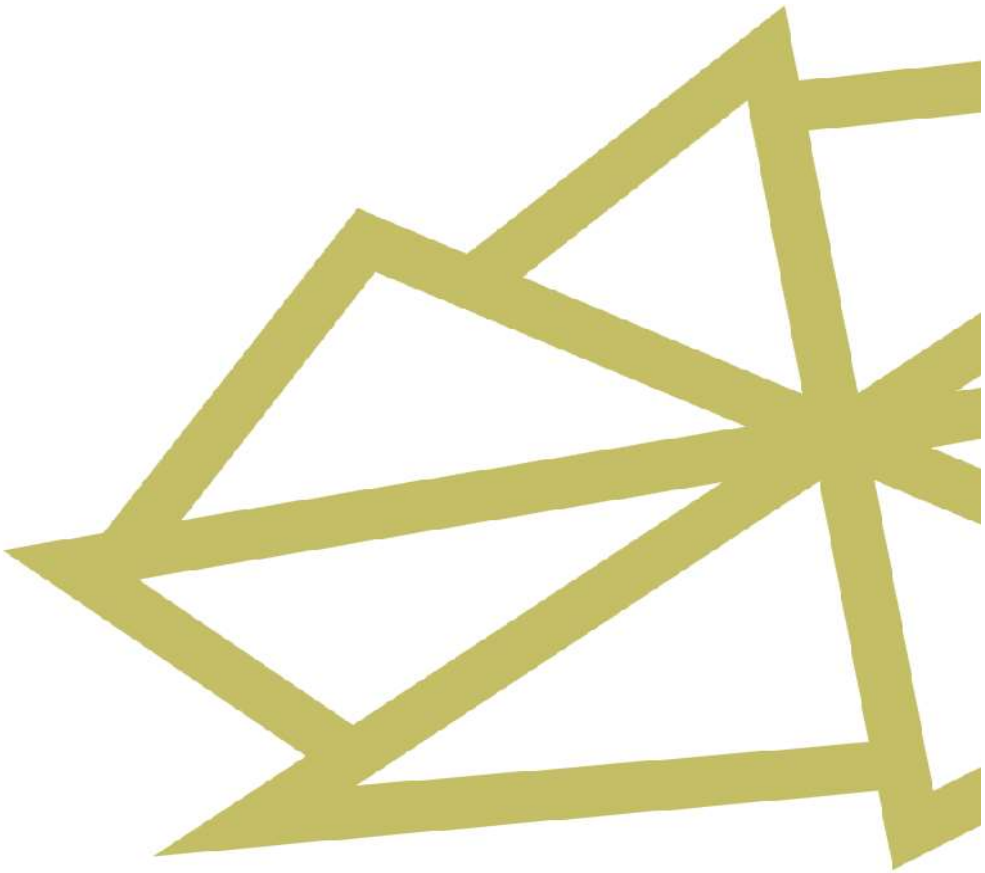
TECHNICAL UNIVERSITY IN ZVOLEN

FACULTY OF TECHNOLOGY

XXVI. INTERNATIONAL CONFERENCE OF YOUNG SCIENTISTS

XXVI. Medzinárodná vedecká konferencia mladých

Book of Extended Abstracts



June 25 - 26, 2024, Zvolen, Slovakia

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EFFICIENCY OF MANUAL SORTING PLANTS FOR PLASTIC WASTE

ÚČINNOSŤ RUČNÝCH TRIEDIČIEK PLASTOVÉHO ODPADU

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ABSTRACT: Waste management is an integral part of people's lives. With the overall growth in wealth and population, the amount of waste that society produces is increasing. A frequently mentioned type of waste is plastic waste, which is generated by people's daily activities. Thus, plastic waste forms an integral part of municipal waste. Despite the very high percentage of people who sort plastics in the Czech Republic, the recycling of plastics does not reach similarly high percentages. An important precursor to recycling, and an intermediate step after sorting by citizens, are sorting lines. These lines sort plastics into different types, mainly polyethylene terephthalate (PET), polypropylene (PP) and polyethylene (PE). With two exceptions, sorting of plastics in the Czech Republic is carried out manually, with the help of operators who pull the different types of plastics from a conveyor belt. Manual sorting has its physical limits, and as the capacity of the input waste increases, the sorting efficiency decreases, which has a major impact on the economics of the entire line. Despite the impossibility of knowing the type of plastic, these lines achieve desirable yields of plastics for recycling. In view of the rising cost of human labour and low unemployment, it can be predicted that manual sorting will be gradually reduced in the future and replaced by machine sorting. This phenomenon can also be observed in the more developed countries of the European Union.

Key words: waste, waste management, waste plastic sorting, plastic

ABSTRAKT: Odpadové hospodárstvo je neoddeliteľnou súčasťou života ľudí. S celkovým rastom bohatstva a počtu obyvateľov sa zvyšuje množstvo odpadu, ktoré spoločnosť produkuje. Často spomínaným druhom odpadu je plastový odpad, ktorý vzniká pri každodenných činnostiach ľudí. Plastový odpad tak tvorí neoddeliteľnú súčasť komunálneho odpadu. Napriek veľmi vysokému percentu ľudí, ktorí v Českej republike triedia plasty, recyklácia plastov nedosahuje podobne vysoké percento. Dôležitým predstúpenom recyklácie a medzistupňom po triedení občanmi sú triediace linky. Tieto linky triedia plasty na rôzne druhy, najmä na polyetyléntereftalát (PET), polypropylén (PP) a polyetylén (PE). Až na dve výnimky sa triedenie plastov v Českej republike vykonáva ručne, pomocou operátorov, ktorí jednotlivé druhy plastov sťahujú z dopravníkového pásu. Ručné triedenie má svoje fyzikálne limity a so zvyšujúcou sa kapacitou vstupného odpadu klesá účinnosť triedenia, čo má veľký vplyv na ekonomiku celej linky. Napriek nemožnosti poznať typ plastu dosahujú tieto linky želateľnú výťažnosť plastov určených na recykláciu. Vzhľadom na rastúce náklady na ľudskú prácu a nízku nezamestnanosť možno predpokladať, že ručné triedenie sa bude v budúcnosti postupne obmedzovať a nahrádzať strojovým triedením. Tento jav možno pozorovať aj vo vyspelejších krajinách Európskej únie.

Kľúčové slová: odpad, odpadové hospodárstvo, triedenie plastového odpadu, plast

REFERENCES

ASCHENBRENNER, D., COLLOSEUS, C., KHOURY, R., FANGEROW, N. 2023. Robot-assisted automated sorting techniques for plastic recycling. *Procedia CIRP*, 120, 1232-1237. https://doi.org/10.1016/j.procir.2023.09.154

GADALETA, G., DE GISI, S., BINETTI, S. M. C., NOTARNICOLA, M. 2020. Outlining a comprehensive techno-economic approach to evaluate the performance of an advanced sorting plant for plastic waste recovery. *Process Safety and Environmental Protection*, 143, 248-261. https://doi.org/10.1016/j.psep.2020.07.008

LIM, J., AHN, Y., KIM, J. 2023. Optimal sorting and recycling of plastic waste as a renewable energy resource considering economic feasibility and environmental pollution. *Process Safety and Environmental Protection*, 169, 685-696. https://doi.org/10.1016/j.psep.2022.11.027

ERIKSEN, M. K., DAMGAARD, A., BOLDRIN, A., ASTRUP, T. F. 2019. Quality Assessment and Circularity Potential of Recovery Systems for Household Plastic Waste. *Journal of Industrial Ecology*, 23(1), 156-168. https://doi.org/10.1111/jiec.12822

THANH NGUYEN, T., TUNG LUU, T., THANH AN TONG, P. 2024. Fine-tuning DETR: Toward holistic process in plastic waste sorting system. *Waste Management*, 179, 154-162. https://doi.org/10.1016/j.wasman.2024.03.015

ZHANG, L., LIU, Y., ZHAO, Z., YANG, G., MA, S., ZHOU, C. 2023. Estimating the quantities and compositions of household plastic packaging waste in China by integrating large-sample questionnaires and lab-test methods. *Resources, Conservation and Recycling*, 198. https://doi.org/10.1016/j.resconrec.2023.107192

NCUBE, L. K., UDE, A. U., OGUNMUYIWA, E. N., ZULKIFLI, R., BEAS, I. N. 2021. An Overview of Plastic Waste Generation and Management in Food Packaging Industries. *Recycling*, 6(1). https://doi.org/10.3390/recycling6010012

LAHTELA, V., HYVÄRINEN, M., KÄRKI, T. 2019. Composition of Plastic Fractions in Waste Streams: Toward More Efficient Recycling and Utilization. *Polymers*, 11(1). https://doi.org/10.3390/polym11010069

ROOSEN, M., MYS, N., KUSENBERG, M., BILLEN, P., DUMOULIN, A., DEWULF, J., VAN GEEM, K. M., RAGAERT, K., DE MEESTER, S. 2020. Detailed Analysis of the Composition of Selected Plastic Packaging Waste Products and Its Implications for Mechanical and Thermochemical Recycling. *Environmental Science & Technology*, 54(20), 13282-13293. https://doi.org/10.1021/acs.est.0c03371

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POTENTIAL OF MAIZE BIOPHYSICAL PARAMETERS DETECTION USING SAR IMAGES

POTENCIÁL ZJIŠŤOVÁNÍ BIOFYZIKÁLNÍCH PARAMETRŮ KUKUŘICE POMOCÍ SAR SNÍMKŮ

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ABSTRACT: The integration of Synthetic Aperture Radar (SAR) with its Radar Vegetation Index (RVI) alongside ground reference data offers a potent methodology for environmental monitoring, particularly in the field of agriculture and precision farming. This study, conducted in April 2023 in the Czech Republic, focused on a maize field provided by the Agricultural Co-operative Dolní Újezd. Leveraging SAR data sourced from Sentinel-1, a satellite mission managed by the European Space Agency (ESA), we assessed the utility of SAR imagery for delineating vegetation variability.

This investigation yielded findings demonstrating a positive correlation between SAR-derived metrics and ground reference data, encompassing parameters such as plant height, fresh weight, and Ncrop measurements. The fusion of SAR imagery with field-acquired data bolstered the precision of vegetation variability mapping, particularly in the context of maize cultivation.

The SAR data were processed, including resampling at varying pixel resolutions (10, 50, and 100 meters) and subsequent speckle filtering employing methodologies such as Frost, Gamma Map, Lee Sigma, Median, Refined Lee, and Boxcar. Terrain correction via Range-Doppler Terrain Correction was implemented to mitigate distortions. The computation of the RVI index, formulated as (4sigmaVH)/(sigma*VV+sigmaVH), facilitated the assessment of vegetation characteristics. Subsequent statistical analyses were performed to validate the outcomes.

From the correlation analysis, it was determined that utilizing Cubic Convolution and resampling to a 10-meter resolution yielded the most consistent results with the field measurements when it comes to fresh weight samples and plant height. However, for Ncrop measurements, Bilinear Interpolation yielded better outcomes.

Key words: Geoinformation, SAR, statistical analysis, speckle filtering, field variability, Maize

ABSTRAKT: Spojení radaru se syntetickou aperturou (SAR) a jeho radarového vegetačního indexu (RVI) s pozemními referenčními daty, nabízí účinnou koncepci monitorování životního prostředí, zejména v oblasti zemědělství a precizního zemědělství. Tato studie, provedená v dubnu 2023 v České republice, se zaměřila na kukuřičné pole poskytnuté Zemědělským družstvem Dolní Újezd. S využitím dat SAR pocházejících z družicové mise Sentinel-1, kterou řídí Evropská kosmická agentura (ESA), byla zkoumána vhodnost použití snímků SAR pro vymezení variability vegetace.

Výzkum přinesl zjištění, která prokázala pozitivní korelaci mezi ukazateli odvozenými ze SAR a referenčními pozemními údaji zahrnujícími parametry, jako je výška rostlin, čerstvá hmotnost a měření Ncrop. Spojení snímků SAR s daty získanými v terénu posílilo přesnost mapování variability vegetace, zejména v kontextu pěstování kukuřice.

Data SAR byla podrobena zpracování, včetně převzorkování s různým rozlišením pixelů (10, 50 a 100 metrů) a následného filtrování speckle pomocí filtrů Frost, Gamma Map, Lee Sigma, Median, Refined Lee a Boxcar. Pro zmírnění zkreslení byla provedena korekce terénu pomocí Range-Doppler Terrain Correction. Výpočet indexu RVI, formulovaný jako (4sigmaVH)/(sigma*VV+sigmaVH), usnadnil hodnocení charakteristik vegetace. K ověření výsledků byly provedeny následné statistické analýzy.

Na základě korelační analýzy bylo zjištěno, že použití kubické konvoluce a převzorkování na rozlišení 10 metrů přineslo nejkonzistentnější výsledky s terénními měřeními, pokud jde o vzorky čerstvé hmotnosti a výšky rostlin. Nicméně v případě měření Ncrop poskytla Bilineární interpolace lepší výsledky.

