An Experimental Study of the Tribological Properties of a Wedge Gate Valve Components with Sv-10X17T Welding Wire Surfacing

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ABSTRACT

This study investigates the effect of surfacing with Sv-10X17T welding wire on the tribological properties of steel samples. The research is motivated by the need to extend the service life of components operating under frictional loads while reducing the maintenance and repair costs. The focus is on a key element of the pipeline shut-off valves, the wedge of a wedge gate valve, which experiences high contact stresses and severe wear during operation. Laboratory tests were conducted under various friction conditions, involving dry friction, water-based media, and oil-based media. Parameters, such as the coefficient and moment of friction, contact temperature, mass loss, wear depth, surface microhardness (both before and after testing), and surface roughness (Ra), were systematically measured. Experiments with steel samples surfaced using Sv-10X17T welding wire were designed to replicate actual valve working conditions. The results showed that Sv-10X17T surfacing significantly increased wear resistance, reduced friction, and enhanced surface microhardness, particularly under prolonged dry friction. The microstructural analysis confirmed the formation of a hardened riveted surface layer with deformation strengthening and partial thermal treatment. These findings indicate that Sv-10X17T surfacing not only restores, but also improves the performance of the steel components, offering an effective method to extend the operational life. The outcomes of this research have practical value for mechanical engineering, as well as the repair and maintenance of pipeline equipment, turbines, gearboxes, bearings, valves, and other critical components.

Keywords-wedge gate valve; surfacing; welding wire; friction; wear

I. INTRODUCTION

The study of friction and wear remains highly relevant due to their strong influence on the efficiency and reliability of machines and mechanisms. Friction causes energy losses, overheating, and accelerated wear of components, reducing the equipment lifespan and raising the maintenance costs [1]. A deeper understanding of these processes enables the use of more effective lubricants, the development of improved designs, and the selection of optimal materials, ultimately enhancing performance and reliability. Several models have been proposed to explain friction and wear, each with specific strengths and limitations. The Amonton–Coulomb law states that friction is proportional to the normal load but does not account for temperature, microstructure, or chemical interactions [2]. Bowen and Tabor's adhesive theory attributes friction to adhesion; yet, it neglects the role of third bodies and lubricants [3]. The Archard wear model links wear to the load and material properties but overlooks the dynamic effects and temperature influences [4]. The mechanochemical approach considers wear as a combination of mechanical and chemical processes; though, quantifying such reactions remains difficult [5]. The third-body theory highlights the role of wear particles forming an intermediate layer that affects friction, but modeling its evolution is challenging [6].

Modern numerical methods, such as molecular dynamics and finite element modeling, allow the simulation of processes at the micro- and nanoscale [7], but they demand significant computational resources and highly accurate input data. Taken together, these limitations underscore the need for an integrated approach and further research to better describe and predict the friction and wear behavior. Despite significant progress in tribology, several challenges remain unresolved. The combined effects of physical factors, such as temperature, humidity, and chemical environment, on friction and wear are still not fully understood, while the accurate modeling of these influences remains difficult. Most existing models primarily describe short-term wear, while the long-term behavior of materials under prolonged service conditions has received less attention. Furthermore, a gap persists between microscopic and macroscopic friction models, making it difficult to connect molecular dynamics simulations with large-scale system behavior. Laboratory tests also often fail to replicate real operating conditions, reducing the reliability of the wear predictions and highlighting the need for more realistic experimental methods. One promising approach is surfacing, which modifies the surface of parts to improve properties, such as hardness, roughness, and adhesion. These changes have a direct impact on the tribological performance, influencing parameters like the coefficient of friction, contact temperature, and wear rate [8].

