Energy Management Options in a Fertilizer Manufacturing Plant

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Abstract – **This study highlights energy savings that could be realized in a fertilizer plant through application of various energy management options to reduce energy expenditure through efficient use of available energy resources. Energy audits were done as reference point for monitoring progress of measures put in place. It also revealed many opportunities for savings in coal usage, steam utilization and correction of electrical power factor. At the same time preserving the environment, by reducing emission of greenhouse gases which pollute the atmosphere.**

I. INTRODUCTION

Lack of proper use of energy conservation measures is taking its toll on the industry. Such measures have to be taken without damaging the environment. The commonly used power plant fuels – coal and oil – produce large quantities of dangerous corrosive chemicals into the air. Energy efficiency initiatives include - facility energy audits and reviews for energy savings opportunities. Other operational measures that can be adopted for energy savings can be in form of thermal insulation and heat re-direction to reduce overall system energy requirements. While smoothing load factors and selecting optimal tariffs can result in substantially lower energy bills. The country is facing an energy deficit and the industrial activity is negatively affected.

Fertilizer manufacturing plants are among the largest energy users in Zimbabwe since they operate throughout the year and twenty four hours a day. The major sections are the sulphur melting operations, crushing of iron pyrites plant, water filtration plants, water pumping stations and office buildings. The implementation of coordinated Energy Management Program is a response to the increasing of electric tariffs and need to achieve business efficiency, including the reduction of operating costs.

II. ENERGY MANAGEMENT OVERVIEW

Energy management options seek to conserve material resources as well as to the supply conversion and utilization of energy expended in resource exploration, extraction, transportation, conversion of product, manufacture, advertising and marketing, distribution retailing. Energy utilization could be alleviated substantially by energy conscious design and planning in all sectors of production activity and support services from design right through to consumption of the product. The energy consumption by manufacturing processes depends upon the quality of the materials involved, the efficiencies of plant and equipment and the appropriateness of the environment. The savings obtained as a result of the installation of energy-conserving devices in thermal structures must be discounted by the energy costs of the materials and products introduced. Energy management seeks to account for the energy consumption at each stage in the production of a product.

III. ENERGY CONSERVATION MEASURES

To conserve energy machines, equipment and facilities should be efficient, operated by skilled personnel, and maintained in good order. Tight production schedules should be adhered to and space and time delays should be eliminated. Production sequences, factory layout and process paths should be designed to reduce overall operating times and distances traveled by materials, manpower and items in manufacture. Measures should be taken to minimize unnecessary heat losses by insulating and by redirecting waste heat for useful purposes wherever economically possible.

A. *Energy saving techniques*

Techniques include supplying demands for energy from alternative energy sources. Reduce the overall demand by reclaiming rejected energy using recuperative or regenerative heat exchangers. Incorporating thermal stores to balance load factors. Decisions on whether to modify an energy consuming system to reduce its rates of consumption. Need for committing considerable resources to model systems with a view to optimize energy allocation

B. Energy accounting and audits

It involves the systematic and regular recording of the company's total energy consumption. This information entails historical energy usage, energy audits, engineering analysis and economic analysis. Energy accounting also covers energy auditing which is a balance of the energy input and outputs which provides insight into the major areas of energy use as given by Fig1.1 below

