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ENERGY CONSERVATION IN INDUSTRY
(CASE STUDY)
REVAMPING THE PUSHER-TYPE REHEATING FURNACE OF THE STEEL ROLLING MILL*

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* The views expressed in this paper are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO. This document has not been edited.

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I. ENERGY AND ENERGY SAVING BACKGROUND:

Industry in general is a heavy energy consumer. In Egypt, the industrial sector consumes about 60% of the country's electric energy production and about 30% of the oil consumed nationally. The high increase in energy consumption in the country as a whole and the inefficient utilization of energy lead to increased energy demands.

It is logical that through the implementation of industrial energy conservation measures, a considerable improvement in energy consumption can be achieved. Some actions that have already been taken are:

-- Since the oil crisis, the Ministries of Petroleum, Electricity and Industry, as well as national scientific and technical organizations, have begun to provide awareness of the benefits of energy conservation.

-- As a result, the Ministry of Industry has paid considerable attention to the measures to be followed in the industrial sector to improve energy uses.

-- Moreover, intensive contacts have been made with international organizations for technical cooperation to support the industrial sector in taking energy conservation measures.

II. COMPANY BACKGROUND:

-- E.C.W. is considered to be one of the leading metallurgical companies in Egypt as it was established in I935,and is still playing an important role in production after 54 Years.

-- E.C.W. can be considered to be a big complex as it comprises more than 24 different factories (Fig. 5).

-- E.C.W. works in the field of copper,steel,and aluminium as well as industrial gases and dolomite.

-- This wide variety creates intensive efforts for top management, but it gives the advantage of balancing and a wide range of experience.

-- As a result of the above potentials we can find many different technologies which vary between high energy consumers and reduced energy ones.

-- As a matter of fact,the company can be considered to be a relatively big consumer of energy.

The data tabulated in Fig. I below shows the company's consumption of different energy sources during I987 and I988.

(FIG. I)

E.C.W. ENERGY CONSUMPTION I987-I988

Electric power K.W.H.	Mazout (ton)	Solar (ton)	Coke-Coal (ton)
72×10^6	20×10^3	15×10^3	500

III. COMPANY TARGET AND PLAN FOR ENERGY SAVINGS:-

The company has decided that part of its corporate obligation is to participate in the fulfillment of the national target for energy savings.

To contribute to this national target,and to cutdown the energy cost of its products,the company adopted a five year plan for energy conservation(87/88-91/92), with a realistic target for energy savings of 15-20% from the existing consumption rates.

A) Completed projects.

In this field the company has executed the following projects:

-- The I st project entitled"Oxygen Lancing and Oxygen enrichment in steel melting furnaces"

-- The 2nd project,entitled " Revamping the Pusher-Type reheating furnace of the steel rolling mill " is the emphasis of this case study.

B) Projects under consideration:

The projects now being considered by the company are:

-- The Ist project entitled " Power Factor Improvement" This project is under consideration with UNDP and TIMS .

-- The 2nd project entitled " Energy Diagnosis Laboratory and energy Bus" This bus would serve the company and other industries in Alexandria area.

N.B: Alexandria covers about 40% of the total industry in Egypt.

This project is under consideration with TIMS and the corresponding foreign organizations.

-- The 3rd project entitled " Energy savings in open Hearth 50 and 30 Ton furnaces " is under consideration with USAID and the energy conservation and Efficiency project(ECEP) through TIMS .

-- The 4th project entitled " Technical and Feasibility studies for energy savings and Waste-Heat Recovery in Five Non-Ferrous Plants " This project is under consideration by the organization for energy planning (OEP) and its coordinating foreign organizations.

IV. EGYPTIAN COPPER WORKS-CASE STUDY

" REVAMPING THE PUSHER-TYPE REHEATING FURNACE OF THE STEEL ROLLING MILL "

--From the results of energy audits and studies carried out in industrial companies, a considerable potential for energy savings was recorded that could be achieved with low capital investment.UNIDO agreed to assist in the implementation of such projects on a cost sharing basis leading to substantial energy savings.So,UNDP/UNIDO supported a project entitled" Energy conservation in Metallurgical, Glass and other industries" through EL-Tabbin Institute (TIMS).