The wedge of a pipeline wedge gate valve, characterized by high frictional loads during operation, was chosen as an example for conducting tribological tests. The wedge valve of the pipeline is a shut-off device designed to block the flow of the medium by moving the wedge. During operation, the valve wedge is subjected to significant frictional loads, which eventually lead to its wear and a decrease in the tightness of the assembly. The principle of operation of the gate valve is simple. The working body moves perpendicularly to the direction of flow, while it can completely block the passage of the pipeline. However, if an industrial shut–off valve is used, the valves can be adjustable. The valve operation is controlled by means of a pneumatic, hydraulic, electric drive, or manually. In comparison with other types of shut-off valves, wedge gate valves (Figure 1) have several advantages (low hydraulic resistance with a fully open passage, ease of maintenance, the ability to feed raw materials in any direction, etc.). The variety of valve operating conditions, issues of reliability and durability, and various designs make it difficult to select fittings for certain specific working conditions. This process is complicated by the fact that when designing wedge gate valves, the strength calculation of the individual parts is carried out without considering actual operating conditions, such as the flow rate of the transported medium, temperature, and position of the wedge [9]. The most worn part of the wedge gate valve is the wedge itself (Figure 2).

An analysis of the surfacing effects allows laboratory tests to better simulate real-world operating conditions and addresses the lack of data on the surface behavior under friction. The purpose of this article is to investigate the impact of surfacing on the coefficient of friction and wear of materials under laboratory conditions. To achieve this, the following tasks were formulated:

1. Choosing the optimal surfacing mode.
2. Assessment of the changes in the coefficient of friction and wear under varying conditions (load, temperature, etc.).
3. Analysis of the relationship between hardness, roughness, and wear resistance of the deposited layer.
4. Comparison of the results for samples with and without surfacing, as well as an assessment of their impact on the service life of machine elements.

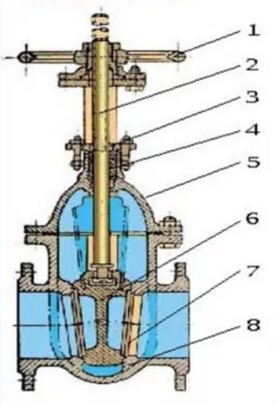

Fig. 1. Wedge gate valve: 1 – flywheel, 2 – spindle, 3 – pressure sleeve, 4 – oil seal, 5 – valve cover, 6 – wedge, 7 – seat, 8 – housing.

Fig. 2. The worn part of the wedge.

II. MATERIALS AND METHODS

The research was conducted in accordance with [16, 17], where procedures for quantifying the abrasion and wear resistance of materials under various friction conditions are established. Friction and wear tests were performed using the UMT-200 friction machine, as shown in Figure 3, designed to evaluate tribological characteristics, such as the coefficient of friction and wear resistance. The UMT-200 operates under different tribological modes, including dry friction, boundary lubrication, and liquid lubrication, while allowing the precise control of load, speed, and temperature. In addition, it records and analyzes the coefficient of friction in real time, rendering it suitable for testing a wide range of materials and coatings.

Fig. 3. UMT-200 universal friction machine.

Wear resistance tests were performed on the UMT-200 under conditions simulating real operation, with samples exposed to air, water, and petroleum products. During testing, the coefficient of friction, friction moment, and contact zone temperature were measured, while the mass loss, wear depth, and microhardness (before and after testing) were evaluated. A vernier caliper with 0.01 mm accuracy was used to measure the linear dimensions of the samples before and after testing to determine the material loss. Hardness was assessed using a TR110 tester, with measurements taken both before and after wear to monitor the structural changes. Ra was evaluated using a TIME3200 roughness meter by measuring the Ra parameter on untreated surfaces, after wear, surfacing, and machining, and again following friction tests [10]. The worn surfaces were further examined through three methods: microscopic observation with an A13.0207-DIC microscope, microstructural analysis of the coating and worn areas, and visual inspection for defects, such as cracks, chips, and plastic deformation. The test samples consisted of 11 St20 steel bars, each measuring 40 mm × 40 mm × 10 mm and weighing approximately 150 g. They were coated with Sv-10X17T welding wire applied in five layers, with the coating thickness corresponding to the wire diameter (5 mm). Heat treatment was carried out according to the manufacturer's recommendations to ensure stable hardness and chemical composition (with at least 12% chromium content). This process included tempering to relieve internal stresses, stabilize the deposited layer's structure, and provide the required hardness and wear resistance [11].

III. EXPERIMENTAL SETUP

The appearance of the experimental samples after surfacing and subsequent tests is displayed in Figure 4, illustrating the structural integrity and surface condition of the applied layer. Metallographic analysis was performed to identify the structural changes, and Ra was measured, as presented in Figure 5 and Table I. The Ra readings of the samples are summarized in Table II.