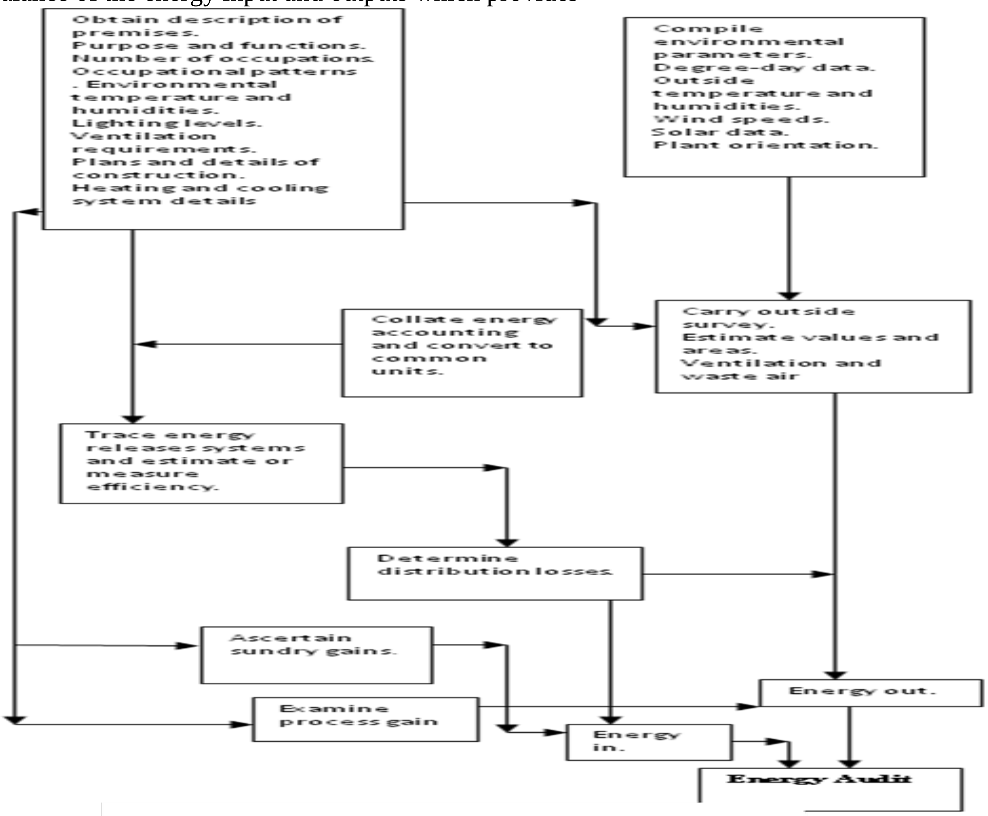

Fig. 1.Sequence of conducting energy audit [1]

The plant facility energy can be sub-metered by departmental processes to establish energy accountable centers. Required data is mostly obtained from the monthly utility bills or regular fuel invoices.

C. Energy Management Implementation

The implementation stage is the most important aspect of the entire program, since it is the central goal of any energy management effort. What is needed here is that the firm now carries out those measures, which have been identified by the Energy Manager. Maintenance and housekeeping measures should be implemented first to begin capturing energy cost savings and improving efficiency.

Staff Training and Motivation: This part is very important because the success of the total energy management program depends on the interest and cooperation of operations and maintenance personnel.

Monitoring and targeting: This involves careful checking, analysis of energy consumption and the setting of both goals and reducing energy consumption. It is a management approach that enables companies to manage energy as a controllable resource in the same way that other resources such as finance and people are managed. The importance of monitoring is to measure energy use and compare the measurements with standards derived from the firm's own operating experiences and capabilities. Targets then follows and these are set to motivate all those involved by seeking improvement in performance.

***Energy management and control*:** Automatic monitoring systems are useful with lighting, air distribution systems, chillers, boilers, heat pumps, pumping systems, compressed air systems, water heating, and other major energy-consuming equipment. Controls may be simple and inexpensive, such as simple controls, including time clocks, occupancy sensors, photocells, and programmable thermostats. Facility managers should consider automatic controls and sensing technology when equipment can be turned on, shut off, or modulated based on schedules, temperatures, pressures, light levels, or the presence of occupants.

The following are common controls available to help reduce energy consumption:

- *Time clocks* are electrical or electromechanical devices that can turn equipment on and off according to a schedule. Small loads can be switched directly and large loads can be controlled indirectly through the use of relays.

- *Occupancy sensors* detect the presence of people by sensing heat (infrared), motion (ultrasonic), or sound. Some systems directly control small lighting loads at line voltage and directly replace wall switches.
- *Programmable electronic thermostats* allow facility managers to reset heating and cooling set points for different operating modes. Daytime, nighttime, and weekends typically have different target temperatures in order to allow the building temperature to drift appropriately when unoccupied.
- *Spring-wound timers* are simple devices that automatically turn off loads after a predetermined number of minutes or hours. They can be used to control bathroom exhaust fans allowing them to remove moist air after showering, and preventing continuous operation.
- *Photocells* are devices that open and close switches in response to light levels. Some photocells are not very sensitive to low light at dusk and dawn.
- *Steam meter* is the first plant tool in good steam housekeeping. It provides the knowledge of steam usage and cost which is vital to an efficient operated plant. Steam is the most widely used heat-carrying medium. It is used in the processes that requires heat. It is used to melt sulphur in the granulation section, to maintain temperature at roasting stage, to dry sulphur dioxide (SO_2). A reduction in steam leakage will reduce water loss, boiler chemical usage and most importantly energy consumption.

D. Electrical management

Electrical motors, lighting and heating loads are the main consumers of electrical energy. Active and reactive energy supplied depends on the number and size of loads. Power factor correction capacitors should be matched with and located as close as physically possible to the inductive equipment e.g. connected to the terminals of motor etc. this would minimize plant distribution losses caused by transmission of the reactive current between the equipment and the capacitors. Capacitor banks with changes with load and automatically switches the required capacitors in and out of service to maintain the power factor level within prescribed limits. Demand management is an exercise to averaging out the plant demand profile curve as much as possible. Shifting loads and or shedding non-essential loads does this. Demand management may be dictated by the need to maintain production. Decision by the management may be that the cost benefits resulting from demand control adequately compensate for production disruptions.

