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Approved by:

**Deputy Director General
of VNII Neftemash**

_____ **V.A. Emelkina**

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Agreed upon:

**Director General
of ZAO Energometall**

_____ **V.S. Vakin**

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**FOR BIMETAL PLATES
FOR CHEMICAL ENGINEERING APPLICATION**

**STANDARD SPECIFICATION
TU 1880-002-15190236-2011**

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This specification covers the bimetal plates for chemical and petrochemical engineering application (hereinafter, plates), meant for production of components of heat exchangers and air coolers, reactors, columns and vessels for chemical and petrochemical engineering application.

The plates are produced by the two ply method of explosion welding, where the base metal is a rolled product, as well as flat forgings of carbon or low-alloyed or alloyed steel and the cladding layer is of corrosion resistant steel, nickel or copper alloys.

Ordering information and designation code

When making an order the customer should specify to the manufacturer the following information:

- scope of supply;
- the steel grade of the base metal;
- the steel or nickel or copper alloy grade of the cladding metal;
- nominal dimensions (thickness of the base and cladding metal, length and width) of the clad plates;
- tolerated thickness variations of the base and cladding metal;
- mechanical properties and impact strength of the base metal;
- class (level) of bond integrity between the layers;
- as-delivered conditions and additional kinds of treatment;
- finish quality of the cladding metal;
- conditions of heat-treatment performed after explosion, or a note if heat-treatment must not be performed;
- other additional requirements (if necessary, a sketch of an article must be submitted);
- specification and norms for bond integrity control and homogeneity of a cladding metal (methods of Ultrasonic control, liquid-penetrant test, X-ray control, etc.);
- the size and integrity of the zone of detonation initiation point;
- other specifications and norms for determination of bond quality, if they are not indicated in this specification.

1.2. Example:

The bimetal plate in 40 mm thick, thickness of a cladding layer 3 mm, width 1500 mm and length 6000 mm, in combination of steel 09G2S category 17 according to GOST 5520 as a base metal, and corrosion resistant steel grade 08Cr18Ni10Ti according to GOST 5632-72 as a cladding metal, bond integrity of class 1 according to GOST 22727:

Bimetal plate **40(37+3) x 1500 x 6000 TU 1880-002-15190236-2011**

(09G2S17 + 08H18N10T)-cl.1

For the complete list of all norms and standards indicated in this specifications see Annex A

1 Technical requirements

The bimetal plates for chemical and petrochemical engineering application must conform this standard specification and other technological documentation, approved by a prescribed procedure.

1.1 RANGE OF SIZES

1.1.1 The bimetal plates are rectangular plates in thickness of 10 to 320 mm, width of 300 to 5000 mm, and length of 500 to 10000 mm. It is the customer who specifies the sizes, according to which the acceptance will be done, and who specifies, if edge cut after welding is needed, the acceptable kind of cutting (plasma, gas, mechanical, water-abrasive), tolerance for machining, preparation of edges for welding.

The bimetal plates can be furnished in other types of configuration (different from a rectangular type) by an agreement with the Customer.

Overall dimensions of each bimetal plate in a lot are specified in the order.

1.1.2. The thickness of the cladding layer can be from 2 up to 15 mm.

1.2 Main parameters and characteristics

1.2.1 The requirements to mechanical properties of plates

1.2.1.1 The base metal must meet the requirements of GOST 5520, GOST 8479 or of ASTM A516, ASTM A387, ASTM A105, ASTM A182, ASTM A336, EN10028-2, EN10028-3, and EN10222-3.

1.2.1.2 . The mechanical properties of the cladding metal must correspond to the performance specification and specified in the certificate. On Customer's request all corrosion-resistant cladding-steel undergo intercrystalline corrosion test with results recorded in the test-certificate.

1.2.1.3 The mechanical properties of plates must meet this specification and other standard requirements, accepted by the Customer and stipulated in the order, including GOST 10885, ASTM A263, A264, A265, and EN 13445-2. In case of a reference to another standard a standard for tests should be also agreed including number and shape of specimens and sampling locations.

1.2.1.4 The shear strength while determination of the bond quality must be at least 220 MPa.

1.2.1.5 The delaminating strength while separation of the cladding metal from the base metal must be at least 260 MPa for corrosion resistant steel and at least 220 MPa for copper and nickel alloyed steel.

1.2.1.6 The strength of bond can be defined by the cold bend test performed with the angle of 160 degrees with the cladding layer in compression. Bending of the sample must not show the separation of the cladding metal from the base metal and visible cracks in the contact zone of the bonded layers.

1.2.1.7 The bimetal plates are produced heat-treated for stress relief. The type and mode of thermal

treatment are specified by the Manufacturer. The recommended modes of heat treatment are in the range of temperatures from 420 °C up to maximal 720 °C, holding time at the specified temperature is 1 to 4 hours. The heat treatment schedule can be attached to the certificate for the bimetal plate by agreement with the Customer.

