

TECHNO-ECONOMIC STUDY OF OXYGEN PLANT IN A LARGE HEAVY ENGINEERING INDUSTRY

Dilip Kumar Adhwarjee,

Email : adhwarjeevicky_48@rediffmail.com

Associate Professor, Mechanical Engineering department, DR. B.C. Roy Engineering College, Durgapur - 713206, INDIA

1. Abstract :

Oxygen for internal consumption is produced in the oxygen plant and supplied on daily/weekly/monthly basis to different shops/departments as per their requirements. A portion of the requirements for structural shop is being purchased from outside at present. Moreover, there were some complaints from different departments regarding insufficient supply of oxygen and, thus, creating a bottleneck in production. A detailed techno-economic study was taken up in consultation with Manager(Power Engineering), Chief Chemist and Manager (Fettling shop) as directed by Director(Marketing). The Chief Industrial Engineer along with his team took up the study.

2. Keywords :

Cost analysis, pressure, Purity, Separator, Expenditure, Economical

3. Procedure :

3.1 Supply Position :

A complaint had been received from Manager(Fettling shop) regarding insufficient supply of oxygen cylinder. The consumer shops and their normal and peak requirements were analysed as shown in Annexure -1

Annexure -1

SR NO	SHOP/DE PTT.	NORMAL REQUIREMENT	PEAK REQUIREMENT	FREQUENCY
1	Fettling shop	45	60	Daily
2	Forge shop	15	20	Daily
3	Structural shop	18	22	Daily
4	Salvage & Reclamation	05	10	Daily
5	Ancillary Stores	04	07	Daily
6	Scrap Preparation	02	02	10-15 weekly
7	Steel Foundry	01	01	7-8 weekly
8	Other prodn. Shops	01	02	4-15 fortnightly
9	Other deptt.	01	02	5-15 fortnightly
	TOTAL	92	126	

There are only 4 shops namely Fettling, Forge, structural, salvage & Redamation and Ancillary stores which require oxygen cylinders daily. Among them structural shop is partially supplied with purchased oxygen. The present plant capacity of 115 cylinders per day with only one separator(the

other separator being under break down) is sufficient to meet average daily demand of 92 cylinders. Moreover, there are about 200 to 300 filled up cylinders always available in the store attached with oxygen plant (except during the period of major break down). Therefore, the question of scarcity should not arise. However, there are certain bottlenecks which create artificial scarcity. Their remedial action is also suggested below:

- (1) Oxygen plant receives empty cylinders daily and an equivalent number of filled cylinders are to be issued to shops. However, assessing the trend of consumption the supply of a few nos. of cylinders are increased or decreased to shops/ department concerned. On the other hand, if less no of empty cylinders are returned to oxygen plant then a less no of (equal) filled cylinders are received by the consumer shop. It is, therefore, necessary for the consumer shops concerned to send all the empty cylinders daily.
- (2) For daily consuming shops a practice is made to maintain the stock of cylinders equivalent to the peak load consumption of the shop. Annexure-2 shows the total no of cylinders with different consumers shops/ deptt as on 01.08.13.
Annexure-2 (Account of 700 cylinders as on 01.08.2013)

SR . NO	SHOPS/DEPTT	EMPTY CYLINDERS	FILLED UP CYLINDERS	TOTAL
1	Fettling shop	25	51	76
2	Forge shop	10	24	34
3	Structural shop	20	33	53
4	Scrap preparation	10	10	20

5	M/C shop-1	05	05	10
6	M/C shop-2	02	06	08
7	M/C shop-3	02	06	08
8	M/C shop-4	01	03	04
9	M/C shop-5	08	06	14
10	Steel Foundry	03	09	12
11	Iron Foundry	08	04	12
12	Tool room	01	05	06
13	Heat Treatment	02	08	10
14	Salvage & Reclamation	04	14	18
15	Ancillary store	07	06	13
16	Compatibility Testing	07	04	11
17	Mechanical Engg. Division	06	10	16
18	Electrical Repair Shop	03	04	07
19	Plant Civil Maintenance	02	04	06
20	Central plant laboratory	01	02	03
21	Transport	01	01	02
22	Roads & Buildings	00	02	02
23	PMD(DTPS site)	00	03	03
24	Under maintenance	00	34	34
25	Cylinders in oxygen plant	318	00	318
26	TOTAL			700

Manager (O₂ plant) is advised to maintain the stock of filled cylinders against each shop equivalent to their peak load requirements plus a few extra to those shops who complain regarding inadequate supply. This can easily be done with the available no of cylinders in the plant at present. The extra cylinders must be sent back to oxygen plant.

After analysis and discussion the fettling shop has adequate cylinders, thus the complain is fake.

(3)One separator is sufficient to meet the requirement of the plant. However, 3 to 4 days per month are lost at the time of defrosting the oxygen separator at present. Since there is only one separator under running condition, the demand during those period is partly met by the available stock and partly by the purchased oxygen cylinders. But this may create a crisis when running separator also goes under break down.

Hence it is necessary to get the second separator repaired quickly. Till the completion of repair of the second separator , the scarcity of demand during defrosting period may be continued to be met by purchased oxygen

3.2 Purchase of oxygen:

Oxygen is being purchased mainly for structural shop due to the following reasons:-

(1)Purity (2) Inadequate pressure

A detailed discussion was held with Manager(structural shop), Manager(oxygen plant) and Manager (CPL). The followings are the suggestions regarding purchase of oxygen on grounds of purity and pressure

PURITY :

For industrial use the requirement of purity of oxygen is 99% as per B.I.S. However, for plasma cutting machine (optical scanner) the purity of oxygen required is 99.5%. A random checking of oxygen cylinders was done in oxygen plant jointly by IED & CPL .The result of random checking of purity and pressure is shown in Annexure-3A&B.