E. Waste heat sources

Combustion flue gas is the most common source of heat waste since most plants have some boilers, furnaces or direct-fire dryers and kilns. Waste heat steam is discharged in a steady stream of heated air or water. Such waste streams are not suitable for re-use in the process either because of contamination or it dries the moisture in the air. It is very possible to recover heat energy from these waste streams through a heat exchanger before they are vented or sent to the drain.

IV. FERTILIZER COMPANY OPERATION OVERVIEW

The study was done at Fertilizer Company which is located in Harare. The company is one of the producer of Sulphuric acid in the country. The production of sulphuric acid is a continuous process. That is the production of the acid is done for 24 hours per day. The stoppages are planned that is only on shutdowns for major maintenance and breakdowns.

Production is measured by the amount of blown air, which blows the pyrites into the roaster. The main products are sulphuric acid and phosphate acid.

A. Material flow

An overview of the flow of material through the pyrites burning plant is shown in Fig 1.2

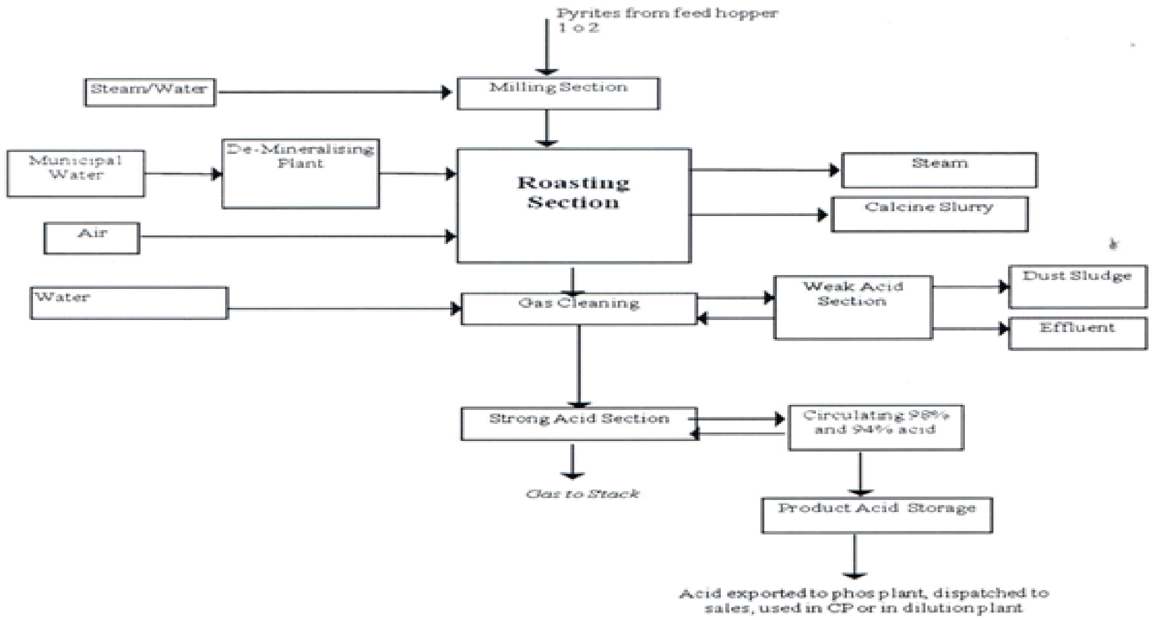

Fig. 2. Material flow through the plant

The plant produces 98-100% sulphuric acid (H_2SO_4) by producing sulphur dioxide (SO_2) from the burning of pyrites in a fluidized roaster. The dust ladened gas exit the roaster is drawn through the gas cleaning section prior to entry into the strong acid section where sulphuric acid is produced by the conventional contact process.

Heat is recovered at the pyrites roaster by raising 32 bar steam at a rate of 8 tonnes per hour. This steam is generated in a steam drum with heat from the roaster cooling coils. However further opportunities of heat recovery, exit the roaster, are not utilized in cooling the SO_2 gas prior to entry into the gas cleaning section. Within the strong acid section, the reaction heat from the converter is used to pre-heat the incoming gases. Any excess heat from the converter is then dissipated to the atmosphere through a trombone cooler preceding the absorption tower. Further heat removal from the circulating and product acid is achieved by water-cooling

The overall reaction in the roaster is shown in equation (1) below, whilst, equations (2) and (3) apply to the strong acid section.

$$2FeS_2 + 5.5O_2 = Fe_2O_3 + 4SO_2 \quad \Delta H = -1660\ kJ \quad (1)$$

$$SO_2 + 0.5O_2 = SO_3 \quad \Delta H = -99.0\ kJ \quad (2)$$

$$SO_3 + H_2O = H_2SO_4 \quad \Delta H = 132.5\ kJ \quad (3)$$

The main environmental concerns associated with the plant, are the discharge of unconverted SO_2 via the stack, disposal of burnt pyrites (calcine or cinder), disposal of acidic effluent from the gas cleaning section and the discharge of acid mist via the stack. Other significant impacts include the aeration of dust from the handling of pyrites and calcine as well as fugitive emissions of SO_2.

