Potassium Xanthate Production, Market and Forecast in the CIS
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ANNOTATION

The report is devoted to investigation of current standing of the market of potassium xanthate in Russia and the CIS and the forecast of its development for the period of up to 2020. The report consists of 6 chapters, contains 90 pages, including 52 Tables, 18 Figures and 2 Appendices.

As information sources, data of the Federal Service of State Statistics of Russia (Rosstat), JSC "Russian Railways" (statistics of rail transport), Federal Customs Service of Russia, the Agency of Statistics of the Republic of Kazakhstan, the UN database were used. In addition, data of the sectoral and regional press, annual and quarterly reports of companies, websites of companies-producers and consumers of potassium xanthate were employed, interviews with representatives of some companies engaged in production of xanthate were conducted.

The first chapter of the report describes the technology of manufacture of potassium xanthate, raw materials for its production and the requirements to the quality of xanthate in Russia.

The second chapter is devoted to the study of the xanthate production in Russia/CIS. The object of the study is potassium butyl xanthate. This section presents data on the release of this reagent. The chapter examines the current state of the main producers of potassium xanthate in Russia.

The third chapter of the report analyzes foreign trade operations in Russia with potassium xanthate. The data on exports and imports of the product in 2005-2011 years are given, the regional structure of the supplies is evaluated. The major exporters and importers of potassium xanthate are identified.

The fourth chapter is devoted to the analysis of the price conjuncture of the market of this product in Russia. This section discusses the dynamics of the export-import prices on potassium xanthate in recent years.

The fifth chapter of the report is devoted to the consumption of the reagent in Russia/CIS, the structure of the domestic market of potassium xanthate is evaluated, the production-consumption balance of the product is given, the dynamics of the "apparent" consumption is outlined.

Also this section analyzes the factors that lead to the demand for the product, the basic end-uses of xanthates are considered.

The sixth, final chapter of the report is devoted to the forecast of production and consumption of potassium xanthate in Russia in 2012-2020. The forecast of consumption of the product, based on an assessment of the development of basic industries that use potassium xanthates, is given.

Appendices present contact information on the main enterprises-producers and consumers of the reagent in Russia/CIS.
INTRODUCTION

Xanthates are representatives of sulphydryl reagents and are derivatives of carbonic acid. Xanthates are stable compounds, pale yellow in color with an unpleasant odor.

Butyl and ethyl xanthates are combustible substances. Their dust-air mixtures are explosive and they belong to the third class of danger. The ignition temperature of dust for butyl xanthate is 565ºC, and for ethyl xanthate - 840ºC. Butyl and ethyl xanthates are toxic and belong to the third class of hazard according to GOST 12.1.007. (moderately hazardous). The maximum allowable concentration of dust of potassium butyl xanthate in the air of industrial premises is 10 mg/m³.

Ethyl potassium xanthate (a potassium salt of ethylxanthogenic acid, potassium O-ethyl-dithiocarbonate) \( \text{C}_3\text{H}_7\text{OS}_2\text{K} \) is a powder from light yellow to grayish color. The molecular weight is 160.3, the melting point is 225-226ºC; the density is 1.558 g/cm³. It is soluble in water and ethanol, insoluble in ether. The mass fraction of the base material is not less than 93%, of the free potassium hydroxide - not more than 0.2%, of volatile compounds - less than 1.5%.

Russian enterprises produced potassium butyl xanthate.

Potassium butyl xanthate (potassium salt of butylxanthogenic acid, potassium O-butyl-dithiocarbonate) \( \text{C}_5\text{H}_{9}\text{OS}_2\text{K} \) is crystals from light gray to yellow in color with a specific odor, with a molecular weight of 188.36. The mass fraction of the base material is not less than 87%, of the free potassium hydroxide - not less than 0.2%, of volatile compounds - no more than 5%. It is soluble in water, ethyl, methyl and butyl alcohol, insoluble in ether and benzene.

