RIGA TECHNICAL UNIVERSITY

Riga Technical University
61st International
Scientific Conference

MECHANICAL ENGINEERING TECHNOLOGY
AND HEAT ENGINEERING

PROGRAMME AND ABSTRACT BOOK

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2020

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and Heat Engineering

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INNOVATIONS IN HEAT AND ELECTRICITY GENERATION TO BOOST ENERGY EFFICIENCY

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European policy in the energy sector aimed in decarbonisation of electricity and heat production requires power plant operators to look for innovations and new technologies to boost energy efficiency and reduce its footprint on environment. With increase of intermittent generation (wind and solar PV), reduction and high variation (more cycling) of electricity output of thermal power plants, the importance of different energy storage technologies start to prevail. Heat storage ensures savings of primary energy consumption, reduction in CO_2 emissions and enhancement of security of heat supply (figure 1). This is achieved by optimised utilisation of generating capacities in power plants.

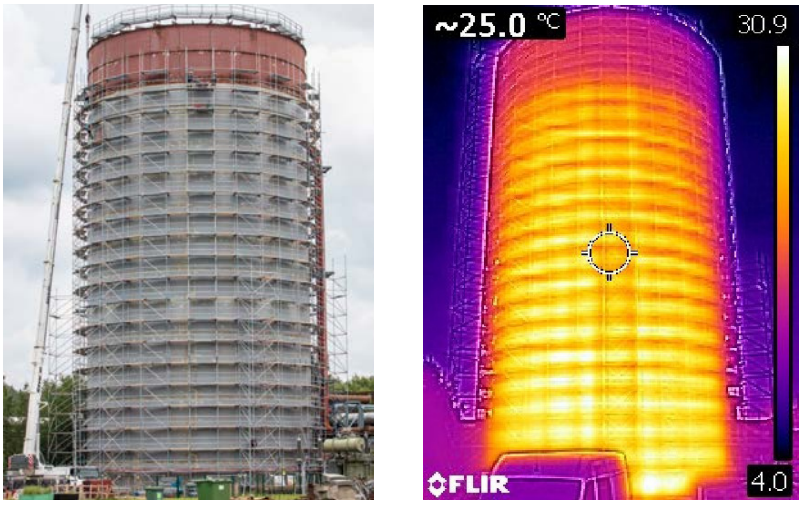

Figure 1. Construction of heat storage tank in Riga CHP-2

It is obvious that during the initial stage of decarbonisation process European society will be highly dependent on energy production from fossil fuel power plants. That is why it is of key importance to improve energy efficiency and reduce CO_2 emission by improving technological process.

After the synchronisation of Baltic power systems with European continental networks, new requirements on electricity generators (RfG) and ancillary services (such as FCR – frequency containment reserve and inertia) shall be ensured. Existing generators could ensure such services, but not for entire 24/7/365 period. That is why battery electric storage systems (BESS) are considered.

In the future the great role for "green" hydrogen production in "Power-to-Gas" conversion, hydrogen storage and hydrogen utilisation in gas turbines in "Gas-to-Power" conversion is forecasted.

Acknowledgements

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BIOMASS PELLETS COMBUSTION PROCESS ACTIVATION WITH MICROWAVE PRE-TREATMENT

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Biomass as a source for energy is becoming widespread with the policy of EU towards the climate neutral Europe. Biomass pellets are a popular fuel for households as well as for industrial utilization, but the sources are limited. With the objective to expand the sources with agricultural and forestry residues and to improve their characteristics experiments of the effects of microwave pretreatment on the biomass combustion process were carried out.

The impact of microwave pretreatment on the kinetics of biomass pellets chemical transformation processes, the kinetics of combustion dynamics has been conducted experimentally considering the effect of pellet activation with microwave pretreatment on flame temperature, velocity and flue gas composition variations, as well as the amount of heat released in process of biomass gasification and combustion of volatile compounds.

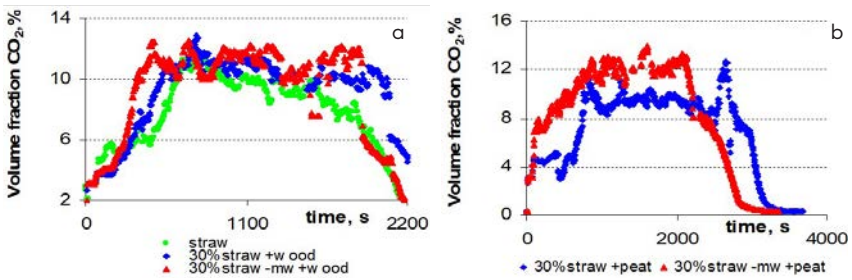

Figure 1. The volume fraction of CO_2 a – straw, straw mw and wood mixtures, b – straw, straw mw and peat mixtures.

It was approved that mw pre-treatment of pellets activates the thermal decomposition of the main constituents of biomass (hemicellulose, cellulose and lignin), their faster ignition and burnout, which depends on the duration of mw pre-treatment of biomass pellets. The amount of produced heat power by the device for mixtures with activated straw pellets increases – respectively for wood pellets by 12%, but for mixtures with peat pellets by 20%. Faster and more complete combustion of volatile compounds was confirmed by an increase in the maximum and average values of the volume fraction of the main combustion product (CO_2) (2-3.2%) and a correlated decrease in the average and minimum values of the air excess value.

Acknowledgements

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BIOENERĢIJAS IZMANTOŠANA NĀKOTNĒ

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Saskaņā ar Eiropas Savienības stratēģiju, līdz 2050. gadam tiek plānota Eiropas klimat neitralitāte (100 % SEG emisijas samazinājums) izmantojot vairāk bioenerģijas. Klimat neitralitātes mērķis Eiropas Savienībā, noturēt pasaules vidējās temperatūras pieaugumu līdz 1,5–2 grādiem Celsija [1].

Bioenerģijas ražošana no 2000. gada strauji aug (1. att.) un pateicoties Eiropas Savienības stratēģijai paaugstināsies vairākas reizes līdz 2050. gadam [2, 3].

Bioenerģijas izmantošana kļūs īpaši lietderīga transporta sektorā, spēlējot svarīgo lomu izmešu samazināšanā kravu pārvadājumiem [2].

