

ENERGY SAVING

7.3. New sealing and fire-proof materials for power enterprises

7.3.1. Basic requirements for the sealing materials and products used in electric power industry and their comparison characteristics

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Reliability and security (including the environmental aspect) of equipment, operating under excessive pressure, depend substantially on the faultiness of seals and their different joints. Under conditions of general production automation, the especially important objective is the provision of sealing and reliable operation of executive and adjusting devices (for TPPs it concerns, first of all, the stop and control valves). Occurrence of vaporizations, flows, decapsulation of joints can result in equipment failure, emission of toxic and harmful substances, forced standstills of high-value equipment, for which one hour of downtime could cost hundreds and millions rubles.

In this connection the main requirements that are made for the sealing pieces can be stated in the following way:

- provision of leak-proofness during the total service life (as a rule, more than the overhaul period of basic unit) in the wide temperature and pressure range;

- possibility of long-term storage of sealing product without losing its physical-chemical and mechanical properties;

- possibility of long-term storage and transportation of sealing joints bodily without the risk of their corrosion.

In connection with the above mentioned requirements, the sealing materials, used for manufacturing the sealing pieces, must correspond to the following requirements:

- provide the reliable leak-proofness of sealed connection during its operation without additional overhaul service;

- possess the stability against wear and ejection of sealing material;

- no to result in corrosion in sealed surfaces;

- have a high durability to burning under thermal effect during the operation in the specified temperature range;

- no to have the substantial mechanical impact on the sealed element (rod, spindle or shaft), resulting in its wear and appearance of scorings or burrs on it;

- have a low friction ratio as well as the reduction of electricity consumption for auxiliaries in the process of operation and load on the rod of attachment;

- possess a high capability to the destruction in the medium of usual atmospheric air, water steam, water, acids, alkali and salts solution and to the combined effect of medium, pressure and temperature;

- possess the plasticity, due to which the sealing material fills all proximities of joint faces during the connections assembly and their clamping;

- keep elasticity during the cyclical fluctuations of working medium pressure and temperature and thereby to provide the power contact with the surfaces of flanges (to compensate their relocations), which is necessary for leak-proofness ;

- have a low thermal-expansion coefficient for preventing the self-sealing in the process of maintenance with cyclic temperature change;

- not to change the above mentioned chemical-physical and mechanical characteristics in the process of maintenance, i.e. to keep the durability;

- possess the environmental safety, not to impact on personnel working with material.

Availability (an absence of lack) of such materials is as well of significant importance.

At present there is no material, which completely corresponds to all the mentioned requirements. The materials presented in table 7.1 are currently used for manufacturing the sealing pieces depending on the operating conditions.

Table 7.1. Sealing materials

Class	Material
Natural	Asbestos, cotton, flax, hemp, ramie
Synthetic	Polyamids (SVN, kevlar); PTFE (teflon's)
High-temperature	Glass fiber, ceramics, carbon fiber, graphite

A comparison of the main characteristics of sealing materials used in electric power industry and other industries is presented in table 7.2.

The fillings of marks AG, AGI, AS, AFT, AP, APR and others were most widely used at the Russian TPPs up to date. The asbestos is the main component of these stuffing. The compression rings of mark AG-50 containing 50 % of graphite, 45 % of asbestos and 5 % of aluminum powder were used more often for sealing the rods of high-pressure accessories. These rings have the sufficiently good sealing properties, however they promote to the active development of corrosion processes during storage, transportation and long equipment downtime. Therefore, these sealing elements are delivered, as a rule, in the form of spare sets separately from the basic equipment. Setting of the sealings is carried out only at equipment mounting at the site.

The negative consequences caused by many years' extensive application of traditional sealings (paronite, asbestos packing, asbestos-and-steel plates and gaskets) are well known. In conditions of variable thermal and dynamic loads the asbestos-containing sealing materials relax (that results in the decapsulation of connections because of the reduced degree of compression), and their constant padding is required.

The loss of asbestos-containing packing demands the large initial volume that results in increasing the sizes of sealing assembly, overall dimensions and steel intensity of main unit (accessories, pump etc.).

The analysis of material characteristics, presented in table 7, shows that the products made of polytetrafluoroethylene (PTFE) have the low friction ratio and plasticity, don't cause the corrosion, are practically inert in all media, however have the sufficiently small upper temperature boundary for application ($t_{\max}=+260$ °C). In addition, the products from usual PTFE (polytetrafluoroethylene) possess the raised curv rate even under not high temperatures that restrain rigidly the gaps between rod and housing in comparison with other materials (tolerances for polytetrafluoroethylene – by classes H9/d9, for other materials - H11/d11).

It should be added hereto that the materials, based on PTFE with the changed spatial pattern or so-called expanded PTFE, appeared currently. The best samples of these materials produced by company GORE (USA) have practically no

«cold» flow. However, a high price and sufficiently high upper boundary of temperature application restrain the wide application of these materials.

The sealing products made of polyamide and carbon fibers are mainly used for manufacturing the braided packing. The advantage of such packing is the high strength of fibers that allows using them for sealing the glands of pumps working in the crystallizable media and the media with content of abrasive materials (pulp etc.). The low elasticity of these materials and insufficient plasticity don't allow using them widely for sealing the gland assembly of accessories rods.

As one can see from table 7.2, the sealing materials from thermoexpanded graphite correspond more to the basic requirements. Therefore, they were widely used in the conditions of maintenance under high pressures and temperatures. The additional advantage of seals from TEG is a possibility to manufacture all types of sealing products: gland rings, braided packing, gaskets.

The more detailed characteristics and conditions of application for the products made of TEG will be presented further as applied to TEG of mark "Graphlex" produced by SPA "Unikhimtek".

Table 7.2. Main characteristics of sealing materials

Item	Asbestos (AG-50)	TEG*	Aramid fiber	Carbon fiber	PTFE
Density, g/cm ³	2.25	1... 1.6	1...2	1... 1.6	1.3...1.8
Temperature of application, °C	400	from -196 to +450 (3000)	280	+240...+500	from -200 to +260
Thermal conductivity, W/(m·K)	0/03	3...150	0,32	3	0,24 (1/14)**
Chemical stability, pH	3...12	1...14	2...13	1...14	0...14
Plasticity	Not plastic	Plastic	Not plastic	Not plastic	Not plastic
Elastic deformations, %	1.5...3.5	10...15	2...3.3	2...3.5	1.4... 3
Friction ratio on steel	0.37	0.02...0.12	0.3	0.20	0.,02... 0.04
Corrosion effect	Doesn't cause the corrosion	Doesn't practically cause the corrosion	Doesn't practically cause the corrosion	Doesn't practically cause the corrosion	Doesn't cause the corrosion

* TEG — thermoexpanded graphite

** For graphite-filled teflon