The recommended modes of heat treatment are shown in Table 1:

Table 1

Cladding steel/alloy	Temperature, °C	Holding time, hours	Rate heating/cooling, not faster °C/hour
Austenitic steel	560 - 920	1 - 3	90
Ferritic steel	620 - 920	1 - 3	90
Nickel alloy	610 - 720	2 - 4	90
Copper alloy	420 - 520	1 - 2	90

The bimetal plates can be furnished without heat-treatment as agreed upon with the Customer.

1.2.2. Bond integrity

1.2.2.1 Continuity and integrity of bond between the layers in the bimetal plate must correspond to the classification according to the standard specification GOST 22727 and as shown in Table 2:

Table 2

Class of plate	Total unbounded area, cm ²	
	to be considered, min	tolerated, max
01	as agreed with the Customer	
0	5	20
1	10	50

The Customer can stipulate the more restrictive requirements in the certain case and choose another standard specification for the bond quality inspection, in particular according to ASTM A578/578M-07, EN10160.

1.2.3. Surface finishing

1.2.3.1. The plate surface at the cladding layer side should meet the following conditions:

- without conditioning;
- sandblast cleaned;
- grinded;
- vacuum-arc cleaned (patent RF no.2133274).

1.2.3.2 Condition of the plate surface after explosion welding and sandblast cleaning:

- any blisters, pockets, scab, cracks or grubs on the plate surface are not permissible.

1.2.3.3 Condition of the plate surface after mechanical grinding and vacuum-arc treatment:

- surface roughness must be Ra 3,2 according to GOST 2789.

1.2.4. Over-all dimensions

1.2.4.1. In case the bimetal plate is furnished with edges uncut, it is tolerated to have some spalls in the cladding metal but not deeper than 10 mm from the edge of the base metal, as well as some edge delaminations of cladding and base metal but not deeper than 20 mm.

1.2.4.2. Tolerated deviations of thickness, width and length of the bimetal plates must correspond to the normal accuracy of rolled material according to the standard GOST 19903 or GOST 10885 and Table 3. Other standard specifications or special tolerances can be applied upon the Customer's request. Tolerated deviation must be specified in the order.

Table 3

Thickness of bimetal plate, mm	Tolerated deviation, mm	Thickness of bimetal plate, mm	Tolerated deviation, mm
10	±0.9	30,32	±1.8
11	±1.0	34,36	±1.9
12,13,14	±1.1	38,40	±2.0
15,16,17	±1.2	42	±2.1
18,19	±1.3	45	±2.2
20,21,22	±1.4	48	±2.3
24,25	±1.5	50,52	±2.4
26	±1.6	55,60	±2.5
28	±1.7	over 60	±2.8
		over 120	±3.0

1.2.4.3. In order to fulfill the order, the Manufacturer uses the initial material within the standard range of sizes, if not otherwise indicated. If the size prescribed in the order is out of the standard range, the Manufacturer uses the nearest maximum standard size. The cladding layer is always taken with the positive tolerance, if otherwise is not indicated in the order.

1.2.4.4. Deviation of flatness for the bimetal plates must not exceed 5 mm per 1 meter length. Other deviations of flatness are available by an agreement with the Customer, in particular according to EN 10029.

1.3 Materials requirements

1.3.1 All material used for the plate manufacturing should meet the materials technical standards and provide production of items according to the specifications.

Materials used for the plates manufacturing should have manufacturer's quality certificates.

1.3.2 As the base metal for plates workpieces of rolled sheets of carbon, low alloyed steel of grades 20K, 22K, 09Г2С, 12ХМ etc. as per GOST 5520, or as per ASTM A516 Gr.60, Gr65, Gr70, ASTM A387 Gr.11, Gr.12, Gr.22 etc., or as per EN10028-2 13GrMo4-5, 10CrMo9-10, P235 – P355NH (normalized), EN10028-3 etc., as well as of flat forgings as per GOST 8479, ASTM A105, ASTM A182, ASTM A336, EN10222-3 etc. of similar steel grades must be used.

For the cladding metal workpieces of rolled sheets of corrosion resistant steel of grades 08X13, 08X18H10T, 12X18H10T, 08X17H13M2T etc. as per GOST 5632, GOST 5582 and GOST 7350, as per ASTM A240: 410S, 304, 321, 316L, 316Ti etc and analoges as per EN 10028-7, as well as copper alloys as per GOST 2208, ASTM (SB-171/SB-171M), EN 1652 and nickel alloys in accordance with applicable specifications and standards must be used.

