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TRANSLATION

FAOLITE FOR ANTI-CORROSION PROTECTION

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FAOLITE FOR ANTI-CORROSION PROTECTION

L. Schwartz

In the specialized literature on corrosion-resistant plastics we find, under various commercial names, such as Faolite (USSR, CSR), Haveg (GERMAN FEDERAL REPUBLIC, U.S.A.), Keebush (GR. BRITAIN), etc., an interesting product with these qualities:

- remarkable chemical resistance to nonoxidizing acids, and in some products to alkalis too;
- relatively high thermal resistance (150°C);
- relatively low specific gravity (1.4-1.7);
- easy processing, etc.

All these qualities have led, in the last decades, to its increasing use, since the new synthetic resins that have made their appearance have permitted the manufacture of this product in a variety of assortments. (At the Gotwaldow Research Institute, Prague, more than 20 qualities of faolite were obtained [5]).

From the viewpoint of composition, the material consists of the following elements: a resin (phenolic, furanic, etc.), asbestos (anthophyllite, chrysolite), graphite, or sand. By varying these elements quantitatively or qualitatively, it is possible to obtain products with qualities suitable to the purpose one has in mind (mechanical strength, thermal conductivity, etc.).

The technological process of faolite manufacture (we shall retain this designation) can be described broadly as follows: into a mixer of the Werner-Pfeiderer type (preferably), the resin, heated to

60-70°C, is put first, and then the filler (asbestos, graphite, etc.) is added gradually. This mass is then mixed for a certain time, after which it is taken out of the mixer and calendered in order to increase its uniformity and to remove part of the volatile substances. The resulting material is cut into sheets, which will have a crumpled surface. The cold rolling that follows immediately has the purpose of finishing these sheets from the viewpoint of appearance and thickness. The raw plastic sheets that are thus obtained can be used, after a period of aging, to coat apparatus.

This is followed by hot polymerization for the purpose of bringing the resin in question into the insoluble and infusible state. The polymerization diagram has a duration of 30 hours, and the temperature range is between 60° and 130°C.

The calendering operation is necessary only for the fabrication of sheets.

The Use of Faolite in the Manufacture of Parts and Apparatus

The use of faolite in the manufacture of parts and apparatus is based on the following properties of this material:

- raw faolite can easily be cut with a knife, and when hot it can easily be molded at a relatively low pressure; thus, a monolithic object is obtained which retains its shape when it hardens;

- hardened faolite can undergo any mechanical working process (cutting, lathing, polishing);

- hardened faolite parts can be joined by means of faolite cement, and the resulting seam is quite strong and tight.

Faolite can be used for the manufacture of a variety of apparatus, such as: tanks, reagent vessels, wash towers, rectifying and absorption columns, filters, pickling bath vessels, crystallization vessels, reflux condensers, parts for pumps and fans, pipes and fittings, valves,

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etc. [1, 2].

The method of fabricating faolite parts and apparatus depends on their shape and purpose. Thus, tubes with diameters up to 100 mm are made with a worm press by compressing faolite heated to 50-60°C (transferred from the rollers). Faolite tubes with diameters of 150-200 mm and more, and also cylindrical apparatus, are manufactured from raw sheets, with the aid of metallic or wooden molds.

Apparatus that has rectangular shapes (bath vessels, crystallization vessels, etc.), is made of hardened faolite sheets. For this purpose, the raw sheets, calendered to the required thickness, are tailored to the needed sizes and undergo heat treatment for hardening.

Taps, valves, etc., are manufactured – in mass production – by the method of pressing in knock-apart molds. After pressing, the object is placed in an oven for the purpose of polymerization; here the material is hardened at 160-180°C for about 3 to 6 hours (depending on the thickness of the object).

Steel and cast-iron apparatus is lined with faolite sheet cut in such a manner that the surface area of each piece does not exceed 0.5 m^2. The sheet is preheated, then a coat of varnish is applied to it (phenolic, furanic, etc.), after which it is pressed to the appropriate metal surface, which has also been varnished and smoothed. Then follows the polymerization of the material and the application of 1 to 3 coats of varnish.

