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Application of ISO tank in chemimcal logisitcs in China and relative issues

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APPLICATION OF ISO TANK IN CHEMICAL LOGISTICS IN CHINA AND RELATIVE ISSUES

By

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China

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DECLARATION

I certify that all the material in this research paper that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

(Signature): .....
(Date): .....

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ABSTRACT

Title of Dissertation: **APPLICATION OF ISO TANK IN CHEMICAL LOGISTICS IN CHINA AND RELATIVE ISSUES**

Degree: **MSC**

Nowadays, with the fast-expanding demand of the domestic chemical products, the Chinese chemical industry is blooming dramatically. However, the lower developed chemical logistics is becoming a big restriction in front of Chinese chemical industry to get closer to the world advanced level. The major problems of Chinese chemical logistics are high cost, low efficiency, poor reliability and lack of value added service. The application of ISO tank in chemical logistics in China can help to solve such problem effective and help the Chinese chemical manufacturers to improve their competitive advantages. But up to now, there is still only a small potion of chemicals choice to use ISO tank. Therefore, applying ISO tank in China, so as to well support the consistent development of the chemical industry still has a long way to go. This essay mainly focuses on the application of ISO tank in chemical logistics in China, and gives some general solutions and suggestions to the problems, which may occur during the process of applying ISO tank in China, based on the analysis of ISO tank's characteristics and chemical logistics market in China. Then some indications are given to the involved parties in this industry, hoping to give some scientific guidance for the development of China chemical product logistics.

Key Words：ISO tank, tank container, chemical logistics, China

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LIST OF ABBREVIATIONS

3PL	Third Party Logistics
ISO	International Organization for Standardization
IMO	International Maritime Organization
IMDG	International Maritime Dangerous Goods
ADR	European Agreement Concerning the International Carriage of Dangerous Goods by Road
RID	International regulations concerning the International carriage of dangerous goods by rail
DOT	Regulations for dangerous cargo transportation of American Federal Law
CSC	International Convention for Safe Containers
CCC	Customs Convention on Containers
UIC	Regulations of International Union of Railway
ITCO	International Tank Container Organization
GP	General Purpose
CBM	Cubic Meter
MW	Measuring Weight
CIMC	China International Marine Containers (Group) Ltd
CY	Container Yard
BENDS	Both ends
FCL	Full container load
LCL	Less than container load

APPLICATION OF ISO TANK[1] IN CHEMICAL LOGISTICS IN CHINA AND RELATIVE ISSUES

Chapter 1. Introduction

1.1 Brief objective of this topic

As the title shown, my dissertation will mainly focus on the application of ISO tank in the chemical logistics industry in China. The current situation, trend of development, problems occurred, and some relative issues of application of ISO tank in chemical logistics in China will be discussed and some brief solutions, indications and guidance will be given for relative party involved in this industry in order to help and guide the health and stable development of Chinese chemical logistics industry based on ISO tank.

1.2 Background of ISO tank

With the quick development of international chemical product trading, both the transportation volume and cargo value of chemical product kept increasing stably in the past decade. Meanwhile, cargo owners also put forward a higher requirement on efficiency, safety, convenience, value adding service and other aspects of transport process in front of the chemical logistics service providers. ISO tank is born under such background.

ISO tank container indicates tank container constructed according to the

[1] ISO tank in this essay indicates for the tank container built according to the ISO standard.

standards of International Standard Organization. (ISO 1496-3:1995/Amd 1:2006), which is suitable for the carriage of gases, liquids and solid substances (dry bulk) which may be loaded or unloaded as liquids by gravity or pressure discharge, for international exchange and for conveyance by road, rail and sea, including interchange between these forms of transport.

———— ISO 1496-3:1995/Amd 1:2006

Following is the major parameters of ISO series tank container,[2]

(01) Dimension: 6058mm x 2438mm x 2591mm (L * W * H);

(02) Tank diameter: 2200 – 2400mm;

(03) Tank designing pressure: 0.175MPa – 0.40MPa;

(04) Tank experimental pressure: 0.265MPa – 0.60MPa;

(05) Maximum cubage: 20 – 24cbm;

(06) Maximum total weight: 2400kg - 30480kg;

(07) Self weight: 3500kg - 4180kg;

(08) Maximum loading weight: 20500kg - 26300kg;

(09) Working temperature: Optional;

(10) Heating Method: Steaming or electronic bar heating;

(11) Heat insulation: 50mm thick heat insulation layer;

(12) Made by [Cr18N 9T], [316], [316L] or other kinds of stainless steel, and choose suitable inner material according to the requirement of cargo worthy.

ISO tank is composed by a container framework and a bearing tank inside. The body of ISO tank is built by stainless steel, which is wedged in a framework of mild steel,

[2] ISO 1496-3:1995/Amd 1:2006; International Standard Organization

and equipped with steam and electronic heating system to carry heat sensitive cargo. The volume of ISO tank is usually ranging from 14,000L to 25,000L. ISO tank is widely used for international transportation of poison, harmful, flammable, dangerous, explosive, deteriorative and non-dangerous liquid, gas and solid pulverous cargo, food liquid cargo and compressed gas cargo. The two prevailing model of ISO tank in the market of China are 1CC and 1D.

Besides, according to the standards of IMO / IMDG CODE, ISO tank can be divided into following eight categories.[3]

(1)IMO0 —— For carriage of non-dangerous cargo (flash point is not exceed 61℃), non-poison cargo, non- deteriorative cargo and some liquid food excludes cargo in the list of forbidden cargo.

(2)IMO1 —— For carriage of dangerous cargo. Maximum working pressure is higher than0.175MPa

(3)IMO2 —— For carriage of inferior dangerous cargo. Maximum Working pressure: 0.1MPa-0.175Mpa

(4)IMO4 —— Truck equipped with IMO1 or IMO2 for road transportation.

(5)XMO5 —— For carriage of non-reefer liquid gas or chemicals with low dangerousness in normal temperature

(6)IMO6 —— Truck equipped with IMO5。

(7)IMO7 —— Equipped with reefer facility for carriage of reefer liquid gas and liquid deteriorative cargo

(8)IMO8 ——Truck equipped with IMO7

[3] IMO / IMDG CODE; International Maritime Organization

The smooth and healthy development of ISO tank can’t leave an effective law and regulation system. Especially in Europe and America, there have been comprehensive legal system and series of standards to regulate the whole ISO tank industry. The major international and Chinese regulations and standards of ISO tank application are,

(01)UN / IMO IMDG —— United Nation/ International Maritime Organization International Maritime Dangerous Goods Code

(02)ADR —— European Agreement Concerning the International Carriage of Dangerous Goods by Road

(03)RID —— International regulations concerning the International carriage of dangerous goods by rail

(04)UN ORANGE BOOK —— the internationally recognized recommendations for classification, package testing and marking requirements for the transport of Dangerous Goods by the United Nation

(05)DOT —— Regulations for dangerous cargo transportation of American Federal Law

(06)CSC —— International Convention for Safe Containers

(07)ISO 1496 / 3 —— freight containers -- Specification and testing -- Part 3: Tank containers for liquids, gases and pressurized dry bulk

(08)CCC —— Customs Convention on Containers

(09)UIC —— Regulations of International Union of Railway

(10)Standard and regulation of classification society like ABS, BV, GL and so on.

(11)Regulations of General Administration of Quality Supervision, Inspection and Quarantine of the People’s Republic of China.

1.3 Literature Review

The manufacture of tank container started in Europe. By the end of 1994, there are only 76617[4] tank containers in the world, which occupies only 1% of the total volume of containers. But from 1995, tank container industry entered a period of fast-growing. Comparing with traditional chemical transportation modes, ISO tank has the advantages of safety, reliability, flexibility, economic and environment protection. Nowadays, ISO tank has been widely used in developed countries, and in some countries using ISO tank for dangerous cargo transportation is compulsory.[5] Recently, a researching and investigating report of chemical product transport and long-term develop trend of ISO tank industry[6] is accomplished by scholars of Rotterdam Erasmus University, which is entrusted by the International Tank Container Organization (ITCO). This report gives the statistics data and prediction for the development and growth trend in the following two years in this industry.

It stated that the use of inter-modal tank containers by chemical producers will continue to rise steadily around the world over the next five years. Asia will come through a Period of strong growth, and tank container shipments from and within the region will expand at least twice as fast as elsewhere. In addition, chemical companies will follow the current trend of third party chemical logistics and continue to outsource the management of their tank transportation activities to specialized tank container operators and third party chemical logistics providers..

