How to Start Manufacturing Industries

CYCLOHEXANE

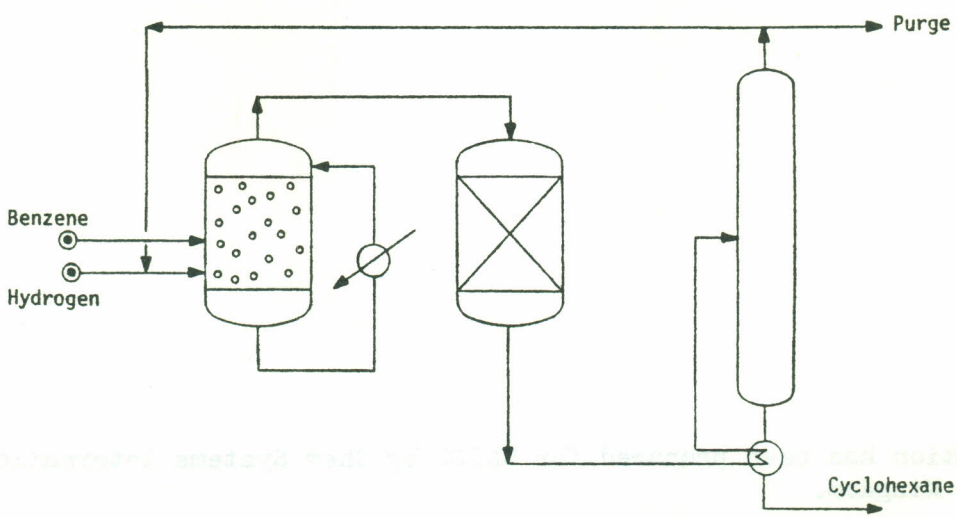
Process Description

Benzene and hydrogen-rich gas are fed to a liquid-phase reactor in which raney nickel catalyst is maintained in uniform dispersion at a temperature below 250^{o}C and a pressure above 3 bar. Overheads are sent to a finishing reactor where the remaining benzene is converted Use of the second reactor allows the main liquid-phase reactor to be kept to a reasonable size.

Effluent from the second reactor is cooled and liquid separated in a high pressure drum. Benzene from hydrodealkylation or RTX extraction feeds may be used. Hydrogen feeds must have low sulphur and carbon oxide levels.

Uses

Major use is as a raw material in nylon-6 and nylon-6,6 manufacture. Cyclohexane is an excellent solvent for resins, waxes, fats, oils, etc when used in conjunction with other hydrocarbons. Nearly all the cyclohexane production is consumed in nylon-6 and nylon-6,6. Other uses as a solvent for cellulose ethers, resins and waxes.



Plot area required for a typical plant of 180 000 tonnes per year capacity would be in the region of 2 000 square metres. The minimum capacity of this plant may be as small as 30 000 tonnes per year from a technical point of view.

This information has been prepared for UNIDO by Chem Systems International Ltd., United Kingdom.

Any inquiry about the information contained should be sent to: IO/COOP, Registry file No. ID/562/12, UNIDO, P.O. Box 300, A-1400, Vienna, Austria.

COST OF PRODUCTION ESTIMATE FOR CYCLOHEXANE
(EXPRESSED IN CONSTANT 1980 US DOLLARS)
PROCESS - BENZENE HYDROGN

BASIS
LOCATION- BENELUX
CAPACITY- 180 000 TONNES PER YEAR
PRODUCTN- 180 000 TONNES PER YEAR
YEAR - 1980
STR.TIME- 8000 HOURS PER YEAR

