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Frictional wear of improved valve hermetic elements caused by heat transfer

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KEYWORDS

Wear
Hermetic elements
Thermal conductivity
Temperature-resistant
Friction

ABSTRACT

Valve is one of the significant constructions that is being used for transfer of products in oil and gas industry. Main part of the valves is considered its hermetic elements which are subject to wear and tear. The main purpose of this work is to simulate frictional heat mechanism and turbulence dissipation during valve semi-open position. Simulation process for the thermal conductivity, as well as turbulence flow conducted by using SolidWorks software program. Temperature-dependent wear assessment on the improved valve construction working surfaces run and gained results are compared. Processing of the results determined that wear occurs faster at the crisis point of surface temperature thickening. The results show that thermal treatment of temperature-resistant coatings over the hermetic elements surfaces is required in order to decrease the weariness being caused by heat transfer.

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NOMENCLATURES

ϕ_{T}	heat flow, Vt,
d_{τ}	amount of heat, K
$F_T d_{\tau}$	unit time
τ	heating time of the part, sec
C	total heat capacity of the part C/K,
A	heat flux when temperature changes by 1˚ Vt/K
Q	amount of heat, coul
α	heat transfer coefficient, Vt/m^2K,
S	the area of the heat transfer surface, m^2
t	temperature, K
t_{max}	maximum temperature, K
t_0	initial temperature, K
$e^{-\frac{\tau}{T}}$	exponential dependence
H	hardness for metal materials under increasing temperature, HB
H_0	hardness at annual temperature, HB
β	temperature coefficient
Δt	temperature coefficient when the surface heats up due to friction.
L_T	friction pair
$\frac{\partial^2 \vartheta_1}{\partial z_1^2}$	friction path, m/s
a_1	Coefficient of thermal expansion, 1/K
ϑ_1	initial velocity, m/s
ϑ_2	last velocity, m/s
W_c	friction work
V_{yey}	volume of material consumed, m^3
f	friction coefficient
N	overload, N
L	friction path, m/s

1.0 INTRODUCTION

One of the major components in oil and gas industry is the vale being used to transfer the production from one to another location. Various parts of the valve constructions are always subject to different static and dynamic forces. The parts of the equipment are also subject to wear that is caused by friction as well as the tear which appears itself after a dedicated timespan. Besides, inner elements of the valve work under harsh environment that is classified with its highest abrasive wear and corrosion as well as a higher temperature factor (Linz et al., 2020).

The valve constructions that used for drilling and production differ from each other. Thus, the reason of failure in these operations are different. Studies run that to identify operational fault allows to divide the reason of failures into three main groups:

a) Deformation and fractures
b) Wear and Tear
c) Chemical-thermal damage

Wear caused by friction and tear are the main two reasons for valve hermetic elements rejections. Wear is classified to four main types due to its physical characteristics which are mechanical, chemical, or corrosive, electrical and wear caused by heat. The valve constructions work under different pressure distributions mainly applied to oil and gas industry where the mechanical failures are the main failure factor to consider. Special attention to be paid abrasive wear for the valves which is the type of mechanical wear.

This type of wear is much more complicated than the other types. Abrasive wear occurs when abrasive particles fall on friction surfaces. If the size of abrasive particle is smaller than the size of gap between pairs, then this particle has little effect on wear. Otherwise, according to the theory of micro-cutting, abrasive particle sinks into the softer metal and acts as a cutting tool. Thus, it begins to cut the second hard metal in joint. One of the commonly used valve types is the gate valve. It is mainly applied to harsh environment due to its good performance as well as positive sealing feature at higher pressures of systems as shown in Figure 1.

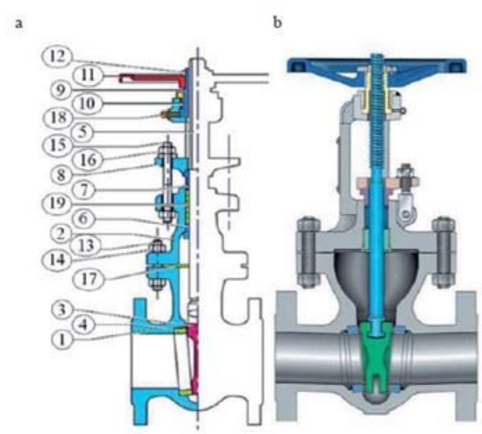

Figure1: Gate valve: a – cross-section (1 – body, 2 – bonnet, 3 – solid wedge, 4 – body seats, 5 – stem, 6 – back seat, 7 – gland follower, 8 – gland flange, 9 – stem nut, 10 – yoke nut, 11 – handwheel, 12 – handwheel nut, 13 – stud bolts, 14 – nuts, 15 – stud bolts, 16 – nuts, 17 – bonnet gasket, 18 – lubricator, 19 – packing); b – model with solid wedge (Adapted after Banko, 2019).

They are used in different industry applications. For instance, refinery, power plant, rigs, nuclear plants, wells etc. Flow velocity is another measure must be considered to choose the application of a valve in an industry. When it is higher, the partial opening of the valve could be ended up with the erosion to the walls of the valve (Banko, 2019). Gate valve is very versatile unit of the system which is used for closing and opening of the flow for production transfer. However, they require a huge number of forces to apply during opening and closing process of the valve. This is because to avoid the possible leakages might occur due to wear and tear. The is the main disadvantage for the gate valves. Apart, the valves are requiring several turning to apply for movement of valve gate up and down which leads to have it opened or closed accordingly.

