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Energy saving and fuel switching opportunities in Ceramic Products Share Company - Ethiopia

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Abstract

Several energy saving opportunities in the ethiopia ceramics factory are obtained by this research and can be directly implemented in the factory. It is tried to classify some of energy saving options based on cost of implementing them and this is done by estimating the capital cost and annual cost of operation as well as saving that could be achieved by implementing the saving option and by calculating the payback period of the measures. The result of the current research has showed that more saving can be achieved by investing more on identified energy saving opportunities. Energy saving measures identified by the current research like reducing thermal mass of existing kiln cars, installing new modern low thermal mass kiln cars, recovering waste heat from cooling zone of tunnel kilns especially from glost kiln, installing high speed burners in kilns, avoiding dummy firing in tunnel kilns, reducing loss of products at each step of production, applying monitoring and targeting system etc can be implemented with low cost there by resulting in huge energy saving which can pay back the investment cost in less than two years time, for most of them the payback period being below one year. But above all the energy saving opportunity that can make ceramics factory competent in local as well as in world market by greatly reducing its specific energy consumption. This measure will require substantial investment cost and change in process and the reward will be very high; saving of about 50% with payback period of below three years.

The major fuel switching opportunities identified by current research and to be applied in Ceramics Factory are mainly focused on switching to cheaper fuels that can be obtained within Ethiopia thereby saving the foreign currency the country expends to import petroleum fuels. According to the researcher this can be achieved by using Ethiopian coal as fuel in spry drier which currently uses gasoil, effectively recovering heat from cooling zones of kilns to supply heat required for drying sanitary wares to save fuel used in boilers to produce hot water for mentioned purpose, and as there is plan that Ethiopia will be commercially producing natural gas in coming six years it is wise decision to switch fuel of kilns from current kerosene to natural gas. This will have multi-benefit as experiences from developed countries shows that they have already done this measure because natural gas is environmentally friendly fuel than other solid and liquid fuels and in our case it will save foreign currency for fuel of kilns when produced in Ethiopia.

Keywords:

Energy saving;
Fuel saving;
Low thermal mass kiln cars;
Payback period;
Saving foreign currency.

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1. Introduction

The conservation of energy is an essential stage we can all take towards overcoming the mounting problems of worldwide energy crisis and environmental degradation. The know-how on modern energy saving and conservation technologies should be disseminated to government and industrial managers, as well as to engineers and operators at plant level in developing countries. It is particularly important that they acquire practical knowledge of the currently available energy conservation technologies and techniques.

After the world energy crisis of 1980s, plenty of energy efficient technologies were introduced in the European ceramic industry sector, resulting in significant energy reduction together with reduction of production time and cost .Ceramics is defined as inorganic, non-metallic materials those are consolidated and acquire their desired properties under the application of heat. This application of heat in practice takes place inside high-temperature kilns, usually for long period of time. Therefore, the ceramics industry is by definition an energy intensive one (others being steel, cement, and glass industries). All these industries are characterized by the lengthy operation of high-temperature kilns and furnaces; not only a high amount of energy is consumed during the production process, but the energy cost is a significant percentage of the total production costs. The implementation of energy saving technologies, therefore, is imperative for reasons that have to do both with the worldwide energy crisis and environmental degradation as well as with product cost reduction. The ceramic sector energy requirements are covered largely by (environmentally harmful) fossil fuels and are therefore frequently coupled with the requirements for reduced emissions and switching to renewable source of energy as necessary.

There is no question that Ethiopia is developing at the rate which is one of the fastest growth rates in the world. This fastest growth has resulted in fast urbanization rate which in turn resulted in high growth of building industry. But modern buildings are unthinkable without floor and wall tiles as well as sanitary equipments. Ceramic Products Share Company which is the only ceramic manufacturer of the country produces less than 15% of the demand, above 85% of ceramic products is imported. In addition to that it is estimated that the demand for these materials is growing annually by 10% while TCF is facing challenges even failing to operate to its full potential i.e. its operating up to 50% of its designed capacity. The major challenge to the company is the energy consumption and increasing of fuel cost in addition lack of trained man power in respective area specially lack of well trained engineers. There is lack of awareness among the

operators of equipment about the value of heat and compressed air i.e. why there are workers who feel uncomfortable due to heating of the room by radiated heat from the kiln increase the compressed atomizing air flow to burner nozzle which will disturb the combustion and cause the cooling of the room.

