Current state of the world and domestic aluminium production and consumption

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Current state of the world and domestic aluminium production and consumption

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Abstract. The analysis of the current state of world and domestic aluminium production and consumption is carried out, the dominant tendencies are determined and the forecast for in the immediate future is given.

1. Introduction

Due to its lowest cost in comparison with other non-ferrous metals and its physicochemical properties, aluminium is widely used in aircraft and automotive, transport industries, in manufacturing of home appliances, in electrical engineering etc. Aluminium often successfully replaces other metals – lead, zinc, copper, and also competes with steel products. Therefore, aluminium consumption and production throughout the world is increasing rapidly.

2. Analysis of aluminium production

In 2016, world aluminium production increased by 3.6% compared to 2015 and amounted to 59 million tonnes [1], 37 million tonnes of which are primary aluminium produced by the electrolytic method, and 22 million tonnes are secondary aluminium, i.e. aluminium alloys, obtained by processing scrap and waste. The production of secondary aluminium is a rapidly developing branch of non-ferrous metallurgy in advanced foreign countries. Japan completely abandoned the production of primary aluminium and moved to the production of secondary aluminium, and the United States currently has the largest volumes of secondary aluminium production. Russia and the factories of the United Company RUSAL located on its territory are one of the largest aluminium producers, occupying in the group of leaders – Chalco, Rio Tinto Alcan, Alcoa the second place in the world (3.724 million tonnes in 2016) with a share of 6.8% after the Chinese companies (share 45.0%) [2]. Russia and UC RUSAL are also the largest aluminium exporter, providing 15.3% of the world exports. At the same time, 82.7% of the output is exported, which makes the financial condition of UC RUSAL directly dependent on the global market environment. These indicators also indicate a low capacity of the Russian market of aluminium-containing products.

The world aluminium production in 2016 by region is presented in figure 1 [1] and can be conditionally divided into 2 parts: China and the rest of the world.

Figure 1. Aluminium production in the world in 2016, million tonnes.

Over the past 10 years, China has demonstrated incredible economic growth rates and has become the largest aluminium producer. According to the International Aluminum Institute and the analytical agency CRU, the world primary aluminium production excluding China in 2016 increased by 2.2% – 26.7 million tonnes [1]. According to Aladdiny agency, the aluminium production in China in 2016 was 32.3 million tonnes, increased by 5.5% as a result of the launch of new facilities. However, aluminium plants in China operate on thermal power, which leads to severe environmental pollution and the need for a reasonable increase in production [3]. The main aluminium producers after China are the USA and European countries, where demand is historically high due to the high level of technical and industrial development of these economies. Also Japan is a major consumer of aluminium, it imports all the primary metal it needs, liquidating its own capacity for its production. The reason for this is the lack of powerful and affordable sources of electricity on its territory and a significant tightening of the national environmental legislation. A good growth in aluminium production is shown by actively developing countries in South-East Asia. Companies from the Middle East have an important advantage: the ability to use relatively cheap electricity for production, produced by burning associated gas from oil fields.

Plans for the future development of many aluminium-producing corporations envisage an increase in aluminium production [3]. Thus, India is expected to cease exporting alumina and its processing in full and increase the aluminium production from 460 thousand tonnes to 2 million tonnes. Norse Hydro Corporation (Norway) at the Grevenbroich and Neuss plants in Germany increases the output of automotive aluminium rolled products from 50 to 200 thousand tonnes and introduces recycling of used aluminium cans with 50 thousand tonnes per year. UC RUSAL continues the commissioning of the production capacities of Boguchansky aluminium plant with the projected production of 750 thousand tonnes per year.

The price of aluminium on the London Metal Exchange in February 2017 reached $ 1905 per tonne [1]. This was due to the deficit of metal in the market: in 2016 it amounted to approximately 0.7 million tons. Figure 2 shows the dynamics of prices for aluminium in 2010-2017.

