

SHORT NOTE

A new still for the prevention of mercury poisoning in small-scale gold mining by amalgam extraction

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RESUMEN

Se describe un nuevo sistema de destilación para amalgama que permite recuperar el mercurio usado en la pequeña minería aurífera en Colombia. La destilación de hasta 300 g de amalgama toma 10-20 minutos. Más del 90% del mercurio que antes se perdía en la atmósfera, se recupera y se recicla. El hornito puede ser a gasolina o a gas licuado. Puede usarse también para fundir oro en pequeñas cantidades y quitar su aspecto esponjoso. El nuevo sistema es popular entre los mineros por ser económico y prevenir los efectos del mercurio sobre la salud.

PALABRAS CLAVE: Minería pequeña de oro, Colombia, método de amalgama.

ABSTRACT

A system for the recovery of mercury in small-scale gold mining in Colombia has been designed and tested. Distillation of up to 300 g of gold amalgam takes ten to 20 minutes, and more than 90% of the mercury formerly lost in the atmosphere is recovered for recycling. The equipment pays for itself and may be locally built using available materials. It has been widely accepted by miners because of the improved safety to miners and their families. The furnace can be fueled either with gasoline or LP gas. It may also be used for smelting small amounts of gold, thus getting rid of the sponginess which detracts from marketability. The new system is popular in Colombia because of the improved safety to mine operators.

KEY WORDS: Small-scale gold extraction, Colombia, amalgam method.

1. INTRODUCTION

The improvement described here was developed in the framework of a cooperative technical project between Colombia and Germany in the Suratá River gold mining district near Bucaramanga, Colombia. The purpose of the project is to control negative environmental effects of gold mining pollution in the area, especially as related to the use of mercury and cyanide in gold extraction.

In the Vetas and California mining districts of north-eastern Colombia, gold occurs in hydrothermal deposits as veins in the mother lode. Common procedures of gold recovery include milling, concentration by gravity, amalgamation and cyanidization. The amalgam method is historically the oldest and remains popular. The concentrate is filled into barrels and gold amalgam is extracted after 8 to 18 hours of lixiviation with mercury in the barrel.

Next the amalgam is heated to temperatures above 356°C to vaporize the mercury. Industrial installations for amounts of amalgam in excess of 300 g use special stills for this purpose; however, in some of the smaller mines the

amalgam is heated on pans in the open, using charcoal fires or liquid-propane stoves. As a result, the mercury fumes are diffused into the living space and their inhalation may produce serious health problems to miners and their families.

2. REMEDIATION ATTEMPTS

In 1997 the Project began distributing coal-heated stills made of steel among the miners in the Suratá River area. These stills were designed in the 80's by technical assistance project in the Pasto area in southern Colombia. However, miners in the Suratá River area complained about the low rate of recovery and the impurities in the recovered mercury. Heating was slow and operation, fired by wood, coke, or in foundries, was unstable. Attempting to heat the stills with gas torches took a long time and the operation was too expensive. As a result, the miners abandoned the use of the stills and went back to the earlier open-air procedure.

Next we attempted to introduce the MEDMIN (1998) still which was designed to address some of the above-mentioned problems. However, the miners continued to request a faster, less expensive heat source. Also, the screw-type seal

of the MEDMIN container had some possible leakages. Finally we decided to design a new system which would aim to comply with the miners' requirements.

3. HEATING UNIT

We decided to use liquid-propane burners because of the availability of LP gas in the region. Alternatively, we provided for the use of portable gasoline stoves when the distance to the nearest road was too great.

We tried different types of furnaces: a clay furnace, a carbon steel furnaces without lining and one with a refractory cement inner lining. The latter option turned out to be best in terms of heat performance and structural resilience. The final design was a cylindrical furnace with a capacity of 1530 cubic centimeters in the firing area (Figure 1).

For operation with LP gas we selected a burner made by Jackwal, Brazil, Ref 75.102.200. This burner was safe, easy to use, and was available locally (including spare parts.) The diameter of the intakes was increased from 0.2 mm to 0.8 mm for the gas, and from 2 mm to 5 mm for the air intake. The nominal gas consumption, according to the manufacturer, was 1200 g/h.

4. STILL

Our still can be either LP-gas or gasoline fired. All parts in contact with mercury were made of AISI 304 stainless steel. The cooling tank was built of low-cost galvanized sheet iron which was adequately corrosion resistant.

The condensation tube is curved to prevent liquid mercury from flowing back into the still, instead of the cooling tank. This part of the tube can become as hot as the still during operation. When water-cooled, our condensation tube is steeper than in conventional stills in order to minimize the amount of mercury sticking to the inner walls of the tube.

Two optional stills of different volume (for 200 g and 400 g of amalgam) were provided in every equipment to match the requirements of different miners. The locks on the containers have a self-sealing conical thread. The cooling tank is a cylinder for better stability in handling. It has a capacity of 7.8 liters of water which is adequate for continuous cooling (Figure 1).

5. TESTS

The new stills were tested in the laboratory of the Project and in the field. We used mercury samples and samples of amalgam with known mercury content. We also used samples of unknown mercury content supplied by miners. Table 1 shows the results of the tests.

Note that the recovery rate is above 99% for pure mercury, showing minimal leakage in the system. Gasoline-fueled stills required a longer time because of the natural draft in the furnace and because of the standard capacity of the gasoline stove. However, recovery was around 90%. Gas-fired stills were faster and the recovery was better—around 92%. This was mainly due to the better heat efficiency of the furnace.