Kľúčové slová: Geoinformatika, SAR, statistická analýza, speckle filtering, variabilita pole, kukuřice

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REFERENCES

LAPAZ OLVEIRA, A. M., CASTRO-FRANCO, M., SAÍNZ ROZAS, H. R., CARCIOCHI, W. D., BALZARINI, M., AVILA, O., CIAMPITTI, I., REUSSI CALVO, N. I. 2023. Monitoring corn nitrogen nutrition index from optical and synthetic aperture radar satellite data and soil available nitrogen. *Precision Agriculture*, *24*(6), 2592–2606. https://doi.org/10.1007/s11119-023-10054-4

MANDAL, D., KUMAR, V., RATHA, D., DEY, S., BHATTACHARYA, A., LOPEZ-SANCHEZ, J. M., MCNAIRN, H., RAO, Y. S. 2020. Dual polarimetric radar vegetation index for crop growth monitoring using sentinel-1 SAR data. *Remote Sensing of Environment*, *247*, 111954. https://doi.org/10.1016/J.RSE.2020.111954

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APPLICATION OF FMEA FOR FAILURE ANALYSIS IN MICROBREWERY PRODUCTION TECHNOLOGY

APLIKACE METODY FMEA PRO ANALÝZU PORUCH VE VÝROBNÍ TECHNOLOGII MINIPIVOVARŮ

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ABSTRACT: The global beer production industry has seen a rise in demand for craft beers in recent years, necessitating their production in microbreweries, which represent a significant manufacturing segment. Beer production is a complex process requiring sophisticated equipment. To achieve optimal production outcomes, it is crucial for microbreweries to maintain a well-managed quality control of the production equipment. Downtimes due to mechanical failures not only lead to production losses but can also adversely affect the final product. In this context, the application of the Failure Mode and Effects Analysis (FMEA) method proves particularly useful, helping to identify potential failures in the production equipment. This allows brewery staff to proactively address issues that could negatively impact the performance and lifespan of the equipment. This article examines the implementation of the FMEA method in the microbrewery setting to address concerns not only about the reliability of the production equipment but also about the safety and quality of the final product. After conducting a literature review on the application of the FMEA method in other food industries, a case study was carried out in a microbrewery operation. Specifically, the FMEA method was applied to the mash copper, which, from a long-term perspective, represents the weakest link in terms of reliability in the studied operation. The evaluation of critical points in the mash copper led to the calculation of the Risk Priority Number (RPN). The inability to expel brewing vapors through the chimney during the mashing and wort boiling process was identified as the most severe failure with the highest RPN, particularly threatening the qualitative parameters of the final product. The failure of isolated steam conduits to transfer heat to the mash copper was deemed the most severe failure in terms of executing the brewing process, with the most significant impact on the operation's economy. Preventive, predictive, and proactive maintenance emerged as the most effective measures. Thanks to these approaches, it is ensured that there will be a minimization of major failures that will result in the outage of the entire technology.

Key words: food safety and quality; machine dependability; mash copper; preventive maintenance; risk priority number

ABSTRAKT: Výroba piva je globálně rozšířená. V posledních letech roste poptávka po řemeslném pivu, což souvisí s nutností jeho výroby v minipivovarech, které představují významný výrobní segment. Výroba piva je složitý proces, pro jehož realizaci je nutné využít sofistikované výrobní zařízení. Pro dosažení co nejlepších výrobních výsledků je podstatné, aby minipivovary měly dobře nastaven management jakosti výrobního zařízení. Prostoje způsobené mechanickými poruchami vedou nejen ke ztrátám ve výrobě, ale mohou také negativně ovlivnit finální produkt výroby. V tomto kontextu je zvláště užitečná aplikace metody FMEA (Failure Mode and Effects Analysis), která pomáhá identifikovat potenciální poruchy na výrobním zařízením. Zaměstnanci pivovaru tedy mohou preventivně řešit problémy, které by mohly negativně ovlivnit výkon a životnost výrobního zařízení. Tento článek zkoumá implementaci metody FMEA v prostředí minipivovarů s cílem řešit nejen obavy o spolehlivost výrobního zařízení, ale také obavy o bezpečnost a kvalitu finálního produktu. Po provedení literární rešerše o aplikaci metody FMEA v jiných potravinářských odvětví byla provedena případová studie v provozu minipivovaru. Konkrétně byla metoda FMEA aplikována na rmutomladinovou pánev, která z dlouhodobé perspektivy představuje ve zkoumaném provozu z hlediska spolehlivosti nejslabší místo. Na základě popsání a posouzení kritických míst ve rmutomladinové pánvi bylo vypočítáno RPN (Risk Priority Number). Jako nejzávažnější porucha s nejvyšším RPN byla vyhodnocena neschopnost odvodu brýdových par komínem během rmutování a chmelovaru. Tato porucha ohrožuje zejména kvalitativní parametry výsledného produktu. Neschopnost izolovaného parního vedení přenášet teplo do rmutomladinové pánve byla vyhodnocena jako nejzávažnější porucha z hlediska realizace samotného varního procesu s nejzásadnějším dopadem na ekonomiku provozu. Jako nejúčinnější opatření se zdá být preventivní, prediktivní a proaktivní údržba. Díky těmto přístupům je zajištěno, že dojde k minimalizaci havarijních poruch, které budou mít za následek výpadek celé technologie.

Klíčová slova: bezpečnost a kvalita potravin; preventivní údržba; rizikové číslo; rmutomladinová pánev; spolehlivost strojů

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REFERENCES

BAIANO, A., 2021. Craft beer: An overview. Comprehensive Reviews in Food Science and Food Safety. vol. 20, p. 1829-1856.

BRIGGS, D.E.; BOULTON, Ch.A.; BROOKES, P.A. and STEVENS, R., 2004. Brewing: science and practice. Boca Raton: CRC Press.

FITHRI, P.; RAFI, M.; PAWENARY and PRABUWONO, A.S., 2021. Risk analysis of production process for food SMEs using FMEA method: a case study. In: E3S Web of Conferences. 331, 02010. Available at: https://doi.org/https://doi.org/10.1051/e3sconf/202133102010.

INTERNATIONAL ELECTROTECHNICAL COMMISSION, 2019. ČSN EN IEC 60812, Failure modes and effects analysis (FMEA and FMECA). Ed. 2.

KUNZE, W., 2010. Technology Brewing & Malting. Berlin: VLB.

LIONG, Ch.-Y.; HAMID, S.H. Ab and IBRAHIM, I.M., 2016. Improving the Performance of Chili Sauce Manufacturing Process using Simulation Approach. In: AIP Conference Proceedings. American Institute of Physics, 1750, 030026. Available at: https://doi.org/10.1063/1.4954562.

POP, C.; FRUNZĂ, G. and CIOBANU, M.M., 2019. Study regarding application of the FMEA method within a food safety management system. Scientific Papers-Animal Science Series. vol. 71, p. 189-196.

VARZAKAS, T.H. and ARVANITOYANNIS, I.S., 2009. Application of failure mode and effect analysis and cause and effect analysis on processing of ready to eat vegetables – part II. International Journal of Food Science and Technology. vol. 44, p. 932-939.

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EVALUATION OF FORAGE HARVESTING TECHNIQUES

HODNOCENÍ TECHNOLOGICKÝCH LINEK NA SKLIZEŇ PÍCE

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ABSTRACT: Forage is a vital component of plant-based feed. It is an essential source of roughage that significantly impacts the production and quality of meat, milk, and other animal products. Some of the forage crops can be harvested up to five times under favourable conditions. An important factor is climatic conditions, which may be varied from region to region. In mountainous areas the growing season is shorter and therefore the harvesting period is shorter. In case of adding low quality conservated forage to the feed ration, the need for grain feed increases.

This paper presents the results of a field experiment evaulated using different mowing machines to the drying rate of forage, second cut grass. Disc mower with conditioner and drum mower both with rotary blades. Furthermore, the influence of the number of tedding on the forage drying process was evaluated. The field experiment took place in the north-eastern part of the Czech Republic during the 2022 season in August.

The test field was divided into four parts (A, B, C, D). The first two parts (A, B) were cut with a drum mower without conditioner. The third and fourth parts (C, D) were mowed with a disc mower with conditioner. The tedding of forage took place on all parts during day 3 and day 5. On day 4, only parts B and D were tedded. During the experiment, samples were taken sequentially after a given activity (mowing, tedding) to compare the dry matter content of each section. The evaluation of dry matter content was obtained from the dried residual weight of the forage sample.

The forage samples taken for the first two measurements did not show statistically significant differences in dry matter content. Due to several rainfall events, no significant loss of moisture content of forage was observed between the first two measurements. Significant loss of moisture content was observed between measurements 2 and 3. The forage that was conditioned and more times tedded showed on average higher moisture loss.

Key words: forage, moisture loss, conditioning

ABSTRAKT: Pícniny jsou velmi důležitým krmivem rostlinného původu. Jedná se o nepostradatelné objemné krmivo, které má rozhodující podíl na výrobě a kvalitě masa, mléka a dalších živočišných produktů. Některé plodiny je možné v příznivých podmínkách sklízet až pětkrát. Důležitým faktorem jsou klimatické podmínky, které se mohou lišit v jednotlivých oblastech. V horských oblastech je vegetační období kratší, tudíž jsou i špičky sklizní v kratším rozmezí. V případě, že je přidávána nekvalitně konzervovaná píce do krmných dávek, zvyšuje se potřeba jadrných krmiv.

Tato práce představuje výsledky polního experimentu, při kterém byly porovnávány dva žací rotační stroje a jejich vliv na průběh sušení píce při druhé sklizni píce. Porovnáván byl diskový žací stroj s čechračem a bubnový žací stroj bez výbavy pro úpravu píce. Dále byla zjišťován vliv počtu obracení píce na průběh sušení píce. Pokusný pozemek se nachází v obci Orlické Záhoří, v severovýchodní části České republiky. Experiment byl uskutečněn během sklizňové sezóny v srpnu roku 2022.

Pokusný pozemek byl rozdělen do čtyř částí (A, B, C, D). Nejprve proběhlo sečení prvních dvou částí (A, B) pozemku pomocí bubnového žacího stroje. Následovalo sečení druhých dvou částí (C, D) diskovým žacím strojem vybaveným čechracím rotorem. Třetí den proběhlo rozhození řádků na široko všech částí (A. B, C, D). Čtvrtý den proběhlo obrácení pouze části B a D. Pátý den proběhlo obrácení všech čtyř částí (A, B, C, D). Během experimentu byly po každém úkonu (sečení, obracení) odebrány vzorky z jednotlivých částí pozemku Vzorky byly uloženy do neprodyšných sáčků pro následné dosušení a určení obsahu sušiny.

Odebrané vzorky píce pro první dvě měření nevykazovaly statisticky významné rozdíly v podílu sušiny. Vzhledem k několika dešťovým srážkám nebyl zaznamenán mezi prvními dvěma měřeními ani výrazný úbytek vlhkosti píce. Výraznější úbytek vlhkosti byl zaznamenán mezi měřením č. 2 a 3. U vzorků odebraných pro měření č. 3 zaznamenán statisticky významný rozdíl v podílu sušiny. Píce, která byla čechrána a vícekrát obrácena, vykazovala průměrně vyšší hodnoty podílu sušiny, avšak na hranici statistické významnosti.

Kľúčové slová: píce, úbytek vlhkosti, čechrání

REFERENCES

LI, YU WEI, et al. 2019. Effect of Tedding Time and Frequency on the Feed Value and Drying Rate of Rye (Secale cereale L.) Hay. *Journal of The Korean Society of Grassland and Forage Science,* 2019, 39.3: 171-177.

PATTEY, E., SAVOIE, P., DUBE, P. A. 1988. The effect of a hay tedder on the field drying rate. *Can. Agric. Eng,* 1988, 30.1: 43-50.

ROTZ, C. A., SHINNERS, K. J., BARNES, R. F. 2007. Hay harvest and storage. *Forages*, 2007, 2: 601-616.

SHINNERS, K. J., FRIEDE, J. C. 2017. Enhancing Switchgrass Drying Rate. *BioEnergy Research,* 2017, 10: 603-612.

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THE USE OF REGULATORY CHARACTERISTICS TO PREDICT THE FUTURE BEHAVIOR OF A WATER TREATMENT PLANT WITH RESPECT TO THE QUALITY OF THE INLET WATERTITLE

VYUŽITÍ REGULAČNÍCH CHARAKTERISTIK PRO PREDIKCI BUDOUCÍHO CHOVÁNÍ ÚPRAVNY VODY S OHLEDEM NA KVALITU VSTUPNÍ VODYTITLE

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ABSTRACT:

The main goal of the project "Use of regulatory characteristics to predict the future behavior of a water treatment plant with respect to the quality of the inlet water" is the prediction of the behavior of the water treatment plant depending on the regulatory characteristics and the quality of the inlet water.

Regulatory characteristics:
- Flow rate
- Temperature
- Pollution degree of inlet water
- pH
- EC – electrical conductivity
- CF – amount of ions dissolved in water
- Ppm – concentration ratio of undesirable substances in water

The first thing that will be tested is the change in water quality in the pipe flowing into the treatment plant at a distance of 180-200 meters. The aim is to analyze the negative effect of distance on the content of undesirable substances. The Aqua Master test units will be located in three locations approximately 65 meters apart. Each test site will have a 100-liter tank for easier access and the possibility of placing the probes of the test unit. The test unit will measure electrical conductivity, the amount of ions dissolved in the water, the concentration ratio of undesirable substances in the water, pH and temperature. There will be a total of nine tests on two differently polluted water samples (standing and flowing) and one that meets drinking water standards. The negative influence of the distance from the source to the treatment plant on water quality will be investigated.

The second phase of the experiment will be focused on testing the water treatment plant, with an emphasis on its filtration capacity if the water is not filtered using reverse osmosis technology. This innovative technology plays a key role in the drinking water production process, as it ensures the effective removal of unwanted substances and pollution, thereby achieving quality standards for drinking water.

In order to obtain results, it was necessary to prepare suitable conditions for collecting a sufficient amount of the most accurate data on the change in water quality with different flow rates that were influenced by distance.

Data was collected on three types of differently polluted water, which was always collected in a thousand-liter tank. Running water was taken using pumps from the Vltava in the Podbaba area. Standing water was taken from a pond in Turkey, and drinking water was taken from a water supply on the ČZU premises. Using a trailer, it was transported to the CZU campus and subjected to an experiment

Aqua Master P700 PRO2 units were placed in each hundred liter tank and the change in water quality was measured at a flow rate of 20 lit/min.

