CHAPTER - IX

SUMMARY OF FINDINGS AND CONCLUSION

9.1 Introduction:

Bongaigaon Refinery & Petrochemicals Limited (BRPL) being a refinery-cum petrochemical complex has a unique distinction from other three refineries of Assam, namely- Digboi, Guwahati and Numaligarh, which are only petroleum refining units. With the increase in the production of crude in Assam oil fields and also with the increase in the demand for petroleum products in the North Eastern Region, the Petroleum Ministry, Govt. of India took a decision to set up the third refinery cum petrochemical complex at Bongaigaon in Assam in the public sector. Accordingly the Refinery cum Petrochemicals complex started functioning from 20th February, 1974.

The summary of findings of the foregoing chapters has been presented in this chapter and the policy implications of the findings are listed out. The constraints and weak spots of our study are also stated.
The Refinery sector include -

(i) Crude Distillation Unit (CDU)
(ii) Kerosene Treating Unit (KTU)
(iii) Delayed Coker Unit (DCU)
(iv) Coke Calcination Unit (CCU)

The Petrochemicals units include -

(i) Xylene Plant
(ii) Dimethyl Terephthalate (DMT) Plant
(iii) Polyster Staple Fibre (PSF) Plant

The main refinery products of BRPL include - Naptha, Motor Spirit (Petrol), Aviation Turbo Fuel (ATF), Diesel, Kerosene, BRPSOL-100 etc.

The petrochemical products produced by BRPL include - Para-xylene, Ortho-xylene, Cee-nine Solvent, DMT, Polyster Staple Fibre (PSF) and PSF waste. Among these, the most prestigious product is the PSF and trade name ‘Bonpoly’ used as industrial raw materials in a number of petro- based industries.
9.2 *The Findings relating to Production, Employment, Income - generation and Profitability:*

(a) The first commercial production of BRPL started from 1979-80. The actual throughput showed rising trend since 1981-82 till 1989-90. During this period (1981-82 to 1989-90) production of SRN (Straight Run Naptha), MRN (Mixed Run Naptha) were going on increasing and production of SRN was highest in the year 1989-90 i.e. 1,02,482 tonnes and the production of MRN was highest in the year 1982-83 i.e. 71,393 tonnes. Again the production of RFN (Reformer Feed Naptha) was highest in the year 1989-90 i.e. 55,635 tonnes.

From 1990-91 to 1994-95, the overall performance of the refinery was satisfactory. Among these five years, the production of MS (Motor Spirit) was highest in 1994-95 i.e. 46,442 tonnes. The production of SRN was highest in 1991-92 i.e. 95,499 tonnes, the production of MRN was highest in 1990-91 i.e. 46,721 tonnes, the production of RFN was highest in 1994-95 i.e. 76,989 tonnes.

Thus total crude throughput of BRPL showed an increasing trend till 1999-2000 output being 1.90 million tonnes. But in 2001-02 crude throughput of BRPL declined to 1.48 million tonnes. As a
result, the refinery faced the problem of underutilization of its production capacity. But recently, BRPL has received Ravva crude source of Krishna Godabari Basin and able to overcome the crisis. In 2001-02, the percentage of capacity utilization of the refinery was 63%, which increased to 100% in 2005-06.

(b) The total direct employment generated by BRPL in its production center was 1,921 till 1994-95 which came down to 1,723 in 2005-06. This is mainly due to modernization and computerization in the administration and production system. But BRPL has important role to expand indirect employment in the near by areas. The expansion of employment else where in the country in the downstream industries like – textiles, paints, rubber based on the petrochemical products has been increasing due to forward linkage effect of BRPL.

c) During ten years i.e. from 1990-91 to 1999-2000, profits after tax was highest in the year 1995-96 i.e.Rs. 9,015 lakhs. On the other hand,
the amount of profit was lowest in 1992-93 i.e. Rs. 2,901 lakhs. The reasons for fluctuation in the profits are listed in Chapter-V above.

During the five years i.e. from 2001-02 to 2005-06, the amount of profit was highest in 2004-05.

