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GLOBAL TITANIUM INDUSTRY. TITANIUM CONSUMPTION SINCE 2011-2014 IN THE RUSSIAN MARKET

Thesis
Kajaani University of Applied Sciences
School of Business
Bachelor of Business Administration
Spring, 2015

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THESIS ABSTRACT

School Kajaani University of Applied Sciences	Degree Programme Bachelor of Business Administration
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Title Global Titanium Industry. Titanium Consumption Since 2011 -2014 in the Russian market.	
Optional Professional Studies	Supervisor(s) Simo Määtä
	Commissioned by
Date Spring, 2015	Total Number of Pages and Appendices 54

The topic of the current research is the global titanium industry and the titanium consumption in the Russian market since 2011 till 2014. The aim of the investigation is to discover the titanium demand and product peculiarities which were purchased at that period.

As for the theoretical background, the narration starts with the description of how the metal is manufactured and which characteristics it possesses. Besides, there is a short overview of titanium alloys and grades. Moreover, it was necessary to mention in which industries the metal is applied and since it is used in the industry of food equipments, it was agreed to describe briefly the titanium influence on a human body as well. Further the focus is moved to the global titanium industry and the Russian one.

With regards to the empirical part, a market research method has been chosen to implement. For the research, it was decided to gather such peculiarities as consumers, suppliers, type of products, its size and diameter, alloy type, price with and without VAT, delivery conditions. When data was obtained, the analysis of it was concluded and reported into the research result part.

As the outcome of the research, the demand of titanium was investigated and types of alloy and product sizes were defined.

Language of Thesis	English
Keywords	Market research, titanium industry, Russian titanium market, titanium consumption
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PREFACE

I would like to express gratitude to my supervisor Simo Määtä. Thank you for supporting and encouraging me during the process of the research.

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1 INTRODUCTION

The current research is based on an investigation of what the titanium industry presents today. It is in a developing stage and titanium products are used widely by diversified industries such as chemical, transportation, medicine, construction, electrotechnical, oil and even food. Besides, new manufacturers are launched all over the world and there is a strong competition between them.

Since titanium became a metal that was included in various items, its production was been modified sufficiently. Modern manners were created in order to improve titanium characteristics and metal influence on the global environment.

The countries which provide titanium use different approaches of manufacturing. Furthermore, their industries have significant features that distinguish them. The Russian titanium industry is familiar to me as I got acquainted with it while having the practical training at the Chepetsky Mechanical Plant. That is the Open Joint Stock Company, which is a part of the Fuel Company TVEL to the State Corporation ROSATOM.

The job was taken place at an analytical department where my duties were concentrated on working at titanium products such as bars, pipes, wires and sheets of the Russian market. One of the tasks was analysis of titanium consumption where leading customers were marked out and their comparison of production volume.

Thus, I chose the current research topic because there is a foundation of my previous investigation that should be executed into an accomplished form. *The aim of this research* is to explore an actual global market condition of titanium. Besides, leading manufactures and application scope of titanium will be identified. Further there should be done a consumption analysis of titanium wire, bars, pipes and sheets in Russia since 2011 until 2014. As a result of the research, the most favourable alloys and sizes will be figure out.

Russia possesses several plants for titanium production and it is important to know which positions they occupy in the market. I plan to connect my future job with such an industry in Russia and the knowledge which will be gained in a process of the research will be very useful and applied later.

2 TITANIUM MANUFACTURE

Titanium was discovered more than 200 years ago by William Gregor in Great Britain and named for the Greek mythology Titans. Nowadays the metal is in a high demand all over the world. However, the commercial use of titanium began relatively a while ago. Dr W. J. Kroll was the first scientist who invented a coke-like mass which was called as "sponge". Thus, by the late 1940s titanium was spread in the form of sponge and included into few manufactures (Marsh, 1996).

It should be taken into consideration that to obtain titanium is a long term process. An essential part of manufacturing is metal mining. Such countries as Canada, Finland, Guatemala, Russia, South Africa, Norway and few others are included in the list of mining places. However, the largest deposit areas are located in Finland, Madagascar and Russia.

Table 1. The largest ore regions (Wikipedia, 2015)

Country of deposit	Region	Reserves, million tonnes
Canada	Ontario	49
Chili	Atacama Region	116
Finland	Central Ostrobothnia Vuolijoki	62,2 1,348
Guatemala	Cuilco	50
Kenya	Kwale	140,8
Madagascar	Melaky Atsimo-Andrafana	959 464
Norway	Sogn og Fjordane Norland Vestfold More og Romsdal Rogaland	154 400 70 131 157
Russia	Republic of Karelia Far Eastern Federal District Murmansk	516,7 3 583,5
South Africa	Eastern Cape	348,7

Submarine and military industries were main manufactures applying that metal when it began to be well known. Besides, consumption of titanium gained momentum during the period of the Cold War; thus, it facilitated rapid launching of new fabrics in many countries especially in the USA and the Soviet Union (Kearns, 2005).

Later some military details commenced to be substituted with steel and as a result, the titanium industry experienced recession. Over the years, people have been discovering new ways of titanium application. Today 80 % of this metal is applied into aerospace production, while 20 % are accounted for the other types of manufacture (Kearns, 2005).

2.1. Definition of titanium and its characteristics

Titanium is a metal with an atomic number 22 and a symbol of Ti in the periodic table of Mendeleev. This element is considered as a transition one which is twice lighter than steel. Besides, it possesses some significant characteristics which segregate this metal among the others (Wikipedia, 2015).

One of such features is high thermal conductivity. Moreover, titanium is incombustible and it is very hard to dissolve. Corrosion is not typical for that metal as well as erosion. As a fact, low coefficient of expansion allows titanium to be used in conjunction with such materials as glass and ceramics. The products which are made from this metal are sustainable and might guarantee durability (Stwertka, 1998).

Figure 2. Ingot of titanium (Himprom.com, 2015)

2.2 Process of manufacturing

Pure titanium can be obtained using various methods according to a company's preference of which manner to follow. However, there is one common mode of production that includes 4 steps. An initial action is extraction which occurs when such elements as rutile and ilmenite contain enough titanium dioxide. These metals are inserted into a reactor where chlorine gas and carbon are already set there. When all elements are together then hot air is directed to the reactor, thereby they become heated to 900 °C. Due to it, a chemical reaction occurs which creates unpurified titanium tetrachloride in the combination with carbon monoxide (Stwertka, 1998).

The next stage is purifying. This tetrachloride is placed into a distillation container and that metal is subjected to heat treatment again. Thus, this procedure allows getting pure tetrachloride titanium dislodging all excess metals (Stwertka, 1998).

The third step is called "manufacture of the sponge". The point of this phase is interaction of tetrachloride with magnesium that is affected by heat. In the result, titanium solid is obtained, nevertheless water and hydrochloric acid is used in order to separate titanium from unnecessary metals. Thereby, titanium sponge is extracted (Stwertka, 1998).

The final stadium is focused on alloy creation. The prepared sponge is mixed with some different alloy additives. They are welded together forming sponge electrode which is melted and turned into an ingot. That is how the process of production is completed (Stwertka, 1998).

2.3 Titanium alloys

There is a wide range of titanium alloys which differ according to their peculiarities and properties. Flourishing manufacture has classified alloys in alpha, alpha - beta and beta types. With regard to the alpha category, these alloys resist the corrosion the best among the others. Besides, they are quite flexible and their strength varies from low to medium. One

more distinctive feature of alpha alloys is good mechanical properties. As for the alpha - beta category, the strength here can alter from medium to high. Usually the qualities of hot forming are better rather than cold forming. The main property of the alpha- beta alloys is broad applicability. In other words, many industries of different specializations mostly prefer to use that type of alloy because it is considered as a universal one. The alloys of the beta category are the strongest in comparison to the alpha and alpha-beta types and possess fine plasticity (RTI, 2000).

In addition to that classification, the alloys are divided into grades which numbers are around 29. They are classified based on an eventual product and an industry which will apply. For example, grade 1 is used while manufacturing tubes for the architecture, the marine industry and air frame structure. However, grade 2 which qualities include good formability and flexibility might be applied in architecture as well. The other example is grade 23, which is called a medical titanium grade. Its characteristics are biomedical; thereby that grade is popular in orthodontics, orthopaedics and surgical scope (Stwertka, 1998).

Those classifications are regarded as international. Nevertheless, each country might establish its own marking of alloy depending on the name of who produces them. The example of this case is Russia. Those titanium alloys which are manufactured by "Prometey", it is a research university with an industrial base in Saint Petersburg, are labelled as "PT". The alloys that are marked as "BT" are produced by the research institute of aviation materials VIAM in Moscow. Besides, some letters can be added to the name of fusion in order to clarify a function. So, the abbreviation of PT-7M is explained as a 7 grade modernized alloy which is made in " Prometey"(RTI, 2000).

The table below shows some typical alloys and the areas where they are applied.

Table 3. Table of alloys and their application (RTI, 2000)

Name of alloy	Scope of application
Ti-6Al-4V	Aircraft ducting ,Airframe components, Automotive components, Automotive components, Ballistic armour ,Consumer products, Gas turbine engine components, Hydrometallurgical extraction/electrowinning
Ti-6Al-4V-0.1Ru	Chemical processing equipment, Desalination brine concentration/evaporation, Geothermal brine energy extraction, Pulp/paper bleaching/washing equipment

Ti-6Al-7Nb	Medical implants/devices, surgical instruments
Ti-4.5Al-3V-2Mo-2Fe	Airframe components, Consumer products, Gas turbine engine components, Sports/recreational equipment, Space vehicles/structures, missile components
Ti-10V-2Fe-3Al	Airframe components, Landing gear components
Ti-3Al-8V-6Cr-4Zr-4Mo	Geothermal brine energy extraction, Landing gear components, Navy ship components, Hydrocarbon production/drilling
Ti-3Al-8V-6Cr-4Zr-4Mo-0.05Pd	Geothermal brine energy extraction ,Navy ship components, Hydrocarbon production/drilling
Ti-8Al-1Mo-1V	Gas turbine engine components
Ti-0.15Pd	Anode/cathode/cell components, Air pollution control equipment, Chemical processing equipment, Desalination, brine concentration/evaporation

Thus, the nomenclature of fusion might be vey diversified depending on a country. Even when an alloy enters an international market, a fusion label remains the same but it is possible that some international clarifications are added.

2.4 Titanium application

Titanium possesses superior properties in comparison to the other materials like stainless steel, nickel or ceramics. There are some explanations why it is in demand in industrial applications and the first advantage is its cost effectiveness. Titanium's quality is equal to cost of manufacturing. Besides, the titanium products excel in availability of different characteristics such as type, fusion and size. In addition to it, they have sufficient data corresponding engineering specifications (Stwertka, 1998).

Due to the alloy diverstity and good technical properties of the metal, it is applied actively all over the world. The USA is the main user who utilizes titanium primarily for the aerospace industry. The second largest consumer is Europe which disposes the mineral in frames of

engineering and chemical manufactories. Japan follows Europe and over those mentioned industries there, it applies titanium in the leisure and amusement ones (TDMA, 2013).

2.4.1 Industries that apply titanium

The major industry applying titanium is the *aerospace* one which includes commercial and military aircrafts. Being in an economic recession in late 90s, it is recovering now and 5 % annual growth is predicted in the nearest future. Referring to the past, a cause of titanium recession was cost. It was much preferable to apply aluminium because there were economic constraints at that time. However, such a factor as reduction of price for titanium constructional elements closer to the price of aluminium changed the position and returned the demand for titanium production (Liu, 2008).

