessarily paying for it to begin with, to help demonstrate their purpose
- Practical trainings in PPE use and regular follow up checks on usage helps miners develop the behavioural pattern to use them.
- Communication needs to stress inefficiencies as much as negative health impacts.

Mercury Vapour Capture using Retorts

- Procure retorts locally to support local manufacturers.
- Make the use of retorts an obligatory prerequisite for a mine to qualify for investment.
- Following up with mines, either via phone, or in-person, is crucial in facilitating change.

Mercury Reduction through Improved Concentration Techniques

- Involve miners at every stage of equipment provision, allowing them the space to clearly communicate their wants and needs.
- Thorough feasibility assessments regarding mine productivity must be conducted to justify investment.
- Certain equipment such as shaking table or smelting apparatus will not be financially viable at the beginning of a mine partnership, due to the high costs and considerable site preparation required.
- Invest in technical training and support of miners on the ground during the introductory period to ensure skilled operation.
- **Note on Tanzania:** The Impact Facility found that the high cost of importing equipment to Tanzania, particularly very high import taxes and fees for private clearing agents, was such that it may have an acute impact on the ability and willingness of ASGM miners in Tanzania to invest

Appendix I: Mercury Management Equipment Profiles

Retort

Increase in Production	Increase of Recovery	Increase of OHS
Neutral	Neutral	Strong

Availability	Costs	Maintenance
2-5 weeks	\$100	Easy



What is it used for, and how does it work?

A retort is a small equipment that can easily be fabricated locally, whose purpose is to ensure that the burning of a gold amalgam process will not generate fumes emission to the atmosphere.

When amalgam ball is inserted at the burning porch/point, and lid tightened, the roasting process ensures that the mercury fumes are condensed/cooled by a water jacket surrounding the pipe and collected into a separate container for re-use.

How to use

Amalgam is inserted and tightly closed-back; after this, you start heating the bowl from below with a torch. As a result, the mercury in the amalgam begins to evaporate and travels through the pipe where there is another big pipe with circulating cold water; this cools off the mercury vapour to liquid back which collects in the water collector and can be re-used.



How to maintain

Retort must be kept in a dry place and out of rains and moistures. It is also essential to check the welded parts of the retort tube that they are not leaking which can be harmful to the user who might be unaware of.

Availability of spare parts

A retort tube requires metal tubes components and water pipe for water circulations; the parts are readily available in most hardware shops.

Parts which would need replacement can be bought in the nearest hardware shops.

Accessories needed to operate

Apart from the equipment, water and pipe from a running source are needed, a small bucket with clean water to help collect the recovered mercury, Source of fire to heat the amalgam part.

Legal Permits Required

Trained technician, Smelting technology certificate.

Known Local Fabricators

Company name: Maxius Engineering Ltd

Email address: maxiusengltd@gmail.com

Contacts Contact number: +254712089695

Physical Location: Nairobi, Thika Town.

Centrifugal Concentrators

Increase in Production	Increase of Recovery	Increase of OHS
Neutral	Very High	Strong

Availability	Costs	Maintenance
2-5 weeks	\$2,500- \$3,500	Easy



What is it used for, and how does it work?

There are many varieties of the centrifugal concentrator, they usually employ the same principle but different models, for the sake of our research as ASM solution providers, The Impact facility knows which concentrator best suits ASM miners.

We discuss one brand by South African processing equipment specialized company APT, Gold Kacha, which is a small equipment that is customized for the concentration of gold by the principle of centrifugal force.

How to use

With a pipe of running water, the gold ore is fed on top of the sieve opening of the Gold Kacha while water is run over the ore and wetting it ready to enter in the swirling bowl run by a motor at a moderate speed enough to sweep away lighter materials while heavy one is embedded in the riffles of the bowl.

Once the ore is done, the equipment should be opened, and sieve kept aside while the heavy materials are removed thoroughly by washing well and emptying the rich slurry through an outlet just below the equipment ready for further processing.



How to maintain

Gold Kacha has is powered equipment which needs extra care from water spilling on the covered motor and heavy rains.

Wash the equipment once the work is done, thoroughly washing the riffled bowl to avoid clogging which interferes with the next process.

Availability of spare parts

The power side of the Gold Kacha made up of a particular motor which may not be readily available.

The bowl made of special material riffles can be imported or replaced from nearest agents of this Equipment in Tanzania.

Accessories needed to operate

Must-have: water tank reservoir, Generator, Electrical cable, Sluice mat.