1.3.3 Requirements to the primary sheet (forging)

1.3.3.1 The clad steel workpieces should meet the requirements of GOST 5520 (of the corresponding category), ASTM A516, ASTM A387, ASTM A105, ASTM A182, ASTM A336 or EN10028-2, EN 10028-3, EN 10222-2 with an ultrasonic integrity check as per class 1 GOST 22727 or ASTM A578/A578M-07, EN 10160 or other corresponding standards.

1.3.3.2 The clad steel workpieces should meet the requirements of the performance standard. On the Customer's request all corrosion-resistant cladding-steel undergo intercrystalline corrosion test with results recorded into the test-certificate.

1.3.3.3 corrosion resistance steel sheets can be enlarged by arc-argon or plasma-arc welding according to the indications and requirements of the Customer specified in the order. In particular, the Customer can specify or not the method of weld quality testing (X-ray, dye penetrant or others). If necessary, the enlarged plates can be tempered and straightened. Weld reinforcement is removed from both sides of the plate.

1.3.3.4 The surfaces of the sheets or plates to be welded by explosion are subject to prior finish until complete removing of scale pits, scale, oxide film or other contaminations, including all kind of marking, up to metal.

The recommended type of finishing the surfaces to be clad:

- mechanical grinding,
- vacuum-arc preparation by technology developed by ZAO Energometall.

Before assembling into a package for welding, the surface roughness Rz of the sheets/plate after mechanical finishing must not exceed 6,3 according to GOST 2789

1.3.3.5 The process of vacuum-arc preparation of the surfaces to be explosion welded developed by ZAO Energometall is a copyright property of ZAO Energometall: patent RF no. 2311274 «The manufacturing of bimetal material».

1. 4 Marking and packing

1.4.1. Marking and packing of the bimetal plates should keep cladding surface safe and protected against rust of carbon, low-alloyed or alloyed base steel. Marking is applied on the surface of cladding metal and includes the number of the bimetal plate, steel grades of cladding and base metal, heat numbers of both cladding and base metal.

Additional marking and packaging of bimetal plate is to be performed according to the Customer's request.

1.4.2 Additional marking must be as per GOST 14192.

2. Requirements on staff safety and environment protection

2.1 Bimetal plates must be manufactured according to the safety regulations effective at the enterprise.

2.2 As the protection measures against hazards, the workers must be provided with the personal protective equipment according to the typical industrial norms.

2.3 The materials applied must not contain hazardous substances (hazard class 1 or class 2 according to GOST 12.1.007), indicated in the table of hazardous substances according to GOST 12.1.005, polluted the environment and badly affected the men's health.

3. ACCEPTANCE REGULATIONS

3.1. Acceptance of the bimetal plates is carried out in lots.

Each lot should comprise the bimetal plates of the same thickness and thickness ratio for the base metal and, the same heat of the base steel and a single heat of titanium, as well as the same heat treatment mode (of a single charge).

3.2 Each lot of the bimetal plates should be provided with the quality assurance document according to GOST 7566 with the following additional information:

- steel grade of the base metal;
- steel (alloy) grade of the cladding metal;
- heat number and chemical content of base metal;
- heat number and chemical content of cladding metal (alloy);
- thickness of cladding metal (alloy);
- shear strength and tearing strength;
- results of bending testing;
- class of bond continuity between layers;
- ultrasonic chart;
- a chart of enlargement of the initial cladding sheets (plates),
- designation of applicable specification.

3.3 After explosion welding, each plate should be visually inspected and measured, including control of dimensions, surface defects and edge condition.

3.4 Each bimetal plate should be ultrasonic tested for bond continuity between the layers.

3.5 Two bimetal plates from a lot should be subjected for the control of the thickness of the cladding metal.

3.6 Two bimetal plates from a lot should be subjected for the bending, shear and tearing tests.

3.7 Intercristalline corrosion test for corrosion resistant cladding steel should be performed for two bimetal plates with cladding steel of the same melting.

3.8. If the test results for at least one of the tested parameters is unsatisfactory, then the tests should be repeated for the doubled quantity of the samples for that kind of test that was not passed. The results of the repeated tests are considered the final results.

4. TEST METHODS

4.1. Quality of the surface and edges of each bimetal plate should be checked by visual inspection and measurements.

The dimensions and non-flatness of the bimetal plates should be checked according to the requirements of GOST 19903 and EN 10029, if otherwise is not agreed with the customer.

4.2. The following specimens should be taken from each tested bimetal plate:

- for control measurement of thickness of cladding metal – two specimens;
- for shear test of cladding metal – three specimens;
- for tearing test of cladding metal – three specimens;
- for bending test - two specimens;
- for elongation test of base metal – one specimen;
- for impact bending test of base metal – three specimens;
- for intercrystalline corrosion test of corrosion resistant cladding steel – two specimens with cladding steel of the same melting

4.3. Test specimens for the shear test, delamination of cladding metal, bending of bimetal plate, and elongation and impact bending of the base metal should be sampled according to the requirements of GOST 7564 or other standards indicated in the order.