It is true that the profit of BRPL is not increasing continuously. But income generation process of the refinery is appreciable. For example, amount of investment was Rs. 7,849 Lakhs in the year 2005-06 and the figures of investment were again Rs. 6,356 Lakhs, Rs. 6,519 Lakhs, Rs. 6,616 Lakhs, Rs. 6,683 Lakhs in the years 2001-02, 2002-03, 2003-04 and 2004-05 respectively.

9.3 Forward and Backward Linkages of BRPL as well as Petroleum Sector:

The BRPL, refining cum petrochemicals complex, has high backward and forward linkages.

(a) Forward linkage is evident in the BRPL's production process. BRPL's different products can be used to develop different industries. For example, Cee Seven is a petrochemical product produced from Xylene plant used in different industries like paint, thinner, varnish,
adhesive, and rubber. Similarly, Polyster Staple Fibre is used in the textile industry. It can be blended with cotton, eri, muga, wool and acrylics. In this way, different BRPL products like Naptha, Petrol, Cee-nine etc. are used to develop different industries.

(b) Backward linkages of BRPL are estimated in three different years to show that how inputs are used in the production process of BRPL. Crude oil is the most important input of BRPL concentrating backward linkages.

(c) The importance of petroleum industry of Assam is analyzed in terms of forward and backward linkages. Forward and backward linkages of petroleum sector are estimated on the basis of the input-output table Assam, 1982-83 prepared by the Planning and Development Department, Govt. of Assam. There are 41 sectors in the said I-O table and the flow of output of petroleum is found to almost all the sectors of the I-O table indicating a high forward linkages. Total production of petroleum sector is used in itself as well as other 40 sectors. In the said study forward linkage of railways and other
transports is highest. That is, railways and other transport services are using highest quantity of petroleum. In this way, forward linkage of miscellaneous coal and petroleum sector and tea manufacturing rank second and third positions respectively.

(d) The backward linkage of petroleum sector is highest from crude oil. Besides, other metal production and chemical, drugs, pharmaceuticals, refractory production occupy the second and third positions in the case of backward linkage of petroleum sector. (Chapter V)

9.4 Study of Production Behaviour of BRPL:

As stated in detail in Chapter VI, the production behaviour of BRPL is investigated using three important production functions, namely, Cobb-Douglas (C-D) production function, Constant Elasticity of Substitution (CES) production function and Variable Elasticity of Substitution (VES) or Translog production function.

In the estimation of production functions, sixteen years data of output, capital and labour of BRPL are considered.
9.4(i) In the estimation of C-D production function findings are -

(a) From the estimation of C-D production function we get that the elasticity of output with respect to capital (α) and elasticity of output with respect to labour (β) are 1.009 and 2.384 respectively. Since α + β > 1, the industry (BRPL) is operating under increasing returns to scale. It implies that proportionate rise in the output is larger than the proportionate rise in capital and labour inputs.

(b) The efficiency parameter A is equal to 93.901 implying high economic efficiency of the Industry. It implies that there is good management as well as high technical efficiency of the industry.

(c) From statistical point of view the estimated regression line fit the data well because $R^2$ and $\bar{R}^2$ value found to be .71 and .66 respectively.

(d) Since Variance of Inflation Factor (VIF) is two (less than 10), there is no severe multicollinearity problem.
(e) The Durbin-Watson $d$ statistic is found to be 1.78 implying no auto-correction.

9.4(ii) In the estimation of CES production function the findings are-

(a) For BRPL, the distribution parameter $\delta$ is estimated at 3.23 and substitution parameter $\rho = 0.155$. Hence substitution between capital and labour is

$$\frac{1}{1 + \rho} = 0.865$$

which is smaller than unity implying relatively inelastic.

(b) $\theta$ indicating returns to scale is estimated at 3.626 implies that the BRPL is operating under increasing returns to scale.

(c) $R^2$ and $\bar{R}^2$ are found to be 0.84 and 0.81 implying good fit.

(d) For BRPL, efficiency parameter $A$ is found to be very high i.e. 55.334 implying the good management and high technical efficiency.
The estimation of VES or Translog production function shows that elasticity of substitution is not constant since \( \beta_{KK} = \beta_{LL} = \frac{1}{2} \beta_{LK} \) does not hold good. In other words, the nature of elasticity of substitution at the industry is variable.

