Development of standards for industrial control materials to improve quality control of rubbers

M A Efremova and V Sh Sulaberidze
Saint-Petersburg State University of Aerospace Instrumentation, 67, Bolshaya Morskaia str., Saint-Petersburg, 19000, Russia

E-mail: masha-efremova@mail.ru

Abstract. The development of standards for industrial control materials is the basis for improving the quality control of commercially available synthetic rubbers. The presence of such technical standards is important for the formation and implementation of an integrated approach of modern quality control. In developing the standards, international experience was used, adapted to the domestic characteristics of production and technical documentation, which contributes to the development of the industry’s innovative infrastructure, the elimination of technical barriers in the interaction of various industries and the acceleration of the introduction of new types of rubbers. It is shown that such works unite the industry to solve complex problems, contributing to the additional interaction of science and production.

1. International experience in quality control of synthetic rubbers
Consumers of modern mass-produced synthetic rubbers (SR) are many industries. As a consequence of this, the issue of improving the effectiveness of quality control of SR products is relevant.

A specificity of the industry is a mechanism for obtaining compliance characteristics. Its essence lies in the processing of rubber itself by introducing additional components and obtaining vulcanizates, followed by studies of their physical and mechanical characteristics. This is a certain algorithm of action, which is influenced by: the equipment of laboratories, the level of qualification of personnel, not up-to-date technical documentation, the lack of a unified database of verified additional materials, the lack of regulatory documentation governing the development, production, certification and use of these additional materials.

In the international practice of quality control of synthetic rubbers, there is an approach that was formed at the end of the 20th century in the United States of America (USA). It consists in the isolation of additional materials in a separate group [1]. They form special requirements. The quality of these requirements is monitored from batch to batch. These materials are called Industrial Referens Materials (IRM) [2].

The composition of IRM varies depending on the brand of rubbers produced, but it is always present in it: carbon black, zinc oxide, sulfur and stearic acid. The composition, ratio, characteristics of vulcanization are prescribed in the regulatory and technical documentation for each SC. Because in the formulations of Industrial Referens Black (IRB) is from 40 to 60 mass. %, this determined the definition of its allocation from the general list of IRM, because from the quality of this material, the characteristics of the resulting vulcanizates substantially change. The release of IRB each time occurs at different plants in the United States specializing in the production of carbon black, and quality indicators are given in
the maintenance tables. To date, the ninth batch of this material has already been released and is being used. The remaining IRMs are supervised by Akron Rubber Development Laboratory, inc. (ARDL) [3]. ARDL is an independent certified laboratory specializing in rubber, plastic and latex.

Requirements for IRM and IRB are contained in the standards of ASTM D 4122, ASTM D 4678 and ASTM D 5900. These standards were developed under the jurisdiction of ASTM D11 Committee "Rubber and rubber-like materials", ASTM Internaional in 1984, 1986 and 1998, respectively. Over time, these documents were processed, expanded and updated. Currently, there are ASTM D 4122-17, ASTM D 4678-15, and ASTM D 5900-17 [4, 5, 6].

This approach, formed in the United States, has found application worldwide among consumers and manufacturers of SR. However, for many organizations, getting IRM and IRB is a problem. Small companies can not afford to buy these materials abroad – it's too expensive and long. And these materials are needed in sufficient quantity to control the quality of each incoming batch of rubber, i.e. their number used by the organization is large enough.

Another factor complicating the supply of these materials is the political situation in the world. Some Russian enterprises cannot work with American organizations. Access to their market is simply closed.

The same way the problems of high cost, difficulties of orders and a certain “dependence” of our market on us supplies IRM and IRB initiated the beginning of work on the creation of regulatory and technical documentation (TD) and the formation of a database of domestic industrial reference materials.

2. Development of normative and technical documents for industrial control materials

Using the best practices of economically developed countries, in 2018 FSUE "NIISK" together with FSUE "STANDARTINFORM" developed draft national standards: "Rubber and rubber. Materials industrial control. Part 1. General requirements" and "Rubber and rubber. Materials industrial control. Part 2. Technical conditions", regulating the requirements for the production and certification of IRM [7]. In may 2019, the standards were approved [8].

These standards apply to industrial control materials used in quality control of rubbers during their production and testing, including arbitration. They set general requirements for the development of technical documentation for the organization of their production and use, development, testing, acceptance, documentation and use of control materials, as well as requirements for control ingredients and technical carbon used in standard rubber compounding formulations for commercially available rubbers.

Based on international practice and in accordance with the requirements of the newly developed TD, interlaboratory certification tests were planned, organized and conducted using a package of reference materials in 14 laboratories of manufacturers and consumers of the SR.

The tests compared imported and domestic IRM. Domestic control materials were selected according to the developed technical specifications from large, proven in the market factories.

Domestic materials comparison, presented by: industrial control carbon IRB (production of Omsk Carbon Group), zinc oxide (production LLC "Chelyabinsk chemical plant "Oxide") and gray (the production of LLC "Kaspiygaz") [9]. For each material, technical specifications were developed with the establishment of quality indicators in accordance with the developed draft national standards. In accordance with the developed requirements, the first domestic candidate control ingredients were selected from serial production. Imported PCMs were represented by carbon black (IRB-9), zinc oxide (IRM 91), sulfur (IRM 31), stearic acid (IRM 21) and TBBS (LANXESS E.C.).