Butyl xanthate is prepared by reacting potassium hydroxide with butyl alcohol and carbon disulfide. This product is used as a reagent-collector in the hydrometallurgical industry and in the process of enrichment of non-ferrous and rare metals by flotation. The substance is effective in the flotation of copper and oxidized lead minerals after their sulfidation, and in flotation of all sulfides and native copper.

Very valuable properties xanthates are their complete lack of foaming properties, which allows to use them as selective agents, and the fact that xanthates are not collectors of waste rocks: oxides, silicates, aluminosilicates and salt-alkaline minerals.

Potassium xanthate can also be used in the rubber industry, printing industry, hydro- and electrometallurgy.
I. Technology of production of potassium xanthate and raw materials used

I.1. Methods of production of potassium xanthate

In Russia xanthates are produced by mixing an aqueous solution of an alkali (potassium hydroxide) with an equivalent amount of alcohol (in terms of alkali) and a subsequent addition of carbon disulfide.

\[ 2\text{ROH} + \text{CS}_2 + \text{KOH} = \text{ROC(S)SK} + \text{H}_2\text{O} \]

Russian enterprises can produce butyl, ethyl, amyl, and isopropyl xanthates. The largest amount of xanthate is produced in the form of butyl xanthate (by an estimate of "InfoMine" - 95%).

According to the current technology, the yield of butyl xanthate is 83-86% of the theoretical, and 70-72% is obtained in the form of a crystalline product, and the remainder stays in the mother liquor.

With vacuum evaporation of stock solutions it can be possible to further extract 85% of butyl and 76% of ethyl xanthate, and to partially recover alcohol. Without drying the crystalline product contains up to 15% of moisture, which reduces the storage stability of xanthates.

There is another method to produce potassium xanthate, which consists in treating ethers with carbon disulfide and potassium hydroxide:

\[ (\text{C}_2\text{H}_5)_2\text{O} + 2\text{CS}_2 + 2\text{KOH} = 2\text{C}_2\text{H}_5\text{OC(S)SK} + \text{H}_2\text{O} \]

However, this method is not used by Russian enterprises.
I.2. Raw materials for the production of potassium xanthate

The raw materials for the production of potassium butyl xanthate is carbon disulfide CS₂, butyl alcohol and potassium hydroxide KOH.

One of the main raw materials for the production of potassium butyl xanthate is potassium hydroxide. The manufacture of this product must be carried out according to GOST 9285-78. According to the physical and chemical indicators the quality of potassium hydroxide must meet specifications listed in Table 1.

**Table 1. Requirements for the quality of technical potassium hydroxide (liquid), GOST 9285-78**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Premium grade</th>
<th>First grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Appearance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Mass fraction of alkali recalculated to KOH, %, at least</td>
<td>54,0</td>
<td>52,0</td>
</tr>
<tr>
<td>3. Mass fraction of potassium carbonate, %, at most</td>
<td>0,4</td>
<td>0,8</td>
</tr>
<tr>
<td>4. Mass fraction of chlorides recalculated to Cl, %, at most</td>
<td>0,7</td>
<td>0,8</td>
</tr>
<tr>
<td>5. Mass fraction of sulfates, %, at most</td>
<td>0,03</td>
<td>0,1</td>
</tr>
<tr>
<td>6. Mass fraction of iron, %, at most</td>
<td>0,004</td>
<td>0,01</td>
</tr>
<tr>
<td>7. Mass fraction of potassium hypochlorite, %, at most</td>
<td>0,15</td>
<td>0,3</td>
</tr>
<tr>
<td>8. Mass fraction of silicon, %, at most</td>
<td>0,015</td>
<td>not specified</td>
</tr>
<tr>
<td>9. Mass fraction of sodium recalculated to NaOH, %, at most</td>
<td>1,7</td>
<td>2,0</td>
</tr>
<tr>
<td>10. Mass fraction of calcium, %, at most</td>
<td>0,005</td>
<td>not specified</td>
</tr>
<tr>
<td>11. Mass fraction of aluminum, %, at most</td>
<td>0,003</td>
<td>not specified</td>
</tr>
<tr>
<td>12. Mass fraction of nitrates and nitrites recalculated to nitrogen, %, at most</td>
<td>0,003</td>
<td>not specified</td>
</tr>
</tbody>
</table>

