TECHNICAL CONFERENCE
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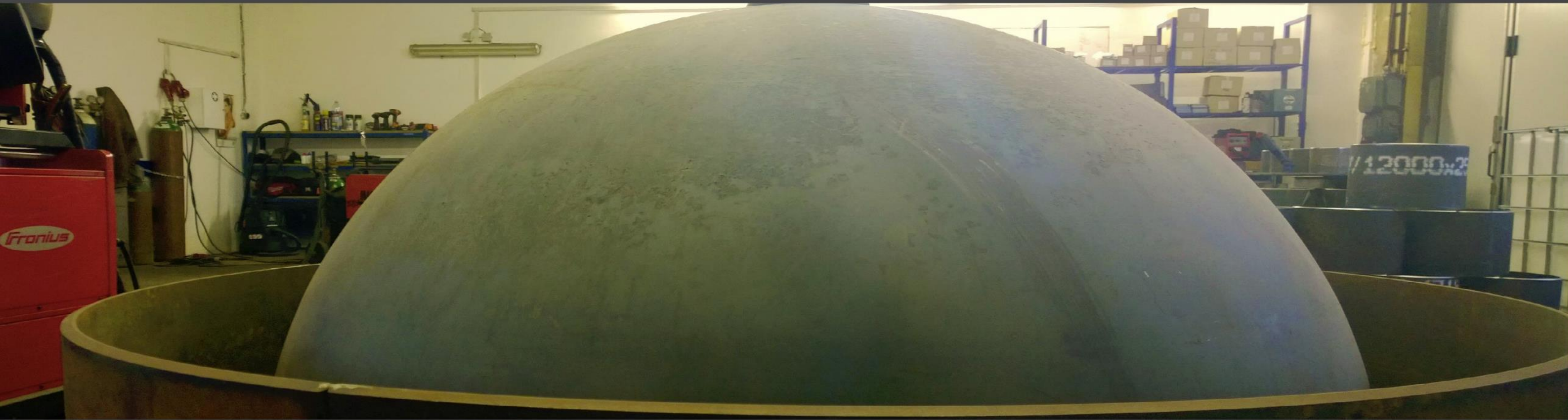
CZECH REPUBLIC

Development of materials for technological equipment in power engineering and pharmaceutical industries



PROGroup Engineering®

Development of materials for technological equipment in power engineering and pharmaceutical industries

Keywords

Creep-resisting steels, Ni alloys, research of new materials

1. Introduction

Creep resisting steels are used as structural materials for technological devices that are operated in the work environment of the high temperature. They are characterized by high strength, toughness and resistance against creep and oxidation. Steel must have the ability to accommodate long-term external stresses and comply with the value of the ultimate strength in creep for 10^5 to 2.10^5 hours. For these steels are characteristic by resistance to creep and oxidation resistance in the work environment. Creep is defined as a time-dependent plastic deformation at constant temperature and voltage. Oxidation resistance depends on the presence of alloying elements (Cr, Ni), which have a higher affinity for oxygen than iron, and for this reason it creates on the material surface protective passivating layer Heat resisting steel. are mainly used in the energy industry, it is of thermal power plants and nuclear power. This is the production of turbines rotors and stators, turbine blades, industrial piping, steam pipelines, separators, membrane walls, chambers, heaters, superheaters and sheaths of reactors.

2. Basic distribution of creep – resisting steels

2.1 Creep – resisting steels according to chemical composition

- Unalloyed steels, usable up to 480°C
- Low-alloy steels, usable up to 590°C
- High-alloy chrome steels *(modified 9-12%Cr)*, useable at 600 - 620°C
- Austenitic steels, usable at 620-700°C
- Austenitic hardened steels, useable up to 650 - 750°C

2.2 Distribution of creep – resisting steels according to TNI CEN ISO/TR 15608

- Group 5 - Cr-Mo steels without vanadium with C≤0,35 %;
- Group 6 - Cr-Mo-(Ni) steels with high vanadium *(V)*;
- Group 7 – ferritic (martensitic) and precipitated cured steels with C≤0,35% and 10,5%≤Cr 30%;
- Group 8 – austenitic steels CrNi (alloys);
- Group 10 – austenitic-ferritic steels CrNiN (duplex steels);

