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RATIONALIZATION OF ENERGY CONSUMPTION IN MINERO PERU'S CAJAMARQUILLA ZINC REFINERY

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Abstract

This paper's purpose is to present the main aspects of energy consumption in the Zinc Refinery of MINERO PERU S.A., where electricity is a major imput, accounting for 69% of production costs (cost no including depreciation, interest nor the value of concentrates). The oil products consumed account for no more than 2.5% of total costs.

A brief account of the processes used is given, in order to explain the main step taken in energy conservation. Despite the modern technology of the -- plant, which leaves little room for savings, those still possible have been made. In addition, the plant is being operated so as to have as small possible an impact on Lima's peak electric load.

RATIONALIZATION OF ENERGY CONSUMPTION IN MINERO PERU'S CAJAMARQUILLA ZINC REFINERY.

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Introduction.

The zinc refinery is located 29 km NE of Lima at an altitude of - 450 metres above sea level, in the District of Lurigancho, Department of Lima.
The plant started up in March, 1981; having been taken over by - MINERO PERU from the contractor on August 10, after the plant's - capacity and product quality had been thoroughly checked, according to contract. Since this last date, the Refinery has been operated exclusi_ vely by MINERO PERU S.A. Staff.

The plant processes a yearly total of 220,000 tons of 52% zinc concentrates, which originate in the Central Sierra of Perú. As a result of processing, 100,000 tons of refined zinc are obtained per year , along with the following sub-products : 160,000 tons of sulphuric acid, - 330 tons of refined cadmium, 1,200 tons of copper residues and ,- 12,000 tons of lead-silver residues.

1. Metallurgical Process.

This process consists of the following three main stages :

- Roasting and Sulphuric Acid.

The zinc concentrates that arrive are roasted at 930° C in the presence of air but without external heat being supplied, since the transformation of sulphides into oxides generates heat which is used for steam raising, and afterwards, for electricity generation and process heating.

The roasted products are :

Calcine : Mainly zinc oxide and the oxides of various other metals contained as ore impurities.

Gases : Mainly sulphur dioxide, but also oxigen and nitrogen, is purified, dried and then used in sulphuric acid manufacture. The residual gases are then released by a chimney whose discharge point reaches 690 metres above sea level.

Steam : Between 26 and 30 tons/hour of 40 atmosphere - steam are produced for the generation of 2,200 - kW in a turbine-alternator. The steam leaving - the turbine has a pressure of 4 atm. and is used for process heating.

- Leaching and Purification

The leaching is carried out by applying 95°C steam, to the calcine: continuously and in several stages, with the object of dissolving the largest possible amount of zinc.

During this process, lead and silver is separated from the - zinc and iron is eliminated in the form of Jarosite in a diffe - rent residue..

The zinc sulphate solution is purified by adding zinc powder. The Cu, Cd. Ni, Co and other impurities are thereby eliminated.

- Electrodeposition and smelting.

The pure zinc sulphate solution is used as the electrolyte. Upon de passage of electricity, the zinc is deposited on the cathodes and sulphuric acid is recovered, to be reused in the leaching process. The zinc sheets are then smelted in an electric furnace and cast in either of three commercial-shapes, according to demand.

2. Energy System of the Zinc Refinery.

The main energy forms used are :

a) electricity of hydro origin
b) electricity, steam generated
c) electricity, using diesel oil N° 2 as fuel.

a) Hydro-Electricity.

The plant's electric system is fed by ELECTROLIMA and has an installed capacity of 81 MVA, i.e. three monophase 27 MVA and 220/30 kV transformers.

The distribution system is at 30 kV and is connected to four - transformer-rectifiers of 12.5 MW power, whith the electrolysis system at a maximum of 446 V (DC) and 56,000 amp., - where two units operate in parallel. Current is also fed at this voltage to an induction furnace with a power of 2.5 MW - and also to two 12.5 MVA, 30/4.16 kV, transformers. Current at 4.16 kV is then fed into 15 motors of different powers, as well as into 4.16/0.44 kV transformers for feeding of smaller motors. The lighting system is at 220 V and controls at 110 V.

The maximum power made available by ELECTROLIMA is 60,000 kW and the monthly average consumption is 35'000,000 kWh, 15'000,000 kVARh, with a power factor of 0.91.

The Refinery has the capacity to work with a stable load during the full 24 hours or varying according to peak power limits. Thus, the load factor is high at 0.89.

b) Steam-Generated Electricity.

During normal roasting plant operation, the waste heat of the furnace gases is recovered in LAMONT WH boilers for the production of super-heated steam. These are watertubes - with a nominal capacity of 30 ton/h steam at 40 bar pressure and 350°C.
With this steam, electricity is generated in an ACEC turbogenerator with a power of 2170 KW, and exit voltage of 4,160 V which is synchronized with the grid.

In addition, two emergency boilers of the following characteristics are available.

Directly Fired Boilers.