Saskaņā ar Starptautiskās Enerģētikas aģentūras (IEA) prognozēm, bioenerģijas ražošana pasaulē 2030. gadā pārsniegs 1000 TW stundas (1. att.) [3].

1. att. Bioenerģijas ražošanas dati un prognoze [3]

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TRANSPORTA LĪDZEKĻA AVĀRIJAS TEHNISKĀ ANALĪZE

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Mūsdienās pieaug transporta līdzekļu daudzums, darbības ātrums, līdz ar to novēro vairāk to avārijas. Tas nes līdzi ne tikai finanšu zaudējumus, bet arī cilvēku upurus. Transporta darbības nodrošināšanai jāveic to nepārtraukta uzraudzība.

Aviācijas tehnikā stingri noteikti veicamie pārbaudes darbi, gan pēc nolidoto stundu skaita, gan pēc attāluma. Ja dzinēju darbības kontrole tiek realizēta stingri noteiktā kārtība, tad lidmašīnas spārnu, astes stāvoklis tiek kontrolēts visu lidojuma laiku.

Sliktāks stāvoklis ir ar lidmašīnas šasijas apkopi un regulāru kontroli. Tieši lidmašīnas nosēšanās laikā tā saņem ievērojamu dinamisku triecienu.

Dotā gadījumā priekšējas šasijas balsta konstrukcijas daļa – leņķa atloks, kurā nostiprināta horizontālā ass, ekspluatācijas laikā salūza.

Lūzuma tehniskā analīze parādīja, ka lūzuma sākuma vietā lējumā bija neliels ieslēgums vai cits struktūras defekts. No tā sākās mazcikla noguruma lūzums, kas attīstījās pakāpju veidā. Kad palikušais dzīvais šķērsgriezums nevarēja izturēt nosēšanas laikā radīto slodzi, tas trausli sagruva un priekšējā šasijas balsta konstrukcija pārstāja normāli darboties. Avāriju varēja novērst regulāras konstrukcijas apskates-monitorings.

HEAT TRANSFER PROCESS IN LASER WELDING TECHNOLOGY

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The laser beam application for metal treatment technology like welding, cutting and cladding become common tool in modern technology. High-power laser systems up to 100 kW make possible welding in single pass the metal with thickness up to 50 mm. Welding speed along keyhole up to 2 meter per minute and great power density of focused laser beam up to 10^6 MW per square meter will create temperature gradient up 5513 K/mm for non-oscillating laser welding, however. During short flight time of 70–80 microsecond temperature of powder particle (cladding process) in laser beam will increase from ambient to melting level of 1673 K, then during 15 microseconds will occur melting and in additional 150 microseconds temperature will reach 3200 K at evaporation level.

The complete understanding of laser treatment process of materials requests deep consideration of heat transfer process consideration during laser beam interaction with metal. It is important to consider different materials processing like stainless steel SS304 with heat conductivity of 27 W/mK or aluminium alloy 5083 with heat conductivity of 120 W/mK – both for solid state. The combination of solidification rate R (mm/s) and temperature gradient G (K/mm) will create dendritic structures of metal after laser processing.

Number of parameters are considered in many researches works, like distribution of power in laser beam cross section, thermal conduction and convection ratio described by Peclet number, also Marangoni force to buoyancy in molten pool and liquid surface tension to electromagnetic forces.

The calculation of unsteady heat transfer during warming and cooling process allow to create temperature distribution as function of time and position in metal. This calculation possible to perform by numerical or analytical way. Analytical solution for transient heat

conduction involves time t, coordinate r, thermal diffusivity of metal α, density ρ and specific heat C_p described by equation

$$T(r,\tau) = T_0 + \frac{Q}{4\pi\lambda r} erfc \frac{1}{2\sqrt{Fo}}$$

where Q is energy of focused laser beam absorbed by metal surface calculated from available experimental data and $Fo = \alpha\tau/r^2$ dimensionless time represented by Fourier number.

This fundamental solution for fixed amount of energy instantaneously released (as thermal explosion) were considered together with another well-known analytical equations with purpose to estimate deviation of analytical equations from available results of numerical and experimental investigations. Further consideration reveal influence of Biot and Fourier numbers for transient process description.

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TEMPERATŪRAS UN GAISA MITRUMA IETEKME UZ METĀLS-LEDUS SLĪDĒŠANAS ĪPAŠĪBĀM

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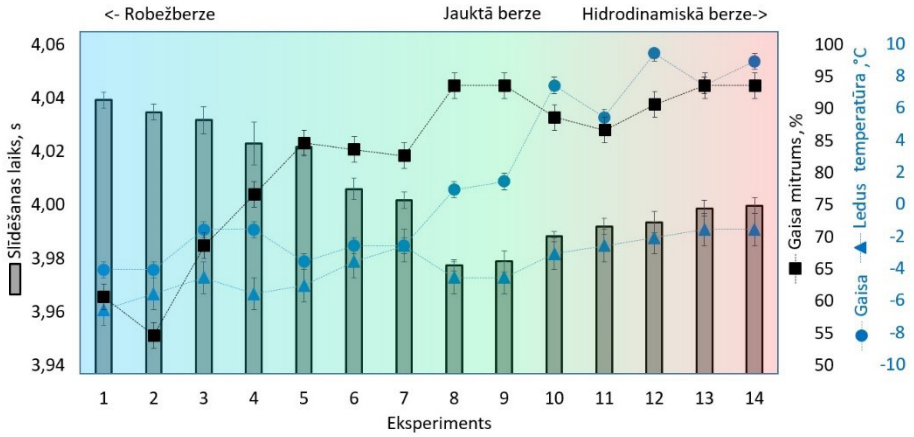
Līdz šim zinātnieki ar ledu saistītos pētījumos nedefinē pilnvērtīgi apstākļus kādos norisinās eksperiments, lielākoties ņemot vērā tikai ledus temperatūru, kā eksperimentu apstākļus raksturojošo parametru [1–4]. Taču norādot tikai ledus temperatūru un, neņemot vērā citus parametrus, kā gaisa mitrumu un gaisa temperatūru, kas ietekmē robežslāņa uz ledus biezumu un attiecīgi objekta slīdēšanas īpašības [5], rodas neizskaidrojami eksperimentu rezultāti un zūd salīdzināšanas iespējas starp dažādu autoru darbiem. Rezultātā, ja tiek pētītas, piemēram, objekta slīdošās virsmas tekstūras izmaiņas, var rasties būtiski atšķirīgi rezultāti ar dažādām pētījumu metodēm pie it kā līdzīgiem, nepietiekami definētiem, eksperimentu uzstādījumiem.



