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The properties of chromium steel overlaying used as a hardening coating for stop valve sealing surface

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Abstract

Operational reliability of a pipeline valve depends on the durability of the weld sealing surfaces of the stop device, while the durability of the sealing surface is determined by the coating material properties. To enhance stop valve durability, a new composition for a flux-cored wire was developed, ensuring the generation of the surfacing metal with alloying system Cr-Ni-Mo-Mn-Si-Nb-Ti-B. Such wire provides overall hardening of the coating matrix with carboboride and intermetallic phases, providing an advanced operational reliability of stop valve nodes operating under friction conditions in aggressive environment.

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Keywords: stop valve; overlaying; flux-cored wire; structure; hardness; wear resistance

1. Introduction

Despite being an extremely expensive device, stop valves are of considerable importance for petrochemical enterprises, and therefore it is necessary to prolong their actual service and inter-repair time.

Cost estimates demonstrate that the efficiency of repairing a default stop device by a specialized repair agency is, on the average, 60% higher than the cost of a new product. The most promising way of solving this issue is to improve the repair profitability level by increasing the inter-repair period, that being achieved due to a higher operational reliability of the repaired stop device in contrast with the reliability of a new series-produced one [1].

The practice of operating the stop valves shows that their durability and reliability are greatly dependent on the operational capability of the parts sealing surfaces that is usually ensured by overlaying with specific kinds of steel

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and alloys. The properties of such overlayings are to meet a set of hard-compatible requirements, such as scoring resistance under dry friction conditions at possible high temperatures and contact pressure, corrosion and erosion resistance in the carrier environment, sufficiently high hardness to prevent crumpling, resistance to cracking due to thermal cycling, machinability at overlaying and tooling, cost effectiveness and non-deficiency of alloying, and others [2,3].

Expensive cobalt-based alloys are usually used for overlaying stop valve parts in the Western countries. Such alloys were used in Russian valve industry previously, but then they were replaced with more machinable and cost-efficient alloys based on austenite-ferrite precipitation-hardening Cr-Ni-Si steel, developed in Central Research Institute of Machine Building Technology. Long-term experience of applying such alloys for sealing surfaces of stop valve parts demonstrated that they can surely replace cobalt-based alloys [4]. Table 1 contains various techniques of mechanized overlaying of valve parts and weld materials used in Russian valve plants [5].

Table 1. Weld materials and techniques of mechanized overlaying of valve parts

Types of deposited metal	Overlaying methods	Weld materials	Amount of layers	Hardness of surface, HRC
Steel 08Kh17N8S6G An analogue of the electrode brand CN-6L	Overlaying arc flux welding or overlaying in an argon	Flux-cored wires: PP-AN-133, SK Antinit Dur 290	3-4	30-40
	Overlaying arc welding by ceramic flux PKNL 128	Strip 15Kh18N12S4TYu (EI 654)	1	30-44
Steel 13Kh16N8M5S5G4B An analogue of the electrode brand CN-12M	Overlaying arc flux welding or overlaying in an argon	Flux-cored wire SK Arttinit Dur 500	3-4	40-50
	Overlaying arc flux welding	Flux-cored strip PL-AN150	3	40-50
Steel 13Kh14N9S4F3G An analogue of the electrode brand CN-24	Overlaying in an argon	Wire Sv-13Kh14N9S4F3G (EK 119)	2	27-30
Steel 15Kh18N11G4M2	Overlaying arc flux welding or overlaying in an argon	Wire Sv-10Kh18N11S5M2TYu (EP 987)	2	26-31

The given materials are highly resistant to corrosive and erosive wear and preserve their characteristics during a long operational period.

To prevent cracking of the surfaces, details should, however, be preheated at high temperatures. In overlaying with Cr-Ni-Si-steel having the hardness of 40-50 HRC, the temperatures reach 500°C and higher, making the process highly labor intensive, especially during hand-operated overlaying on bulky parts. Preheating results in increased sizes and prolonged existence of weld pool, causing the loss of alloying elements highly reactive to oxygen. The hardness of weld Cr-Ni-Si-steel is affected by the presence of alloying elements (silicon and chrome) in its composition, and by the amount of ferrite phase and the extent of its decomposition when heated. Therefore, temperature-time modes for overlaying and preheating the parts must be precisely specified, including the mode of the subsequent heat treating.

At the same time, tapes and wires from the named steel have been used less on the valve plants for the last few years. The quality of the welding wire has changed for the worse, resulting in increased cost of the coating work. Flux-cored wires and tapes of the trademark PP-AN133, PL-AN150 have not become widely-spread because of their unstable composition [5].

Meanwhile, high-quality import flux-cored wires from Cr-Ni-Si-steel have found some application in mechanized overlaying. Thus, flux-cored wire SK Antinit Dur 500 can be used in overlaying under flux or in argon, to obtain weld coating metal of 10Kh17N8M5S5G4B (CN-12M) type with hardness of 40-50 HRC. The overlaying process is characterized as being highly stable. The quality of the weld metal meets the requirements for valve sealing surfaces. Weld surfaces are resistant to scoring, corrosion and erosion.