

Hydraulic potential use of mine water from mountain mining activities

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Abstract The mining activities have generated for centuries mining voids and fracture zones that act as karstic-type aquifers, which is called 'artificial karst'. Currently, the energetic use of water in abandoned mines consists on the extraction of geothermal energy from the fluid to provide buildings air-conditioning systems. However, there is another possibility: the hydraulic potential use of mine water from mining activities, where important net heads are located. In order to obtain energetic optimal use, it has been designed a pumping equipment that, using the minimum energy in its drive, would allow mine water pumping to be used later as hydropower.

Key Words pumping, hydropower

Introduction

One of the main factors that determine the economic, technological and social world today is energy. Nowadays, it is common to believe that natural resources and the balance that governs the world do not support the continued and steady increase of energy that characterizes the present moment. Despite this awareness, the current energy system is based on power generation from fossil fuels. Therefore, the use of natural resources is now one of the ways to the sustainability of the planet.

The mining activities have generated for centuries mining voids and fracture zones that act as karstic-type aquifers, which is called 'artificial karst' (Price, 1996). Currently, the energetic use of water in abandoned mines consists on the extraction of geothermal energy from the fluid to provide buildings air-conditioning systems (Donovan, 2010). However, according to Jessop (1995) there is another possibility: the hydraulic potential use of mine water from mining activities, where important net heads are located (fig.1, fig.2).

Water pumping and distribution requires a significant use of electricity, and this consumption means thousands of GWh. In other words, much of the electricity consumed in the country is used to move water vertically and (minor) horizontally. This means that millions of oil barrels are consumed in order to get the water to homes and also that billions of tons of CO₂ are transmitted into the atmosphere.

Note the possibility of pumping water through a new system that requires no electricity or fossil fuels to operate, actually the system is an engine that works by potential energy, by means of water height difference that can be found in nature or that can be built to serve as a power generator.

This system consists of a pumping unit de-

signed to perform the pumping of water from a reservoir (figure 3), lake or similar to a large tank without using any electricity, so that once water is raised, it can be used for population supply, irrigation by gravity. Unlike hydraulic or mini-hydraulic plants, these kinds of facilities have, amongst other advantages, the absence of environmental impact, and they do not affect the ecological flow of rivers.

Methods

This equipment consists of a beam system that acts as a lever machine, two cylinders with pistons as a water pump, valve clearance to get the pumping which in this case acts as a suction pump impeller, and lower and higher tank simulation, in order to act as a reservoir to pump and as a repository engine, a connecting pipe between the upper



Figure 1 Waterfall from a mountain mine (net drop height = 5 m). Net height to the next river > 100 m.



Figure 2 Photographs of a typical mountain mine and mine water output.



Figure 3 Photograph of the pumping system.

tank and beam, which is the central part of the system (fig.4).

This system has two small and two large tanks connected by a beam system that will allow performing the water pumping. The large tank has a plunger that moves up or down, depending on whether the small tank is full or empty of water.

Water from the high level tank falls by gravity into a small deposit from a considerable height, it causes that the piston of the large tank moves upwards; thus, the water from this tank is driven to the elevated tank through a system of automatic and check valves. Subsequently, the small tank is emptied by an automatic valve, so that the piston from the large tank moves downward causing a vacuum that can suck up water from the reservoir bottom to the large tank, repeating the cycle all over again. To achieve maximum efficiency of the equipment, the system is found in duplicate in the

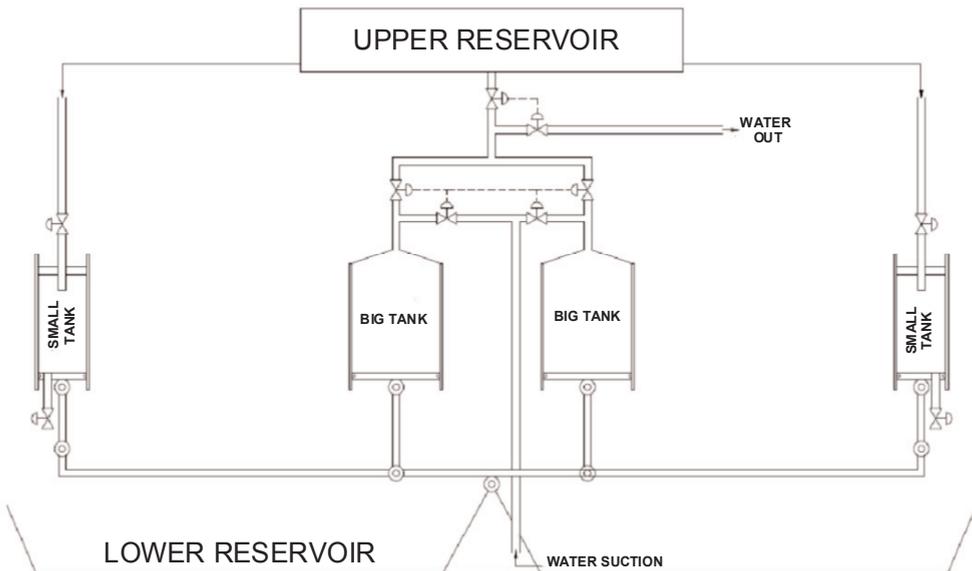


Figure 4 Simplified schematic of the pumping system.

same beam, so that while a system is loaded, the other is pumping water.

Preliminary results

Really good results are achieved in this first test. The height test is done with 10 meters so we get a weight of 176 kg of the beam, for the movement only 90 – 100 kg are necessary. Part of hose in which the water was thrown is 3 meters with what it was returned to the lower deposit, water pump, 53 litres of water. In each cycle pumping 93 litres of water; therefore there was an efficient pumping of 40 litres in every movement. The number of cycles per hour was achieved in approximately 300, giving us for this first test a total volume of 28 m³.

Conclusions

The use of this type of water lifting system with two parallel pumping systems represents a virtually inexhaustible natural source. Besides, it has several additional advantages:

- It does not produce greenhouse gases or other emissions.
- No electricity consumption for pumping as water is loaded by vacuum and unloaded by pressure
- The duplicate of the system allows no downtime between loads and water discharges.

The test shows that the system works and that despite the poor conditions that have been made, so the performance has been very low in comparison to what can be done, once we have enough height available for tests, and/or a telescopic hose – pipe, with small heights the system is also effective. This telescoping or bellows system to unload the section at the end of the pipe could not be achieved so it should be developed for this application.

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