Standard Technical Specifications

Feed rate: 1-3tph

Electric Motor: 0.75Kw

Water Requirement 2-4 m³ /hr

Legal Permits Required

Trained technician, Processing technology certificate

Warranty

Usually 1-year warranty

Known Vendors

Company name: **Akili Minerals services Ltd.**

Email address: joseph.komu87@gmail.com

Contacts number: +254726216110

Physical Location: Nairobi, Ngong.

Company name: Borassus Company Ltd

Email address: hamishmanning@borassus.com

Contacts: +255 784345387

Physical Location: Tanzania.

High-Quality Manufacturers

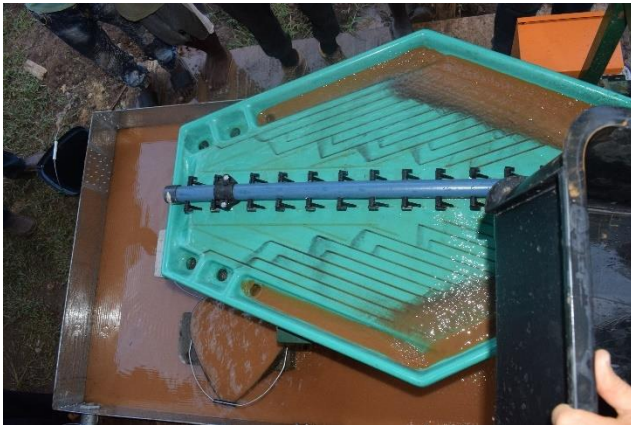


WELL-TECH INTERNATIONAL

Gravity Concentrators (Shaking Table)

Increase in Production	Increase of Recovery	Increase of OHS
Neutral	Very High	Strong

Availability	Costs	Maintenance
2-5 weeks	\$9,000-\$10,000	Easy



What is it used for, and how does it work?

It is used for separating light and heavy minerals (Gold) by the asymmetric reciprocating motion of the table surface.

Depending on the materials nature, the action can always be adjusted to separate heavy and light materials efficiently. The motion comes from a motor beneath the table which is eccentrically coupled with a camshaft thrust resulting in a nonlinear motion

resulting in a vibration effect.

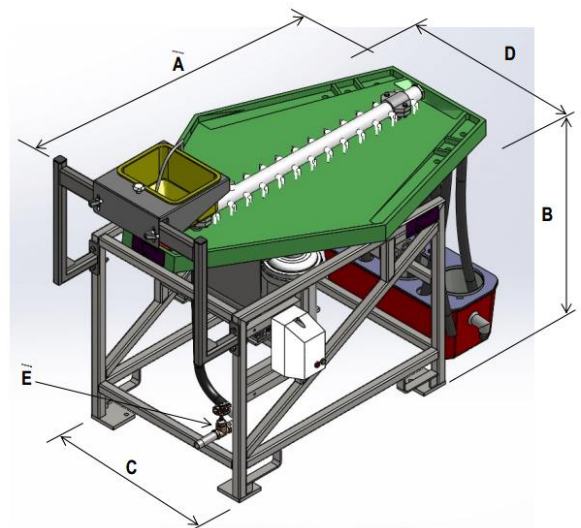
The combined action of the symmetrical reciprocating motion of a mechanical slab and the flow of water on a thin inclined plane causes loose layering and zoning of ore particles on the table surface that is normally riffled on its surface, thereby causing the mineral separation process to be carried out according to different densities.

How to use

A slurry is fed on one end of the vibrating shaking table; there are always beams of water flowing on the table, these serve to wash away any light materials away from the table while the heavier elements are typically left on the table near the centre. Heavy materials will follow one direction to a bucket of water. In contrast, all other light contents will be emptied to a different basin. This concentrate is usually the last process and will, therefore, be panned ready for smelting.

How to maintain

Shaking table is sensitive to levels; it is, therefore, important to ensure that the ground where it is installed is levelled and no surrounding ground movements.



Since the equipment is powered, it will need an electrician always to check the condition of the motor.

For the long life of the table, it would be right to have a shelter since the material that makes the tabletop is hard plastic, and it could be damaged by prolonged sun heating.

Protect the table from scratching by vandalism; this may interfere with the separation mechanism of the equipment.

Availability of spare parts

Most of the components for this equipment are repairable. The motor is sensitive and would always require a competent person to fix it in case of failure.