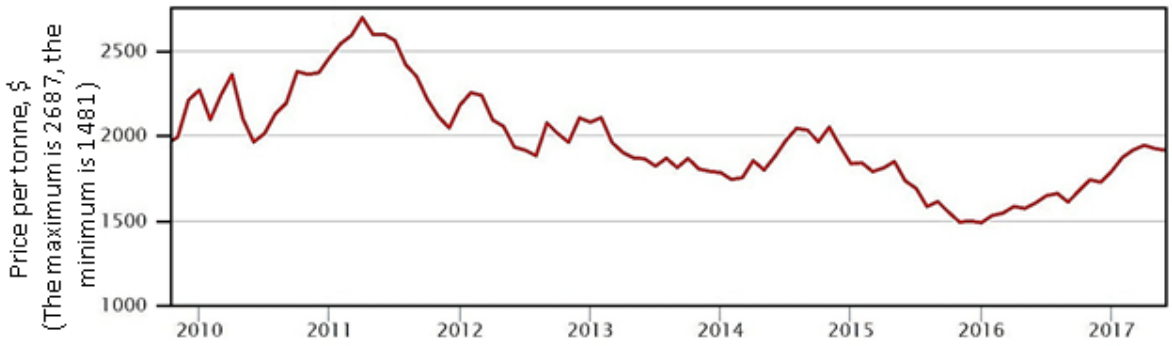

Figure 2. Performance of aluminium.

3. Analysis of aluminium consumption

Data on world aluminium consumption and production in the period 2010 – 2016 are shown in figure 3 [5].

According to the estimates [5] in 2017 the capacity of the global aluminium market could increase to almost 64 million tonnes, in 2018 – up to 66 million tonnes, in 2023 – up to 78 million tonnes. Demand for aluminium is provided by construction (+4 million tonnes), transport (+5 million tonnes), electric power (+2 million tonnes), packaging and machine building (+1 million tonnes) industries. The existing structure of the world aluminium consumption is presented in figure 4 [4, 5].

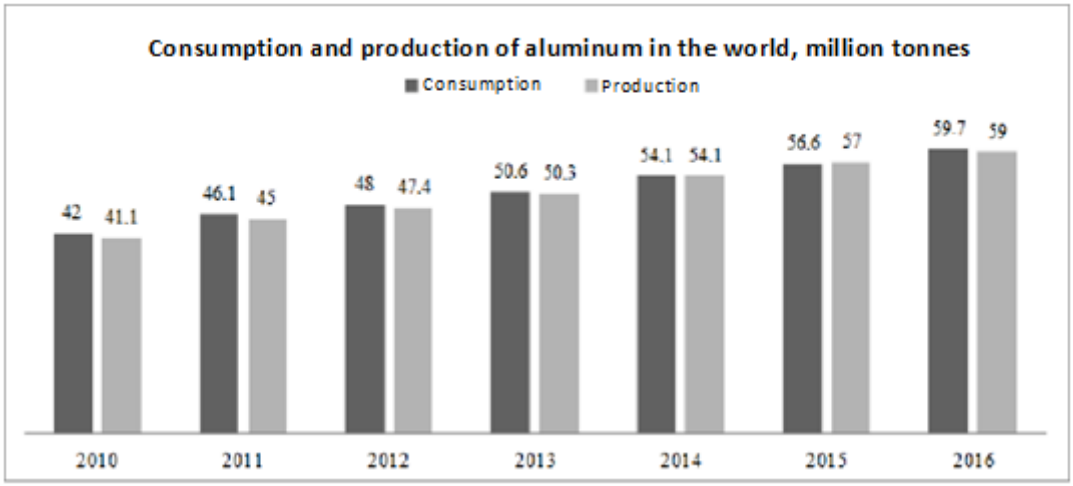

Figure 3. Diagram of world aluminium consumption and production.

The average per capita consumption of aluminium in the world at the end of 2015 was estimated at 7.7 kg. It is expected that by 2020 this figure will grow to almost 9 kg. The highest level of aluminium consumption is currently observed in countries with highly developed automotive industry – Germany and South Korea, where the per capita consumption level exceeds 26 kg per year. Next come the USA, Sweden, Japan, the United Arab Emirates, China – 15-16 kg per year [4]. Data on world average per capita consumption of aluminium are shown in figure 5.

