Contemporary Engineering Sciences, Vol. 2, 2009, no. 7, 299 - 317

Recognition of Demand Changes Pattern of Petrochemical Downstream Products Supply Chain with Continues Simulation (Case Study: METAXYLEN Chain)

Mohamad Ali Afshar Kazemi [1], Abbas Toloie Eshlaghy [2], Karim Hamdi[3] and Masoud Keyhanfar [3]

[1] Industrial Management Dept., I.A.U., Central Tehran Branch, Tehran, Iran
afshinafshar44@yahoo.com

[2] Industrial Management Dept., I.A.U., Science and Research Branch, Tehran, Iran
toloie @gmail.com

[2] Business Management Dept., I.A.U., Science and Research Branch, Tehran, Iran
karimhamdi@gmail.com

[4] Industrial Engineering Dept., I.A.U., Science and Research Branch, Tehran, Iran
masoud_keyhan@yahoo.com

Abstract

Supply Chains management requires predictable decision making and new capacities development with comprehensive approach one of the analytic tools is "system dynamics" enabling simulate complex supply chain for decision-making support. Indefinite decision outcomes will be cleared with simulation. Main objective of this method is simulation, fast learning of systems behavior at present future situation.The supply chain model has developed and supplied a branch of Petrochemical Products "METAXYLEN" for survey the effect of different

policies of preproduction and supply products during the chain. Recognition and survey the behavior of most important variables is possible with comprehensive attitude and system dynamics. This has been done by forming the models sub-systems and gathering required information from petrochemical down stream industries development official sources. The results of dynamic analysis of Products supply chain model leads the managers towards understandable tool for comprehending available problems reasons: Potential capability, supply demands mean while, the model represents changes process pf products storage volume of chain in future and the effect of different mane genral scenarios.

Keywords: Supply chain management, Simulation, System dynamics, Petrochemical downstream industries, MEATXYLEN

Introduction

Oil industry has been entered in Iran more than fifteen Years and Petrochemical industry has been run in last four decades. Despite having oil and gas enrichment and 50 year background in petrochemical, gas, and oil industry. This industry has not been developed of well so that some products are imported after five decades. Get rid of severe dependence to oil export, it is tired to change pattern and rely on non-oil export and developing this kind of industries in last years. Petrochemical industry is one of the limited industries be cause of having abundant materials and added value, its products can be replaced by oil export and compete internationally which must decrease raw oil export firstly by development of down stream industries in the country which it causes to increase the petrochemical material consumption inside the country and helps to export and competing goods and produced products from petrochemical materials and their export.

In definition of petro chemistry products we can say chain relationship between raw material and added value material that applied in vary of industrial like automobile, agriculture, defensive technology, hence that products are very important.

During last years, with special effort of government for investing in oil, country gas and petrochemical has been imported greatly especially with development petrochemical industries and downstream products, considerable added-value has been provided for supplying requirements and development of country export. Meanwhile, extensive researches have been done for searching and providing required conditions for investment in products. The products that their production unit is justified on technology transfer discussion and increasing engineering capability and internal expert’s knowledge economically. However, the thing

which is ignored in this reaches is the Reaction of Products supply and demand which is done by replacement most of the materials with similar products. Also, consumption changes pattern of petrochemical products for and user's ID resulted from technological changes, environmental limitation and market changes.

Of course, there are a lot of problems against this industry. Petrochemical downstream industries lose its security by linking to world trading organization, and if it wants to continue, it should match the final prices and production quality with global standards. Otherwise, it can not export its products and endanger its availability. Like wise, expending petrochemical industries for occupation and developing poor areas where are not justified economical and technically, and granting the development of downstream industries to private department which are not able to upgrade the selves with modern technology, lacking research units are the main weaknesses that can not join to WTO. Creating a lot of different companies with limited capacity in production of petrochemical down stream products are problems that caused to encounter principle problems in globalization process. Some of them are not successful in achieving internal market having essential security in supply the materials, using modern technology, because they applied the quantity of companies not quality of them. Although, these are suitable adverting tools for petrochemical in a short time. They cause some problems for themselves (private companies) and petrochemical industries in a long time. Nowadays, petrochemical downstream industries in Asian countries by using raw materials with world market prices produce their products with minimum lost and best quality.

Considering above factors, representing model, which could consider the key variable of supply and demand of these products and simulate the future economical changes of industry, can have a valuable role in helping the country petrochemical industry decision makers for developing special chains of product which economically has priority in the country. Because of this, there is no choice except careful and comprehensive of available interactions in supply chain.