Technicians for this equipment are now available in Kenya and neighbouring Tanzania where some of the delicate components can be sourced.

Accessories needed to operate

Must-have: water tank reservoir, Buckets of water for concentrates, A shaded area away from the sun.

Additional: feeding spoon/small Bucket.

Standard Technical Specifications

Feedrate:30-50kg/Hr

Electric Motor): 0.75Kw

Water Requirement 1 m³/ hour

Legal Permits Required

Trained technician, Processing technology certificate

Warranty

Usually 1-year warranty

Known Local Vendors

Company name: **Akili Minerals services Ltd.**

Email address: joseph.komu87@gmail.com

Contacts number: +254726216110

Physical Location: Nairobi, Ngong.

Company name: Borassus Company Ltd

Email address: hamishmanning@borassus.com

Contacts: +255 784345387

Physical Location: Tanzania.

High-Quality Manufacturers



WELL-TECH INTERNATIONAL



Appendix II: Case Study – Installing Improved Gold Processing Equipment in Busia, Uganda

Full Cost to Install A Gold Kacha And Shaking Table

Description	Cost (USD)
Customs fees	\$11,488
Diesel generator (Stamford; PS30 Perkins 1100 series engine)	\$13,325
Fencing, storage and toilet facilities	\$1,390
Gold Kacha	\$2,175
Installation costs	\$3,275
Shaker table	\$9,845
Smelter	\$1,500
Submersible pump (WEDA 10N)	\$3,233
Training	\$3,000
Transport (APT Freight)	\$1,985
TOTAL	\$51,216

Table 2: equipment, transport and installation costs to establish the complete system of gravity concentration in Busia

Appendix III: Case Study – Invoice for Gold Kacha and Shaking Table



Appropriate Process Technologies Pty Ltd
218 NEW MARKET ROAD NORTHRIDING JOHANNESBURG
2162

Proforma Invoice

Date	PF1 #
2018/11/06	2018-11065

Name / Address	Ship To
Fairtrade Foundation, 5.7 The Loom, 14 Gower's Walk, London, E1 8PY	Uganda

Description	Qty	Rate	Total
• GoldKacha Concentrator • Polyurethane bowl • Feed funnel with integral 3mm wire mesh screen • 220 V/50 Hz electric drive with gearbox • V-belt power transmission • Water control valve and hose.	1	2 175.00	2 175.00
• ST 30 Bullman Upgrade Table with 0.75 kW motor, d/b with starter base frame and tray • H-base frame • Galvanised Tray • 600L Poly Tank with piping and fittings • Water piping • Submersible Water feed pump / 380V / 250 W	1	9845.00	9 845.00
Freight: • Packing and Air Freight estimate to C.L.F Entebbe airport, Uganda • Valid till 25 November 2018	1	1985	1 985.00
Terms of Sale • Payment : - 100% prior to shipping including the shipping and freight in the Exclusions below • Exclusions from this quotation: 1. Pre-inspection, duties, brokerage & taxes, demurrage, site preparation, raw water supply, onward training on plant, test-work, battery on Korea VAT 15% 2. Storage/damage at any part of process, Abnormal SARS inspections, Permits, All destination charges, Courier of OBL to destination & Telex release fee 3. Freight and shipping costs – if shipping and freight is to be effected into a non South African tax jurisdiction, APT requires the customer to agree to appoint APT as being responsible for arranging the shipping and freight to the customer site, which then results in no VAT being payable on the invoice amounts payable to APT. APT will separately invoice the customer for shipping and freight charges prior to date of shipping. Only upon receipt of all payments due will APT effect shipping of the plant to the customer. • Site Preparation must be effected by the customer according to our instructions and the site manual. • Delivery : - 4-6 weeks ex receipt of funds • Conditions : - APT Terms & Conditions apply • ROE : - Plant origin South Africa, any changes to the rate of exchange may be applied at APT's discretion. • Freight Estimate includes: Uplift of equipment from warehouse, Airport charges, Freight to required destination, Insurance for given value			
Nedbank GBC ITT Volume Business, Ground Floor Nedcor Park 2, 6 Press Avenue, Selby, Gauteng - Swift Address: NEDSZAJJ A/c no: 7900016244 Branch Sort Code: 198765			Subtotal USD 14 005.00 VAT Total USD 0.00 Total USD 14 005.00

Appendix IV: Mercury Retort Pledge and Recognition of Value

As part of The Impact Facility's efforts to encourage the use of retorts to reduce the exposure of mercury to workers and the environment, this document is used to acknowledge retort receipt and recognition of the benefit that they bring.