Several studies carried out by the various authors to identify the wear effect of valve hermetic elements. Wear is occurred at a significant number in walls of valve, while there is a high velocity of the fluid passing through. Such a velocity can end up the partial open valve with erosion which will bring the usage period of valve to the end of its life span. Vibration is another factor which can cause the damage to hermetic elements of the unit (Quimby, 2007). Closing of valve is managed by lowering down the gate of the valve to the seat. This reduces the flow. Consequently, it decreases the pressure affect at lower body of the valve which is being proven by the pressure unequal distribution over the surfaces.

Krishnamurti et al (2019) reviewed the joints of the units which are mainly made by AISI 1040 steel. Elements prepared by the respective steel material is being operated under the high pressure which is continuously work under fretting wear. A test conducted for the steel material under nominal loads in order to determine the amount of fretting wear. At the result, the author concludes that wear depth increases in fretting condition during operational cases of the units.

Tianyang et al (2021) has reviewed different rigid bodies tribological analysis such as the grooves. They used picosecond laser partially textured thrust bearings to identify the wear coefficient over the bodies. A comparison matrix prepared in order to identify the differentials among gained result components. Besides, the authors offered a new method to use a two-dimensional analytical model for the chosen case. The transfer of the results to a two-dimensional system arranged and Reynold equation entered to the case due to have a consideration given to the mass cavitation. The experiment itself conducted in the machine classified as MMW-1 tribological rig. Friction value for various components achieved and its average coefficient calculated. The gained results compared to the friction reduction ratio, and this directed the author to run an analysis for the tribological performance of the chosen bearings.

Having the comparative analysis, experimental summary was in a good connecting with the theoretical analysis. Stress analysis (SA) in the critical parts of the gate valve conducted by using the Finite elements analysis methods (Jatkar and Dhanwe, 2013). The authors modelled the components of the valves in the CATIA V5R17 software. The FEM run for each component of the closing elements nodes in ANSYS - 11 software. Several working conditions considered for the simulation of components and achieved results compared in the program against each other. Conclusion for the results made by software and it is supported analytically by an SA by using solid mechanics classical theory.

Patil and Gambhire (2014) run a study through CAD software program. The model built up in CAD version and transferred for a FEA. The pressure increase achieved gradually and reached its highest operating pressure at the end. It allowed to simulate the pressure distribution over the body of valve hermetic elements. Once the FEA completed, the results collected for a comparison and transferred to apply the thermal and harmonic analysis as well as the electromagnetic simulation using CATIA. To optimize achieved results and conclude the research, Ansys Fluent software used to collocate actual pressure parameters in hermetic elements of the valve where touching surfaces are in relationship with each other.

The research that is conducted by Wang (2014) is referred to the CAD/CAE system. The Author reviewed several factors in the paper which are considered as a crucial factor for the type of wears to occur in the critical parts of a valve. Fluid flow was the first parameter that has been researched in the paper and a relationship provided between the fluid flow and flow velocity. Besides, the wall thickness measurement considered in the paper and an overview for the research conducted to identify the effects of flow onto the inner elements which has a small gap between the packing units and body wall.

Pujari and Joshi (2016) run an analysis to define optimization of gate valve parameters. The research mainly based on the design of gate valve bodies which are different in several constructions. FE analysis was the tool used for investigation. Stress analysis of different bodies conducted by the researcher for gate valve elements.

Katkar et al (2017) researched the critical components of the gate valve such as the hermetic element parts. The analysis run by applying different techniques. The design factor considered for valve constructions and wear factor was taken as a main point during the evaluation. CATIA software used to define the flow's affect over the body walls. Achieved equations from the analysis applied in ANSYS workbench as a software package and the flow simulation conducted. The conclusion of the paper was with definition of the FEM techniques.

Various constructions of valve available in oil and gas industry. Despite most of the valve bodies made by carbon steel, some of them developed to be made by stainless steel. Varun Kumar et al (2019) researched increasing of duplex stainless-steel hardness. DSS are designated to have 2 phases which are consisted of nearly 50% austenite and 50% ferrite. Such a combination makes the materials to be much more resistance in terms of corrosion. Such materials also gain a higher hardness in surface. The Authors tested an experiment in a heating temperature and gained a result of 311.235 BHN for the chosen steel material. From the experiments and the simulation analysis, the authors concluded that DSS hardness factor can only be defined due to the percentage of the austenite in it. Summary of the paper is given a conclusion for the topic that the increase of austenite in the material surface will have a positive effect for an increase of the material hardness.

There are several works in the literature dedicated to numerical or simulation solutions for eliminating of the wear factor to a minimum for valve constructions. This is because of increasing the workability of valves. Although the studies declare minimalization of wear for the hermetic elements, it cannot be negligible for all the parts. Therefore, the studies concluded that decrease of wear factors in the valve elements are expectable, however its avoidance is almost nonexistent. The purpose of this paper is to simulate frictional heat mechanism and turbulence dissipation during valve semi-open position. The simulations process for the thermal conductivity, as well as turbulence flow conducted by using SolidWorks software program.

2.0 SIMULATION OF IMPROVED VALVE CONSTRUCTION IN SEMI-OPEN POSITION

2.1 Governing Equations

The main type of wear in oil and gas industry is mechanical wear. Cause of wear is usually being classified because of friction. Friction is the main factor which needs to be considered in all steps of hermetic elements sealing process. During friction, interaction of working surfaces of the parts is accompanied by intense heat release. Plastic deformation and cutting of roughness create distortion in the crystal lattice of material in the parts, which is the first to detect local heat. In actual contact surfaces there up to 100 C heat could be generated (Aslanov J.N. 2011).

