

Management of Propylene Recovery Unit

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Abstract: This paper deals with the functioning of a Propylene Recovery Unit (PRU) in a chemical industry and the various Managerial and Human Resource considerations that need to be accounted for, in this process. This report discusses various aspects that are to be considered, before initializing the setup of PRU, ranging from a Management perspective. Mission and objective was decided and subsequently the managerial model was developed. Propylene is an indispensable raw material that has a variety of end use. A detailed analysis pertaining to propylene demand in the market along with major sources has been incorporated in this paper. Emphasis has been placed on the type of departmentation required. Managerial aspects of various functions ranging from warehousing to quality control have also been taken into consideration. Delegations of functional departments have been defined to prevent redundancy of duties and major managerial functions of Planning, Organizing, Staffing, Leading and Controlling has also been discussed. Internal and External factors that affect the company have been analyzed through SWOT Analysis and MBO strategies are also broadly classified. Finally, Total Quality Management and strategies for adoption of Lean Manufacturing as also touched upon briefly.

Keywords-Human resource, Decision making, Controlling, Total quality management, Control system, Operations management

I. INTRODUCTION

Propylene is one of the most important components in the petrochemical industry after ethylene. It acts as a raw material for a large number of products. The dominant outlet for propylene is polypropylene, films, packaging, caps, closures, acrylonitrile, propylene oxide, cumene, isopropanol and acrylic acid.

The largest fragment of propylene is obtained as a primary byproduct from ethylene manufacture. Ethylene plants that charge liquid feedstock typically produce around 15% by weight propylene. The remaining 70% propylene is utilized by petrochemical industry. Fluid catalytic cracking (FCC) supplies almost 30% of the petrochemical requirement in the United States.

Over the years, there has been a considerable increase in Propylene demand as compared to that of ethylene. Since steam cracking is an inefficient process for propylene production, alternate sources of propylene are of increased interest, including scaling-up production from FCC units.

A. Applications

The primary consumption of propylene is for the polypropylene (PP) production, which accounts for approximately two-thirds of propylene consumption worldwide. For example, Propylene has a large market demand starting from the production of films and packaging caps to closures. Other major end uses of Propylene are for Acrylonitrile (ACN), Propylene Oxide (PO), alcohols, cumene, isopropanol and acrylic acid production.

Propylene is often used for calibration of gas mixtures in petrochemical industries; environmental emission monitoring system, industrial hygiene monitors and trace impurity analyzers are among a few.

B. What is Propylene Recovery Unit (PRU)?

The LPG from the FCCU contains ethane, ethylene, propane, propylene, butane etc. Distillation is performed in order to extract propylene from the mixture. But complete isolation cannot be done in a single stage because propane and propylene have a very low relative volatility. Hence two distillation columns are used for the production of chemical grade propylene.

C. Quality Control - Laboratory Testing

For any product to be sold in a market, it should satisfy some specifications, which is where the quality control lab comes into play. It is therefore essential to have an independent unit for monitoring the product quality via a number of tests. The quality control lab tests the products made before beginning a process (like raw materials, additives), while the process is going on (to determine how far the reaction has completed and the extent or reactants to be replenished in recovery) and after the product has been formed (final testing before releasing it commercially). The parameters are set beforehand as advised by the R&D and the lab takes care that the test materials follow the parameters accordingly. Any deviation from approved limits, correction factors and methods are suggested and the product is re-tested.

In case of propylene and LPG, gas chromatography is the major qualitative test performed. In case of propylene, no other test is used as gas chromatography shows the composition of the mixture tested. For other products such as gasoline, kerosene, diesel etc tests such as flash and fire point, viscosity, freezing point, octane or cetane number, pour point etc are performed.

Utilities are common resources that are used by every part of a major plant and it is therefore important to ensure that each portion gets their allocated share of resources. Need for safety is very important especially in a chemical plant. A well-documented work and safety permit system to undertake maintenance job in the plants would prevent unauthorized personnel who do not possess the pre-requisites to operate or repair a machine. The major hazard that is likely to be encountered is fire. All operators are trained in basic fire and safety skills pertaining to their area in the plant. It is the responsibility of the supervisor to ensure that the safety gear is made use of.

