Power Saving Industrial Plant

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Abstract - *The article is based on power saving industrial plant. The bulky electrical equipments used in industrial purpose require high power to be driven. Again their maintenance and safe running process requires some more power consuming equipments to be driven simultaneously. The power requirement to drive these heavy electrical loads can neither be avoided nor be reduced due to their high wattage and heavy duty, but by making some changes to the industrial infrastructure the efficiency can be improved. In this paper some useful methods has been suggested that can be implemented in the industrial plants to run them in energy saving mode. There are various industrial sectors which undergoes various types of energy losses. Hence considering the different ways of energy losses, different solutions can be followed. Here we are representing particularly three different cases of energy losses those are generally occur in industrial plants and corresponding energy saving models are suggested.*

Key Words: Chemical absorption for CO2capture,Energy-saving mechanism, Exergy destruction, Waste heat recovery Coal-fired power plant ,compression .

1.INTRODUCTION *(Size 11 , cambria font)*

Industries are increasing day by day and all of them involve the consumption of high amount of input energy. But according to law of conservation of energy,"Energy can neither be created nor be destroyed; it can only be converted from one form to another."From this statement it is obvious that the total amount of energy available is limited but this limited amount of energy is to be used to serve for the increasing industrial requirement. So during the planning of an industrial plant it is very much essential to calculate the energy efficiency of that plant. Basically the hardware industries such as power plant implements bulky devices which requires a high amount of input energy to be driven. Also they involves high amount of energy loss in form of heat, sound or any other form of mechanical energy. The energy loss due to moving parts, frictional loss, heat loss etc. cannot be avoided in hardware industries. Such a high amount of energy involvement in an industry reduces its energy efficiency and it is always a trending research how to minimize the loss to increase the performance of the plant. Hence now a days almost all the industrial plants prefer to incorporate an energy saving mode of operation.

2. DIFFERENT METHODS OF ENERGY SAVING

Industrial plants are having a variety of structures involving a variety of equipments depending upon their purpose. Accordingly the causes of energy loss also differ. So obviously the methods used to minimize the loss must be different for different plants. Hence there are a number of ways used to incorporate power saving method.

2.1 Energy Saving By CO_2 Absorption Process

This method is incorporated in those plants where high amount of CO_2 emission takes place (i.e. basically in coal-fired power plant). CO_2 has an ability to capture the heat. Hence most of the loss in this plant is caused by this excessive amount of CO_2 emission. The chemical process involved in the plant for which the CO_2 emission occurs must not be avoided but the only method can be adapted to minimize the loss is CO_2 absorption.

The commonly used absorbents for the chemical absorption of CO_2 are amine based solutions (mono ethanol amine (MEA) and di-ethanol amine (DEA)) and potassium carbonate solutions (K2CO3)[1,2]. But again another problem is that a high amount of energy is consumed during the re-extraction of the absorbents from the steam which reduces the efficiency up to a remarkable point. To compensate this reduction in efficiency some absorbent improvement methods can also be adapted. They are addition of activator to the absorbent to increase its rate of absorption, optimization of some parameters like lean solvent loading, amine solvent concentration, and the stripper operating pressure etc [5]. Also by system integration, two systems can be combined so that the waste heat from the stripped steam and CO2 compression process can be recovered to preheat the feed water [6].

From a theoretical analysis the energy and exergy balanced equation is given by

$$H_{flue,g} + Q_{steam} + W_{work} + H_{water} = H_{flue,e} + H_{COS} + Q_{C1} + Q_{Fl} + Q_{I-Cl} \quad \text{.........} (1)$$

Hflue,g- Enthalpy of the inlet flue gas
Hwater- Enthalpy of the supplemental water
Hflue,e- - Enthalpy of the ejected flue gas
HCOS-Enthalpy changed by net input and output stream
QCI- Heat lost in lean solvent cooler
QFI- Heat lost in stripped vapour flasher
QI-CI- Heat lost in inter cooler of CO_2 compression
EDAb&Ds- Exergy destruction related to absorption and Desorption process