Besides, some scholars found that chemical manufacturers favor tank containers over

[4] YunDong Li (1997.3) Global tank container development and current situation of China. China: Wuhan Science University
[5] JianLiang Zhang (2006.3) Current Market of ISO tank. China: Container Manufacturing
[6] Prof Dr MBM de Koster (2006.7) Longer Term Trends Developments of the Tank Container Industry. Rotterdam: ErasmusUniversity

the drum, specialized bulk container and flexi-tank 'bag in-the-box' options for ocean transportation on intercontinental routes for the purpose of guarantee of cargo's safety, efficiency and environmental protection[7]. Because the most of new type of seagoing chemical tanker vessels are being built with larger and larger cargo tanks than the previous models, the unique volume of tank containers can help it to win many shipment of relatively small quantity from the previous bulk carriers.

In mainland Europe, where the tank container concept was born almost four decades ago, chemical shippers increasingly favor the use of inter-modal swap body tank containers over road tankers on longer haul routes. Furthermore, the attractiveness of the tank container option in Europe will continue to increase as the trade with Eastern and Central European countries keep blossoming, and plans to promote rail transport and short-sea shipping capacity to help relieve the continent's road transportation congestion have got success and obvious effect..

Some Chinese scholars stated that in Asia, the region with biggest potential of growth, the prospects are even brighter.[8] Boosted by the continuous completion of new chemical production plants and joint projects, chemical trade level based on tank container in the Asia to Europe route is estimated to expand by 5-10 per cent per annum over the next five years, while the annual growth in the intra-Asian movement of chemicals using tank containers will exceed 10 per cent.

In China, chemical logistics based on ISO tank is just on its initial stage of development. But with the development of international chemical trade, ISO tank must replace some traditional type of chemical logistics such as barrels, drums and

[7] ITCO Secretary, Willy Freson (2006.11) Buoyant Future For Tank Container Industry. International Tank Container Organisation Press Release

[8] DaoZhong Liu (2005.11) Development of liquid material logistics. China: Jiangsu Xinhuachang Group

bags because of its high economic benefit. And environment protection is another important reason for the application of ISO tank in global area so as to meet the requirement of global standards sooner or later, and it is estimated that the throughout volume of ISO tanks in China will exceed 15000 tons per year by the end of 2006.[9]

There are few researches of ISO tank application in China before. Most relative researches are conducted on the techniques of ISO tank manufacturing. Recently, many scholars have found this trend of ISO tank, and we can see a lot of discussion of ISO tank in different transportation magazines, but most of them are simple qualitative introduction.

1.4 Research Methodology

Because there is few such research of ISO tank's application in China before, so large potion of this dissertation is conducted based on the current data processing and its analysis result. The major researching methodologies of this essay will be mathematics model trend forecasting based on the existing statistics, structure analysis, economic benefit calculation based on current transportation market, comparison of similar situation and assisted with some quantitative and qualitative analysis.

[9] JianLiang Zhang (2006.5) Domestic demand and forecast of ISO tank China: Containerization

1.5 Flow Chart of this dissertation

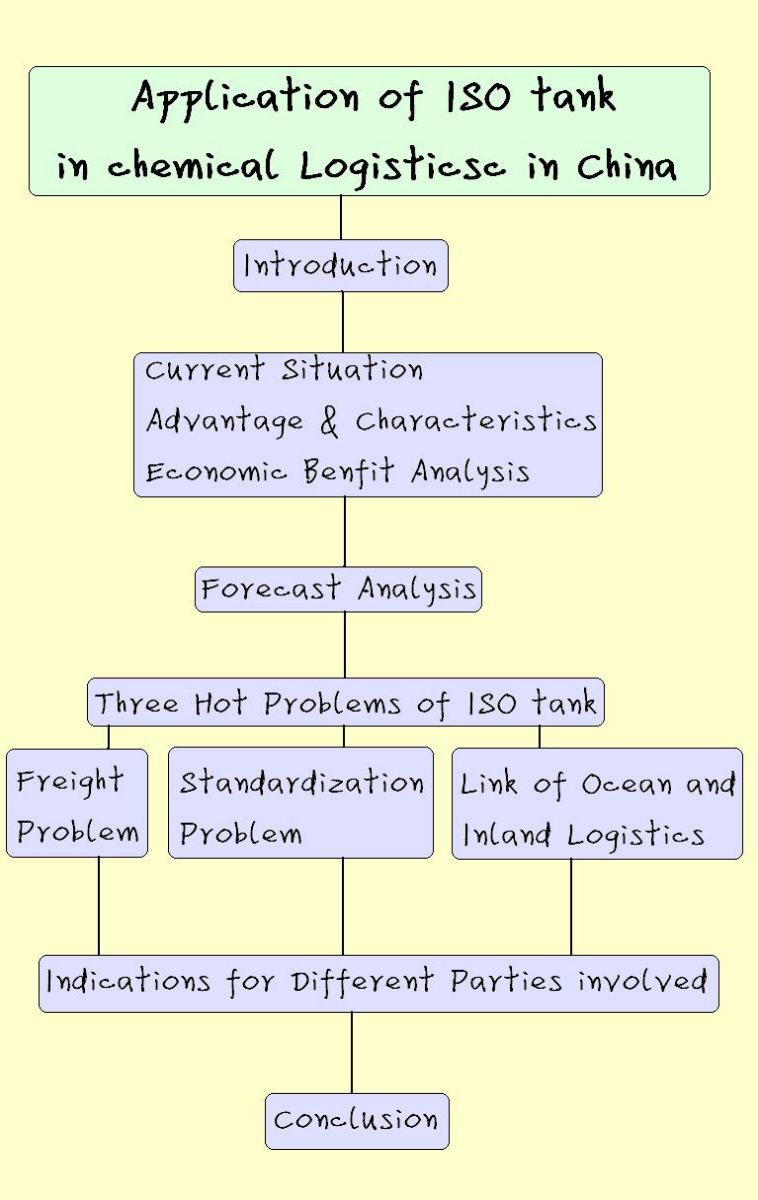

Figure 1 – Flow chart of the dissertation

Source: draw according to the frame of the dissertation

Chapter 2. Application of ISO tank in chemical logistics in China

2.1. Current situation of ISO tank logistics in China

In China, ISO tank has been accepted by more and more people because of its outstanding economic benefit and convenience. It has looted lots of transportation business from the traditional mode of chemical logistics like tank truck, drum, bag and etc. Graph is the throughput of ISO tank ex China seaports.

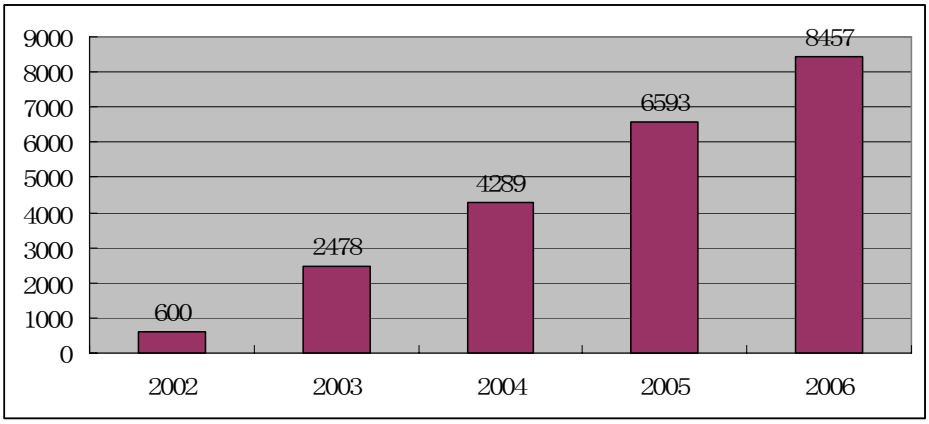

Figure 2 - Throughput of ISO tank ex China seaports

Source: Yearbook of China transportation 2002-2006, National Statistics Bureau

From Figure 2, we can find that from the entrance of ISO tank into China, the throughput of ISO tank ex China seaports keeps going up stably from 600 standard ISO tank in 2002 to 8457 in 2006, which is about 1400% of the number in 2002. Such great growth shows that the mode of ISO tank transportation has been gradually accepted by the Chinese shippers, and become prevailing in recent years.