9.5 The Production Behaviour of BRPL is compared to Production Behaviour of Guwahati Refinery:

In order to compare the production behaviour of two refineries, C-D production function is estimated. The findings are:

(a) BRPL as well as Guwahati Refinery are operating under increasing returns to scale.

(b) The economic efficiency of both the Refineries are appreciable.

9.6 Economic Impact of BRPL:

To study the economic impact of BRPL a sample survey is conducted for 500 households in the nearby areas of BRPL like Bortalowa, Chapaguri, Kukurmari, Barpathar, Chatipur, Dhaligaon, Pub-Hatipotha, BRPL township and Bongaigaon town (Chapter VII).
The findings are -

(a) The survey conducted reveals that the size of family is large in the case of agriculturists as well as working class. On the other hand, the family size is small in the case of educated people.

(b) In the study area, percentage of literacy is 57.2. The literacy rate for Assam as per census 2001 comes to 63 percent with 71 percent for males and 55 percent for females and for Bongaigaon District the literacy percentage is 59.3. Thus, the literacy percentage of study area is not far below than the literacy percentage of Bongaigaon District. But the female literacy rate of the study area (32.8%) is lower than that of Assam (55%) as a whole.

(c) Income is one of the important indicators of economic development. In the study area, we get that the number of families is highest whose annual income below Rs. 12,000/-. The percentage is 23.2. On the other hand, annual income of 9% of people is above Rs. 60,000/-.
The income of the people of surroundings of BRPL is not much satisfactory. Because the per-capita income of the study area at current prices is Rs. 18,340/- per annum in 2005-06. At the State level the figure is Rs. 20,143/- per annum in the same year. It is true that the economic condition of people of surroundings of BRPL has been improving due to direct and indirect employment opportunities provided by BRPL.

(d) It is revealed that consumption expenditure of people is highest i.e. 26.0% whose income is lowest and consumption expenditure of people is lowest i.e. 8.4% whose income is highest.

(e) The survey conducted in the study area also reflects the occupational pattern.

The findings are -

(i) The study shows that 64% of the population of surroundings of BRPL are employed. BRPL provides 31.25% of total employment of the study area. The percentage of female employment in BRPL is 9%.
(ii) The salaried job combined of both BRPL and State Government constitutes about 41.4% of household of which BRPL provides salary jobs as main occupation to 20% of the households and subsidiary occupation to 19.5% households.

(iii) Female salaried job holders in the area of study constituted only 15% of the total salaried persons.

(iv) BRPL has a better position in sex-wise distribution of salaried job between male and female compared to salaried jobs outside BRPL within the area of survey. While thus 2 female salaried persons against 5 male in BRPL, there is only one female salaried person against 10 male outside BRPL.

(v) The BRPL follows the Presidential Directives and Govt. guidelines issued from time to time in the matters of recruitment and promotion of SCs & STs and in direct recruitment of OBCs, persons with disabilities and ex-serviceman. Constant endeavour has been made by the refinery for promoting welfare of weaker sections of the society. The percentages of recruitment of different castes of people in the study area outside BRPL is also at par with BRPL.
(vi) There is positive correlation (.65) between production and employment in BRPL.

(f) Infrastructural amenities like banking, transport facilities, medical facilities, etc. are essential for economic development. The findings relating to infrastructural amenities in the study area are –

(i) In the study area, 82% of the total banking and insurance facilities is provided by the public sector.

(ii) 63% of total district roads are unsurfaced. Besides, private buses are playing vital role in the transportation of study area. That is, 71% of total buses run by private sector.

(iii) BRPL provides 49% of the population under the survey area so far health care facility is concerned.

(iv) BRPL provides 21% of the total educational facilities from which BRPL employees as well as people of surroundings of BRPL are benefited.

(v) 60% and 43% of the total population belonging to urban and rural areas respectively in the study area get medical facilities.
9.7 Environmental Issues of BRPL:

Industrial development is essential for economic development of a country. At the same time healthy and hygienic environment is a pre-requisite of economic development of a country. Chapter-VIII deals environmental issues of BRPL.