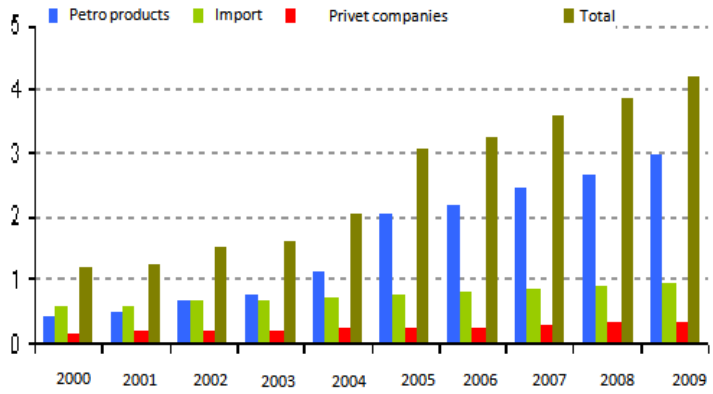

Fig 1: The process of consuming raw material of petrochemical downstream industries (1379-88)

The case that has particularly been noticed in this research is the simulation of supply chain of petrochemical downstream products known " METAXYLEN" which during last years, noticeable investments has been done for developing main branches in ASALUYE zone petrochemical special area, and macro plans are there for developing downstream chains. Principle variables of model consist of considerable variables in economic possibility studies especially in knowing the market like production process, past consumption and future prediction of products consumption and production, past export process and end export during future years for each of the chain products. Chronologically, the study limitation includes the process of last then years and predicting future ten years.

Technical literature of using system dynamics in simulation of supply chains

Utilization of simulating dynamic systems in supply chain is one of the problems which have been noticed by supply chains management researchers. Present researches focus on decision making about assets, development politics and suppliers management, consisting the time of material and accessories supply, demand changes, design and unite supply chain, and management of supply multi national chains.

The primary roots of using dynamic systems in supply chain management returns to industrial dynamics book (Forrster, 1961) which be besides representing a model for production and distribution system, consider the six principles: information, material, orders, money, human force, and capital equipments. Then, he extended his primary model through enchaining more details, and making

relation between user and management training. In spite of Forrster model simplicity he included important concepts in supply chains dynamic. Recognition of demand changes have been considered as a serious problems in supply chain by scholars.

After faster who has considered supply chain as an industrial system, other scholars has done their research in different areas.

By the way, as Towill (1996) Points out that using industrial dynamic model making during last years has been noticed after a decreasing period. The following table shows the Performed researches category in supply chain management by using dynamic systems.

Table 1.Performed research category in SCM and used tools

Goal / Limits	Theory making	Solving problems	Attitude reformation
Inventory management	b	b/c	
Pattern recognition	b	b	
Re engineering		a/b/c	a/b/c
Design	a	a/b/c	a/b/c
Unity/consolidation	a	a/b/c	a/b/c/d

At the end, above mentioned categories is surveyed:

- ***International supply chain management (ISCM)***

Akkerman and colleague researches is a suitable sample e of applying model making of dynamic systems in international supply chain management. In fact, they and consider more complex fields in international supply chain management.

Based on the common meeting which they had with ISCM experts, they posed new theories about cause and effect models, obstacles and enabling in the way of obtaining to efficient international supply chain management as "good or bad cycles". Akkerman and colleague made up various workshops for answering posed questions in supply chain management with participation of supply chain experts from different industries. They wanted to answer the following questions:

  - *Main targets of ISCM performance.*
  - *Obstacles and enablers of ISCM performance.*
  - *Mutual relationship between factors.*

During this process, various obstacles were defined through ISCM development which is: district optimization, Functionality, unsuitable relationships in supply chain, and lack of higher management support. In other words, performing successful IT systems, extending the activities of cross functional teams, The emphases of customers for achieving better services, using and applying performed successful experiences by pioneer and creative companies are knows as

efficient and enabling factors in the way of movement of organizations and companies towards ISCM.

"Akkerman","Bogerd", and "voous" represented cause and effect model which stands for their theory about mutual relations of posed factors in international supply chain management.

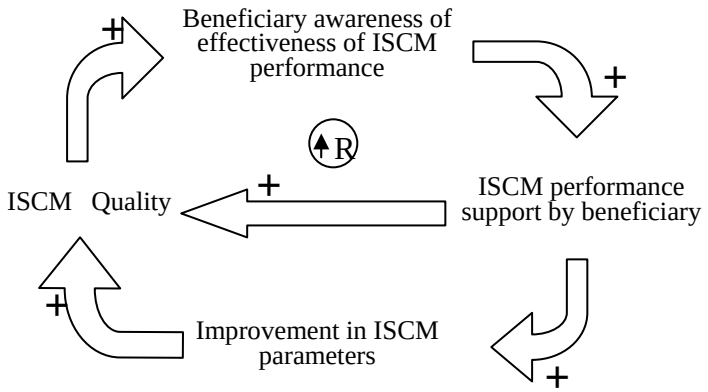

Fig 2: Suitable and unsuitable cycles in ISCM (Akkerman 1999)

As it is observed in above diagram, Akkerman and colleague believe that main core of dynamics in ISCM is the same, and organizations follow similar loops in both cases; success and failure.

- ***Decision making in inventory management.***

Sterman (1989) represented a common model for inventories management which can be performed in different scenarios such as raw materials order, production control, or in macro economic level or control money stock. This models I consist of two parts: physical inventories along with their structures, and applied rules for controlling systems. According to Stermen theories, in most of the situations and real conditions, decision making about inventories, complexity of reflexive relations among different variables refrain the recognition of optimized strategy.

