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# ENERGY AUDIT OF PRASOL CHEMICALS AT KHOPOLI

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***Abstract:*** Energy consumption is on the rise all over the world. Owing to the rise in population and increasing Human Development Index (HDI), this trend is expected to carry on, resulting in increased global warming and fast depletion of fossil fuels. Hence, it is essential to reduce energy consumption, for which, energy conservation is needed. Energy audit is one of the process by which we can implement energy conservation. For this project, we are conducting an Energy Audit on "Prasol Chemicals", a chemical supplier industry at Khopoli. Our aim with this project can be divided into two segments, first is to reduce maximum load demand without affecting the production capacity of industry and second is to reduce losses occurring while transmission and consumption.

We would recommend some changes in equipment, increasing maintenance and suggest some alternative energy sources, which would result in decreasing the yearly budget for the industry, increasing their profits, as well as decreasing the overall carbon footprint of the world.

**Key words: Energy audit, energy efficiency, energy conservation, Energy billing, Energy Saving.**

## 1. Introduction

An energy audit is a systematic examination of how power is used within the organization with the goal of discovering and quantifying energy waste. It will aid in reducing energy costs, reducing pollution, enhancing safety, and suggesting ways to improve the operational procedures of the programme. It is the secret of a machine designed to depict and pursue total energy. The audit transforms the protective measurements into reality by providing the technically feasible guidance with economic and other organizational factors within a specified period. The references to

the organization for better energy usage are established by this review. A database is provided by the review process in order to keep the overall power utilization analysis. It is a method through which we can lower the system's input power requirements without having an adverse effect on the output. Prasol Chemicals in Khopoli is undergoing an energy audit, which requires input from several processes as well as historical data on output level and specific power use.

We have created a list of prospective courses of action, calculated their potential savings, and determined how best to use our limited resources. Setting a priority for its implementation would be the next stage. We anticipate that the administrators of the institute, the staff, and the students will endeavor to ensure that the recommendations are implemented to the fullest extent possible and that this work is successful.

### 1.2 What is energy audit?

Verification, monitoring, and analysis of energy use, as well as the creation of a technical report with suggestions for enhancing energy effectiveness, a cost-benefit analysis, and a strategy for cutting energy use." National energy conservation laws state the regulations for energy consumption, investigation, and energy audit management. A survey of all electrical devices has been done which consume energy in a building. It is an efficient and firm method to speed up the process of energy conservation in every type of building and industrial process. An energy audit is also known by names like Energy Assessment, Energy survey, etc.

### 1.3 Need for energy audit

To find energy-saving opportunities in a building or areas that use more energy than is necessary in comparison to established criteria, an energy audit must be conducted. An effective method for energy management to use energy Efficiently and Effectively is an energy audit. In other words, an energy audit is a process or methodology to determine how much energy is used in various areas and at various times, as well as the total connected load, the maximum demand, the power factor, and the load factor. Most importantly, it proposes economic measures to save energy with a thorough comparison of the cost of energy-saving measures and the investment necessary in terms of payback time. An energy audit's goals are to find and create changes that will lower energy consumption, operating costs, and ensure the best load dispatch in a given industry. The findings ought to be presented in a way that will give an industry's energy management the data they need to decide whether to carry out any suggested changes.

An energy Audit includes the following steps:

I. Gathering and analyzing historical data and bills from past years.
II. Determining the different kinds of loads and recording the nameplate values of the generator and motor.
III. Finding workable alternatives to lower energy use and/or costs.
IV. To conduct a technical and financial examination of probable changes.
V. Creation of a list of relevant adjustments that is ranked.
VI. Writing an audit report to describe the analysis's methodology and findings.

### 2. Types of energy audit

The term "energy audit" is frequently used to refer to a broad range of energy studies, including everything from a walk-through of a location to a detailed analysis of a specific area to the financial implications of alternative energy efficiency measures adequate to satisfy sophisticated investors.