B. Milling section

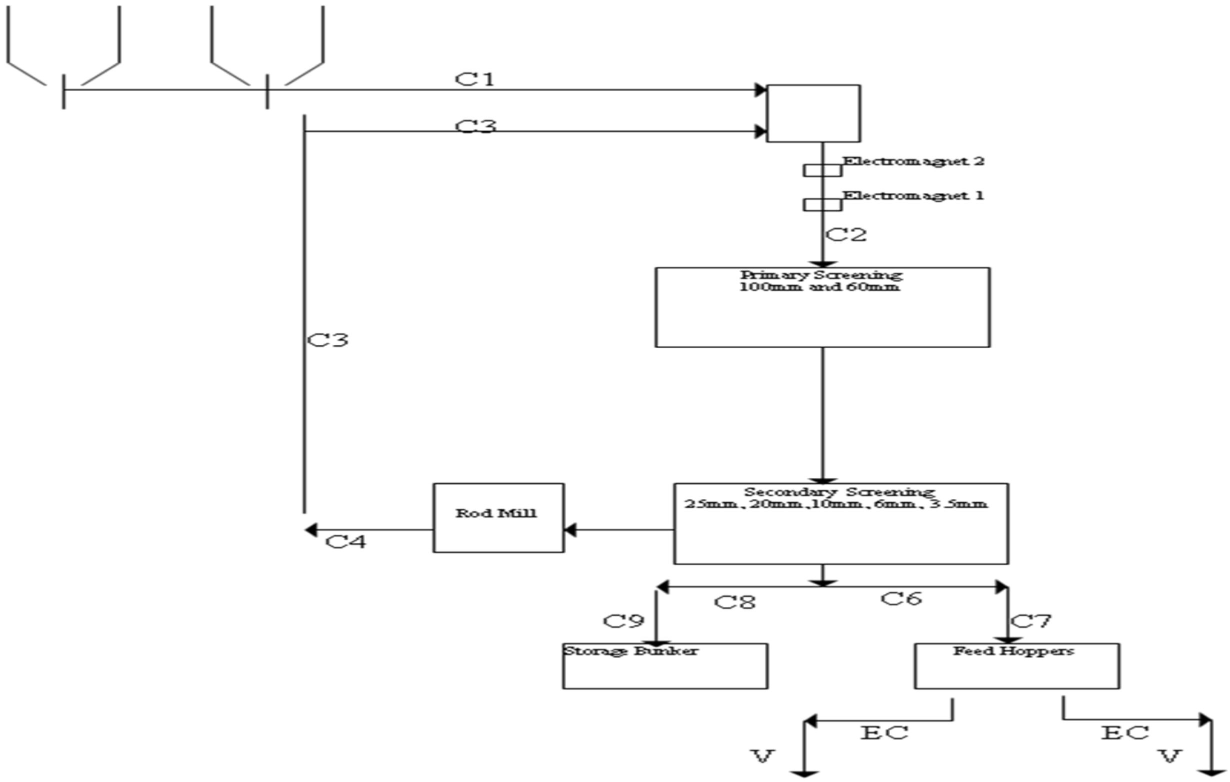

Fig.3. Milling section

Pyrites is received in rail wagons from the mine and off loaded into hoppers which feed conveyor as shown in Fig 3. The pyrites are then crushed before storage in either the roaster feed hoppers or in the pyrites storage bunkers.

The larger particles are re-circulated on the conveyor system via the rod mill and the jaw crusher depending on their size. When the feed hoppers are full, the crushed pyrites are stored in storage bunker from where they are loaded into the milling hopper before going through both the primary and secondary screens and onto the storage hoppers.

C. The Roaster section

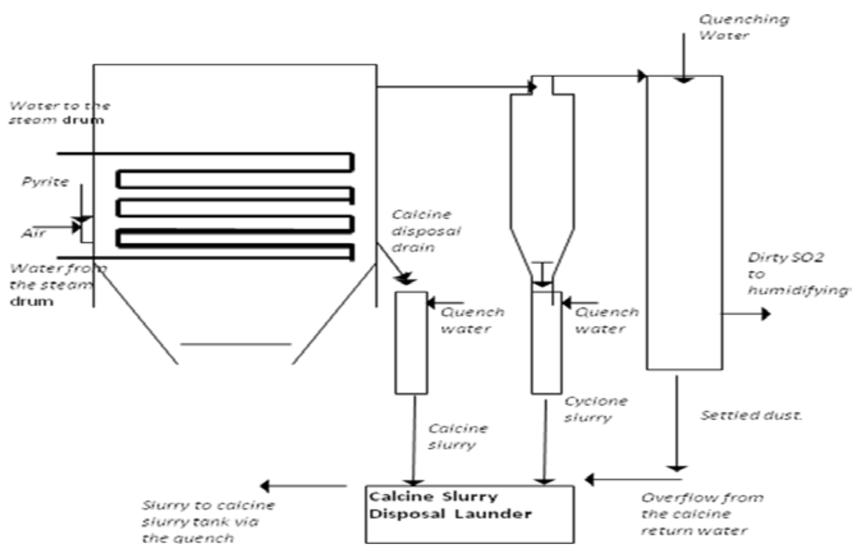

Fig.4. Roasting section

The roaster section is shown in Fig 4. It consists of the roaster, gas cyclones and the quenching tower. In the roaster, pyrites is burnt in a fluidized bed roaster to