Fig. 4. Samples of blanks for experiments.

TABLE I. METALLOGRAPHIC ANALYSIS DATA

Parameter	**Ra**	**R3z**	**Rv**	**Rp**	**RS**	**Rsk**	**RSm**
Value /unit of measurement	0.805 mm	2.468 mm	4.121 mm	2.222 mm	0.048 mm	-0.313	0.07 mm
Parameter	Rmax	Rpc	Rt	Rq	Rz	RzJIS	Ry
Value /unit of measurement	12.32 mm	95 pks/cm	12.32 mm	1.236 mm	6.343 mm	3.214 mm	12.32 mm

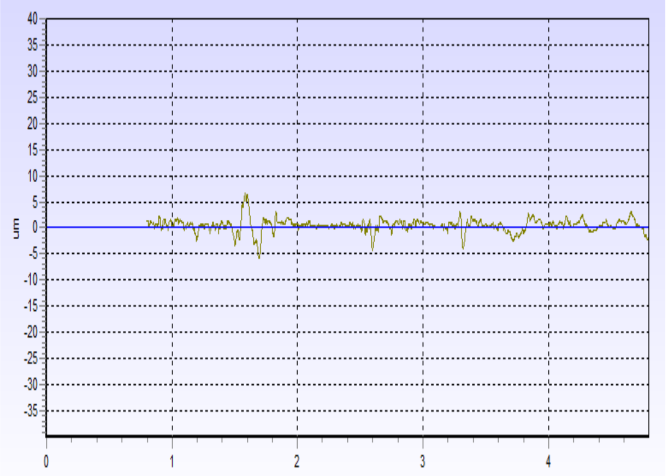

Fig. 5. Metallographic analysis to identify structural changes. Ra was measured on the sample.

TABLE II. SUMMARY OF SURFACE ROUGHNESS (RA)

Ra, microns	**Sample number**
2.342	1
2.341	2
2.345	3
2.344	4
2.341	5
2.344	6
2,400	7
2.405	8
2,348	9
2.344	10
2.328	11

The wear was measured under experimental conditions with a pressing force of 50 N, a rotational speed of 450 (up to 840), and a temperature range of 35 °C–290 °C, both with and without lubrication, as exhibited in Figure 6 and in [12]. During testing, the variations in friction moment, clamping force, and lubricant temperature were recorded at different time intervals (1 and 10 min) under dry friction conditions. In the initial stage, these parameters remained relatively stable; however, as time progressed, noticeable fluctuations appeared in the clamping force and friction moment, which is characteristic of the dry contact behavior and indicates progressive surface wear. The lubricant temperature, as shown in the diagrams, remained nearly constant and low, reflecting the absence of lubrication and the minimal thermal effect of friction. Figure 6 demonstrates that after surfacing, the wear rate decreased by approximately 1.2 times, which directly contributes to an increased service life of the component. Moreover, the absence of lubrication causes uneven variations in the clamping force and a gradual increase in friction, indicating an accelerated wear of the contact surfaces during prolonged operation. These results highlight the importance of using lubricants to stabilize the frictional conditions and extend the equipment service life.

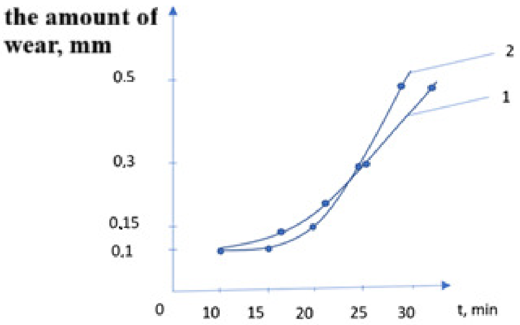

Fig. 6. Graph of the main results of the experiment.

IV. RESEARCH RESULTS AND DISCUSSION

Experimental studies of three types of friction have been conducted: dry steel-steel without the use of coolant, liquid steel-steel friction and "Distilled water" coolant, and liquid steel-steel friction using HOCUT 795 H-eu coolant (emulsion), as portrayed in Tables III-V.