Barlas and Aksogan (1997) performed a case study in textile industries for development a dynamic simulated model. The chain contains three loops; Producer, whole seller, retailer with consumer. Their aim with this simulation was development and creating inventory maintenance politics which as increasing the retailer's income, cause to costs. Their initial target was researching about the effect of different strategies. Represented model by them stand for system physical structure, meanwhile represented decision making rules of production. Required data and information were gathered from clothing productions which were used as an estimation of model parameters. Data gathering was done through interview with executive management, logistic, sale department, and agents of retailers. In next steps, model reliability by using data from industries and accepted by simulated model conclusion. Represented model was performed again and different order strategies and demand pattern was tested.

- ***Demand changes***

Anderson, Fine and Parker (1997) by using a case study in car industries surveyed the effect of demand changes in lead time, inventories, production, productivity, and human force. Anderson and his partners in order to survey demand changes, and different effective strategies for improving the performance, utilized dynamic system model.

Dynamic system methodology gathered all variables and effective main indicators on car industries which can be pointed as delays, non linear relation. although in some of modeling process, using extend simulation principles seems more reality, for modeling time and stock used continuous simulation, and finally, it was cleared that the result was not ambiguous, and industry dynamics was correctly recognized .

- ***Supply chain reengineering***

Towill (1998) showed that rapid and effective response to market changes is one of the most important is sues in supply chain. So, time compressing is one of the most important solution .According to Towill's suggestions and focus on time compressing strategies in simulation models, improvement of supply chain performance will be accessible.

Faster by using model concepts as system performance frame work, suggested a system for categorizing supply chain re engineering framework.

According to this research result, represented the applicable cases of supply chain re engineering starkly according to followings:

- *Decreasing all lead times (material, information, finance/*
- *Deleting time delay in decision making.*
- *Representing accepted information to all high level decision makers.*

Also, Cakravastia and Diawati represented dynamic model about ship making industries in Indonesia which could recognize potential bottle neck and predict logistic performable they defined logistic in three axis : product quality, lost, and delivery time. At first, a common structure of ship making industries has been displayed industries has been displayed and material and information current is shown. Then, cause and effect diagrams were drawn related to financial, physical, and informational resources. Dynamic model was formed according to initial analysis which the behavior of key indicators as orders, current work, their distribution and postpone drawn the total sale and net profit. Finally, by recognizing logistic performance and logistic design politics found a new application for model development.

- ***Supply chain design***

Globalization has posed new issues about multinational companies. Posed parameters were different in different areas and cause to complicate the decision making. Beside literacy, issues like quality and lead time were considered. Most

of the old methodologies were failed in clearing systems dynamics which cause to a new approach.

"Voos" and "Akkerman" have used a combination of Voos's suggesting method and modeling the dynamic systems for representing as a supporting as a supporting model of management decision making activities.

Model borders

The territory of the research contains a chain of petrochemical products entitled "METAXYLEN" brand". The mixture of XYLENEs is aromatic hydrocarbons which naturally found in oil and coal. After benzene, XYLENEs are the most important aromatics in petrochemical down stream industries. The mixtures of XYLENEs are made up three isomers: "ORTHOXYLEN ", "PARAXYLEN" and "META XYLEN" which METAYLEN is considered in the research.

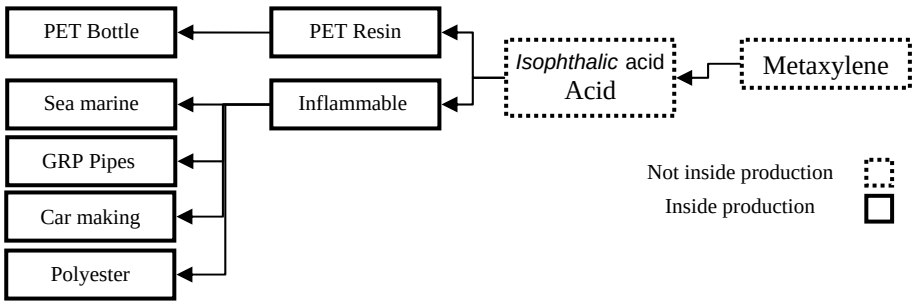

Fig 3: Meta xylem and its application

According to above diagram, Meta xylem oxidation makes "ISOPHTHALIC ACID" which its main consumption is making and preparing PET resin and inflammable polyester resin. Inflammable polyester is one the most consuming products of petrochemical which the most important one is drawn in above diagram. Mean PET resins are used for production PET bottles which is abundant for liquids especially gaseous drinks.

The research is along with countries studies for developing XYLENE development (ASALOYE and MAHSHAHR Zone). Their territories are internal markets of Iran. Represented data contains available information in published documents of petrochemical downstream development office during 1371 to 1383. It also contains its result and predication to 1399.

The survey of model sub systems and its cause and effect diagram

According to model 3 supply chain model of METAXYLEN consists of four main parts:

- Inflatable Polyester subsystem.
- PET resin subsystem.
- ACID ISOPHTHALIC subsystem.
- METAXYLEN subsystem.