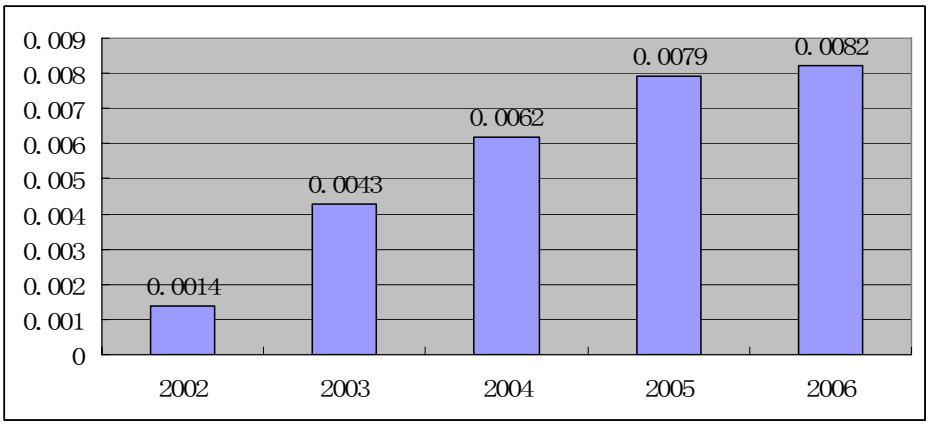

Figure 3 - Percentage of ISO tank transportation in Chemical transportation in China

Source: Calculated based on the data from Yearbook of China transportation 2002-2006, National Statistics Bureau

Figure 3 is the percentage of ISO tank transportation occupies in the whole volume of chemical product transportation. It shows that the chemical logistics based on ISO tank grows quickly in the past years, and its outstanding characteristics and performance have been accepted by more and more chemical manufacturers. As a result, many chemical transportation volume of other traditional mode of transportation has changed to favor ISO tank, and this help to raise to potion of ISO tank transportation in the whole chemical transportation volume.

2.2. Characteristics and advantages of ISO tank

The volume of usual 20 inch (6.096m) ISO tank is smaller than the tank truck, but it shows strong advantages in long distance overland transportation, ocean transportation and multi-mode transportation. And extra package like drum and bag also cost a lot of waste on package expenses. The ISO tank can be lifted from the trailer easily and can be loaded on railway just like common containers. And during

the period it is carried by vessel or railway, no driver is needed. It even can be used as a temporary storage place for the carrying cargo while the consignee is ready for reception of the cargo. Besides, the framework of ISO tank can provide better protection for its carrying cargo. It's said that the latest model of ISO tank developed by CIMC can bear the hit of train with a speed of 100km/h. Meanwhile, ISO tank also has obvious advantages comparing with railway tank and tank vessel. In China, nowadays the manufacturer of special chemical product and high value chemical product all prefer ISO tank and rarely use railway tank and tank vessel, because ISO tank made by stainless steel is easy to learn and more suitable for small volume and high frequency cargo transportation, and this advantage is incomparable by bulk or other type of tank transportation.

Following is some of the obvious advantage of ISO tank,

1) Reduce produce process

For using the ISO tank, the whole process of loading only needs one measuring worker and one loading worker with very low working load and high efficiency, because chemical cargo can be loaded automatically and without any pollution.
If ton bags are used for carrying chemical cargo, two workers are needed for loading, measuring and driving forklift for storage in warehouse. And while loading the cargo two workers are needed, one for hooking and one for crane controlling. The whole process will need another two workers because of high working load and low efficiency.

While discharging the cargo, ISO tank only need to connect tube and control valve. Cargo will be discharged automatically. But ton bags packed chemical product needs

forklift or crane handling, transporting to warehouse and manually discharging.

2) Reduce package expense

Usually chemical product is calculated by ton. If drums and ton bags are used for chemical product transportation, it will cost extra 10USD for one ton bag and 20USD for one drum.[10] In Europe and USA, 10USD is forced for recycling per drum. Nowadays customers have become more and more price sensitive, and this package cost will become a high burden for the cargo owner.

3) Save labor cost

Despite the cargo handling labor, ISO tank carries 20mt chemical cargo per time and one driver is needed. If ton bag is used, common truck can only carry 8mt per time, and 20mt cargo will need 2.5 drivers. So while carrying such chemical product, the labor cost of ISO tank is only 40%of ton bag transportation. One standard ISO tank can carry 24CBM liquid chemical cargo, which can save 40% of the total cost of using GP container with drums, and ISO tank doesn't need to be cleaned because it's exclusively for specific chemical cargo and circulate all over the world.

Besides, in Europe and USA, the government ruled that import trader must recycle the storage drum. If it's calculated by 10USD/drum, there is another 780USD cost. Furthermore, ISO tank can be used as transport unit deliver to the ultimate customer and this can help to reduce large amount of storage expense.

[10] Unknown Author (2004.6) Regulation of transportation of dangerous cargo by tank container in Russia; Russia: <В е с т н и к В Н И И Ж Т>

4) Ensure cargo quality

During the transportation period of ton bagged chemical cargo, there will be many dusty and pollutions pasting on the bag or some water infiltrate into the bag and while discharging from bag, these pollutions will affect the quality of the cargo. If ISO tank is used, nitrogen will help to separate the discharging process from the outer environment so as to prevent the deterioration of carrying cargo.

5) Short circulation time

The chemical logistics based on ISO tank can help to save a lot of time and shorten the total circulation time. While using other mode of transportation, a lot of time is wasted on the process of packaging, unpacking, manually loading, discharging and waiting. Waiting time for pack, load, truck, CY space, reload to vessel, discharging and etc is the direct cause of low efficiency and long circulation time of the chemical logistics system. ISO tank help shipper to solve such problem and simplify the transportation flow.

6) Environmental friendly

Because of the advanced loading and discharging techniques of ISO tank, it can help to reduce the pollution effectively. No floating dust and leakage will happen during the loading and discharging process both in the factory and port.

7) High Safety

ISO tank has a very high level of safety. The inner tank has a very good ability of

bearing pressure, and the outer framework and support can protect the inner tank effectively while hit happens. There is some auxiliary facility in the ISO tank to ensure the transportation of specific dangerous cargo such as pressure controller, reefer and heating equipment

8) High frequency

The ISO tank can be carried by common container vessel. Nowadays, the container line has been very mature and covers a wide service range. People can find container vessel with suitable sailing schedule easily, because container lines have a very high frequency comparing with bulk vessel. Previously, the manufacture has to storage the cargo in its own warehouse until it become a large quantity then they can charter a vessel for the transportation. Now ISO tank help them to transport cargo freewheeling.

2.3. Economic benefit analysis of ISO tank in China

Freight is a very important parameter for manufacturers to measure their transportation cost, and choosing transportation mode. Here we take freight to be the research objective and measuring parameter. Following is the freight calculation of three prevalent mode of chemical cargo transportation.

Bulk, ISO tank and General Purpose (GP) Container with drums are three prevailing transportation modes in chemical logistics in China. One standard 1CC ISO tank occupies one slot of 20 inch general purpose container. One 20’GP only can carry

15600L liquid cargo per voyage (78pcs drums × 200L/drum)[11], but one ISO tank can carry more than 23000L liquid cargo (47% more than GP container) and there is little leftover volume. If we calculate every drum as 20USD, one 20'GP chemical cargo will cost another 1560USD package expense.

Here I will use some latest accurate freight data from Shanghai, China to Pusan, Korea for the calculation of the transportation cost for following three modes of chemical product transportation.

	Bulk	ISO tank	GP container
Ocean freight	18USD/MW*	880USD all in	190USD all in
BAF, CAF	Nil		
THC	Nil	90USD total	90USD total
Loading / Discharging	4USD BENDS	Nil	Nil
Package	Nil	Nil	16USD / DRUM
Port inducement	10,000USD**	Nil	Nil

Figure 4 – Cost of three modes of transportation ex Shanghai, China to Pusan, Korea

Source: data collect from current shipping market

*MW indicates measuring weight, ship owner collects freight according to the bigger one of CBM and MT, and 18USB/MW is the freight of about 7000MT bulk vessel.

**Ship owner will pay for the Port inducement for booking of more than half of total available space. Actually, the port inducement is contained within the 18USD/MW.[12]

The parameter I choose to analyze is the transportation cost is the freight of per ton of chemical cargo, then we set this parameter to be F and transportation volume to be

[11] Xu Wenbin (2001.12) Suggestions for tank container designing; China: Containerization
[12] MW indicates the measuring weight, which means the bigger one of weight or volume

V (unit: liters). Here I suppose the carrying cargo is common liquid chemical cargo, and its SF (stowage factor) is 1 cbm/ton.