produce SO_2 gas and cinder (calcine) which is consists mainly of iron (II).
Pyrites is fed into the roaster from the roaster feed hoppers by extractor conveyors which discharge onto the vibrator conveyors that in turn discharge into chutes above the Garr Gun. With the aid of air, flowing into the Garr Gun, the pyrites is fired into the roaster. The burnt pyrites is removed from the lower section of the bed via the manually operated calcine disposal drains.

D. Steam generation system

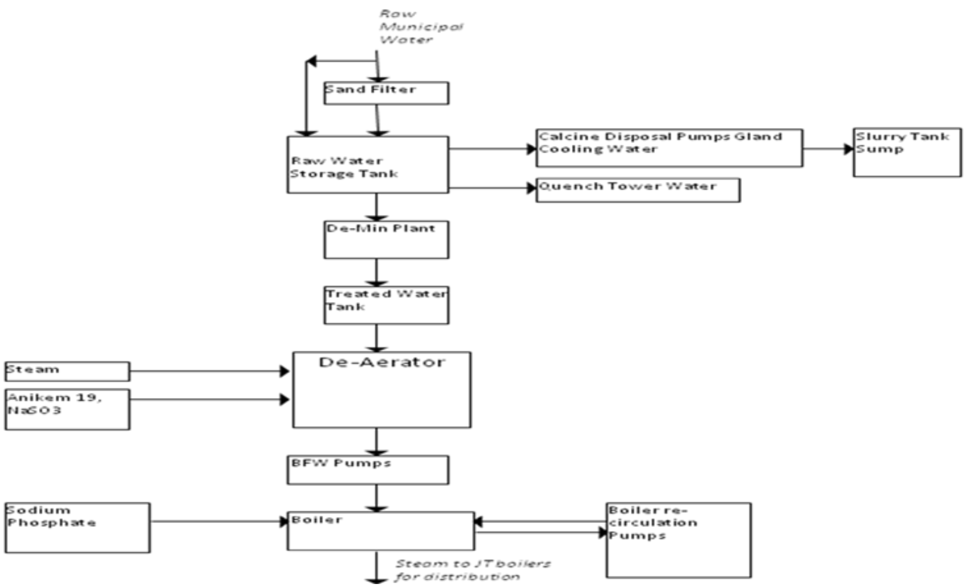

Fig. 5. An over view of the steam raising system

Municipal water from the mains is passed through a sand filter before it is stored in the raw water tank. Water is then pumped to the disposal pumps for gland cooling and to the quench tower by the booster pumps and to the de-min plant by the de-min pumps. The de-mineralized water is stored in the treated water tank from where it is pumped into de-aerator and onto the boilers by the boiler feed water pumps. Water in the boiler is gravity feed into the roaster cooling tubes where it is heated and lifted up into the steam drum where it gives up its heat to raise steam. The bulk of the treated water is used for steam raising in the roaster section.

E. The strong acid section

After the mist precipitators the SO_2 gas is dried in the drying tower by circulating 94-96 % acid. The dried gas is then passed through the KKK blower before enters the shell side of the heat exchanger network where it is used to cool the product gas between converter passes. After the converter section (i.e. converter and heat exchanger) circulating 98% acid that is diluted with water to maintain the acid concentration at 98% absorbs the SO_3. Product acid is bled from the circulating acid in the acid cooling section.

F. Air blowers

The feed air for the burner and for the whole system is provided by blowers. These centrifugal blowers supply the necessary pressure to drive the gases through the system. Air is drawn in from the ambient through dust filters located above the blower houses. The filtered air is then compressed to pressures ranging from 50-88 inches water gauge depending on the air flow rate. The compressed air is then passed through a drying tower, where the air is dried by 94-96% circulating acid (H_2SO_4). Opening the blending valves on the two tanks (i.e. 94% and 98% acid circulation tanks) tests every 2 hrs, the acid strength in the circulation tank. The bulk of the dried air is introduced to the burner, whilst a small proportion is used as dilute air to control the inter pass temperatures in the converter.

G. The boiler system

Treated municipal water is used for the waste heat boilers. Municipal water from the main line, is initially sand filtered then softened in the water softening plant. It is temporally stored in the cold water storage tank (where it is actually preheated by returned plant condensate) before being pumped into the aerator and into the header tank.
Steam is raised in the waste heat boiler at the end of the burner, where the combustion gases are cooled to

about 380-390ºC. Part of the steam raised is used in the melting section whilst part of it is exported to the boiler house for distribution to other parts of the factory e.g. fertilizer unit..