Apparatus made of faolite is used extensively in many chemical plants, since the experience accumulated over the years shows that it is especially valuable as a structural material that resists various aggressive media. Of course, this resistance is conditioned, first of all, by the nature of the resin that enters into the product's composition, then by the quality of the filler. But all varieties of faolite show resistance to nonoxidizing acids.

But faolite should not be employed with the following media: acetone, aniline, nitric acid, highly concentrated chromic acid, sulfuric acid having a concentration of more than 90%, benzene, phenol, sodium sulfide, carbon disulfide, etc.

Based on the experimental data given in the specialized literature [1, 5, 6] regarding faolite products that have shown good applicational results, we shall mention the following: pressure tanks (maximum 1.8 kg/cm^2) with a maximum length of 4,500 mm and maximum diameter of 1,560 mm, manufactured in the USSR; standardized cylindrical tanks in USA, with diameters of 300-3,000 mm; separators for hydrochloric acid; 28-m^3 vertical towers; a smokestack 61 m high, with a diameter of 1,500 mm, put together from 12 parts, with metal flanges; cooling towers; galvanizing or pickling vats; the whole equipment of a plant for the production of magnesium oxide from sea water, etc.

Work Done at the "Anticoroziv" Enterprise

The lack of a plastic material to resist corrosion at temperatures above 100°C led to the initiation of work for the fabrication of faolite by the above-mentioned enterprise. The technological process was adapted to the raw material available, and to the existing technical possibilities within the enterprise at the time when the work was undertaken.

This is what was used: phenolic resin supplied by the "13 September" factory, asbestos of the chrysolite type imported from the USSR, and graphite powder, which was waste material resulting from the processing of graphite electrodes. In order to eliminate the soluble substances, the asbestos was first treated with 10% hydrochloric acid for 24 hours and then washed until the acid was completely removed.

Two types of faolite were fabricated:

Type 1 - faolite without graphite, with higher mechanical strength.

Type 2 - faolite with graphite, with better thermal conductivity.

The phenolic resin was mixed with the filler in a Werner-Pfleiderer mixing machine; then the mass was processed at 70-90°C. The sheets were cold-rolled. Sheets were obtained with a thickness of 8 to 10 mm and a surface area of 0.25-0.40 m^2. These sheets were used to give anti-corrosive protection to certain equipment; but first, certain physicomechanical characteristics of the product were established. These characteristics are given in Table 1, and compared to similar foreign products [7].

TABLE 1

Physicomechanical Properties of Some Varieties of Faolite

1 Proprietăţile fizico-mecanice / U/M	2 Sortul de faolit				
	3 Faolit U.R.S.S.	4 Faolit R.S.C. cu grafit	5 Haveg 43 cu grafit S.U.A., R.F.G.	6 Keebush Anglia	7 Faolit „Anticoroziv" cu grafit
8 Greutatea specifică	1,54–1,70	1,4–1,6	1,6	1,6	1,5–1,6
9 Rezistenţa la tracţiune, kg/cm²	150–330	265	175	175	210–320
10 Rezistenţa la compresiune, kg/cm²	500–900	1 140	560	740	900–1 100
11 Rezistenţa la încovoiere, kg/cm²	300–600	700	320	190	460–540
12 Conductibilitatea termică, kcal/mh°C	0,3–0,4	0,7	0,915	0,31	0,9
13 Stabilitatea termică, °C	110–140	150	150	130	140
14 Absorbţia apă, %	–	–	–	–	< 1

1) Physicomechanical properties; 2) variety of faolite; 3) USSR faolite; 4) faolite with graphite, from the CSR; 5) Haveg 43 with graphite, United States, German Fed. Rep.; 6) Keebush, England; 7) faolite with with graphite produced by "Anticoroziv;" 8) specific gravity; 9) tensile strength, kg/cm^2; 10) compressive strength, kg/cm^2; 11) bending strength, kg/cm^2; 12) thermal conductivity, kcal/mh°C; 13) thermal stability, °C; 14) water absorption, %.

Determination of the Product's Chemical Resistance

The determination of faolite's resistance to corrosion has been the object of special studies by some researchers [8, 9]. The method adopted was that of Dolezal and Mojzis, because it also makes possible a comparison with products manufactured of foreign faolite, from the viewpoint of chemical resistance.