1. att. Kopējā slīdēšanas laika atkarība no gaisa temperatūras, ledus temperatūras un relatīvā gaisa mitruma.

Pa liela izmēra slīpo plakni, tika veikti 14 eksperimenti, izmantojot skeletonu, kā eksperimentālo objektu, atšķirīgās dienās un salīdzināts kopējais slīdēšanas laiks 24 metru garā posmā. Rezultāti tika analizēti kā neatkarīgu parametru – gaisa mitruma, gaisa temperatūras un ledus temperatūras ietekme uz kopējo slīdēšanas laiku, kā arī kā 3 parametru savstarpējā mijiedarbība uz kopējo slīdēšanas laiku (skat. 1. att.).

No iegūtajiem datiem, visnenozīmīgākā sakarība tika novērota starp ledus temperatūru un slīdēšanas laiku. Ja tiek apskatīta iegūto rezultātu mijiedarbība (skat. 1.att.), ātrākais slīdēšanas laiks tika iegūts pie potenciāli jauktās berzes režīma (autoru darbos tiek uzskatīts kā optimālie slīdēšanas apstākļi [5,6]), palielinoties gaisa un ledus temperatūrai slīdēšanas laiks nedaudz palielinājās, taču temperatūrai un gaisa mitrumam krītoties, slīdēšanas laiks palielinājās ievērojami.

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COMPARISON OF EXPERIMENTAL AND THEORETICAL WEAR STUDIES OF SLIDING FRICTION PAIRS OF METALLIC SURFACES

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A great number of different mechanisms in mechatronic systems may involve sliding-friction surfaces. One of the principal objectives of modern production process is the improvement of quality level. This means also guaranteeing the required service life of different products and increase in their wear resistance. Having studied the wear process prediction theories that have been developed in the course of time one can state that each of them has different shortcomings, which might affect the result precision, when essential basic parameters have been disregarded. Another approach how to determine the service life is to make long-time practical experiments which quite often requires specific equipment.

The wear process is characterised and affected by different parameters: the geometry of surface peaks (roughness, buckles, shape deviations, etc.), physically-mechanical conditions of the upper layer, material of components, temperature of sliding fittings during the wear process, wear conditions, etc.

Already initially there is a problem that all these factors affecting the fittings' wear process cannot be taken into consideration in the analytical calculation and therefore the wear calculation development in the course of time went into different directions. Each this direction made theoretical calculations assessing sets of affecting quantities.

The article determines the most suitable theoretical wear calculation model that allows considering the set of parameters necessary for calculating slide-friction pair. Wearing usually proceeds in three stages: the running-in stage, the normal wear stage, and the intensive wear stage.

The proposed model is provided for normal wear stage calculations. The proposed model for wear calculation is based on the application of theories from several branches of science to the description of 3D surface micro-topography in accordance with random field theory, assessing the material's physical and mechanical characteristic quantities, substantiating the regularities in creation of material particles separated during the wear process and taking into consideration definite service conditions of fittings. Since the wear process is variable and many-sided, it is influenced by numerous different parameters, for example, surface geometry (roughness, waviness, form deviation, etc.), physical and mechanical conditions of the upper layer, material components, wear regime, wear temperature, etc.

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PORAINA TITĀNA IEGŪŠANAS TEHNOLOĢIJA IZSTRĀDĀJUMU RAŽOŠANAI

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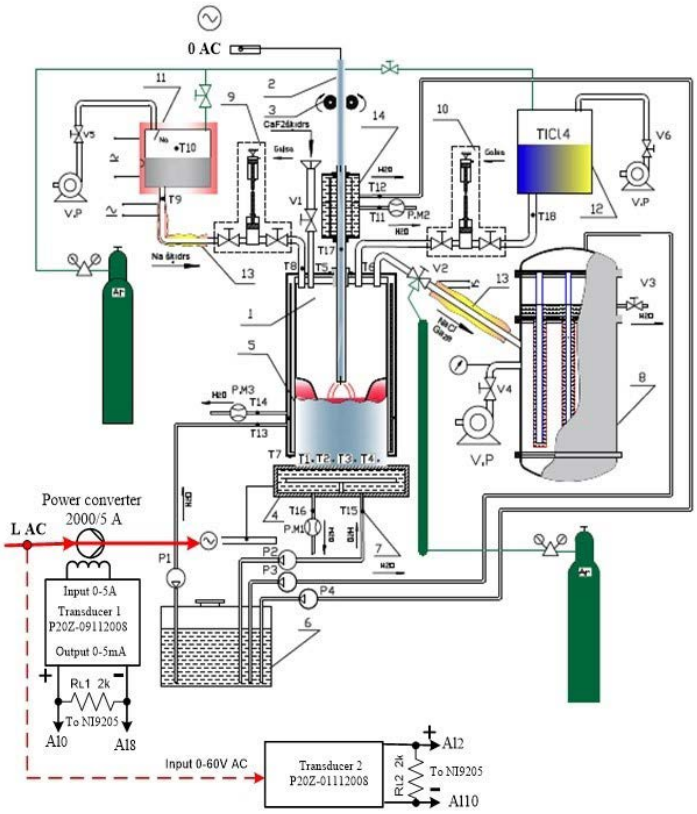
Latvijas Universitātes Fizikas Institūtā ERAF Projekta Nr. 1.1.1.1./16/A/85 "Elektrosārņu process labākai titāna nogulsnējumu morfoloģijai" ietvaros tika izstrādāta tehnoloģija, kas strauji samazina titāna ražošanas izmaksas, lai nodrošinātu tā plašu izmantošanu būvniecībā. titāna un titāna sakausējumu un iegūtu no tiem pusfabrikātu iegūšanas tehnoloģija ļauj veikt ražošanu mazos un vidējos uzņēmumos, līdzīgi kā lietuves darbs rūpniecības uzņēmumā. Ievērojami samazinās kapitālieguldījumi ražošanā. Attiecīgi tiek samazinātas titāna un titāna sakausējumu un no tiem iegūtu pusfabrikātu ražošanas izmaksas.