D. Organisational Structure

The Propylene Recovery Unit is an auxiliary plant in Refinery. However, a certain amount of freedom is given to this plant to enable it to function as an independent organization. Financing and sales are done by the finance department and marketing department of Refinery respectively. The plant does not have its own sales and finance dept. This is a production unit hence narrow span organization structure is ideal.

E. Delegation of Functional Department

1) Engineering Department:

Engineering department undertakes the design of processes and equipment and monitoring of overall day to day functioning of the plant via DCS (Distributed Control System).

2) Production Engineering:

They carry out on-field plant maintenance and monitoring. They must also undertake the calling of tenders to hire skilled laborers on a contract basis. Stocking and managing of utilities and also negotiating with suppliers are done by personnel of this department.

3) Management and Communications:

This department is responsible for establishing communication with the parent group. They undertake flow of investment, technology, and facilities from the parent group. They also carry out intra-plant communication e.g. from the control room to the site etc. This panel consists of members with good managing experience and technical background in communications.

4) Human Resource:

They undertake activities of recruitment, training, and development etc. They also schedule the working shifts of employees ensuring that day and night shifts are judiciously distributed. They also conduct activities for the welfare of staff and engage in headhunting of new talents.

F. Planning

Planning involves selecting future missions and objectives with the aim of achieving them through methods like decision making, which is, choosing suitable course of action from various alternatives

1) Types of Plans

i. Mission or Purposes

To recover propylene from petroleum process stream and use it as an additional material or sell it to the outside market to generate more revenue for the industry.

ii. Objectives or Goals

In order to satisfy the market demand for propylene, the propylene needs to be recovered from the process streams, purified, stored and sold. This would bring about additional revenue for the company as well as increase its market shares and production capacity.

iii. Strategies

One of the sources for propylene is from cracking process, which aims to produce ethylene. Propylene is profitably obtained as a result from refinery cracking operation, which often produces other economically viable products also. Propylene can be separated by fractional distillation from hydrocarbon mixtures produced from various refinery operations.

iv. Policies

One major policy requirement needed is regarding the land or the premise that is chosen for setting up the PRU. Final decision making cannot be taken at once, and usually involves considering factors such as the cost of land, operational constraints, transportation facilities etc. Suitable options are then chosen by the expert committee. Another major policy that stands in the way of work is government approval. This is commonly found to take a lot of time and is sometimes tedious.

2) Procedures

- i. Inception Stage
- ii. Preliminary feasibility studies and evaluation of market studies
- iii. Development of data necessary for final design
- iv. Final Economic evaluation
- v. Detailed Engineering Design
- vi. Complete construction design
- vii. Procurement
- viii. Erection
- ix. Startup and trial run

3) Rules

- i. Ensure safety for buildings situated inside refinery complex
- ii. Restrict access to unauthorized personnel
- iii. Quick access to emergency services
- iv. Employees are requested to follow Standard Operating Procedures appropriately

4) Program

The PRU unit setup should direct the product streams from various units located in the Refinery Complex to its plant site and ultimately aim is at improving the recovery of propylene and selling it as and when the market demand arises.

G. Estimation of Capital Investment Cost

- i. Purchased Equipment Cost (PEC):(15-40% of Fixed-capital investment)
- ii. Installation, including Insulation and Painting:(25-55% of purchased equipment cost)
- iii. Instrumentation and controls [Installed]:(6-30% of Purchased equipment cost.)Consider the installation cost =20% of Purchased equipment cost
- iv. Piping [Installed]: (10-80% of Purchased equipment cost)
- v. Electrical [Installed]: (10-40% of Purchased equipment cost)
- vi. Buildings, process and Auxiliary: (10-70% of Purchased equipment cost)
- vii. Service facilities and yard improvements: (40-100% of Purchased equipment cost)Facilities and yard improvement=70% of PEC
- viii. **Land:** (1-2% of fixed capital investment or 4-8% of Purchased equipment cost) Consider the cost of land =6% PEC
- ix. Indirect costs
- x. Total Capital Investment (TCI)
TCI = Fixed capital investment + . . Working capital
- xi. Total Product cost = Manufacture cost + General Expenses

H. Coordination of Short- and Long-Range Plans

The short-range plans are not taken independently without considering proper long-range plans. For example, short-range plans of adding new equipment to the already existing system to increase the efficiency, is only done after calculating payback period and profitability of the product in future markets.