Thanks to its crack resistance and high strength titanium is mostly used in two fields such as gas turbines and airframes. As a fact, wings and body are 2 main parts, which are tensed above all in a plane. So, applying titanium in those details ensures weight reduction. As for gas turbines, all rotating pieces are made from this metal. Besides, a recent improvement in temperature limit of Ti-6Al-4V alloy allows utilizing titanium even for turbine engines (Marsh, 1996).

What is more, choosing titanium as a core element of the aerospace industry is a principle which is based on the compromise of durability, cost, effectiveness and titanium properties. In addition, engineers prefer applying titanium and removing existing shortcomings rather than using a new material and facing unfamiliar difficulties that might affect a whole interconnected structure (Gambogi, 2012).

Titanium is widely used in *defense*. The metal integrates such characteristics as toughness and light weight that makes titanium one of the components for armament equipments. As far as military scope is considered as secrecy, it is hard to discover a real range of application. However, as an alloy of Ti-6Al-4V is applied in the aerospace industry it is mostly used in defense as well (Marsh, 1996).

The next industry is *automotive*. Although there is titanium demand, it is expensive for some manufactures to apply it. Thereby, low cost alloys were developed especially for those producers who lack budget but still choose to create quality vehicles with titanium application. Besides, due to a growing tendency of environment - friendly cars there is a need of this metal in the global automotive market. The mineral reduces weight of engines and provides automobile with upgraded performance and increases fuel efficiency (Liu, 2008).

Moreover, titanium as non-toxic was first implemented for bone fractures in 1951. Thus, it laid the foundation for further application in *the medical industry*. In order to treat cracks titanium implants were created for screws and hip prosthesis. Since that time when a pure metal served as a basis for implants, a number of alloys have been changed until a new fusion Ti-6Al-7Nb took a permanent place. On the other hand, titanium came into dentistry a bit later but its feature to assimilate successfully with the bone tissue makes the metal one of the most demanded material in that industry(Marsh, 1996).

In addition, *the industries of leisure and recreation* include the mineral into manufacture of various productions. More than 45 % of golf- clubs are made from the metal in Japan. The second place belongs to the USA where its golf- clubs production is 14 %. The Asian countries are following the trend, so China and Taiwan were launched some manufactures recently. Besides, bicycles were affected by titanium as well, by that aluminium springs and body frames are substituted with the ingot (Gambogi, 2012).

Undoubtedly, it is widespread in *the chemical industry*. The plants which are specialized in work with purified terephtalic acid use titanium in order to construct pipelines and valves. One of the first such fabrics was built in India, Madras and later it was built in China along with Malaysia. Taiwan and Pakistan went on-stream their plants after a while (Marsh, 1996).

It is quite obvious that titanium properties like resistance to sea water corrosion and lightness make it preferable for *the marine industry*. Thus, the metal is used for creating floating platforms which are applied in offshore oil production. An advantage of titanium implementation here is engineering efficiency and cost effectiveness that is calculated by the long operating cycle and savings of repair works (Liu, 2008).

The other type of production where titanium is in demand is *the energy industry*. Nowadays more than 50 % of the global energy market belongs to independent power producers.

When condenser pipes for power plant were invented, a material they were made from was cupro - nickel. Later it was substituted with stainless still; however, this transformation did not last for long time and a main component was changed to titanium. Nowadays those pipes are thinner and are able to withstand cooling water flow (Gambogi, 2012).

Furthermore, the mineral is applied in *the construction manufactory*. A favoured position was given to roofs. It is of the current interest for Japan which is an earthquake zone. Such roofs are very light and a warranty period is extended up to 100 years. Later there was launched a project named "A house of the future". The aim was to build environmentally friendly buildings with the use of titanium roofs. Thereby, there are 2 construction of that type in Netherlands, Houten and in Spain, Bilbao(Marsh, 1996).

Along with all utilizations, titanium finds its relevance in *the industry of food preparation equipment*. The metal excels with biocompatibility, its resistance to fruit acid and high temperature, thus it is mostly used in ovens where heat reaches over 200° (Gambogi, 2012).

Besides, the material is applied in *the electronics industry* which latest innovation is the metal inclusion in computer manufactory. Additionally, titanium is included in such consumer goods as watches and jewellery. What is more, it is used as a part of diffusers for bleaching in *the paper industry* (Marsh, 1996).

2.5 Titanium impact on health

Titanium is utilized in various industries ranging from building ships to producing cosmetics. Scientists approve that the metal is totally safe for people, otherwise there would not be found so many applications of the mineral.

The human body must obtain physiological titanium for normal functioning of all organs. Besides, the titanium content in a body is about 9 mg, along with it there are 2, 4 mg in lungs. As a fact, it is included in hair, nails, in the lens of the eye, bones and epithelium. The profound titanium influence on regenerative process in damaged joints and arthritis was well studied. Working together with silicon and vanadium, titanium helps in recovery of bone fractures. Titan is directly involved in the regulation of oxidative processes in the blood

serum, stimulates the formation of blood. Moreover, high concentration of titanium was found in the brain, especially in the visual centre of the balance center (Liu, 2008).

Titanium enters a body every day with daily food, fluids of drinking water and air. Absorption of titanium compounds proceeds as follows: firstly, 1-3 % of the total titanium quantity leaves in the gastro- intestinal tract. Secondly, less than 1% of the absorbed dose enters the body via inhalation. Eventually, the third part of the entire consumable substance is trapped in lungs (Gambogi, 2012).

It was generally accepted that the dust of city streets, industrial and automobile emissions might be a reason of the increased content in lungs. Therefore, the older a person is, the higher the concentration of titanium in the body. Furthermore, smoking increases the amount of substance tenfold (Stwertka, 1998).

With regard to a manufactory perspective, there was launched a "Responsible Care" program in Europe. Due to it, all factories have been improving environmental and health performance (TDMA, 2013).

Thus, titanium is regarded as a safe material with non- toxic properties. It cannot have a negative impact on a human body if it is used accordingly to assignments.

The titanium manufactory is diversified with productions which might be released in shapes of ingot, mill, sponge, bar, sheet, scrap and so on. Thereby, there are a number of worldwide fabrics transferring the metal into those forms. However, equipments had been invented and a valid approach had been found by the means of fails and errors, before plants could use current methods of making. Besides, there is still a need to improve technologies and producers intend to achieve environmentally friendly manufacturing as soon as possible (TDMA, 2013).

3 TITANIUM INDUSTRY

3.1 Condition of the geographic titanium market in the end of 20th century

Nowadays there are found new applications of titanium that influences demand pace which rapidly grows. Plants are increasingly built in countries which are newcomers of the industry. As for old timers like North America, Japan, Russia, India and China, some of them are gaining momentum and the rest has been still striving for being a profitable member of the industry.

With regard to *North America*, its leading manufactures were Timet and Ormit at the end of 1980. By that time, the US titanium was applied only into aerospace industry. Later it was suffering because all efforts were put into developing other markets. In addition, the investments were sufficiently restricted during 5 years. Thus, the demand decreased by 50 % for that industry. Nevertheless, there were few other industries where decline was observed. Building production was lingered when California as an earthquake area needed titanium roofs due to lifesaving reasons. There was a recession in the military industry as well where airplanes were required by no one organization (Liu, 2008).

Going through ups and downs, the USA titanium industry returned to a normal state which supposed a slow growth. Thereby, it has been gaining strength since 1993 to the present day. The table below shows the amount of production export for 1993-1994.

Figure 4. US exports of titanium products in 1993 and 1994 (Marsh, 1996)

	1993		**1994**	
	Quantity Value		Quantity Value	
	Metric tonnes	$000's	Metric tonnes	$000s
Sponge	104	748	126	738
Scrap	3,890	9.070	2,120	7,440
Billet	240	4,790	258	5,250
Sheet bars	342	6,280	630	12,000
Ingot	275	4,010	374	5,970
Bars/rods	663	18,000	863	22,500
Other	1,720	54,700	2,990	108,000
TOTAL	**7,890**	**110,000**	**9,660**	**166,000**

However, the situation was slightly changed trough the increased demand for golf clubs and leisure items. Besides, the chemical industry remained stable. A number of plants located in the USA collaborated with other fabrics in South America and South East Asia. By the mean of cooperation, the USA was provided with orders for items applied in oil extraction.

Quite similar case is *Japan* where the market condition of the industry has altered from flourish to recession and returning towards prosperity again. The country concentrated on development of new applications for the power generation market in the 80's. Particularly an emphasis was made on thin walled pipes and a processing approach which chemical plants had (Gambogi, 2012).

Fractionally evaluating several industries, it might be stated that prosperity was detected especially in the aerospace one where 2 % growth was noticed since 1987 till 1989 and in mill production where output varied within the framework of 9,000 tonnes. Nonetheless,the Japanese titanium industry was disadvantageously influenced by followings causes: changes in Yen's rate, world economic depression and cheap products which were provided by Russia (Marsh, 1996).

Giving an example of how the titanium industry was affected, there is a figure of titanium sponge since 1989 till 1994. It is obviously clear that a decline of the industry accounted for 1992 and 1993 years. The year of 1994 is regarded as a recuperation stage.

Table 5. Titanium sponge shipment since 1989-1994 in Japan (Marsh, 1996)

	1989	**1990**	**1991**	**1992**	**1993**	**1994**
Titanium sponge (metric in tonnes)						
Production	21,341	25,630	18,945	14,554	14,426	14,847
Domestic shipments	16,593	18,631	13,915	10,881	12,132	11,235
Exports	5,495	6,455	3,376	3,395	2,962	4,516
Total shipments	**22,088**	**25,086**	**17,291**	**14,776**	**15,094**	**15,751**

Moving to *Europe*, it is worth taking into consideration that its market might be called as a self- supporting because it could handle overall production nearly without outside providers. In 1994 it was manufactured 7,400 tonnes of mill products. 60% of it was made in side of Europe and the rest was provided by Japan and the USA. Besides, 4,500 tonnes of the total amount were utilized within Europe.

The most important industries of this market were the aerospace and nuclear power stations. France and UK were the countries which were in charge of it. As a fact, there was a tendency to reduce consumption of titanium for the aerospace from 55% to 50%. In addition, chemical plants and production of condenser tubes were "duties" of Germany and Italy. What is more, general - purpose application there was nuclear power and chemical plants.

With regards to manufacturing, titanium produced in Europe could be divided in the ratio of 70% to 30% where the largest part belonged to alloy and the remaining was pure commercial metal. From an economic perspective, the growth was ensured by South East Asia which was viewed as a place to export European production. However, deficiency of a trade association impeded this growth because there was no any market data or prospects concerning commerce which could be supplied by that organization.

One of the largest titanium suppliers and consumers of the 20th century was *the Soviet Union*. Its major industries were the aerospace and the defence ones. Besides, it could provide many other countries all over the world with production. At an initial phase of business which was in the late 1960's, the Soviet Union set relatively low prices. However, its commerce was considered as fraudulent because there was a number of evidence which reported that deals could be implemented via the Russian Mafia.

