Development of Rolled and Cabling-Wiring Production from Aluminum Alloys at Plants in Russia

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Received 04.10.2014, received in revised form 14.11.2014, accepted 06.12.2014

This article provides an overview the state of production and consumption cabling-wiring production, plates, sheets and foil from a different aluminum alloys in Russia, CIS and other countries. Also the forecast consumption of aluminum semi-finished products in the coming years.

Keywords: aluminum, rolling, cabling-wiring production, aluminum alloys, foil.

Развитие производства проката и кабельно-проводниковой продукции из алюминиевых сплавов на заводах РФ

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В статье приведен обзор состояния производства и потребления проводниково-кабельной продукции, плит, листов и фольги из различных алюминиевых сплавов в России, странах СНГ и прочих странах. Представлен прогноз потребления алюминиевых полуфабрикатов на ближайшие годы.

Ключевые слова: алюминий, прокатка, проводниково-кабельная продукция, алюминиевые сплавы, фольга.

Refusal of planning and distribution system of production organization and the transition to market conditions, management of the economy, accompanied by our country in the 90’s of last century, the conversion of defense industries, subsequently was characterized by a sharp drop in consumption of deformed semi-finished products from aluminum alloys in almost all areas and, accordingly, their
collapse in industrial production. For the last period of time the situation will definitely improve, but the recovery in output of machine-building enterprises and their competitiveness in some industries remains an urgent task.

Considering the results of activity in recent years the main branches of the Russian economy potentially targeted at a wide use of aluminum alloys, the following results can be noted (Table 1).

The results presented in some positions (for example, the number of civil and transport aircraft, passenger coaches, civilian vessels) significantly lower than previously reached a maximum of industrial production, not to mention the performance of leading foreign firms. Naturally, this is reflected in the volume consumption these sectors of semi-finished products from aluminum alloys.

It should be noted that in a number of basic branches of machine building low level of consumption aluminum semi-finished products defined not by a lack of demand for the final product, but low competitiveness of domestic products of mechanical engineering defined as the level of scientific and engineering developments and technical condition of the enterprises industrial base. For this reason, some sectors of the national economy focused more on the purchase of foreign equipment (for example, civil aviation), and others to establish assembly plants of foreign products in Russia with a relatively low degree of localization components production at domestic plants (as, for example, the automobile industry). Last also entails a strong drop in consumption of aluminum and semi-finished products from it. For example, in the automobile industry for the first half of 2013 it is projected at 18 % (compared to the same period of last year).

In the absence of sufficient demand for aluminum semi-finished products from the domestic engineering industry many of the metallurgical plants are forced to shift to foreign markets. However, not in all cases they are able to provide the stringent requirements of the external market for the quality and price of products. It is for this reason main volume aluminum, produced at the company «Rusal» plants 4,174 mln tons, not implemented domestic enterprises, and sent for export. According to the

<table>
<thead>
<tr>
<th>Branch of industry</th>
<th>The volume of production</th>
</tr>
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<tbody>
<tr>
<td>Aircraft construction</td>
<td>- in 2012 – 23 passenger and cargo aircraft *</td>
</tr>
<tr>
<td></td>
<td>- in 2011 – more than 120 military aircraft (2nd place in the world)</td>
</tr>
<tr>
<td>Helicopter construction</td>
<td>- in 2011 – 267 helicopters (steady growth, the 3rd place in the world)</td>
</tr>
<tr>
<td>Electric power and cable industry</td>
<td>Development of UNPG from 2013 – 1880 km (96, 636 kt)</td>
</tr>
<tr>
<td></td>
<td>In 2012 volume of processing – 211kt</td>
</tr>
<tr>
<td>Building</td>
<td>62, 5 mln. sqr. m (in 1985 – 16,3 mln. sqr. m)</td>
</tr>
<tr>
<td>Passenger railcar construction in 2012</td>
<td>378 passenger carriages</td>
</tr>
<tr>
<td>(TVZ JSC)</td>
<td>351 underground carriages</td>
</tr>
<tr>
<td>Automobile manufacturing in 2012</td>
<td>Passenger a/m – 1968,8 thousand units</td>
</tr>
<tr>
<td></td>
<td>Buses – 57,2 thousand units</td>
</tr>
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<td></td>
<td>Trucks – 208,1 thousand units</td>
</tr>
<tr>
<td>Shipbuilding</td>
<td>1,3 % of world volume by the number of civilian transport ship</td>
</tr>
</tbody>
</table>

* In 2011 Airbus sold 1608 civil aircraft, Boeing – 921, Bombardier – 245, Embraer -105, i.e. all about 2900 units.
Directorate of Marketing UC «Rusal» in 2012 aluminum consumption among industries of Russia and some CIS countries was divided as follows (Table 2).