I. Verifiable Objectives

The verifiable objective is mainly to inspect the profit generated by plant and recovery of propylene over the years. This mainly involves checking and evaluating the records on a periodical basis.

Multiplicity of objectives:

The complexity and multiplicity of objectives are generally kept as low as possible to avoid complex procedures of evaluation and critical thinking. Since this is a recovery unit, which acts as a sub-unit to the main plant operations, the recovery efficiency is only taken into consideration.

J. SWOT Analysis

Internal Factors External Factors	Strength(S) :	Weakness(W):
	<ul style="list-style-type: none"> • Strong Management • High product demand 	<ul style="list-style-type: none"> • Need to improve marketing strategies
Opportunity(O):	SO:	WO:
<ul style="list-style-type: none"> • High market value 	<ul style="list-style-type: none"> • Increased Efficiency 	<ul style="list-style-type: none"> • Increase/Widen market
Threat(T):	ST:	WT:
<ul style="list-style-type: none"> • Other similar companies 	<ul style="list-style-type: none"> • Branched development 	<ul style="list-style-type: none"> • Liquidation

K. Blue Ocean Strategy

The competitors are eliminated or reduced by widening the markets and increasing the manufacture of allied products that require propylene. This is important in the present scenario since another company set up with the same propylene recovery unit can compete by also supplying to the external markets.

L. Objectives & Organisational Hierarchy

Lower level managers are expected to monitor the performance and other personal development strategies connected with the total working force of a particular section. Their responsibilities also extend to achieving department and sectional goals with due consideration of quality, efficiency, and effectiveness without creating any personal dissatisfaction among company employees.

They should look into day-to-day matters of the company in a much narrow perspective and the profit-making policies and decisions taken up by the higher authorities do not affect them in any manner.

Middle-level managers in the production unit should look into specific departments like purchase, production, warehousing, maintenance, quality control and accounts.Their overall specific objective job design should allow them to focus on specific regions or areas of the company where improvement is needed. This also helps them exert a line authority over the lower level managers. Only the employees with potential managerial skills should be put in this position.

Top level managers exercise a direct control over the middle and lower level managers. They are solely responsible for handling a particular department of a company and is

considered a very critical position to be in. Long-range plans are put-up in consultation with the Board of Directors and are entrusted with working towards the mission and vision of the company.

The top level managers in this PRU should communicate to the line staff in a formal as well as in an informal fashion. Strict rules should be enforced so as to ensure proper communication channels.

The strategies followed should include Top-Down, Bottom-Up and Diagonal approaches with the staff having the authority to hold formal as well as informal meetings that benefit the company.

M. Management by Objective (MBO)

Management by objective is a complex managerial approach that combines many key managerial activities in a systematic and effective manner

The Managers at each and every level should be advised to motivate and encourage the employees or the Staff Authorities by praising them for their good work, create a friendly environment for competition among employees, allot incentives for effective work done outside their scope and create proper unbiased promotion programs. Focusing on the fact that managers are working to achieve a certain task or objective in-hand, creates a notion of a well-defined goal.

Responsibilities of employees should inform during the training period. This is a very fundamental approach since, knowing their objective can make them work for it in a much faster way.

Periodically, results are analyzed to come up with the SWOT analysis of various sections in the unit. The managers of the respective units should be informed of their strengths and weaknesses. In the case of finding any weaknesses, the managers must be given some time to take remedial measures.

N. Decision Making Process

1) Premising

It is highly important to place the unit and the managers connected to it, in the right location. PRU unit should be set up by considering various factors like raw material availability, external markets, demand, and consumption. It has been found that it is profitable to place the plant near the Refineries complex taking into account the various factors mentioned above.

2) Identifying Alternatives

The alternative options available are regarding markets and source of raw materials. It has been analyzed and arrived upon the conclusion that a nearby refinery complex can act as the source for raw materials.

3) Evaluating Alternatives in terms of Future Goals

The support from a Public Sector Enterprise would often strengthen the PRU as the stability, both in terms of market shares and new future ventures are favorable, by entering into a deal and working as a subsidiary unit.