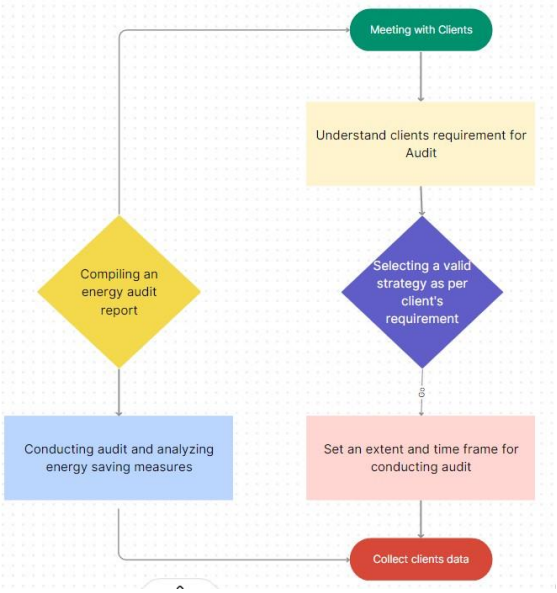
For industrial audits, many auditing processes have been established. To find the energy conservation opportunities (ECOs) or measures that are most efficient and economical, it is necessary to conduct an energy audit (ECMs). Opportunities (or methods) for energy conservation may include more efficient usage or partial or complete replacement of the current installation.

The types of energy audit are: -

1. Preliminary Energy Audit
2. Targeted Energy Audit
3. Detailed Energy Audit

## 3. Methodology

### 3.1 Flow Chart




## 4. Data collection

### 4.1 Consumption data of Prasol chemicals:-

Data of MSEDCL bills Dec-21 to Oct-22 is as under. Power Factor can be maintained at Unity consistently (>0.995). Saving of Rs.1.43 Lakh/month is feasible on p.f. incentive:

**Table 4.1 Energy consumption of Prasol chemicals**

| ELECTRICITY BILL ANALYSIS – Dec-21 to Oct-22 | | | | | | | |
|---|---|---|---|---|---|---|---|
| CONSUMER : M/S PRASOL CHEMICAL LTD | | | | | | | |
| ADDRESS : AT VILLAGE HONDA, TAL KHALAPUR DIST RAIGAD | | | | | | | |
| CONSUMER NO. : 031009019114 | | | | | | | |
| UTILITY : MSEDCL | | | | | | | |
| INCOMING VOLTAGE : 22000 V | | | | | | | |
| TARIFF : 101 HT-I A | | | | | | | |
| CONTRACT DEMAND : 2400 KVA | | | | | | | |
| **SL** | **MONTH** | **KWH** | **PF** | **BILLED DEMAND ( KVA)** | **BILL (Rs)** | **Rate (Rs./kWh)** | **PF INCEN-TIVE** |
| 1 | Dec 21 | 853125 | 1.000 | 1602 | 7193700 | 8.43 | 487568 |
| 2 | Jan 22 | 1025520 | 1.000 | 1812 | 8635920 | 8.42 | 585309 |
| 3 | Feb 22 | 877872 | 0.999 | 2029 | 7501790 | 8.55 | 508512 |
| 4 | Mar 22 | 914121 | 0.999 | 1637 | 7496990 | 8.20 | 507987 |
| 5 | Apr 22 | 1117110 | 0.989 | 2150 | 8685435 | 7.77 | 412084 |
| 6 | May 22 | 1076355 | 1.000 | 1987 | 9777160 | 9.08 | 663122 |
| 7 | Jun 22 | 964350 | 0.993 | 1947 | 8648720 | 8.97 | 410910 |
| 8 | July 22 | 1002332 | 0.999 | 2130 | 8446850 | 8.43 | 572499 |
| 9 | Aug 22 | 990122 | 0.989 | 2185 | 8128480 | 8.21 | 385871 |
| 10 | Sept 22 | 1139487 | 0.973 | 2387 | 9365860 | 8.22 | 173510 |
| 11 | Oct 22 | 1153140 | 0.976 | 2218 | 9737750 | 8.44 | 272215 |
| AVG | | 1010321 | 0.992 | 2008 | 8510787 | 8.4 | 452690 |