1. att. Tehnoloģiskā prototipa skats.



2. att. Eksperimentālās ierīces shematisks attēlojums – prototips (bez mēroga):
1 – reaktors; 2 – elektrods; 3 – elektrodu darbināms mehānisms; 4 – reaktora dibena dzesētājs; 5 – reaktora korpusa dzesēšanas sistēma; 6 – vanna (tvertne) ar ūdeni; 7 – termopāri T1-T18; 8 – kondensators; 9 – Mg dozators; 10 – $TiCl_4$ dozators; 11 – magnija padeves tvertne; 12 – $TiCl_4$ padeves tvertne; 13 – sildītājs; 14 – elektrodu dzesētājs; P1–P4 – ūdens sūkņi; P M1, P M2 un P M3 – ūdens plūsmas mērītāji.

Titāna izmantošana ļaus mainīt dažus titānbetona konstrukciju parametrus salīdzinājumā ar dzelzsbetona konstrukcijām. Tiks ievērojami samazināts betona aizsargslānis, kas kalpo armatūras aizsardzībai no ārējās vides iedarbības. Tas veicinās betona konstrukciju masas samazināšanu, vienlaikus saglabājot izturības īpašības, un ļaus izveidot vieglākas konstrukcijas, kas būs spējīgas izturēt lielākas slodzes.

RECENT DEVELOPMENT OF THE CARBON-RICH NANOSTRUCTURED SMART COATINGS AND THEIR CHARACTERIZATION

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Nowadays, carbon enriched nanostructured smart coatings on the carbonitride basis having ultra-low friction and wear, as well as dynamical self-healing properties at high operating loads and temperatures are in the focus of interest, especially for high-tech applications. For instance, one can mention a large variety of machine components operating as friction partners in highly aggressive environment. Very high technical requirements concerning strength and toughness of the machine components are in the aircraft, space, and automotive industries, which force to develop effective deposition processes and novel super-hard and tough nanocoatings that enable high-volume production at a lower cost with high reliability [1]. However, despite the many recent researches and developments concerning hard and tough nanocoatings [2, 3], combining low friction and ultra-low wear properties all in one coating is still a great challenge.

One of the promising directions in the elaboration of novel carbon-rich nanostructured smart coatings is pure amorphous carbon (a-C) films and/or diamond-like coatings (DLC), which have been intensively studied due to their high hardness, low coefficient of friction, chemical inertness, and high electrical resistivity. However, a-C coatings' practical uses – especially as strengthening coatings for cutting tools – are limited because of high residual internal compressive stresses, poor adhesion to the substrate, low toughness, as well as low thermal stability [4]. DLC coatings will probably become one of the most versatile coating materials when they can be deposited at a more moderate temperature, and ways of improving their toughness have been established.

Therefore, we propose a novel approach based on modified 3-phase non-stoichiometric carbonitride films to overcome mentioned above limitations. NSC based on carbon nitride constituents (denoted here as CN, C_3N_4, or C_xN_y) would theoretically be harder than diamond-type coatings if they could be deposited in the same structure as Si_3N_4. Producing crystalline carbon nitride coatings is of great interest, though no one has for the time being presented fully crystalline C_3N_4 coatings. Some specific carbon nitride coatings produced and reported up to now have shown extreme elastic properties combined with relatively high hardness values as (10–50) GPa.

Additionally, we propose a new approach for the characterization of the machining parts' functional surfaces based on the use of selected 3D-texture parameters. Nowadays, the transition from the 2D roughness parameters to the 3D-texture parameters, defined according to the EN ISO 25178-2:2012, is going on. The necessity of such a transition is connected with the fact that using 3D texture parameters is a considerably more preferable method for the functional surface characterization due to its adequate and precise description of the parts' operating surfaces because they are, in fact, 3D objects, not 2D ones.

Acknowledgements

This research is funded by the Latvian Council of Science, project "Carbon-rich self-healing multifunctional nanostructured smart coatings (NSC) for high-tech applications using high-power confined plasma technology for their deposition", project No. 2019/1-0385.

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ACCELERATION OF MATERIALS BY PULSED ELECTROMAGNETIC FIELDS

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A pulsed electromagnetic field is used for electromagnetic orientation and dumping of parts from a conveyor, powders pressing, stamping and assembling parts. In this paper, the results of experimental studies in the field of impulse acceleration of discrete elements are considered. For this purpose, an experimental installation of a capacitor type with an energy intensity of 1.6 KJ was created. (fig. 1). A relay-type arrester was used as a discharge device. The pulse current was measured using a Rogowski coil. For oscillogram recording and analysis, a system has been developed that includes a digital storage oscilloscope and a computer with a microphone-type sensor.

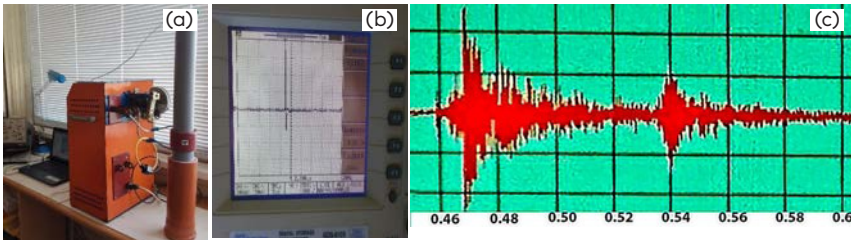

Figure 1. Experimental complex (a), a current oscillogram (b), recording of the displacement signal (c)

The discharge current in the inductor was 8 kA. To determine the average speed of the test object, the time of flight of the object along the abscissa axis was determined as a value equal to the difference in values between the peaks of the left and right bursts of pulses. In this case, this value was 0.07 s. Knowing the length of the pipe $S = 0.85$ s, the average speed of the object movement $V = S / t$ was determined, which was 12–15 m/s.

Acknowledgements

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VERIFICATION OF VACUUM GAUGES USING THE DEVELOPED METHODOLOGY FOR SiO_2 PROCESSES

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Vacuum nano-coating deposition process is performed using specialized vacuum systems. In order to ensure consistent vacuum nano-coating properties, technological process parameters must remain unchanged and controlled at certain level[1]. For SiO_2 coating it is essential to maintain stable sputtering process and remain high vacuum gauge accuracy. Incorrect pressure measurements and even small pressure deviations can reduce SiO_2 nano-coating properties and quality, thus light transmission coefficient and thickness.