4) Final Decision Making

Final Decisions have to be taken only after holding meetings with the top level authorities of mother industry. Since, the PRU does not exist independently and is a company based on mutual trust and coordination, the higher-ups of the PRU do not exercise complete decision-making power.

O. Staffing

Staffing is defined as filling up of positions available in the organization structure by recruiting the right amount of suitable candidates who can aid in company's development

The Staffing procedures are carried out in the following manner:

1) Recruitment

2) Selection

The call for managers or other staff required to fill vacant positions, should be put up in company's website and also as a newspaper article. The applicants are required to fill up the online form available on the website or get the form offline from the company's main office.

A written test on basic engineering skills must be conducted followed by an interview. The candidates are selected on the basis of their knowledge on core. A language proficiency test must be conducted. The interview should test the candidate's ability to undertake decision making.

3) Placement

The successful candidates who clear the selection process should be placed in various departments according to their core competencies. The first year will be a training period, where a stipend must be provided on a monthly basis. After the first year, according to the available vacancies on position, they should be sent to various divisions of the unit.

4) Promotion

Only the candidates who contribute largely to the company should be promoted. The others are just lead a stagnant position or must be re-trained to avert over-utilization of resources.

5) Separation/Retirement

In this company, it should be noted that appraisal to the managers must not be provided merely on the basis of Verifiable Objectives they achieve. The Manager should exhibit his persona in a good way, which is considered the basis for appraisal. Therefore, Non-Verifiable Objectives should be taken into consideration when an appraisal is to be given.

According to the article titled "Let First Level Supervisors do their Job" (Frank.S.Leonard and W.EarlSasser) it is said that our knowledge of the traits that a true manager possesses is still not complete enough.

The article quotes that highly productive working groups had an inbuilt sense of pride in them. It is even said that the Managers of High Productivity groups maintain a general supervision over their employees when compared with other managers of low productivity groups, who often maintain a stringent control over their employees.

P. Digital Enterprise For Increased Productivity

As suggested by Lisa London (Industry Week), the digital revolution is transforming every aspect of our world, disrupting traditional business models and changing the way many organizations — and their end customers — are operating. For example, the explosive growth of e-commerce has created tremendous pressure on retailers, distribution centers, and logistics companies, forcing them to deliver orders faster and more cost-effectively than ever before. At the same time, increases in shipping rates and challenges with delivery capacity have driven e-commerce retailers to find new ways to manage costs and optimize inventory.

In addition, companies and their workers in distribution centers or in the field are demanding advanced access on their mobile devices and the ability to quickly and easily capture critical data in an intuitive way. This creates opportunity — for applications, data management, and insights — but also forces enterprises to ensure solutions they invest in are user-friendly, improve productivity and are future-proof.

Q. Leading

Leading refers to the process of influencing people, to make them contribute to organizational as well as group goals

In order to provide motivation to the employees of the PRU, periodical assessment of their performance should be carried out and managers linked with higher productivity should be encouraged to celebrate their success and share small tokens of their happiness with their fellow employees who did not achieve their targets or goals for that particular method.

Managers are, however, strictly advised not to lose control out of their hands. They should be authoritarian in working environments and friendly when handling human resource. The company should understand that employees are motivated only under circumstances that foster complete productivity and mundane works are avoided.

'Leading' literally refers to being a leader of a group or an organization. It is a trait that is expected from a manager and something which all managers must fulfill for being called a successful manager.

As discussed earlier, PRU has almost 20 major managers handling various aspects that are crucial for the smooth

running of the plant. Be it any manager, if he/she is found to involve in any deceitful activities which would harm the unit, the person must be dismissed from the company with immediate effect. Therefore, mutual understanding among various departmental managers and between the line and staff authorities should be of much importance here.

R. Controlling

Controlling is the analysis and correction of performance related tasks in order to achieve objectives efficiently and effectively

The basic control processes include:

1) Establishment of standards

Employee standard: Working hour's flexibility must be ensured. The plant must be operational throughout the day with employee shift occurring for every 8 hours. Employees engaging in work during Sundays and public holidays should receive bonuses inclusive of paid holidays.

2) Production standards

The production capacity of sufficient quantity of distillate (propylene) is to be maintained in accordance with market demands. The purity of the distillate must be 95% as per the Lab standards.

