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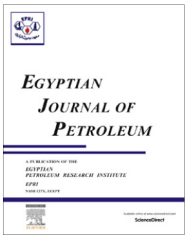

FULL LENGTH ARTICLE

Economic evaluation of aromatics production, a case study for financial model application in petrochemical projects

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KEYWORDS

Petrochemical projects economics;
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Abstract Economics is the engine that drives industry. For complete understanding of project economics four major items must be discussed; capital requirements, operating expenses, cash flow and profitability measures.

Petrochemicals in general are compounds and polymers derived directly or indirectly from petroleum. C_6–C_8 aromatics are petrochemical intermediates that include benzene, toluene and xylenes.

This research work aims to execute a financial model template using MICROSOFT EXCEL PROGRAM which can be applied on any industry to check its profitability.

Two configurations for aromatics production had been considered as a case study for model application, Configuration I for the production of benzene, toluene and xylenes and Configuration II for the production of benzene and para xylene only based on 3 million tons of straight run naphtha feedstock. In addition, the economic effect of the integration between Configuration II and MIDOR refinery had been studied.

The designed and initiated financial model performed in this paper is applied on a real and existing petrochemical project to check its validation. The economic indicators calculated using the initiated financial model were found to match with the actual status of the project.

The research resulted in; Configuration I and II are not profitable under the mentioned basis. The integration between Configuration II and MIDOR refinery is more profitable than the standalone one.

Configurations I and II shall be feasible if the quantity of naphtha feedstock increases to 70,000 and 5500 thousand tons per year respectively. Configurations I and II shall be feasible if the discount in naphtha feedstock price reaches to 9% and 4.5% respectively.

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1. Introduction

Economics plays a significant role at various stages of any industrial project development and progresses [1]. Petrochemicals in general are compounds and polymers derived directly or indirectly from petroleum and used in the chemical market. Among the major petrochemical products are plastics, synthetic fibers, synthetic rubber, detergents, and nitrogen fertilizers.

The petrochemical industry is mainly based on three types of intermediates, which are derived from the primary raw materials. These are the C_2–C_4 olefins, synthesis gas (H_2/CO mixture) and C_6–C_8 aromatic hydrocarbons. In the petrochemical industry, the aromatic hydrocarbons of commercial interest include benzene, toluene, ortho-xylene and para-xylene [2].

As economics is the engine that derives industry and because of the local and global demand of aromatics, the main concern of the present work is to execute a financial model using MICROSOFT EXCEL PROGRAM that could be applied on any project to check its profitability. Further, apply the financial model to perform an economic evaluation of aromatics production configurations based on 3 million tons per year of straight run naphtha feedstock and calculate the economic indicators (Internal Rate of Return (IRR), Net Present Value (NPV) and Payback Period (PBP)) for each configuration. In addition the effect of changing some parameters such as feedstock capacity and feedstock price on those economic indicators is analyzed (configuration sensitivity analysis). Nevertheless, the financial model template is applied to analyze the economic effect of the integration between aromatics production Configuration II with an existing refinery (MIDOR).

2. Background

2.1. Economic background

For complete understanding of project economics and feasibility study three major items must be discussed; capital requirements, operating expenses, cash flow and profitability measures [1].

2.2. Capital requirement

Capital requirements include funds required to purchase land, design, install equipment and install buildings, as well as to bring the facility into operation. Source of funds are debt and equity [3,4].

2.3. Estimation of capital cost

Capital cost is divided into hard, owners and soft costs. Hard cost is the cost of inside and outside battery limit equipment cost. Owner's cost includes engineering fees, project contingency allowance, preoperational cost and start up and commissioning costs. Soft cost equals the summation of working capital (working funds necessary to conduct a day-to-day business of the firm), indirect cost and financing fee [1,4].

2.4. Annual operating cost

Operating cost is the annual cost of operation divided into fixed and variable costs. Fixed cost includes the cost of maintenance and insurance and variable cost is the cost of raw materials, chemicals and catalyst, utilities, land lease and salaries [1,5].

2.5. Annual net revenues

The annual net revenue is equal to the annual gross revenue after the deduction of all annual expenses such as operating cost, depreciation and taxes [1,6].

2.6. Economic indicators

2.6.1. Internal Rate of Return (IRR)

IRR is the rate of return used in capital budgeting to measure and compare the profitability of investment opportunities. It is also called the discounted cash flow rate of return (DCFROR) [5].

2.6.2. Payback Period (PBP)

PBP is the period of time (years) required to recover the cost of an investment. It is the capital investment cost divided by the annual profit [7,8].

$$\text{PBP} = \frac{\text{Capital investment cost}}{\text{Annual profit}} \quad (1)$$

2.6.3. Net Present Value (NPV)

The Net Present Value (NPV) or net present worth (NPW) of a time series of cash flows, (both incoming and outgoing) is defined as the sum of the present values of the individual cash flows. NPV is a central tool in discounted cash flow (DCF) analysis, and is a standard method for using the time value of money to appraise long-term projects [9].

2.7. Project sensitivity analysis

Sensitivity analysis is the study of the effect of changing some parameters such as plant capacity, feedstock price, capital investment cost...etc. on project economic indicators [10,4].

2.8. Aromatics background

Benzene, toluene, xylenes (BTX), and ethyl-benzene are the aromatic hydrocarbons with a widespread use as petrochemicals. They are important precursors for many commercial chemicals and polymers such as phenol, trinitrotoluene (TNT), nylons, and plastics. The wide range of applications involving the main aromatics, benzene, toluene and xylenes Fig. 1, illustrates the importance of these intermediate products to the chemical and petrochemical industry [2,11].

2.9. Various feedstocks of aromatics production

The main sources of aromatics (benzene, toluene and xylenes) are reformate from catalytic reforming of straight run

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