Annexure-3A(Filled up cylinders)

SR.NO	PRESSURE(Kgf/ cm ²)	PURITY(%)
1	100	99.6
2	110	99.3
3	105	99.3
4	78	99.4
5	110	99.2
6	100	99.3
7	100	99.2
8	90	99.0
9	115	99.3
10	80	99.4
11	105	99.3
12	115	99.3
13	115	99.2
14	110	99.1

Annexure-3B(Empty /partly filled cylinders)

SR.NO	PRESSURE(Kgf/cm ²)
1	30
2	105
3	0
4	110
5	45
6	45

From the result it can be seen that in all the cases purity of oxygen is found to be more than 99%, but in most of the cases less than 99.5%. In one case it was found to be 99.6%. Thus, the small amount required for the plasma cutting machine can also be met by the oxygen plant itself. However, to be on the safe side, cylinders of high purity should be identified and kept separately for exclusive use of plasma cutting machine in structural shop

PRESSURE :

The oxygen pressure for plasma cutting machine is required to be around 150 Kgf/cm², whereas the plant produces oxygen at a pressure of around 120 Kgf/cm². Due to various reasons like leakage the pressure of cylinders available in various shops is less than 120 Kgf/cm² as shown in Annexure-4A&B

Annexure-4A(Fettling shop, plant production of oxygen)

4	140
5	140

SR.NO	PRESSURE(Kgf/cm ²)
1	107.5
2	95.0
3	110
4	95.0
5	97.0
6	110
7	105
8	55.0
9	80.0
10	110

Annexure-4D

ASIATIC OXYGEN	
SR.NO	PURITY(%)
1	99.3
2	99.25
3	99.30
HINDUSTAN GAS LTD	
1	99.25
2	99.25

Annexure-4B(Structural shop, plant production of oxygen)

SR.NO	PRESSURE(Kgf/cm ²)
1	115
2	95
3	105
4	110
5	100

As the purchased filled up cylinders were not available in the shop floor, the testing for pressure and purity was done in the store . This is shown in annexure -4C&D

Annexure-4C

ASIATIC OXYGEN	
SR.NO	PRESSURE(Kgf/cm ²)
1	155
2	160
3	140
4	160
5	160
HIDUSTAN GAS LTD	
1	130
2	145
3	140

3.3 Cost analysis:

The cost analysis of production of oxygen in the plant and purchased oxygen is shown in Annexure-5A,5B,5C

Annexure-5A (Cost of production of oxygen in the plant)

1. Cost of labour per month	
a) salary of workmen(29 nos)	Rs 776250
b) salary of officers(6nos)	Rs 293250
c) P.F. corporation's share	Rs 128340
Sub total	Rs 1197840
2. Cost of material per month	
a) Lubricant	Rs 25000
b) Chemicals	Rs 7500
Sub total	Rs 32500
3. Cost of spares per month (based on annual expenditure)	Rs 50000
4. Cost of power per month	Rs 286452
5. Govt. duty total per month	Rs 69246
6. Cost of water per month	Rs 147168

Grand total	Rs 1720886
Add 20% overhead	Rs 344177
Total cost per month	Rs 2065063
Average monthly production =1644 cylinders	
Capacity of one cylinder = 5.2 m ³	
Hence cost/ cylinder	Rs 1257
Cost per 100 m ³	Rs 24173

Annexure-5B(Cost of oxygen purchased from Asiatic oxygen Ltd)

1.Purchase cost for 100 m ³	
a)price	Rs753.48
b)total Govt duty	Rs 129.93
2.Rent for cylinder	Rs 17.47
3.Cost of transport	Rs 174.12
Total cost	Rs 1075
Cost per equivalent cylinder	Rs 56

Annexure-5C(Cost of oxygen purchased from Hindustan Gas Ltd)

1.Purchase cost for 100 m ³	
a)price	Rs840.17
b)total Govt duty	Rs 16.80
2.Rent for cylinder	Rs 20
3.Cost of transport	Rs 248.03
Total cost	Rs 1125
Cost per equivalent cylinder	Rs 60

4. *Conclusion* : The comparative study of cost shows that it is economic at present to purchase oxygen from outside. To keep the oxygen plant in running condition under break even point manpower reduction in the plant is required.

5.Scope for further study :

The author studied here only the oxygen plant, the researchers can take up other area of the plant and cost-benefit analysis can be done.

6.References :

- [1] Hand book of Industrial Engineering : Technology & Operations Management, 3rd edition by Gavriel Salvendy
- [2] Hand book of Industrial Engineering : by Maynard
- [3] Operations Management : by Massimiliano M Schiraldi
- [4] Industrial Engineering and Production Management : by M. Mahajan
- [5] Industrial Engineering : by O.P.Khanna
- [6] Industrial Engineering : by M.I.Khan

7.Author's Biographics :

The author was born in Maliara, in the district of Bankura in 5th July 1957. He was awarded Government of India National Scholarship in 1975 for Higher Secondary results. He did his B.E in Mechanical Engineering from Regional Engineering College(presently N.I.T) ,Durgapur in 1980. He passed his M-Tech in Mechanical Engineering from R.E.C(N.I.T),Durgapur in 1992 . His field of studies include

a) Industrial Engineering b) Quality Management System(ISO9000) c) Fluid mechanics

d) Strength of materials e) Operations Research . He has written 5 books for UG engg students. He has published many papers in the International journals. He is having 32 years of experience in Industries and Educational Institutions. He is doing research in N.I.T.,Durgapur.