The most productive plant was located in Ust Kamenogorsk. The Zaporozhe Magnesium was in charge of defence and provided with titanium sponge but the factory was closed in 1993 due to its senility and ineffectiveness. The same sponge was produced by the Berezniki plant. By the same time when the Zaporozhe Magnesium stopped its activities, a decline in demand of Berezniki was observed. This situation contributed into the capacity of the factory which consisted 50 %. Later it was announced that Ust Kamenogorsk and Berezniki decided to consolidate and put their activities into the Japanese market (Marsh, 1996).

The output of Verkhnaya Salda Metallurgical Production Association, which was called as VSMPO, was 3,800 tonnes in 1994. By the end of 1995 the aim of an organization was to increase shipments. After a while, Berezniki and Magnesium Titanium was united and called as AVISMA. It produced around 9,000 tonnes of titanium production for domestic utilization. In addition, it is exported 800 tonnes to Japan, Europe and the USA.

A great advantage for the Soviet Union was researches that allowed discovering techniques which saved costs in the process of manufacturing up to 70%. Those methods are not used so far in other leading manufactures. But political shift has changed the situation and caused a short recession in the market.

The next geographic market is *South - East Asia*. The main Asian plant was located in China, Baoji. This plant produced 80% of the overall output of the whole country. In order to

support the factory, there was launched an investment programme which lasted 10 years (Gambogi, 2012).

China was at a developing stage at that moment and industrialization process gained momentum. Due to it, living standards were rising and it required expanding power stations where the titanium condenser tubes were applied. Besides, chemical plants were widely demanded as well since a need for plastics grew. Thereby, the market of South – East Asia took a leading position in that type of manufacture (Marsh, 1996).

A beginner of the titanium industry in late 80's was India. Its first plant stated to exploit in 1993 which was named Mishra Dhatu Nigam (Midhani). The plant possessed with superiority among the other plants. It could produce tubes without any scratches. The factory specialized in producing of pipes for industrial usage where low quality products were applicable (Gambogi, 2012).

The Indian's oil industry was mostly located in Assam, the Northern- Western state. A great deal of efforts was put into exploration of oil and gas in the North Sea. In addition, the same program was implemented in the regions of South- East Asia such as Borneo and Vietnam (Gambogi, 2012).

One more geographic market is *Middle East*, particularly Saudi Arabia. The Al-Taweelah B plant manufactured tubes which output was 150 tonnes in 1986. In this case, the supplier of titanium for the current factory was Japan. The oil industry was developing at that moment and it required supplying items for it as well (Gambogi, 2012).

Indonesia, Malaysia and Singapore were potential markets where industrialization process became its influence towards them and demanded to start building power plants.

3.2 Global market situation in 21st century

Production of titanium dioxide has been constantly growing since 2000 and by the end of 2008 the global titanium capacity was presented with the output of 5,1 million tonnes that exceeded by 30 % compare to 2000 year. As a fact, the world faced the economic crisis in

2009 and production capacity dropped to 4, 7 million tonnes, although it returned to the normal state with an index of 5, 0 million tonnes one year later (Seong, 2009).

In addition, the Chinese production was increased by 6 times since 2000 to 2011 and represented 1, 8 million tonnes; thereby that enlargement was very crucial for worldwide growth either. In 2012 the global output gained strength presenting 5, 3 million tonnes of titanium (Seong, 2009).

According to the US Geological Survey, titanium reserves amounted 692 million tonnes in 2012. That is an impressive number facilitated manufactures to work effectively and meet rapidly growing demand of the aircraft and the industrial equipment industries. Besides, new approaches were developed in order to create titanium sponge mostly in China and in the rest of countries which were specialized in that product (Seong, 2009).

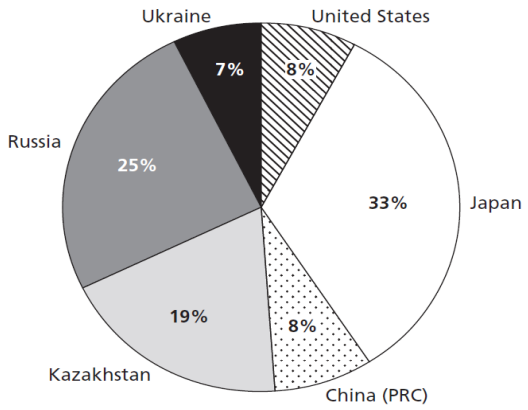
Figure 6. Titanium reserves in 2012 (metric in tonnes),(Wikipedia,2015)

Country	tonnes
China	200.0
Australia	118.0
India	85.0
Republic of South Africa	71.3
Norway	37.0
Others	180.7
Total reserves	692.0

Thus, sponge manufacture increased from 74,000 tonnes in 2003 to 176,000 tonnes in 2008. However, the global economic downturn occurred in the same year and it heavily reflected decline in demand. As a consequence, plenty of Chinese works were closed and the world titanium output dropped to 120,000 tonnes in 2009. The situation began to recover by the middle of 2010 when the demand of sponge increased; due to it, the amount of global titanium manufacture grew to 150,000 tonnes (Gambogi, 2012).

Referring to 2005 and still considering the titanium sponge manufacture, such producers as Russia, Kazakhstan and Ukraine possessed by a half of the sponge market while Japan had 33 % of the total global production. United States and China occupied the same position having an 8 % capacity. But with regard to the Chinese production, sponge was produced mostly for industrial applications rather than for the aerospace industry compare to the USA which were focused on the aerospace utilization. The diagram below establishes titanium sponge distribution in 2005 with a division of the geographic markets (Seong, 2009).

Figure 7. Global titanium sponge distribution in 2005 (Seong, 2009)



With regard to the aircraft industry, the demand continued to increase in 2012 and reached up to 60,000 tonnes. The leading suppliers of sponge for the USA at that moment were Japan and Kazakhstan. The table below establishes consumption of titanium production in 2012 excluding Russia and China (Gambogi, 2012).

Table 8. Consumption of titanium production in 2012 (metric in thousands of tonnes), (Gambogi, 2012)

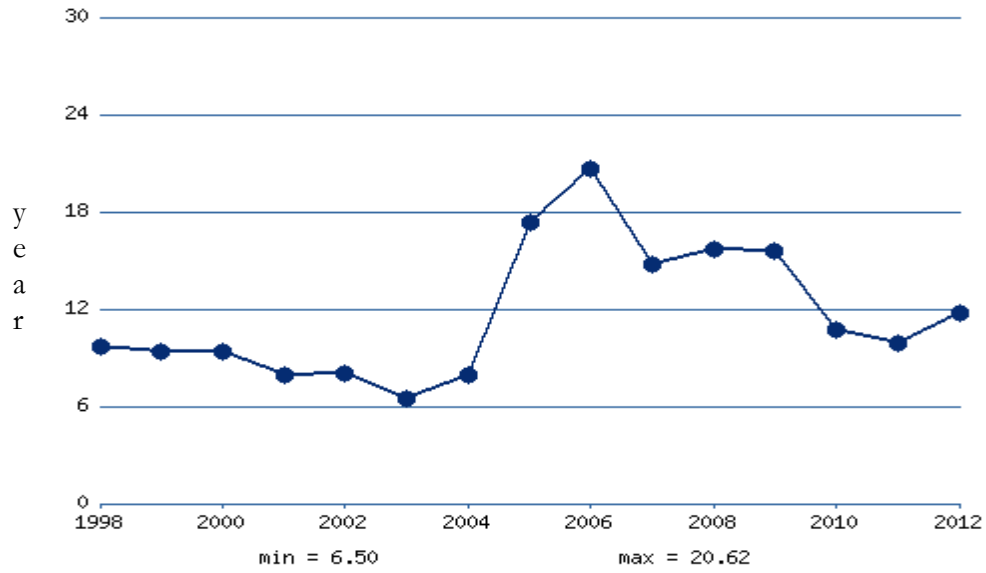
	2008	2009	2010	2011	2012
Aircraft industry	46.9	29.8	41.2	47.0	60.0
Defense industry	6.4	5.8	6.7	6.0	6.0
Others	43.0	27.6	36.9	52.1	53.0
Developing markets	5.3	1.7	2.4	3.0	3.0
Total	101.6	64.9	87.1	108.1	122.0

In the matter of price, it was stable for several years before in the middle of 2005 costs began increasing in all regions of the world. Thus, an average export price of titanium was within 1592- 1634 dollars per tonne and an average import one varied from 2131 – 2192 dollars per tonne in China. In contrast to it, the average import costs in the USA were 1,97 - 2,35 dollars per kilo. In Europe the titanium price reached a pre-crisis level in 2006, when it was established as 3200 dollars per tonnes. Relatively low prices were in Saudi Arabia, Australia and India which requested 2050 – 2215 dollars per tonne (Gambogi, 2012).

Nevertheless, prices were partially stabilized in 2010 and amounted 11.97 dollars per kilo. The value was significantly less rather than it was set in 2006 when the required price was 20, 62 dollars per kilo (Gambogi, 2012).

The figure below demonstrated the curve of price during 14 years (1998- 2012).

Figure 9. Price of titanium since 1998 till 2012 (Gambogi, 2012)



Referring to experts, the global titanium market should grow up to 7 million tonnes in 2015. However, there would be a possible chance that a new wave of crisis might occur due to lack of demand in 2012 (Marsh, 1996).

The global supply of titanium sponge increased on 51% in 2012 and reached 241,000 tonnes when it was only 124,000 tonnes in 2009. A large part of that growth belonged to China which used additional titanium volume in the industries of the country (Marsh, 1996).

Nowadays, titanium sponge is applied in the aerospace technology whose producers are Russia, Japan, the USA and Kazakhstan. As reported by Roskill, the volume of sponge production in the market will be able to meet current and forecasted demand since there are still auxiliary capabilities which were not used yet (Roskill, 2009). Besides, the USA plants strongly depend on Japanese and Kazakhstan import of sponge, although the decline of Kazakhstan supplies is observed because of the production share which constantly increases and is utilized locally (Marsh, 1996).

3.4 Global leading producers of titanium items

Considering leading producers in the world, it is worth saying that their positions might change from year to year due to an economic situation, companies' investments, intensity of the competition in the market and others. Thereby, it is hard to estimate accurately whether a company will be in a list of the most demanded ones in a couple of years. Nevertheless, the research is focused on the period of the titanium market since 2011 till 2014, in this way there will be established only those companies which succeeded at that time.

The first producer is *TIMET* (Titanium Metals Corporation) which has subsidiaries in various parts of the world. The main office is located in Dallas, besides there is a number of manufactures in Texas, California and Houston. In addition, there are factories in Canada, Germany, Italy, England and China (Timet, 2015).

The company was founded in 1950 and two years later it began to produce world's first titanium ingots that initiated manufacturing of aircraft items. However, its branch offices and factories were opened quite late in 1990. Thus, it took 40 years in order to develop technologies, structures, to adjust manufacture and to attract a range of customers (Timet, 2013).

In the end of 1950 the industry primarily was concentrated on the missiles items moving away the aircraft manufacture. However, as soon as sales dropped down, the company directed the aircraft production to a privileged position and recovered its income. Moreover, sales rose rapidly when the Soviet Union established titanium in the American market asking the price which was harmful for the USA internal trade. Regard to it, TIMET decreased its

prices within 20% on overall production and won the competition enhancing the company's budget (Timet, 2009).

In 1996 TIMET was expanded and as a result, 46.5% was owned by the Tremont Corporation, 38 % belonged to IMI Plc, while the rest was possessed by the United Titanium Sponge Corporation which was located in Japan. Besides, the total income incremented either thanks to increasing prices in the aerospace and the commercial markets (Timet, 2009).