At the result, due to materials friction parts thermal conductivity, the heat released during friction is divided into several heat fluxes. Some of these flows are directed into each of interacting parts and the other to the environment. Thus, working surfaces of joining parts are accompanied by heat distribution to the material or environment. The law of parts friction surfaces average temperature change can be obtained according to the law of energy conservation. d_τ amount of heat released because of interaction of surfaces in a unit time which is $F_T d_\tau$. This amount is used to heat the parts and transfer it to the environment. In this case, the heat balance equation can be written as follows:

$$\phi_T d_\tau = Cdt + A_t d_\tau \tag{1}$$

here, ϕ_{T} -heat flow, Vt,

$$\phi_{\mathrm{T}} = {}^{\mathrm{Q}}/_{\tau} \tag{2}$$

Q - amount of heat, coul,
τ - heating time of the part, sec
C - total heat capacity of the part C/K,
A- heat flux on the entire cooling surface of the part when temperature changes by 1° Vt/K, :

$$\mathrm{A} = \alpha \bullet \mathrm{S} \tag{3}$$

α - heat transfer coefficient, Vt/m^{2}K,
S - the area of the heat transfer surface, m^2

The established maximum temperature of working surfaces does not depend on mass of the t_{max} particle, initial temperature, but depends on amount of heat released in a single time unit and heat transfer conditions.

Provided that the latter equality is considered, regularity of increase in temperature of parts working surfaces during friction is described by an exponential dependence :

$$\mathrm{t} = t_{max}(1 - e^{-\frac{\tau}{T}}) = t_0 \bullet t = t_{max} (1 - e^{-\frac{\tau}{T}}) = t_0 \bullet e^{-\frac{\tau}{T}} \tag{4}$$

if we consider that $\phi_{\mathrm{T}} = 0$, in the basic equation of heat balance, then we get the cooling equation:

$$A_t d_\tau + \mathrm{Cdt} = 0 \tag{5}$$

then,

$$\mathrm{t} = t_{max} - e^{-\frac{\tau}{T}} \tag{6}$$

The following has not been considered in description of temperature change processes on working surfaces of parts in friction pairs:

a) Environmental heat capacity is too large that its temperature does not change in heat exchange
b) cooling conditions are the same throughout the pair surface
c) heat capacity and heat yield do not depend on temperature
d) temperature is the same at all points on the pairs surface

An increase of working surfaces temperature leads to a change in mechanical and molecular components of friction force. Changes in mechanical particles of friction force for metal surfaces are mainly due to a decrease in the hardness of the material (Aslanov, 2011). Exponential dependence of change in hardness for metal materials under increasing temperature conditions is described as per following:

$$H = H_0 \bullet e^{-\beta \Delta t} \tag{7}$$

where,
H_0 - hardness at annual temperature,
β- temperature coefficient,
Δt- is the temperature coefficient when the surface heats up due to friction.

As a result of changes in the temperature of working surfaces, molecular structure of friction force may decrease, increase or even not subject to a change. In external friction process, dependence between working surfaces friction force and temperature usually exceeds its minimum. This minimum joint is best suited to the temperature regime. To find temperature field in volume of friction pair elements and average temperature of friction area, need to consider a simplified model of one-dimensional heat problem objects in contact. In this case, do not consider heat transfer in friction process (Oday, et al. 2019). Usually, the presence of temperature flash changes between 10^{-3}... 10^{-6} second. Therefore, the equation is made for average size d at the point of contact. The friction path of a single contact L_T friction pair depends on materials mechanical properties, surface microenvironment, intensity of physicochemical processes of friction and the wear on friction contact. In this case, the friction path can be evaluated by solving the following equation:

$$\frac{\partial^2 \vartheta_1}{\partial z_1^2} = \frac{1}{a_1} \frac{\partial \vartheta_1}{\partial t} \tag{8}$$

here, $\lambda_1 \frac{\partial \vartheta_1}{\partial z_1} = q_1$ $z_1 = 0$ $\vartheta_1 = 0$ $\vartheta_2 = \infty$

when

$$0 \le t \le t''_{bcn} = {}^{d_r}/_{v_{ck}} \tag{9}$$

then,

$$e_c = \frac{W_c}{V_{yey}} \tag{10}$$

here, W_c – friction work; V_{yey} – volume of material consumed.

$$W_c = f \bullet N \bullet L \tag{11}$$

f -friction coefficient
N - overload
L- friction path

2.2 Model Definition and Mesh Details

To simulate heat transfer over improved valve construction inner elements, the model of the gate valve built up via Solidworks. Several side effects avoided while building up the model. Wall condition of valve is chosen as adiabatic wall and transfer transparently reviewed over the hermetic elements of unit. Hermetic elements of the valve chosen as their given construction and open, semi-open, close positions of valve reviewed. The heat transfer for open and closed position of the valve are identifiable, however semi-open position is different for the given construction. The fluid is passing through sealing parts under 45 degree and weariness occurred in given model during dedicated timeline.