9.7 (i) Rainfall, Humidity and Temperatures in the study area:

Rainfall, humidity and temperature are three important factors effecting environment. The variations in these three indicators are summarized below -

(a) The study of rainfall shows that establishment or expansion of BRPL has not create any adverse effect on rainfall which is one of the important indicators of environmental changes.

(b) Data of relative humidity are collected from BRPL, Laboratory in two different years i.e. 2000 and 2006. It is observed that the study area is of comparatively high humidity but the relative humidity shows normal changing pattern.
Average temperatures are collected from BRPL laboratory on the month of February and July in two different years i.e. 2000 and 2006. In these two situations, it is statistically established that the temperatures are not varying significantly.

9.7 (ii) Stack Emission:

(a) Stack emission monitoring is carried out for all the major plant sources i.e. Reformer furnace, Hot oil furnace, KTU stack, DCU Stack, PSF Stack, CDU Stack and Power plant stack.

Suspended particulate matter emitted from the sources are well within permissible limit (500 mg/nm³) and gaseous emissions like - Sulpher-dioxide (SO₂), Carbon Monoxide (CO), Hydro Carbons (HC) from all these stacks to surrounding areas are well below the respective permissible limits (500 ppm for SO₂, 100 ppm for CO and 50 ppm for HC) laid down by the Central Pollution Board, New Delhi.
(b) It is found that gaseous pollutants and suspended particulate matter in the ambient air are also within permissible limits laid down by the Central Pollution Control Board.

(c) The chemical analysis (BRPL, Pollution Monitoring Section) of water sample collected just before the confluence with Champavati river indicates that the parameters tested have lower values than that of samples collected from the upper reaches of Tunia, thereby indicating an improvement in the quality of water. However, at a distance of about 7 KM from the BRPL effluent discharge point, the effluent from New Bongaigaon Railway Colony affects water quality of Tunia locally. Finally, near the confluence with Champavati river (at a distance of 25 km) the water quality appears to be good.

Hence, despite of the fact that effluent from the BRPL is being discharged into Tunia, the river Tunia is not finally polluting Champavati river, which is used for irrigation purposes.
(d) The chemical analysis by BRPL, Pollution Monitoring Section of water samples collected from shallow and deep tube-wells reveals that the water quality is remarkably good.

The ground water quality in the study area during pre-monsoon is good. Oil, grease, sulphate, fluoride and cyanide are not detected. The ground water quality in the study area are during monsoon i.e. June-September is also free from oil, grease, fluoride, iron and cyanide. The ground water quality during post monsoon i.e. October-January oil, grease, fluoride, cyanide and sulfide are not detected. In short, the ground water quality in the study area is classified as fresh water.

(e) An assessment is made to study the noise environment at the boundary of BRPL

i) The effect of BRPL Plant is not felt in the township area.

ii) There is hardly any effect of BRPL plant noise beyond one Kilometer.

iii) The general noise environment inside the plant at majority of places ranged from 75 db (A) and 80 db (A) with a pervasive tissing noise.
iv) The noise level recorded along the BRPL boundary indicates that the existing units of BRPL contribute noise levels rarely exceed 55 db (A) along western, northern and eastern stretches of the boundaries and do not contribute to levels likely to cause discomfort in the inhabitant on these sides. (Pollution Monitoring Section, BRPL)

9.7 (iii) Impact on the Health Condition of the people of Study Area:

To study the impact of BRPL on the health condition of population in and around the Refinery complex, a sample survey is conducted in the area reveals the following -

(a) The statistics of total annual income and medical expenditure show that lower the income, higher is the proportion of medical expenditure and vice-versa. Besides households as a whole spend 5.9% on an average of their total expenditure on medical head .

(b) From the survey, it is found that 52.67% of the population in the surroundings of BRPL are suffering from different diseases like
malaria, muscular disorder, gastritis, cardiacl disorder, tuberculosis, skin ailments and liver disorder.

(c) 41.13% of the people of surroundings of BRPL are suffering from gastritis and other stomach disorder.

(d) 6.33% of the people of surroundings of BRPL are suffering from skin ailments.