3) Correction of deviations

Correcting deviations often involve appointing an Inspection team of experts comprising of:

- a. Chief Chemical Engineer
- b. Chief Mechanical Engineer
- c. Instrumentation engineer
- d. Senior Lab Technician
- e. Production Manager.

The team should ensure corrective measures inclusive of training, re-staffing. Feedback control system that measures the purity of output and informs the production team if changes are necessary.

S. Critical Point Standards

1. Physical standards

Human Resource team must be appointed by HQ to monitor labor employed. Supply Chain Management must monitor raw material usage, output stocking, delivery to the market, labor hour per unit output and fuel to product ratio etc.

2. Capital and Cost Standards

The cost accounting team must keep track of material costs, machine costs per hour and selling costs.

3. Program Standards

The top-level management must constitute technical officers who look after innovation and introduction of new products and programs for improving quality of sales force.

4. Intangible Standards

Sales team is in charge of intangible standards like effect and quality of advertising, the competence of purchasing agent etc.

T. Control System

Control system adopted is feedback control system. Managers do the actual performance, measures the actual performance-labor, machines and overall production. Compares the performance against previously standard and develops corrective action in consultation with correction deviation team mentioned above comprising of 5 experts.

U. Profit and Loss Control

The accounting team in coordination with sales managers and purchase managers should keep track of cash inflow and outflow and also the computation of profits at the end of each fiscal year.

Control through return on investment is the ratio of earnings to capital investment.

V. Operations Management

The various tasks pertinent to production/operations are:

- 1) Raw material procurement
- 2) Transportation
- 3) Warehousing
- 4) Mobility of goods with factory
- 5) Engineering
- 6) Production and Utility Management
- 7) Stocking Product
- 8) Sales

Just-In-Time Inventory System: This is not applicable for PRU because the furnace consumes fuel continuously abrupt shut down in case of contingencies such as late arrival of raw material is highly undesired.

W. Outsourcing

The creation and updating of software for running DCS (Distributed Control System) should be outsourced to a software firm. The canteen and provision for other recreational facilities for the working and support staff can be outsourced to Catering and HR based institutes necessarily. This happens via calling of tenders on a yearly basis.

X. Operations Research

This involves the application of scientific methods to analyze and existing problem and development of alternatives. The emphasis on scientific method includes validation on

quantitative data, goals, and determination of best means of reaching goals.

1) Value Engineering:

In this step, the production is divided into various steps in order to improve efficiency and cut costs.

2) Raw material procurement:

Search for suppliers and establish rapport with those who provide high-quality raw material or low cost.

3) Auxiliary Services:

Utilities like steam and coke needs to procure at low cost.

4) Equipment Maintenance:

Frequent checks for fouling or any other anomaly that reduces the efficiency or performance of equipment or a process are carried out.

5) Research

Involves finding out alternate reaction mechanisms or pathways, to carry out production related tasks.

6) Work Simplification:

This involves monitoring of participation of workers and seeking their opinions. Working timings and shifts has to be decided upon incorporating conveniences of the operators and engineers.

7) Quality Circles:

This refers to a group of people who has the same area of specialization. They meet together and discuss ideas to in the area of their competency.

Y. Total Quality Management

The policies are made at the top level to ensure overall quality. The principle of KAIZEN or continuous and small progress is incorporated into the system of functioning. We cannot control anything that we cannot measure. Thus, monitoring duties are delegated for measuring the quality in terms of performance, service and employee satisfaction. Necessary methods are adopted and periodically modified to ensure this.

Adoption of Lean Manufacturing:

1. Continuous improvements with strategic breakthroughs.
2. Aiming at zero defects.
3. Just in time inventory system
4. Team management
5. The responsibility of problem lies on everybody, especially management

II. RESULT

The nuances of managing a Propylene Recovery Unit have been understood and premising has been undertaken to analyze situations and potential threats to ensure a smooth running of the plant. Organizational structure outlining clearly the delegations of each department in accordance with company objectives has been created.

III. CONCLUSION

For an organization that engages in the production of a commodity, functional departmentation yields best possible results. Premising and process are essential to monitor company's stature in business environment. Activities such as the functioning of the staff canteen and organization of events for staff welfare which are not in line with company objectives can be outsourced to simplify planning and organization processes.

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