Vacuum gauges are used to measure a pressure within the vacuum chamber in result of which proper vacuum level is controlled[1]. After certain operation time pressure measurements of the vacuum gauges start to vary considerably. Hence a vacuum gauge calibration is commonly used when the pressure measurement accuracy starts to fail, and it is impossible to secure necessary nano-coating quality and properties[1]. Nevertheless, there is no guaranty that calibrated vacuum gauge accuracy will remain at certain level under manufacturing conditions and everyday use.

Therefore, the new vacuum gauge verification methodology was created (Figure 1). The new approach allows to acquire a full spectre of vacuum gauge performance data and perform correction on tested vacuum gauge, thus enhancing deposited vacuum nano-coating properties and implement correction coefficient. This verification methodology allows to evaluate the need for vacuum gauge calibration.

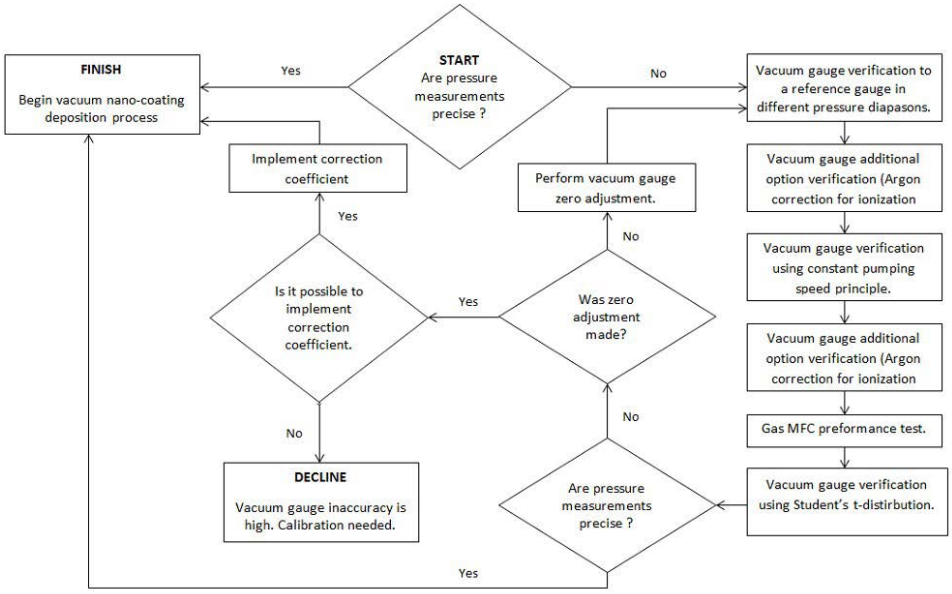

Figure 1. Vacuum gauge verification methodology.

Here we give an overview on the vacuum gauge verification experiments in order to ensure SiO_2 technological sputtering process, achieve high quality and coating properties.

Acknowledgements

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THERMAL PROCESSES OF ELECTRIC MILKING MACHINES

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Thermal processes taking place in the Workout period of electric milking machine, affects its milking efficiency and longevity of device. Thermographic research held on the vacuum equipment of the particular milking machine gave an opportunity to detect heating and cooling regularities. This research helps to visually predict the effective Workout process, see. Figure 1., and determine the heating of the electric motor P0 from the vacuum pump P2 through the interconnection P1. After mathematical processing of gained results, the following equations were obtained: for vacuum pump heating – $°t = 24.877e^{289.2t}$ ($R^2 = 0.9909$), for cooling – $°t = -18.66\ln(t) - 28.833$($R^2 = 0.9666$).

The interesting fact in connection with this research is that milking machine, produced by Rezekne milking equipment factory after 28 years of its shelf is operational and after performing the authors' method for its Workout, it can still be used in the dairying[1]. Research results are approbated at scientific conferences of Latvia University of Life sciences and technology and Riga Technical University.

Figure 1. The Thermographic Photography of Electric Milking Machine.

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Our Research Team is expressing gratitude to LULST asoc. prof. Vitālijs Osadčuks for ensuring our team with Vacuum Equipment of Milking Machine AID-1-01, RTU Institute of Energy Systems and Environment for ensuring our research team with Thermal Camera.

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STRATEGY FOR GREEN DESIGN OF THE MECHANISMS

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While examining the life cycles of assemblies and mechanisms, it was concluded that it is necessary to make conventional order changes. This matter was discussed in our publications in Journal "Agronomy Research" in 2019 and 2020 [1, 2]. Thus, the new vision of the Product life-cycle was proposed (figure 1). As we can see, modern methods of research and processing of materials allow extending the service life of assemblies by rebuilding or changing the characteristics of components according to new requirements.

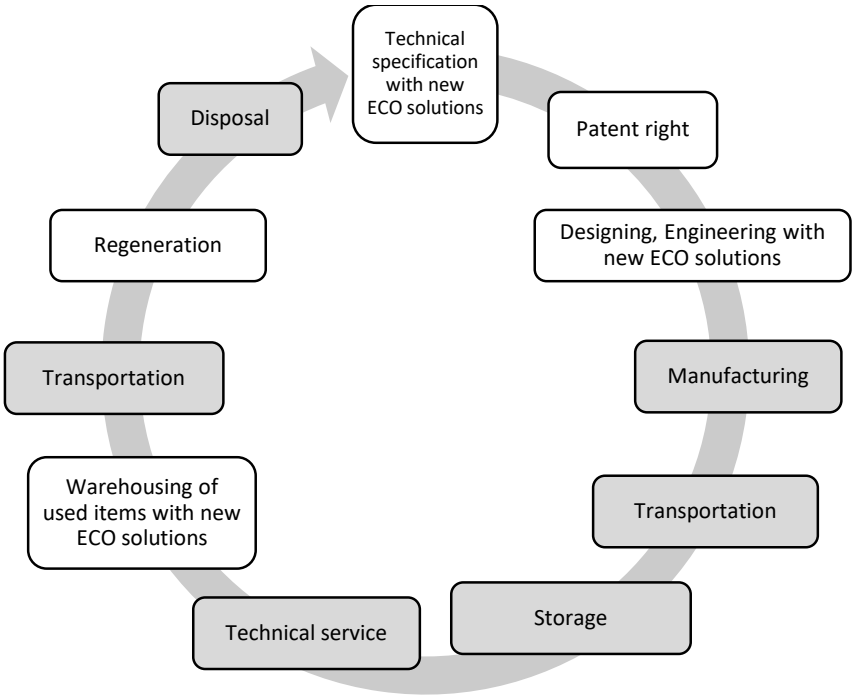

Figure 1. New vision of Product life-cycle [1].