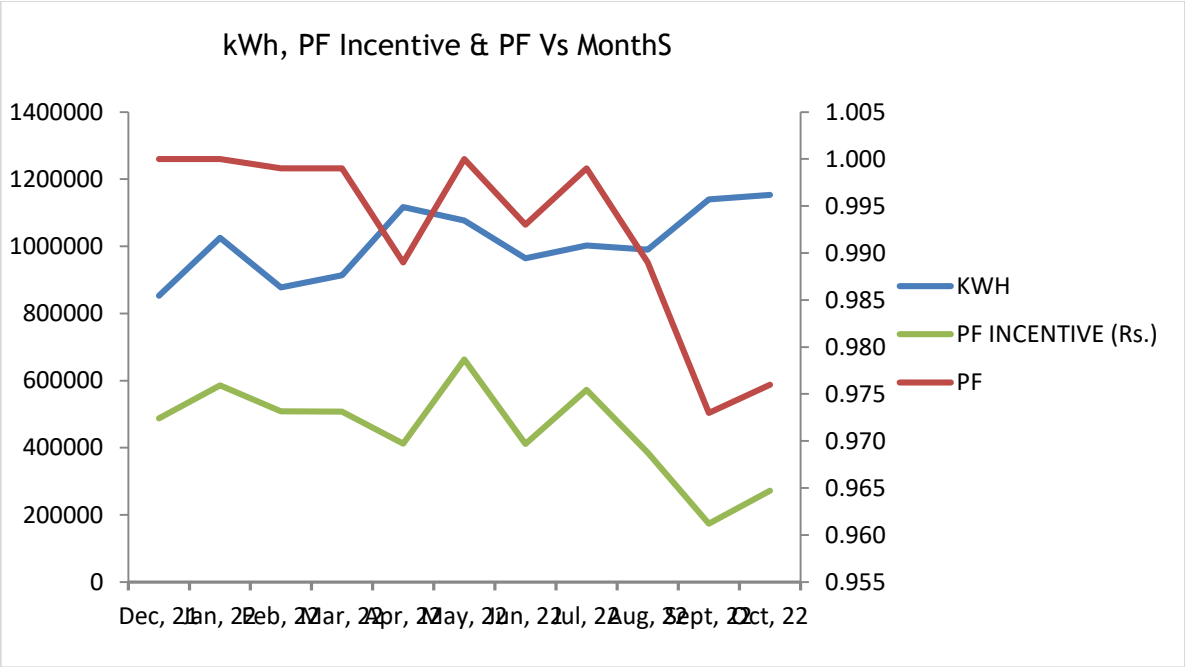



**Fig. 4.1 Line graph of Energy consumption, PF and PF incentive**

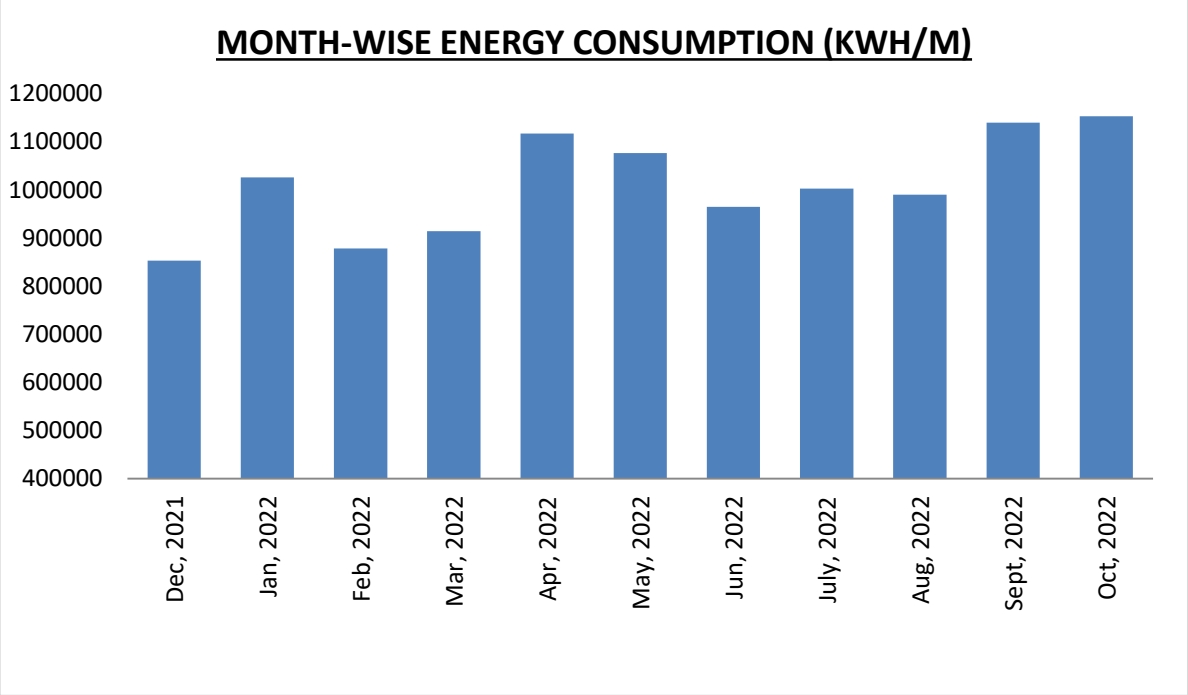



**Fig. 4.2 rend of month-wise power consumption from Dec-21 and Oct-22 is shown below.**

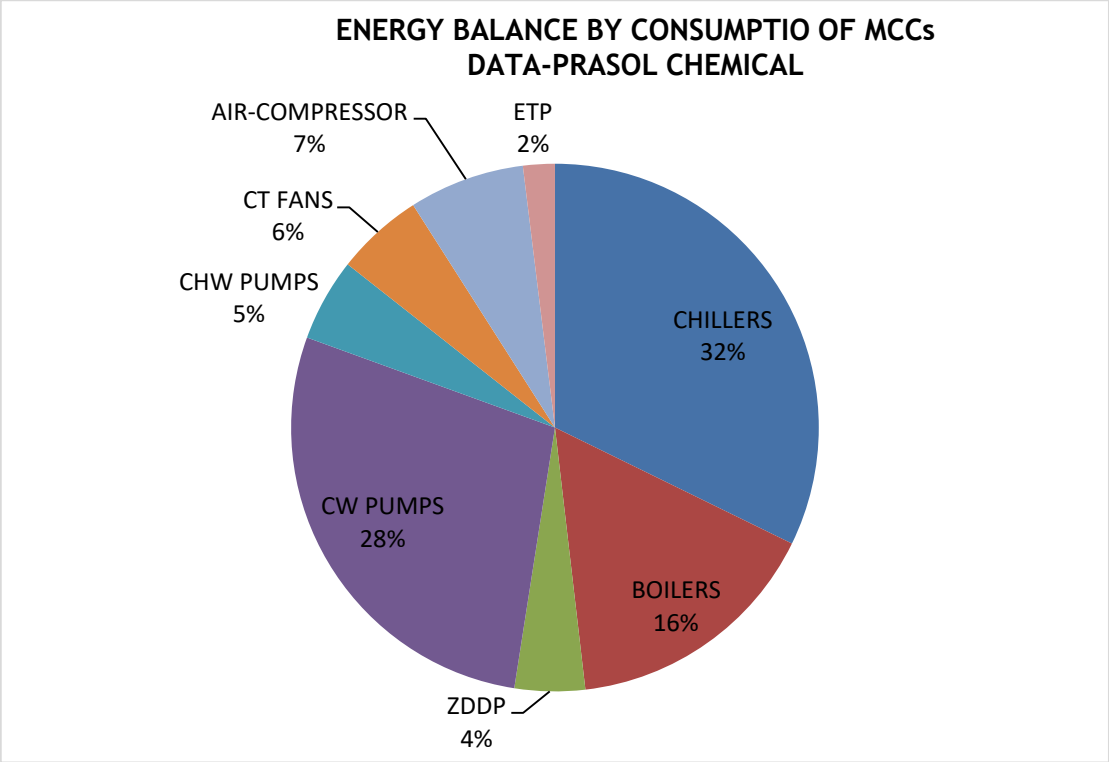



**Fig. 4.3 Load data on various outgoing feeders**

## 4.2 Energy readings (MCC):

| Panel | Voltage | | | Current | | | P.F |
|---|---|---|---|---|---|---|---|
| | RY/RN | YB/YN | BR/BN | R | Y | B | |
| LT 1 Mains | 423.7/234.3 | 424.5/254.1 | 423.2/243.6 | 13478 | 1185 | 1199 | 0.935 |
| LT 1 Sub breaker | 423.4/244.3 | 424.1/245.3 | 422.5/240.7 | 839.4 | 898.4 | 853.2 | 0.899 |
| LT 1 pps new pcc | 423.2/244.69 | 318.5/245.4 | 421.03/241.4 | 644.5 | 514 | 505 | 0.969 |
| LT 1 mains panel | 428.0/248.9 | 425.5/250.4 | 425.5/2401 | 1783 | 1781 | 1693 | 0.914 |
| LT 1 sub breaker | 426.4/248.1 | 423.7/238.9 | 423.7/249.3 | 948.2 | 1031 | 967.7 | 0.969 |

## 4.3 Observations (MCC):

1. We observe that the average voltage across all panels is about 420 Volts.