It is not permissible to take the specimens for checking of the quality of bimetal work-pieces in the area of 50 mm width along edges of the bimetal plate.

4.4 The chemical content of the base metal is defined according to GOST 5520, GOST 10885, GOST 8479 or requirements of ASTM A516, ASTM A387, ASTM A105, ASTM A182, ASTM A336, EN10028-2, EN10028-3, EN10222-3. The chemical content of the cladding metal is defined according to the manufacturing standard indicated in the certificate.

4.5 Bending test should be performed at the normal temperature.

During bending testing of the bimetal plate, the thickness (diameter) of a mandrel should be equal to double thickness of the specimen. If thickness of the bimetal plate is over 30 mm, the test specimen for the bending test is machined up to the necessary thickness.

4.6 The thickness of the cladding metal should be checked by the metallographic method by a magnifier or microscope using two micro-section metallographic specimens of 10x30 mm size taken from the front and rear ends of the bimetal plate.

4.7 Other types of mechanical tests are tolerated according to the agreement between the Manufacturer and the Customer and reflected in the order.

5. PACKING, TRANSPORTATION AND STORAGE

- 5.1. The plates must be transported by any means of transport, observing the transportation regulations applicable for the given transportation mode.
- 5.2 The bimetal plates are allowed to be stored either in open or closed storage facilities. In case of being stored at open areas, surface of base metal must be additionally preventive treated.

6. MANUFACTURER'S WARRANTY

6.1 The Manufacturer guarantees that the bimetal plates intended for application in chemical and petrochemical engineering are in conformity with the requirements of the presented specifications, provided the Customer follows the transportation and storage requirements.

6.2 The warranty period is set as one year from the date of shipment to the customer.

Appendix A
(for reference)
List of norms,

referenced herein

Designation	Description
GOST 12.1.005-88	General sanitary requirements for air in the working zone
GOST 12.1.007-76	Noxious substances. Classification and general safety requirements
GOST 2208-2007	Brass sheets and strips. Specifications
GOST 2789-73	The surface roughness. Parameters and characteristics
GOST 5520-79	Carbon, low-alloy and alloy sheet steel for boilers and pressure vessels. Specifications
GOST 5582--75	Corrosion-resistant, heat-proof, and heat-resistant thin-sheet rolled stock
GOST 5632-72	High-alloy steels and corrosion-proof, heat-resisting and heat treated alloys. Grades
GOST 7350-77	Plate, corrosion-resistant, heat-resistant, and high-temperature steel. Specifications
GOST 7564- 97	Rolled products general rules of samples, rough specimens and test pieces selection for mechanical and technological testing
GOST 7566-94	Metal products. Acceptance, marking, packing, transportation and storage.
GOST 8479-70	Structural carbon and alloy steel forgings. General specifications
GOST 10885-85	Hot-rolled two-ply corrosion-resistant steel sheets. Specifications
GOST 14192-96	Cargo marking
GOST 19903-74	Hot-rolled steel sheets. Dimensions
GOST 22727-88	Rolled sheet. Ultrasonic test methods
ASTM A105	<i>Standard Specification for Carbon Steel Forgings for Piping Applications</i>
ASTM A182	<i>Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service</i>
ASTM A240	<i>Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications</i>
ASTM A336	<i>Standard Specification for Alloy Steel Forgings for Pressure and High-Temperature Parts</i>
ASTM A387	<i>Standard Specification for pressure vessel parts, alloy steel, Chromium-Molibdenium</i>

Designation	Description
ASTM A516	<i>Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service</i>
ASTM A263	<i>Standard Specification for Stainless Chromium Steel-Clad Plate</i>
ASTM A264	<i>Standard Specification for Stainless Chromium-Nickel Steel-Clad Plate</i>
ASTM A265	<i>Standard Specification for Nickel and Nickel-Base Alloy-Clad Steel Plate</i>
ASTM SB171/SB171M	<i>Standard Specification for Copper-Alloy Plate and Sheet for Pressure Vessels, Condensers, and Heat Exchangers</i>
ASTM A578/A578M	<i>Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications</i>
EN 10028-2	<i>Flat products made of steel for pressure purposes. Part 2: Non-alloy and alloy steels with specified elevated temperature purposes.</i>
EN 10028-3	Flat products made of steels for pressure purposes - Part 3: Weldable fine grain steels, normalized
EN 10029	Specification for Tolerances on dimensions, shape and mass for hot rolled steel plates 3 mm thick or above
EN 10160	Ultrasonic testing of steel flat product with the thickness equal or greater than 6mm (reflection method)
EN 10222-3	Steel forgings for pressure purposes - Part 3: Nickel steels with specified low-temperature properties
EN 13445-2	Unfired pressure vessels - Part 2: Materials

APPENDIX B

(compulsory)