Atmospheric pressure considered in outlet of the valve, whereas inlet is followed with working pressure. Heat transfer over the elements divided due to the relative pressure distribution. Thus, the diagram and results of the pressure distribution over the valve inner elements identified prior to processing with the heat transfer and its conductivity. Boundary conditions for meshing is noted as default given by program itself. 2D plane flow reviewed over the inner body of the construction. Static pressure and temperature were chosen as an initial thermodynamic parameter of the unit. Velocity vector is another point of factor which is considered during the flow movement. Despite the flow is laminar for valve constructions, there might be a turbulence observed while the position of valve set to 45 degrees. Therefore, turbulence characteristics of valve was given as per following; (a) Turbulence intensity of 2.00 % indication and (b) Turbulence length of 0.002 m. Static pressure applied in inlet; however, it is being summed up with the atmospheric pressure in outlet. Therefore, tow boundary conditions considered for the current case. Table 1 shows the boundary condition details of test for static pressure applied case. Table 2 illustrates the boundary condition details of test for environmental pressure applied case.

In current simulation flow freezing strategy is turned off and it is considered that improved valve constructions inner elements always subject to various amount of heating.

The inlet and working pressure for the current case consider the same as 70 MPa. The martial chosen for the valve hermetic elements is considered ST 20 (GOST 7809). The characteristics of steel material is not considered in the simulation process considering the current study is to identify the heat distribution over the valve body in three different cases independence from their materials. Points described above transferred onto SOLIDWORKS 2021 SP 4.1. by opening a new model file and 3D model of the improved valve construction made as shown in Figure 2.

Table 1: Details of test for static pressure applied case.

Details	**Parameters**
Type	Static Pressure
Faces	LID14-1/Imported1//Face
Coordinate system	Face Coordinate System
Reference axis	X
Thermodynamic parameters	Static pressure: 7.00e+07 Pa
	Temperature type: Temperature of initial components
	Temperature: 293.20 K
Turbulence parameters	Turbulence intensity and length
	Intensity: 2.00 %
	Length: 0.002 m
Boundary layer parameters	Boundary layer type: Turbulent

Table 2: Details of test for environment pressure applied case.

Details	Parameters
Type	Environment Pressure
Faces	LID13-1/Imported1//Face
Coordinate system	Face Coordinate System
Reference axis	X
Thermodynamic parameters	Environment pressure: 101325.00 Pa Temperature type: Temperature of initial components Temperature: 293.20 K
Turbulence parameters	Turbulence intensity and length Intensity: 2.00 % Length: 0.002 m
Boundary layer parameters	Boundary layer type: Turbulent

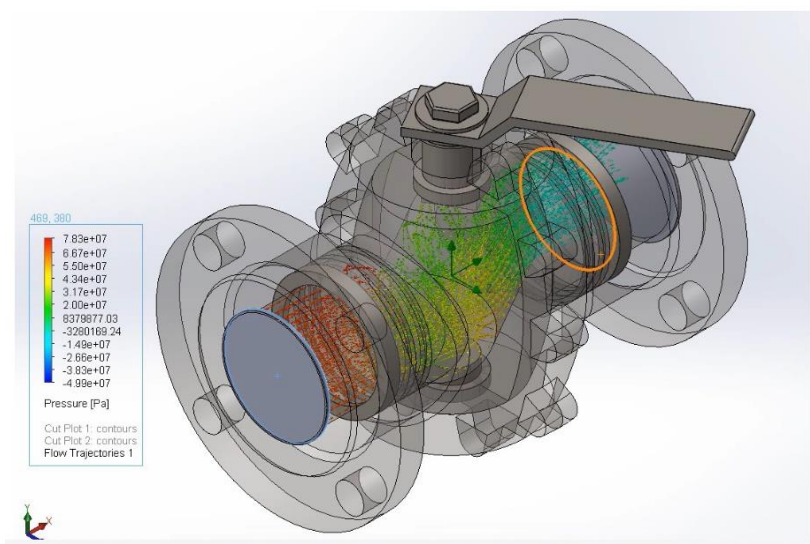

Figure 2: 3D Model of improved valve construction drawn in SOLIDWORKS 2021, SP 4.1.

3.0 RESULTS AND DISCUSSION

After preparation of the simulation model, it is applied to check the distribution of flow parameters over inner elements of improved valve construction. Flow simulation considered in direction of hermetic elements joint body. Type of wears occurred in main parts of valves differ from each other due to several factors. Initial applied pressure to inlet of valve being distributed over the hermetic elements of construction. First step considered to run a pressure distribution simulation for the hermetic elements. Figure 3 shows relative pressure distribution over the valve hermetic elements in semi-open position. In essence, the pressure distribution is in its maximum in inlet, however it turns from red to green once the flow running obtained