These data provide only an indirect idea of the volume of production of deformed and cast semi-finished products by domestic metallurgical enterprises, as for the preparation of alloys used a significant amount of scrap, attracted from the market. According to various expert estimates, total production volume of semi-finished products from aluminum alloys in the considered period of time is more than 900 kt. Thus the structure production by shares of different types semi-finished products in the total volume of production quite significantly different from the global representation. In particular this applies to flat rolled, production of which in Russia is concentrated in the factories of the company «Alcoa Rus», «KUMZ», «SMK» and plants of company «Rusal».

**Production of plates and sheets from aluminum alloys.** The product line of domestic rolling plants includes the full range of semi-finished products – plates, rolled sheets and foil. According to various sources, the total production of plates and sheet in 2010 amounted to only 237 kt (Table 3), in 2011 increased by 26.7 %, and for the 6 months of 2012 decreased by 10 % compared to the same period of the previous year.

Thus, taking into account volume of production foil in RF share of rolled in the total production of semi-finished products from aluminum is less than 40 % (in universal practice –

<table>
<thead>
<tr>
<th>Sector of industry</th>
<th>Armenia</th>
<th>Byelorussia</th>
<th>Kazakhstan</th>
<th>Russia</th>
<th>Ukraine</th>
<th>Uzbekistan</th>
<th>In all</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolled products</td>
<td>27</td>
<td>265</td>
<td>291</td>
<td>237</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable</td>
<td>10</td>
<td>3</td>
<td>186</td>
<td>22</td>
<td>6</td>
<td>229</td>
<td></td>
</tr>
<tr>
<td>Extrusion</td>
<td>17</td>
<td>1</td>
<td>81</td>
<td>4</td>
<td>4</td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>Automobile Industry</td>
<td>2</td>
<td>69</td>
<td>71</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferrous metallurgy</td>
<td>3</td>
<td>42</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other processing</td>
<td>1</td>
<td>41</td>
<td>43</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grand total</td>
<td>27</td>
<td>30</td>
<td>7</td>
<td>684</td>
<td>27</td>
<td>11</td>
<td>788</td>
</tr>
</tbody>
</table>

Table 3. Production of plates and sheets from aluminum alloys by leading RF enterprises in 2010

<table>
<thead>
<tr>
<th>Enterprises</th>
<th>Production of plates and sheets in RF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2010, kt</td>
</tr>
<tr>
<td>Alcoa SMZ</td>
<td>145</td>
</tr>
<tr>
<td>KUMZ</td>
<td>60</td>
</tr>
<tr>
<td>BKMPPO/AMR</td>
<td>20</td>
</tr>
<tr>
<td>SMK</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>237</td>
</tr>
</tbody>
</table>
about 70%). Of these, about 140 kt of production is exported and not consumed by domestic enterprises.

At the same time, it should be noted that the metallurgical enterprises in recent years has begun actively invest in the development of the industrial base for the production of rolled products, bringing it closer to the state of the worldwide requirements. One of the first modernization of rolling production began plants of company «Alcoa Rus» (plate production plant AMR in White Kalitva with capacity 22.4 kt per year and ribbon rolling production at Alcoa SMZ). The same path followed Kamensk-Uralsk metallurgical plant, modernizing plate production with production capacities similar AMR and beginning at the present time to implement the following investment project. In the interests of the aviation industry KUMZ implementing a project to build a new hot rolling mill 5000 for the production of plates width 3800-4500 mm, length of 30 m and a production capacity of nearly 166 kt per year.

According to published statements by management of KUMZ in its technical and technological equipment the project of rolling production exceeds the Russian and European analogue. Its implementation will ensure the supply of high quality new for the geometry and nomenclature semi-finished products increase the share of Russian production of the most advanced aluminum and aluminum-lithium alloys to 20% of the total supply semi-finished products for leading aircraft corporations such as Boeing, Airbus and Bombardier.

After lengthy work stoppages at the Krasnoyarsk Metallurgical Plant in March 2013 board of directors En+Group considered a proposal by the company’s management to modify the unfinished rolling complex and commissioned before the end of the year to submit for approval an updated project. Key differences between the updated projects of the previously developed are less capital-intensive in more rapid return on investment and the possibility of a phased implementation.