TABLE III. COMPARISON OF THE TRIBOLOGICAL CHARACTERISTICS OF THE SAMPLES (DRY FRICTION)

Parameter	**New samples**	**Recovered samples (surfacing)**	**Note**
Coefficient of friction (μ)	0.5	0.5	Constant load and speed
Moment of friction (M)	125 N·m	87.5 N·m	Average or maximum
Weight loss	25 mg/hr–40 mg/hr	10 mg/hr–15 mg/hr	For one cycle or for the entire test
Depth of wear	8 microns/hr–12 microns/hr	3 microns/hr–5 microns/hr	According to the profilometry data
Temperature in the friction zone	30–70°C	40-80°C	With prolonged friction
Microhardness of the surface (up to)	200–250 HV	260 HV–300 HV	Before the test
Microhardness of the surface (after)	280–320 HV	330 HV–380 HV	After wear and tear
Roughness of Ra	1.6 microns – 2.5 microns	1.8 microns – 2.5 microns	After grinding / before friction
Structural changes (description)	Formation of a riveted layer, deformation hardening, fine-grained structure, and possible formation of an oxide film.	Fine-grained riveted layer, deformation hardening, partial oxidation, local thermal effect with martensite.	In the presence of microscopic analysis
Repeatability of the result	Average	Average variation in friction moment and wear is ±10%. The deposited layer operates effectively without lubrication, and its structure is more stable than that of the base metal.	For example, the average of 3 trials

TABLE IV. COMPARISON OF TRIBOLOGICAL CHARACTERISTICS OF SAMPLES (COOLING LIQUID – WATER, LIQUID FRICTION)

Parameter	**A new sample**	**The recovered sample (surfacing)**	**Note**
Coefficient of friction (μ)	0.25	0.25	Constant load and speed
Moment of friction (M)	62.5 N·m	50 N·m	Average or maximum
Weight loss	15 mg/hr–25 mg/hr	5 mg/hr–10 mg/hr	For one cycle or for the entire test
Depth of wear	5 microns/hr–8 microns/hr	2 microns/hr–4 microns/hr	According to the profilometry data
Temperature in the friction zone	15 °C–25 °C	20 °C-30 °C	With prolonged friction
Microhardness of the surface (up to)	200 HV–250 HV	260 HV –300 HV	Before the test
Microhardness of the surface (after)	260 HV–300 HV	300 HV –340 HV	After wear and tear
Roughness of Ra	1.2 microns – 1.8 microns	1.4 microns – 2 microns	After grinding / before friction
Structural changes (description)	Partial destruction of the surface layer. Corrosion softening of grain boundaries, increased porosity, and possible intercrystallite fracture.	Surface corrosion at grain boundaries. Microcracks from cyclic moisture and friction. Weakening of the structure of the weld and the near-seam zone. Partial leaching of alloying elements.	In the presence of microscopic analysis
Repeatability of the result	Low	Moderately high — due to the corrosion resistance of the Sv-10X17T coating, the spread decreases to 10%, and the aquatic environment has less influence on the surface structure.	For example, the average of 3 trials

TABLE V. COMPARISON OF TRIBOLOGICAL CHARACTERISTICS OF SAMPLES (HOCUT 795 H-EU BRAND COOLANT (EMULSION))

Parameter	**A new sample**	**The recovered sample (surfacing)**	**Note**
Coefficient of friction (μ)	0.09	0.07	Cnstant load and speed
Moment of friction (M)	25 N·m	15 N·m	Average or maximum
Weight loss	5 mg/hr –10 mg/hr	2–5 mg/hr	For one cycle or for the entire test
Depth of wear	2 microns/hr–4 microns/hr	1 microns/hr–2 microns/hr	According to the profilometry data
Temperature in the friction zone	40 °C–80 °C	50 °C-70 °C	With prolonged friction
Microhardness of the surface (up to)	200 HV–250 HV	260 HV–300 HV	Before the test
Microhardness of the surface (after)	240 HV–280 HV	280 HV–320 HV	After wear and tear
Roughness of Ra	0.8 microns – 1.4 microns	1 microns – 1.6 microns	After grinding / before friction
Structural changes (description)	A smaller change in the structure and delayed aging of the surface preserves the ferrite-pearlite structure with local deformations and traces of overheating.	The material demonstrates good environmental resistance and minimal corrosion, with moderate friction-induced hardening. Its microstructure is primarily ferritic carbide, with potential surface hardening in areas exposed to overheating.	In the presence of microscopic analysis
Repeatability of the result	High	High stability, minimal spread (up to =5%), good compatibility with oil-containing media, providing stable friction and wear.	For example, the average of 3 trials