As the base rubber, in which tests were conducted was used a butadiene-styrene rubber stamps SCS-30 ARC (analogue of SBR-1500, production of The Sterlitamak Petrochemical Plant) and SCMS-30 ARC (production of PJSC “Omsky Kauchuk”). In international practice, only SBR-1500 is used, due to the low prevalence of production and use abroad. But the situation in our country is different. Therefore, it was decided to use the methylstyrol brand of this rubber, for the convenience of the entire industry.

The certification tests were attended by laboratories of various state and private enterprises, manufacturers and consumers of synthetic rubbers: Belshina JSC, LLC "Scientific-research Institute of elastomeric materials and products" (2 laboratories), The Sterlitzamak Petrochemical Plant, Limited
Liability Company center "YARELASTEST", Tula RTI Plant JSC, SIBUR Tolyatti LLC, Omsk Rubber JSC, Kurskrezinotekhnika JSC, Voronezhsintekauchuk JSC, FSUE "NIIISR" and Voronezh Branch of FSUE "NIIISR", Balakovrezinotekhnika JSC, Nizhnekamskneftekhim JSC [10].

To obtain objective data, the rubber compounds were vulcanized in 2 plates at a temperature of 145 °C for 35 and 50 minutes. Five blades were cut from the obtained plates (the total number of samples was 10) and tested according to GOST 270. An array of data on two rubbers using imported and domestic materials made it possible to carry out a metrological calculation of the values [11].

The main purpose of interlaboratory tests is to establish the basic strength parameters of the properties of rubbers on the basis of rubbers SCS-30 ARC and SCMS-30 ARC, as well as a comparison of the obtained indicators using the domestic package of control ingredients and carbon black with imported. The results were included in the Certificate on PCM, the form of which is set in GOST R "Rubber. Materials industrial control. Part 1. General requirements». These data will guide consumers and manufacturers of these types of rubbers in the course of input and output control, arbitration, in controversial issues in determining the quality of products in the SR industry.

Carrying out and coordination of all work took over FSUE "NIISK", which is the base of the Subcommittee on standardization CS № 5 "Rubbers and latexes" technical Committee TC 160 "petrochemical complex Products" [12]. Uniting all interested parties and contributing to more operational work, the institute developed the Test Program and provided all participants with materials.

Based on the test results, a meeting of CS № 5 was held and the data obtained were discussed.

3. Result of work
In the course of the work the following results were obtained:

- Developed GOST R "Rubber and rubber. Materials industrial control. Part 1. General requirements" and GOST R "Rubber and rubber. Materials industrial control. Part 2. Technical conditions».
- The first pilot batch of PCTM was produced and certified, the quality is not inferior to imported technical carbon IRB.
- Formed and certified package the domestic industrial reference materials for rubbers SKS-30 ark and SKMS-30 ark, tested in 14 laboratories of manufacturers and consumers of the SR.

The work also showed the possibility of combining industry institutes and the synthetic rubber industry to solve complex problems. Such cooperation helps the development of science in the field of UK, industry and the economy as a whole. Identify further ways of interaction and form a new infrastructure for our country to control the quality of synthetic rubbers.

4. Further perspectives
In the future, work is planned to create a complete set of IRM, namely: the resumption of production of domestic control stearic acid, naphthenic oil, accelerators and other ingredients.

The development of a system of industrial control materials contributes to the unification of quality control of commercially available rubbers. This helps to resolve disagreements between producers and consumers of insurance companies, and also promotes trade cooperation between countries. Thus, developing the national strategic goals of the Russian Federation [13].

References
[1] Grishin B S 2010 Materials of the rubber industry part 1 (Kazan: KSTU) p 506
[2] Grishin B S 2010 Materials of the rubber industry part 2 (Kazan: KSTU) p 488
[3] Lyusova L R, Naumova Yu A and Bukhina M J 2016 To the history of the rubber industry J. Kauchuk i Rezina 6 56-8
[4] Lomakin M, Dokukin and Budkin Yu, O. P and Balvanovich A 2019 Modern stage of improvement of fundamental standards J. Standards and Quality 3 8-12
[5] Tarasyev Yu, Dunaevsky C and Venediktov T 2018 Standards development practice J. Standards and Quality 4 21-6

[6] Papkov V N, Rivin E M and Blinov E V 2015 Styrene butadiene rubbers. Synthesis and Properties (Voronezh: Voronezh State University) p 315

[7] Boreiko N P, Tkachenko G T and Efremova M A 2017 Ways to solve the problems of ensuring quality control of SR products at the international level J. Kauchuk i Rezina 2 96-7

[8] Hartonova R S, Boreiko N P, Gerasimova I L and Tsypkina I M 2016 Coordination of efforts of producers and consumers of SR is the key to high quality products. About the activities of technical committees J. Kauchuk i Rezina 6 44-5

[9] Azarenkov B, Mozgalev B, Nefedova And and Peregodov C 2018 On the formation of regulatory documents. Interconnection of general technical requirements with the requirements of metrology and standardization Standards and Quality 12 8-12

[10] Efremova M A, Boreiko N P, Khartyunova R S and Sulaberidze V Sh 2019 Synthetic rubbers: to quality through standardization J. Standards and Quality 7 56-7

[11] Sulaberidze VS 2013 Methods of analysis and processing of measured values of values (St. Petersburg: BSTU) p 122

[12] Sokolov C 2019 How to evaluate and regulate the work of the TC on standardization J. Standards and Quality 4 22-7

[13] Shalaev A and Sirotkin R 2018 Standardization tools in the implementation of priority development directions J. Standards and Quality 10 20-3