As an example can serve the excellent work of the Ph. D. S. Locs, in which the methods of laser surface treatment have been described (Laser Cladded Surface Hardening Coating with Gradient of Mechanical Properties, Doctoral Thesis, RTU, 2020). The methods that can dramatically reduce the burden on the environment of spare parts, which service life has expired, are studying and publishing.

Currently, most innovations solve the problem of the implementation of some mechanism post-factum. It is very difficult for technologists and designers who develop new assemblies to learn about innovations and understand whether these developments have been implemented in life or not and whether their application is applicable and whether there are tools in place to support them. We propose to structure the innovations of scientists and apply statuses to them that indicate their feasibility.

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AUGSTAS TEMPERATŪRAS SILTUMSŪKŅA INTEGRĀCIJA CENTRALIZĒTAJĀ SILTUMAPGĀDES SISTĒMĀ

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Ar fosilo kurināmo darbināmu katlu nomaiņa augstas temperatūras ūdens un tvaika ražošanai ir ļoti svarīga energoapgādes sistēmas efektivitātes paaugstināšanai. Augstas temperatūras siltumsūkņi tiek uzskatīti par labu tehnoloģiju, kā efektīvi atgūt zemas temperatūras atlikumsiltumu no dažāda veida procesiem, tādā veidā samazinot enerģijas patēriņu un CO_2 emisijas. Elastīgu augstas temperatūras siltumsūkņa integrēšana siltumapgādes sistēmās ir atzīta par nozīmīgu soli 100% atjaunojamās enerģijas sistēmas virzienā, pārvēršot siltumā elektrisko enerģiju.

Darbā tika apkopoti aktuāli zinātniskie raksti [1-11] par augstas temperatūras siltumsūkņu veidiem, izmantošanas iespējam un priekšrocībām. Tika apskatīta augstas temperatūras siltumsūkņa (vienpakāpes kompresijas siltumsūkņa) termodinamiskā analīze un augstas temperatūras siltumsūkņu cikli: vienpakāpes cikls, vienpakāpes cikls ar iekšējo siltummaini, divpakāpju cikls, divpakāpju cikls ar iekšējo siltummaini un divpakāpju cikls ar starpposma iekšējo siltummaini, kā arī tika pievērsta uzmanība aukstumaģentiem, to veidiem, piemērotai izvēlei, apskatot pašlaik pieejamos un izmantojamos. Tika izvērtētas augstas temperatūras sultumsūkņu izmantošanas iespējas Latvijas centralizētājos siltumapgādes tīklos.

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DAUDZDZĪVOKĻU DZĪVOJAMĀS MĀJAS ENERGOEFEKTIVITĀTES ATKARĪBAS NO SĒRIJAS UN NODOŠANAS EKSPLUATĀCIJĀ PERIODA ANALĪZE

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Pamatojoties uz Centrālās statistikas pārvaldes 2015. g. datiem, 74,2 % no visiem Latvijas teritorijā esošajiem mājokļiem sastādīja dzīvokļi2. No tiem tajā gadā, 88,1 % veidoja īpašumā (tie, kuri netika īrēti no Valsts vai pašvaldības) esošie dzīvokli daudzdzīvokļu dzīvojamās mājās ar 10 un vairāk dzīvokļiem (rēķināts no visiem mājokļu veidiem)[2]. 2010. g. 2. oktobrī stājās spēkā Ministru kabineta noteikumi Nr. 907 "Noteikumi par dzīvojamās mājas apsekošanu, tehnisko apkopi, kārtējo remontu un energoefektivitātes minimālajam prasībām", kuru pirmajā pielikumā "Dzīvojamo māju iedalījums kapitalitātes grupās atbilstoši lietotajiem materiāliem, konstrukcijām un vidējam kalpošanas ilgumam" visas celtnes, lietotas dzīvošanai, ir sadalītās 6 grupās. Skaitliskā ziņā vislielākās grupas ir IV un V grupas masveida apbūves jeb tipveida daudzdzīvokļu dzīvojamās mājas, kuru būvniecības periods aptver 20. gadsimtā otro pusi[1]. Lielākoties abās grupās ietilpstošas mājas ir 316. un 318. (Hruščova laika mājas), 464., 467., 467a., 103., 104., 602., 119. sērijas (uzskaitītas hronoloģiski), kuru norobežojošo konstrukcijas ir veidotas no ķieģeļiem, akmens (33,0 %), betona vai dzelzsbetona (33,6 %), jauktā materiāla (17,9 %)[2]. Analizējot paredzamo kalpošanas ilgumu ap 60–70 gadiem[1] un nodošanas ekspluatācijā periodu var viennozīmīgi apgalvot, ka jau šodien ir nepieciešams ieguldīt līdzekļus mājokļu atbilstošā uzturēšanā, saglabāšanā un attīstīšanā, tai skaitā energoefektivitātes pasākumu īstenošanā, inženierkomunikāciju modernizēšanā, siltināšanā, nesošo konstrukciju nomaiņā vai atjaunošanā.