2. The current differs from panel to panel based on which equipment runs on the connected system.
3. The R, Y, B currents for LT1 Mains is 13478, 1185, 1199 (Ampere) while the power factor is 0.935, which can be considered great by industry standards, but can still be improvised.
4. The R, Y, B currents for LT1 Sub breaker is 839.4, 898.4, 853.2 (Ampere) while the power factor is 0.899, which has to be improved.

### 4.4 Energy readings (PA New PCC):

| Panel | Kwh | Kvar | P.F | Current | Vph | Angle | KW | KVA |
|---|---|---|---|---|---|---|---|---|
| Main panel | 5628625.36 | 348.7 | 0.787 | 876.1 | 415.5 | 38.46 | 490.3 | 59.8 |
| Xylenol | 204090.314 | 11.81 | 0.748 | 90.38 | 414.8 | 44.30 | 140.3 | 19.87 |
| PA Cooling Tower | 17334.245 | 125.9 | 0.758 | 171.15 | 425.4 | 40.52 | 95.72 | 125.9 |
| New DAA cooling | 725291.43 | 92.62 | 125.8 | 214.4 | 423.7 | 36.48 | 125.8 | 156.8 |
| PA Chiller 1 | 364256.95 | 33.78 | 0.824 | 1017 | 425.38 | 29.29 | 68.29 | 33.78 |
| Boiler 1 | 30560.521 | 20.52 | 0.727 | 40.48 | 425.8 | 29.29 | 68.71 | 77.8 |
| Boiler 2 | 110928.636 | 184.4 | 0,957 | 0.413 | 247.3 | 17.66 | 2.31 | 2.322` |

### 4.5 Observations (PA new PCC):

TABLE I. Contrary to the readings from MCC, we observe here that the Power factor at the main panel of PA New PCC is 0.787, which is extremely bad, even by industry standards.

TABLE II. Similarly at all other panels, we see at power factors are 0.748, 0.758, 0.804, 0.824, 0.727, 0.957 for Xylenol plant, PA cooling tower, New DAA cooling, PA chiller 1, Boiler 1 and Boiler 2 respectively.

**TABLE III.** Except for Boiler 2, all other P.Fs are not acceptable and have to be fixed as soon as possible, increasing current draw can also cause damage to the cables used, which can decrease the lifespan by many years.

## 5. Final product of Audit and Recommendations

### 5.1 Power factor correction at PA New PCC :

From the main panel we observe the power factort be 0.787 which is acceptable by industry standard to correct the power factor we suggest the installation of a capacitor bank at PA New PCC.

### 5.2 Calculation:s for PA New PCC:-

Total average load current was 876 Ampere and power factor shows to be 0.787.Reactive power shows 348 Kvar (lagging).