1. Bulk carrier

Loading/Discharging Expenses + Ocean Freight + Port Charge

F=[(4+4+18)×V/SF/1000 +10000]/(V/SF/1000)=26+10^7/V

*0<V<3500*SF*1000 = 0<V<3,500,000*

F=[(4+4+18)×V/SF/1000]/V/SF/1000=26

3,500,000<V<infinite

2. ISO tank

THC + Ocean Freight +BAF,CAF

F=(90+880)/[23000/1000/SF]=42.174

3. GP container (FCL or LCL)

THC + Ocean Freight + BAF,CAF+ Package

*F=(90+190×V/15600+V*16/200)/(V/1000/SF)=0.09V+0.0922*

0<V<infinite

Intersectant point of 1 and 2,

(90+880)/[23000/1000/SF]= [(4+4+18)×V/SF/1000 +10000]/(V/SF/1000)

V=618,276

Intersectant point of 1 and 3,

[(4+4+18)×V/SF/1000 +10000]/(V/SF/1000)=

*(90+190×V/15600+V*16/200)/(V/1000/SF)*

The value of V is extremely big and >> V of ISO tank, so we ignore this value

Intersectant point of 2and 3,

*(90+880)/[23000/1000/SF]= (90+190×V/15600+V*16/200)/(V/1000/SF)*

V=467

The three freight curve and intersectant points can be shown as Figure 5,

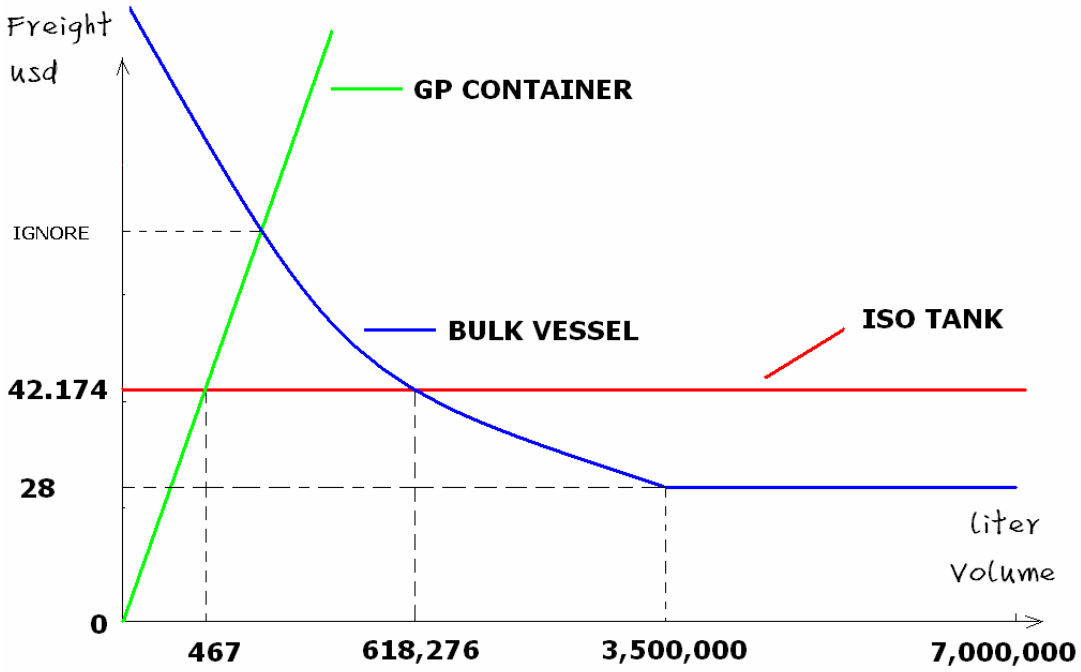

Figure 5 – Freight function curve of three mode of transportation

Source: draw according to the three freight functions

From the above calculation and Figure 5, we can found in the transportation example we set, the solution of GP container with drums is very suitable for small amount of chemical cargo transportation, because drums are very flexible and shipping company also accept LCL (part cargo) in certain situation. Bulk transportation shows its advantages when the cargo volume exceeds 618,276 liters per voyage because of the effect of scale economy. So this kind of transportation is widely used for large

quantity and low value cargo such as fertilizer, because they are more price sensitive. But with the development of technology, the production of such cargo keeps decreasing in China and moving to other developing countries in South East Asia such as Vietnam and Indonesia. And the manufacturer of such low value cargo usually can't earn lot of money, because your price must be lower than the import country's price minus the transportation cost. This is a big challenge to the manufacturer, so more and more manufacturers have to move their factory to the import country for their profit. And this section of chemical transportation will shrink gradually in the following years. The GP container with drums only shows its advantage while carrying small amount of cargo, because the cost on repeated package is so high, and this is the major cause of losing competitive advantage in transportation.

The freight advantage of ISO tank is very obvious when the cargo volume is from 467 to 618,276 liters. This section is very important in chemical industry of China. Many cargo such as sophisticated chemicals, chemical commodity, food product and so on falls into this section. Recently, we can find a lot of foreign chemical magnates begin to invest and start joint chemical project in China for the manufacturing of high technology chemical products. Such cargo usually has the characteristics of not very large quantity, moderately higher value, relatively high frequency and high requirement of transportation. From the latest statistics of China chemical industry, such cargo will be the new growth point in the following decade, and become a crucial part in the chemical industry of China. And ISO tank transportation is the best choice for this section of chemical product. So in the following decades, ISO tank must become the main role of chemical logistics industry in China.

2.4. Significance of applying ISO tank in China

Nowadays, with the fast-expanding demand of the domestic chemical products, the Chinese chemical industry is blooming corresponding. However, the lower developed chemical logistics is becoming a big restriction in front of Chinese chemical industry to get closer to the world advanced level. The major problems of Chinese chemical logistics are high cost, low efficiency, poor reliability and lack of value added service. The application of ISO tank in chemical logistics in China can help to solve such problem effective and help the Chinese chemical manufacturers to improve their competitive advantages so as to support the health and stable development of Chinese chemical industry. So ISO tank transportation must play an important role in the future development of Chinese chemical logistics

Chapter 3. Forecasting of ISO tank logistics in China

CIMC is the biggest manufacturer of container and ISO tank in the world. From year 2002, CIMC began to develop and research its own ISO tank technique and successfully manufactured 300 ISO tank at that year. In the following years, many Chinese companies devote into the market of ISO tank manufacturing and greatly promoted the development of ISO tank which is made in China. Table 1 is the production of ISO tank in China in the past 5 years calculated by China container industry consortium.

Table 1 - Production volume of ISO tank in China[13]

China	2002	2003	2004	2005	2006
Production	300	2533	3793	6323	7056

Source: Unpublished annually report of year 2006 of CIMC

Unit: Standard 20 inch ISO tank

According to the latest statistics of National Statistics Bureau, from year 2002, the throughput volume of ISO tank ex China seaports has increased greatly and stably. The detail numbers are shown as Table 2

Table 2 - Throughput volume of ISO tank ex China seaport

Year	2002	2003	2004	2005	2006
Throughput Volume	600	2478	4289	6593	8457

Source: Yearbook of China transportation 2002-2006, National Statistics Bureau

Unit: Standard 20 inch ISO tank

[13] Unpublished annually report of year 2006 of CIMC

Table 3 - Throughput volume of chemical products in China

Year	2002	2003	2004	2005	2006
Throughput Volume	975	1330	1596	1930	2366

Source: Yearbook of China transportation 2002-2006, National Statistics Bureau

Unit: million ton

Table 4 - Total throughput volume of containers in China[14]

Year	2005	2006	2007	2008	2010
Throughput Volume	7564	9300	10000	11500	15000

Source: Number in this figure is forecasted by shanghai shipping exchange bureau

Unit: million TEU

Here I will use the quadratic equation curve model (time series) for forecasting. We take time spots as independent variables to analyze the variation of dependent variable. [15]

The quadratic equation curve model:

$y = a + bx + cx^2$

Here y indicates the amount and x indicates the calculative periods we can set $x1=x$, $x2=x^2$, and change it into a liner equation: $f(x)=a+bx1+cx2$, then we can establish a standard equation group as follow,

[14] Wang lan (2006.5) The trend of container transportation in 2007 and 2008; Shanghai Shipping Exchange Bureau

[15] Ni Xinghua M.A.(2005.10) The integration and regulation of the logistics ways in chemical system; Shanghai Maritime University, Shanghai, China

$$\begin{cases} \sum y = na + b\sum x_1 + c\sum x_2 \\ \sum x_1 y = a\sum x_1 + b\sum x_1^2 + c\sum x_1 x_2 \\ \sum x_2 y = a\sum x_2 + b\sum x_1 x_2 + c\sum x_2^2 \end{cases}$$

We can solve this equation and get the value of *a, b, c*

3.1 Forecasting analysis of production volume of ISO tank in China

Table 5 - Forecasting of production volume of ISO tank in China

Data Series	300	2533	3793	6323	7056
Number of data	5	**Total**	20005	**Average**	4001
Deviation	6124079.6	**Standard Deviation**			2474.6878
Quadratic Curve Model	y=-2054.6+2471.628571t-123.571429t^				
Original Data	300	2533	3793	6323	7056
Model Data	293.4572	2394.371	4248.143	5854.771	7214.257
Estimated difference	6.5428	138.6287	-455.143	468.2285	-158.2573
Decision coefficient	0.9923	**Average absolute difference**	306.7		
Estimated standard difference	396.1057				
Difference ratio	0.124	**Precision grade**	Good		
Estimate data	2007(t=6)	2008(t=7)	2009(t=8)	2010(t=9)	
Estimate result	8326.6	9191.8	9809.857	10180.77	