V. ENERGY OPTIONS AND EVALUTION

A. Coal use

Use of coal is on the increase despite the introduction of other sources of fuel and new technology. Solar energy is one of the recently introduced source of energy. The use of coal is likely to escalate even in light of the foregoing factors owing primarily to its relatively secure availability both on a short term and long term basis and its lower cost. Coal use is associated with the following negative factors:

- Environmental limitations that necessitate the insulation of expensive equipment to control particles such as sulphur dioxide and NO_x.
- Space requirements for equipment and coal storage.
- Higher capital investments for pollution abatement coal receiving equipment, coal preparation, ash handing.
- Higher maintenance costs associated with the installation of more equipment.
- Increasing transportation costs.

At Fertilizer Company coal is used to fire boilers to generate steam requirements. From a fundamental analysis of combustion on the stoker there are free coal characteristics that affect performance.

- The rate at which coal is ignited.
- The particle size distribution that dictates the resistance to air flow through the fuel bed. The ash fusion temperature. Low ash fusion temperature coals cannot be burnt at high combustion intensities without slag formation on the grate.

B. Steam consumption

The steam produced are from sulphur plant and boilers. The generated steam is supplied to different sections of the factory and allocation demanded by each section per hour is given by Table I below.

TABLE I. STEAM USAGE

Section	**Consumption (tonnes)/hour**
Dips&Chem	4
Laundry	7
Alum	7
Fertilizer unit	2
Conc plant	12
Sulphuric acid plant	`1

The Thermal Audit shows that the factory is losing in excess of USD500 000 annually, through poor lagging, poor operation of steam traps and steam leaks. About 12.5% of the steam traps are defective and a proper steam trap management system needs to be set-up. The chemicals section is the problem area in terms of energy losses.

The bare pipes were used to estimate the energy usage due to heat loss from un-insulated steel and copper piping.

Typical loss through defective steam traps may on average be 30% to 60% of the maximum loss calculated

TABLE II. STEAM LOSSES IN USD

Section	loss (USD)	Loss(USD)	Loss(USD)	Total
	P.Lagging	Steam Traps	Other Leaks	loss (USD)
Pyrites plant	228	6200	0	6429
Sulphur plant	0	9300	0	9300
Phos/conc	407	9300	665	10373
Alum plant	3833	9300	706	13841
Fertilizer unit	39	0	0	39
Dip&chemical	5249	15501	665	21416
Others	645	3100	0	3746
Total	**1040**	**52705**	**2036**	**65147**

Major losses of steam occur at Dips and Chemicals section.

Recommendations

- A steam trap management system is essential and must be set up.
- Respective Process Superintendents to raise job cards for repairs of steam leaks and lagging.
- Monthly energy audits should be conducted4.Redundant steam lines should be removed.
- Steam traps can be scavenged from redundant plants, refurbished and reused.
- Flanges should be lagged because they are a source of heat loss.
- Losses through steam blowing will be addressed by condensing the steam.
- Formulate a properly focused Energy Management Program.

C. Electrical energy

Electrical system transfer electrical energy from a generating source to an end user requiring it to provide light, heat or mechanical work. It is mainly used for running electrical motors.

It is impossible to specify standards for electrical consumption since great improvements is plant modernization, new and improved processes and other procedures can make initial such data sadly out of date. But the principle of “turning it off when you do not need it” can reduce kilowatt-hours per unit of product produced or service rendered. Some times it is most paying to put senses to one computerized to turn off and an electric device e.g. heater, fan and others.

Power = voltage x current

where power, voltage and current are instantaneous variants. In a resistive circuit voltage and current that is in phase results in positive or active power which is dissipated at heat.

Power factor: this is a ratio between active power and the total power supplied.

Power factor (p.f) = Active power/total power

Energy management by power factor improvement helps in saving dollars through reduction in cost for power from the supplying utility than with saving energy. Reduction of reactive currents, doing no useful work in the plant will save some dollars. Electricity contributes about 60% of the total energy costs of the plants at Fertilizer Company. The maximum demand occurs during on-peak hours. The maximum demand during off peak hours is 74% of the on-peak maximum demand and 48% of the electrical energy consumption occur the off-peak hours.

It is shown that the production and electrical demand are not proportional as can be expected. Between April and May production decreases were as electrical demand increased significantly and a reverse is also seen between May and July production increases dramatically were as electrical demand decreases.