MSW & HEC- Exergy change related to separation of CO_2-G from flue gas
MCW- Minimum CO_2 compression work neglecting water Water condensation
EDCI- Exergy destruction in lean solvent cooler
EDFI- Exergy destruction in flasher
EDI-CI- Exergy destruction in the inter cooler
EDCM&PM- Exergy destruction in the compression Process

A simple blueprint of the proposed plant has been shown in the block diagram given in fig.1. Here the inputs to the plant are input work supply, which is given to gas compressor and the input heat supply which is given to disrober.

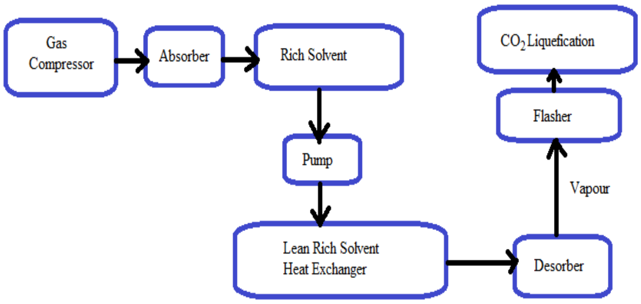

Fig -1: Block Diagram of CO2 absorption Process

Table -1: Energy Distribution percentage

Energy Factors	Percentage
QCI	36
QFI	45
QI-CI	15
HCOS	4

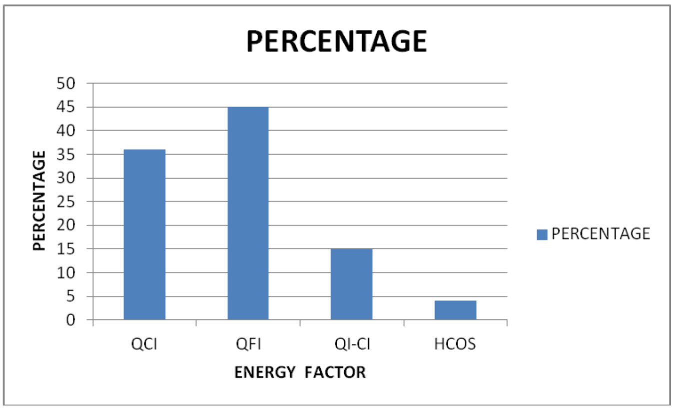

Chart -1: Energy Distribution Chart

Table -2: Exergy Distribution percentage

Exergy Factors	Percentage
EDAb&Ds	25
MSW&HEC	19
MCW	15
EDCI	9
EDFI	20
EDI-CI	8
EDCM&PM	4

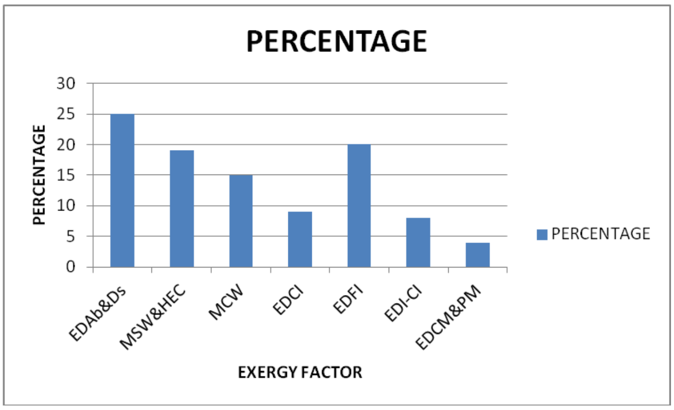

Chart -2: Exergy Distribution Chart

2.2 Energy Saving in Compressed air System

Basically the industries of glass and ceramic production, refining processes and automotive/aerospace manufacturing suffers from high amount of energy loss due to compressed air systems involved in the plants. It has been found by research that up to 50% of the total electricity produced is consumed by the industries and up to 20% of this energy is consumed only [3] . This loss can be reduced by reducing the work done during the compression process which can be achieved by cooling the air adiabatically [7,8]. To analyse how to use this type of system in power saving mode, here the best example can be considered as Gas Engine driven Heat Pump (GEHP) system.

