RSC | Advancing the Chemical Sciences

Linear Cost Equation Example

A chemical company operates a plant to produce ethylbenzene from benzene and ethene using a Friedel-Crafts alkylation process. A summary of information about the manufacturing plant is provided below:

Item	Value
Labour costs	£500,000 a^{-1}
Benzene purchase price	£600 t^{-1}
Benzene usage	0.75 t t^{-1}(of ethylbenzene produced)
Process water	£10,000 a^{-1}
Management costs	£100,000 a^{-1}
Marketing costs	£200,000 a^{-1}
Plant capacity	100,000 t a^{-1}
Maintenance costs	£50,000 a^{-1}
Ethene purchase price	£450 t^{-1}
Ethene usage	0.28 t t^{-1}(of ethylbenzene produced)
Catalyst costs	£100,000 a^{-1}
R&D costs	£100,000 a^{-1}
Ethylbenzene selling price	£1600 t^{-1}
Process energy costs	£84,000 a^{-1}
Depreciation of plant capital	£500,000 a^{-1}
Central Administration costs	£50,000 a^{-1}

Answer the following questions:

(a) Categorise the cost items as either ***fixed*** or ***variable*** costs. Comment on any assumptions you may make.

(b) Determine the values in the empty table below:

Quantity manufactured (*x*) (t a^{-1})	**Total Fixed costs (*F*) (£ a^{-1})**	**Fixed costs per tonne of ethylbenzene (*f*) (£ t^{-1})**	**Total Variable costs (*V*) (£ a^{-1})**	**Variable costs per tonne of ethylbenzene (*v*) (£ t^{-1})**
0				
999				
1000				
1999				
2000				
2999				
3000				
3999				
4000				
4999				
5000				
5999				
6000				
6999				

7000				
7999				
8000				
8999				
9000				
9999				
10000				

(c) Draw a graph to show the variation of ***average fixed costs per tonne (f)*** and ***average variable costs per tonne (v)*** with the **quantity (*x*)** of ethylbenzene produced. Comment on your graphs.

(d) Prepare a Total Cost equation, which will show the variation of **total costs (*C*)** with **quantity (*x*)** of ethylbenzene produced.

(e) Prepare an Average Cost equation, which will show the variation of **average cost (*AC*)** with **quantity (*x*)** of ethylbenzene produced.

(f) Determine the numerical values in the empty table below.

Quantity manufactured (*x*) (t a^{-1})	**Total cost (C)**	**Total revenue (R)**	**Average cost (AC)**	**Marginal cost (MC)**	**Marginal revenue (MR)**	**Profit (P)**
0						
999						
1000						
1999						
2000						
2999						
3000						
3999						
4000						
4999						
5000						
5999						
6000						
6999						
7000						
7999						
8000						
8999						
9000						
9999						
10000						

(g) Prepare a **marginal cost (*MC*)** equation and a **marginal revenue (*MR*)** equation

(h) Draw a graph to show the variation of ***total fixed costs (F)***, ***total variable costs (V)*** and ***total costs (C)*** with **quantity (*x*)** manufactured. Comment on your graphs.

(i) Draw a graph to show the variation of ***marginal cost (MC)***, **average costs (*AC*)**, ***marginal revenue (MR)*** and **profit (*P*)** with **quantity (*x*)** manufactured. Comment on your graphs.

(j) How much ethylbenzene should be manufactured in order to maximise the **profit (*P*)** for the company? What is the minimum amount of ethylbenzene that should be manufactured in order to make a profit for the company?