According to data published in the first phase KraMZ planning to start production aviation plates and components for the aerospace industry in the amount of 60 kt per year. This will be upgraded existing capacity of the plant, put into operation the hot rolling mill, line of milling, quenching treatment unit and other equipment. In the future, based on market demand will be considered the possibility of rolling complex capacity expansion to 250 kt per year and organizing the production of aluminum sheets, can sheet and other products.

In May 2013 adopted an extension program of metallurgical production for Krasnoyarsk region which provides for the establishment in 2016 rolling complex production capacity of 420 kt per year. According to the Industry and Trade Ministry of region the project will cost 16.5 billion rubles.

It is assumed that the project will create the first aluminum rolling production in Siberia in the immediate vicinity, as to the largest aluminum producers, as well as to aircraft. Lower transport costs coupled with the use as feedstock of liquid aluminum of Krasnoyarsk aluminum smelter and lower electricity prices compared to the European part of Russia and the Ural where there are other rolling plants will make products from KraMZ most competitive on the market. The company has already held preliminary talks on the supply of plates to largest aircraft manufacturers.

In fairness it should be noted that the increased use of aluminum alloys is planned not only in aircraft and helicopter construction. For example, in 2006 a group of companies «Volgabus» introduced the first fully low-floor bus with aluminum body series «CityRythm». The appearance of this machine has completely changed the market of passenger vehicles. «CityRythm» set new standards in design, ergonomics, comfort, safety and technical equipment.
«Group GAZ» which is the absolute leader in the segment of light commercial vehicles and in
the segment of buses began increasing the volume of use of aluminum alloys in these vehicles. At the
same time there were samples of vehicles with tanks from rolled aluminum sheet, wagons – hoppers
for grain transportation, discusses the restoration of production hovercrafts, body which are wholly
made of aluminum alloys and other projects.

Despite the progress in the development of domestic machine building projects for the development
of rolling productions carry a certain element of risk. This is due to the fact that on the one hand the
growth rate of domestic consumption market leaves much to be desired, but on the other hand there is
an intense increase production capacity of enterprises in South-East Asia (in the first place China), to
which are increasingly turning domestic consumers of rolled products.

Since it is known that in addition to the presence of existing rolling production facilities in China
the company Northeast Light Alloy Co Ltd (Harbin) ordered the company SMS Demag slab mill
capacity of 300 kt per year. In March 2011, Airbus and its partner EADS have signed with a Chinese
group of Southwest Aluminium contract to supply aluminum plates. The company is certified by
suppliers.

In early 2011, the company Aleris International Inc (headquartered in Beachwood, Ohio, USA)
began construction of the plant for the production of rolled aluminum in Chzhentszyan Jiangsu
Province, China. The company known as Aleris Dingsheng Aluminium (Zhenjiang) Co Ltd, has a
designed capacity 250 kt per year. According to media reports the potential power of the hot rolling
mill puts it on par with the most powerful companies in the world, for example, such as Aleris plant
in Koblenz.

November 4, 2011 the Japanese company Furukawa-Sky Aluminum announced the first phase of
the project to create a new rolling plant in Thailand, under which planned installation and start cold
rolling mill. Board of Directors Furukawa-Sky Aluminum decided a second phase provides for the
purchase and installation of a hot rolling mill. The second phase of the project will start in February
2013 and will be completed in March 2015. The plant’s capacity is expected to grow from 100 kt to 180
kt of rolled aluminum per year. In April 2012 it was reported that Novelis Corporation intends to build
a plant in China to produce aluminum sheets for automobile industry. She signed an agreement on its
construction with the district Changzhou National Hi-Tech administration (near the city of Changzhou,
Jiangsu Province). The company will have a capacity of 120 kt of rolled products per year; it will cost
$ 100 million. The launch is scheduled at the end of 2014.

Given the fact that China and Japan already have plenty of modern rolling production, introduction
of new facilities could create significant competition to domestic producers.

\textit{Foil production.} The total foil production at three plants UC «Rusal», included in the packaging
division, according to the website of the company is around 86 kt per year (Table 4).

In this group the largest enterprise «Sayanal» JSC. It produces more than 40 kt of foil on
the basis of three lines of direct strand reduction rolling. In 2010 mastered the production on an
industrial scale foil with a thickness of 5 microns. In November 2011 together with the established
in the packaging division of «Rusal» the One Technology Center produced the first batch of ultrathin
foil thickness of 4.5 microns. At the moment the equipment «Sayanal» allows to produce a smooth
foil thickness of 4-6 microns, which is used for the production of multi-layer composite packaging
materials for various purposes, condensers, and in other industries. Producing this type of foil is
considered one of the most promising directions in the development of «Sayanal», because it is a product with high added value.