Results of the change in water quality recorded by the measuring unit:

	Flowing			Still			Drinking		
	65m	130m	195m	65m	130m	195m	65m	130m	195m
pH	7.3	7.2	7.2	8.6	8.6	8.8	7.3	7.3	7.5
ppm	220	210	180	457	464	480	190	200	204
Temp	15	15.3	16.3	12.1	12.7	13.3	13.4	13.7	14.1
EC	0.3	0.3	0.4	0.6	0.6	0.3	0.4	0.4	0.4
CF	3.1	3.1	1.7	6.5	6.6	3.6	4.9	4.5	4.1

Picture 1: Measured values at a flow rate of 20 liters/min

The table summarizes water quality measurements at three different types of sites – running water, stagnant water and drinking water – at different distances (65 m, 130 m, 195 m). For running water, the pH is maintained between 7.2 and 7.3, the solids concentration (ppm) decreases from 220 to 180 ppm with increasing distance, the water temperature increases from 15 °C to 16.3 °C, the electrical conductivity (EC) and the conductivity factor (CF) are at low values, indicating a lower amount of dissolved salts. Standing water has a higher pH, ranging between 8.6 and 8.8, ppm values are considerably higher (457 to 480 ppm), temperature is lower than flowing water, and EC and CF values are significantly higher, indicating higher mineral content. Drinking water has a pH similar to running water, ppm values are low and temperature increases slightly with distance.

Key words: water treatment plant, filtration, pollution

ABSTRAKT:

Hlavním cílem projektu „Využití regulačních charakteristik pro predikci budoucího chování úpravny vody s ohledem na kvalitu vstupní vody´´ je predikce chování úpravny vody v závislosti na regulačních charakteristikách a kvalitě vstupní vody.

Regulační charakteristiky:
- Průtok
- Teplota
- Míra znečištění vstupní vody
- pH
- EC – elektrická vodivost
- CF – množství iontů rozpuštěných ve vodě
- Ppm – poměr koncentrace nežádoucích látek ve vodě

Jako první bude testována změna kvality vody v potrubí přitékající do úpravny na vzdálenost 180-200 metrů. Cílem je analyzovat negativní vliv vzdálenosti na obsah nežádoucích látek. Testovací jednotky Aqua Master budou umístěny ve třech místech vzdálené od sebe cca 65 metrů. V každém testovacím místě bude 100 litrová nadrž pro jednodušší přístup a možnost umístění sond testovací jednotky. Testovací jednotka bude měřit elektrickou vodivost, množství iontů rozpuštěných ve vodě, poměr koncentrace nežádoucích látek ve vodě, pH a teplotu. Bude probíhat celkem devět testování na dvou různě znečištěných vzorcích vody (stojatá a tekoucí) a jedné, která splňuje normy pitné vody. Bude zkoumán negativní vliv vzdálenosti od zdroje k úpravně na kvalitu vody.

Druhá fáze experimentu bude zaměřena na testování úpravny vody, s důrazem na její filtrační kapacitu v případě, že nebude voda filtrována pomocí technologie reverzní osmózy. Tato inovativní technologie hraje klíčovou úlohu

v procesu výroby pitné vody, jelikož zajišťuje efektivní odstranění nežádoucích látek a znečištění, čímž je dosaženo standardů kvality pro pitnou vodu.

Pro získání výsledků bylo zapotřebí připravit vhodné podmínky pro nashromáždění dostatečného množství co nejpřesnějších dat změny kvality vody s rozdílnými průtoky, které byly ovlivňovány vzdáleností.

Data byla nasbírána na třech typech různě znečištěné vody, která byla vždy odebrána do tisícilitrové nádrže. Tekoucí voda byla odebrána pomocí čerpadel z Vltavy v oblasti Podbaba. Stojatá vody byla odebrána z rybníku v Tursku a pitná voda byla odebrána z vodovodu v areálu ČZU. Pomocí přípojného vozíku byla dopravena do areálu ČZU a podrobena experimentu.

Jednotky Aqua Master P700 PRO2 byly umístěny v každé sto litrové nádrži a změna kvality vody byla měřena při průtoku 20 lit/min.

Výsledky změny kvality vody zaznamenané měřicí jednotkou:

	Tekoucí			Stojatá			Pitná		
vzdálenost	65m	130m	195m	65m	130m	195m	65m	130m	195m
pH	7,3	7,2	7,2	8,6	8,6	8,8	7,3	7,3	7,5
ppm	220	210	180	457	464	480	190	200	204
Teplota	15	15,3	16,3	12,1	12,7	13,3	13,4	13,7	14,1
EC	0,3	0,3	0,4	0,6	0,6	0,3	0,4	0,4	0,4
CF	3,1	3,1	1,7	6,5	6,6	3,6	4,9	4,5	4,1

Tabulka 1: Naměřené hodnoty při průtoku 20 l/min

Tabulka shrnuje měření kvality vody na třech různých typech míst – tekoucí voda, stojatá voda a pitná voda – a to v různých vzdálenostech (65 m, 130 m, 195 m). Pro tekoucí vodu se pH udržuje mezi 7,2 a 7,3, koncentrace pevných látek (ppm) se snižuje z 220 na 180 ppm s rostoucí vzdáleností, teplota vody se zvyšuje z 15 °C na 16,3 °C, elektrická vodivost (EC) a faktor vodivosti (CF) se pohybují v nízkých hodnotách, což naznačuje menší množství rozpuštěných solí. U stojaté vody je pH vyšší, pohybuje se mezi 8,6 a 8,8, ppm hodnoty jsou značně vyšší (457 až 480 ppm), teplota je nižší než u tekoucí vody, a hodnoty EC a CF jsou výrazně vyšší, což ukazuje na vyšší obsah minerálů. Pitná voda má pH podobné tekoucí vodě, ppm hodnoty jsou nízké a teplota se mírně zvyšuje s vzdáleností.

Kľúčové slová: úpravna vody, filtrace, znečištění

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REFERENCES

1. Omer, I., Pintea, I., Mateescu, R., 2013. Monitoring of water quality in thewater treatment plant, managed by Aquabis Bistrita, Romania -Web of Science Core Collection. (n.d.). Retrieved February 7, 2023, from https://www-webofscience-com.infozdroje.czu.cz/wos/woscc/full-record/WOS:000366031900029

2. Bornmann, K., Wricke, B., Habel, D., 2002. Optimization of particle removal in drinking water treatment of reservoir water in a pressure filter plant. *Water Supply*, 2(1), 241–247. https://doi.org/10.2166/WS.2002.0029

3. WHO (1982) Rural Water Supplies. World Health Organisation (WHO) Stevenage, UK,

4. Momba, M.N.B., Obi, C.L., Thompson, P., 2009. Survey of disinfection efficiency of small drinking water treatment plants: Challenges facing small water treatment plants in South Africa-Web of Science Core Collection. (n.d.). Retrieved February 7, 2023, from https://www-webofscience-com.infozdroje.czu.cz/wos/woscc/full-record/WOS:000269620900014

5. Calabrese, A., Massarelli, C., Uricchio, V. F., Campanale, C., 2014. Safeguarding Drinking Water: Use and Quality of Water, Case Study of Taranto Province. *Procedia Engineering*, 89, 232–238. https://doi.org/10.1016/J.PROENG.2014.11.182

6. Chabi, K., Zeng, J., Guo, L., Li, X., Ye, C., Yu, X., 2020. Small-scale drinking water treatment unit of filtration and UV disinfection for remote area. *Water Supply*, 20(6), 2106–2118. https://doi.org/10.2166/WS.2020.109

7. Lom, M., Pribyl, O., Svitek, M. 2016. Industry 4.0 as a part of smart cities. *2016 Smart Cities Symposium Prague*, SCSP 2016. https://doi.org/10.1109/SCSP.2016.7501015

8. Pooi C. K., Ng H. Y., 2018 Review of low-cost point-of-use water treatment systems for developing communities. npj *Clean Water* 1 (1), 11. http://dx.doi.org/10.1038/s41545-018-0011-0.

9. Ahmad1, B., Hamza, A., Ahmed, S., Najam, Z., Ishtiaq, A. 2019. Synthesis and Characterization of PMMA Nanofibers for Filtration of Drinking Water. *J. Mech. Cont.& Math. Sci*, 14(4), 102–116. https://doi.org/10.26782/jmcms.2019.08.00009

10. Thompson, T., Fawell, J., Kunikane, S., Jackson, D., Appleyard, S., Callan, P., Bartram, J., Kingston, P. 2007. Chemical safety of drinking water: assessing priorities for risk management. Geneva: World Health Organization.

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DEVELOPMENT AND PROGRAMMING OF A THERMAL VISION CAMERA USING THE MLX90640 SENSOR: TECHNICAL ASPECTS AND APPLICATIONS IN DRIVER SAFETY

VÝVOJ A PROGRAMOVANIE TERMOVÍZNEJ KAMERY POMOCOU SNÍMAČA MLX90640: TECHNICKÉ ASPEKTY A APLIKÁCIE V OBLASTI BEZPEČNOSTI VODIČA

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ABSTRACT: In today's era, it is crucial to monitor and optimize the microclimate of the interior environment to enhance the comfort and safety of drivers and passengers. When adjusting the parameters of the cabin microclimate, several factors come into play, which affect the health and safety of the passengers, such as the time and attention devoted to parameter settings, as well as the selected parameters themselves. This article focuses on the design, implementation, and testing of an infrared (IR) sensor integrated with an ESP32 module for monitoring the surface temperature of the driver's face in the vehicle. The goal is to analyse the rate of temperature change and optimize the airflow speed and temperature from the vehicle's air conditioning system outlets. The left lower area of the rearview mirror was chosen for sensor placement to capture the largest possible area of the face without obstructing the driver's view. The MLX90640 sensor with a resolution of 32x24 pixels was selected for its ability to record temperatures ranging from -40°C to 300°C. Connection to other components was established via the I2C protocol. For signal processing from the sensor, the ESP32 microcontroller from Laskakit, featuring Wi-Fi and Bluetooth capabilities, was chosen. Programming was done using Arduino source code, and the results were processed using Processing code. Measurements included experiments with various airflow speeds and their impact on the surface temperature of the driver's face. The results revealed a positive correlation between airflow speed and the rate of temperature change. This finding has the potential to increase the comfort and safety of drivers and passengers in the vehicle. In conclusion, the potential of infrared sensors in future intelligent vehicles is emphasized, highlighting their contribution to optimizing the microclimate and enhancing the comfort and safety of drivers and passengers.

Key words: microclimate, infrared thermography, thermal comfort, HVAC

ABSTRAKT: V súčasnosti je dôležité sledovať a optimalizovať mikroklímu vnútorného prostredia vozidiel s cieľom zvýšiť pohodlie a bezpečnosť vodičov a cestujúcich. Pri nastavovaní parametrov mikroklímy v kabíne sa stretávame s viacerými faktormi, ktoré ohrozujú zdravie a bezpečnosť posádky, ako je čas a pozornosť venovaná nastaveniu parametrov a samotné vybrané parametre. Tento článok sa zameriava na návrh, implementáciu a testovanie infračerveného (IR) senzora integrovaného s modulom ESP32 na monitorovanie teploty povrchu tváre vodiča vozidla. Cieľom je analyzovať rýchlosť zmeny teploty a optimalizovať rýchlosť prúdenia vzduchu a teploty z výstupov klimatizačného systému vozidla. Pre umiestnenie senzora bol zvolený ľavý spodný roh spätného zrkadla s cieľom zachytiť čo najväčšiu plochu tváre bez obmedzenia vodičovho výhľadu. Senzor MLX90640 s rozlíšením 32x24 pixelov bol vybraný pre svoje schopnosti zaznamenávať teploty v rozsahu od -40 °C do 300 °C. Prepojenie s ostatnými komponentami bolo zabezpečené prostredníctvom I2C protokolu. Na spracovanie signálov zo senzora bol zvolený mikrokontrolér ESP32 od značky Laskakit, ktorý disponuje funkciou Wi-Fi a Bluetooth. Programovanie prebehlo pomocou zdrojového kódu pre Arduino a spracovanie výsledkov pomocou kódu pre Processing. Merania zahŕňali aj experimenty s rôznymi rýchlosťami prúdenia vzduchu a ich vplyvom na zmenu teploty povrchu tváre vodiča. Výsledky ukázali pozitívnu koreláciu medzi rýchlosťou prúdenia vzduchu a rýchlosťou zmeny teploty. Tento poznatok má potenciál zvýšiť komfort a bezpečnosť vodiča a cestujúcich vo vozidle. V závere sa zdôrazňuje potenciál infračervených senzorov v inteligentných vozidlách budúcnosti a ich prínos pri optimalizácii mikroklímy a zvýšení komfortu a bezpečnosti vodičov a cestujúcich.

Kľúčové slová: mikroklíma, infračervená termografia, tepelná pohoda, HVAC

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REFERENCES

CIAMPA F., MAHMOODI P., PINTO M. 2018. Recent Advances in Active Infrared Thermography for Non-Destructive Testing of Aerospace Components. In *Sensors*, vol. 18, p. 609, DOI:10.3390/s18020609.

SHIN Y., IM, G., YU K., CHO H. 2017. Experimental study on the change in driver's physiological signals in automobile HVAC system under Full load condition. In *Applied Thermal Engineering*, vol.112, pp. 1213-1222, ISSN 1359-4311, DOI: 10.1016/j.applthermaleng.2016.10.193.

SURESH P., THEIVADAS R., KUMAR H., ENINARSON D. 2022. Driver monitoring and passenger interaction system using wearable device in intelligent vehicle. In *Computers and Electrical Engineering*, vol. 103, pp. 108323, ISSN 0045-7906, DOI: 10.1016/j.compeleceng.2022.108323.

UGURSAL A., CULP H. 2012. An Empirical Thermal Comfort Model for Transient Metabolic Conditions. In *ASHRAE Transactions*, vol. 118, no. 1, pp. 742-750, ISSN 0001-2505.

VITÁZEK I., TKÁČ Z., MAJDAN R. 2021. Interior environment in vehicles: features and their evaluation (in Slovak). 1. Release. Nitra: Slovak University of Agriculture, 2021. Article 133, ISBN 978-80-552-2424-4.