(e) 13.93% people of study area are suffering from liver disorder.

(f) 14.56% of people of study area are suffering from blood pressure.

(g) 5.06% people of study area are suffering from cardiacl disorder.

(h) 13.93% of people are suffering from malaria in the study area.

(i) 5.06% people are suffering from tuberculosis.

(j) 80% people of study area are in support of further future industrial development in the study area.
Thus, we get important findings of the study.

There are certain objectives of the study. Now, we examine whether the objectives are fulfilled or not. The important objectives of the study are –

i) To study the role as well as impact of petroleum sector on economic development of Assam.

ii) To study the production behaviour of BRPL.

iii) To study the economic impact of the establishment of BRPL.

iv) To study the environmental Issues of BRPL.

The importance of petroleum industry on economic development of Assam is studied in the Chapter IV. The contribution of petroleum industry towards State Domestic Product, employment opportunities provided by the petroleum sector, profits earned by petroleum sector and development of four refineries of Assam with their status of refinery throughputs are discussed in Chapter IV. The backward and forward linkages of petroleum sector are estimated (Chapter V) to ascertain the impact of petroleum sector on the
economy of Assam. The study reveals that the forward linkage of petroleum sector is highest in the case of railways and other transports and backward linkage of petroleum sector is highest in the case of crude oil. Besides, backward linkage of BRPL is also estimated. The study of forward linkage shows the importance of BRPL to develop different down-stream industries. Hence the study fulfills the first objective.

One of the important objectives of the study is to analyse the production behaviour of BRPL. To study the production behaviour of the industry three important production functions i.e. Cobb-Douglas (C-D) production function, Constant Elasticity of Substitution (CES) production function and Variable Elasticity of Substitution (VES) production function are used. In three cases, from statistical point of view, the estimated regression line fit the data well. $R^2$ and $\bar{R}^2$ values differ from one to other method due to differences in methods of estimation. But the fitting by CES or VES is more efficient than C-D production function. The estimation of C-D and CES production functions show that the industry (BRPL) is operating under increasing returns to scale with high economic efficiency. Estimation
of VES or Translog production function shows that the elasticity of substitution is not constant rather variable.

A comparative study of production behaviour of BRPL and that of Guwahati Refinery is worked out from which we get that both the refineries are operating under increasing returns to scale with high economic efficiency.

It is essential to study the economic impact of BRPL. To study the economic impact, a survey is conducted in the surroundings of BRPL. The survey reveals that the educational status of the residents of study area is at par with the State as a whole. BRPL is playing an important role in expanding educational facilities. Only BRPL has to take steps to increase female literacy. In this way, different determinants of economic development like income level, occupational pattern, infrastructural facilities etc. of the study area are considered to access the economic impact of BRPL. It is true that BRPL provides employment opportunities, infrastructural amenities to uplift the economic status of the study area. The object to study economic impact of BRPL will be fulfilled in real sense if BRPL undertakes further socio-economic development programmes.
The studies relating to industry must encompass the environmental issues. In our study also different environmental components are studied (Chapter VIII). As mentioned earlier, a sample survey is conducted to ascertain whether the BRPL has any adverse impact on health condition of people in and around the refinery complex. According to medical experts, the diseases prevailing in the study area are normal in nature, not due to industrial pollution. But some people are also suffering from diseases like skin ailments, cardiac disorder and liver disorder which may have relationship with environmental factor. Besides the percentages of people suffering from such diseases are not high. Periodic medical examination in the six month interval is necessary. Regular health check-up programmes have been undertaken by BRPL from time to time.

Thus the objective to study the environmental issues of BRPL like BRPL - Its impact on health condition of the people, study of changes in different environmental factors like rainfall, humidity and temperatures in the surroundings of BRPL etc. is fulfilled if such studies will be carried on in future.
The present study is based on the hypotheses like (i) BRPL is running under increasing returns to scale with high economic efficiency, (ii) The environment protection programmes taken by BRPL has kept the pollution level within permissible limit.