CAPITAL COST	$ MILL
BATTERY LIMITS	8.90
OFFSITES	4.01
TOTAL FIXED INV.	12.91
WORKING	40.91

RAW MATERIALS	QUANTITY/TONNE	PRICE*	ANNUAL COST	UNIT* COST
BENZENE	.9280 TONNE	590.000	98 553 600	
HYDROGEN	.0760 TONNE	1100.000	15 048 000	
CATALYST+CHEMS	1.0444 DOLLARS	1.000	188 000	
TOTAL RAW MATERIALS			113 789 600	632.16
UTILITIES				
POWER	.0270 MWH	61.500	298 890	
COOLING WATER	.5360 KTONNE	17.000	1 640 160	
TOTAL UTILITIES COST			1 939 050	10.77
OPERATING COSTS				
LABOUR	27.00 MEN @ 17 700 $/YEAR		477 900	
SUPERVISION	1.00 MEN @ 29 200 $/YEAR		29 200	
MAINTENANCE	@ .04×BLCC		356 029	
TOTAL OPERATING COST			863 129	4.80
OVERHEAD EXPENSES				
DIRECT OVERHEAD	@ .400× LAB+SUPERVISION		202 840	
GEN PLANT OVERHEAD	@ .650× OPERATING COSTS		561 034	
INSURANCE+PTY TAX	@ .015× TOTAL FIXED CAP		193 685	
DEPRECIATION	@ .100× BLCC+ .050×OFFS		1 090 652	
INTEREST	@ .100× WORKING CAPITAL		4 091 034	
TOTAL OVERHEAD EXPENSES			6 139 245	34.11
BYPRODUCT CREDIT				
TOTAL BYPRODUCT CREDIT			0	.00
NET COST OF PRODUCTION			122 731 024	681.84

VARIABLE COST OF PRODUCTION	642.94
CASH COST OF PRODUCTION	675.78
TRANSFER PRICE @ 10.0PC RETURN ON FIXED INV	689.01
TRANSFER PRICE @ 15.0PC RETURN ON FIXED INV	692.60
TRANSFER PRICE @ 20.0PC RETURN ON FIXED INV	696.19

* $/UNIT. TONNE=METRIC TON=2204.6 LB.

VARIATION ANALYSIS FOR CYCLOHEXANE BENZENE HYDROGN BENELUX LANG FACTOR 0.65

CASE NO	1	2	3	4	5	6	7
	TONNES PER ANNUM						
PLANT CAPACITY	180000	180000	180000	180000	144000	108000	72000
PLANT OUTPUT	180000	153000	135000	108000	144000	108000	72000
CAPITAL COST	MILLION DOLLARS						
BLCC	8.9	8.9	8.9	8.9	7.7	6.4	4.9
OFFSITES	4.0	4.0	4.0	4.0	3.5	2.9	2.2
TOTAL FIXED	12.9	12.9	12.9	12.9	11.2	9.3	7.1
WORKING	40.9	34.9	30.9	24.9	32.8	24.8	16.7
	DOLLARS PER TONNE PRODUCT - (BASED ON BENZENE AT $590/TONNE)						
RAW MATERIALS	632.2	632.2	632.2	632.2	632.2	632.2	632.2
UTILITIES	10.8	10.8	10.8	10.8	10.8	10.8	10.8
BYPROD. CREDIT	.0	.0	.0	.0	.0	.0	.0
VARIABLE COST	642.9	642.9	642.9	642.9	642.9	642.9	642.9
OPERATION	4.8	5.6	6.4	8.0	5.7	7.1	9.8
OVERHEAD(EXCL.DEPN)	28.0	29.1	30.0	32.0	29.1	30.7	33.8
CASH COST	675.8	677.7	679.3	682.9	677.7	680.7	686.5
DEPRECIATION	6.1	7.1	8.1	10.1	6.6	7.2	8.4
NET COST OF PRODN	681.8	684.8	687.4	693.0	684.2	687.9	694.9
RETURN ON INVESTMENT (AT 15% ON TOTAL FIXED INVESTMENT)	10.8	12.7	14.3	17.9	11.6	12.9	14.8
TRANSFER PRICE	692.6	697.5	701.8	710.9	695.8	700.8	709.7

EFFECT OF BENZENE PRICE VARIATION

PRICE CHANGE	+20%	-20%	+20%	-20%	+20%	-20%	+20%	-20%	+20%	-20%	+20%	-20%	+20%	-20%
RM PRICE $/TONNE	708.0	472.0	708.0	472.0	708.0	472.0	708.0	472.0	708.0	472.0	708.0	472.0	708.0	472.0
NET COST OF PRODN	791.3	572.3	794.3	575.3	796.9	577.9	802.5	583.5	793.7	574.7	797.4	578.4	804.4	585.4
TRANSFER PRICE	802.1	583.1	807.0	587.9	811.3	592.3	820.4	601.4	805.3	586.3	810.3	591.3	819.2	600.2