YI X., ZHAOMING L., JIANGYAN L., KUINING L., YANGJUN Z., CUNXUE W., PINGZHONG W., XIAOBO W. 2020. A Self-learning intelligent passenger vehicle comfort cooling system control strategy, In *Applied Thermal Engineering*, vol. 166, 2020, Article 114646, ISSN 1359-4311, DOI: 10.1016/j.applthermaleng.2019.114646.

YUE Y., YUQI H., JISHENG Z. 2020. Optimization of the automotive air conditioning strategy based on the study of dewing phenomenon and defogging progress, In *Applied Thermal Engineering*, vol. 169, 2020, Article 114932, ISSN 1359-4311, DOI: 10.1016/j.applthermaleng.2020.114932.

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TESTING THE ADHESION PROPERTIES OF MOTORCYCLE TIRES

TESTOVANIE ADHÉZNYCH VLASTNOSTÍ MOTOPNEUMATÍK

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ABSTRACT: The main objective of this research is to test the adhesion properties of Honda motorcycle tires and brakes with the year of manufacture 2003 and type designation CB600S with Nankang Sportiac WF-2 tires using deceleration. Nowadays, the probability of a traffic accident is increased with the ever-increasing number of vehicles on our roads, while most accidents can be prevented by improving the condition and driving characteristics of the vehicle and training the driver in critical situations. It is also necessary to improve the driving characteristics of the motorcycle with the ever-increasing power of motorcycles. Our measured motorcycle is equipped with a sports exhaust and on the front pair of brakes it is equipped with Brembo brake pads with a sintered compound. At the time of measurement, the front tire had approximately 3,000 km and the rear approximately 1,000 km. We used the device XL MeterTM Pro Alfa designed to measure the acceleration or deceleration of the vehicle needed to calculate tire adhesion while the device must be positioned such way that its attachment is perpendicular to the road and the axis of the measuring device is parallel to the axis of the vehicle. Another device was a digital rollmeter used to measure ground distances and to check the results of the braking distance. Before the measurements themselves, it was necessary to make a handle to attach the measuring device to the vehicle and to fix the measuring device and to perform test rides to evaluate the road quality and warm up the test motorcycle. Measurements on the said motorcycle were carried out at three different speeds of 50, 70 and 100 $km.h^{-1}$, while at each speed braking was measured either with only the front brake, the rear brake or both brakes together. In all measurements with only the rear brake, the rear wheel skidded, while when braking with the rear brake from speeds of 75 and 98 $km.h^{-1}$ and when braking from speeds of 67 and 102 $km.h^{-1}$, the rear wheel lifted into the air. The highest deceleration was achieved at a speed of 79 $km.h^{-1}$ at a value of 9.77 $m.s^{-2}$ when braking with only the front brake, which corresponds to an adhesion of 0.99, while the lowest adhesion values were achieved at braking with the rear brake only in the value of 0.34 due to the low load on the rear wheel and dynamic load transfer. During limit braking with the front brake, the entire gravitational force is dynamically transferred to the front wheel, which makes it possible to use the entire weight for braking power, thus this phenomenon has a great influence on the resulting deceleration. The given method of determining the limit adhesion can be considered technically acceptable and correct. From the resulting measurement values, it follows that braking with the rear brake is very difficult due to the rapid occurrence of wheel locking and the subsequent threat of loss of stability.

Key words: motorcycle, tires, deceleration, adhesion

ABSTRAKT: Hlavným cieľom tohto výskumu je testovanie adhéznych vlastností a bŕzd pomocou spomalenia na motocykle Honda s rokom výroby 2003 a typovým označením CB600S s pneumatikami Nankang Sportiac WF-2. V dnešnej dobe s neustále sa zvyšujúcim počtom vozidiel na našich cestách je zvýšená pravdepodobnosť dopravnej nehody, pričom väčšine nehôd sa dá predísť zlepšením stavu a jazdných vlastností vozidla a školením vodiča v kritických situáciách. S neustále sa zvyšujúcim výkonom motocyklov je potrebné zlepšovať aj jazdné vlastnosti motocykla. Náš meraný motocykel je vybavený športovým výfukom a na prednom páre bŕzd je vybavený brzdovými doštičkami Brembo so sintrovanou zmesou. V čase merania mala predná pneumatika najazdených približne 3000 km a zadná približne 1000 km. Pri meraniach sme použili prístroj XL MeterTM Pro Alfa určený na meranie zrýchlenia alebo spomalenia vozidla potrebného na výpočet adhézie pneumatík pričom zariadenie musí byť umiestnené tak, aby jeho upevnenie bolo kolmé na vozovku a os meracieho zariadenia bola rovnobežná s osou vozidla. Ďalší použitý prístroj bol digitálny rollmeter určený na meranie vzdialeností od zeme a na kontrolu výsledkov brzdnej dráhy. Pred samotnými meraniami bola potrebná výroba rukoväte na pripevnenie meracieho zariadenia na vozidlo a upevnenie meracieho zariadenia a vykonanie testovacích jázd na vyhodnotenie kvality vozovky a zahriatie testovaného motocykla. Merania na uvedenom motocykli boli realizované pri troch rôznych rýchlostiach 50, 70 a 100 $km.h^{-1}$, pričom pri každej rýchlosti bolo merané brzdenie buď len prednou brzdou,

zadnou brzdou alebo oboma brzdami spolu. Pri všetkých meraniach len so zadnou brzdou došlo k šmyku zadného kolesa pričom pri brzdení zadnou brzdou z rýchlosti 75 a 98 km.h^{-1} a pri brzdení z rýchlosti 67 a 102 km.h^{-1} sa zadné koleso zdvihlo do vzduchu. Najvyššie spomalenie bolo dosiahnuté pri rýchlosti 79 km.h^{-1} pri hodnote 9,77 m.s^{-2} pri brzdení len prednou brzdou, čo zodpovedá adhézii 0,99, pričom najnižšie hodnoty adhézie boli dosiahnuté pri brzdení so zadnou brzdou len v hodnote 0,34 z dôvodu nízkej záťaže zadného kolesa a dynamického prenosu záťaže. Pri limitnom brzdení prednou brzdou sa celá gravitačná sila dynamicky prenáša na predné koleso, čo umožňuje využiť celú hmotnosť na brzdnú silu, tým pádom tento jav má veľký vplyv na výsledné dosiahnuté spomalenie. Daný spôsob stanovenia limitnej adhézie možno považovať za technicky prijateľný a správny. Z výsledných hodnôt merania vyplýva, že brzdenie zadnou brzdou je veľmi náročné z dôvodu rýchleho vzniku zablokovania kolies a následnej hrozby straty stability.
Kľúčové slová: motocykel, pneumatiky, spomalenie, adhézia

REFERENCES

DOČKAL, V., KOVANDA, J., HRUBEC, F. 1998. Tires. Praha: ČVUT. [In Czech: Pneumatiky]. pp 71. ISBN 80-01-01882-2

HUDÁK, A. – VRÁBEĽ, J. 2010. Factors affecting the safety of tire-road contact. In *Doprava a spoje*, vol. 6, no. 1. [In Slovak: Faktory ovplyvňujúce bezpečnosť styku pneumatiky a vozovky] pp. 99-106. ISSN 1336-7676

HUGO, W. 1994. The big book about motorcycles. Bratislava: Gemini. 191 pp. (In Slovak: Veľká kniha o motocykloch). ISBN 80-7161-096-8

KOTEK, F. 2017. Adhesion properties of tires on the selected surface. Diploma thesis. Nitra: Slovak University of Agriculture, Faculty of Engineering. [In Slovak: Adhézne vlastnosti pneumatík na vybranom povrchu]. pp. 62. Dostupné na: https://opac.crzp.sk/?fn=docview2ChildATLMU&record=DF521320909666631F7BE2F290DD&seo=CRZP-Prehliadanie-pr%C3%A1c

NOVOSAD, J. 2017. Adhesion properties of road tires. Bachelor thesis. Nitra: Slovak University of Agriculture, Faculty of Engineering. [In Slovak: Adhézne vlastnosti cestných pneumatík]. pp. 48. Dostupné na: https://opac.crzp.sk/?fn=docview2ChildQV9KN&record=998D604438B59F55B68053FC0D22&seo=CRZP-Prehliadanie-pr%C3%A1c

VOKÁLEK, J. 2008. The perfect ride on a motorcycle. České Budějovice: Kopp. 212 pp. (In Czech: Dokonalá jízda na motocyklu). ISBN 8072323474

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OPERATIONAL TESTING OF GASOLINE FUEL ADDITIVE

PREVÁDZKOVÉ SKÚŠKY ADITÍVA DO BENZÍNU

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ABSTRACT: The present papers deal with the issue of assessing the influence of the selected additive to automobile gasoline fuel on the power, energy and emission parameters of the selected motor vehicle Renault Clio 1,2i. During the entire measurement process, Matador MP 56 winter tires with size 175/65 R14 and inflated to the prescribed operating pressure of 200 kPa were used. Nowadays, due to the constant development in the field of automobile transport, it is necessary to carefully monitor the impact of motor vehicle operation on the environment. The main indicators in this area are vehicle consumption, which is followed by motor vehicle emissions. Fuel Save Natural 95 gasoline from Shell was used for laboratory measurement of fuel consumption and emissions. During the entire measurement process, we used VIF Super Benzin Aditiv gasoline engine additive, which was used in a ratio of 125 ml of additive to 25 liters of fuel. Measurements of individual parameters were carried out in laboratory conditions in the form of simulated driving cycles according to procedure described in the methodology section on the cylinder test bench of motor vehicles of the MSR 500 ALLRAD type from the manufacturer MAHA, enabling testing of 4x4 vehicles. As an external measuring device, we used the AIC - 5004 FUEL FLOWMASTER flowmeter from AIC SYSTEMS AG to measure fuel consumption. A five-gas combined exhaust gas analyzer MAHA Kombi tester MGT/MDO2 – LON was used to determine the representation of individual emission components in exhaust gases. The power parameters were assessed based on a comparison of the external speed characteristics of the motor vehicle. Performance of the speed characteristics of the vehicle engine was carried out twice before and after the addition of the additive. Energy and emission parameters were determined in the form of vehicle load during selected time intervals. Ten time measurements were carried out, 5 before the addition of the additive and 5 after the addition of the additive at an engine speed of 3400 min^{-1} with the 4th gear engaged and according to a preselected 120 second time interval. The value of unburned hydrocarbons HC decreased by more than 50 % and carbon monoxide CO decreased more than 30 %. For fuel consumption, we found that it increased slightly due to the increased average rpm and power. After evaluating the results, partial changes are visible in all measured parameters of the vehicle which confirms the effectiveness of additive VIF Super Benzin Aditiv with the given fuel even after a short-term use.

Key words: additives to gasoline, gasoline, testing of automobile, consumption, emissions

ABSTRAKT: Predložený príspevok sa zaoberá problematikou hodnotenia vplyvu zvolenej prísady do automobilového benzínu na výkonové, energetické a emisné parametre vybraného motorového vozidla Renault Clio 1,2i. Počas celého procesu merania boli použité zimné pneumatiky Matador MP 56 s rozmerom 175/65 R14 a nahustené na predpísaný prevádzkový tlak 200 kPa. V dnešnej dobe vzhľadom na neustály vývoj v oblasti automobilovej dopravy je potrebné dôsledne sledovať vplyv prevádzky motorových vozidiel na životné prostredie. Hlavnými ukazovateľmi v tejto oblasti sú spotreba vozidiel, na ktorú nadväzujú emisie motorových vozidiel. Na laboratórne meranie spotreby paliva a emisií bol použitý benzín Fuel Save Natural 95 od značky Shell. Počas celého procesu merania sme použili aditívum do benzínových motorov VIF Super Benzin Aditiv, ktoré bolo použité v pomere 125 ml aditíva na 25 litrov paliva. Merania jednotlivých parametrov boli realizované v laboratórnych podmienkach formou simulovaných jazdných cyklov podľa postupu opísaného v časti Materiál a metódy na valcovej skúšobni motorových vozidiel typu MSR 500 ALLRAD od výrobcu Maschinenbau Haldenwang (MAHA) umožňujúca testovať vozidlá 4x4. Ako externé meracie zariadenie sme na meranie spotreby paliva použili prietokomer AIC - 5004 FUEL FLOWMASTER od AIC SYSTEMS AG. Na zistenie zastúpenia jednotlivých emisných zložiek vo výfukových plynoch bol použitý päťplynový kombinovaný analyzátor výfukových plynov značky MAHA Kombi tester MGT/MDO2 – LON. Výkonové parametre boli hodnotené na základe porovnania vonkajších rýchlostných charakteristík motorového vozidla. Vykonávanie otáčkových charakteristík motora vozidla bolo realizované dvakrát pred a po pridaní aditíva. Energetické a emisné parametre boli zisťované formou zaťaženia vozidla počas zvolených časových intervalov. Vykonalo sa desať časových

meraní z toho 5 pred pridaním aditíva a 5 po pridaní aditíva pri otáčkach motora 3400 min^{-1} so zaradeným 4. prevodovým stupňom a podľa vopred zvoleného 120 sekundového časového intervalu. Meranie s aditívom ukázalo, že hodnota nespálených uhľovodíkov HC klesla asi o viac ako 50 % a oxidu uhoľnatého CO sa znížil o viac ako 30 %. Vyhodnotené výsledky ukazujú čiastkové zmeny vo všetkých nameraných parametroch vozidla, čo potvrdzuje účinnosť aditíva VIF Super Benzin Aditiv s daným palivom aj po krátkodobom používaní. Pri spotrebe paliva sme zistili, že sa mierne zvýšila v dôsledku zvýšených priemerných otáčok a výkonu.
Kľúčové slová: prísady do benzínu, benzín, testovanie automobilu, spotreba, emisie

REFERENCES

BEHCET, R., YAKIN, A. 2022. Evaluation of hydrogen-containing $NaBH_4$ and oxygen-containing alcohols (CH_3OH, C_2H_5OH) as fuel additives in a gasoline engine. In *International journal of hydrogen energy*, vol. 47, no. 53, pp. 22316-22327. ISSN 0360-3199

JABLONICKÝ, J. 2010. Motor vehicles 1. Nitra: Slovenská poľnohospodárska univerzita. 97 pp. (In Slovak: Motorové vozidlá 1). ISBN 978-80-552-0474-1

KRÁLIK, M. et al. 2016. Monitoring of selected emissions of internal combustion engine. In *Research in agriculture engineering*, vol. 62, no. 1, pp 66–70. doi: 10.17221/72/2015-RAE.