The ceramic sector is one of well advanced manufacturing sectors in the world being classified as traditional ceramics and advanced ceramics. Advanced ceramics is the field of ceramics manufacturing to be used in advanced equipments like electronics space technology and others while the traditional ceramics which is highly energy intensive one is concerned with the manufacturing of ceramic floor and wall tiles sanitary equipments and table wares. The growing need for ceramic products due to development of the country, increasing fuel cost from time to time and well known energy saving practices in European and Asian ceramic industries which can be easily adapted to our countries ceramic plant necessitated this study. The low cost and no cost energy saving opportunities in TCF will be identified and the saving by implementing those measures is to be estimated. Potential fuel switching opportunities are also to be identified and recommendations are going to be made to the managers of the company in particular and the other concerned body to give due attention in expanding this sector to save the foreign currency wasted by importing ceramic products.

2. Problem Statement

Ceramic industry is one of energy intensive industries in which the energy cost accounts 5-25% [1] of the total production cost. However the cost of fuel is increasing from time to time causing increase of production cost. It is known that even easily done housekeeping measures can result in potential saving in energy intensive industries like ceramic industries. The case of Ceramic Products Share Company is not different from this. Following the fact that old equipments and old practices are being used in the factory and the company producing less than half of it is capacity and suffering from financial loss year from year despite big market for its products, it is assumed that there are so many energy saving opportunities in the factory that can result in increase of profitability of the company and contribute to economic growth of the country. In addition to that the factory relies mainly on petroleum fuels which are very expensive for its energy need in kilns, boilers spry driers and other devices and spends millions for import of fuel annually. Clearly some of the equipments using petroleum fuels can be operated by using cheaper and cleaner fuels like electricity and natural gas and cheaper ones like coal.

The company has not adopted the known energy saving opportunities that are already discovered and applied by ceramic industries in Europe, Japan, USA and other developed nations before decades.

3. Objectives of the Study

3.1 General objective:

The general objective of this research is to identify the applicable energy saving and fuel switching opportunities in Ceramic Products Share Company.

3.2 Specific objectives:

- To observe the working conditions of the major energy intensive equipments in the factory like kiln, boiler, spry driers etc.
- To identify the energy management system of the company
- To indentify if there is any fuel switching options in the company
- To analyze the advantage obtained if the expensive fuels replaced with other forms of fuels
- To identify the practices in the factory that worsens their energy management process
- To measure the exhaust gas and surface temperatures of energy intensive equipments to analyze whether there is substantial amount of heat lost by heat transfer by convection conduction and via flue gas
- To analyze the working condition of hot water lines
- To organize all the obtained solutions to improve energy efficiency and profitability of the company
- To assess the feasibility of recommended fuel switching options and other energy saving options
- To recommend the final outcome of the research to the company managers so that they can improve the profitability of their factory

4. Significance of the Study

This research will help Ceramic Products Share Company by pointing out potential areas of energy saving and fuel switching within the factory. By applying the energy conservation measures it would be possible to reduce energy cost which currently accounts about half of total production cost of the company thereby increasing profitability of the company. Since the company produces

much below its capacity due to different reasons, one being loss of products at different stage of production which caused increase of cost of production for one ton of finished products, much saving can be achieved by reducing this rejects. Whenever the production capacity of the company increases by applying the energy saving and fuel switching opportunities identified by this research the country will save some of foreign currency for importing ceramic products and fuel. Finally the study has to do with the increase in profitability of the company there by contributing to the countries development. The study will also help the company and other researchers by being standing stone for further detailed study of energy saving opportunities in TCF and other energy intensive industries and equipments.

5. Research Method

The methods employed to achieve the objectives of the research are:

- Literature review of all available energy saving and fuel switching technologies and opportunities already identified and practiced in ceramic industries of developed countries
- Observation of the working conditions of the energy utilizing equipments in the factory
- Measuring some parameters to identify the working conditions of energy intensive equipments: measurements can be flue gas temperature, surface temperature, pressure, velocity (in the case of steam line) and others
- Survey of the energy consumption of energy intensive equipments like kilns in the factory
- Interview with workers of all level in the factory on topics of energy saving
- Questioners to concerned bodies in the factory about their energy consumption trend and energy management
- Analyzing the data
- Obtaining energy saving and fuel switching opportunities

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6. Results and Analysis

There is no question that Ethiopian economy is developing at the rate which is one of the fastest economic growth rates in the world. This fastest economic growth has resulted in fast urbanization rate which in turn resulted in high growth of construction industry. But modern buildings are unthinkable without floor and wall tiles as well as sanitary equipments. Ceramic Products Share Company is the only ceramic manufacturer in the country and it produces less than 15% of the domestic ceramic products demand. In addition to that it is estimated that the demand for these materials is growing annually by 10% while TCF is facing challenges and failing to operate to its full potential i.e. it's producing up to 50% of its designed capacity because of its inefficient equipments and processes and frequent failures of old machines. The other challenges to the company are the inefficient energy consumption and increasing of fuel price. This is evident from the share that energy cost holds from total production cost in TCF. As seen in chapter three of this paper energy cost accounts almost half of total production cost in the factory and this is extraordinarily high when compared with the expected and average energy cost in ceramic industries around the world which is 5-25% of total production cost [2].