Source: Based on the forecasting calculation

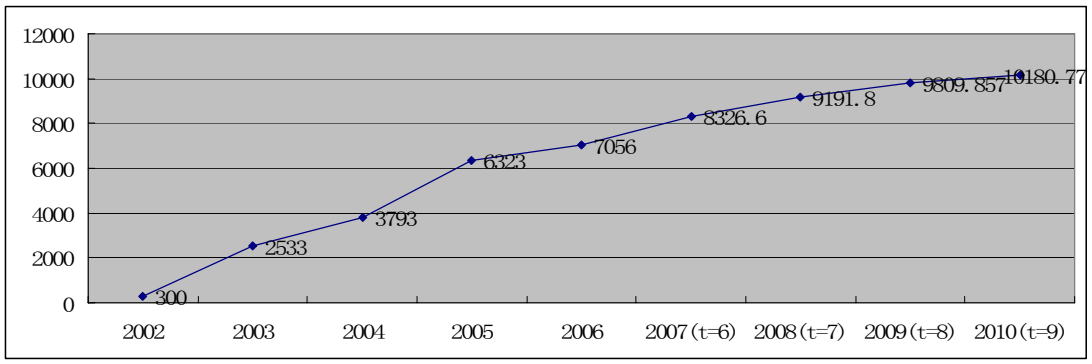

Figure 6 – Forecasting production volume of ISO tank in China

Source: Based on table 5

We can learn from Figure 6 that the quantity of annual production of ISO tank in China keeps increasing since the beginning of ISO tank manufacturing by CIMC in year 2002. Through seven years of development, the production will reach 10181 standard ISO tank per year in 2010. But we can also find that the manufacturing industry of ISO tank has passed it quick growing period and turn into a stable and slowly develop period, because with the increasing number of ISO tanks, the demand of ISO tank is tend to be stable and decrease slightly. Instead there is increasing demand of specialized ISO tank for specific cargo (such as fruit juice tank container, LPG tank container, cement tank container and so on). This shows that with the improvement of ISO tank manufacturing techniques, people put forward higher requirement on specific ISO tank so as to help the shipper to achieve maximum of economic benefit. Besides, it also told us that more and more people begin to know and accept this new mode of transportation. As for the Chinese manufacturer, they should pay attention not only to the producing capacity of ISO tank, but also their capacity of research and develop.

3.2 Forecasting analysis of throughput volume of ISO tank ex China seaport

Table 6 - Forecasting of throughput volume of ISO tank ex China seaport

Quadratic Curve Model	y=-1232.8+1783.614286t+33.214286t^			
Estimate data	2007(t=6)	2008(t=7)	2009(t=8)	2010(t=9)
Estimate result	10664.6	12880	15161.83	17510.09

Source: Based on the forecasting calculation

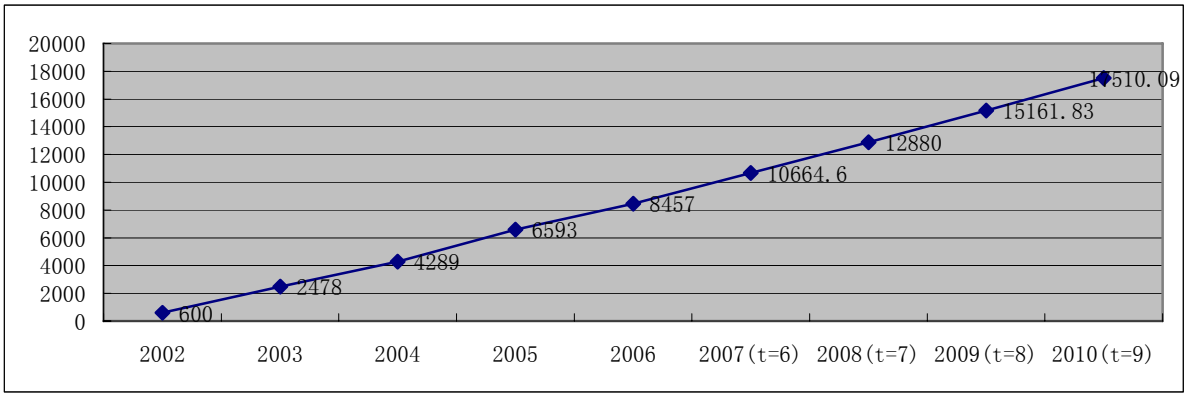

Figure 7 - Forecasting of throughput volume of ISO tank ex China seaport

Source: Based on table 6

From the above mathematics model forecasting result, we can find the throughput of ISO tank kept increasing in the past 5 years and will keep this trend in the following years. And from the slope of this increasing curve, we can find its almost linear, so the increasing rate of demand of ISO tank is very stable. The application of ISO tank in China will keep growing with a relative fixed trend and the throughput of ISO tank will reach a new height of 17510 standard ISO tank annually in year 2010, because the ISO tank industry of china is at a quick developing period now. So there will be a big chance and challenge for every participant of ISO tank industry in the following

years. Shipping company, terminal, inland logistics company and other parties involved can take advantage of such good period and get developed quickly. Meanwhile, such quick development also brings us great challenges of both volume and service quality in front of these service providers. So the ISO tank companies should also pay attention to this and make preparation and accurate strategy for their long-term development.

3.3 Forecasting analysis of percent of ISO tank transportation in the whole chemical transportation

Table 7 – Forecasting of percent of ISO tank transportation in the whole chemical transportation*

Quadratic Curve Model	y=739.8+239.628571t+16.428571t^			
Estimate data	2007(t=6)	2008(t=7)	2009(t=8)	2010(t=9)
Estimate result	2769	3222.2	3708.257	4227.171

Source: Based on the forecasting calculation

*Here we measure a standard 20 inch ISO tank as 23 ton

Table 8 – Forecasting percent of ISO tank transportation in the whole chemical transportation

2002	2003	2004	2005	2006	2007	2008	2009	2010
0.0014	0.0043	0.0062	0.0079	0.0082	0.0089	0.0092	0.0094	0.0095

Source: Calculated based on the data from Table 4 and Table7

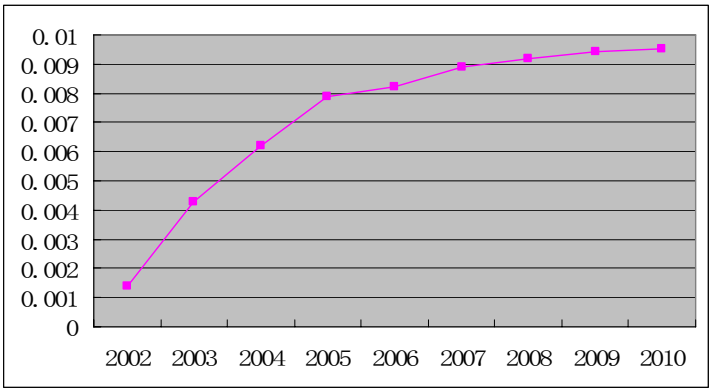

Figure 8 – Forecasting percent of ISO tank transportation in the whole chemical transportation

Source: Based on Table 8

From the above graph we can find in the following years the percentage of utilization of ISO tank in the whole chemical transportation will keep increasing and reach 0.0095% in year 2010. It shows more and more people begin to know and accept ISO tank transportation and more and more potion of chemical cargo change to use ISO tank because it outstanding economic benefit. From this graph, we can find both the rapid development period and mature application period. Before year 2005, the percentage of using of ISO tank grows rapidly because people begin to know and use ISO tank. After year 2005, the utilization of ISO tank is tend to be stable and get into a stable long-term develop period.

3.4 Forecasting analysis of percentage of ISO tank transportation in the whole throughput of container

Table 9 – Forecasting percentage of ISO tank transportation in the whole throughput of container

2005	2006	2007	2008	2010
0.0000872	0.0000909	0.0001066	0.0001120	0.0001167

Source: Calculated based on the data in Table 4 and Table 6

Figure 9 - Forecasting percentage of ISO tank transportation in the whole throughput of container

Source: Based on Table 9

From the Figure 9, we can find the percentage of ISO tank in the whole throughput of container increases slightly and will keep this trend in the following years. In this graph, two points are worthy mentioning. First, the base number of container throughput is very big, which is about 10000 times bigger than the quantity of ISO tank. So even small increasing here is also very large amount of development to the ISO tank industry. Besides, the increasing of percent comes from two aspect effect. One is the newly increasing demand of ISO tank, the other is the volume comes from previous GP container transportation. Using most suitable container to carry most suitable cargo, this shows the structure of China container transportation is becoming more and more reasonable. Besides, the extra cost saved can help the chemical industry to reduce unnecessary loss so as to win long-term benefit and healthy development.