Manufacturer	:	Menaeyer-Willebruck
Fuel	:	Diesel Oil N° 2
Type	:	Watertube
Fuel Control	:	Automatic
Capacity	:	33 Ton/h and 13 Ton/h
Pressure	:	10 bar, 10 bar
Flue gases	:	250° C, 270° C

c) Diesel-Generated Electricity.

During grid blackouts, the diesel engine and generator switchs on automatically. This equipment has the following characteristics :

Manufacturer	:	Cockerill/ACEC
Power	:	3121 KVA
Power Factor	:	0.8
Fuel	:	Diesel Oil N° 2
Voltage	:	4,160 V

3. Specific Energy Consumption : 1982

Production of zinc bars	92,147 MT
Energy consumption :	
Electricity	354,697.6 MWh
Diesel Oil N° 2	2,343.4 TEP
LPG (0.25 gal/MT fine Zn)	48.7 TEP
TOTAL FUEL	2,392.1 TEP

(1 TEP = 10^7 kcal)

Specific Consumption of Electricity

SEC_{el} = 3,849 kWh/MT fine zinc.

Fuels.

SEC_{th} = 260 kcal/kg fine zinc.

4. Electricity Rationalization.

During the plant's firs year of operation the aim has been to take the best advantage of the established electricity tariff, the structure of which was 70% for active energy, 17% for reactive energy and 13% for maximum demand. Given these rates, the plant's consumption was programmed to be as uniform as possible during the full 24 hours. The reduction of reactive energy was planned and this is now under way.

In 1982 negotiations regarding a new tariff with ELECTROLIMA were started with the following results, as of May of that year : It was seen that Cajamarquilla's consumption could follow the load curve of ELECTROLIMA, where the peak occurrs between 18:00 and 22:00 hours. It was therefore proposed that the Refinery operate at 40,000 kW during this period and also eliminate the reactive energy by Jan. 1st., 1984, in exchange for no extra charges being made during peak hours, a proposal that was accepted by ELECTROLIMA. The Refinery thus took steps to maximize profitability by the best possible use of electricity supply.

The yearly established tariff ended on April 30, 1983, for which reason MINERO PERU has expressed its points of view to the pertinent authorities with regards to lowering power demand to 20,000 kW during peak hours, on condition that the lower revenue obtained

would be compensated by an at least 10% reduction in the effective - rate.

The application of the tariff just expired has meant a lower bill, with respect to the original tariff, of US $ 7 million per year, in spite - of the fact that the former was fixed in US $ and not in soles, as is the case for all other consumers.

Tariff System.

Under the agreement with ELECTROLIMA, the new tariff is a follows:

a) Dry period.

Comprising the 7 months between May and November.

b) Wet period.

Comprising the 5 months running from December to April.

In each season, active energy is differentiated into two daily periods:

- Peak. Between 18:00 and 22:00 hours, during which the Refinery may demand up to 40,000 kW by paying the highst tariff. Peak energy consumption is about 5'000,000 kWh/month.

- Base and Shoulder. Comprising the hours 22:00 to 18:00, during which the Refinery may demand the full 60,000 kW.

The peak tariff (active energy) is about double the base and shoulder - rates.

Regarding reactive energy, a transitional tariff was approved, subject to the elimination of this energy during the current year. A low rate would be charged for reactive energy with a power factor of 0.98 and a much higher rate for lower factors.

Reactive energy will be eliminated by October of this year by the installation of a 25 MVAR bank of condensers and a synchronous, 2 MVAR, - motor.

A study on the efficiency of the plant's electric system is under way, which includes the operation of the motors at full load, using the transformers at maximum capacity and continuously checking the system's insulation.

Maximum demand is computed on the basis of peak load. The tariff is re-calculated monthly, according to the current US $/sol exchange - rate. The average annual cost per kWh (including 25% tax) is 3.6 US¢.

5. Rationalization of Oil Consumption.

The contractor that built the Refinery was also charged with start up, delivering the Plant to MINERO PERU in fully operational conditions, where zinc recovery reaches 94 %. However, for this, additional steam to that raised by the waste best boilers was required-some 6 t/h - made possible by a 50 % capacity use of the Willebruck boiler, which entailed the use of some 60,000 gal/month.

Various tests were carried out with the view of saving oil and the conclusion was that the lower recovery of zinc by eliminating the additional steam would be less than 1 %, and this would lead to a bonus - side-effect of reducing silica dissolution, always a problem in zinc recovery.
Hence, the following adjustments have been made :

a) Uniform operation of the roasting plant by maintaining a minimum ratio of 2.3 between concentrates and zinc bars.

b) No use of extra steam, not even during roasting plant outage of less than 8 hours.

It has been found that the lower recovery of zinc in the leaching has affected total recovery by less than 0.5 % or a monthly loss of US$ 13,000. However, the fuel saving are larger, at US$ 48,000 per - month.