Our purpose of subsystem in model making is mutual balance mechanism of supply and demand which is shown as schematic:

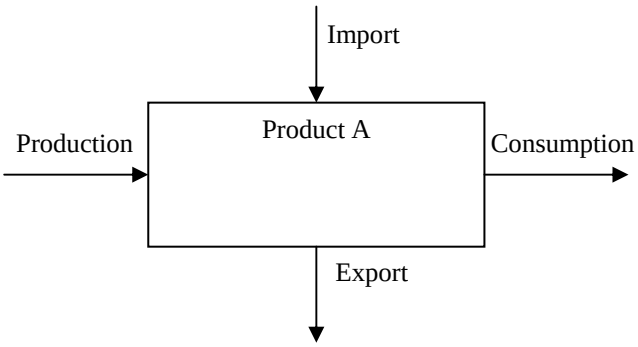

Fig 4: Schematic structure of model subsystem

According to above diagram, market system of each product is subdivision of supply and demand mutual interaction of the product. Anyway, in the process of supply chain of METAXYLENs and due to available information, the same hypothesis considered for every four systems which current and strong models are made up these hypothesis. These hypotheses are:

- ***Reactionary of imports of every chain products***

  The assumption the import of each material is only for shortage of supply to demand, in the case that production can perform the internal requires, and then we no need to import therefore, cases like product import for increasing bargain against supplier is not mentioned. It is mentioned that the assumption due to compatible petrochemical is for independence to petrochemical imports which mostly acceptable.

- ***Production stability and consumption of internal chain material during simulation***

  Based on this assumption, none of the chain material is obsolete during simulation and its application will not be stopped. None of the material is replaced and they are listed in material safety data sheet.

- ***Export conditions***

One of the most important assumptions is products export. It is assumed that the excess of supply to demand for export is required condition, not enough one. In other words, export of each product export excess of supply to demand, requires supplying interred solutions which is out of the discussion, because of its extent. But, export potential of chain material is calculated due to "extra consumption of available capability" and "market avidity". Re-export of goods is considered.

- ***chain politics***

The governing system of supply and demand is assumed as a demand not supplies pressure.

In figure 5, surveyed supply chain model is shown in cause and effect loop model.

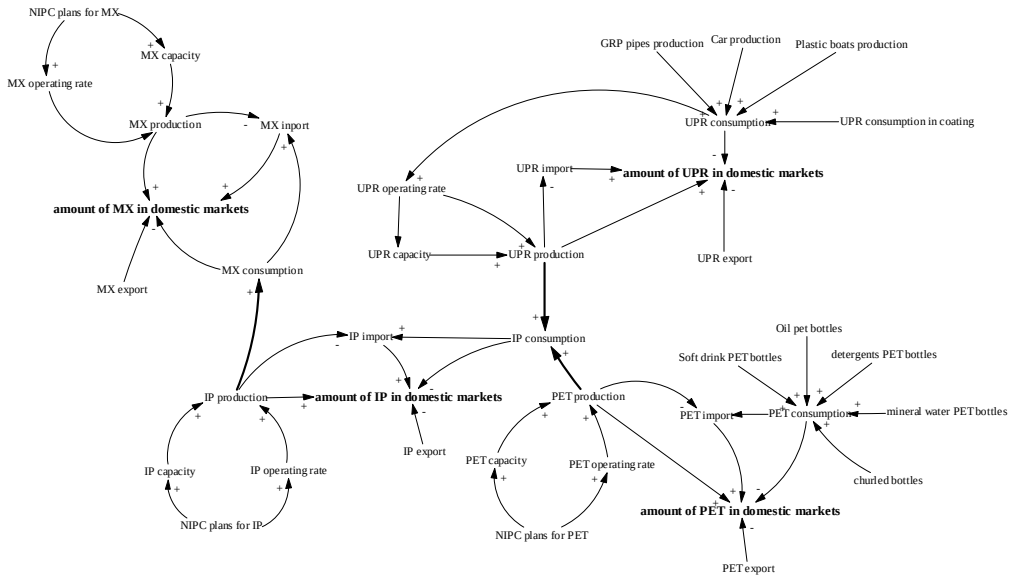

Fig 5: Cause and effect structure of system

As you know the general structure of cause and effect relations lip in all subsystems are the same. It means that find applications form internal consumption and internal and export consumption causes the decreasing of inventories inside the country. On the other hand, imports and internal production causes the increasing of inventories. Internal production is subdivisions of available capacities and causes the productivity which in three cases from four subsystems. This is because of production of inflammable polyester is except because of private departments.

Level diagram and METAXYLEN chain flow

METAXYLEN flow diagram is changing figure 5 to system consent of stocks, rate variables and interaction of them. METAXYLEN chain stock and flow diagram which contains all variables in cause and effect diagram is drawn in VENSIM software. These simulation soft wares have done the system dynamics and represent sensitive analysis along with different liabilities of decision making support.

One of the most developed cases in stock and flow diagrams due to cause and effect diagrams are modeling considerable delays in system which two main delays are recognized. Time delay is cause of required time for manufacturing and establishing new production units and import delay of lack of internal production for supplying country's requirement which are considered flow and stock diagram. Mean while, in this step and for defining mathematical relation among variables, information related to internal production, import, export and internal consumption are represented besides available condition of subsystem's variables, production, consumption, future import, and export of materials by internal and global information of petrochemical industries under three scenarios: pessimistic, base, optimistic.