Corrosion tests were made with samples of Type 2 faolite (with graphite) in the size 8 X 30 X 80 mm. The samples were put in bottles with ground stoppers, containing the aggressive medium at the temperature of the surroundings. Two samples were used for each medium. The duration of the test was 90 days. At the end of the test, the samples were rinsed with distilled water and dried with filter paper. After that, the changes in weight, size and appearance were noted. An evaluation was also made of the changes that had occurred in the appearance of the medium.

<u>Manner of interpretation</u>. The interpretation of the test results has two main aspects:

1. Evaluation of the changes in the appearance of the medium (color change, sediments).

2. Evaluation of the changes undergone by the material (appearance, change in weight, volume change).

TABLE 2

Evaluation of Faclite's Resistance to Corrosion

Valoarea coeficientului K 1	Rezistența la coroziune 2	Observații 3
91—100	0	Material complet rezistent. Durata minimă de utilizare 10 ani. 4
81—91	1	Material utilizabil în mod curent. Durata minimă de utilizare 6 ani. 5
75—81	2	Material utilizabil în majoritatea cazurilor. Durata minimă de utilizare 2—3 ani. 6
8 sub 75	3	Material inutilizabil. 7

1) Value of the coefficient K; 2) resistance to corrosion; 3) observations; 4) fully resistant material, minimum service life: 10 years; 5) material currently usable, minimum service life: 6 years; 6) material usable in most cases, minimum service life: 2-3 years; 7) unusable material; 8) below 75.

Each change is expressed by a rating (from 1 to 10), which goes up with the rate of the change. The final result is given by a coefficient K, which is obtained by subtracting from the factor 100 the sum of the scores characterizing each change.

The determination of faolite's resistance to corrosion and of its utility in the experimental medium was made according to Table 2.

The evaluation of the service life was made on the basis of practical data resulting from the performance of faolite equipment in actual use. This is the basis of the results shown in Table 3, obtained from tests with the purpose of determining the chemical resistance of processed faolite.

Experimental use of faolite. In order to establish under what conditions the processed faolite can be used, and to check its performance in use, a few parts and some equipment were manufactured for some enterprises. Thus, two heating coils, one agitator with blades, and a lid for an autoclave with a diameter of 1500 mm were manufactured for the "Icechim" plant. The coils were made of OL steel protected with type 2 faolite, and the lid was covered with type 1 faolite. The same material was used for the agitator too, but two layers of glass cloth were inserted as reinforcement.

The above components underwent experimentation for one year, in a medium of hydrochloric acid and ferric chloride, at a temperature of 110-120°C. After this period it became possible to reach the conclusion that the material offers good resistance to this form of chemical attack.

A lead coil that had been used previously corroded very rapidly and required frequent replacement. From the standpoint of thermal conductivity, however, it was necessary to increase the heating area of the faolite-coated coil in order to reach the same temperature in a time roughly equal to that observed with the lead coil.

A 60-liter faolite-coated autoclave was made for the "Reactivul" Enterprise and used for two weeks; during that time, oxalic acid, zinc thiocyanate and zinc chloride were prepared at temperatures up to 120°C. The purity of the reagents obtained met specifications, thus confirming the material's resistance to corrosion. However, a crack appeared in the faolite layer, so that the vessel could not be used after that.

Two larger faolited autoclaves (200-300 liters), which are now undergoing testing, have also been manufactured for the same plant.

A coil of larger size, for the "Solex" plant, was given a protective coat of faolite for heating a stronger acid; it is now being tested.

Ten 1" valves were fabricated from rolled Type I Faolite and sent for testing to the chemical plant "Nicolae Teclu" and to the Petrochemical Plant No. 2, etc. At the "Nicolae Teclu" plant the valves were used as gating mechanisms to meter 50% sulfuric acid in the installation producing acetone cyanohydrin; these valves have been in use for approximately 7 months, and during that period their performance has been good, from the viewpoint of both operation and metering, and chemical and mechanical resistance.