In 2010 «Rusal» announced the completion of complex modernization program of «Armenal». As part of the German company «Achenbach» carried equipment for direct strand reduction rolling, performed a full-scale modernization of blank and foil mills, Aluminium foil and packaging equipment is equipped with means of control and automatic process control. The production capacity of updated company amounted 25 kt of foil. Investment has exceeded $ 70 million. The plant has already reached the planned level of production. Implementation of the program has allowed «Armenal» to start production of thin foil thickness 6-9 microns as the most demanded products in domestic and international markets. The volume of production is 18 kt per year. The design capacity for the production of household foil is 7 kt per year. It is planned that the main sales markets will be Europe and USA.

UC «Rusal» December 2011 announced plans to increase the total production of the packaging division in 2014 to 100 kt per year, which should be around 5,3 % of world production of foil (excluding China). Investment in the project will amount to approximately $ 17 million. The main prerequisite for such a scenario is the projected increase in sales related to the expansion of demand for a thick foil used for container production, and the growth realization foils for industrial products.

The increase in the total production of the packaging division of the company planned due to the modernization of plants for the production of foil and packaging materials:

– at «Sayanal» – from 38 to 42 kt, the investment will be about $ 4 million;
– at «Armenal» – from 26 to 36 kt, the investment – about $ 6 million;
– at «Ural foil» – from 16 to 24 kt per year, the investment – about $ 7 million.

Payback period – 3-4 years.

At «Ural foil» produces about 16 kt of production, the modernization started in March 2012. To 2014 is planned to upgrade the melting-casting and rolling equipment (including mill Quarto 1800). By that time, the share of thin foils with a thickness of 20 microns will increase from 34 to 50 % of the total output, and the hyperfine 9 – micron foil from 14 to 25 %.

Manufacture of cabling-wiring production. Along with the rolling of production which is the basic consumer of aluminum in all industrialized countries, the Russian Federation is very significant

<table>
<thead>
<tr>
<th>Companies</th>
<th>Foil production per year (kt)</th>
<th>Change</th>
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</thead>
</table>
|                | 2011 | 2012 | (%)
| Russia         |      |      |    |
| Sayanal        | 36,372 | 40,666 | + 12 % |
| «Ural foil»    | 17,305 | 16,509 | − 5 % |
| «Sayan foil»   | 2,164  | 2,808  | + 30 % |
| Armenia        |      |      |    |
| Armenal        | 25,313 | 26,263 | + 4 % |
| Total          | 81,154 | 86,246 |
role plays power and cable industry. If the world average, the industry consumes about 5-6 % recycled aluminum, by the end of last year in Russia for the production of wire and cable products directed 29 % of the total aluminum implemented by UC “Rusal” to domestic consumers. A large proportion of this metal has undergone primary processing into rolled wire in aluminum plants, equipped foundry and rolling equipment and the rest on cable plants.

The main materials used for the production of electrical purposes, were commonly used in our country grades of aluminum A5E, A7E and partially alloys AD31E, AVE and others. In this case, according to various experts in recent years, about 40 % of the final product is sent to the construction and power generation, 5-6 % in the fuel industry and petrochemical industry, and the rest – in metallurgy, transportation and other industries.

Based on estimates from the leaders of non-profit partnership «Association «Power cable», which includes virtually all of the major companies of cable areas, the range and quality of their products mainly satisfies all domestic industries, although some products still exist imports. At the same time, several years ago, series of major accidents related to icing of high-voltage power lines, forced domestic power industry draw on the experience of foreign countries on the use of alloys of aluminum – zirconium.

Abroad, these alloys have been widely used as a material for the production of cables and wires in the early 70-ies of the last century. Al-Zr alloy provides performance wire for overhead power lines at temperatures up to 210-250 °C, that not only keeps the load-bearing capacity of lines of power transmission lines, but also opens the possibility for self-cleaning from icing.

In the future, 3M (USA) has developed with the use of aluminum-zirconium alloys, a new cable for high voltage overhead power lines, that is, having a composite core of fiber aluminum oxide is able to transmit two-three times more power than the conventional section of the same cable at the same time improving the mechanical and strength characteristics. Since 2007, 3M Company in a number of regions of the Russian Federation, in particular, in the Kuzbass, successfully implemented the new cables to the domestic power lines, which naturally gave rise to the Russian producers desire for import substitution of the product.