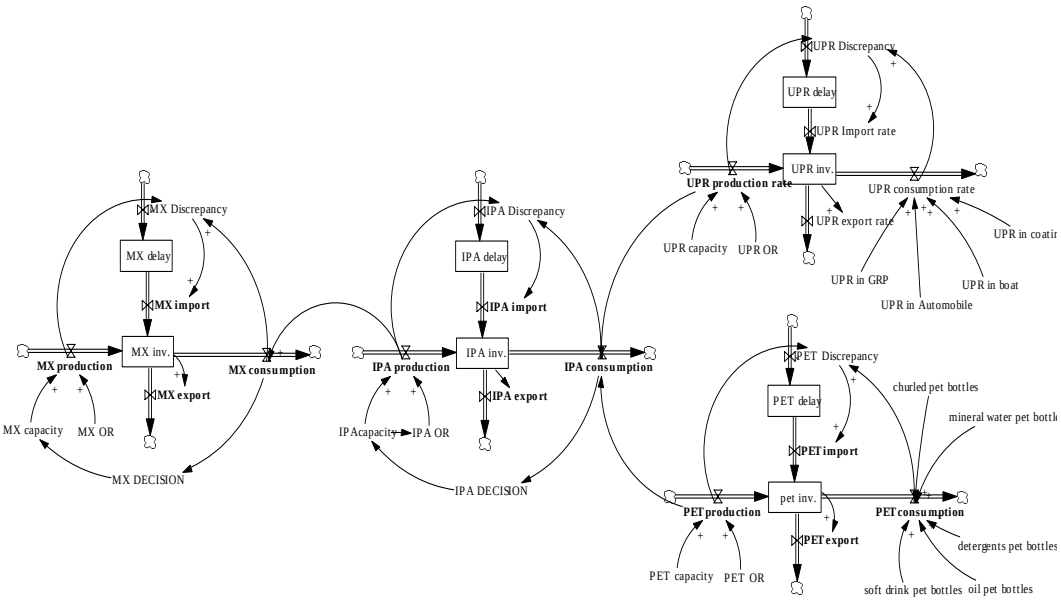

Fig 6: Fundamental model for XYLENE chain

Table 2: Initial State for model running (Under middle scenario)

Description	Relationship	No.
Consumption of each materials equal to sum of materials consumption cases	*UPR consumption rate = UPR in Automobile + UPR in coating + UPR in boat + UPR in GRP*	1
	PET consumption = churled pet bottles + detergents pet bottles + mineral water pet bottles + oil pet bottles + soft drink pet bottles	2
	*IPA consumption = PET production*RANDOM UNIFORM(0.02, 0.03, 2)+UPR production rate*RANDOM UNIFORM(0.16, 0.25 , 2)*	3
	*MX consumption= 0.68 * IPA production*	4
Production of each product equal to multiplication of production capacity to exploit rate	*UPR production rate = UPR capacity * UPR OR*	5
	*PET production = capacity * PET OR*	6
	*IPA production= IPA capacity * IPA OR*	7
	*MX production= MX capacity * MX OR*	8
Difference between production and consumption for each year calculate with DISCREPANCY variables	*UPR Discrepancy = UPR consumption rate - UPR production rate*	9
	PET Discrepancy = PET consumption rate - PET production rate	10
	IPA Discrepancy = IPA consumption rate - IPA production rate	11
	MX Discrepancy = MX consumption rate - MX production rate	12
If consumption is greater than production, we have import equal to this differences	*UPR Import rate = IF THEN ELSE(UPR Discrepancy>=0, MAX(UPR Discrepancy -14700,0), 0)*	13
	PET import rate = IF THEN ELSE(PET Discrepancy>=0, PET Discrepancy-22000 , 0)	14
	IPA import = IF THEN ELSE(IPA Discrepancy>=0, IPA Discrepancy , 0)	15
	MX import = IF THEN ELSE(MX Discrepancy>=0, MX Discrepancy , 0)	16
Establish ISOPHTHALIC ACID and METAXYLEN units happened if only sum of internal consumption is greater than unit production with minimum economic capacity and mean of global exploit rate	*IPAcapacity = IF THEN ELSE(IPA consumption>=13000 , STEP(25000, 10), 0)*	17
	MX capacity =IF THEN ELSE(MX consumption>=13000, STEP(25000, 20),0)	18
Develop of PET production capacity in IRAN(from The National Petrochemical Company (NPC) plans)	*PET capacity = STEP(177000,1384)+STEP(132000, 1386)+RAMP(76.2 , 1386 , 1390)*	19
Stability of UPR production capacity	*UPR capacity=8000+STEP(4000, 1380)*	20
The duration for establish a petro chemical unit with 25000 ton capacity is about 2 or 3 years	*IPAcapacity =DELAY FIXED(IPA DECISION,RANDOM UNIFORM(2, 3 , 1),0)*	21
	MX capacity=DELAY FIXED(MX DECISION,RANDOM UNIFORM(2, 3 ,1),0)	23