2.3 Selected creep-resisting steels according to use

Selected materials for membrane walls

13CrMo4-5, (15121), bainitic steel, 540ºC

7CrWVMoNb 9-6, (T/P23), bainitic steel, 550ºC

X12CrCoWNb 12-2-2 (VM12- SHC), martensitic steel, 610ºC

X10CrWMoVNb9-2 (T/P92), martensitic 9% Cr steel, 625 ºC

Selected materials for heaters and superheaters

X12CrCoWNb 12-2-2 (VM12- SHC), martensitic steel, 610ºC

TP 347H FGF, austenitic steel, 615ºC

SUPER 304 H, austenitic steel, 660ºC

HR 3 C, austenitic steel, 670 ºC

SANICRO 25, austenitic steel, 700 ºC

Alloy 617, nickel alloy, 770 ºC

Alloy 740, nickel alloy, 770 ºC

Selected materials for steam ducts, steam and pipe collectors

X10CrMoVNb9-1 (T/P91), martensitic 9% Cr steel, 580 ºC

X11CrMoWVNb9-1-1 (E911), martensitic 9% Cr steel, 600 ºC

X10CrWMoVNb9-2 (T/P92), martensitic 9% Cr steel, 625 ºC

Alloy 617, nickel alloy, 770 ºC

Alloy 740, nickel alloy, 770 ºC

Special refractory and creep – resistant Ni alloy

NIMONIC 75
NIMONIC 80A
NIMONIC 90
NIMONIC 105
NIMONIC 115
NIMONIC 263
INCOLOY 20
INCOLOY 800
INCOLOY 800H
INCOLOY 800HT
INCOLOY 925
INCOLOY 945
INCOLOY 945X
HASTELLOY C-22
HASTELLOY C-263
HASTELLOY C-276
HASTELLOY X
INCONEL 600
INCONEL 625
INCONEL 718
INCONEL X-750
INCONEL 713 C
INCONEL 713 LC
INCONEL 738
INCONEL 738 LC
INCONEL 792

3. Current development of new creep – resistant steels

Development of new creep - resisting steels is carried out on the basis of the new required parameters of energy blocks. Each such development of the new steel is broken down into specific use specifically given a technological component. Of such research, then new modified boiler steel, steel, steel for rotor turbine blades, chemical reactors, etc.

In the framework of the research and development of new modified steels is systematically followed from the very design of the chemical composition on the basis of thermodynamic simulation and previous experience of the Research Center. The following is a casting laboratory small melting, which are then examined and evaluated experimentally. Specifically, the tensile test, combustion tests, tests, tests of oxidative creep resistance, etc. In the case that the initial tests show promising results, as is the production of selected prototypes to evaluate other influences and to examine all the technological properties of the new modified steel.

At present, the main intention of development of modified steels for working environment – 620 650 °C. As to the need to increase the strength of the industrial units for new creep - resisting materials in order to increase the overall efficiency of energy blocks based on the increase in operating temperature and pressure of steam and reducing fuel consumption and emissions. Great expectations in these research I present a modified high-alloy 12% chromium steel because of the high level of creep resistant, but above all the oxidative resistance of steels in the environment of steam at temperatures up 650 to 600°C. Chrome increases traceability strength, abrasion resistance, strength, resistance to oxidation (a chemical corrosion) and electrochemical corrosion. In binary notation Fe-Cr high-content chromium appears Intermedia σ phase with variable composition. On cooling the eutectoid temperature of 460 °C decays to stage α. It is assumed that the fragility of high-alloyed steels raises the coexistence of these phases, not itself stage α. A range of homogeneous area σ phase and heterogeneous areas depends on the content of other elements. In terminations alloys Fe-Cr-C is part of the chromium in the base metal matrix and the other part carbon form the carbides. If the low content of chromium is mixed carbide $(Fe, Cr)_3C$, also known as Kc, M_3C. Gradually with increasing chromium content $(Fe, Cr)_7C_3$ (carbide K2) and $(Fe, Cr)_{23}C_6$ (carbide K1). The high chromium content for creep – resisting steels improves resistance to oxidation on the other hand, adversely affect the dimensional stability $M_{23}C_6$ carbides.