Power consumption at current of 876 Ampere.

$P = \sqrt{3}\ V * I * \cos \varphi$

$P = \sqrt{3} * 415 * 876 * 0.787$

$P = 495$ KW.

**Using power factor correction formula :-**

Required capacitor = KW (tan $\omega_1$ - tan $\omega_2$)

Present power factor = cos $\omega_1$= 0.787

Improvement required for power factor = cos $\omega_2$ = 0.999

Since,

cos $\omega_1$ = 0.787

therefore, $\omega_1 = \cos^{-1}(0.787)$

$\omega_1 = 38.093^o$ ……1

and,

cos $\omega_1$ = 0.9999

therefore, $\omega_1 = \cos^{-1}(0.9999)$

$\omega_2 = 0.810^o$ ……2

hence, put 1 and 2 in equation for required capacitor :-

Required capacitor = KW (tan $\omega_1$ - tan $\omega_2$ )

= 495 * (tan (38.093) – tan(0.810))

= 495 * (0.783 – 0.014)

= 495 (0.769)

= 380

capacitor required = 380 Kvar

After adding 125 KVAR bank circuit current reduced to 88 amp in load and

PF = 0.846

therefore,

power conservation P =$\sqrt{3}$ *V*I*cosω

P = $\sqrt{3}$ *415*88*0.846

P = 53.51 KW

we save 53.51 Kw/hr

Now, for 24 hr 53.51*24= 1284 kw/day

for a month = 1284*31 days

= 39,804 kw/month

Now per unit cost for mseb is = Rs. 7

therefore,

cost saving = 39804*7

= Rs. 2,78,628 /month

Total cost saving /month = Rs. 2,78,628

We suggested the capacitor bank of 380 kvar & use of 125 kvar capacitor bank was done by industry.