Simulation conclusions under different scenario planning

After calibration, and survey the way of variables behavior in conditions except base conditions, and representing the results of most probable scenarios, different management politics was simulated in METAXYLEN chain model. The model

can be categorized in two conditions: high test, and low test. Base result is lacking justification of establishing METAXYLEN and ISOPHTHALIC ACID units with minimum economic capacity and average productivity rate of world. It is obvious that model test in low condition (pessimistic consumption of inflammable polyester, minimum consumption of ISOPHTHALIC ACID in producing inflammable polyester, resin and PET, considering products export in minimum predicated rates has similar results with base model. In other words, establishing ISOPHTHALIC ACID and METAXYLEN acid is cancelled. ISOPHTHALIC ACID is continued for supplying internal requirement and METAXYLEN consumption is cancelled. Therefore, the result of model performance is represented and analyzed in high condition. Considered conditions are:

- ***UPR optimistic consumption*:** in this condition, regression reaction of inflammable polyester consumption is defined based on most predictable rate.
- ***Maximum consumption rate:*** in this condition, exophthalmia acid consumption rate is 25% in producing inflammable polyester and 3% in PET resin. About METAXYLEN consumption, in producing ISOPHTHALIC ACID due to chemical and technical reactions, consumption rate in 68% weight is unchangeable.
- ***Maximum export capacity:*** It is assumed that export rate of all chain material is done by maximum studied rate.
- ***Setup new units of inflammable polyester production:*** based on documents of mining and industry ministry, the permit of establishing some of URP production units with capacity of 17 thousand tons was issued by 1383 which progress rate of all designs are announced less than 10% If during 1383-88, half of capacities of new units of in flammable polyester is gradually produced, by 1388, 2300 tons. Will be added and total capacity will be increased to 14300 tons.

Decreasing decision making condition for setting up base units

it is assumed in base condition that setting up production units of METAXYLEN and ISOPHTHALIC ACID because of complex technology and high investment if is surveyed when their internal consumption be more than producing unit with minimum economical capacity and in production be un base rate of global productivity Minimum announced economical capacities for bas material of this chain are announced based on popular institute’s studies about petro chemical products and considering required current and fixed environment rate.

But in productivity rate of established capacities, southeast Asian countries activates with productivity fate of 20% which this rate is surveyed as minimum acceptable productivity rate .METAXYLEN belongs to southeast

Asian which is about 30-35% which all of them were tested .At the end, simulated conclusion will be analyzed and represented with base condition.

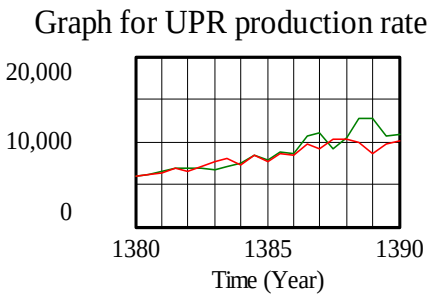

Fig 7:
UPR consumption in high level condition and comparison with base condition

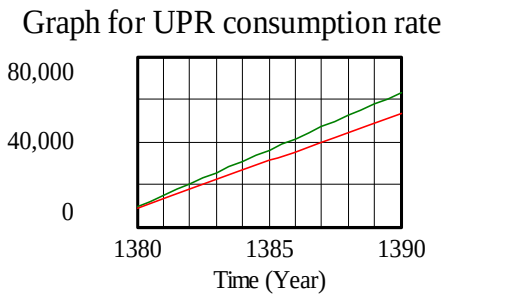

Fig 8:
UPR production in high level condition and comparison with base condition

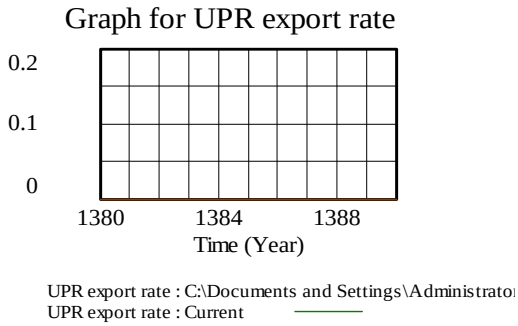

Fig 9:
IPA consumption in high level condition and comparison with base condition

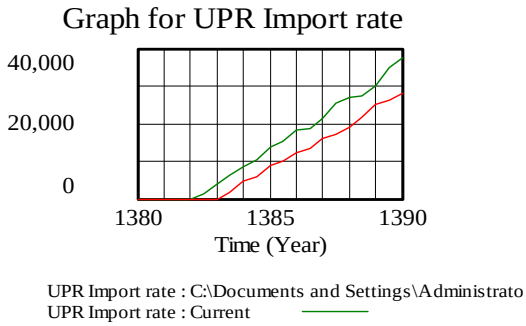

Fig 10:
IPA performance time in high level condition and comparison with base condition

Because of limitation of in hand capacities, high incensement is not expected in UPR production. In this condition it natural that import process in creases and no export is done.

No new condition is considered in pet resin production and consumption which its production and consumption is according to base condition, but with considering the export of product export increase.