LENĎÁK, P., JABLONICKÝ J. 2015. Draft methodology for performance of emission controls for vehicles with a spark-ignition engine and an improved emission system. Nitra: Slovenská poľnohospodárska univerzita. 208 pp. (In Slovak: Návrh metodiky výkonu emisných kontrol pre vozidlá so zážihovým motorom a zdokonaleným emisným systémom). ISBN 978-80-552-1319-4

MUSYAROH, WIJAYANTI, W., SASONGKO, M. N., WINARTO. 2024. The effects of limonene and eugenol additives in n-heptane and low-octane gasoline on the emission characteristics and fuel consumption of single-cylinder gasoline engine. In *Engineering Science and Technology*, an International Journal, vol. 51. ISSN 2215-0986

STN EN 228 + A1: 2018. Automotive fuels. Unleaded gasoline. Requirements and test methods.

www page of Maha GmbH & Co. KG. Haldenwang. MSR 500 4WD. [online] [cit. 2024-04-11]. Available from: https://www.maha.de/en/products/performance-measurement-technology/dynamometers/msr-5002-pkw-allrad~p2012

www page of Maha GmbH & Co. KG. Haldenwang. MCT Maha Combi Tester. [online]. [cit. 2024-04-12]. Available from: https://www.maha.de/en/products/emission-measurement-technology/emission-tester/mct~p25150

www page of Seka s.r.o., Nitra. [online]. [cit. 2024-03-23]. Available from: https://www.seka.sk/verejnost/informacie/postup-pri-emisnej-kontrole

SYNÁK, F., SYNÁK, J. 2022. Study of the Impact of Malfunctions of and Interferences in the Exhaust Gas Recirculation System on Selected Vehicle Characteristics. In *SAE International Journal of Engines*, vol. 15, no. 6. ISSN19463936

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DESIGN OF TECHNOLOGY FOR THE APPLICATION OF RECYCLED GRANULATE MATERIAL TO THE PRODUCTION PROCESS OF PARTICLEBOARDS

NÁVRH TECHNOLÓGIE PRE APLIKÁCIU RECYKLOVANÉHO GRANULÁTOVÉHO MATERIÁLU DO PROCESU VÝROBY DREVOTRIESKOVÝCH DOSIEK

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ABSTRACT: The aim of the paper is to design a technology that will make it possible to use recycled rubber or plastic material from waste automobile parts, such as: tires, seals, carpets, hoses, cuffs, bumpers, fuel tanks, lights, covers and so on. The design of the technology involves recycled material in the form of granulates, which will be applied to the particleboard production process using a conveyor. The paper deals with two types of conveyors that are suitable for transporting bulk material. For the design, a screw and spiral conveyor was used together with a silo for granulate material in the form of technical designs that were created using the Creo Parametric program. Within the design, the basic parameters of individual conveyors and silo were solved. From the basic parameters of the conveyors, the required performance, the amount of recycled granulate per one particleboard according to the weight ratio, the diameter of the screw/spiral and the required engine power were calculated. Calculations showed that the necessary diameter of the spiral for each performance is smaller and the engine power is greater, which is understandable from the point of view that the spiral does not have a central shaft opposite the screw. From the basic parameters of the silo, the volume, the time of material delivery to the conveyor, the angle of the hopper and the load capacity of the construction were designed. At the end, a scheme of the technological production process was designed using the Visio program, which is divided into four main parts of the particleboard production process. The first part is the preparation of the material, which includes the storage of wood particles, drying of the wood particles and sorting of fractions using sieving equipment. The second part is material mixing, which includes mixing of wood particles, recycled granulate and adhesive mixture and forming the mat. The third part is composite pressing, which includes cold pre-pressing and hot pressing. The fourth part is the processing of the composite, which includes cutting, cooling, drying, shaping and final modification.

Key words: screw conveyor, spiral conveyor, recycled material, composite, technology

ABSTRAKT: Cieľom príspevku je návrh technológie, pomocou ktorej bude možné využiť recyklovaný gumený alebo plastový materiál z odpadových častí automobilov, ako napríklad: pneumatiky, tesnenia, koberce, hadice, manžety, nárazníky, palivové nádrže, svetlá, kryty a tak ďalej. Návrh technológie sa vťahuje na recyklovaný materiál vo forme granulátu, ktorý bude do výrobného procesu drevotrieskových dosiek aplikovaný pomocou dopravníka. Príspevok sa zaoberá dvomi typmi dopravníkov, ktoré sú vhodné pre dopravu sypkého materiálu. Pre návrh sa použil závitovkový a špirálový dopravník spolu so zásobníkom pre granulátový materiál v podobe technických návrhov, ktoré boli vytvorené pomocou programu Creo Parametric. V rámci návrhu sa riešili základné parametre jednotlivých dopravníkov a zásobníka. Zo základných parametrov dopravníkov bola vypočítaná potrebná výkonnosť, množstvo recyklovaného granulátu na jednu drevotrieskovú dosku podľa hmotnostného pomeru, priemer závitovky/špirály a potrebný výkon motora. Výpočty ukázali, že potrebný priemer špirály pre jednotlivé výkonnosti je menší a výkon motora väčší, čo je pochopiteľné z hľadiska toho, že špirála nemá stredový hriadeľ oproti závitovke. Zo základných parametrov zásobníka bol navrhnutý objem, čas dodávania materiálu do dopravníka, uhol násypky a nosnosť konštrukcie. Na záver bola navrhnutá schéma technologického procesu výroby pomocou programu Visio, ktorá je rozdelená do štyroch hlavných častí výrobného procesu drevotrieskových dosiek. Prvou časťou je príprava materiálu, ktorá zahrňuje sklad drevnej triesky, sušenie drevných triesok a triedenie frakcií pomocou sitovacích zariadení. Druhou časťou je miešanie materiálu, ktorá zahrňuje miešanie drevných triesok, recyklovaného granulátu a lepidlovej zmesi a formovanie koberca. Treťou časťou je lisovanie kompozitu, ktorá zahrňuje predlisovanie za studena a lisovanie za tepla. Štvrtou časťou je obrábanie kompozitu, ktorá zahrňuje rezanie, chladenie, sušenie, tvarovanie a finálnu úpravu.

Kľúčové slová: závitovkový dopravník, špirálový dopravník, recyklovaný materiál, kompozit, technológia

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REFERENCES

BADIDA, M., SOBOTOVÁ, L., DZURO, T., MORAVEC, M., PIŇOSOVÁ, M., KRÁLIKOVÁ, R. 2022. Development of materials and products with sound and thermal insulating and other properties on the basis of waste from the automotive industry. In *Smart Technologies for Waste Processing from the Automotive Industry*. Germany: RAM-Verlag, 219 p. ISBN 978-3-96595-023-8.

ČABALOVÁ, I., HÁZ, A., KRILEK, J., BUBENÍKOVÁ, T., MELICHERČÍK, J., KUVIK, T. 2021. Recycling of wastes plastics and tires from automotive industry. In *Polymers*, vol. 13, no. 13. DOI: 10.3390/polym13132210.

JASAŇ, V. 1983. *Theory of transport and handling equipment*. Bratislava: Alfa, 318 p. ISBN 80-05-00125-8. (In Slovak).

KARWAT, B., RUBACHA, P., STAŃCZYK, E. 2020. Simulational and experimental determination of the exploitation parameters of a screw conveyor. In *Maintenance and Reliability*, vol. 22, no. 4, p. 741-747. DOI: 10.17531/ein.2020.4.18.

KARWAT, B., RUBACHA, P., STAŃCZYK, E. 2021. Optimization of a screw conveyor's exploitation parameters. In *Maintenance and Reliability*, vol. 23, no. 2, p. 285-293. DOI: 10.17531/ein.2021.2.8.

KRILEK, J., SAMEŠOVÁ, D., ČABALOVÁ, I., POTKÁNY, M., DADO, M., KUČERA, M., 2020. Recycling and recovery of rubber, caoutchouc and plastics into new products. In *Status and vision of recovery of waste from the automotive industry of the Slovak Republic*. Bratislava: Spektrum STU, 285 p. ISBN 978-80-227-5039-4. (In Slovak).

KRILEK, J., SAMEŠOVÁ, D., ČABALOVÁ, I., HYBSKÁ, H., BEŇO, P., POTKÁNY, M., MELICHERČÍK, J., 2021. Recycling and recovery of rubber, caoutchouc and plastics into new products. In *Progressive waste recovery technologies in the automotive industry.* Bratislava: Spektrum STU, 267 p. ISBN 978-80-553-3867-5. (In Slovak).

STN ISO 1050:1993. Equipment for the smooth transport of goods. Screw conveyors. (In Slovak).

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ARTIFICIAL INTELLIGENCE ALGORITHMS FOR MANUFACTURING TECHNOLOGY – A REVIEW

SYSTÉMY UMELEJ INTELIGENCIE PRE VÝROBNÚ TECHNIKU – PREHĽAD

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ABSTRACT: There are many problems that require adequate solution. In general algorithms are methods of solving problem using few steps that loop. Analyse data than based on that data find factors that affect data and based on all data find more suitable solution. This process is repeated till adequate solution is found. This paper summarizes basics of the algorithm, inner principes of algorithms with examples and usage of algorithms in terms of problem solving. In this overview is mentioned several algorithms such as: Generic Algorithm, Decision Tree, Neural Network etc. Each algorithm is tailored for different type of problem so finding algorithm that suits needs is of great importance. In the conclusion section, recommendations for choosing a suitable algorithm are summarized.

Artificial neural network algorithms and their modifications are used in the modelling of production and machining processes based on the amount of real measured data of these processes. Such models then enable the prediction and trend of monitored variables in real time, e.g. prediction of tool wear and the related quality of the created surface.

Optimization algorithms such as particle swarm or ant colony optimisation, and other genetic algorithms are used in the search for the optimal solution as the shortest sizes (distances) between manufacturing systems. This optimization does not have to be only in terms of time, but e.g. also the costs necessary for the implementation of material flows, energy consumption. When choosing a specific algorithm, the type of measured quantity (e.g. acoustic emission, vibration, power consumption, cutting force) and thus the nature of the output signal of a specific sensor must be taken into account. It is also necessary to consider the computational complexity and accuracy of the algorithm within the requirements of a specific application, where e.g. Algorithms such as decision trees are relatively fast, but not as accurate as algorithms using artificial neural networks.

Key words: artificial intelligence, machine learning, algorithm, problem solving, data analysis

ABSTRAKT: V každej dobe existuje veľa technických problémov, ktoré si vyžadujú primerané riešenie. Využívanie algoritmov a ich vlastností zjednodušuje analyzovanie dát a potom na základe nich zistenie faktorov, ktoré ich najviac ovplyvňujú. Tento článok sumarizuje základné algoritmy umelej inteligencie, ich vnútorné princípy s príkladmi na ich využitie v oblasti výrobnej techniky a obrábania. V tomto prehľade je spomenutých niekoľko algoritmov ako: Genetický algoritmus, Rozhodovací strom, Neurónová sieť a iné. Každý algoritmus je vhodný pre iný typ problému, v článku sú stručne uvádzané ich použitia pre výrobu a automatizáciu. V závere sú sumarizované všeobecné odporúčania pre výber vhodného algoritmu.

Algoritmy na princípe umelej neurónovej siete a ich modifikácie sa využívajú pri modelovaní výrobných a obrábacích procesov na základe množstva reálnych nameraných údajov týchto procesov. Takéto modely potom umožňujú predikciu a trend sledovaných premenných v reálnom čase, napr. predikcia opotrebovania nástroja a s tým súvisiacej kvality vytvoreného povrchu.

Pri hľadaní optimálneho riešenia najkratších rozmerov (vzdialeností) medzi výrobnými systémami sa využívajú optimalizačné algoritmy ako optimalizácie zhlukom častíc alebo kolóniou mravcov a ďalšie genetické algoritmy. Táto optimalizácia nemusí byť len z časového hľadiska, ale napr. aj náklady potrebné na realizáciu materiálových tokov, spotrebu energie. Pri výbere konkrétneho algoritmu treba brať do úvahy typ meranej veličiny (napr. akustická emisia, vibrácie, príkon, rezná sila) a tým aj charakter výstupného signálu konkrétneho snímača. Taktiež je potrebné zvážiť výpočtovú náročnosť a presnosť algoritmu v rámci požiadaviek konkrétnej aplikácie, kde napr.

algoritmy ako rozhodovacie stromy sú relatívne rýchle, ale nie také presné ako algoritmy využívajúce umelú neurónovú sieť.

Kľúčové slová: umelá inteligencia, strojové učenie, algoritmus, riešenie problémov, analýza dát

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REFERENCES

ABIODUN O. I., JANTAN A. , OMOLARA A. E.,. DADA K. V, ABD N., MOHAMED E., ARSHAD H., 2018 State-of-the-art in artificial neural network applications: A survey.
ALBADR, M. TIUN S., AYOB M.,AL-DHIEF F., 2020, Genetic Algorithm Based on Natural Selection Theory for Optimization Problems. Symmetry. Available on: http://dx.doi.org/10.3390/sym12111758

ARAVINDPAI P.,2024, Analyzing types of neural network in deep learning

BENARDOS P., VOSNIAKOS, G.C., 2002. Prediction of surface roughness in CNC face milling using neural networks and Taguchi's design of experiments. Robotics and and Computer-Integrated Manufacturing.