Record of Acknowledgement of Receipt of Mercury Retort, Demonstration and Training

Group Beneficiary Name: *Insert Name*

Training Dates: *XX/XX/XXXX*

The group acknowledges that it received mercury retort set comprising of:

1. Mercury retort
2. *X* kg gas cylinder
3. Burner and gas pipe

The group further acknowledge that it received a *X hour* training demonstration which comprised of a theoretical explanation on why mercury is harmful, the benefits of using mercury retort and a physical demonstration on how the retort works. In addition, the practical demonstration was successful, and the trainer roasted *X g* of gold amalgam with the help of the trainees, yielding a perfect yellow colour that is normally required by the gold traders.

Furthermore, the group further committed to make use of the retort at all time in their burning process and as much as possible compare the amount of Mercury recovery when using the retort.

This serves as acknowledgement that the mine group received the equipment and the necessary training to enable the miners especially women eradicate mercury and embrace the safe burning of amalgam.

Mine Name

ASM mine Representative

Name of The Leader:

Name:

Signature: _____

Signature: _____

Date: _____

Date: _____

Location: _____

Location: _____

Appendix V: Additional Resources

Further Resources

Opening the Black Box: Local Insights into the Formal and Informal Global Mercury Trade Revealed

[Author: National Committee of The Netherlands]

https://www.iucn.nl/files/groene_economie/lr_mercury_brochure_digitaal_gebruik.pdf

This report sheds light on trading routes, the supply chain and actors involved in Bolivia, Burkina Faso, Guyana, Kenya, the Philippines, Suriname, Tanzania and Uganda. It further identifies factors that hinder the understanding of mercury trade and highlights mechanisms that drive the continued use of mercury.

Webinars on Gold and Mercury

[Author: various]

https://www.iucn.nl/en/updates/iucn-nl-sheds-light-on-the-formal-and-informal-mercury-trade?utm_medium=social&utm_source=employee-advocacy&utm_campaign=mercury

The first webinar is from the Golden Myth series, which looks at the risks, ethic and opportunities of ASGM, facilitated by The Impact Facility and Dutch NOG Solidaridad. The second webinar presents the findings from the report on global mercury trade (see above.)

Infographics on Mercury

[Author: World Health Organisation]

https://www.who.int/ipcs/assessment/public_health/mercury-infographics/en/

Infographics on what mercury is, its affects and the Minamata Convention to reduce mercury use globally.

Technical Solutions to Reduce Mercury Use and Improve Gold Processing Efficiency

[Author: planetGOLD]

<https://www.planetgold.org/technical-solutions>

Information on alternative technologies and better practices to help ASGM earn more money and reduce community health and environmental risks.

Global Mercury Partnership

[Author: United Nations Environment Programme]

<https://web.unep.org/globalmercurypartnership/our-work/artisanal-and-small-scale-gold-mining-asgm>

Information on a UNEP partnership to minimise and eliminate mercury use and release in ASGM. Further resources provided on ASGM in general

A Path to Mercury-Free Artisanal and Small-Scale Gold Mining

[Author: United Nations Environment Programme]

<https://web.unep.org/globalmercurypartnership/path-mercury-free-artisanal-and-small-scale-gold-mining##Events>

A demonstration story map on mercury use in artisanal and small-scale gold mining.

Mercury Emissions Map; Global Mercury Assessment 2018

[Author: United Nations Environment Programme]

<https://www.unep.org/explore-topics/chemicals-waste/what-we-do/mercury/global-mercury-assessment>

Clickable map showing the mercury emissions by sector in various countries around the world. This data is based on the 2018 Global Mercury Assessment report, with a Technical Background Report as a supplement

Illustrated Guide to Mercury Free Artisanal and Small-Scale Gold Mining

[Author: United Nations Environment Programme]

<https://indd.adobe.com/view/a9b3c39e-e7b7-412a-9d12-5cf47f484e56>

23-page illustrated guide to various mercury management techniques, as well as case studies and additional resources.

Illustrated Guide to Mercury Free Artisanal and Small-Scale Gold Mining

[Author: United Nations Environment Programme]

<https://www.youtube.com/watch?v=BmJTSptLab4&feature=youtu.be>

10-minute video on the background to ASGM and how to eliminate the worst practices in ASGM.