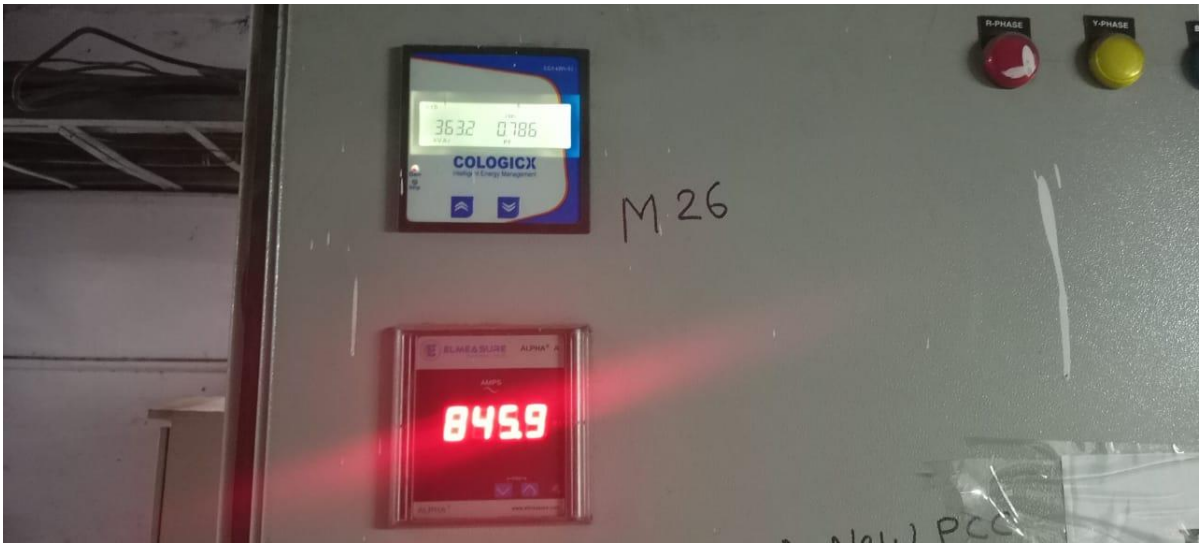



**Fig. 5.1 Current draw and P.F at PA new PCC before installing capacitor bank.**

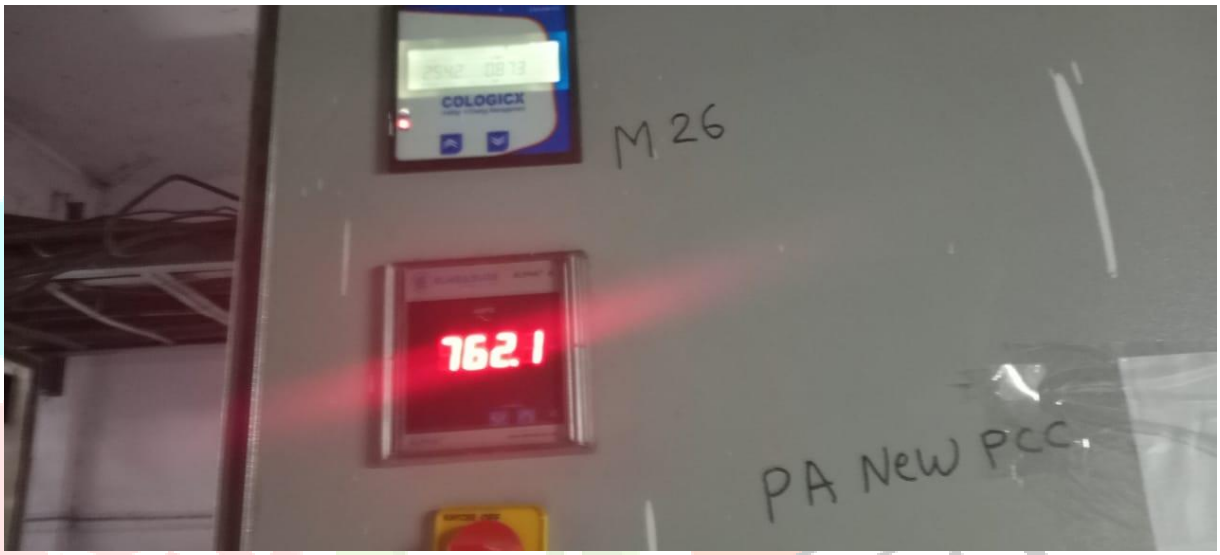



**Fig. 5.2 Current value of PA new pcc after connecting capacitor bank**

### 5.3 Cogen to MSEB

Cogen charge per unit = Rs.12

MSEB charge per unit = Rs.7

P = 495 kw

For, 24 hr 495*24 = 11880 kw/day

For a month = 11880 * 30 days

= 356400 kw/month

Therefore,

Total monthly cost of cogen = 356400 * 12

= Rs. 4276800

Total monthly cost of MSEB = 356400 * 7

= Rs. 2494800

Cost saved by shifting to MSEB = Rs.178200

Cogen initially charged around same amount per unit but in recent years due to rise in cost of coal the per unit priced has almost doubled. So it is more feasible for Prasol Chemicals to use mseb as a main source of power and use cogen as a standby.

## 6. Conclusion:

After careful observations of all the parameters that we could analyze using the tools and knowledge we had, we have compiled this report as a guidebook to be used for reducing the consumption of energy at Prasol Chemicals, Khopoli, which would result in major monetary saving throughout the year.

These below are a few things to think about:

[1] Switch to MSEB as the main source of power and keep Cogen on standby, only to be used during power outage or other emergencies.

[2] Install the recommended 380 Kvar capacitor bank in gradual steps, over the time of one year, while also making sure that the system is not overcompensated.

[3] With the current power bank installed the saving are approximately Rs. 2,78,628 /month.

[4] This can be increased to Rs.4,56,828/ month, if we shift the main source of power to MSEB.

[5] The Cogen power supply runs a generation unit which has maximum capacity of 5 MW, but, to this date, the maximum power requirement has never exceeded 2 - 2.5 MW, the 5 MW plant was installed in hopes of increasing the production units at Prasol, but the plans were subsequently dropped, hence, it is recommended that Cogen exchanges the 5 MW generator for a 3 MW generator to save fuel cost.

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