*Indicators for points 8,10,11,12 are specified only for the production of batteries and reagents
Source: FSUE «Standartinform»

The main suppliers of potassium hydroxide to Russian companies-producers of potassium butyl xanthate - JSC «Volzhsky orgsintez» (Volgograd region), JSC «Sredneuralsky copper smelter» (SUMZ) (Sverdlovsk region), JSC «Beraton» (Perm Territory) - are LLC «Soda Khorat» (Perm Territory) and LLC «Polymer Plant of Kirov-Chepetsk Chemical Combine» (Kirov region). In 2009 JSC «SUMZ» purchased this product also from the company Hamoha Corporation (Korea) (Table 2).
Table 2. The main suppliers of potassium hydroxide to Russian companies-producers of potassium butyl xanthate in 2006-2011, ton

<table>
<thead>
<tr>
<th>Producer</th>
<th>Supplier</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* - supplies were carried out also by the transport companies LLC «Cross» (Perm Territory) and LLC «Modul” (St. Petersburg)
Source: «InfoMine» based on statistics of rail transportation in RF

An average consumption of potassium hydroxide to produce 1 ton of potassium butyl xanthate at JSC «SUMZ» is 400 kg, at JSC «Volzhsky Orgsintez» - 580 kg.

The second necessary component for the production of potassium butyl xanthate is butyl alcohol. According to the physical and chemical indicators the quality of butyl alcohol must comply with GOST 5208-81 (Table 3).

Table 3. Requirements for the quality of butyl alcohol (GOST 5208-81)

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chromaticity of butanol on the platinum-cobalt scale, Hazen units, at most</td>
<td>10</td>
</tr>
<tr>
<td>Density of butyl alcohol at 20°C, g/cm³</td>
<td>0.809–0.811</td>
</tr>
<tr>
<td>Mass fraction of butyl alcohol, %, at least</td>
<td>99.4</td>
</tr>
<tr>
<td>Mass fraction of acids recalculated to acetic acid, %, at most</td>
<td>0.003</td>
</tr>
<tr>
<td>Mass fraction of carbonyl compounds recalculated to butyraldehyde, %, at most</td>
<td>0.06</td>
</tr>
<tr>
<td>Mass fraction of nonvolatile residue, %, at most</td>
<td>0.0025</td>
</tr>
<tr>
<td>Mass fraction of water in butyl alcohol, %, at most</td>
<td>0.1</td>
</tr>
<tr>
<td>Bromine number (g of Br per 100 g of alcohol), %, at most</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Source: FSUE «Standartinform»

The main suppliers of butyl alcohol to companies-producers of butyl xanthate in Russia are JSC «Salavatnefteorgsintez» (Republic of Bashkortostan), CJSC «Sibur-Khimprom» (Perm Territory), CJSC «Nevinnomyssk Azot» (Stavropol Territory) (Table 4).
Table 4. Main suppliers of butyl alcohol to Russian enterprises-producers of potassium xanthate in 2006-2011, ton

<table>
<thead>
<tr>
<th>Producer of butyl xanthate</th>
<th>Supplier of butyl alcohol</th>
<th>Delivery volumes of butyl alcohol, ton</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* - the supplies were also carried out by transport companies CJSC «Yukos-Transservice» (Irkutsk region), CJSC PO «Spetstsisterny» (renamed into CJSC «SIBUR-Trans»)

Source: «InfoMine» based on statistics of rail transportation in RF

An average consumption of butyl alcohol to produce 1 ton of butyl xanthate at JSC «SUMZ» is 380 kg, at JSC «Volzhsky Orgsintez» - 440 kg.

For the production of butyl xanthate carbon disulfide is also required. The sole supplier of it to the Russian market is JSC «Volzhsky Orgsintez». Carbon disulfide in the practice may have various names: carbon sulfide, carbon bisulfide. Physical and chemical properties of carbon disulfide must comply with requirements of GOST 19213-73 (see Table 5).

