Energy Saving Techniques In Petroleum And Refining Industries
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Abstract— As of today, the main focus of many petroleum refining industries is on energy saving or energy conservation and to minimize the losses. In this paper, study on different types of energy saving techniques is done which are carried out in the petroleum industries.

Key words: Energy saving, steam, pressure, heat recovery

I. INTRODUCTION
The petroleum and refining industries are the most energy intensive units in chemical sectors. These industries have a strong financial incentive to save energy because of the large share of energy in the overall cost of operating its facilities. Efficient energy use reduces costs along the whole supply chain, improves supplier’s competitiveness and makes energy more affordable to consumers.

II. VARIOUS TECHNIQUES OF ENERGY SAVING
A. Effective utilization of steam
Steam is introduced into the atmospheric distillation column to reduce the partial pressure of lighter fractions. The injected steam passes through the overhead condenser as overhead steam to be condensed as waste water. This modification uses some part of the overhead steam back in to the distillation column using an injector, and saving energy. Using this method, the steam consumption was decreased by 105,000 tonnes/year. This principle and mechanism for this is as follows:

- The steam ejection which is used creates vacuum inside the body by introducing high-pressure steam at a very high velocity from nozzles and induces low-pressure steam which is used as recycled steam in this case.
- This enables the low-pressure steam which was up until now unused to be pressurized and reused.

![Fig. 1: Structure of Steam Ejector][1]

- Generally, only 30% of the steam is being injected into the furnace heater coils and 70% is sent into the bottom of the tower.
- The above modification reduces the steam consumption by 15 tons per hour at 100,000 barrels per day throughput.[1]

B. By decreasing the pressure inside the regeneration column in Fluid Catalytic cracking unit
The pressure inside the Fluid Catalytic Cracking (FCC) unit can be reduced by increasing the capacity of the cooler at the top of the FCC fractionating column. In this method the energy is saved by reducing the pressure inside the regeneration column and thus decreasing the consumption of steam for running the air blower for the regeneration column.

Here, the main objective is

- To decrease the pressure inside the system by increasing the capacity of the air cooler at the top of the distillation column.
- To reduce the quantity of air for air blower in the regeneration column.

1) Description:

- Fig. 3 shows the system flow which includes FCC regeneration column.
- By increasing the cooling capacity of the air fin cooler, it is possible to reduce the air pressure inside the system, and to decrease the air pressure of the air blower for the regeneration column.
- This modification also confirmed the reduction in air volume of the air blower, resulting in decrease in specific consumption of the high pressure(HP) steam required for driving the air blower.

![Fig. 2: Flow scheme of steam recycling system][1]

![Fig. 3: System flow of Fcc][1]
The amount of energy saved in terms of air volume and column pressure is shown in the table 1.[1]

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Table 1: Regeneration column pressure and air volume[1]

<table>
<thead>
<tr>
<th></th>
<th>Before improvement</th>
<th>After improvement</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regeneration column air pressure (kg/cm²)</td>
<td>2.86</td>
<td>2.63</td>
<td>0.23 reduction</td>
</tr>
<tr>
<td>Air blower air volume (m³/Nh)</td>
<td>1,755</td>
<td>860</td>
<td>89% reduction</td>
</tr>
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Economically, approximately 12 million INR/year was saved and the payback period for the investment is around 3-4 years.

C. Installing a side reboiler in a distillation column

An energy saving technique adopted by petroleum refining industry is to install a side reboiler around the central levels of a column in petroleum refining to reduce consumption of steam.

In the operation of a distillation column, decreasing the reflux ratio at the feed plate such that it is very close to the minimum can reduce consumption of heating steam. This can be achieved by installing a side reboiler. Fig. 4 indicates the effect of the side reboiler on the performance of distillation column.

This modification raises the intermediate plate temperature and thus promote distillation; this reduces the load on the bottom reboiler.[1]

D. Waste heat recovery of the overhead vapor in vacuum distillation unit

The amount of waste heat from the cooler for the overhead vapor of a vacuum distillation unit is very large. However due to its low temperature, the waste heat was not being recovered. This technology make use of the waste heat generated from the cooler as a heat source for preheating the water of the boiler and reduce the amount of steam required for heating the deaerator.

Before improvement, the reflux to the overhead of the vacuum distillation unit was cooled by two coolers, a water cooler and an air cooler, and the waste heat of the fluid, or heat from cooling, was not recovered for reuse. After improvement:

- The amount of waste heat recovered from the air cooler is used to preheat the feed water to the deaerator.
- Deaerator pressure is controlled by an ACS system in the range of 1.5 and 2.0 Kg/cm²g. As a result, the steam consumption of the deaerator is reduced by 30%.

![Flow of waste heat recovery](image)

E. Recuperators and Heat Pipes

- **Recuperators:**
  Recuperators functions to recover exhaust gas waste heat in medium to high temperature applications such as melting furnaces, afterburners and reheat furnaces. Recuperators are based on radiation, convection, or in combinations of both. These are constructed out of either metallic or ceramic materials. A simple recuperator is shown in Fig. 7.[2]

- **Heat Pipes:**
  A heat pipe is a special kind of pipe which transfers up to 100 times more heat energy. In other words, heat pipe is a heat energy absorbing and transferring device and have no moving parts and hence require very less maintenance. Thus, a heat pipe can reduce the losses in temperature which occurs during transportation of fluids.[2]

F. Energy Saving in compressed air systems

In many refining processes, compressed air systems consume a large amount of energy, and thus offer great
potential for large financial savings from reduced energy consumption. The largest component of a compressed air system is the compressor unit.

Energy savings in compressed air systems usually occurs in two areas:

- Compressor unit
- Distribution system

In the compressor unit, these three are the main areas in which energy can be saved.

- Compressor Motor
- Compressor Element (also known as the Airend)
- Compressor Control System

1) Compressor Motor:

Most energy efficient motors are usually made up of higher quality materials and advanced manufacturing techniques and results in lesser amounts of waste energy being generated due to reduced vibration, noise and heat.

Compressor Element:

The airend of the compressor is the main part which is responsible for compressing of air in the compressor unit. The performance of compressor elements will depend largely on the type of element in the unit (screw, reciprocating, rotary vane, rotary or centrifugal) and may vary by as much as 20% between the styles. The size of the element is also an important factor as larger, under utilised or poorly functioning compressors will use more energy than smaller units operating at full capacity. Decreasing the operating pressure of the huge compressor may also result in saving energy.[3]

2) Control Systems:

The development of microprocessors has made an important effect on the efficiency of air compressors. Modulating-demodulating controls are able to match the air supply to the demand in the most efficient way manually, and savings of up to 45% is possible, by installing a number of smaller compressors which can be controlled automatically to match the demand for air.

Not only the savings associated with energy consumption but financial savings will also result from compressor units.

3) The Distribution System:

After the compression of air, transportation is done through a network of pipes to the location of end use. Care should be taken to eliminate audible air leaks, especially in reticulated compressed air systems. These result in huge energy wastage, (between 25 and 35%), maintaining pressure to the compressed air tool or device. [3]

Condensation in the distribution system should be minimised by eliminating its presence in the inlet air or providing systems for removing it from the distribution network. In reticulated systems, condensate traps, which collect and remove moisture from the distribution system, also pose as potential areas of energy loss. Traps which are not functioning correctly, or are manually controlled are especially prone to wasting energy. Filters should be regularly checked and cleaned as blocked or partially blocked filters will increase the pressure, and hence the energy, required to operate the system.[3]

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