Evaluating a current condition of TIMET, the table below demonstrates the amount of production in 2011. The plant which is located in Henderson, Nevada is mostly specialized in the sponge manufacture what makes the factory be a principal sponge deposit in the TIMET Corporation. What is more, Wales and Ohio are places where mill products are fundamental, while the factory in Pennsylvania is in charge of melted manufacture and has a significant proportion in the overall fabrication (Timet, 2013).

Table 10. Capacity of TIMET's properties in 2011(metric in tonnes)

Manufacture	Product Manufactured	Sponge	Melted Products	Mill Products
Henderson, Nevada	Sponge, Ingot	12,600	12,250	—
Morgantown, Pennsylvania	Slab, Ingot	—	40,700	—
Toronto, Ohio	Billet, Bar, Plate, Sheet, Strip	—	—	15,000
Vallejo, California	Ingot (including non titanium super alloys	—	1,600	—
Ugine, France	Ingot, Billet	—	3,200	2,600
Waunarlwyd, Wales	Bar, Plate, Sheet	—	—	3,100
Witton, England	Ingot, Billet, Bar	—	10,700	7,000

Comparing shipments between 2011 and 2012, it is obviously visible that the company was prospering with expanding production output and increasing income. The table 10 establishes the precise numbers where the situation is clear (Timet, 2013).

Table 11. TIMET shipments 2011-2012 (metric in tones)

Shipment during 2012:		**Shipment during 2011:**
Commercial aerospace	10,440	8,375
Military	1,520	2,350
Industrial	3,800	1,675
Emerging markets	310	390
	16,070	**12,790**

Nevertheless, TIMET faced with a decline in 2013. As consequences, the revenue shifted from $262.5 million to $257.7 million that amounted 1, 8 %. The company resolved to cut costs of sales by 1, 5 %; thus, it transferred to 19, 5 % instead of 21%. TIMET suffered reduction in gross profit also which decreased by 5 millions and was presented as $50.3 million. All types of expenses were inflated by 3, 5 % (Timet, 2015).

Experiencing recession time, TIMET remained to be one of the leading producers supplying items for the aircraft industry. Apart from it, TIMET launched a number of capital propositions aimed at the development of melt capability in order to facilitate soon recovery (Timet, 2015).

RTI International Metals is the next corporation in the list of dominants. The company was established in 1950 and by today it possesses facilities in 13 states of the USA, 1 concern in Canada. It operates in Italy, Germany, United Kingdom, France and the furthest point of manufacture is in China. The first appearance of the company on the New York Stock Exchange platform occurred in 1990, by that time the organization performed using the name of RMI Titanium Co. After 8 years when the structure of the firm was modified in shifted toward holding one, the original name became RMI International Metals, which is preserved to this day (Wikipedia, 2015).

RTI competes in 4 markets which are aerospace, medical, defence and energy. However, the aerospace one is a business unit that is emphasized mostly by the company and many efforts are directed exactly toward it and its more effective production. The table below presents sales for 3 years since 2011 till 2013 correspondingly to the markets where the company serves (Form 10-K, 2015):

Table 12. Markets' distribution sales of RTI since 2011 till 2013

Market	2013	2012	2011
Commercial Aerospace	55%	55%	58%
Defence	22%	23%	28%
Energy, Medical, and Other	23%	22%	14%

The demand for aircraft has decreased since 2011and it remained the same compare to 2012. As for the defence industry, the sales here reduced as well; however, the key case which subsequently influenced the current condition was a contract award with Lockheed Martin that obliged RTI to provide 8 million pounds mill products every year. The contract is valid till 2020 that guarantees the RTI production will be in demand and delivers will be made; thereby, the company will be in a prosper stage further. With regard to the energy industry, the demand for products sufficiently increased in 2013. It is explained that there were found new deepwater locations which were rather difficult to reach. Due to it, new and more effective and durable equipment was needed and titanium is a perfect material to get it done from (RTI International Metals, 2015).

Analyzing the RTI export, it is necessary to refer to the table. It demonstrates the export sales which were made mostly in the Europe area. The percentage quantity had been decreasing since 2011 and by 2013 it amounted 30% (Form 10-K, 2015).

Table 13. RTI export 2011-2013

	2013	2012	2011
Export sales	30%	36%	37%

Baoji Titanium Industry is a producer which is relatively young in comparison to the others in the titanium industry because the company was initiated at the turn of the 20th and 21st century in 1999.One of the reasons why the company is in the current demand is its ability to serve in various industries. Thus, Baoji Titanium concentrates not only on the aerospace and the military branches but also on energy, medicine, metallurgy and even sport (Research in China, 2012).

The first place in the company's output belongs to sheet products, then tubes and pipes, afterwards wire follow. Besides, Baoji Titanium constantly experiments with launching new products; thereby they occupy a niche position in a hierarchical output (Research in China, 2012).

In 2011 the company sales amounted 18,312 tonnes and as revenue it was got 2, 92 millions of dollars. However, 2012 was a year when a temporary recession was observed for the whole titanium industry. Referring to TIMET and RTI tables, there is a decline in their sales for 2012 as well. By that reason, Baoji's sales dropped to 11, 800 tonnes with earnings of 2, 2 millions in 2012 (Research in China, 2012).

What is more, this organization is the main exporter of titanium sponge for the USA. In 2012 the amount of exported sponge was 3,610 tonnes and the next year it is increased up to 4,150 tonnes. As for domestic mill shipments, a quantity of 2013 was 24,700 tonnes. 65 % of that production was directed to military, aerospace and commercial purposes (Baoti,2012).

The next company which occupies a leadership position in manufacturing titanium items is *Western Metal Materials Co*. This Chinese organization might be considered as young because it was established in 2000. Originally the firm is sponsored by the Northwest Nonferrous Metal Research Institute. Besides, Western Metal Materials could gain 7 subsidiaries for such a short period. The company's advantage is a capability to produce not only titanium items but to manufacture titanium as a metal. Thereby, its plant is fully equipped with titanium alloys machinery with other composite materials (Western Metal Materials, 2014).

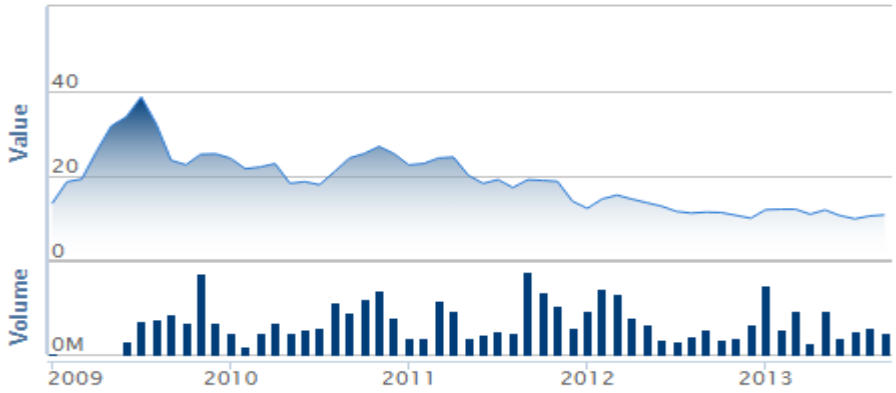
The products are widely used in the aerospace, the marine and the energy industries which are very crucial for the Chinese national economy. However, aside from domestic utilization the company supplies its items to the overseas markets such as Australia, Germany, Italy and others. Its international office is located in the USA (Western Metal Materials, 2007).

Besides, Western Metal Materials pays much attention to developments concerning a manufacture process and due to it, a laboratory was organized which is in charge of innovations (Western Metal Materials, 2007).

According to the data, 2013 year was the time when the company reached recession and its sales amounted 184,647.859 dollars. The percentage difference in sales of 2013 and 2012

was 18, 5. The figure below demonstrates the volume of manufacturing since 2010 till 2013 years (Corporate Information, 2013).

Figure 14. Western Metal Materials production capacity 2010-2013 (EMIS,2015)



In correspondence to an Euromoney Institutional Investor Company (EMIS), it was stated that the most intensive periods of manufacturing were in the end of 2010, 2011 and in the beginning of 2012. Moreover, it is worth mentioning that the less productivity was the larger required price was. Thus, the price had been varying from 10 dollars to 25 dollars for 3 years (Corporate Information, 2013).

The last but not least in a list of leading companies is *Public Stock Company VSMPO-AVISMA Co.* which is located in Russia. That is the oldest enterprise among the others. It was found in 1933 in the region of Verkhnaya Salda. Nowadays its production diapason is much diversified and the organization supplies items ranging from rolled rings, bars to sheets and pipes of different characteristics. Besides, AVISMA produces items made from aluminium, steel and nickel. Those items are applied in the same industries which were mentioned in RTI, TIMET and the rest. Nevertheless, the main industry the company primarily concentrates on is the aerospace one. The ability to supply this branch with high - tech stuff allows the enterprise to occupy a leader position in that industry (Bloomberg, 2015).

AVISMA Corporation is the powerful titanium market and possesses several distribution units around the world in such places as Germany, UK, USA, Sweden, Ukraine, China and Switzerland. On the table below there is export data and domestic utilization for 3 years. The percentage ratio increased respectively by 4.07%, 16.06% and 9.96 % since 2012 (Wikipedia, 2015).

Table 15. AVISMA shipments 2011- 2013 (metric in tonnes) (Wikipedia, 2015)

	2011	2012	2013
Export	16 067	16 539	17 211
Domestic market	7 817	9 703	11 644
Total shipments	23 883	26 242	28 856

As it was mentioned above, the aerospace industry is one of the main focuses of the enterprise. It supplies more than 40 % of material for Boeing. Besides, AVISMA is a leading provider of titanium for Airbus and Ural Boeing Manufacturing. With regard to producing of the medicine titanium, the share of it was increased 25 % in the world market. Concerning Russian customers, the demand grew by 2000 tonnes in 2013. Evaluating the total output of AVISMA, it might be stated that 30 % of it goes to the industrial production, 40% is used in the aerospace industry, 20 % is applied into engine building and the rest 10 % belongs to the missile production (VSMPO-AVISMA, 2007).

3.4 Russian titanium industry

When the Soviet Union disintegrated in the end of 1991 year, the Russian economic condition suffered with all principal industries. What is more, the titanium industry lacked customers and raw materials at that moment. However, the government efforts were directed on solving those issues and changing the condition of economy. Thus, it was agreed within a federal program to engage international investments especially in a field of the titanium manufacture under Russian governmental guarantees. The project had been functioning since 1993 till 2003 and those measures sufficiently influenced the current state of the industry making it prospering and successful (Smirnov, 1995).

3.4.1 Development of titanium industry in Russia

The great global titanium industry had been forming during 30 years since 1960 till 1990 in Russia. As a fact, the titanium production capacity exceeded total output of the USA, China, Germany, England and France. A root of success lay into principals of the union national economy. The main location of mining took place in Ukraine. Evaluating the total production of titanium sponge in a period of the Soviet Union existence during those years, 40 % amounted to AVISMA, 20% were produced by Kazakhstan and 40% were Ukrainian output. 78% of that production which was 105 thousand of tonnes accounted for the defense and the aerospace applications in 1990. Besides, leading consumers of titanium metal were aviation, missiles production, shipbuilding and space engineering (Smirnov, 1995). Nowadays, those industries remain to be in a top list.