Chapter 4. Problems in chemical logistics by ISO tank in China and solutions

4.1 Freight analysis of ISO tank application in China

As for ISO tank industry, one interesting topic is the allocation of benefit for different parts in this industry chain. Every party involved wants to maximize their own benefit and control the industry chain. The crucial point of this problem is the decision of freight.

The current situation of ISO tank industry chain in China is that there are not many chemical manufacturers and ISO tank logistics service providers in this market. Both parties have the right to accept or reject the cargo offer or logistics offer, but neither party has the ability to set the freight. (Nobody can decide tomorrow the price of one apple will be 200usd.) It's not a monopoly industry. In my opinion, the ISO tank industry chain in China is demand oriented. The characteristics of demand oriented industry chain is from one side of the chain it can be understood as a source oriented chain, while from another side of the chain it can be understood as a production oriented chain. Both parties rely on the other party, and they can choose their cooperator but they don't have the power to change the price.[16] In order to describe it more clearly, we suppose there are only two parties involved as Figure 10. * indicates the ability of choose cooperator, and $ indicates the ability to adjust the price.

[16] Unknown Author (2006.7) The illustration of IPTV industry chain. Alvin investigation Co,. Ltd China: Market; P.102

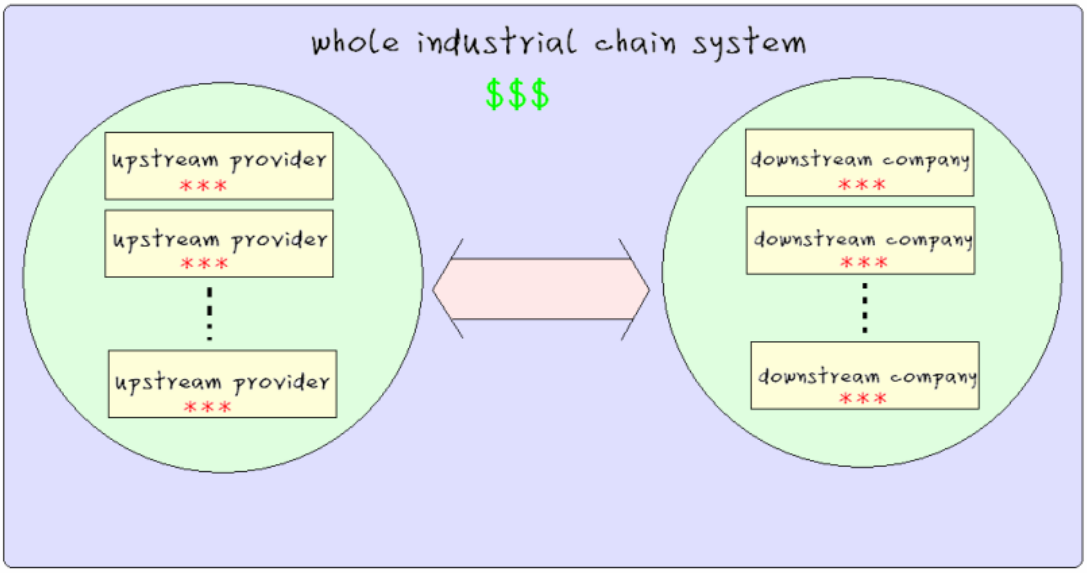

Figure 10 –Demand oriented industry chain model

Source: draw by myself

There are some providers and some downstream companies, both of them have the right to accept or reject the opposite offer. But in some specific situation either party may become the only choice for the other and become a monopoly. For example, in the midseason of transportation the provider of ISO tank logistics service maybe the monopoly because there are not many such service providers in the market, and in the off-season of transportation of transportation, the chemical manufacturers become monopoly in the market, because there are not so many cargos to carry. For the ISO tank logistics providers, the downstream chemical manufacturers are very important because if there is no demand of ISO tank logistics, they will go bankrupt. And for the chemical manufacturers, the ISO tank logistics providers are also important, because the economy benefit of ISO tank can help them to save a lot of transportation cost and raise the competitive advantage of the company. So in such industry chain, both sides have a very high reliance on the other side. Leave of any side will cause great trouble for the other and break the industry chain.

As for such demand oriented industry chain, both sides don’t have the ability to control the industry chain. Both sides can not know the cost of the other. So in such situation, the freight will not be set easily, and there must pass through a long way of negotiation and gaming. And this shows that there must exists a dynamic period of setting the freight. Although the companies in demand oriented industry china don’t have the ability to decide the freight, but they all has the right to adjust their own production to realize the maximum of benefit. (If apple cost 0.01usd tomorrow, farmers will choose to grow other kinds of fruit.) When a price is given, the provider will produce according to this price, and got an optimal production quantity *[Qa]* to realize maximum of benefit. According the given price, the downstream company also gets an optimal production quantity *[Qb]* of itself to realize the maximum of its benefit. Following analysis will falls into two situations.

Here we suppose the downstream company is rational, and accepts to manufacture according *[Qa]* this time, because ISO tank is so good and can really help them to reduce transportation cost and win long-term benefit compared with GP container. But the downstream company will suffer a lose of maximum revenue *R(Qb)-R(Qa)*. Rational companies can bear temporary loss of benefit in order to win much bigger long-term benefit but they can bear all the time and they will make up these lose at next time. High price will cause the downstream company to reduce their demand, and according to the principle of supply and demand, the provider has to reduce the price to win some business back. Then the downstream company will increase its quantity because of the low price, and the price will go up slightly again. The adjustment of price will fall into such circulation and be astringed to a fixed value.

Let us take an example to make it clear.

We suppose the optimal quantity function to be linear and set:

The function of optimal quantity of provider to be: $Q=bP+a$

The function of optimal quantity of downstream company to be $Q=dP+c$

Q= manufacturing quantity

P= price within the industry chain

C= sales price revenue (sales price – cost price)

R= actual revenue

a= The optimal quantity of provider when price =0

c= The optimal quantity of downstream company when price =0

b= the slope of optimal quantity function of provider

d= the slope of optimal quantity function of downstream company

Then the revenue will be,

Provider: *Ra= P*Q-P*Qo+Ca*[17]

Downstream company: *Rb=P*Q-P*Qo+Cb*

Here we suppose the revenue function to be:

Provider: *Ra=Pa*Qa-Qa^2/2b+Qa*a/b+Ca*

Downstream company: *Rb=c*Qb/d-Qb^2/2d-Pa*Qb+Cb*

and the optimal quantity function to be:

Provider: *Q=P/2+1/2*

Downstream company: *Q=2-P*

Then we can get following revenue functions:

Provider: *Ra=P*Q-Q^2+Q+Ca*

[17] Jian Xinhua (2001.11) Industrial economics Wuhan University China: Wuhan University Press

Downstream company: *Rb=(2-P)Q-0.5Q^2+Cb*

The system of price adjustment of the industry chain can be shown as Figure 11 and Figure 12,