CUI J., WU L., HUANG X., XU D., LIU C., XIAO W., 2024, Multi-strategy Adaptable Ant Colony Optimization Algorithm and Its Application in Robot Path Planning, Volume 288, ISSN 0950-7051, Available on: https://www.sciencedirect.com/science/article/pii/S0950705124000947

DONGARE A.D., KHARDE R.R., KACHARE A. D., 2012 Introduction to Artificial Neural Network, vol 2, issue 1available on: https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=04d0b6952a4f0c7203577afc9476c2fcab2cba06

DORIGO M., STÜTZLE T., 2004, Ant Colony Optimization, MIT Press. ISBN 0-262-04219-3

DURAIRAJ, M., GOWRI, S., 2013, Parametric optimization for improved tool life and surface finish in micro turning using genetic algorithm. Procedia Engineering, 64, 878–87. Available on: https://doi.org/10.1016/j.proeng.2013.09.164

GILL N., KAUR H., 2013, Host based Anomaly Detection using Fuzzy Genetic Approach (FGA) available on: https://www.researchgate.net/publication/260973150_Host_based_Anomaly_Detection_using_Fuzzy_Genetic_Approach_FGA

HASTIE T., TIBSHIRANI R., FRIEDMAN J., 2011, The Elements of Statistical Learning: Data Mining, Inference, and Prediction (Springer, New York, 2011).

HOSAIN MD.T., JIM J. R., MRIDHA M.F., KABIR MD. M., 2024, Explainable AI approaches in deep learning: Advancements, applications and challenges, Computers and Electrical Engineering, Volume 117, ISSN 0045-7906, available on: https://www.sciencedirect.com/science/article/pii/S0045790624001745

JANG, J.S. (1993). ANFIS: Adaptive-network-based fuzzy inference system. IEEE Transactions on Systems, Man, and Cybernetics, 23, 665–685

KUMAR, A., PRADHAN, S. K., JAIN, V., 2019, Experimental investigation and optimization using regression genetic algorithm of hard turning operation with wiper geometry inserts. Materials Today Proceedings, 27, 2724–2730. Available on: https://doi.org/10.1016/j.matpr.2019.12.191

LIM H.W., ISA N.A.M., 2015, Adaptive division of labor particle swarm optimization. Expert Systems with Applications Volume 42, Issue 14, 15 August 2015, Pages 5887-5903 available on: https://doi.org/10.1016/j.eswa.2015.03.025

LIU Z., SUN Y., XING C., LIU J., HE Y., ZHOU Y., ZHANG G., 2022, Artificial intelligence powered large-scale renewable integrations in multi-energy systems for carbon neutrality transition: Challenges and future perspectives, Energy and AI, Volume 10, ISSN 2666-5468, Available on: https://doi.org/10.1016/j.egyai.2022.100195

MAHESH B:, 2020, Machine Learning Algorithms - A Review Available on: https://www.researchgate.net/publication/344717762_Machine_Learning_Algorithms_-A_Review

MIRJALILI S., LEWIS A., 2016,The Whale Optimization Algorithm, Pages 51-67, ISSN 0965-9978, Available on: https://www.sciencedirect.com/science/article/pii/S0965997816300163

MOHD N., TALPUR N., HUSSA K. ,2017, Adaptive Neuro-Fuzzy Inference System: Overview, Strengths, Limitations, and Solutions, 527-534

https://link.springer.com/chapter/10.1007/978-3-319-61845-6_52

NADIMI-SHAHRAKI, M., ZAMANI, H., ASGHARI VARZANEH, Z.,2023, A Systematic Review of the Whale Optimization Algorithm: Theoretical Foundation, Improvements, and Hybridizations. Available on: https://doi.org/10.1007/s11831-023-09928-7

OKOKPUJIE, I.P., TARTIBU, L.K. (2023). Global Machining Prediction and Optimization. In: Modern Optimization Techniques for Advanced Machining. Studies in Systems, Decision and Control, vol 485. Springer, Cham. https://doi.org/10.1007/978-3-031-35455-7_4

ROKACH L., MAIMON O., 2005, Top-down induction of decision trees classifiers-a survey, IEEE Transactions on Systems Man and Cybernetics Part C: Applications and Reviews, vol. 35, no. 4, pp. 476-487,

SAINI A., 2024, What is Decision Tree? Available on: https://www.analyticsvidhya.com/blog/2021/08/decision-tree-algorithm/

SHRIVASTAVA, Y., SINGH, B. POSSIBLE, 2018, Way to Diminish the Effect of Chatter in CNC Turning Based on EMD and ANN Approaches. Arab J Sci Eng 43, 4571–4591. https://doi.org/10.1007/s13369-017-2993-1

SHARMA, V., KUMAR, P., PRAKASH MISRA J., 2020, Cutting force predictive modelling of hard turning operation using fuzzy logic. Materials Today Proceedings, 26, 740–740. Available on: https://doi.org/10.1016/j.matpr.2020.01.018

SHIN Y., KITA E., 2014, Search performance improvement of particle swarm optimization by second best particle information. Applied Mathematics and Computation Volume 246, 1 November 2014, Pages 346-354 available on: https://doi.org/10.1016/j.amc.2014.08.013

SOFUOGLU, M. A., ÇAKIR, F. H., KUSHAN, M. C., ORAK, S., 2019, Optimization of different non-traditional turning processes using soft computing methods. Soft Computing, 23, 5213–5231. Available on: https://doi.org/10.1007/s00500-018-3471-8

VELUCHAMY B., KARTHIKEYAN N., RADHA KRISHNAN B., MATHALAI SUNDARAM C., 2021, Surface roughness accuracy prediction in turning of Al7075 by adaptive neuro-fuzzy inference system, Materials Today: Proceedings, Volume 37, Part 2, Pages 1356-1358, ISSN 2214-7853, Available on: https://www.sciencedirect.com/science/article/pii/S2214785320350410

Introduction to Deep Learning, 2024 [online] [cit. 2024-04-23]. Available on: https://www.geeksforgeeks.org/introduction-deep-learning/

Reinforcement learning, 2023 [online] [cit. 2024-04-23]. Available on https://www.geeksforgeeks.org/what-is-reinforcement-learning/

Decision Tree, 2024. [online] [cit. 2024-04-23]. Available on https://www.geeksforgeeks.org/decision-tree/

Mathworks Help Center, 2024. What Is the Genetic Algorithm? [online] [cit. 2024-04-23]. Available on https://uk.mathworks.com/help/gads/what-is-the-genetic-algorithm.html

IMB, 2024, *What is Machine Learning (ML)*? [online] [cit. 2024-04-23]. Available on: <https://www.ibm.com/topics/machine-learning>

ZHANG D., YOU X., LIU S., PAN H., 2020,Dynamic Multi-Role Adaptive Collaborative Ant Colony Optimization for Robot Path Planning , IEEE Access, vol. 8, pp. 129958-129974, Available on: https://ieeexplore.ieee.org/document/9141250

ZHANG Y.,2010, New Advances in Machine Learning. InTech. Available on: http://dx.doi.org/10.5772/225.

PIMENOV, D. Y, BUSTILLO, A., WOJCIECHOWSKI, S., SHARMA, V. S., GUPTA, M. K. 2023. Artificial intelligence systmes for tool condition monitoring in machining: analysis and critical review. In *Journal of Intelligent Manufacturing*, no. 34, pp. 2079-2121. https://doi.org/10.1007/s10845-022-01923-2

SERIN, B., SENER, B., OZBAYOGLU, A. M., UNVER, H. O. 2020. Review of tool conditon monitoring in machining and opportunities for deep learning. In *The International Journal of Advanced Manufacturing Technology*, no. 109, pp. 953-974. https://doi.org/10.1007/s00170-020-05449-w

SUTTON, R. S., BARTO A. G., BACH, F. 2018. Reinforcement learning and introduction. The MIT Press. 552 p. ISBN 9780262039246

HUANG, Z., ZHU, J., LEI, J., LI, X., TIAN, F. 2019. Tool wear predicting based on multi-domain feature fusion by deep convolutional neural network in milling operations. Journal of Intelligent Manufacturing, 31, 953–966.

CAI, W., ZHANG, W., HU, X., LIU, Y. 2020. A hybrid information model based on long short-term memory network for tool condition monitoring. Journal of Intelligent Manufacturing, 31, 1497–1510.

SUN, H., ZHANG, J., MO, R., ZHANG, X. 2020. In-process tool condition forecasting based on a deep learning method. Robotics and Computer-Integrated Manufacturing, 64, p. 101924.

XU, L., HUANG, C., LI, C., WANG, J., LIU, H., WANG, X. 2020. Estimation of tool wear and optimization of cutting parameters based on novel ANFIS-PSO method toward intelligent machining. In *Journal of Intelligent Manufacturing*, no. 32, pp. 77–90.

MANIRAJ, M., PAKKIRISAMY, V., JEYAPAUL, R. 2017. An ant colony optimization–based approach for a single-product flow-line reconfigurable manufacturing systems.

Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture. Vol. 231, no. 7, pp. 1229-1236. doi:10.1177/0954405415585260

KUNCHEVA, L. I. 2014. Combining pattern classifiers: methods and algorithms. John Wiley & Sons. 350 p. ISBN:9780471210788

SANAPALA, P., 2023. AI/ML Advantage in Manufacturing. Linkedin.com. Available on https://www.linkedin.com/pulse/aiml-advantage-manufacturing-padma-sanapala-vrqtc

JINIA, A. J., MAURER, T. E., MEERT, CH. A., HUA, M. Y. CLARKE, S. D., KIM, H., WENTZLOFF, D. D., POZI, S. A., 2021. An Artificial Neural Network System for Photon-Based Active Interrogation Applications. In IEEE Access, vol. 9, pp. 119871-119880, doi: 10.1109/ACCESS.2021.3108406.

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RESEARCH ON THE COOLING PROCESS IN THE COOLING CIRCUIT OF AN AUTOMOBILE ENGINE WITH RAM AIR

VÝSKUM PROCESU CHLADENIA V OKRUHU CHLADENIA MOTORA AUTOMOBILU NÁPOROVÝM VZDUCHOM

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ABSTRACT: The paper deals with the investigation of the effect of air impingement on the cooling process of heated coolant circulating through the cooling circuit of an automobile engine. An axial drum fan, used to simulate the surge airflow, is placed in the experimental setup in front of the heat exchanger. The total volume of air generated by the fan flowed through the heatsink core at 6, 8 and 10 m/s during a series of laboratory tests. A factory engine cooler fan is also fitted to the experimental Skoda Fabia cooling circuit assembly, to compare the time required to remove excess heat naturally (ram air) and conversely forced (factory fan) from the cooler core. The heated and subsequently cooled heat transfer medium contained in the cooling circuit is based on ethylene glycol in concentration with pure water. Thermistors and thermal imaging are used to determine the inlet and outlet temperatures of the coolant in the cooler and the distribution of the cooler core temperature fields. The process of cooling the hot coolant in the cooler below the operating temperature in a real car cooling circuit takes a few seconds. In the laboratory tests, a time of 180 seconds is monitored with the intention of plotting the detailed heat transfer process from the coolant to the ambient environment even after the coolant flow is interrupted by the thermostatic valve. The shortest duration of the cooling process of the hot coolant was recorded at an air velocity of 10 m/s. In this case, the thermostatic valve passed hot coolant into the large circuit for 20 seconds. Subsequently, the coolant temperature dropped below the operating value of 80°C, the thermostatic valve closed the flow to the large circuit (Tin = 79.98°C), and the experimental assembly (engine) operated again in the optimum temperature range. The heat transfer from the coolant to the surroundings increases as the volume and flow rate of the cooling air flowing through the cooler core increases, which positively affects the efficiency of engine operation.

Key words: engine cooler, automotive cooling circuit, heat transfer medium, ram air, heat exchange surface

ABSTRAKT: Príspevok sa zaoberá skúmaním vplyvu náporového vzduchu na proces chladenia ohriatej chladiacej kvapaliny cirkulujúcej chladiacim okruhom motora automobilu. Axiálny bubnový ventilátor, slúžiaci pre simuláciu prúdu náporového vzduchu je umiestnený do experimentálnej zostavy pred výmenník tepla. Celkový objem vzduchu, generovaný ventilátorom prúdil počas série laboratórnych testov jadrom chladiča rýchlosťou 6, 8 a 10 m/s. Do experimentálnej zostavy chladiaceho okruhu z vodidla Škoda Fabia je osadený aj továrenský ventilátor chladiča motora, za účelom porovnania času potrebného pre odvod prebytočného tepla prirodzeným (nápor vzduchu) a naopak núteným (továrenský ventilátor) spôsobom z jadra chladiča. Ohrievané a následne ochladzované teplonosné médium obsiahnuté v chladiacom okruhu je na báze etylénglykolu v koncentrácií s čistou vodou. Na určenie vstupných a výstupných teplôt chladiacej kvapaliny v chladiči a rozloženia teplotných polí jadra chladiča sú použité termistory a termovízna technika. Proces chladenia horúcej chladiacej kvapaliny v chladiči pod úroveň prevádzkovej teploty v reálnom okruhu chladenia automobilu trvá niekoľko sekúnd. V rámci laboratórnych testov je sledovaný časový úsek 180 sekúnd, so zámerom vykreslenia detailných priebehov procesu prenosu tepla z chladiacej kvapaliny do okolitého prostredia aj po prerušení prietoku chladiacej kvapaliny termostatickým ventilom. Najkratšie trvanie procesu chladenia horúcej chladiacej kvapaliny, bolo zaznamenané pri rýchlosti náporového vzduchu 10 m/s. V tomto prípade termostatický ventil prepúšťal horúcu chladiacu kvapalinu do veľkého okruhu po dobu 20 sekúnd. Následne teplota chladiacej kvapaliny klesla pod prevádzkovú hodnotu 80 °C, termostatický ventil uzavrel prietok do veľkého okruhu (T_{vs} = 79,98 °C) a experimentálna zostava (motor) pracoval opätovne v optimálnom rozmedzí teplôt. Prenos tepla z chladiacej kvapaliny do okolia stúpa spolu so zväčšujúcim sa objemom a prietokom prúdiaceho chladiaceho vzduchu jadrom chladiča, čo pozitívne ovplyvňuje efektivitu prevádzky motora.