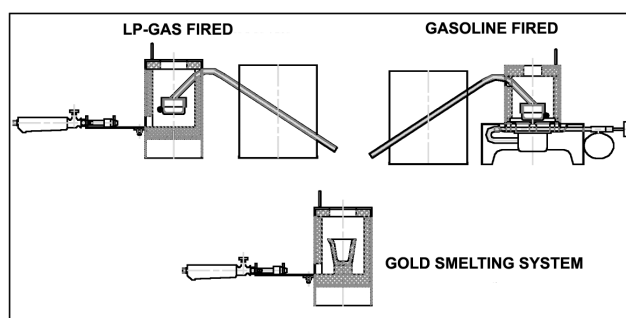


Fig. 1.

Table 1

| Sample | Size [g] | Mercury [g] | Heating | Time [min] | Hg recovered [g] | Gold [g] | Mercury recovery [%] |
|-----------|----------|-------------|----------|------------|------------------|----------|----------------------|
| Mercury | 50 | 50 | Gas | 8.3 | 49.75 | 0 | 99 |
| Amalgam | 6 | 3.2 | Gasoline | 15 | 2.9 | 4.3 | 90 |
| Amalgam | 4 | 1.8 | Gas | 9 | 1.6 | 2.2 | 89 |
| Amalgam | 15.9 | 5.2 | Gas | 10 | 4.8 | 10.6 | 92 |
| Amalgam * | 69.8 | unknow. | Gas | 10 | 39.6 | 27.6 | >94 |

*Sample supplied by miner. Recovery as computed by weight difference.

For small sample sizes the recovery rate goes down because the amount of mercury retained by the still is independent of the amount distilled. The residual mercury alloyed with the gold is roughly proportional to the size of the sample.

6. COST OF OPERATION

The gas-fired unit was found to use 0.2 lbs of gas and ten minutes per operation, while the gasoline-fired unit used 0.3 l of gasoline and twenty minutes per operation. Figure 2 shows the recovery rates of mercury for the gas-fired unit. Note that about 95% of the mercury is recovered in 8 minutes.

Figure 3 shows the heating curve of the system. Within 8 minutes the outside temperature of the still rose to 600°C. It is possible to reach up to 900°C in about 20 minutes by increasing the rate of gas injection. Thus small amounts of gold may be smelted in a graphite crucible of 500 g capacity.

Our cost for a gas-fired system was \$90, and \$80 for a gasoline-fired unit. The stills were successfully introduced among the miners by means of demonstrations and workshops including talks by medical personnel describing the dangerous effects of mercury inhalation. The miners were encouraged to bring their own amalgam samples for demonstrations by Project personnel. Illustrative folders were also printed and distributed.

At present 100 systems have been distributed free of charge to miners, starting in the region with the highest demand (Figure 4).

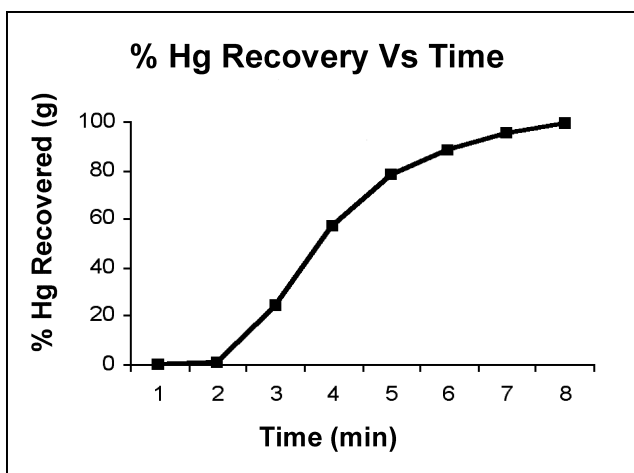


Fig. 2. Mercury recovery for a gas-fired unit.

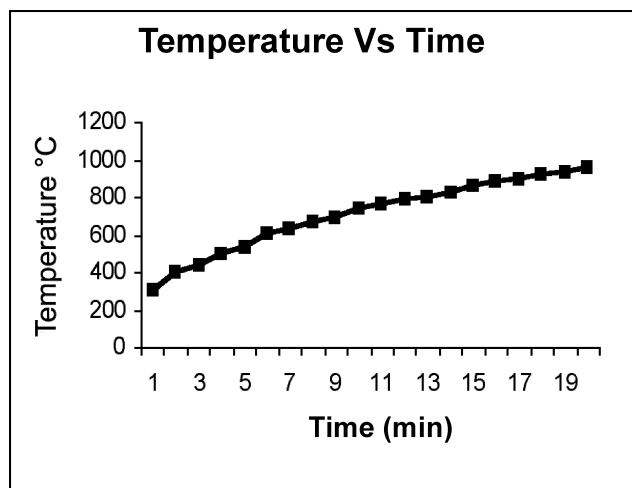


Fig. 3. Heating curve of system.

7. CONCLUSIONS

A simplified system of amalgam treatment for gold extraction has been designed and implemented at the user level in the region of Bucaramanga, northern Colombia. The new system uses locally available materials and workmanship. It was shown to be safe and efficient for amalgams of 3 g to 300 g in weight. The system is expected to raise the quality of life of gold miners by reducing significantly the hazard of mercury inhalation. It pays for itself by increasing the rate of recovery of mercury used in recycling. The furnace may also be used for smelting small amounts of gold, thus eliminating sponginess which detracts from its marketability.

Blueprints and specifications of the new system may be requested from CDMB (cdmbnc@b-manga.multi.net.co), or from the Surata River Project (psurata1@col1.telecom.com.co).

8. ACKNOWLEDGMENTS

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Fig. 4. Gold recovery unit (gas-fired version).

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