GEHP system is typically a vapour compression refrigeration system, which consists of an open type compressor, condenser, expansion valve, evaporator and a gas engine to drive the compressor [4]. There basically two widely used methods for energy saving in GEHP system; one is air cooled compression another is evaporative condensation. Here the discussion is focused on air cooled compression. The below fig.2represents a simple block diagram of air cooled condenser. Here the low pressure steam exhausted from the turbine flows towards the cooling condenser through a bundle of tube then it is condensed by the air flow of properly designed fan. The main advantage of air cooled condenser is it does not use water to condense the fluid hence also saves water.

PER (Primary Energy Ratio) is the most important factor to be calculated here and the related formula is given by

PER = (Cooling Heat rate + Cylinder Jacket heat rate + Exhaust Heat rate)/Natural gas Heat rate

A graph is plotted to show the variation of PER with the varying speed of engine which is shown in chart-3. These data are collected taking the ambient temperature 33^{0}C. It has been found from the equation that the relationship is approximately linear.

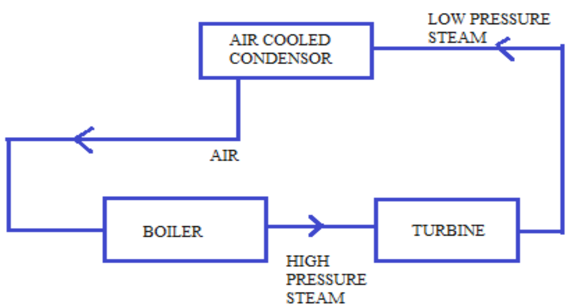

Fig -2: Block Diagram of air cooled condenser

Table -3: Variation of primary Energy ratio with speed of Engine at ambient temperature 33^{0}C.

Speed of Engine in rpm	PER
1200	1.45
1400	1.42
1600	1.38
1800	1.29
2000	1.23
2200	1.15

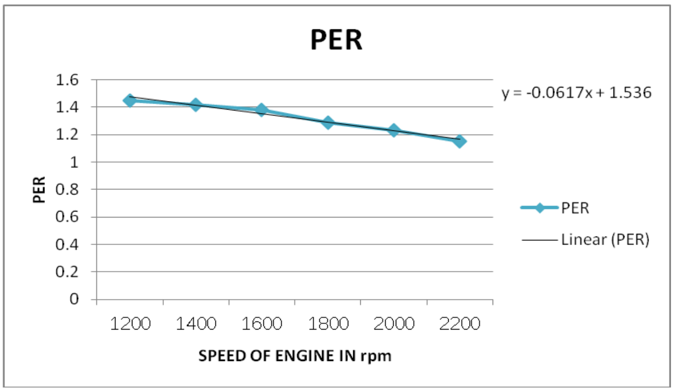

Chart -3: Variation of PER with respect to speed of Engine

Table -4: Energy saving comparison

Comparison factor	Electrical Heat Pump	GEHP with air cooled condenser
PER	0.92	1.18
Total Primary Energy	1111.4	823.33

2.3 Energy Saving in Industrial Exhausting Fans

Exhausting fans are used in industries for cooling purpose or to maintain the temperature rise caused by the excessive amount of heat produced during the running of heavy electrical devices. These exhausting fans require an additional amount of electrical energy to run. So instead of running these fans all the time with the other devices, turning them "ON" only when it is necessary or when the temperature rises more than the threshold value can somehow save the power up to a certain amount. This can be done by implementing an embedded system based control unit which will continuously check the temperature level and automatically turn "ON" the exhausting fan by sending some control instruction when the temperature will rise more than the threshold value and also automatically turn them OFF by another control instruction as the temperature will fall below the threshold value. This type of controlled operating mode of the devices can be indicated as power saving mode of operation.