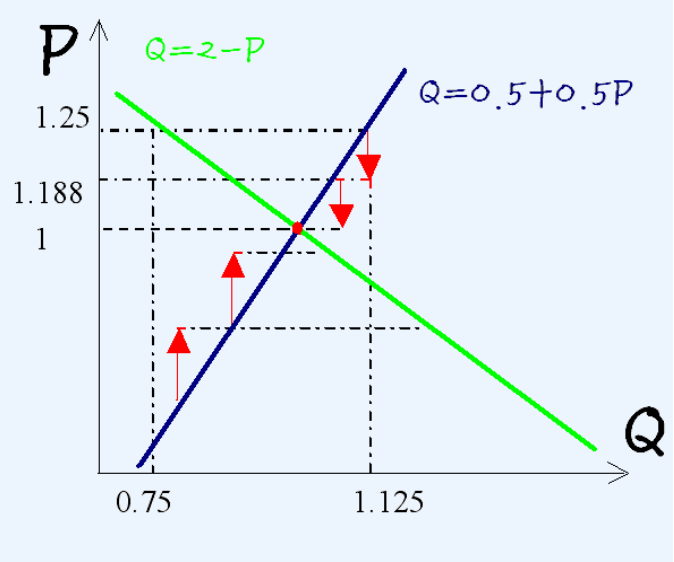

Figure 11 Revenue Function

Source: draw by myself

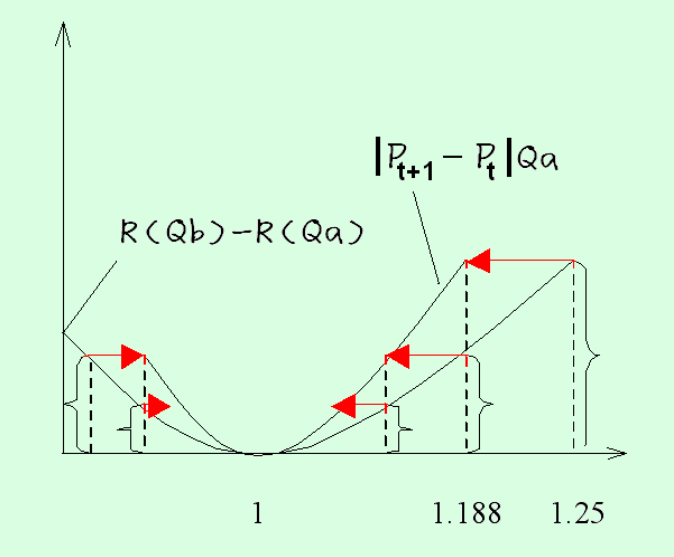

Figure 12 Revenue loss function

Source: draw by myself

The arrows in Figure 11 and Figure 12 indicate the direction of price adjustment, the upstream provider manufactures according to the price and the downstream company manufactures according to the quantity. When a original price *P0=1.25* is given, the upstream provider will decide its manufacturing quantity *Qa0=1.125* according to the reverse function of its optimal quantity. But at this time the optimal quantity of the downstream company is *Qb0=0.75*. According to the set situation the downstream company will manufacture according to the quantity *Qa=1.125* of the provider, Its revenue will be *Rb(Qa0)=0.21,* and its loss compared with optimal quantity revenue is *Rb(Qb0)-Rb(Qa0)=0.28-0.21=0.07,* Because the supply is bigger than demand, so the industry system will adjust the price to 1.188 and meanwhile make the downstream company get compensated by the revenue from lowering price. And at this time, the revenue of whole industry chain *((1.25-1.188)*1.125)* can actually compensate for the loss before. In the next round, when *P1=1.188,* both the upstream provider and downstream company get new optimal quantity respectively, and the whole industry chain get loss again, and the system will adjust the price again. The circulation will continue as this discipline and finally the price will astringe at 1.

From the above analysis, we can find that when all the upstream and downstream companies of the industry chain don’t have the ability to decide the price, when industry chain system itself has a function to adjust the price automatically according to the manufacturing quantity. In a perfect competition market, this is an automatic behavior of the industry chain system itself and is not controlled by any party. But we should pay attention that such effect of automatic price adjusting is based on the assumption that both the upstream and downstream companies should be rational, focus on the long-term benefit and cooperate with each other. Otherwise it’s very easy to cause the behavior of opportunism and finally break the whole industry chain.

So in the imperfect competition market, the process of quantity matching and adjustment relays on the manually price adjusting behavior of the whole industry chain. Our government and industry consortium should pay attention to this point and use effective method to adjust the freight in some extreme situation (very high or very low freight) so as to guide the healthy development of ISO tank transportation industry in China

4.2 Standardization problem

4.21Compare of ISO tank application between China and Europe

Europe is always the biggest chemical product market in the world. With decades of development, European ISO tank transportation has occupied 65% potion of the global liquid transportation market and owns a highly standardized rule for chemical product logistics. European countries use UN rules combined with Europe rules as their law and rule. EU countries use ISO 1496 series rules as their technical standards. From the establishment of EU, the chemical product logistics standards of this region got continuously integrated, and the standardization of ISO tank transportation also got extended. The standards of chemical ISO tank transportation between different countries keep getting united gradually, and one of its results is the use of Safety and Quality Assessment Systems (SQAS).

In the past, there exists different safety and quality standards between different EU countries, so the inspection processes at the loading place and discharge place are very complicated and became a big problem. At 2003 Sep, France, Italy and some other countries signed official agreements to accept the new united standard. At 2004

Mar, The European Federation of Tank Cleaning Organizations (EFTCO), European Chemical Road Transport Association (ECRTA), European Chemical Industry Council (ECFIC) reached consensus, signed new official agreement for nine European countries and developed SQAS based on this agreement. Up to 2004 July, there has been more than 120 ISO tank cleaning station fully or partly using this system, which occupies more than half of the total potion of EU cleaning station members. The use of SQAS system greatly promoted the standardization of EU ISO tank transportation.

The foreground of Chinese ISO tank transportation development has got great attention from global range. At present, there are dangerous cargo transportation rules of road, railway, seaway, air and so on to regulate the transportation of ISO tank in China. The major standards of ISO tank transportation in China are GB/T 16563-1996<series 1: Liquid, gas and compressed dry bulk ISO tank technique requirements and experimentation method>, <International Maritime Dangerous Goods CODE> (IMDG CODE), <Container supervision standard> (by CCS), <Steel made compressing container> (GB150-1998), <Supervision of compressing container techniques> (National Bureau of Quality and Technical Supervision) and so on. Being an initial industry of China, ISO tank transportation still has many problems. Following are two major problems,

4.22 Existing standards are not united and mature

Although China has accepted the suggestion of UN and set some rules for standardization of ISO tank and dangerous cargo transportation, there still exist complicated procedures and different rules between different provinces, cities and departments which prohibit the development of ISO tank transportation because ISO

tank transportation is scattered all over China. For example, maybe one chemical industry base is established in one city, but one bridge ex this city does not permit passing of dangerous cargo, and another bridge only permits passing of dangerous cargo vehicles with local license. Such troublesome situations often occur in China and made many advanced ISO tank logistics service providers get puzzled.

4.23 Existing standards can not get fully executed

Many ISO tank manufacturers only produce ISO tank containers according to the order of their customers and do not have the right to guide their customers according to relative rules. Some logistics service providers and traders of moderate and small scale are using disqualified facilities and overloading the ISO tanks. Existing rules in China sometimes become a mere scrap of paper which do not has the effect of supervision and guidance, and left great hidden safety problems of ISO tank transportation.

To sum up, ISO tank transportation needs to be standardized urgently.

4.3 Linkage of logistics chain（between land and ocean transport）

Nowadays one obvious problem of ISO tank transportation is break of logistics chain. Inland transportation and ocean transportation are two independent party in the ISO tank transportation industry in China, and still don’t have a united market now. One whole transportation process is usually needed to be divided into two parts, and extra expenses occur. As a result, both the inland transportation industry and ISO tank transportation industry are facing limitation in their development.

In order to solve such problem, ISO tank logistics companies can integrate the different periods of transportation and develop their own multi-mode ISO tank logistics system so as to provide a full set of continuous ISO tank logistics service. This can help to reduce the time of circulation and extra cost because of break of logistics chain. America is a good example in doing such work, American logistics companies develop their own multi-mode logistics network based on its mature and wide service system of highway and railway transportation system. The transportation of ISO tank can be extended by 700 miles (1126.538) [18]or longer. International circulating ISO tank can be delivered to the American consignee directly. No more time, work and book are needed, this also help to reduce the total freight.

Besides, in some city, people try to link the two period transportations by establishing specialized logistics zone. Different kinds of transportation modes are integrated in the logistics zone. Inter-mode transportation can be realized within the logistics zone and don't need extra transshipment and waiting. Some big chemical manufacturers begin to develop their own processing factory near or within the logistics zone to shorten the land transportation distance so as to reduce their cost.

[18] Yao Zongming (2006.6) Inter-modal transportation Shanghai Maritime University China: Shanghai Maritime University Press

Chapter 5. Indications for different parties involved in ISO tank logistics

5.1 Shipping company

The characteristics of chemical products decide the special characteristics of vessel which carries ISO tank. In china, most chemical products are carried by large bulk chemical vessel or general purpose container with storage drums in it. In order to adapt the transportation of ISO tank, shipping company must do following jobs.

5.11 Alteration

A fully loaded standard ISO tank is one time heavier than GP container, it puts forward high requirement on vessel strength and weight loading capacity. So alteration of vessel to improve the strength, construction, loading &discharging rate, storage capacity and other parameters of the vessel to be suitable for the transportation and handling of ISO tank. Besides, Adding relative warning, handling and controlling system for ISO tank transportation carriage is also very important.

5.12 Choose type

The stowage of ISO tank may change the center of stability of the vessel because of the pendulum phenomenon and doubled weight than GP container. While the tank is on board, the liquid cargo in it will swing with the vessel. The pendulum phenomenon can be shown as Figure 13.