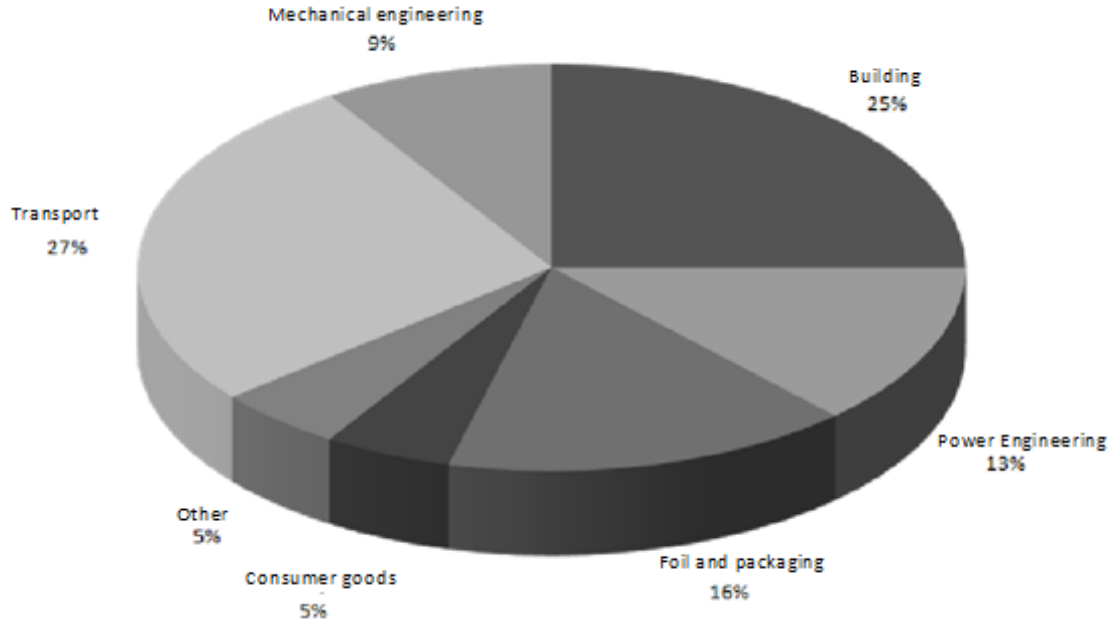

Figure 4. Diagram of world aluminium consumption by economic sectors.

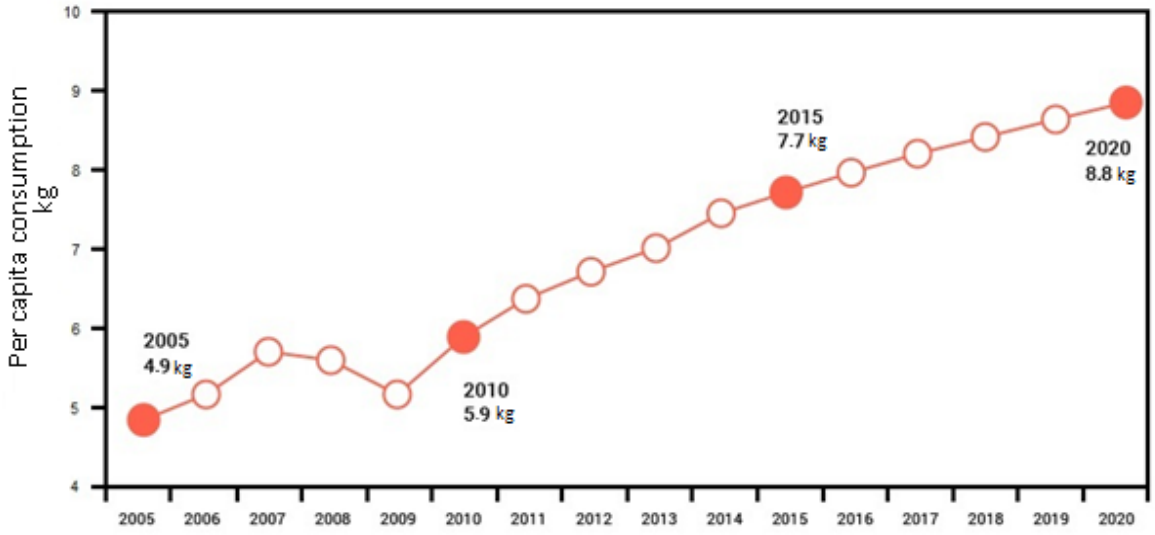

Figure 5. The graph of the change in the world average per capita consumption of aluminium.

The use of aluminium in the transport and engineering industries allows vehicles to save fuel and reduces emissions of harmful substances. Car and trailer hulls, wheel disks, hulls, bumpers, fuselage parts of aircraft, fuel systems, motor parts, marine vessels, space shuttles and rockets are made of aluminium alloys. According to calculations by the Automobile Manufacturers Association, every kilogram of aluminium used in car production leads to a reduction in its weight by kilogram, and each percent of car weight saving results in a 1.0% reduction in fuel consumption [7, 8]. This means that 100 kg of aluminium in the car save more than 1000 liters of gasoline for every 200 thousand kilometers and reduce carbon dioxide emissions by 2500 kg. Today a car produced in North America

contains on average 116 kg of aluminium, Japanese and South Korean - 93, Western European - 90, and domestic - 30-40 kg.