The main conclusions are based on a comparative analysis of the tribological characteristics of new and restored (surfaced) samples under various friction conditions:

- Recovery efficiency. The restored samples (surfaced) demonstrate superior wear resistance compared to the new samples under all conditions. Weight loss is reduced by 2–3 times. Wear depth is lower : dry friction – by 5 microns/hr-7 microns/hr; liquid friction – by 3 microns/hr-4 microns/hr; using a coolant (emulsion) – by 1 microns/hr-2 microns/hr. Microhardness after friction tests increases: dry friction – by 50 HV–60 HV; liquid friction – by 40 HV; coolant (emulsion) – by 40 HV. The friction and behavior are more stable in the restored samples.
- Behavior in different environments. Under dry friction, the coefficient of friction is identical for both samples (0.5), but the restored sample exhibits a lower friction moment (87.5 Nm) and forms a more stable microstructure (martensite, rivet layer). Repeatability is moderate but higher than that of the new sample.
- Friction in water. The restored sample exhibits higher corrosion resistance, lower wear, and more stable performance (±10% compared to ±20% for the new sample). In contrast, the new samples are prone to intercrystallite fracture and softening.
- Friction in petroleum products. Both samples perform stably, but the restored sample demonstrates better results: lower coefficient of friction, higher hardness, and reduced wear, indicating good compatibility with an oil-containing medium.

A comparison of the characteristics with and without surfacing is presented in Table VI.

Reducing the weight loss and wear depth increases the service life of friction components, such as shafts, pins, and gears. Higher microhardness provides protection against deformation and damage, while improved corrosion resistance and reduced intercrystallite fracture preserve the part strength in aggressive environments. Greater friction stability lowers the risk of jamming, overheating, and breakage. For machinery, this translates to fewer unscheduled stops, increased component reliability, lower maintenance costs, and more predictable operation of mechanisms under high loads and extended service [13].

TABLE VI. COMPARISON OF CHARACTERISTICS

Parameter	**New sample (without surfacing)**	**Recovered sample (surfacing)**	**Note**
Weight loss	5 mg/hr – 40 mg/hr	2 mg/h – 15 mg/hr	2-3 times lower for surfacing
Depth of wear	2 microns/hr – 12 microns/hr	1 microns/hr – 5 microns/hr	Wear reduction up to 60%
Coefficient of friction (μ)	0.5 – 0.09	0.5 – 0.07	Lower by ~20% in the oil environment
Moment of friction (M)	125 N·m – 25 N·m	87.5 N·m –15 N·m	Lower friction resistance
Microhardness after testing	320	up to 380 HV	Hardness increases up to 20%
Roughness of Ra	0.8 microns– 2.5 microns	1 microns –2.5 microns	Comparable
Repeatability	From low to medium	from moderate to high	Surfacing provides stability
Structural changes	Destruction, corrosion, cracks	Hardening, martensite, stability	Significant improvement in the structure

V. CONCLUSIONS

The Sv-10X17T surfaced samples demonstrate significantly superior wear resistance, stability, and fracture resistance compared to the new (unmodified) samples, making surfacing an economically and technically viable method for restoring and modernizing worn machine elements. This is particularly valuable for components operating under high loads, dry friction, exposure to aggressive liquids (water, fuel, oil), and prolonged cyclic operation. As a result, surfacing increases durability, reduces operational risks, and improves overall equipment efficiency. A comparison with the literature [14, 15] shows that the recovered (deposited) samples exhibit better tribological properties than both the new and standard materials. Key improvements include a wear reduction by 2–3 times, hardness increases up to 380 HV, an enhanced resistance to corrosion and structural damage, and a stable friction and wear behavior. Practically, this translates to a longer service life for rubbing pairs, lower risk of accidents and overheating, reduced maintenance requirements, and increased reliability of equipment. Therefore, the Sv-10X17T welding wire method can be considered not only a restorative technology, but also an enhancing technique that improves the wear resistance beyond the commonly accepted production standards.