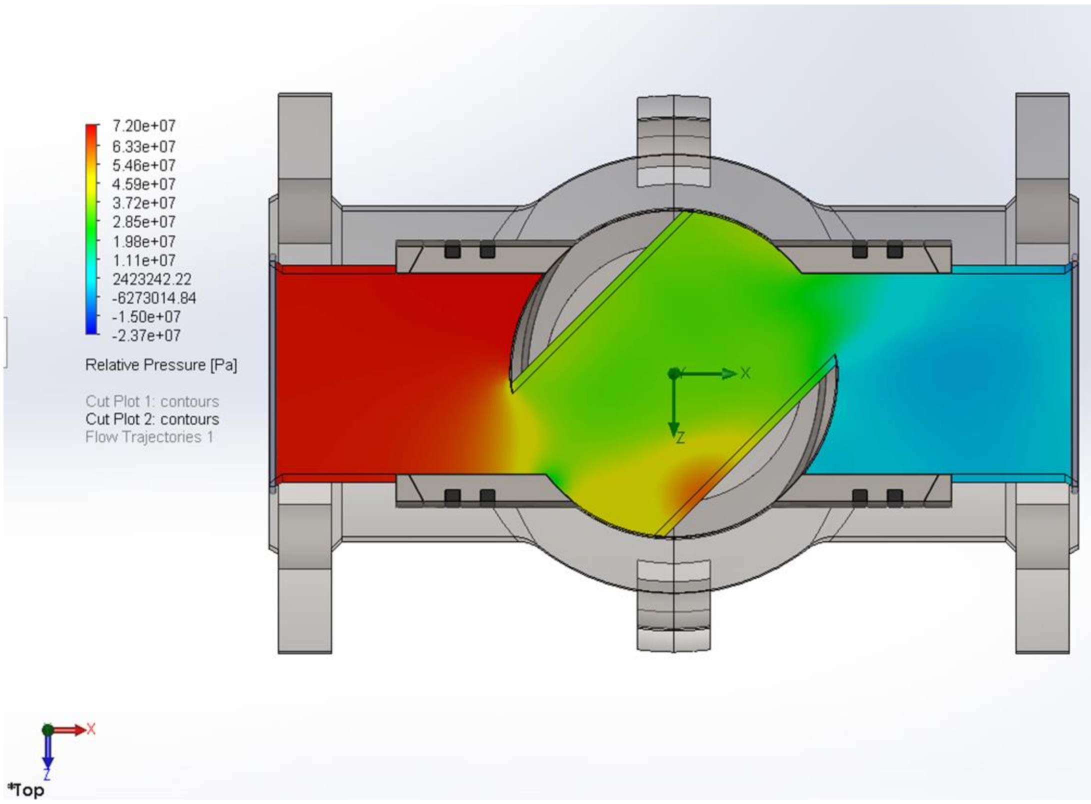

Figure 3: SOLIDWORKS 2021, SP 4.1 simulation of relative pressure over the valve hermetic elements in semi-open position.

Despite the pressure distribution of flow is approximately equal in the middle of gate, it changes and increases in the edges. This can be easily noticed form Figure 3 where the edges of gate have different angles. In simulation, it can be classified by change of the color in flow from green to light red. Product passes through the valve is not always water. Production extracted from oil wells, or oily liquid transferred from one to another point can contain abrasive particles which will lead to an abrasive wear after a timeline followed by such kind of irrelevant pressure distribution. Laminar flow is a characteristic feature for such type of valves. However, it is noted that the valve is also subject to turbulent flow at some points considering pressure changes and various type of production passes through the valve. Due to simulate the turbulence of flow over the inner elements of valve, a loading condition produced. This is made based on the flow velocity and pressure distribution.

Figure 4 illustrates simulation of turbulent viscosity over the valve hermetic elements in semi-open position. Despite, turbulent viscosity is not visible at the first points, it is increased while the flow passes the semi-open positioned hermetic elements. Close to the outlet, turbulent viscosity is much more visible which is colored differently in Figure 4. The pressure distribution in the beginning considered as 0, however it is increased gradually afterwards. The difference between 2 points is around 12 Pa.s. Figure 5 shows the simulation of turbulence length. Its affect to the valve hermetic inner elements is relatively visible from the figure, however the turbulence length is divided too many particles which affects the valve inner wall. This case can be noticed in the semi-open position of the valve construction. Inlet and outlet turbulence distribution is different from each other.

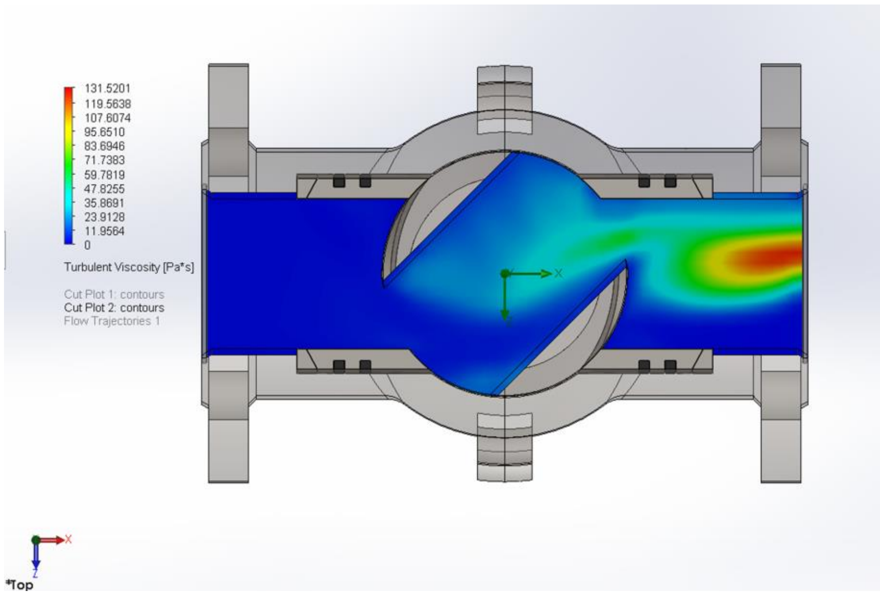

Figure 4: SOLIDWORKS 2021, SP 4.1 simulation of turbulent viscosity over the valve hermetic elements in semi-open position.