<u>The research of new refractory materials is aimed at meeting the following requirements:</u>

- $R_{mT/10^5\ h\ /600°C} \geq 100$ MPa
- $R_{p0,2min.} = 600$ MPa,
- $R_{p0,2min.} = 450$ MPa, application to cast-iron steels
- Crushability and toughness
- Resistance to brittleness during long-term exposure at operating temperatures
- Thermoformability
- Foundry properties
- Weldability
- Resistance to oxidation
- Thermal conductivity low coefficient of thermal expansion

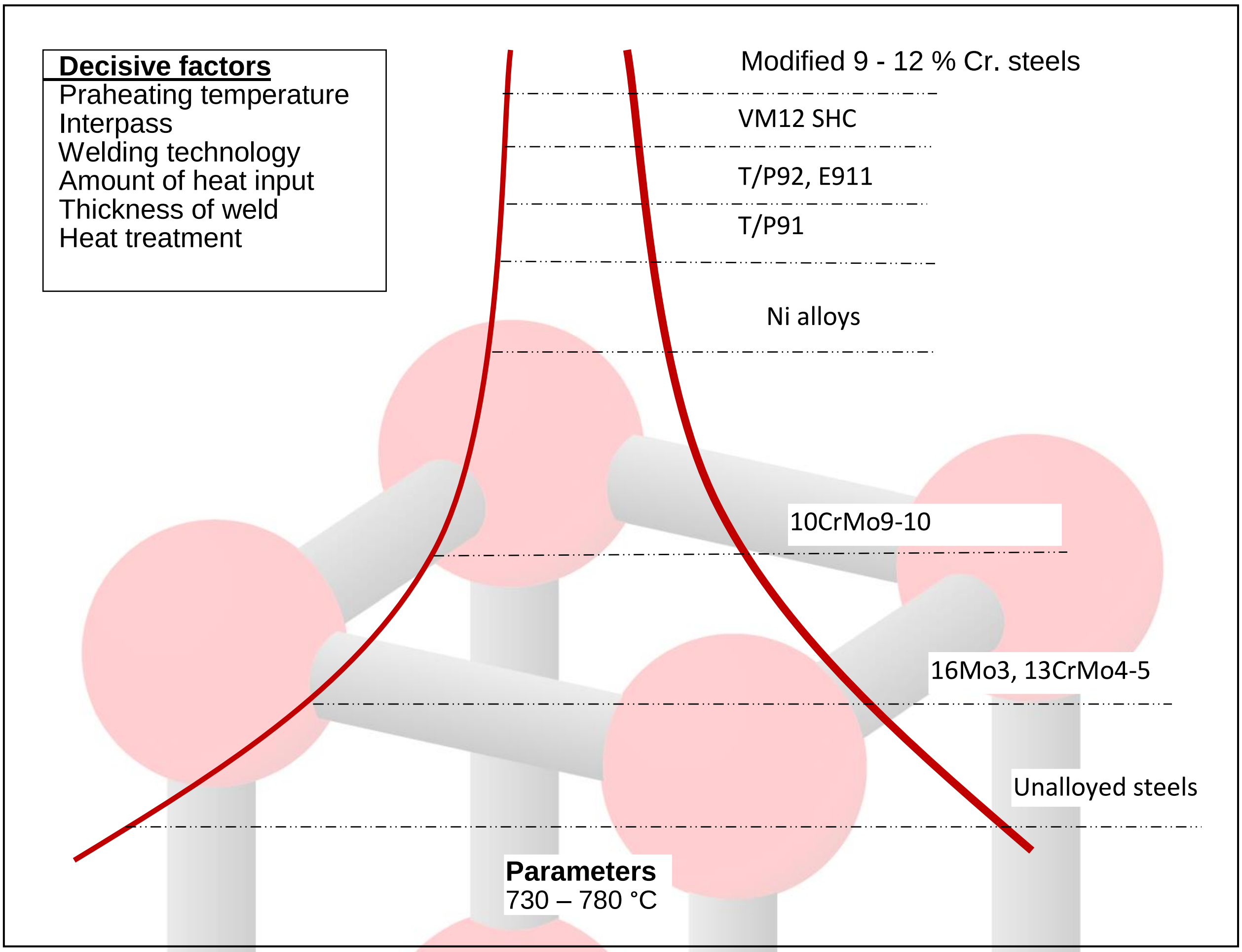


Fig. Interval parameters and criteria selected creep – resisting welding materials

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