Our case study was the first project executed successfully with the UNDP support.

A) PROJECT NUMBER: EGY/85/002

" Energy conservation in metallurgical,glass and other industries "

B) PROJECT PARTICIPANTS:

1. UNDP/ UNIDO
2. Tabbin Institute for Metallurgical Studies (TIMS)
3. AF-Energikonsult (Sweden)
4. Egyptian Copper Works (E.C.W.)

C) OBJECT OF DEVELOPMENT:

A continuous pusher-type reheating furnace is used in the Egyptian Copper Works(E.C.W.) for reheating steel billets before rolling (FIG. 3)

The furnace was originally designed and installed by OFU Company (West Germany) for I2 t/hr capacity.In I952,it was constructed with the following features to match with the rolling mill facilities:

--One side heating for two rows charging system.

--Front charging and side discharging doors;

--Inclined hearth;

--Three thermal zones;preheating, heating and soaking;

--Eight burners;four of them in the heating zone and four in the soaking zone.

--The furnace is fired with heavy oil(mazout)using low pressure atomizers(burners) due to obsolete design.

The furnace was subjected to a detailed energy audit using the " Energy Bus " which belongs to TIES.

The audit included all the items of heat loss from the furnace, in particular,of heat loss from waste gasses,heat loss from the lining,heat loss due to infiltration and heat loss by radiation from the furnace openings.

The results of the study showed a high rate of fuel consumption which was estimated at 67Lit./ton of heated billets.
Comparing this figure with the international records for the heating of steel billets in similar furnaces,a conservative target of 30-35% possible savings was established.This would result in a 2500 tones annual saving of mazout.

The analysis showed that the major part of these losses is due to; inefficient utilization of the heat in waste gases; inadequate burning conditions;lack of automatic control of the

furnace temperature, pressure and air-to-fuel ratio; and the inefficient insulating conditions of the furnace lining.

D) PROBLEM APPROACH (DIAGNOSIS):

The following plan was recommended to achieve the desired target, taking into consideration that the greatest energy conservation results could be achieved if all the possible loss prevention actions were taken:

I. Maximizing the amount of air recuperation from 100°C up to 350°C. This required redesign of the combustion air recuperation, taking into consideration the restriction of the existing layout of the available furnace area.

2. Improving the combustion efficiency through:
   --Increasing the combustion air pressure from 250 mm w.c to 1300 mm w.c.
   --Increasing the pressure(3 kgm/cm^2) and temperature (90°C) of mazout before combustion.
   --Adjustment of air-to-fuel ratio to the minimum allowable value;
   --Efficient mixing of mazout with atomization air.

3. Controlling the furnace pressure to prevent air infiltration.

4. Increasing the efficiency of heat transfer from the flame to the chamber by convection and radiation.

5. Improving the efficiency of thermal insulation in particular:

—Thermal insulation of the furnace lining

—Thermal insulation of hot air piping;and

—Thermal insulation of mazout lines

6. Introducing an advanced automatic control system,in particular:

—Furnace temperature control in heating and soaking zones

—Air-to-fuel ratio control in heating and soaking zones

7. Optimizing the temperature and thermal balance of the furnace relative to the rolling demands.

E) FURNACE REVAMPING :

The furnace was subjected to an intensive modification in order to realize the planned savings.The following main equipment items were introduced to the existing construction through a specialized Swedish firm named " AF-Energikonsult "

I. Recuperator(heat exchanger) for preheating combustion air up to 350 °C. This is made of a special thermal resistance steel and provided with the necessary expansion joints and suspended supports.

2. Two powerful combustion air fans (one of them as standby) to deliver air with a maximum pressure of I800 mm w.c. and flow rate of I0,000 NM^3/ Hr

3. Eight advanced convection flam burners with a total capacity of 800 Lit/hr in heating zone)

The burners have the following advantages over the old ones:

--The burners operate with the minimum possible excess air (n = I.05 - I.IO)

--Low pressure air line for fuel atomization, so that the pressure of combustion air is the same as the atomozing air;

--The convective flame gives rise to the overall coefficient of heat transfer inside the furnace chamber.