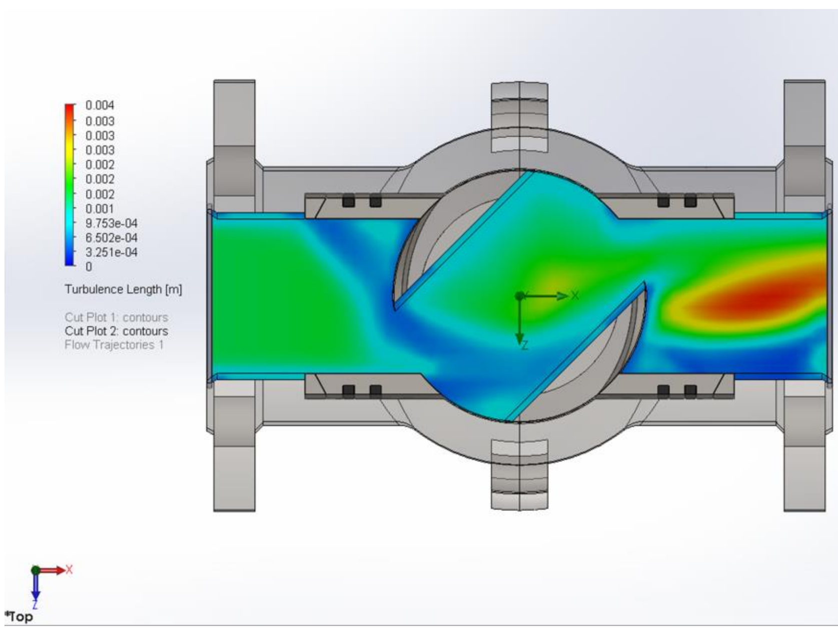

Figure 5: SOLIDWORKS 2021, SP 4.1 simulation of turbulence length over the valve hermetic elements in semi-open position.

70 MPa pressure applied statically to inlet. In the beginning the flow is considered laminar, and therefore turbulence length was close to zero till the opening achieved. Afterwards, it increased after each 3 iterations by 0.001 m which is very low parameter that could be avoided in calculation of the flow passing through valve. However, turbulence flow is also consisted abrasive particles which is ending up damaging the inner surface of the valve as well as the hermetic elements. Another factor which leads to have relatively high level of wear in valve constructions is high velocity of flow that carries the small sand nodes or some other small grains. Figure 6 explicates velocity movement and affect to valve parts during higher flow rates. Basic purpose to run this simulation to run an investigation for identification of fundamental wear techniques and effect of critical parameters those used to open-close valves.

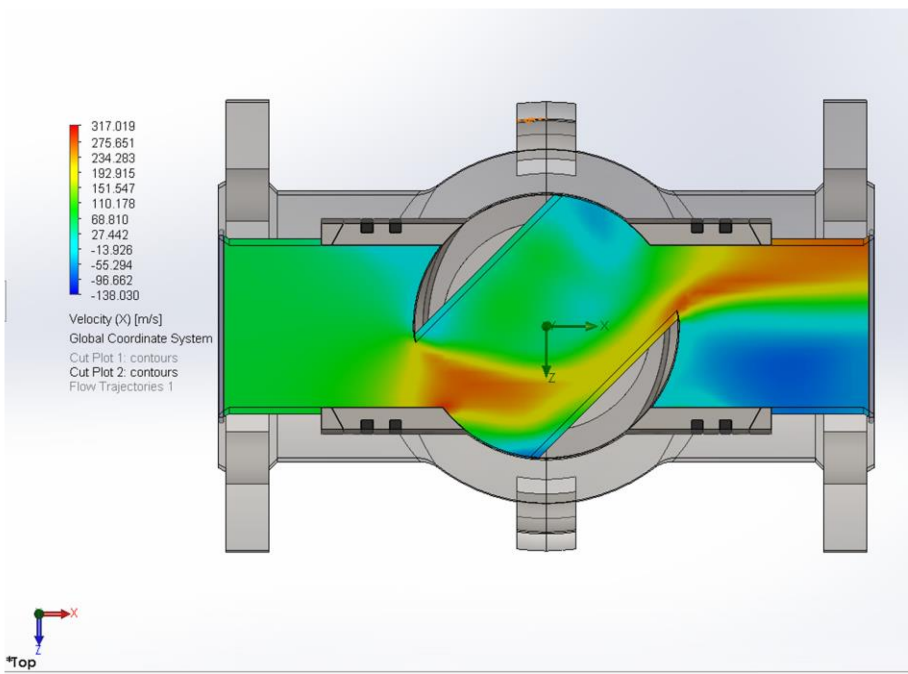

Figure 6: SOLIDWORKS 2021, SP 4.1 simulation of velocity (in X axis) over the valve hermetic elements in semi-open position.

Hermetic elements of proposed valve construction are being also subject to various amount of heat process. Hence, the wear occurred by heating is almost unavoidable. Above parameters of valve considered for another simulation to run to identify heat effect to the valve inner elements. Figure 7 shows simulation of heat transfer over the valve hermetic elements in semi-open position. The initial temperature considered 293 K, however the simulation program decreased it to 287.93 K to divide the range of increase proportionally. Temperature increase is followed by the pressure and velocity increase and their effects to the inner elements of valve. After a while the temperature increment reached to 296.66 K, and then raised to 303.21 K. In this range the functionality of valve was remaining, however the wear factor gradually noticed in the edges of gate. In last pats, temperature increase reached its maximum of 311.94 during the given pressure - 70 MPa.

Temperature changes and its affect to materials are one of the significant factors which leads to wear and tear in elements. The rejection of valves is mainly due to overheating. The unit must operate in lower operational modes during parts adjustment. Otherwise, because of friction at contact of micro-points, the temperature may rise too much, causing material of the part to melt and corrode rapidly. The details of temperature changes graphically looked at in 2-dimensional system by software and relevant results produced.