2019. g. vidējā apsaimniekošanas maksa sastādīja 0,66 EUR/m^2, bet kopējā platība uz vienu pastāvīgo iedzīvotāju 32 m^2 [2]. Visbiežāk dzīvokļu īpašnieku noteikts uzkrājuma apmērs ir vienāds ar 0,20–0,25 EUR/m^2 mēnesī, jeb 6,4–9 EUR/mēnesī par 32 m^2. Šāds uzkrājuma veidošanas temps nav pietiekams pilnvērtīgas mājas renovācijas veikšanai vienā piegājienā, tāpēc katrai sērijai ir jānosaka būtiskākie komforta celšanas paņēmieni. Visbiežākā tehniskās dabas klientu problēma un rezultātā – sūdzība apsaimniekošanas uzņēmumam – ir palielināts mitruma līmenis un pelējums dzīvokļos, kas sākotnēji veido nepatīkamu sajūtu uzturoties telpās, bet ilgtermiņā var novest līdz elpceļu akūtām un hroniskām slimībām. Visizplatītākie mitruma avoti un pelējuma veidošanas veicinošie faktori ir dažādas ventilācijas sistēmas problēmas, t. sk. aizsērējums, piespiedu ventilācijas sistēmu iebūvēšana dabīgas ventilācijas kanālos, kanālu aizmūrēšana utt.; atsevišķa dzīvokļa siltināšana no iekšpusēs; nekvalitatīvi plastmasas logi; šuvju hermetizējošās vielas nolietojums; inženierkomunikāciju avārijas un konstruktīvo elementu bojājumi; iemītnieku dzīves stils un dzīvokļos veicamās darbības; augu veģetācija (piem., vīteņaugi uz fasādēm). Dzelzsbetona paneļu tipveida māju galvenā problēma ir šuvju hermetizējošās vielas nolietojums, kas palielina mājas siltuma zudumus, un ventilācijas sistēmas problēmas vai bojājumi, kas negatīvi ietekme gaisa apmaiņu dzīvokļos. Pašrocīgi veiktās termogrāfijas un apsekošanas liecina, ka savlaicīga šuvju aizpildīšana, ventilācijas kanālu tīrīšana un piespiedu ventilācijas iekārtu neuzlikšana uz dabīgas ventilācijas kanāliem uzlabo dzelzsbetona rūpnieciski ražoto paneļu tipveida māju energoefektivitāti un līdzsvaro mitruma pakāpi 464., 467., 467a., 103., 104., 602. sērijas mājās, bet mazāk ietekmē 119. sērijas mājas, jo tās ir veidotas no ļoti vienkāršiem sendvič-tipa paneļiem ar novecojušos iekšējo siltuma izolācijas slāni. Darbu ir plānots turpināt, lai paustās atziņas pamatotu ar praksē iegūtajiem statistiskajiem datiem, kā arī priekšlikumus nosacīti "lētai" māju atjaunošanai apkopotu tipveida projektos atkarībā no daudzdzīvokļu dzīvojamās mājas sērijas.

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2. Centrālās statistikas pārvaldes dati.

SILTUMIZOLĀCIJAS IZMAKSU IETEKME UZ SILTUMU ZUDUMIEM SILTUMA AKUMULATOROS

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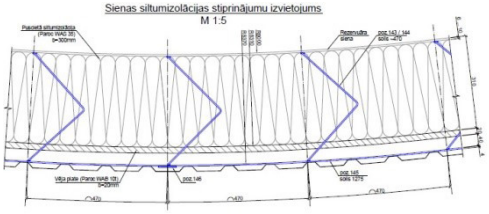
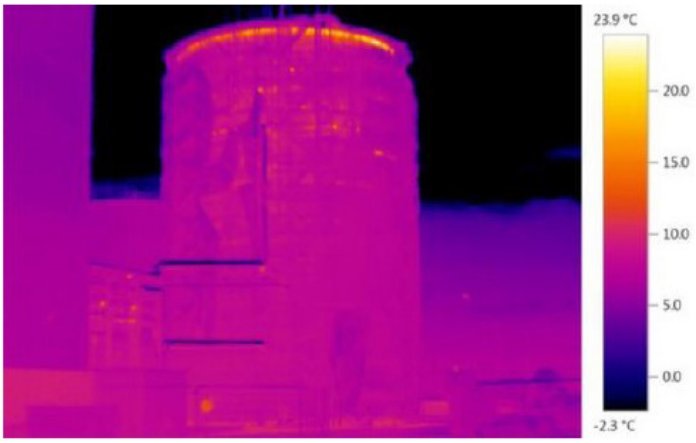
Siltumenerģijas uzkrāšanai siltuma akumulatoros viens no būtiskākajiem faktoriem ir siltumizolācijas efektivitāte. Pētāmajam siltuma akumulatoram kā redzams 1. attēlā ir pielietots nestandarta risinājums siltumizolācijas nodrošināšanai – izmanota celtniecības puscietā fasādes vate ar blīvumu 120 kg/m^3.



1. att. Siltumizolācijas mezgla griezumus

Parasti šāda tipa akumulatoros izmanto 60–80 kg/m^3 industriālo siltumizolāciju, kura ir mazāk blīva, bet vieglāk montējama un mazāks risks nekvalatīvai montāžai uz izliektas virsmas. Pētāmā siltuma akumulatora izolācijas izmaksas sastāda 22,01 % no kopējām izmaksām un ir 181 668,53 Eur, tajā skaitā arī rezevuāra izolācijas stiprinājumi un apšuvums. Ar modelēšanas palīdzību tika aprēķinātas industriālās siltumizolācijas izmaksas – 154 011,00 Eur, kuras saistītas ar ātrāku montāžu, vieglāku izolācijas nesošo karkasu.

Lai pārbaudītu šī siltumizolācijas risinājuma efektivitāti, tika veikts eksperiments – uz 7 diennaktīm (168 h) apturēts strādājošs siltuma akumulators, kur ir pielietots fasādes vates risinājums. Veicot temperatūras mērījumus akumulatora 25 punktos, tika iegūti dati par siltuma zudumiem, kas sastāda 1,81 MW/h. Aprēķinot teorētiskos siltuma zudumus visām akumulatora norobežojošām konstrukcijām tika iegūts rezultāts 1,65 MW/h un iegūtā atšķirība bija tikai 8,57 %. Ar norobežojošo konstrukciju aprēķinu palīdzību tika aprēķināti siltuma zudumi industriālā siltumizolācijas gadījumā, kuri šajā pašā laika periodā radītu 2,04 MW/h siltuma zudumus. Pielietojot puscietās fasādes vates (120kg/m^3) izmantošanu siltuma akumulatoros siltuma zudumus var samazināt par 19,1 %, bet kopējās akumulatora izbūves izmaksas palielināties par 3,7 %.