In modern aircrafts aluminium accounts for an average 80% of the total weight, which, given the size of the airliners, is an impressive figure. So, for example, 75 tonnes of aluminium are used in Boeing 747, and in American shuttles the share of aluminium reaches 90% [7, 8].

Aluminium has also taken a very strong position in the construction. It is used everywhere: in building frameworks, window and door panels, roofing, facade and load-bearing structures, exterior decor elements, siding, stairs, air conditioning and heating systems. With the same load-bearing capacity, the weight of the aluminium structure is two to three times less than the weight of steel and up to seven times less than the weight of the reinforced concrete structure. The minimum design life of aluminium structures is estimated at 80 years [9]. They are resistant to climatic influences and "work" in a wide temperature range from –80ºC to + 300ºC. A potential drawback of the use of aluminium in construction is its high thermal conductivity. Therefore, in aluminium constructions intermediate thermal interlayers or thermal breaks can be used from materials with low thermal conductivity.

Packaging and energy are the following in terms of the volume of aluminium used by the economy. Aluminium has low density, attractive appearance, compatibility with food and beverages, high thermal conductivity, which makes it a demanded material for various types of packaging. In this area, the main positions are occupied by food foil and aluminium can for drinks: annually more than 230 billion cans are produced [9].

The electrical industry is one of the most important consumers of aluminium, which uses this metal for the production of conductor products, power lines, telephone wires, capacitors, radars, small motor cases [2, 9].

In aluminium and magnesium reduction cells, as well as in powerful arc furnaces for the production of silicon and some ferroalloys, tires from various aluminium alloys or from aluminium grade A5E are used to transfer large currents. Now the cross-section of such tires reaches significant sizes, and the cost is only one-third of the cost of copper tires equivalent in conductivity. Therefore, the use of aluminium tires restricts only the geometric dimensions of the units [2].

The scale of aluminium consumption for the production of consumer goods over the past decade has increased dramatically. Aluminium alloys are used for the production of household goods, furniture, components, parts and housings of household goods and equipment. Aluminium alloys have good thermal conductivity and high strength, so they are a good choice for applications in heating, ventilation and refrigeration systems.

Aluminium frying pans and cooking pots, baking trays and kettles, braziers and cooks are practical, cheap, functional, easy and convenient to use. In addition, aluminium has a high thermal conductivity – it is 2.4 times higher than that of steel. The aluminium pan absorbs only 7% of the heat received (four times less than steel) [9].

Aluminium powders and granules of a wide variety of sizes and shapes are of great interest [9]. They are used in metallurgy as alloying additives, for manufacturing semi-finished products and parts by pressing and sintering them, for obtaining a number of chemical compounds of aluminium, for synthesizing organometallic compounds and for catalysis, for increasing the corrosion resistance of steel and cast iron products, especially in atmospheric-exposed structures, as a pigment in coatings and inks used for painting equipment, as well as in printing.

Powder metallurgy makes it possible to reduce significantly the cost of parts and increase the coefficient of metal use, since the part obtained by pressing the powder in the die almost does not require subsequent machining. Aluminium powders have better compaction ability than iron-based powders. This allows the strength of the product to be increased and the possibilities of obtaining various semi-finished products with the same power of the press equipment to be expanded. Sintered aluminium alloys have unique characteristics, so that their area of application is constantly expanding, replacing in some cases titanium and high-strength steel grades [9].

Russia, being one of the world leaders in the production of primary aluminium, is considerably behind the countries of the European Union, North America, and China in its use in finished products.

At the same time, Russian companies export not only primary aluminium and alloys, but also high-tech aluminium semi-finished products, sheets and bars from special alloys for machine building. Along with this, the import of ready-made consumer aluminium products – foil, building structures, furniture profiles and fittings, radiators is quite large [10].

4. Conclusion

In the structure of world production the primary aluminium is 63%, secondary aluminium – 37%. The price for aluminium was $ 1905 per tonne (2017). The largest producer of aluminium is China. Russia and UC RUSAL provide 15.3% of world aluminium exports. The average per capita consumption of aluminium in the world is estimated at 7.7 kg. The world consumption of aluminium by sectors of the economy is, %: transport – 27, construction – 25, foil and packaging – 16, energy – 13, engineering – 9, consumer and other goods – 10.

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