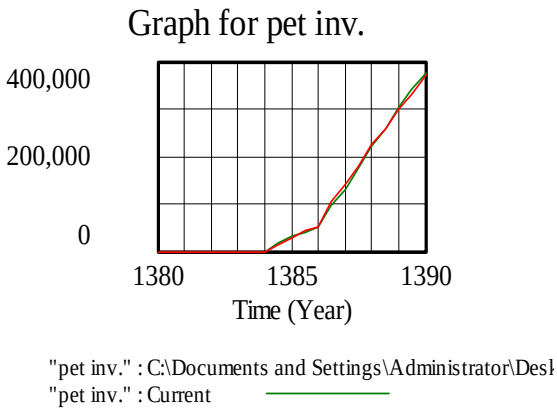

Fig 11:
PET resin export in high level condition and it s comparison with base condition

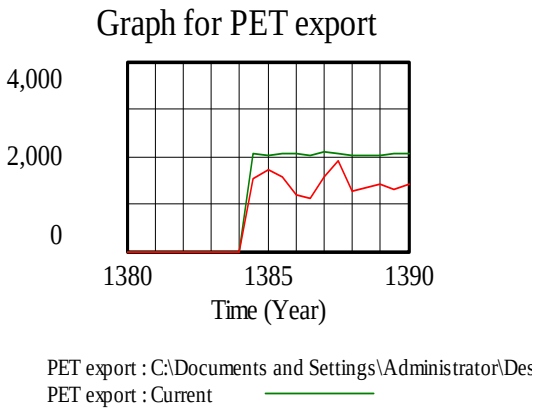

Fig 12:
PET resin stock in high level condition and it s comparison with base condition

Principally, PET resin stock in our country is a part that will cause difficulty in petrochemical downstream industries .Naturally import is not important in this condition.

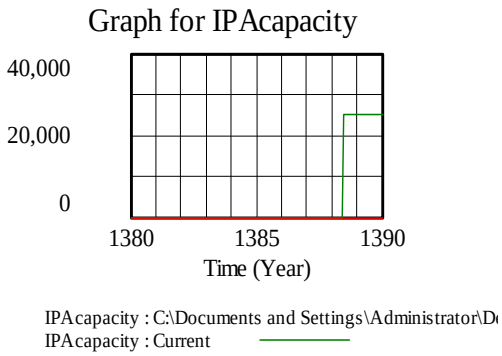

Fig 13:
IPA consumption in high level condition and it s comparison with base condition

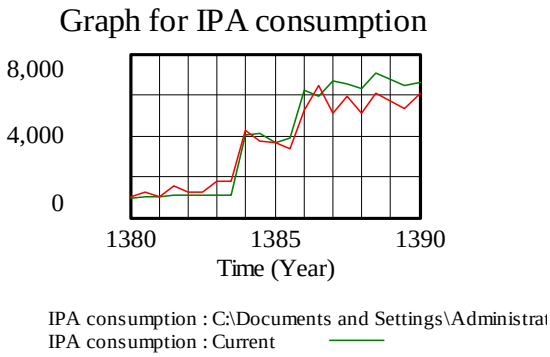

Fig 14:
IPA performance time in high level condition and it s comparison with base condition

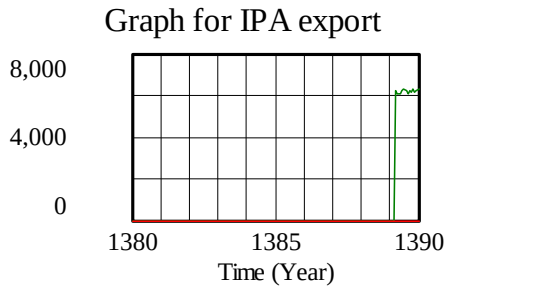

Fig15: IPA production high level condition and it s comparison with base condition

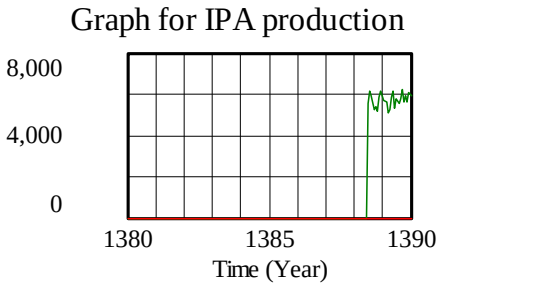

Fig 16: IPA export high level condition and it s comparison with base condition

As it is observed the consumption of this material will be increased about one thousand ton in mid- term and high level condition. meanwhile in the case of decrease condition of unit set up of IPA production the production of this material will be considered and in its following unit will be established with 25 thousand tons with 2-3 years postpone in thus condition the export probability of ISOPHTHALIC ACID will be occurred in late 80.it is expected that it beginning of running IPA production unit it s import is stopped which the model conclusion confirm it.