When the Soviet Union disintegrated, Russia was left without any supplier of the titanium raw materials. Ukraine and Tajikistan began to elaborate their own titanium industries and did not provide Russia with necessary amount of material. Thus, the sponge output of 1994 was 30% of the total quantity in 1989 when the Soviet Union still collaborated with other units (Smirnov, 1995).

Later the period of conversion started and the demand of titanium considerably decreased. It reflected the aerospace production capacity as well which declined by 15%. As a consequence, the sales dropped down in 1994 and it was observed a 20 % decline compare to 1989 (Smirnov, 1995).

It should be mentioned that VSMPO and AVISMA consolidated into one enterprise only in 2005. Being independent leading titanium organizations of the Soviet Union, AVISMA supplied titanium sponge for further processing to VSMPO. However, their relations got tougher when AVISMA required VSMPO to pay for material in advance and by means of money. By that moment of disintegration it was hardly accomplished because of complicated times and the economy recession. Thus, VSMPO used unrealized residue. It was possible because titanium was of the strategic importance and those reserves accumulated into state stocks. However soon or later it dwindled and the enterprise was forced to search for the other source of raw materials (Smirnov, 1995).

Afterwards the Russian titanium industry faced one more problem. The market shrank while there was sufficient amount of production. Thereby, there was a need for export and most manufactures concentrated on that issue. Due to it, 3800 tonnes were exported in 1992 that allowed Russia to occupy the third position in this kind of shipment following the USA and Japan. In this way the export market began to expand and percentage output was 12%, 35%, 60% in 1993, 1994, 1995 years respectively (Smirnov, 1995).

Besides, VSMPO found such companies as Rolls Royce, Pratt & Witney and General Electric as customers. In accordance to it, quite a lot of attention paid to production certificate. It was done through implementation of quality system meeting the international standard requirements (Smirnov, 1995).

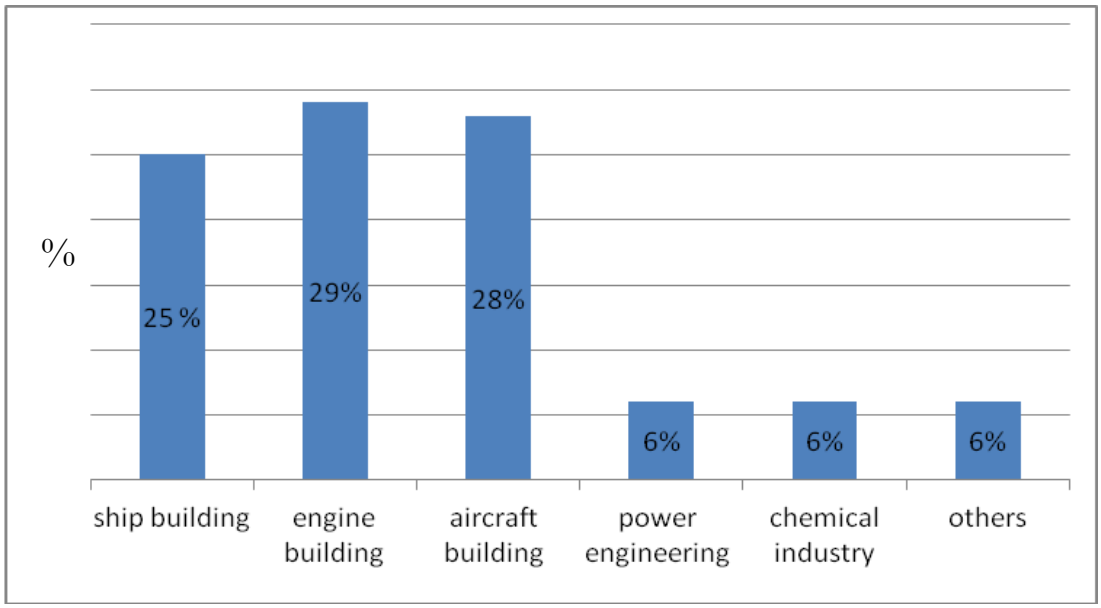
As it was mentioned above, in order to get out of the crisis situation after disintegration, the government launched the project attracting foreign investments. The amount was 100 thousand of dollars and it was used with the purpose to increase export delivery of the titanium production with a further deeper processing. What is more, negotiation between Russia, Ukraine and Kazakhstan were held in 1995 where it was agreed to cooperate in the titanium industry at the intergovernmental level and to create the interstate financial- industrial groups (Smirnov, 1995).

3.4.2 Current market state

Evaluating the Russian market it is worth mentioning that its current state depends on the corporation of VSMPO- AVISMA which is the largest titanium producer in the country. Nowadays the enterprise is in a perfect shape compare to other post- Soviet firms. Thus, the titanium market in Russia is in a prosper condition and strengths its capacity in the world market also (Chertkov, 2013).

The figure below demonstrates demand of titanium in 2013. It is visible that the main consumers are the aerospace industry which includes the missile and the aircraft production, then engine and ship building. The share of other industries is 6 % per each where power engineering, chemical and others took place (VSMPO-AVISMA, 2014).

Figure 16. Russian titanium market demand in 2013 (VSMPO-AVISMA, 2014)



Besides, the demand from the aerospace industry remained at the high position in 2014 because the aircraft manufacture continued to receive orders and its production capacity grew. As a result, demand for titanium increased as well. Moreover, the program of "the Development of the Aviation Industry" was launched, which is supposed to last since 2013 - 2025. The implementation of those measures allows improving the competitiveness of the aircraft titanium products in the world market. The main consumers of titanium in the industrial market are United Shipbuilding Corporation "OSK" and the corporation "Rosatom". Currently there are 11 reactors under construction, hence a number of titanium items are required for application which are primarily supplied be VSMPO- AVISMA. What is more, it is planned to build 25 reactors more and in order to realize it, 12 thousand tonnes of the titanium production will be requested. According to those programs, it might be assumed that there will be the demand of the titanium productions in a midterm perspective. Analogues to the global market, it is predicted a positive growth dynamic. Thereby, the domestic output in 2018 is planned to be doubled in relation to 2010 year. Nowadays, there is not a surplus material because the most part of the aircraft projects are underway according to the plan. As for the industrial sector, the titanium demand remains stable through implementation of the government programs (Chertkov,2013).

The table below establishes the growth of the Russian titanium industry in 2006, 2010 and with a perspective to 2015.

Table 17. Titanium consumption in the Russian market (metric in tonnes) (Proatom, 2007)

Industry	Consumption volume		
	2006	*2010*	*2015*
Aircraft	1950	3000	5000-6000
Shipbuilding	1260	2000	3000
Power engineering	500	2700	4000
Chemical	160	300	450
Offshore	250	1000	2000
Others	-	500	1500
Total	4120	10000	17950

There was observed a significant growth of 740 thousand of tonnes in the industry of power engineering in 2010 in relation to 2006. In addition, the offshore industry demand increased by 1750 thousand of tonnes for 9 years (UralPolit,2014).

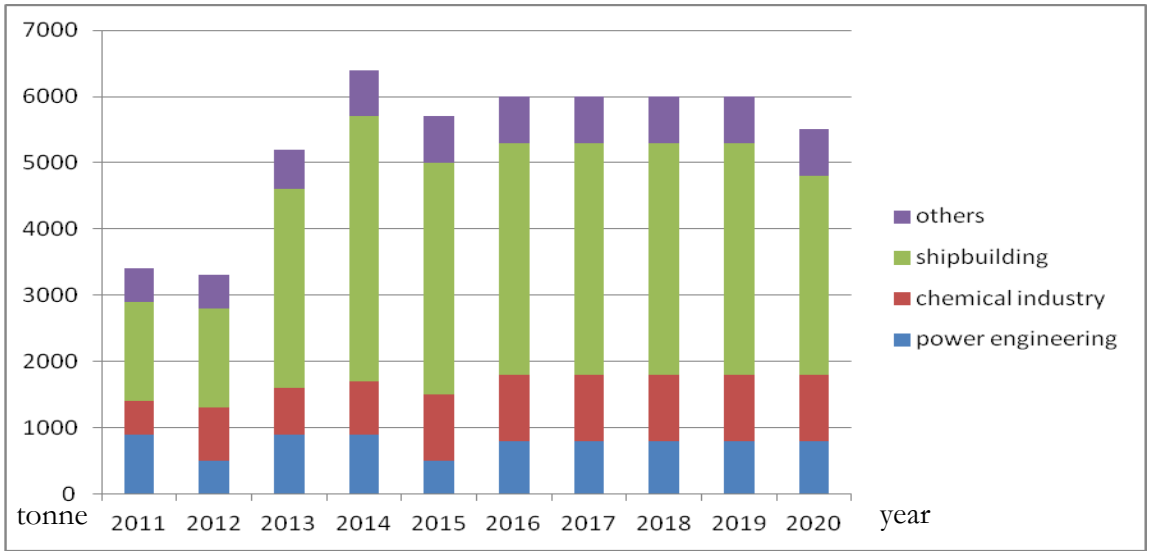
As it was mentioned above, 70 % of titanium is exported while 30 % is left for the domestic market. In comparison to early years, the real output is increased by 15-20% due to deeper processing of titanium mill products and increasing the involvement of the waste and scrap return by 2015 (UralPolit, 2014).

With regard to a price, in the beginning of 2008 the price of titanium for the industrial needs dropped down. However, despite the economic instability in some regions, throughout 2012 a steady demand was for the titanium products. As far as the aircraft industry constantly demands the titanium production, it provides a stable price for those items. Moreover, 95 % of the aerospace market is a long- term sales contracts where prices and volumes had been formulated in advance. Thereby, the aerospace titanium market is the area which is out of the price spikes (Chertkov, 2013).

It is clear that the aerospace industry has a significant impact on development of the titanium industry. Hence, there is a chance to predict how the titanium manufacture will improve basing on the aerospace demand. By 2030 the government of Russia plans to substitute around 46 % of airplanes, such a significant amount promises to require a great deal of titanium supplies (UralPolit,2014).

The figure beneath demonstrates how the titanium production demand of the main industries developed and there is a prediction how it will do further. As far as the global crisis occurred in 2008, it automatically had an impact on the whole economy of the country including the titanium manufacture. Thus, the demand in 2011 and 2012 was considerably poor. Nevertheless, the economy recovered later and there was observed a positive dynamic. 2014 was a year when a need for titanium achieved high value. The metal was in a less demand in 2015. According to VSMPO-AVISMA assumptions, it will be required the same amount of the titanium production for 4 years. As the last year of review which is 2020 is expected be in a less titanium demand (VSMPO-AVISMA,2014).

Figure 18. Dynamics of titanium demand by industries (metric in tonnes) (VSMPO-AVISMA, 2014)



Nonetheless, there is a factor mentioned by VSMPO-AVISMA which might change easily those predictions if this feature is supported. The case is that there was found an alternative to titanium in the aerospace industry namely reinforced aluminum. The metal possesses the same strength as titanium does and the price is cheaper. A base for such production is quite developed in the country and due to it, there is a high chance that the titanium demand will be cut in the nearest future (Chertkov, 2013).