TABLE III. ELECTRICAL CONSUMPTION

MONTH (Jan 2011 to Feb 2012)	MAX DEMAND [kVA]	POWER CONSUMED [kWH](100)	TOTAL COST USD
January	5236	25929	194162
February	4002	15514	136487
March	5223	21334	168490
April	5537	27153	240926
May	5425	28161	240125
June	5262	21148	211848
July	5641	26960	237524
August	5557	27413	235886
September	5572	28205	240498
October	5555	25135	368754
November	5666	26384	380363
December	5154	27218	359237
January	5508	26154	446044
February	5407	23111	423591
TOTAL			

As the maximum demand contributed the major part of the electricity bill the major thrust, of the cost reduction measures should be directed towards the reduction of the maximum demand and shifting it to off-peak hours. Reasons for maximum demand occurring during the on-peak hours and the on-peak occurs during the night since the lights will be on. To shift the maximum demand to off-peak hours it requires switching off all unused lights, motors, fans.

a) Power factor correction

This is defined as the ratio of power producing current in a circuit to the total current in that circuit. There are two mostly used method in power correction, which are;

- shunt-capacitors.
- synchronous motors.

At Fertilizer Company shunt capacitor is used to correct the power factor. This method is more economical than the other one. Reducing Kilovar current that also reduces total current generally does power factor.

The desire is to improve the power factor to more profitable figure. It is hard to improve the power factor close to one. If a power factor of 0.90 is used an energy saving of USD 13 526per year is got. If different values of power factors are used in the process of trying to improve the power factor.

TABLE IV. BENEFITS OF CHANGING POWER FACTOR

Power factor	**Demand reduction (KVA)**	**Cost (USD)**	**Savings (USD)**
0.87	5177.7	2940825.2	33807.2
0.89	5296.5	3008430.4	101406.4
0.86	5118	2907024	
0.90	5356.04	3042233	135208.99
0.95	5653.6	3211245.9	304221094
0.98	5832.14	3312653.7	405629.7

As can be seen from the table greater savings are achieved. This has been so because power factor correction

- Reduces power system losses.
- Improve voltage condition.
- Releases system capacity.

A system has been installed at the plant, which can be used to perform the following functions.

- Monitor the electrical energy of the plant.
- Set target values for consumption.
- Shed electricity when its about to exceed the target values.

b) Electrical motors

The electric motors account for about 80% of the electric energy consumed at Fertilizer Company. A small percentage reduction in motor energy consumption would realize significant energy and cost savings

Uses of electric motors ranges from: Drive fans, Operate pumps, Drive blower, Drive pulley, Operate kilns, Operate cranks. Electrical motors are fairly efficient devices for converting electrical energy into mechanical shaft power.

Efficiency of a motor is the ratio of its output to its input

$$Efficiency = \frac{Output}{input} = \frac{Output}{Output + Losses}$$

This ratio represents the effectiveness with which a motor converts electrical energy to mechanical energy and is a measure of the motor losses. Because of the steeply escalating costs of electric power energy efficient motors are most needed.

TABLE V. MOTOR SCHEDULING COST SAVINGS

Rating (kW)	**Calculated Demand (kVA)**	**Cost Saving (USD)**
7.5	11.4	633
11	15.8	894
30	40.15	2273
45	57.26	3242
55	71.7	4062

The above savings are only noticed when the motors are scheduled to run on off peak demand. This results in altering same of the production to the off peak.

TABLE VI. RELATIONSHIP BETWEEN STANDARD AND ENERGY EFFICIENT MOTORS

Motor rating (kW)	$E_{standard}$	$E_{Efficient}$	Increment cost (USD)	Annual Saving (USD)	Simple Payback (years)
7.5	0.82	0.87	324	201	1.6
11	0.85	0.89	412	385	1.1
30	0.87	0.91	647	255	2.5
45	0.876	0.915	867	178	4.8
55	0.88	0.92	175	203	8.6

It is economic to rewind the motors than replacing them with energy efficient and standard motors.

It is important to consider the energy efficient motors since it offers the following benefits: Lower operating cost, Lower demand changes, Lower ranch circuit losses, Improved bearing life, Lower heat generation, Improved power factor.

c) Motor rewinding

Rewinding a motor if done correctly can result in many more trouble free hours of operation. Table 1.7 compares the costs of replacing and rewinding standard motors.

TABLE VII. COST OF REPLACINGAND REWINDING MOTORS COMPARISON

Motor rating kW	Cost of replacing (uSD)	Cost of rewinding (USD)	Cost of rewinding as % of replacing
0.75	146	70	48
1.1	187	83	44
4	362	148	41
11	818	347	42
22	1596	537	34
30	2168	742	34
45	3037	1670	35
90	4073	1922	47
110	5514	2289	42

According to the company management rewinding motors usually cost as low as new motors. Motor replacement then becomes less economical.

d) Lighting

It has been found out that some lights are left working even in places were adequate natural light is available. These lights then need to switched off. A lot of energy is lost in this way. Switching off these lights in unoccupied areas and in areas where day light provides adequate lighting levels.