2. att. Termoattēls siltumizolācijas montāžas laikā

Veicot fasādes vates montāžas darbus ir ļoti svarīga kvalitāte, katras loksnes malas ir jāpiegriež, lai tās svastarpēji neveidotu tukšus laukumus. Siltumizolācoijas vate ar lielu blīvumu nav elastīga un nevar ieņemt rezervuāra formu. Veicot siltumizolācijas montāžas darbus, vēlams to kontrolēt ar termokameras palīdzību kā parādīts 2. attēlā.

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SINTERED TITANIUM POWDER AERATORS AND THEIR APPLICATIONS

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The processes associated with the dispersion of ozone, oxygen, carbon dioxide and other technological flue (waste) gases in devices and facilities of chemical and biochemical industries, in devices for disinfection of premises are of great importance in technologies related to labor and environment protection. In particular, flat or tubular aerators are used to spray liquids by airborne droplets with the addition of different aerosols. The most significant parameters of the aeration method are the number, size and rate of generation of gas bubbles, the amount of injected gas and its specific flowrate and, of course, the possibility of repair and the total service life of the aerators. Porous permeable elements made of powder materials are of great interest for aeration. Fig. 1 shows the design of the aerator, the porous part of which is made of titanium, and the body is made of stainless steel. This ensures high corrosion resistance and high-quality crashing of the liquid or gas jet. The resistance to the flow of liquid or gas can be decreased by enlarging the size of pores in the flow direction. The pore size can be varied smoothly or stepwise (two-layer structure).

For premises disinfection, of interest are autonomous devices with the following parameters: power 1–12 W, voltage 5–12 V, device weight up to 4 kg, tank capacity 5–10 L. This will allow disinfection of premises up to 5000 m^2.

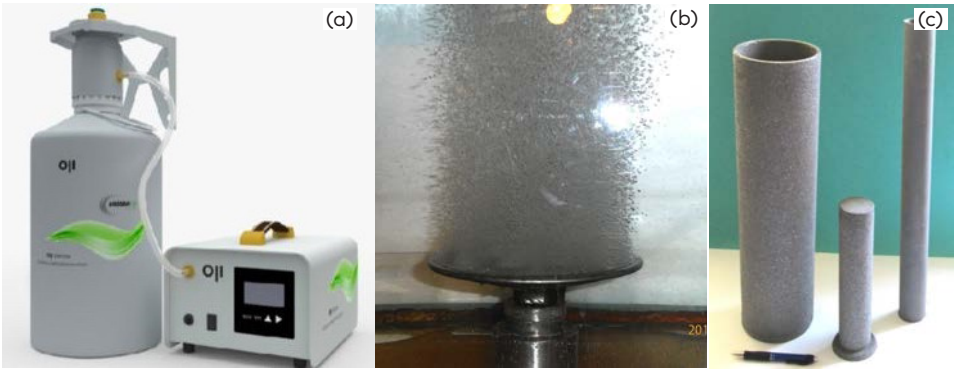

Figure 1. Experimental complex (a), disk-type (b) and tube-type (c) sprayers.

The theoretical and experimental investigations performed to determine the chemical composition of materials and the optimal porous structure of the aerator element have revealed that the most effective are porous elements with pore sizes of 90–120 μm produced from sponge titanium powder.

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INFLUENCE OF TEMPERATURE ON THE PROCESS OF ASSEMBLING A PART WITH INTERFERENCE

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Fixed joints with interference fits are simple in design and provide high precision centering of the connected parts. After assembly, the strength and relative immobility of the joints with an interference fit is provided by the friction forces created by pressure on the mating surfaces and depending on the interference in the joint.

Assembling joints with an interference fit may be performed in three ways:

1. under axial force generated by the press;
2. with thermal action (with heating of the covering or cooling of the covered part or with simultaneous heating of the covering and cooling of the covered part);
3. by the hydraulic press method with the supply of oil to the interface area under high pressure with the simultaneous action of axial force.

The most feasible method of assembly interference fit connections is the thermal assembly, that is, forming a joint with preheating of the covering part or pre-cooling of the covered parts. Such an assembly provides a much higher strength of the joints in comparison with the compounds of the mechanical assembly under pressure due to the almost total absence of longitudinal damage and reduce the influence of the roughness of mating surfaces [1]. This is especially true when assembling large parts in heavy engineering [2], that enhances the quality of the collected compounds. However, during thermal assembly, thermal deformations of the part subjected to heating or cooling occur

not only in the transverse direction, (which precisely provides the interference), but also in the longitudinal direction. As a result, after assembly, as a result of the stabilization of the temperature of this part installed in point-blank, a gap occurs between the ends of the parts to be joined, there is a gap between the ends of the parts, while in many machines of the structure such a gap is not allowed or is limited by the specific value. The objective of this study is a comparative analysis of existing exclusion methods (or reducing to acceptable value) forming a gap between the ends of mating parts in compounds with an interference fit formed by thermal assembly.

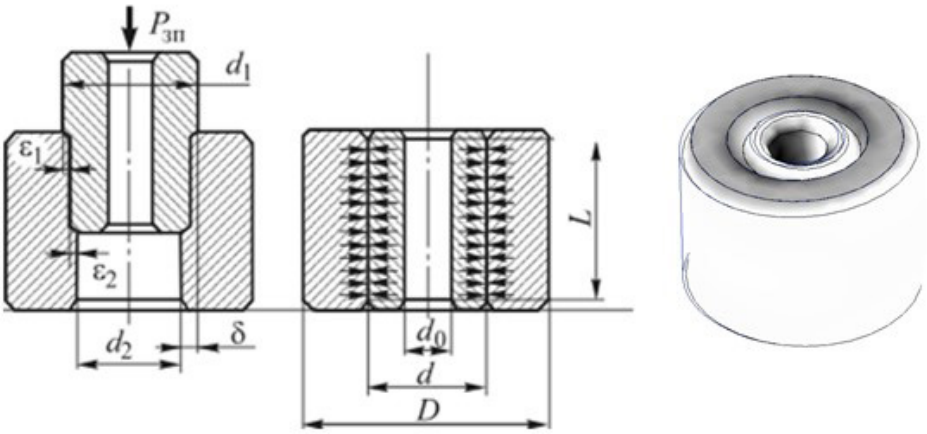

Figure 1. Scheme of a longitudinal-press connection in the process and after pressing.

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