Kľúčové slová: chladič motora, chladiaci okruh automobilu, teplonosné médium, náporový vzduch, teplovýmenná plocha

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REFERENCES

CUEVAS, C., MAKAIRE, D., DARDENNE, L. NGENDAKUMANA, P. 2011. Thermo-hydraulic characterization of a louvered fin and flat tube heat exchanger. In *Experimental Thermal and Fluid Science,* vol. 35, pp 154-164. ISSN:0894-1777.

FATIGATI, F., BATTISTA, D. D., CIPOLLONE, R. 2021. Design improvement of volumetric pump for engine cooling in the transportation sector. In *Energy*, vol. 231, pp 1-18. DOI: 10.1016/j.energy.2021.120936.

GOUDARZI, K., JAMALI, H. 2017. Heat transfer enhancement of Al_2O_3-EG nanofluid a car radiator with wire coil inserts. In *Applied Thermal Engineering*, vol. 118, pp 510-517, DOI: 10.1016/j.applthermaleng.2017.03.016.

HUSSEIN, A. M., BAKAR, R. A., KADIRGARGAMA, K., SHARMA, K. V. 2014. Heat transfer enhancement using nanofluids in an automotive cooling system. In *International Communications in Heat and Mass Transfer*, vol. 53, pp 195-202. DOI: 10.1016/j.icheatmasstransfer.2014.01.003.

CHASTAIN, J., WAGNER, J., EBERTH, J. 2010. Advanced Engine Cooling – Components, Testing and Observations. In *IFAC Proceedings Volumes*, vol. 43, no. 2, pp 294-299. DOI:10.3182/20100712-3-DE-2013.00007.

MOUNIKA, P., SHARMA, R. K., KISHORE, P. S. 2016. Performance Analysis of Automobile Radiator. In *IJRMEE International Journal on Recent Technologies in Mechanical and Electrical Engineering*, vol. 3, no. 5, pp 35-38. ISSN:2349-7947.

PANG, S. C., KALAM, M. A., MASJUKI, H. H., HAZRAT, M. A. 2012. A review on air flow and coolant flow circuit in vehicles – cooling system. In *International Journal of Heat and Mass Transfer*, vol. 55, pp 6295-6306. ISSN 0017-9310.

SALEHI, H., BASIR, H., BIDHENDI, H. M., FARHANI, F., ROSEN, M. A. 2023. Experimental and simulation study of an automobile cooling system: Performance improvement using passive flow control. In *Int. Commun. Heat Mass Transf*, vol. 149, pp 1-16. DOI: 10.1016/j.icheatmasstransfer.2023.107168.

SINGH, S., KUMAR, A., KHAN, F. 2017. Experimental study for heat transfer enhancement of car radiator using twisted inserts with coolants. In *International Journal of Interdisciplinary Research*,
vol. 3, no. 1, ISSN:2455-1600.

VASUDEVAN NAMBESAN, K. P., PARTHIBAN, R., RAM KUMAR, K., ATHUL, U. R., VIVEK, M., THIRUMALINI, S. 2015. Experimental study of heat transfer enhancement in automobile radiator using Al_2O_3/water-ethylene glycol nanofluid coolants. In *IJAME*

International Journal of Automotive and Mechanical Engineering, vol. 12, pp 2857-2865, ISSN:2229-8649.

ZHANG, CH., UDDIN, M., ROBINSON, A. C., FOSTER, L. 2018. Full vehicle CFD investigations on the influence of front-end configuration on radiator performance and cooling drag. In *Appl. Therm. Eng*, vol. 130, pp 1328-40. DOI: 10.1016/j.applthermaleng.2017.11.086.

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MODIFICATION OF TOOLS FOR CRUSHING UNWANTED GROWTHS BY GROOVING AND SUBSEQUENT HARDFACING BY WELDING

ÚPRAVA NÁSTROJOV NA DRVENIE NEŽIADUCICH NÁRASTOV DRÁŽKOVANÍM A NÁSLEDNÝM NAVÁRANÍM

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ABSTRACT: Tools for crushing unwanted growths operate in a strongly heterogeneous environment. After a short time, the tungsten carbide (WC) tip is lost due to the heterogeneity of the environment and the tool body wears further. This results in technical as well as economic problems for companies operating in forestry. For this reason, it is necessary to look for ways to increase the service life of these tools. The article deals with the possibilities of increasing the service life of tools for crushing unwanted growths by grooving with subsequent welding of additional materials. The grooves on the tool were prepared by grinding on the face and back surfaces. Such modification is important because of the preservation of the shape and weight of the tool. For hardfacing by welding into these grooves, two types of electrodes were chosen, namely OK 84.58 and UTP 690. Both electrodes create a weld deposit with a martensitic structure and were applied using the manual metal arc welding method. After applying the weld deposit, the tools were weighed to determine their weight after modified. The difference in weight of the new tool compared to the modified tool with the OK 84.58 weld deposit was 21g and with the UTP 690 weld deposit this difference was only 3g. Subsequently, the tool was cut, and samples were taken for light microscopy. Based on the observations, we can conclude that there was sufficient mixing of the base material of the tool with the weld weld deposit, and also no defects, cracks and pores were observed, which would reduce the quality of mixing of the base material of the tool with the weld deposit. Subsequently, the Rockwell hardness test was performed. Both weld deposits achieved a higher hardness than the base material, whose hardness was 18 HRC. The highest hardness was achieved by UTP 690 at 62 HRC. The OK 84.58 weld deposit reached a hardness of 52 HRC. Furthermore, an abrasion resistance test was performed according to GOST 23.208-79. The essence of this test is a comparison of the weight loss of the tested material and the weight loss of the reference material under the same test conditions. Silica sand with a grain size of 0.1 to 0.2 mm was used as an abrasive. We can also conclude that both weld deposits achieved better results compared to the baseline material. The best results were achieved by UTP 690, its relative resistance to abrasive wear Ψ_{abr} was 24.5 times higher than that of the base material. The relative resistance to abrasive wear Ψ_{abr} of the OK 84.58 weld deposit was 5.2 times higher than that of the base material of the tool. Based on the results, we can conclude that both weld deposits achieved significantly better results than the base material. An appropriate choice of modification of tools is the premise of increasing their service life while maintaining their original shape and weight. At the same time, however, it is necessary in further research to subject such modified tools to operational tests, which will provide more complex results.

Key words: unwanted growth crusher, grooving, hardfacing by welding, abrasive resistance

ABSTRAKT: Nástroje na drvenie nežiaducich nárastov pracujú v silne heterogénnom prostredí. Po krátkom čase dôjde vplyvom heterogenity prostredia k strate volfrám-karbidovej (WC) špičky a telo nástroja sa ďalej opotrebúva. Toto ma za následok technické, ale i ekonomické problémy spoločností pôsobiacich v lesnom hospodárstve. Z tohto dôvodu je potrebné hľadať spôsoby zvyšovania životností týchto nástrojov. Článok sa zaoberá možnosťami zvyšovania životnosti nástrojov na drvenie nežiaducich nárastov drážkovaním s následným naváraním prídavných materiálov. Drážky na nástroji boli pripravené brúsením na čelnej a chrbtovej ploche. Takáto úprava je dôležitá z dôvodu zachovania tvaru a hmotnosti nástroja. Pre naváranie do týchto drážok, boli zvolené dva druhy elektród, a to OK 84.58 a UTP 690. Obe elektródy vytvárajú návar s martenzitickou štruktúrou a boli aplikované metódou ručného oblúkového naválania. Po aplikovaní návaru boli nástroje odvážené, aby sa zistila ich hmotnosť po úprave. Rozdiel v hmotnosti nového nástroja v porovnaní s upraveným nástrojom s návarom OK 84.58 bol 21g a s návarom UTP 690 bol tento rozdiel len 3g. Následne bol nástroj rozpílený, a boli odobraté vzorky pre svetelnú mikroskopiu. Na základe pozorovaní môžeme konštatovať, že došlo k dostatočnému premiešaniu základného materiálu nástroja s návarmi a taktiež neboli pozorované žiadne chyby, trhliny a pór, ktoré

by znižovali kvalitu premiešania základného materiálu nástroja s návarom. Následne bola vykonaná Rockwellova skúška tvrdosti. Oba návary dosiahli vyššiu tvrdosť ako základný materiál, ktorého tvrdosť bola 18 HRC. Najvyššiu tvrdosť dosiahol návar UTP 690, a to 62 HRC. Návar OK 84.58 dosiahol tvrdosť 52 HRC. Ďalej bola vykonaná skúška odolnosti voči abrazívnemu opotrebeniu podľa GOST 23.208-79. Podstata tejto skúšky je v porovnaní hmotnostného úbytku skúšaného materiálu a hmotnostného úbytku referenčného materiálu pri rovnakých skúšobných podmienkach. Ako abrazívum bol použitý kremičitý piesok so zrnitosťou 0,1 až 0,2 mm. Taktiež môžeme konštatovať, že oba návary dosiahli lepšie výsledky v porovnaní so základným materiálom. Najlepšie výsledky dosiahol návar UTP 690, jeho pomerná odolnosť voči abrazívnemu opotrebeniu bola 24,5-násobne vyššia ako mal základný materiál. Pomerná odolnosť voči abrazívnemu opotrebeniu návaru OK 84.58 bola 5,2-násobne vyššia ako mal základný materiál nástroja. Na základe výsledkov môžeme konštatovať, že oba návary dosiahli podstatne lepšie výsledky ako základný materiál. Vhodnou voľbou úpravy nástrojov je predpoklad zvýšenia ich životnosti pri zachovaní ich pôvodného tvaru a hmotnosti. Zároveň je však potrebné v ďalšom výskume podrobiť takto upravené nástroje prevádzkovým skúškam, ktoré poskytnú komplexnejšie výsledky.

Kľúčové slová: drvič nežiaducich nárastov, drážkovanie, naváranie, abrazívna odolnosť

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REFERENCES

BALLA, J., MIKUŠ, R., CVIKOVÁ, H. 2003. *Náuka o Materiáloch: Návody Na Cvičenia*. Nitra: Slovenská Poľnohospodárska Univerzita. 158 s. ISBN 80-8069-217-3

BUCHELY, M.F., GUTIERREZ, J.C., LEON, L.M., TORO, A. 2005. The effect of microstructure on abrasive wear of hardfacing alloys. In *Wear*. vol. 259, no. 1-6, pp.52-61. ISSN 0043-1648. DOI: 10.1016/j.wear.2005.03.002

BRZIAK, P. a kol. autorov. 2003. *Materiály a ich správanie sa pri zváraní*. Bratislava: VÚZ. 355 s. ISBN 80-88734-10-X

DOLUK A., RUDAWSKA A., STANČEKOVÁ, D., MRÁZIK, J. 2021 Influence of surface treatment on the strength of adhesive joints. In *Manufacturing Technology*. vol. 21, no. 5. pp. 585-591. ISSN 2787-9402. DOI: 10.21062/mft.2021.068

FALAT, L., DŽUPON, M., ŤAVODOVÁ, M., HNILICA, R., ĽUPTÁČIKOVÁ, V., ČIRIPOVÁ, L., HOMOLOVÁ, V., ĎURIŠINOVÁ, K. 2019. Microstructure and abrasive wear resistance of various alloy hardfacings for application on heavy-duty chipper tools in forestry shredding and mulching operations. In *Materials*. vol. 12, no. 13, pp. 2212. ISSN 1996-1944. DOI: 10.3390/ma12132212

GOST 23.208-79:1981. Ensuring of wear resistance of products. Wear resistance testing of materials by friction against loosely fixed abrasive particles. [online]. [cit. 2022-01-24]. Available on: http://docs.cntd.ru/document/gost-23-208-79

ISO 6508-1:2016. Metallic Materials—Rockwell Hardness Test—Part 1: Test Method. International Organization for Standardization: London. 2018.

JANKAUSKAS, V., KATINAS, E., PUSVAŠKIS, M. LEIŠYS, R. 2020. A Study of the Durability of Hardened Plough Point. In *Journal of Friction and Wear*. vol. 41, pp. 78–84. ISSN 1934-9386. DOI:10.3103/S1068366620010171

JAVAHERI, V., PORTER, D., KUOKKALA, V. T. 2018. Slurry erosion of steel–Review of tests, mechanisms and materials. In *Wear*. vol. 408, pp. 248-273. ISSN 0043-1648. DOI: 10.1016/j.wear.2018.05.010

KALINCOVÁ, D., ŤAVODOVÁ, M., HNILICOVÁ, M., VEVERKOVÁ, D. 2016. Machinery for forest cultivation - Increase of resistance to abrasive wear of the tool. In *MM Science Journal.* 2016, 5, pp.1269–1272. ISSN 1805-0476. DOI: 10.17973/MMSJ.2016_11_201684

KATALÓG PRÍDAVNÝCH MATERIÁLOV. [online]. [cit. 2024-03-28]. Available on: https://hbt-weld.cz/app/uploads/2019/02/Katalog_CZ_2012.pdf

KOVÁČ, I., MIKUŠ, R., ŽARNOVSKÝ, J., DRLIČKA, R., HARNIČÁROVÁ, M., VALÍČEK, J., KADNÁR, M. 2022. Increasing the wear resistance of surface layers of selected steels by TIG electric arc surface remelting process using a powder based on CaCN2. In *The International Journal of Advanced Manufacturing Technology* vol. 123, no. 5, pp. 1985-1997. ISSN 1433-3015.