TABLE VIII. POTENTIAL LIGHTS ENERGY SAVINGS

Number of lights	Rates (Watts)	Cost Saved (USD)
20	400	1.6
56	80	0.931
11	40	0.091
25	65	0.338
40	200	1.672
Total		**$4.694/yr**

It has been also found out that there are redundant lights and energy saved if there are removed. The saving is calculated as below:

TABLE IX. ENERGY SAVINGS

Number of lights	Rate (watts)	Energy saved (USD)
4	400	0.733
10	200	0.917
5	65	0.149
2	40	0.037
11	80	0.403
Total		**2.239**

VI. RESEARCH RECOMMENDATIONS

Fertilizer Company spends a lot of thousands per year on energy in the form of electricity coal and gas. If all the quantified measures of the survey are implemented, the company could then reduce energy consumption by 23% and reduce energy costs.

A number of opportunities relating to electricity supply and the company's electricity demand profiles were identified.

These included:

- negotiation of a time-of-use tariff, as the company's peak demand (occurs around midday) occurs at a different time to that of Harare city (early evening),
- lumped metering to reduce demand charges as company is metered at a number of different points,
- load shifting

- intelligent load shedding of less important jobs e.g. heat pumps.
- power factor correction.

A. Renewable energy and recycling

Fertilizer Company has been recommended to initiate the following :

- increase the percentage of energy obtained from renewable sources if there is any e.g. from solar energy.
- increase recovery and reuse of energy;
- reduce its expenditure on energy;
- strive to meet best practice in energy management within the water and waste water industry.

B. Energy Management Committees

There is need for the set up Energy Management Committee to identity energy management opportunities and motivate employees to conserve energy and share ideas about possible energy saving measures. In order to broaden new ideas volunteers are selected from each department. A facilitator who can be the plant manager will help to train the volunteer members and co-ordinate the meetings. The volunteers then help to educate and motivate other workers per departmental level to conserve energy.

C. Maintenance

Condition monitoring maintenance system can be put in place to conform well with energy management as energy management is not only concerned with production but also the efficiency of the process. A defective steam trap can go for years and a cost of thousands is lost. It is for these reasons that the plant management is recommended to institute a predictive maintenance and enforce it.

D. Coal transportation

The company should eliminate the use of road transport for coal. Road transport is used when coal has to be expected, which is a sign of poor planning and co-ordination between departments. Since the company transport 25% of coal by road a saving of USD 31 681 is noticed if proper planning is done.

E. Electric motors

The survey of the electric motors shows that 30% of motors operate at less the rated load. At such low loads motors operate at a lower efficiency that then increases the recommended to evaluate motors loads and ensues proper sizing of the motors.

To avert the failures and extend life the motor needs to be adequately controlled and protected. Most of the motors found at the company are not protected.

The protection has to be located at the motor and it must comprise of overload relays, thermal overloads relay, electronic overload relays or fuses overload relay opens the motor controller when the load current becomes too high. Thermal overload relays will sense the heat and disconnect the motor when the temperature gets too high.

F. Steam management

Steam meters should be placed to try to measure steam and it should start with the main consumers. The plant must include energy efficiency as criteria for evaluating technologies and equipment. Emergency overflow line must be installed directly to the main sluit trench.

Energy saving can be achieved through repairing of damaged insulation, insulating of non-insulated pipes, upgrading of existing insulating levels and review economic thickness requirement

The boiler must be maintained well if its efficiency has to remain high. This is achieved by practicing the following points:

- Keep burners in proper adjustment.
- Check for and repair leaking flanges, valve steams and pump glands.
- Maintain tightness of all air ducting and flue gas breaching.
- Check for hot spots on the boiler casing that may indicate deteriorating boiler insulation that should be repaired during the annual shutdown period.
- Keep fireside surfaces of the boiler tubes clean.
- Replace and repair missing or damaged insulation.
- Replace boiler observation or access doors and repair any leaking door seals.

G. Pulleys

Belt drives used in industry today incur energy losses due to windage, flexing and slippage. It is recommended to use cogged or notched V-belts that increases drive efficiency with a saving that ranges from 2% to 4%.

The motor load varies in this instance and must be used with different control devices. This will reduce motor shaft energy being wasted.

H. Lighting

Switching off lights in unoccupied areas and in areas where daylight provides adequate lighting levels. Automatic or manual controls can be done when switching them off.

In the central workshop natural light can be used since there are enough windows. Transparent plastic roofing can be used so that enough light will be provided.

VII. CONCLUSION

As Fertilizer Company seeks to be more efficient in its operations, energy conservation programs provide an avenue for achieving this through various energy saving programs. Usage of coal, electrical energy, steam conservation as well as water usage were found critical parameters which if well managed result in greater efficiency improvement. Detailed investigation on use of electric motors is also critical as they use 80% of the energy used by this organization.

Improving energy efficiency is by itself no panacea but it is essential as it solves most profound company problems that ranges from fuel debts and environmental fines.

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