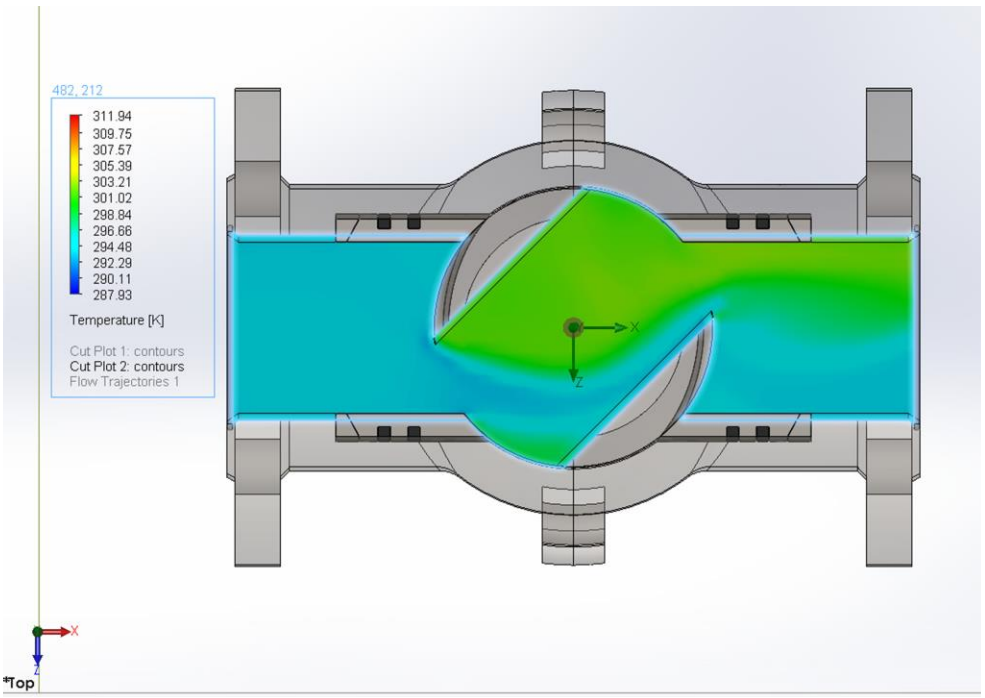

Figure 7: SOLIDWORKS 2021, SP 4.1 simulation of temperature over the valve hermetic elements in semi-open position.

Figure 8 (a) shows the dependence between temperature and density. It is noticeable that the density dependance from temperature is inversely proportional. While density is reached its 1000kg/m^3, temperature slightly exceeded 500 K. Optimal parameters for temperature dependance from density is settled below 300 K. Figure 8 (b) illustrates dynamic viscosity's dependance from Temperature. While the temperature increased in the border of given parameters, dynamic viscosity decreases to its minimums. However, it is noticeable from graph that the dynamic viscosity reached its first minimum when the temperature range was approximately 300K. Comparison between graphs 8a and 8b give us a solid background to state that the temperature increase decreases dynamic velocity as well as density. While the density of flow is low and viscosity decreased in the flow, the velocity of friction and wear as the consequence of it are subject to increase.