3.4.3 VSMPO-AVISMA

The largest part of titanium production manufactured in Russia which is used in the domestic market and partially exported all over the world accounts for VSMPO-AVISMA. Undoubtedly, there are other suppliers of titanium items like a metallurgical plant "FIKO"," TICOM", "SNABMETALL-2000", JSC "MetChemicProm" and others. However, compare to the VSMPO-AVISMA's production volume and scope of supply, the share of those manufactures in the Russian domestic market is minor (VSMPO-AVISMA, 2014).

The corporation is located in the Sverdlovsk region, the town of Verkhnaya Salda. A focus of the enterprise is titanium production; although they are specialized in aluminium and magnesium production manufacture either. As it was mentioned above, VSMPO and AVISMA operated separately till 2005 and then there was agreed to integrate both enterprises. Thereby, AVISMA is a current supplier of titanium sponge and other materials in order VSMPO to produce off-the-shelf items (VSMPO-AVISMA, 2014).

Nowadays there are several distribution complexes of the corporation in Europe, namely in Sweden, Germany, Switzerland and China while some basic manufactures are located in Russia and partially in Ukraine (VSMPO-AVISMA, 2014).

Such markets as medicine, weapons, vehicles gas and consumer goods become increasingly important for the corporation as well. Those fields are quite small but develop rapidly. Besides, they require a standard quality of titanium; thereby, the competition might be very tough in these segments (UralPolit, 2014).

Considering the domestic market where VSMPO-AVISMO supplies a quarter of overall production, it has been prospering year in year out. However, when the wave of crises passed in 2008, the output volume decreased significantly with a further drop in prices. Nevertheless, the corporation increased that output by 27% already in 2011(UralPolit, 2014).

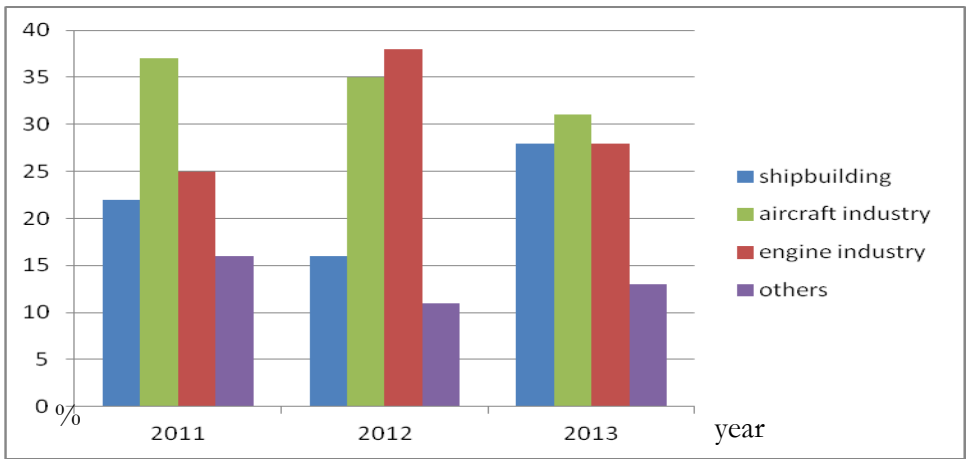
The table below demonstrated the total amount of the titanium production manufactured by VSMPO-AVISMA for 3 years. The output noticeably increased by 3827 tonnes (VSMPO-AVISMA, 2014).

Table 19. VSMPO-AVISMA supply to the domestic market 2011-2013 (VSMPO-AVISMA, 2013)

Year	2011	2012	2013
Domestic market	7817	9703	11644

Evaluating consumption of the VSMPO-AVISMA's products for the same years, it is worth referring to the figure beneath. As for the shipbuilding industry, its development was crooked and the downturn was observed in 2012. Besides, a share of shipbuilding in the domestic marker grew up to 28% in 2013 while for the previous years it accounted for 23 % and 16 % in 2011-2012 relatively. With regards to the aircraft industry, there was a gradual decline from 38% to 31%. Considering the engine industry, since 2011 the percent share had been rising from 25 % up to 38%. However, it dramatically reduced to 28% in 2013. In addition, there was noticed a slight decrease with a consequent growth for the rest of industries, which are chemical, medicine and oil. The fluctuation occurred in the diapason from 12% to 16 % (VSMPO-AVISMA, 2014).

Figure 20. Consumption of the VSMPO-AVISMA production in the domestic market, (metric in percent) (VSMPO-AVISMA, 2014)



Comparing 2012 and 2013, it should be mentioned that the total volume of shipments has increased up to 20%. Primarily such a growth was denoted due to the heightened demand in the energy industry where a great deal of nuclear stations is currently under constructions still. Besides, a significant demand of the shipbuilding industry was at that moment as well. (Chertkov, 2013).

4 RESEARCH METHODOLOGY

As far as the research is concentrated on the titanium market in Russia, the process of gathering information was devoted to that field. In order to analyze consumption of the titanium production, such details as suppliers, customers, characteristics of product and price were collected. Due to it, a method of market research was adopted for the current work.

4.1 Market research method

A method of market research was established in the United States in 1930 when organizations began to compete. In order to win and be a leading company, it required being aware of what customers wanted, which product might satisfy their needs, what the main competitors supplying items were and etc. To discover those issues, a market research method was implemented into the work (Hague, 2004).

According to Igor Ansoff, this method allows to demonstrate how great a possibility of a new product being assimilated in the market. Besides, there might be created a clear concept of what an unfamiliar market presents via this type of the research. Moreover, thanks to applying the method, it is most likely to discover the new areas where products or services might be launched (Hague, 2004).

The market research is able to embrace a large number of fields like pricing, suppliers, product specification, different kinds of forecasts and others. The collected data concerning those issues helps to avoid risks (Hague, 2004).

According to the facts described above, a definition of the market research method can be stated as a process of assembling data, its examination and further explanation which is appropriate for a marketing situation and a purpose. Its process can be divided into 5 stages which are named as brief, proposal, commission, analysis, and reporting (Hague, 2004).

Figure 21. A market research process

At an initial stage of the research – brief– the problem should be defined and there has to be clear understanding which kind of information is needed in order to solve that marketing issue. At a proposal phase, a detailed plan is developed which clarifies how data is going to be gathered. Since the process has gone through those stages, a commission part takes place which is the method of collecting information. When it is done, a need of the analysis appears. This step allows understanding whether data is relevant and it is enough to answer the objectives stated in the beginning of the research. The last phase is reporting. Here it is required reflecting all findings extensively into a report in the way that the people who are in charge of making decisions would be able to do it right (Hague, 2004).

4.2 Data collection process

For the current research the data was gained from 2 electronic sources which are the Russian trading platforms named "Fabricant" and "B2B-Center". They are the main markets where trades are held. Bargains might be occurred in various fields there; however, primarily those platforms focus on trading in industries of corporate, nuclear, shipbuilding and state procurements.

"Fabricant" and "B2B-Center" are the reliable market places where a large number of deals are made every year. The principle of their work looks similar to a usual auction process. First of all, an organization nominates a product or a type of service and establishes its price. That commodity has to be described in details and supported by all relevant certificates. Secondly, potential customers propose their price and the organizer determines a buyer based on the preferable price and his priorities.

At a brief stage, the objective was stated which required to discover the titanium consumption in the Russian market since 2011 till 2014. At a proposal phase, it was agreed to collect

data which was sorted according to a type of product, its size and diameter, a volume, a price with and without VAT, a date of publication, a customer, a final price, an organization of nominated product, a date of shipment, terms of delivery, a status of purchase and its serial number. Further a commission part took place where all information concerning titanium wire, sheet, bar and pipe was entered into Excel document. Then the process moved to an analysis stage and the data began to be analyzed right there. As far as some additional information of product was established in the trading platforms, it was taken into consideration and applied into the research as well. Thus, there were built several diagrams of the demanded products in conformity of their purchased volume and characteristics like type of alloy and size.

The current work is considered as a stage of reporting and is supposed to be used by the analytical department for the subsequent research.

When diagrams were built, it became possible to determine which size and alloy of those products were the most preferable in the Russian market since 2011 till 2014. The outcome of work which was undertaken meets one of the objectives of the current research.

4.2.1 Reliability and validity

Since the practical part of the research is focused primarily on the analysis of gathered information, it is worth mentioning that data which was obtained from 2 sources might be considered as reliable and valid. Those trading platforms were offered by the supervisors at the analytical department where the training period took place. Since the analytical department is in charge of prognostication and analysis, it was supplied with reliable resources which were used in the current research. They have been working using data of "Fabricant" and "B2B- Centre" during a significant period of time. Besides, those marketing platforms are not freely available. They require logging in providing organization details and concluding a contract.

4.2.2 Research limitations

There were several limitations during the research process. First of all, only 2 trading platforms were considered, even though they are basic ones, there are quite many of other market places where auctions are held. Nevertheless, the main deals are made exactly in the frames of "Fabricant" and "B2B-Center" that allows suggesting that the principal titanium purchases were done there.

One more limitation which influenced the result of the research is lack of information. There were a few organizations that did not provide detailed information concerning their products. Thus, some data like diameter or size was neither taken into account nor reflected into diagrams. Unfortunately, it might be considered as imprecision in the research work.

In addition to it, the titanium industry is considered as a strategic field where the information is closed for no insiders. Besides, the titanium manufactures produce a great deal of the production which is a part of the military items; due to it, plenty of information is kept secret.

According to those limitations, the research might be considered as a short overview of what the titanium industry presents today and a rough concept of the titanium consumption in the Russian market.

5 RESEARCH RESULTS

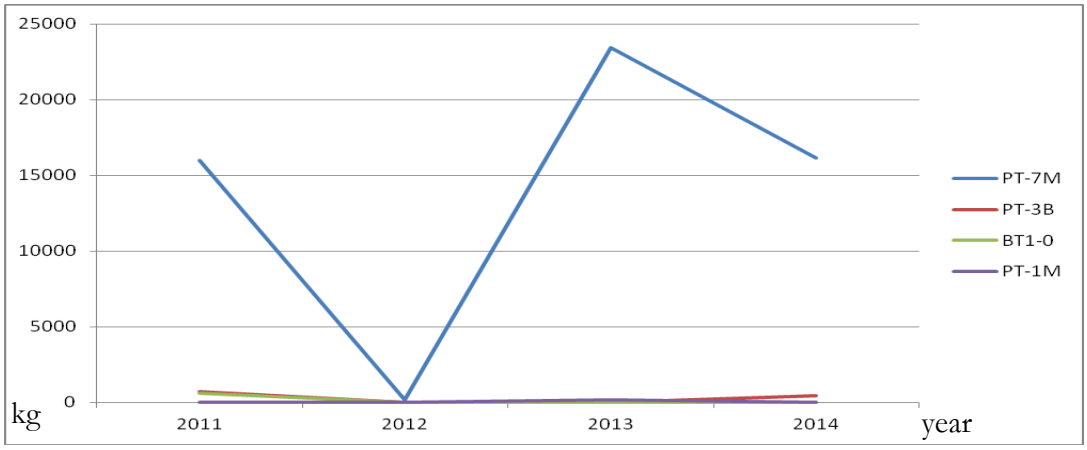
In the research there is brought data concerning consumption of wire, tube, sheet and bar since 2011 till 2014 in the Russian market. Besides, a comparison analysis based on alloy types and sizes was done as well. The first product which is analyzed is wire. As for it consumption, it amounted 6811 kg in 2011,13555.53 kg in 2012, 4532 kg in 2013 and 41120.51 kg in 2014. There was a tendency of the rapid growth in 2014 where the difference in consumption for 4 years was 34309.51 kg. This number is significant for the Russian titanium industry and such a rapid demand for wire in 2014 (and the rest of titanium production also) might be caused by the national programme which is aimed at building of nuclear stations in Russia.