Basically the hardware industries such as power plant implements bulky devices which requires a high amount of input energy to be driven. Also they involves high amount of energy loss in form of heat, sound or any other form of mechanical energy. The energy loss due to moving parts, frictional loss, heat loss etc. cannot be avoided in hardware industries but we can only try to achieve the optimum efficiency by changing the way [9],because such a high amount of energy involvement in an industry reduces its energy efficiency and it is always a trending research how to minimize the loss to increase the performance of the plant. Some exhaust fans operate continuously and many operate when not necessary. When building codes and standards permit, it is important to turn exhaust fans off when they are not serving a useful purpose. Better control of exhaust fans not only saves the electricity required to operate the fan but also the cost of conditioned air that is exhausted unnecessarily.

A model has been designed to study about the proposed industrial plant. Here a thermister has been used to sense the over temperature. A microcontroller is used to automatically control the exhaust fans. When the thermister will sense the over temperature its resistance will fall down and a small current will pass through it which will go to the microcontroller as an input pulse. By getting this input pulse the control unit sends the output instruction to turn "ON" the fans as per the requirement. When the temperature will gradually fall down, the supply to the fans will be cut down one by one, hence they will be turned "OFF" one by one. It seems that the modules which are hit first by the wind are the coolest and the module with the highest temperature is the point at which the air exits the array [10].

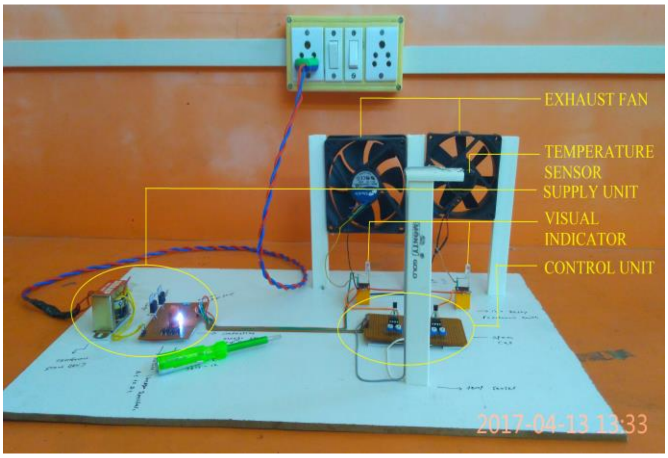

Fig -3: Prototype model for power saving industrial exhausting fan

3. CONCLUSIONS

Industries are consuming the largest part of electricity produced. The three different cases focused in this paper are the highest power consuming industrial sectors. Hence some useful techniques have been explained here with proper analytical information about the amount of energy saving.

In CO2 capture process by applying waste heat recovery and inter cooling integrated system a considerable amount of energy (i.e. up to 40%) can be saved. Further improvement in the overall efficiency needs more analysis on better heat recovery process and economical implementation of the plant providing the proposed techniques. In compressed air system the adiabatic cooling process has been suggested as an energy saving mode of operation that has been studied and verified and the required parameters has been derived regarding its usefulness. The next proposed idea is to be implemented in the heavy equipment industries which use large number of exhausting fans to maintain the temperature during the working period of the heavy machines. Here the suggested energy saving model uses the atomization technique by using a heat sensor and an embedded control unit that automatically controls the running process of the exhausting fan. By applying this mechanism the exhausting fans are being kept in rest for a longer time as compare to those used in non automated plants, hence a very large amount of energy is saved. So this paper is actually aimed to give an overall idea on energy saving mechanism that can be implemented in different industrial plant so that we can properly use the energy and unnecessary power wastage can be avoided.

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