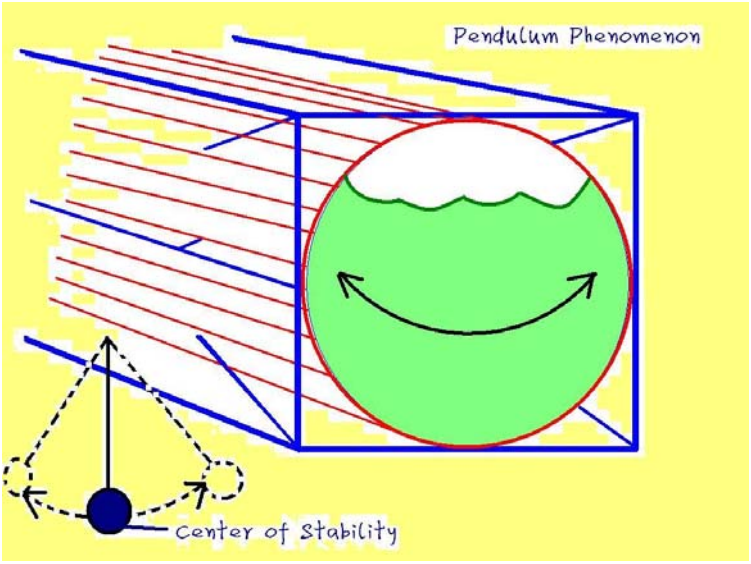

Figure 13 – Sketch map of ISO tank's influence of vessel's center of stability

Source: draw by myself

So choosing a suitable vessel type to improve vessel safety and loading capacity is very important for new building vessels. The dimension and type of new building vessel should be suitable for not only draft of sea route, tonnage of berth and height of bridge, but also the loading, discharge, storage and stowage of ISO tank.

5.13 Amend sailing route and schedule

Reasonably and scientifically set sailing route for ISO tank carrying vessel according to the characteristics of china chemical product trading route can help the carrier to win more business. The freight of tank container is nearly 3time higher than GP container. So carriage of ISO tank can help the carrier to earn more profit with limited space. And the convenience of transportation is also critical for the development of Chinese chemical industry.

5.14 Specialized crewman

Vessel carries ISO tank also need specialized crewman for the safely handle the ISO tank (how to load, discharge, stowage and etc), and be familiar with the chemical characteristics for handling emergency situation.

5.2 Terminal

There is a famous Chinese saying, which is using suitable tool for suitable work. Port's handling of ISO tank should be like this. Ports handling ISO tank in china should lay more stress on the alteration and standardizing for standard tank container handling facility so as to shorten the circulation time of vessel, vehicle and ISO tank; reduce the transportation and operating cost; and improve the efficiency and safety of ISO tank transportation in port range. Besides, the layout of ISO tank terminal should also be designed to be tally with the ISO standards of tank container handling in order to guarantee the safe and efficient operation of the terminal.

5.3 Inland logistics net

The inland logistics net of ISO tank contains not only different transportation routes and modes but also the relative services and facilities. The inland logistics net is the extension and expansion of international ISO tank transportation services as well as the multi-mode transportation. The inland ISO logistics service provider should be very experienced and qualified because city with living residents is much more sophisticated to the dangerous cargo accident than blue sea stretching to the horizon. Any little accident may cause serious result, so specialized and professional vehicles, staff, management and supervision is very crucial. Besides, the inland ISO tank

logistics service provide should pay more attention to the linkage with ocean transportation, rail transportation and road transportation to improve the efficiency of inter-mode transportation of ISO tank. ISO tank Logistics company should develop the inland logistics net suited with the ISO tank terminal and made it standardized to improve the efficiency of ISO tank transportation to the largest extension so as to realize the reliable “door to door ” service for ISO tank.

5.4 Information System

There are many process and spots in the logistics chain of ISO tank. The organizing, operating and managing of transportation must depend on the modernized information system and internet technologies. So the information managing system for ISO tank should integrate the functions of collect, exchange, calculate, storage, analyze the data relative with ISO tank transportation so as to command the situation of ISO tank transportation in time and support production forecasting, statistical analysis, decision making and other advanced managements.

5.5 Government and industry consortium

China has its own specific characteristics of ISO tank logistics, so the government and ISO tank consortium should constitute a new set of transport regulation and relative policies in China based on the ISO tank standards. The globalization of economy and development of international trade have stimulated the market competition. This forced us to expand international market and increase our market share. The problem of incompatible is not allowed to happen today, so the standardization of ISO tank has no time to delay now. So owing a full set of ISO tank standards, which combined with international standard and Chinese characteristics, is very important. Besides, there are some regulations in China to regulate the

dangerous chemical cargo logistics, but few laws and regulations, which quantitatively set standards and rules for logistics of ISO tank in China. With the development of ISO tank transportation, the throughput of ISO tank ex China keeps increasing. Professional use of ISO tank can help to impel the chemical industry in China effectively, but disqualified logistics of ISO tank is just like a movable bomb. So constituting a specific regulation for ISO tank logistics so as to guarantee the healthy development of Chinese ISO tank logistics industry is very urgent and essential. This needs a common effort and participant of not only the government but also the mass chemical manufacturers, logistics companies, industry consortium and institutions of other relative industries.

5.6 Relative service provider

The relative services for ISO tank have become the increasing new source of profit and an importation measurement of ISO tank logistic company's competitive advantage. The service quality of examine, storage, clean, handle and inject will directly influence the efficiency, profit and safety of the process of ISO tank logistics.

The increasing owing volume and using rate of ISO tank caused distinguish increasing in the demand of 24000lit and 26000lit ISO tank. These equipments require complex and high quality additional services. But people still haven't paid enough attention to these services during the operation of storage yard and ignored the additional services like cleaning and repairing. Sometimes, it even influence the normal operation of ISO tank storage yard. Being one process of ISO tank logistics chain, the importance of works in storage yard can never be ignored today. The full set of business services is more comprehensive. It contains not only the usual clean

and maintain works, but also allocation of different cargo, stack controlling, tag refreshing, repairing service, replacement of accessories, construction renewing, safe guard services and so on. So providing comprehensive service scope will be an important trend of ISO tank additional service provider. From the latest news, International Tank Container Organization has set a subsidiary committee to administer this section of services.

Besides these, the measurement of ISO tank safety and quality is also a burgeoning and popular service. In some Europe countries, this service is contained in storage yard service and free of charge. The cost of ISO tank is ten times higher than the general purpose container of same size. So small amount invest of maintenance for prolonging the service period of ISO tank which has been serving for more than 8 years is reasonable and popular with many ISO tank owners. So we can find more and more countries have begun to pay attention to this section of ISO tank service because this has become a new source of profit nowadays.

There is a well-known specialized ISO tank renewing company, which is called ARP in Belgium. (Van Loon’s Antwerp Refurbishing Plant) They did very well in their jobs and ISO tank renewed by them is widely used in Germany and South Europe. There is another ISO tank carrier named Den Hartogh & Hoyer who is widely accepted by the customers and plays an important role in operating multi-function storage yard in Europe. Their business region has been extended to Holland and even Spanish in South Europe, and their service scope contains not only clean, decanting, combining, storage, transship and so on. But in China, such service is just on its initial stage of develop, Although some companies has many branches all over the costal cities, the additional ISO tank services they provide are relatively simple. So enriching service scope become so important and urgent in China today.

5.7 ISO tank manufacturer

People should pay more attention on multipurpose ISO tank, because the function and cost of ISO tank grows reversely. (Single function will increase cost, and more functions can help to reduce cost). In a whole circulation, ISO tank may be required to carry more than two kinds of cargo because of the trading characteristics of international trade. If the ISO tank can not be cargo-worthy in such voyage, reposition of empty ISO tank will cost a lot of extra expenses. So R&D of multipurpose ISO tank can help to reduce transportation cost. Besides, development of accommodated ISO tank and ISO tank with special function to satisfy the needs of transporting special chemical cargo is also very important.

Although transportation of ISO tank has just begin in China, and transportation regulation and law are still not mature now, there are many foreign investment come into China is tank manufacture industry such as Suttens and Hoyer. They bring us not only large amount of fund but also advanced management experience, transportation technology, and international standards. Depending on such abundant resources and experience of china container transportation development, the ISO tank transportation will keep good development in the future.

Chapter6. Conclusion

Through this dissertation, we testified the obvious economy benefit and outstanding advantages of ISO tank, forecasted the future development of ISO tank industry, illustrated three important problems in application of ISO tank in chemical logistics in China and gave some indications to the involved parties of ISO tank logistics industry.

ISO tank has been accepted by more and more people in China because its specific advantages. And in the following several year, ISO tank logistics industry will keeps its trend of quick development. Such rapid growth brings us not only chances but also challenges. In order to guarantee the healthy and stable development of ISO tank logistics in China, people need to solve the problems of benefit allocation in industry chain, linkage of ocean and inland ISO tank logistics and the standardization problem. Some brief solutions like freight adjustment have been given in the dissertation, and every parties involved should use their common effort and participant to solve the problems and impel the continuous development of ISO tank logistics in China.

The application of ISO tank still has a long way to go in China. Many difficulties are waiting to be conquered. But I believe that with the development of ISO tank logistics, it will must play a main role in the chemical logistics industry and make great contributes for the growth of China chemical industry in the near future.

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ISO 1496-3:1995/Amd 1:2006 International Standard Organization

IMO / IMDG CODE International Maritime Organization

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