Table 22 . Wire consumption 2011-2014

Year	2011	2012	2013	2014
Metric in kg	6811	13555.53	4532	41120.51

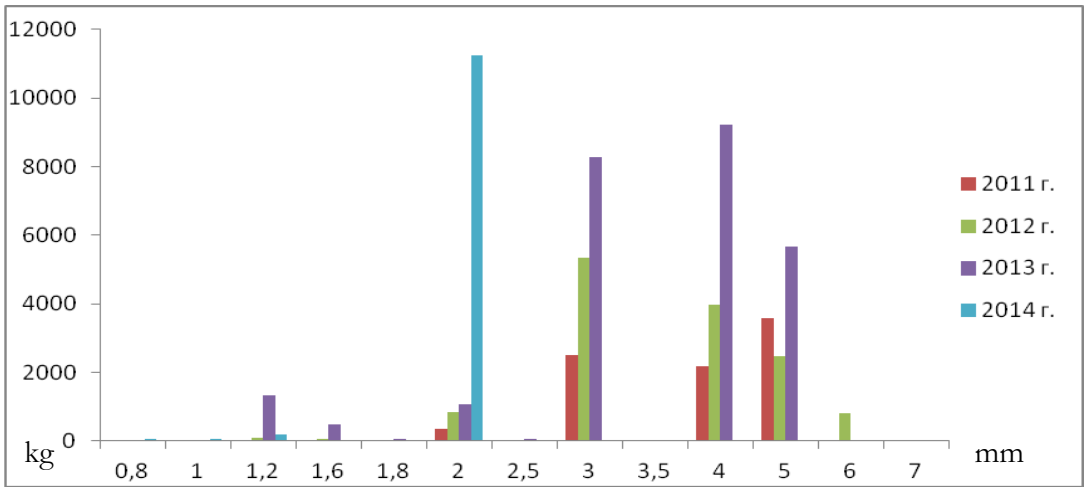
Analyzing *consumption of wire with regards to type of alloy*, it was identified that the leading one was 2B. Its specialty is a composition where an equivalent amount of manganese is replaced by vanadium. The second place by consumption since 2011 till 2013 was given to an alloy of PT-7M. However, BT 1-00 took the leading position in 2014. Those alloys are manufactured by different plants and it might be supposed that the factory of PT-7M could not provide enough production due to some reasons in 2014. Thus, customers had to buy the other alloy which is BT 1-00 in order to continue the process of manufacturing in their own companies. The diagrams below demonstrate this situation.

Figure 23. Wire consumption since 2011-2014



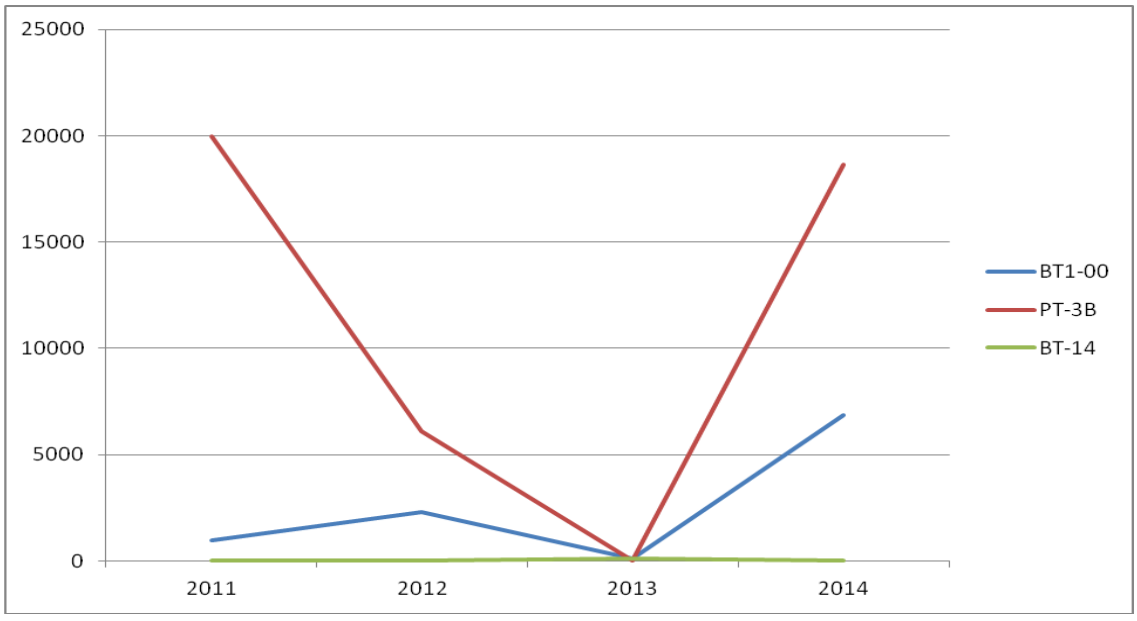
Evaluating which *diameter of wire* was in demand for 4 years, it can be stated that wire of 3, 4 and 5mm was purchased constantly for 3 years. However, there was a rapid growth of diameter 2 in 2014. In a numeric equivalent, it was purchased 23162.72 kg of the wire with diameter of 3 mm since 2011 till 2014. In addition, 4 mm wire amounted 27922.52 kg for the same period. Eventually, 17727.48 kg of production with 5mm diameter was in demand for 4 years. As for 2014, the purchased amount of favourite wire with a diameter of 2 mm was 11233.99 kg. The diagram below demonstrates that situation.

Figure 24 . Consumption of wire according to diameter



The next product which was observed is *sheet*. The total amount of consumption of sheet for 4 years was 20911 kg, 8405 kg, 220 kg and 25500.43 kg respectively. Since 2011 the demand of titanium sheet began to decline and it achieved a peak of recession in 2013 when it was purchased only 220 kg. Nevertheless, a very essential takeoff occurred in 2014 which outperformed the consumption on 2011. The diagrams below demonstrate *sheet's demand due to alloy type*.

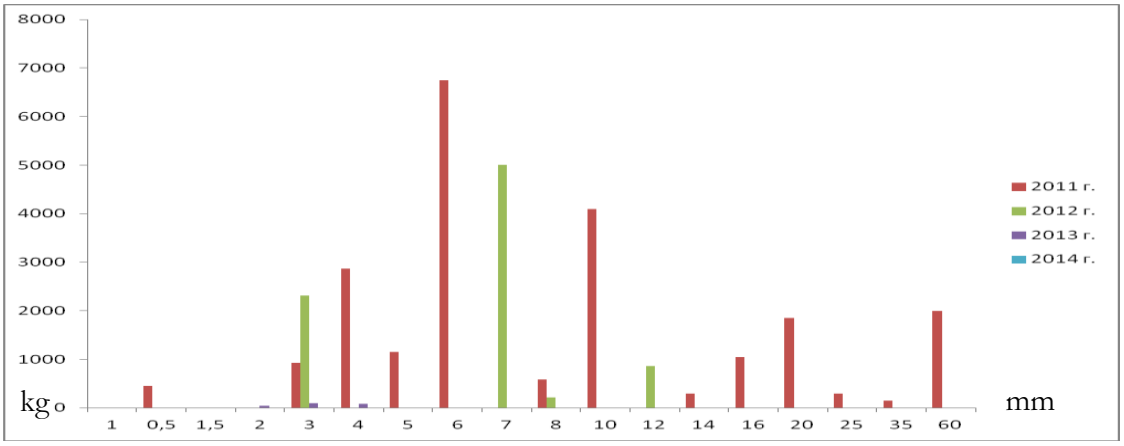
Figure 25. Sheet alloy demand since 2011 till 2014



From diagrams it is visible that a PT-3B alloy was in requisition for 3 years except 2013 when it was not purchased at all. Its total amount was 44690.27 kg. With regard *to sheet thick-*

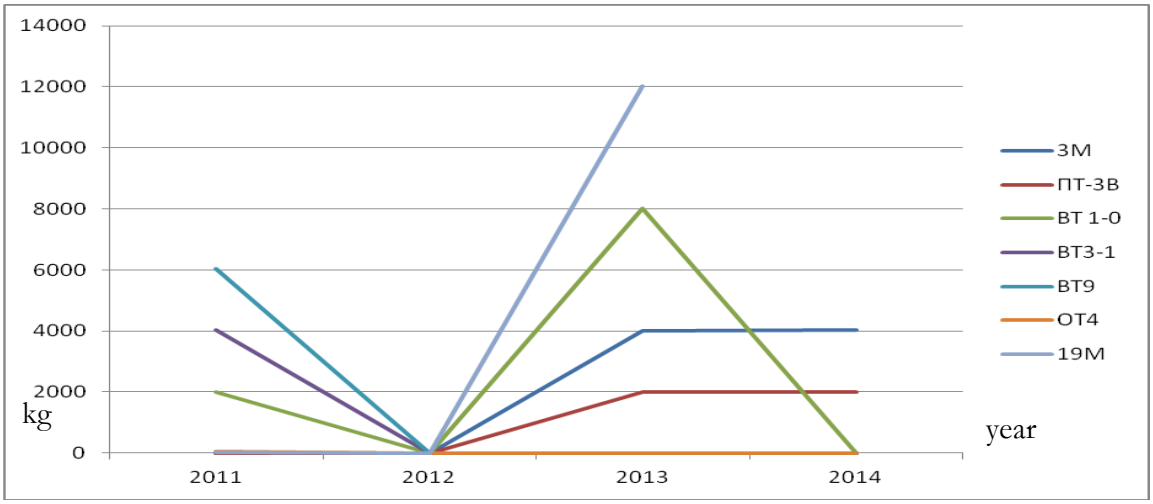
ness, it should be stated that 6mm and 10 mm were demanded mostly. Besides, this consumption was observed primarily in 2011. In 2012 a sheet with a thickness of 7 mm and 3 mm was in requisition. It is impossible to determine which thickness was in demand in 2013 and 2014 due to limitations of data.