TABLE 3

Evaluation of Tests to Determine Corrosion Resistance of Faolites

Mediul de reacție [1]	Concentrația, % [2]	Temperatura, °C [3]	Coeficientul K [4]: Material R.S.C. [5]	Coeficientul K [4]: Material «Anticoroziv» [6]	Rezistența la coroziune [7]: Material R.S.C. [5]	Rezistența la coroziune [7]: Material «Anticoroziv» [6]
Acid sulfuric	20	20	98	96	●	●
Acid sulfuric [7]	70	20	100	92	●	●
Acid clorhidric	20	20	96	96	●	●
Acid clorhidric [8]	30	20	94	96	●	●
Acid azotic [9]	10	20	96	90	●	1
Amoniac	15	20	92	90	●	1
Hidroxid de sodiu [10]	10	20	–	60	–	3

1) Reaction medium; 2) concentration, %; 3) temperature, °C; 4) coefficient K; 5) CSR [Czech] material; 6) "Anticoroziv" material; 7) hydrochloric acid; 8) nitric acid; 9) ammonia; 10) sodium hydroxide.

There have also been attempts to faolite-line metallic valves, e.g., a tap coated on the inside with a 3-4 mm layer of faolite. It was thus possible to evaluate the qualities of faolite from the viewpoint of processing.

Conclusions

The work described represents a modest beginning in the fabrication and use of faolite in our country. At the present time, efforts are being increased for the purpose of perfecting the technological process for the fabrication and use of the material.

Simultaneously, research is being pursued for producing faolite with furanic resins. The data furnished by use testing of the equipment experimented with will permit the continuous improvement of the product, which has real value in anti-corrosion efforts.

"Anticoroziv" Enterprise

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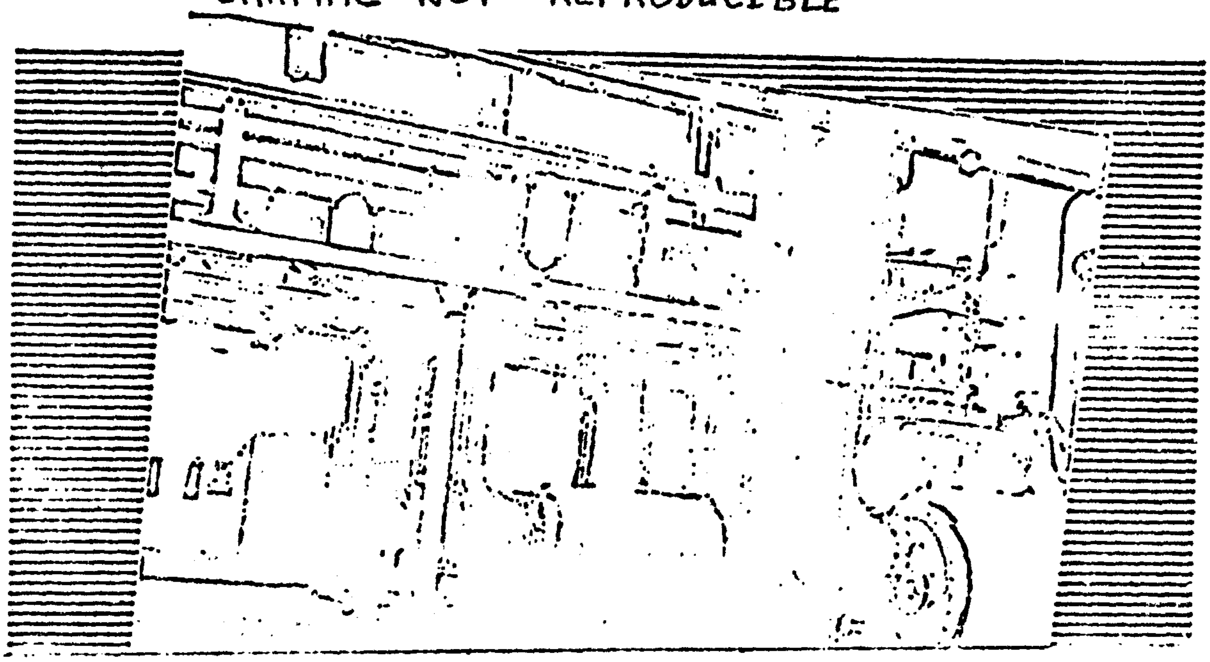

Fig. 1. A scene at the "Solventul" factory, Timisoara.

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