MÜLLER, M., HRABĚ, P. 2013. Overlay materials used for increasing lifetime of machine parts working under conditions of intensive abrasion. In *Research in Agricultural Engineering*. vol. 59, no. 1, pp.16-22. ISSN 1805-9376.

PETRŮ, J., ZLÁMAL, T., ČEP, R., STANČEKOVÁ, D., PAGAČ, M., VORTEL, O. 2015. Mechanism of cutting insert wear and their influence on cutting ability of the tool during machining of special alloys In *Manufacturing Engineering and Technology for Manufacturing Growth (METMG 2015) : 3rd international conference*, Vancouver, Canada, 2015. pp. 36-40. ISBN 978-1-61275-074-3. DOI 10.12913/22998624/64074

RAPIDWELDING. *OK 84.58*. [online]. [cit. 2024-03-28]. Available on: https://www.rapidwelding.com/files/8458504020.pdf

SINGH, J., CHATHA, S.S., SIDHU, B.S. 2020. Abrasive wear behavior of newly developed weld overlaid tillage tools in laboratory and in actual field conditions. In *Journal of Manufacturing Processes.* vol. 55, pp. 143-152. DOI:10.1016/j.jmapro.2020.03.040

SLOTA, J., KUBIT, A., GAJDOŠ, I., TRZEPIECIŃSKI, T., KAŠČÁK, Ľ. 2022. A Comparative Study of Hardfacing Deposits Using a Modified Tribological Testing Strategy. In *Lubricants*. vol. 10, no. 8, p. 187. ISSN 2075-4442. DOI: 10.3390/lubricants10080187

STAWICKI T, KOSTENCKI P, BIAŁOBRZESKA B. 2018. Roughness of Ploughshare Working Surface and Mechanisms of Wear during Operation in Various Soils. In *Metals.* vol. 8, no. 12, pp. 1042. ISSN 2075-4701. DOI:10.3390/met8121042

ŤAVODOVÁ, M., KALINCOVÁ, D., KOTUS, M., PAVLÍK, Ľ. 2018. The possibility of increasing the wearing resistance of mulcher tools. In *Acta technologica agriculturae*. vol. 21, no. 2, pp. 87-93. ISSN 1338-5267. DOI: 10.2478/ata-2018-0016

ŤAVODOVÁ, M., VARGOVÁ, M., FALAT, L. 2020. Possibilities of modification of ploughshares used for winter maintenance of forest roads. In *Manufacturing Technology*. vol. 20, no. 6, pp. 834-844. ISSN 2787-9402. DOI: 10.21062/mft.2020.111

VALTEC. *UTP 690*. [online]. [cit. 2024-03-28]. Available on: https://www.valtec.sk/obchod_homedir/data/2616/prilohy/L1_22771_en__UTP%20690.pdf

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COMPUTATION OF THE HEAT TRANSFER PARAMETER IN A CHANNEL ON THE BASIS OF THE DOMAIN MESH SIZE

VÝPOČET PARAMETRA PRESTUPU TEPLA V KANÁLI NA ZÁKLADE VEĽKOSTI SIETE DOMÉNY

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ABSTRACT: The paper presents an approach to compute the Nusselt number in a channel flow on the basis of the CFD computation and mesh sensitivity test. A rectangular duct and a circular tube are chosen as a channel type since the exact values of the Nusselt number can be analytically reached. Overall, five various mesh distributions are used for the simulation while a dependence of the Nusselt number on the mesh size is shown. On the basis of the data extrapolation using a power function, the value is calculated for infinite number of elements that has a negligible discrepancy from the exact one. Concerning the approach, a possibility to estimate the Nusselt number without using a large number of elements is given while a time-consuming calculation is eliminated.

Key words: Nusselt number, CFD, heat transfer, extrapolation, mesh sensitivity test

ABSTRAKT: Článok popisuje postup výpočtu Nusseltovho čísla pre prúdenie v kanáli na základe CFD simulácie a testu citlivosti siete. Pre tvar kanála bol zvolený obdĺžnikový a kruhový prierez z dôvodu možnosti analytického výpočtu exaktnej hodnoty Nusseltovho čísla. Celkovo bolo pre výpočet použitých päť rôznych veľkostí siete, pričom sa zisťovala závislosť medzi hodnotou Nusseltovho čísla a počtom elementov. Na základe extrapolácie hodnôt bola prostredníctvom mocninovej funkcie vypočítaná jeho hodnota pre teoreticky nekonečný počet elementov, ktorá má zanedbateľnú odchýlku od exaktnej hodnoty. Pomocou tohto postupu je možné odhadnúť hodnotu Nusseltovho čísla bez použitia veľkého počtu elementov, čo prináša šetrenie výpočtového času.

Kľúčové slová: Nusseltovo číslo, CFD, prenos tepla, extrapolácia, test citlivosti siete

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REFERENCES

HAN, J. Ch. 2012. Analytical Heat Transfer. Taylor & Francis Group, Boca Raton, 2012, pp. 314. ISBN 978-1-4398-6196-7.

ERDOGAN, M. E., IMRAK, C. E. 2005. The Effects of Duct Shape on the Nusselt Number. In Mathematical and Computational Applications, no. 1, vol. 10, pp. 79-88. ISSN 2297-8747.

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INOVATIVE ELEMENTS IN THE DESIGN OF ESCALATORS

INOVATÍVNE PRVKY KONŠTRUKČNÉHO NÁVRHU POHYBLIVÝCH SCHODOV

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ABSTRAKT: Predkladaný príspevok sa zaoberá inovatívnymi prvkami konštrukčného návrhu pohyblivých schodov. Pohyblivé schody sú súčasťou moderných dopravných systémov, ktoré sa používajú v rôznych verejných a komerčných priestoroch. Hlavnou otázkou riešenou v tejto práci je optimalizácia dizajnu pohyblivých schodov pre potreby ľudí s obmedzenou mobilitou. Tento príspevok vypĺňa medzeru v súčasnom výskume tým, že navrhuje nové konštrukčné prvky a implementuje moderné technológie, ktoré môžu prispieť k inovácii v tejto oblasti. Naše hlavné zistenia ukazujú, že implementácia inovatívnych prvkov, ako sú pokročilé mechanizmy a inteligentné systémy riadenia, môžu výrazne zvýšiť použitie, efektivitu a bezpečnosť pohyblivých schodov. Okrem toho sme identifikovali možnosti pre zníženie energetickej náročnosti a zvýšenie životnosti zariadení. Význam našich zistení spočíva v príspevku k zlepšeniu celkového dizajnu, použiteľnosti a výkonu pohyblivých schodov, čo môže mať pozitívny dopad na užívateľský komfort a bezpečnosť. Tento príspevok môže slúžiť ako edukačný materiál pre inžinierov a návrhárov, ktorí sa zaoberajú konštrukciou a optimalizáciou dopravných systémov, a bol vytvorený v rámci projektu KEGA.

Kľúčové slová: pohyblivé schody, konštrukcia, inovácia, invalidný vozík

ABSTRACT: The presented article addresses innovative elements in the design of escalators. Escalators are part of modern transportation systems used in various public and commercial spaces. The main issue addressed in this work is the optimization of escalator design to meet the needs of people with limited mobility. This paper fills a gap in current research by proposing new design elements and implementing modern technologies that can contribute to innovation in this area. Our main findings indicate that the implementation of innovative elements, such as advanced mechanisms and intelligent control systems, can significantly enhance the usability, efficiency, and safety of escalators. Additionally, we have identified opportunities to reduce energy consumption and increase the lifespan of the devices. The significance of our findings lies in their contribution to the overall improvement of the design, usability, and performance of escalators, which can have a positive impact on user comfort and safety. This article can serve as an educational resource for engineers and designers involved in the construction and optimization of transportation systems and was created as part of the KEGA project.

Keywords: escalators, construction, innovation, wheelchair

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REFERENCES

[1] BIGOŠ, P. 2012. *Teória a stavba zdvíhacích a dopravných zariadení.* Košice: Technická Univerzita v Košiciach. ISBN 978-80-553-1187-6.

[2] CVEKL, Z. 1984. *Teorie dopravních a manipulačních zařízení.* Praha: ČVUT.

[3] JASAŇ, V. 1990. *Dopravné a manipulačné zariadenia v stavebníctve.* Košice: Vysoká škola technická. ISBN 80-7099-059-7.

[4] JASAŇ, V. 1983. *Teória dopravných a manipulačných zariadení.* Bratislava: Alfa.

[5] KOŠÁBEK, J. 1984. *Teória dopravných a manipulačných zariadení.* Bratislava: Alfa.

[6] KRAJČOVIČOVÁ, M. 2015. *Dopravná a manipulačná technika.* Zvolen: Technická Univerzita vo Zvolene. ISBN 978-80-228-2669-3.

[7] BRITANNICA, *Escalator* [online]. [cit 20.3.2023]. Dostupné na internete: <https://www.britannica.com/technology/escalator>

[8] FOREVERPOINTS, 2023, *The escalators mechanism with diagram* [online]. [cit 20.3.2023]. Dostupné na internete: <http://foreverpoints.blogspot.com/2014/08/escalators.html>

[9] FUJI, 2018, *Návrh eskalátora* [online]. [cit 20.3.2023]. Dostupné na internete: <http://sk.fujihd-elevator.com/escalators/escalator-design.html>

[10] IJASTEMS, 2016, *Design and analysis of escalator frame* [online]. [cit 20.3.2023]. Dostupné na internete: <http://www.ijastems.org/wp-content/uploads/2016/09/2.Design-And-Analysis-of-Escalator-Frame.pdf>

[11] KEB, 2015. *Energy savings with escalator drives* [online]. [cit 20.3.2023]. Dostupné na internete: <https://www.kebamerica.com/blog/energy-savings-with-escalator-drives/>

[12] LA-GRAZIA, 2012, *Article 1 -Standard for escalators and moving walks (EN 115)* [online]. [cit 20.3.2023]. Dostupné na internete: <https://la-grazia.com/e-learning/en-115-standard-for-escalators-and-moving-walks/>

[13] SCIENCE DIRECT, 2023. *Energy consumption of escalators in low traffic environment* [online]. [cit 20.3.2023]. Dostupné na internete: <https://www.sciencedirect.com/science/article/abs/pii/S0378778816303796>

CONSTRUCTION DESIGN OF THE CHAIN CONVEYOR USING THE AUTODESK INVENTOR PROFESSIONAL

KONŠTRUKCIA REŤAZOVÉHO DOPRAVNÍKA S VYUŽITÍM PROGRAMU AUTODESK INVETOR PROFESSIONAL

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ABSTRACT: The article describes the methods of the design process and production of a chain conveyor intended for the transportation of wood. The chain conveyor is part of a modernized wood splitting production line. The production line consists of parts such as a supply conveyor a feed conveyor a shortening saw an operator's workplace and a splitting chamber. The goal of the proposal was to increase the productivity of the production line. Part of the design of the chain conveyor structure is the calculation of the drive and transmission of the conveyor itself, which, in addition to the transported material, are another part of the input conditions for determining the static load of the structure. The structural design of the individual parts was created in the Autodesk Inventor Professional 2018 program, which enabled the creation of a structural solution where we used the generator of frame structures, the generator of shafts, the generator of chain transmission and the generator of sheets. To analyse the selected parts, an analysis of the frame structure and strength analyses for the shafts were created. The article is intended as an educational material for the design of chain conveyors within the KEGA project.

Key words: chain conveyor, conveyor, chain, construction, design

ABSTRAKT: Reťazový dopravník je súčasťou modernizovanej výrobnej linky na štiepanie dreva. Výrobná linka sa skladá z častí ako zásobovací dopravník, podávací dopravník, skracovacia píla, pracovisko operátora a štiepacia komora. Cieľom návrhu bolo zvýšiť produktivitu výrobnej linky. Súčasťou návrhu konštrukcie reťazového dopravníka je výpočet pohonu a prevodu samotného dopravníka, ktoré sú okrem prepravovaného materiálu ďalšou súčasťou vstupných podmienok pre určovanie statického zaťaženia konštrukcie. Konštrukčný návrh jednotlivých častí bol vytvorený v programe Autodesk Inventor Professional 2018, ktorý umožnil tvorbu konštrukčného riešenia, kde sme využili generátor rámových konštrukcií, generátor hriadeľov, generátor reťazového prevodu a generátor plechov. Pre analyzovanie vybraných častí bola vytvorená analýzu rámovej konštrukcie a pevnostné analýzy pre hriadele. Príspevok je určený ako edukačný materiál pre návrhy konštrukcie reťazových dopravníkov rámci projektu KEGA.

Kľúčové slová: reťazový dopravník, dopravník, reťaz, konštrukcia, návrh

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REFERENCES

[1] DRAŽAN, F. a kol. 1983. Teorie a stavba dopravníků. Praha: České vysoké učení technické v Praze. 290 s.

[2] DRAŽAN, F. a kol. 1966. Transportní zařízení. Praha: Státní nakladatelství technické literatury. 456 s.

[3] GAJDOŠ, J. 1988. Teória dopravných a manipulačných zariadení. Bratislava: Alfa. 114 s.

[4] JASAŇ, V.- KOŠÁBEK, J.- SZUTTOR, N. 1989. Teória dopravných a manipulačných zariadení. Bratislava: Alfa. 374 s. ISBN 80-05-00125-8.

[5] JASAŇ, V. 1983. Teória dopravných a manipulačných zariadení. Bratislava: Alfa. 319 s.

[6] OSWALD, J.- BANSKÝ, M.- ZELENÝ, J. 1992. Manipulácia, doprava a dopravná technika. Bratislava: Príroda. 228 s. ISBN 80-07-00404-1.

[7] POLÁK, J. a kol. 2003. Dopravní a manipulační zařízení II.[online]. Ostrava: Vysoká škola báňská, 2003. 104 s. [cit. 20.2.2012] Dostupné na internete: http://www.id.vsb.cz/pol25/Polak_DaMZ_2_NP.pdf [20.2.2023 9:15]

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