Table 5. Requirements for the quality of carbon disulfide synthetic (GOST 19213-73)

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>clear colorless liquid</td>
</tr>
<tr>
<td>Reaction</td>
<td>neutral</td>
</tr>
<tr>
<td>Content of hydrogen sulfide</td>
<td>absence</td>
</tr>
<tr>
<td>Chromaticity in Hazen units</td>
<td>≤ 20</td>
</tr>
<tr>
<td>Density at 20° C, g/cm³</td>
<td>1,263-1,265</td>
</tr>
<tr>
<td>Index of refraction, Pd 20</td>
<td>1,627-1,629</td>
</tr>
</tbody>
</table>

Source: FSUE «Standartinform»
### Table 6. Delivery volumes of carbon disulfide to Russian enterprises-producers of potassium xanthate in 2006-2011, ton

<table>
<thead>
<tr>
<th>Producer of butyl xanthate</th>
<th>Supplier of carbon bisulfide</th>
<th>Delivery volumes of carbon bisulfide, ton</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: «InfoMine» based on statistics of rail transportation in RF

An average consumption of carbon disulfide to produce 1 ton of butyl xanthate at JSC «SUMZ» is 440 kg.
I.3. Requirements of the industry to the quality of products

The analysis showed that the production of potassium xanthate in the CIS is carried out only at Russian companies.

At JSC «SUMZ» (Sverdlovsk region) butyl xanthate is manufactured according to GOST 7927-75. By physico-chemical indicators, this product must comply with the requirements specified in Table 7.

<table>
<thead>
<tr>
<th>Table 7. Requirements for the quality of potassium xanthate (GOST 7927-75)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicator</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>1. Mass fraction of basic compound, %, at least</td>
</tr>
<tr>
<td>91,5</td>
</tr>
<tr>
<td>2. Mass fraction of free potassium hydroxide, %, at most</td>
</tr>
<tr>
<td>0,1</td>
</tr>
<tr>
<td>3. Mass fraction of volatile substances, %, at most</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>

Note:
1. It is allowed to decrease the mass fraction of the main substance in potassium butyl xanthate of premium grade during the warranty period of storage to 90,5%.
2. Indicator 2 is determined only at the request of the consumer.

Source: FSUE «Standartinform»

The second largest producer of potassium xanthate in Russia is JSC «Volzhsky Orgsintez» (Volgograd region). This company produces potassium butyl xanthate according to technical conditions TU 2452-292-00204168-2000. By physico-chemical parameters potassium butyl xanthate must conform to the standards shown in Table 8.

<table>
<thead>
<tr>
<th>Table 8. Requirements for the quality of potassium butyl xanthate of the production of JSC «Volzhsky Orgsintez» (TU 2452-292-00204168-2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicator</td>
</tr>
<tr>
<td>Mass fraction of the main compound, %</td>
</tr>
<tr>
<td>Appearance</td>
</tr>
<tr>
<td>Mass fraction of volatile substances, %</td>
</tr>
<tr>
<td>Mass fraction of free potassium hydroxide, %</td>
</tr>
</tbody>
</table>

Source: data of the enterprise

Another major manufacturer of potassium butyl xanthate until 2008 was JSC «Beraton» (Perm Territory). The enterprise produced potassium butyl xanthate according to GOST 7927-75.
Butyl potassium xanthate is packed in steel drums for chemical products, plastic bags, special soft disposable containers. The product is transported by all modes of transport. Products is transported by rail in carload or small shipments in covered wagons or in universal containers. The product transported by air only in cargo ships with a mass of one package at most 100 kg.

The product, packed in drums, is transported with the solid slab between layers. Butyl potassium xanthate, packed in special soft containers, is transported in the presence at the consignor (consignee) of specialized lifting devices and with the loading (unloading) on access roads of the enterprise.

Butyl potassium xanthate is stored in manufacturer's packing in closed, cool, well-ventilated warehouses at a distance of 0.5 m from the wall and radiators. In hot climates, storage facilities should be inground or cooled.

Butyl potassium xanthate, packed in special soft containers, is stacked during the storage at most in 2 layers. The guaranteed shelf life is 6 months from the date of manufacture.