The first hypothesis is tested by using two production functions i.e. Cobb-Douglas (C-D) production function and Constant Elasticity of Substitution (CES) production function. In the estimation of these two production functions, we get that the Industry is running under increasing returns to scale with high economic efficiency. The high economic efficiency is seen implying efficient management as well as high technical efficiency. That is, first hypothesis is found to be true.

The study encompasses different environmental components like air, water and noise environment. It is found that suspended particulate matters emitted from different sources of the industry are well within permissible limit laid down by the Central Pollution Board, New Delhi.

The Refinery is efficiently maintaining the integrated safety, health and environmental management system conforming to the international standards ISO 14001-2004, OHSAS 1800 : 1999 apart
from continuing the international quality management system standard ISO 9001 : 2000. All these three certificates have been awarded by M/S DNV and the system compliances are being verified by them periodically.

The sample survey reveals that the refinery functioning does not make any adverse effect on the health condition of the people in and around the refinery complex. Because Doctors comment clears that diseases like gastritis, blood pressure, malaria fever, tuberculosis and muscular disorder are the normal pattern of diseases. Besides, percentages of people suffering from diseases like skin ailments, liver disorder, cardiac disorder are not high. Therefore, periodic medical examination can help people to be cured from such diseases.

Thus, we must accept the second hypothesis i.e. the environment protection programmes taken by BRPL has kept the pollution level within permissible limit.

Based on the analysis of the foregoing chapters, though the industry is operating under increasing returns to scale with high economic efficiency, certain suggestions are put forward for improving efficiency and functioning of BRPL as follows:

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i) Government should take necessary steps to make the supply of crude oil sufficient so that the industry (BRPL) can utilize its capacity fully.

ii) BRPL authority should always look after the working environment that can ensure labour efficiency.

iii) In the socio-economic development programmes, the Refinery should emphasis on female literacy programmes.

iv) The Refinery should take steps for technological advancement.

In view of the shortfall in crude oil production in the North East Region vis-à-vis the available refining capacity, the allocation of Ravva crude oil to BRPL is vital for the economic operations of the oil refineries in the North East. This is helping the north east refineries including BRPL to achieve better capacity utilization.

Implementation of improved quality specification Bharat Stage-II for HSD (High Speed Diesel) and MS (Motor Spirit) has commenced from 1st January 2005. Bharat Stage-III (Euro III equivalent) specifications for HSD and MS will come into force from April 2010.
Besides, BRPL has established a Diesel Hydro treatment facility to meet Euro-III/IV quality specification. Motor Spirit (MS) produced at BRPL's refinery conforms to Bharat Stage-II specifications. However, for meeting BS-III specification of MS, which will be effective from April, 2010 and to lower the production of demand limited Naptha, BRPL has initiated action to implement MS Maximisation & Quality Upgradation Project.

The company is engaging a consultant to study its petrochemicals business to determine the future course of action.

The existence of the following systems and procedures ensures effective internal control throughout the organization -

(a) The company has a streamlined delegation of powers which has recently been overhauled for functioning at various levels. This delegation of power ensures scrutiny and approval for procurement at fairly high levels for high value items.

(b) The company being a public sector enterprise follows various guidelines issued by the Government of India from time to time including guidelines of Department for Public Enterprises and Central Vigilance Commission.
(c) The company maintains registers of fixed assets and other assets.

(d) Physical verification of assets is carried out at periodical intervals.

(e) All investments in new projects are done only after techno-economic evaluation.

(f) The company has a full fledged vigilance department.

Thus the internal control system is adequate to safeguard its funds and assets and prevent their misuse.

The Board of Directors of BRPL in their meeting held on 7th July, 2005 had approved in principle the merger of the company with holding company Indian Oil Corporation Limited. Further steps are being taken in this direction. It is expected that merger will lead to synergic benefits resulting in improvement in group’s profitability.

It would not be out of place to mention some of the limitations of the present study. First, we could not estimate the quantitative values of the forward linkages of BRPL due to non-availability of updated full fledged input-output table. Secondly, this study is only
concentrated on the production behaviour or other aspects of BRPL. In spite of these limitations, it is hoped that the findings of this study will be useful to the policy makers and stake-holders to make BRPL a vibrant organization contributing substantially to the economic development of Assam.