Figure 26. Consumption of sheet according to thickness



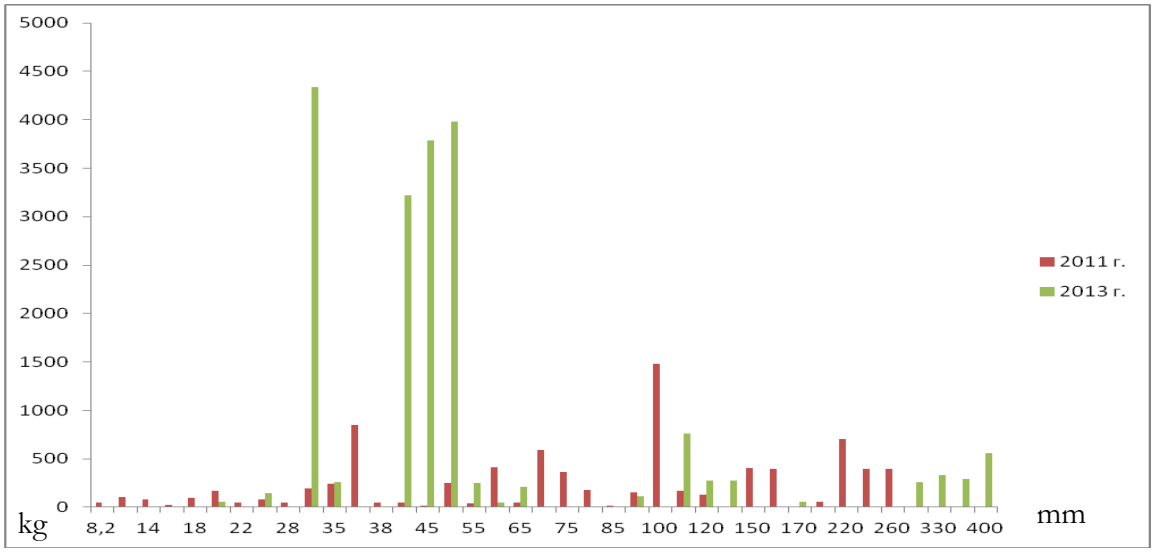
The following product is *bar*. Its consumption was 8162 kg in 2011, 12971.29 kg in 2013 and 31001296.08 kg in 2014. There were no any offers and orders for bar in 2012. Here a clear tendency of the fast growth is observed. It might be explained again with the implementation of the national program which is supposed to get power stations built in the nearest future. The diagrams below reflect a *consumption of bar by a type of alloys*.

Figure 27. Bar alloy demand since 2011 till 2014



According to data, an alloy PT-3B was demanded every year except 2012. However, in 2013 the largest part of purchased bar belonged to 3MM alloy. The same trend is observed in 2014 but its share was represented with a giant number which is 30979344 kg. Making an analysis of *bar consumption by diameter*, it should be mentioned that some data limitations were faced again. Due to it, there were analyzed only 2011 and 2013 years.

Figure 28 . Consumption of bar according to diameter (kg)



Diameters of 30 mm, 40 mm, 45 mm, and 50 mm were in requisition in 2013. As for 2011, 36 mm, 100 mm and 220 mm diameters were demanded that year. It is an interesting observation because those diameters did not repeat from year to year. It might be suggested that some long- term plans were launched which required following schedule. The organizations needed bigger diameters at the stage of 2011 and bars of smallest diameters were needed in 2013.

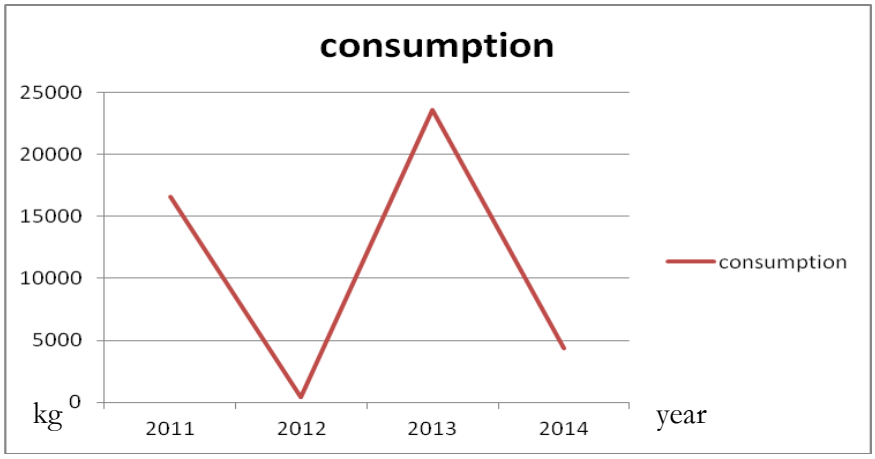
The last product which was analyzed is *pipe*. Its consumption for 4 years amounted 44994.86 kg. Numeric data of the purchased pipes per each year is shown in the table below.

Table 29. Pipe consumption since 2011 till 2014

Year	2011	2012	2013	2014
Metric in kg	16591	425.52	23609.53	4368.81

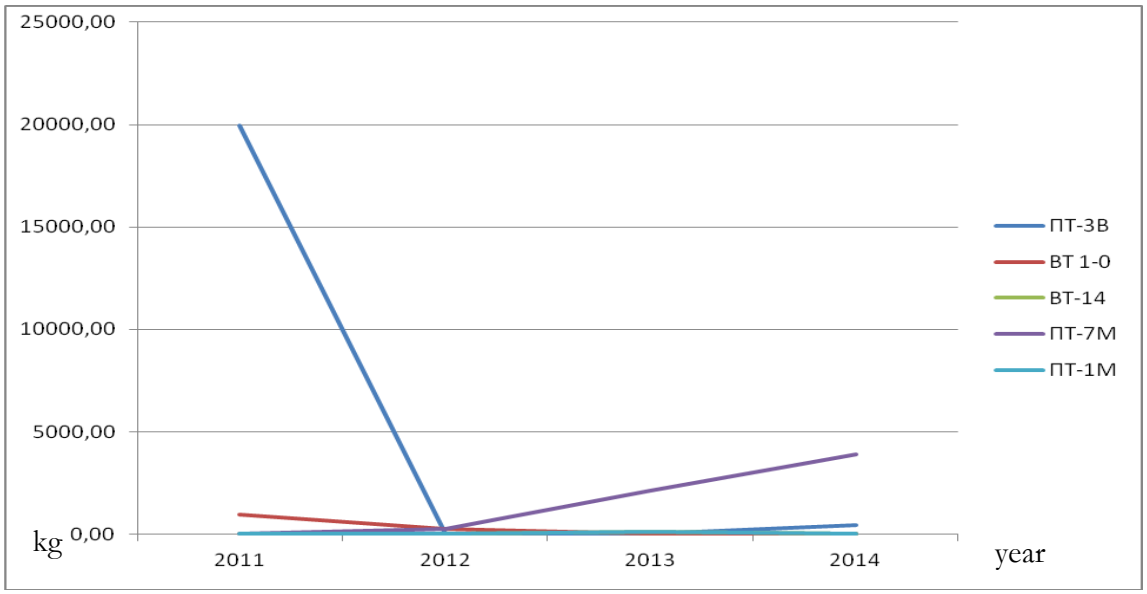
Evaluating the situation, it can be mentioned that there was an abrupt growth in 2013 which occurred after a significant decline in 2012. However, the purchased pipe amount decreased in 2014 again. In this case it is worth reflecting such data via a graphic also. It is expressed by a curve which rises and falls year in year out.

Figure 30. Consumption of pipe 2011-2014 (metric in kg)



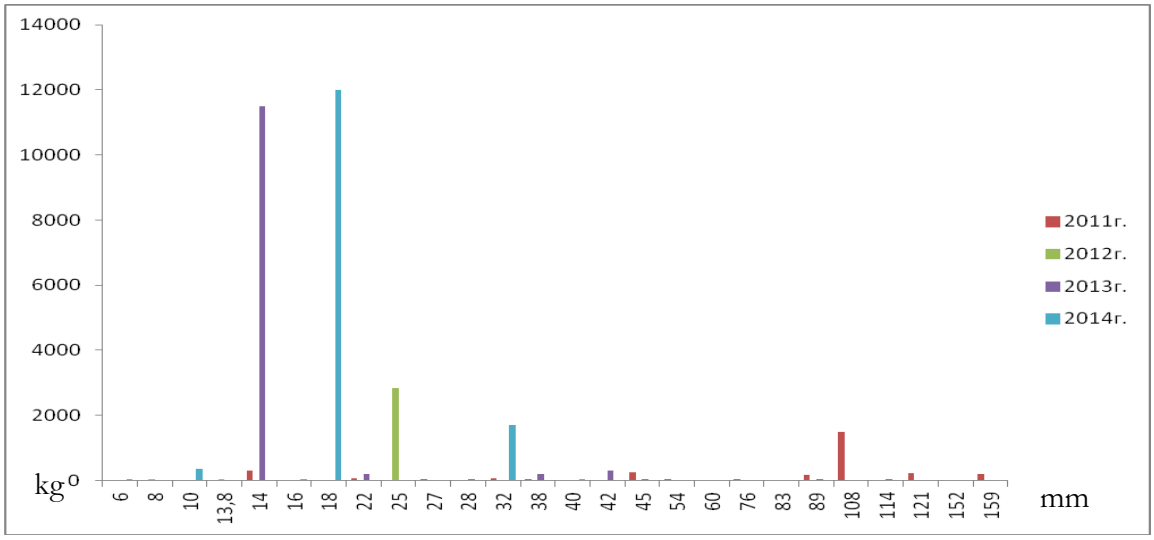
As for *type of alloys*, PT-7M was leading and purchased in the large quantity that amounted 55902.34 kg for 4 years compare to BT1-0 which had a very tiny share of demand. An alloy of PT-3B was in the same situation and was not purchased in plenty. The figure beneath establishes this case graphically.

Figure 31 . Pipe alloy demand since 2011 till 2014



With regard to *the most preferable pipe diameter*, it should be taken into consideration that some data limitations were faced over again that influenced the result directly and the observation is not full. Nevertheless, due to gained information such diameters as 14mm and 108 mm were demanded in 2011. As for 2012, the pipe with diameter of 25 mm was consumed primarily. In 2013, the preference was given to a 14 mm pipe and a year later an 18 mm diameter was purchased in amount of 12010kg.

Figure 32 . Consumption of pipe according to diameter



6 CONCLUSION

The aim of the current research was to explore the actual global market condition of titanium which is in a prospering phase. Titanium began to be used with a commercial purpose less than 100 years ago, however, it is applied in a great deal of diversified industries such as military, chemical, aircraft, defense, marine, energy and others nowadays. Thus, there are numbers of the areas where the metal takes an important position. Besides, since scientists have been searching for more modern and environmentally friendly forms of the titanium production, the interest toward the titanium industry rose and attracted manufactures all over the world.

As for the geographic markets, there should be mentioned 6 of them which are considered as leading: Japan, Russia, Kazakhstan, China, United States and Ukraine. Besides them, the markets of India, Republic of South Africa and Australia are on the way to overtake the leading places.

With regard to the principal titanium producers, TIMET and RTI International Metals are main suppliers of titanium as a material for further processing. Both of them had been originally established in the USA, however later their distribution units were founded in Europe as well. The particular attention should be paid to Public Stock Company VSMPO-AVISMA Co which is located in Russia. That company produces titanium and uses the metal for further treatment which leads to a final product. The largest part of the shipments is reserved for the export utilization while less than 40% of the total production is meant for the Russian domestic market.

Besides, some additional sub aims were established at the beginning of the research which were mostly focused on the Russian market. Namely, the consumption of titanium wire, bars, pipes and sheets since 2011 till 2014 was investigated. Besides, there were defined the most demanded type of alloys and diameters (size) for each product. The table below fully establishes the result.

Table 33. Research results

Product	Wire	Sheet	Pipe	Bar
The most demanded alloy	2B	PT-3B	PT 7M	3MM, PT 3B
Diameter/thickness	3,4,5 mm	6 mm	14, 18 mm	30,50,100 mm

With regard to the future perspective of the Russian titanium market, it might be stated that it will be in a prosper condition since the Russian government agreed to launch the program of reactors renovation. Due to it, there will be a high demand of titanium at least at the power engineering industry. As for the aircraft building, the helicopter and rocket production, the titanium demand of those industries will be stable according to the VSMPO- AVISMA report. Besides, analytics suppose that all the industries that apply titanium will require the same amount of the metal as they did in 2014.

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