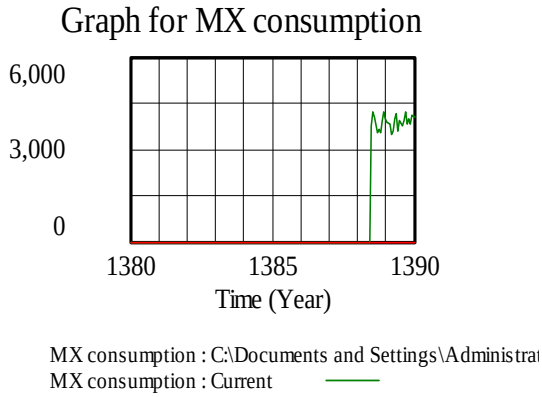

Fig 17: IPA stock volume in high level condition and it s comparison with base condition

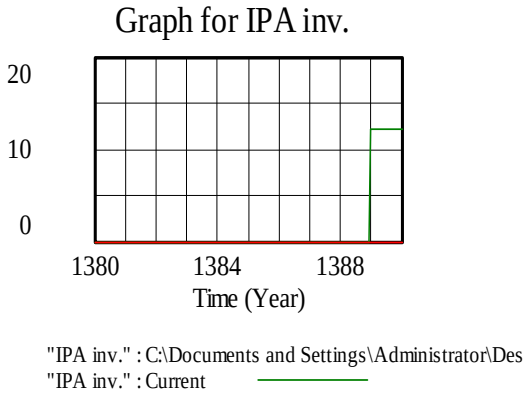

Fig 18: METAXYLEN consumption in high level condition and it s comparison with base condition

METAXYLEN consumption will be done simultaneously with IPA production. But the volume of METAXYLEN consumption is not justifiable with decreasing base condition, so required METAXYLEN should be supplied through import. Due to lack of making METAXYLEN capacity the production and export of this product will be zero in high level condition.

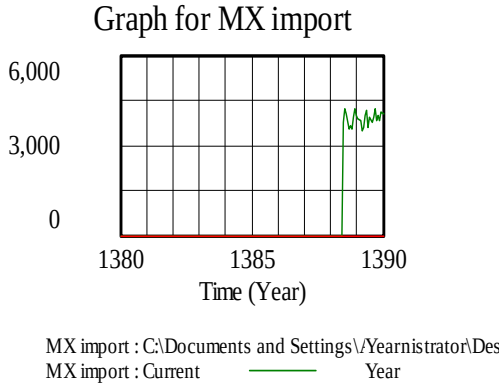

Fig19:
METAXYLEN import in
high level condition and
it s comparison with base condition

Conclusion

Following cases are represented as conclusion:
Daring mid-term, the country faces lack of inflammable polyester and it s production units set up can be considered by private common parts.
Because of gigantic capacitance of pet resin the set up extension of export markets should be considered rapidly .mean while because of high properties and reflexives of product new consumed cases should be searched inside the country .in fact PET Resin consumption increase requires up to down modeling because present demand can not respond to high production.
.Principally the cause of low consumption of ISOPHTHALIC ACID in its application total consumption of this material will not change during mid-term .if we want avoid import a unit with 25000 tones is acceptable. On the other hand, in case of developing export markets we can look seriously to increase the production.
Development of METAXYLEN production units continuous gradually which does not include METAXYLEN and is justified by mid chain .principally production and consume of METAXYLEN is distinctly its export is very risk.Therefore except internal consumption it’s not recommended the unit set up even in pessimistic scenarios.

Resources

[1]Angerhofer, B. and Angelides, M.,“ SYSTEM DYNAMICS MODELING IN SUPPLY CHAIN MANAGEMENT”, RESEARCH REVIEW, 2003.

[2] Bean, M., Bullwhips and Beer,” why supply chain management is so difficult”, Available online via www.forio.com/nearbeer.htm (Accessed July 10, 2004).

[3] Chang, Y. and Makatsoris, H,” SUPPLY CHAIN MODELING USING SIMULATION”, 2002.

[4] Iranian technology analyst network peter chemical industries challenges entering to WTO, 2004, NPC publication,TEHRAN,IRAN.

[5] Petrochemical downstream industries development office production design,report, 2004 ,NPC publication,TEHRAN,IRAN.

[6] Petrochemical downstream Industries development office production design, report, ISOPHTHALIC ACID, 2004, NPC publication, TEHRAN, IRAN.

[7] Petrochemical downstream Indus development office production design, report, METAXYLEN, 2004, NPC publication,TEHRAN,IRAN.

[8] Petrochemical downstream Indus extent company production design, report, flammable polyester, 2004, NPC publication,TEHRAN,IRAN.

[9] Petrochemical downstream Indus development office production design, report, ISOPHTHALIC PET RESIN, 2004, NPC publication,TEHRAN,IRAN.

[10] Polyethylene Terephetalate(PET) solid-state resins,” CEH Marketing Research Report”, SRI International-2002.

[11] Rabelo, L. and Helal, M.,” ANALYSIS OF SUPPLY CHAINS USING SYSTEM DYNAMICS NEURAL NETS, AND EIGENVALUES”,2004.

[12] Sterman, J.,” Bussiness Dynamics- Modelling and system thinking for a complex world”, McGraw Hill, New York, USA, 2000.

[13]Unsaturated Polyester Resins (UPR), CEH Marketing Research Report, SRI International-2002.

[14] Unsaturated Polyester Resins (UPR), CEH Marketing Research Report, SRI International-2005.

Received: November, 2008