Due to this high energy cost from total production cost of the factory and due to the fact that the price of petroleum fuels is increasing from time to time, the situation of the factory productivity is worsening. Even if the company is the only of its kind in Ethiopia and despite the fact that there is big market for its products locally the company could not become competent with those who import ceramic products from abroad. The company lacks the practical knowledge of currently available energy saving technologies and techniques. However there are numerous energy saving techniques in ceramic industries which have greatly reduced energy cost in production process and were practiced in Europe, Asia, and America before decades. These energy saving options and technologies haven't yet adapted in ceramics factory. That is why the energy intensity (amount (in Gj) of energy needed to produce a ton of products) of each of the production lines i.e. tiles, sanitary wares and table wares is much higher than the international bench mark energy intensity values. The analysis of comparing with international bench mark energy intensity has revealed that the ceramics factory has to save above 70% of the current energy consumption trend to reach on the front runners in tiles, sanitary wares and table wares production. Achieving the existing saving potential fully would require process improvement as well as installing new and modern equipments which would require relatively high capital cost, like installing roller kiln for

tiles manufacturing. This will avoid the current double firing of tiles and will help tiles manufacturing of the factory to approach energy intensity of international front runners, 2Gj/ton. The another energy saving options identified by this research will not require much capital cost to apply them they will result in substantial reduction of energy cost in production of ceramic products in TCF. These measures will require the improvement of the existing production process consequently will not need much investment cost. There are also no cost energy saving measures which are identified in TCF; improving/optimizing loading of kiln cars, and optimizing the firing schedule being some. Others which can be implemented with some investment cost and to mention some; installing low thermal mass kiln cars, installing high speed burners, using heat recovery from cooling zone of kilns, avoiding dummy firing, implementing monitoring and targeting (M&T) etc. In addition to energy saving by improving the currently operating equipments and processes, the profitability of the company can be improved also by cheaper fuels which can be obtained easily within the country. In this regard the research has identified some options to take this advantage of saving by using cheaper and locally available fuels. This can be achieved by using coal firing in spry drier replacing the currently used diesel oil firing. The coal for this purpose is available from Ethiopia. Actually it is known that the coal currently produced in Ethiopia is low grade coal with lower heating value, but it can supply enough energy that is needed by the spry drier. This is because the experiences of developed nations show that the spry drier of their ceramic industries use low grade fuels like saw dust, wood and others as fuel in spry drier. Another opportunity to switch fuel is using recovered heat from kilns' cooling zone to drying purposes in S/W and T/W production. The analysis in chapter four has revealed that there is more than twice energy needed for drying purpose in the factory in mentioned departments is wasted from the cooling zone of glost kiln alone. By effectively recovering this heat it can supply 100% energy needed for drying of S/W and T/W products. The experience of frontrunners in ceramic manufacturing too shows this. Finally switching of fuel of kilns from current kerosene firing to natural gas firing is another opportunity to improve the energy efficiency of TCF. There is plan that Ethiopia will be commercially producing natural gas in next five years. There is enough natural gas reserve already discovered for this purpose and the work is already on the way. This is very good news for not only TCF but also all Ethiopian industrial sector. The experience of the models in ceramics manufacturing and common practice around the world most of the kilns of ceramics manufacturers use natural gas to fire their products. The advantage

of using natural gas firing in kilns will be multiple; first it is known that natural gas is cleaner and environmentally friendly fuel among fossil fuels and less polluting, secondly it will reduce energy cost of the factory in total production cost thereby increasing its profitability, and thirdly the country will save foreign currency which would have been used for importing fuel.

Even if the cost of electrical energy is much lower (about 5% of total energy cost) when compared to thermal energy cost in the company, there are still opportunities to make it even lower. Similar to thermal energy, the company has not adapted available and known methods of saving electrical energy too. This is evident from the facts that the electrical motors which are major consumers of electric energy of the company are as old as the company. But it is known that installing high efficiency motors pays back the cost within two years and directly adds to the profit of the company then after. The another opportunity is to save electrical energy is by optimizing compressed air system and by installing variable speed drives as well as installing efficient lighting system.

As it can be seen from table 6.1 most of energy saving opportunities can payback investment cost related to them within a year time. The energy saving opportunities in the current paper deal with thermal energy saving mainly b/c it accounts for more than 94% of total energy cost in TCF. For the case of tiles line of manufacturing the installing of roller kiln will avoid the implementation of energy saving options listed in the table 6.1 below because it will avoid the use of biscuit kiln and glost kiln as well as things related to them to produce tiles thereby resulting in new efficient production of tiles by single firing and resulting in the saving of 17,500GJ of energy per year.