Earliest known work to create domestic analogues alloys of aluminum-zirconium were held by MISA and Kirsinsk cable plant, which, together with Irkutsk cable plant enters the UC «Uncomtech». Given the potentially high demand for the product with the use of aluminum-zirconium alloys and enormity of the task to create a group of new power transmission lines, UC «Rusal» included this theme in the list of promising developments. In summer 2010 there was information about the manufacture of an experimental batch of heat-resistant aluminum alloy in a joint project CJSC «Moscabelmet» and the Moscow Power Engineering Institute. Then UC «Rusal» attracted SFU for implementation the program of work on the organization of the production of wire rod at the Irkutsk aluminum smelter. The technology is based at production wire rod at the suggestion of Siberian specialists put the combined application of the method of casting and rolling-extruding (CCRE), developed by the department «Metal Forming» SFU. Experimental work on this installation started on IrkAZ in the middle of 2012.

Works on development of the rod from aluminum-zirconium alloy were performed on Kandalaksha aluminum smelter. Under the redevelopment of this company in 2011 started the modernization of the foundry department which includes the installation of an additional rolling mill for producing wire
rod. The purpose of the program – to increase production rod is 50.4 kt per year. At the beginning of
the modernization works planned to be completed in 2013. In addition, when discussing options for the
partial conversion of the Bogoslovsk AS UC «Rusal» also decided to establish a modern production of
wire rod capacity of more than 30 kt per year. In 2013 planned to do most of the project works. In 2014
must be made supply and installation of new equipment. And in early 2015 – the conclusion of a new
complex of production wire rod for project capacity.

Opportunity to produce cable products using aluminum-zirconium alloys probably has one of
the leaders of the industry Saransk cable plant included recently in «Sevcable-Holding» (utility model
№97203 – «Bare conductor»). It provides wire rod CJSC «Centrolit» which a few years ago put into
operation modern foundry and rolling equipment purchased abroad.

Most efficiently the task of providing the market with the use of cable products from aluminum-
zirconium alloy decided Russian-Belgian Company «Sim-Russ-Lamifil» that in December 2012 put
into operation production in Uglich, Yaroslavl region. Cable of this manufacturer different in that
the core is made of aluminum-carbon fiber composite material, instead of aluminum-alumina as in
company «3M». At the end of the first quarter of 2013 and reported in the media in Uglich plant began
commercial sale of the product. In the absence of domestic components for the cable industry, the
company imports them from Belgium what determines a sufficiently high value of the product. At the
next stage, the company plans to establish its own foundry-rolling capacity with output wire rod up to
250 kt per year.

Modern equipment for the production of wire rod possesses plant «Secondary metals and alloys»
(Podolsk) which in 2005 put into operation line «Continuus Properzi». The production of this enterprise
is aimed at providing the steel industry by deoxidizer of steel in the form of wire rod, made from scrap
aluminum. However, according to statements made by management of the plant in the short term,
provides for the possibility to manufacture electrotechnical wire rod and wire rod for the production
of self-supporting insulated wires.

Thus, as for the production of flat rolled and cable products at domestic plants there are common
tendencies associated with the building of modern production facilities and development of new
products competitive with similar products of foreign companies.

However, in the first quarter of 2013 according to UC «Rusal» was a decrease in the consumption
aluminum wire rod for more than 17%. This is caused by a shortage in funding by the state investment
programs of power grid complex over the protracted process of reorganization of the Federal Grid
Company and the Interregional Distribution Grid Company, which are the main buyers cable and wire
products.

It is noted that at the same time in almost all areas is increasing import of products from aluminum
alloys since rolling products of China and the EU cables and finishing of high-tech components for
the automotive industry. Therefore, it is expected that in 2013 the production of primary aluminum in
Russia will amount to 3856 million tons, down compared with 4116 million tons in 2012. According to
forecasts, in 2013 the volume of imports of products of deep processing of aluminum will grow from
412 to 450 – 700 kt in terms of aluminum. As a result, the share of imports in total consumption in
Russia could reach 40 % or more.

According to some experts, while maintaining tendency by 2017 imported products of aluminum
is already close to 50 % of Russian needs (up to 600 kt in terms of aluminum). Therefore, along with
the modernization of existing and development of new production of aluminum semi-finished products for the Russian industry to the development of competitive markets, the application of production and the development of measures of state support for domestic producers.