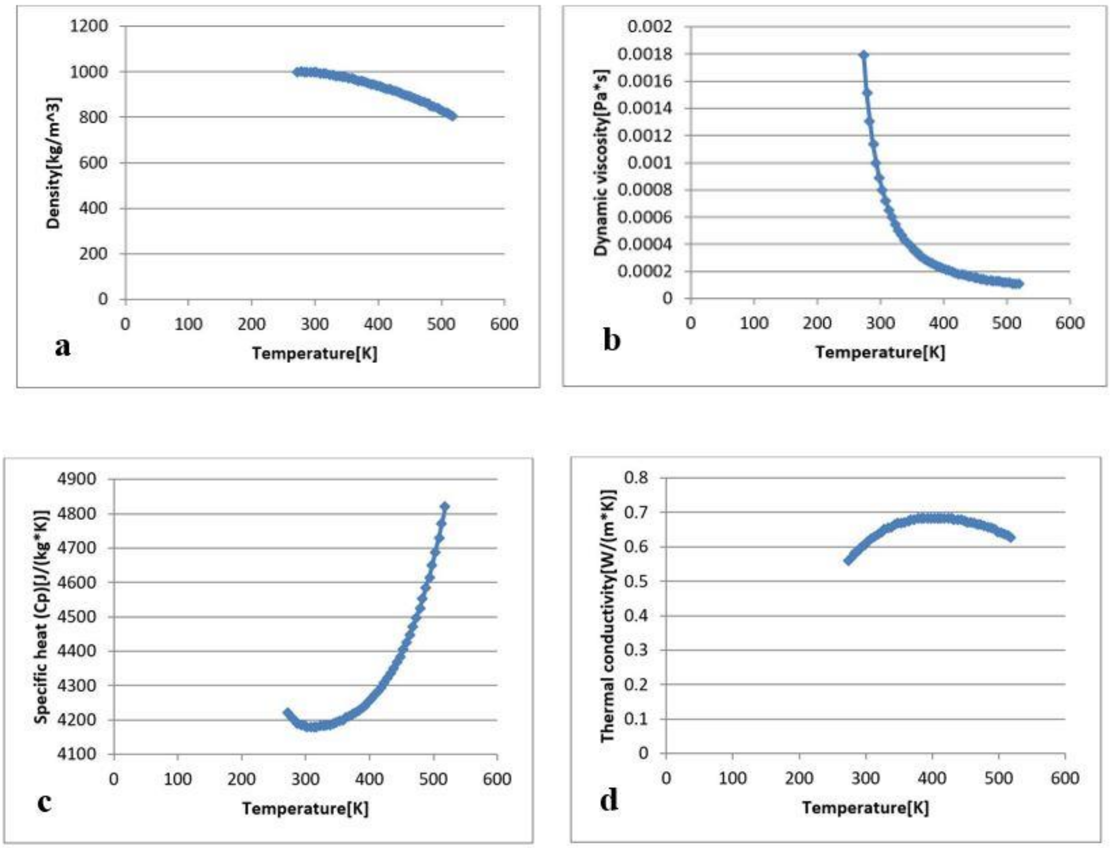

Figure 8: Parameters dependance graphics with temperature as a variable, (a) Dependance of density from temperature; (b) Dependance of dynamic viscosity from temperature; (c) Dependance of specific heat from temperature; (d) Dependance of thermal conductivity from temperature.

Figure 8 (c) shows specific heat differentiation due to the temperature changes. At initial point special heat considered to be in a range of 4200-4300, however it is increased followed by the normal temperature increment. Figure 8 (d) illustrates thermal conductivity dependance from temperature. Considering thermal conductivity is directly dependent on temperature as well as the material itself, therefore it never gets to be 0. The variables for thermal conductivity during change of temperature is another factor to be considered and based on while the wear factor researched. It can be noticed from the comparison of 8 (c) and 8 (d) that temperature increase is proportionally affecting neither specific heat nor thermal conductivity.

All above referenced discussions conclude that the wear factor for valve hermetic elements is one of the main points still to be reviewed and improved to achieve a decrease in amount. One of the main issues in oil and gas industries equipment development and operation is to solve the problem of wear of parts. This requires minimizing wear intensity of parts, creating and selecting new materials that provide wear resistance, as well as extensive use of surface reinforcement methods (Dzhanakhmedov et. al 2018).

Figure 9 illustrates a part which has thickness of d, and surface is being reinforced. Current industrial demands change day by day and it requires much cheaper materials to be utilized for a long timeline with the high efficiency. Provided new valve constructions hermetic elements materials are considered stainless stell which is much higher cost compared to relevant carbon steel. Two main methods are currently being applied for reinforcement which are the laser techniques or thermal processing. Therefore, it is being recommended that surface of carbon steel construction to be reinforced with a material which is resistance to heat transfers. In essence, it was visible that the heat transfer which leads to wear process increased while the overall pressure in inlet gradually raised. The pressure distribution over the valve inner elements is not equal at each point as well as heat effect differ from in the edge of gate compared to the mid-section.

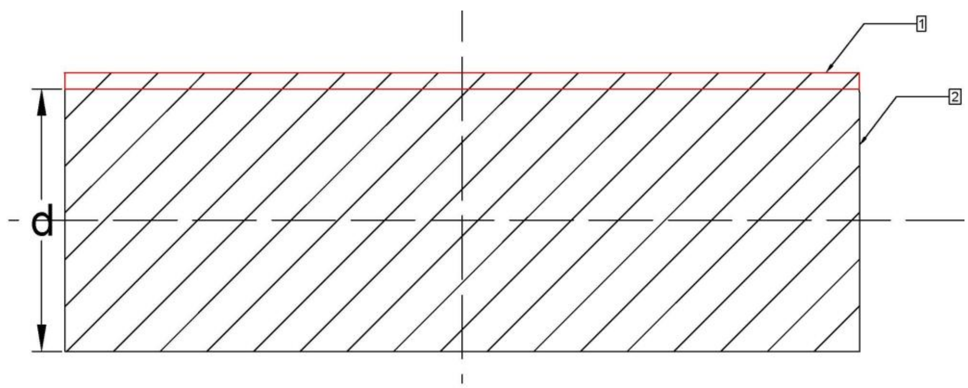

Figure 9: Material surface reinforcement.

CONCLUSIONS

In this paper, the authors have examined the temperature-dependent wear assessment on the improved valve construction working surfaces. In this particular, a solidworks model of new valve constuction made and overall review run over the hermetic elements of the stucture. Studies shown that working surfaces of valve structures are more prone to wear depending on the temperature distrubance. At result, consurtcuion workability decreases and consequently conlcuded with a failure of the valve. Therefore a further study of wear in inner element of the valve is a pressing problem. Current research has illustrated that changes in temperature affect expansion of the valve parts and joints internal materials structure, and this effect leads to an uneven distribution of internal stresses.

In our study, interaction of new valve structure proposed materials with wear under temperature influence was carried out in solidworks program. As a result, several simulation grapichs produced such as simulation of relative pressure, temperature, velocity, turbulent viscosity, trubulent lenght over the valve hermetic elements in semi-open position. Moreover the temperature dependance grapichs from dynamic vistosity, specific heat, thermal conductivity, specific heat are exported. Processing of the results showed that wear occurs faster at the crisis point of surface temperature thickening over a period. In order to solve the problem, thermal treatment of temperature-resistant coatings over the hermetic elements surfaces is required. Based on the results obtained, parameters such as temperature change, velocity, pressure distribution over the hermetic elements of improved valve construction, specific heat, thermal conductivity, and turbulence dissipation can be investigated. Further studies can also be carried out in order to elucidate the given conclusion in detail by running the physical experiments for surface reinforcement.

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