Table 6.1 Energy Saving Opportunities, Related Savings and SPP

No.	***Energy Saving Opportunity***	***Annual Energy Saving that can be achieved (GJ)***	***Simple payback period (SPP)***	***Remark***
1	Optimization of Kiln Car Loading for Biscuit Kiln	1,758.75GJ	-	No cost measure
2	Reducing Rejects from Biscuit Kiln	1,315.545GJ	0.53years	
3	Avoiding Dummy Firing in Biscuit and Glost Kilns	1,260GJ	1.32years	

4	Optimization of Kiln Car Loading for Glost Kiln	510.305GJ	-	No cost measure
5	Optimization of Kiln Car Loading for Glost Kiln (new cassettes with capacity of 18tiles)	2,705.769GJ	0.23years	
6	Introduction of New Firing Schedule of Biscuit Kiln	281.4GJ	-	No cost measure
7	Introduction of New Firing Schedule of Glost Kiln	171.78GJ	-	No cost measure
8	Energy Saving by Monitoring & Targeting (M&T) System in tiles dep't	2,872GJ	0.36years	
9	Heat Recovery from Cooling Zone of Glost Kiln	2,062GJ	0.36years	
10	Better Maintenance of Kiln Cars	577GJ	1.2years	
11	Installing High Speed Burners in biscuit and glost Kilns	2,051GJ	1.2years	
12	Installing Law Thermal Mass Kiln Cars for Biscuit & Glost Kilns	7,181GJ	0.45years	
13	Fast Firing and Installing Roller Kilns	17,500GJ	2.82years	SPP may be much below this value as the cost of installing roller kilns is somewhat exaggerated to show that it is feasible to implement even with that high cost
14	Installing Law Thermal Mass Kiln Cars for Shuttle Kiln	3,780 GJ	0.523years	
15	Optimization of Kiln Car Loading of Shuttle Kiln	557.515GJ	-	No cost measure
16	Implement Periodic Inspection and Adjustment of Burners in the Shuttle Kiln/Installing High Speed Burners	1,890 GJ	0.65years	
17	Heat Recovery from Cooling Zone of Glost Kiln	960GJ	0.36years	

18	Optimization of Drier and Casting Shop of S/W Dep't	48GJ	0.6586years	
19	Applying Monitoring and Targeting (M&T) System in S/W Production Line	603GJ	-	Low cost measure with SPP less than one year
20	Boilers and Steam Distribution	119GJ	-	Low cost measure with SPP less than one year

Another advantage of energy saving is reducing the emission of environmentally harmful gases like carbon dioxide. In the case of tiles department the annual emission reduction when implementing the energy saving options listed in table 6.1 will be above 1500tons of carbon dioxide and if roller kiln is installed will be 1300tons of carbon dioxide. Implementing energy saving options in table 6.1 the emission that can be prevented annually is equivalent to 591tons of carbon dioxide.

7. Conclusion

The energy saving practices in the industries has the advantage of increasing the profit of the industries; conserve the non renewable energy reserves of the world and reducing the emission of polluting (GHG) gases. In the case of Ethiopia much of the national budget is spent for importing petroleum fuels. Unlike the case of developed world in Ethiopia the energy share of industrial sector is much lower and the main consumers of energy are households, transportation sector, and service providers. But now the industrial sector of the country is growing rapidly and it is better if the energy efficiency is given great attention by taking late comers advantage. This will have great impact in the economy of the country. The existing industries as well as other energy intensive institutions should practice energy auditing and at least adapt the available technologies which are being implemented in developed world. The government too has to give attention to energy saving technologies in every sector not less than expanding energy producing plants. The universities and other concerned professional associations have to do their part in this regard by working with the industries helping. Managers of the industries should not overlook the profits that can be achieved by properly implementing energy saving endeavors. The plant level managers and engineers should always update themselves with new arrival technologies and

methods in saving energies. Workshops should be prepared at the plant level and also at the national level to train energy managers of the companies and factories.

Lastly the energy saving as well as fuel switching opportunities identified by current research to be implemented in TCF are those which are proved effective after applied in the leading countries in ceramics production technologies like Spain and Italy. They implemented these technologies long ago, and have enjoyed the related reward. However it is not too late for TCF to implement these technologies and enter in to the track of competitors. The increasing productivity of the company will in one way or another help many people. In the first row are above 400 employees of the company. The country will also save some of foreign currency that could have spent for importing ceramic products when the company supplies its products using its full potential. The reward of being energy efficient and using locally available fuel is many to company and to the country development as well.

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