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REFERENCES

[1] M. K. A. Ali, "Friction and Wear in Machine Design," *Lubricants*, vol. 11, no. 2, Feb. 2023, Art. no. 40, https://doi.org/10.3390/lubricants11020040.

[2] M. Kalin and P. Jan, "Understanding the friction laws of Amontons and Coulomb by evaluating the real contact area," *Tsinghua University Press*, vol. 13, no. 1, Jan. 2025, Art. no. 9440986, https://doi.org/10.26599/FRICT.2025.9440986.

[3] T. Brink, E. Milanese, and J.-F. Molinari, "Effect of wear particles and roughness on nanoscale friction," *Physical Review Materials*, vol. 6, no. 1, Jan. 2022, Art. no. 013606, https://doi.org/10.1103/PhysRevMaterials.6.013606.

[4] J. Choudhry, A. Almqvist, and R. Larsson, "Improving Archard's Wear Model: An Energy-Based Approach," *Tribology Letters*, vol. 72, no. 3, July 2024, Art. no. 93, https://doi.org/10.1007/s11249-024-01888-8.

[5] J. Guo *et al.*, "Interplay between counter-surface chemistry and mechanical activation in mechanochemical removal of N-faced GaN surface in humid ambient," *Tribology International*, vol. 159, July 2021, Art. no. 107004, https://doi.org/10.1016/j.triboint.2021.107004.

[6] J. Denape, "Third Body Concept and Wear Particle Behavior in Dry Friction Sliding Conditions," *Key Engineering Materials*, vol. 640, pp. 1–12, 2015, https://doi.org/10.4028/www.scientific.net/KEM.640.1.

[7] Q. Gao, L. Qi, S. Gao, L. Lu, L. Song, and F. Zhang, "A FEM based modeling method for analyzing the static performance of aerostatic thrust bearings considering the fluid-structure interaction," *Tribology International*, vol. 156, Apr. 2021, Art. no. 106849, https://doi.org/10.1016/j.triboint.2020.106849.

[8] S. Wen and P. Huang, *Principles of Tribology*. John Wiley & Sons, 2017.

[9] K. Sotoodeh, "Chapter 6 - Wedge gate valve applications and design," in *A Practical Guide to Piping and Valves for the Oil and Gas Industry*, K. Sotoodeh, Ed. Gulf Professional Publishing, 2021, pp. 321–360.

[10] TIME Portable Roughness Tester TR3200 / TR3202. South Africa: BAMR.

[11] I. Alenezi, "Effects of Heat Treatment on the Corrosion Behavior of ASTM A-36 Steel," *Engineering, Technology & Applied Science Research*, vol. 10, no. 1, pp. 5320–5324, Feb. 2020, https://doi.org/10.48084/etasr.3326.

[12] А. Ж. Касенов, Д. А. Искакова, А. С. Янюшкин, А. А. Ткачук, and Д. Т. Қабдымали, "Анализ Напряженно-Деформированного Состояния Трубной Запорной Арматуры," *Science and Technology of Kazakhstan*, no. 4, pp. 138–150, 2024, https://doi.org/10.48081/LOWU5474.

[13] R. A. Al-Samarai and Y. Al-Douri, *Friction and Wear in Metals*. Singapore: Springer Nature, 2024.

[14] P. Liu *et al.*, "Design optimization for subsea gate valve based on combined analyses of fluid characteristics and sensitivity," *Journal of Petroleum Science and Engineering*, vol. 182, Nov. 2019, Art. no. 106277, https://doi.org/10.1016/j.petrol.2019.106277.

[15] S. Enekçi, Ü. Demir, and K. Yılmaz, "Investigation of a standard gate valve in terms of flow rate, opening distance, and wedge angle with CFD," *Journal of Thermal Engineering*, vol. 10, no. 5, pp. 1306–1322, Sept. 2024.

[16] *GOST 23.204-78 Method for Assessing the Abrasion Resistance of Surfaces under Friction*. Russia: Russian technical standard, 1980.

[17] *GOST 23.224 Methods for Assessing the Wear Resistance of Restored Parts*. Russia: Russian technical standard, 1986.

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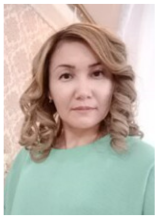

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