4. Automatic control system and measuring instruments, including the following items:

--Air-to-fuel ratio control systems in heating and soaking zones

--Temperature control systems in heating and soaking zones

--Furnace pressure indicator

--Temperature and air-to-fuel ratio recorders

--Mazout flow rate indicators in soaking and heating zones

--Temperature controller for mazout heaters

--Pressure and temperature indicators on mazout lines

5. Ceramic fiber tiles were used for lining the inner surface of the heating and soaking zones.
Also ceramic fusion cast blocks were used to skid the discharged billets, in order to eliminate the necessity for water cooling of the existing cast iron blocks.

6. Thermal insulation for preheated air and mazout lines.

7. Modifying piping systems of the furnace(air gasses and mazout) to fulfill the planned target.(FIG. 4)

F) PROJECT PERFORMANCE :

Furnace performance data were recorded before and after revamping. The annual savings were expected to be 2000 to 2500 tones of mazout/year at I2 t/h productivity rate. But,as a result of combustion efficiency improvements, convective flame action,and increase of the heating zone temperature,the energy savings exceeded the planned target.

Figure 2 gives a summary of the furnace data and the fuel savings after revamping(compared with the fuel consumption before revamping) as approved by the E.C.W., supplier and TIMS representatives during the performance test which was carried out over 3 days (from I to 3 Nov.,I988)

FURNACE DATA BEFORE AND AFTER REVAMPING
(PERFORMANCE AVERAGE DATA) (FIG.2)

ITEM	CALC. PURN. CAPAC. TN / YR	AVG. PROD. RATE TN/HR	AVG. FLOW USE LT/HR	SPEC. OIL LT/HR	OIL SAVING LT/TN	OIL SAVING TN/YR
BEFORE	84,000	I2	800	66.6	--	--
AFTER	84,000	I2	420	35	3I.6	2440
	98,000	I4	462	33	33.6	3030
	II2,000	I6	5I2	32	34.6	3560
	I26,000	I8	540	30	36.6	4240
	I40,000	20	620	3I	35.6	4580

N.B: The performance test for the average furnace production in t/h was carried out separately from the tests of the capacity and capability of the rolling facilities.

G) PROJECT RESULTS AND EVALUATION :-

I. Basis of evaluation:

— The approved project documents

— The approved TIMS energy audit and technical report for energy performance and the pre-estimated savings.

— The UNDP consultants' technical report.

— The approved furnace performance evaluation after revamping.

2. Project planned objective:

— To reduce fuel consumption from 800 Lit./hr. to 500 Lit./hr of mazout(a savings of about 300 Lit./hr ≈ 2100 - 2500 T/year).

3. Project results and evaluation:

— Oil savings of 500 Lit./hr mazout with annual savings of about 3500 t.o.e. on average(e.g. about 50% savings)

— Increased furnace efficiency (output)

— Reduced repair time

— Homogeneous billet temperature resulting in a smooth rolling process and better quality.

— Considerable increase in rolling production within the rolling mill capacity.

N.B: project was put in to operation on 3/II/88

H) PROJECT INVESTMENT AND PAYBACK PERIOD :

1. Project investments:

360,000 U.S.Dollars

100,000 Egyptian pounds (company contribution)

2. Company cost share

The project was executed on the bases that the company share as follows:-

- 50% of the cost of imported equipment (in local currency)-to beused with other resorces as arevolving fond
- 100% of the local component of the project (as company contribution)

3. Payback period

From oil saving point of evaluation:

- According to local oil prices,the payback period of the project will be about 10 yeers.
  (Local mazout price for public sector about 30 L.E/ton)
- According to international oil prices,the payback period of the project will be one year.
  (internatonal oil prices is about 100 dollar/ton)

Finally our company hopes that it is on the right track in the field of energy conservation.

And ,I hope as well that I have transferred to you a brief review of,how we are thinking,what we are doing and the results of our efforts.