Bulletin n°3

Veille thermique
Période : février 2023

Objectifs :

L'INRS est de plus en plus sollicité sur des questions concernant les activités en entreprise par forte chaleur : les activités en extérieur, l'été en période de canicule, mais aussi les activités en intérieur, dans des lieux aux conditions thermiques extrêmes. L'objectif de cette veille est de se tenir informé sur ces thématiques, dans une période où la problématique thermique croît avec les changements climatiques.

Les liens mentionnés dans le bulletin donnent accès aux documents sous réserve d'un abonnement à la ressource.

La validation des informations fournies (exactitude, fiabilité, pertinence par rapport aux principes de prévention, etc.) est du ressort des auteurs des articles signalés dans la veille. Les informations ne sont pas le reflet de la position de l'INRS.

Sommaire :

EPI, matériaux protecteurs/refroidissants

R. Shree, R. B. Naik and G. Gunasekaran.

Development of elastomeric intumescent fire-retardant coating for protection of structures at sub-zero temperature condition.

MATERIALS CHEMISTRY AND PHYSICS. 2023;296.

https://doi.org/10.1016/j.matchemphys.2022.127229

The aim of this work is to develop an elastomeric intumescent fire retardant (IFR) coating which can protect the substrates against fire after application and remain stable without any phase separation during storage at sub-zero temperatures. Initially, an elastomeric polymer solution (15 wt%) was prepared using a combination of solvents such as xylene, ethyl acetate and butanol. Thereafter, fire retardant materials along with some fillers such as TiO2 and kaolin were added to the prepared polymeric solution to make an IFR paint. Three different paint compositions were prepared by varying percentages of kaolin and TiO2 using a fixed PVC, and named as TK10, TK73 and TK11. The unpigmented polymeric solution was used as a control during the performance evaluation of the pigmented compositions. The effect of TiO2 and kaolin percentage on the prepared coatings was evaluated in terms of mechanical properties, thermal stability, fire retardancy and char stability characteristics using various analytical instruments. To simulate real conditions, the prepared coatings were also applied over the cotton cloth and fire protection ability was studied in detail. Results revealed that the kaolin and TiO2 combination increased the strength of the char and fire-resistant properties when used in the ratio of 7:3 i.e. TK73.

C. Hu, Z. Wang, R. Bo, C. Li and X. Meng.

Effect of the cooling clothing integrating with phase change material on the thermal comfort of healthcare workers with personal protective equipment during the COVID-19.

Case Studies in Thermal Engineering. 2023;42:102725.

https://doi.org/10.1016/j.csite.2023.102725

Wearing Personal Protective Equipment (PPE) is essential to protect healthcare workers during the COVID-19, but the traditional cooling methods do not meet the requirements of epidemic prevention during the COVID-19. Therefore, the cooling clothing integrated with phase change material (PCM-CC) was proposed for healthcare workers performing nucleic acid sample collection outdoors. Human experiments and subjective questionnaires were used to test the effect of wearing PCM-CC on the thermal sensations of healthcare workers and to analyze the effectiveness of PCM-CC in relieving thermal stress and thereby, improving the thermal comfort of healthcare workers. Results showed that wearing PCM-CC was effective in alleviating various heat symptoms associated with wearing PPE in a hot-temperature environment. Wearing PCM-CC reduced head and facial discomfort by 25% and 41% under the 26 °C thermal environment, while it improved the mean thermal sensation vote (TSV) values by 0.71 and 1.85 under the 26 °C and 32 °C thermal environments, respectively, and made the mean TSV value close to the neutral value. Meanwhile, wearing PCM-CC reduced mean skin temperatures by 0.65 °C, and the pronounced cooling effect was found in the chest. Wearing PCM-CC could be an effective thermoregulation measure to refine the thermal comfort of healthcare workers during the COVID-19 pandemic.

U. Ciuha, T. Valencic, L. G. Ioannou and I. B. Mekjavic.

Efficacy of cooling vests based on different heat-extraction concepts: The HEAT-SHIELD project.

JOURNAL OF THERMAL BIOLOGY. 2023;112.

https://doi.org/10.1016/j.jtherbio.2022.103442

Introduction: A wide range of cooling vests for heat-strain mitigation purposes during physical work are available on the market. The decision regarding the optimal cooling vest/concept for a specific environment can be challenging by relying solely on the information provided by the manufacturers. The aim of this study was to investigate how different types of cooling vests would manifest/perform in a simulated industrial setting, in a warm and moderately humid environment with low air velocity. Methods: Ten young males completed six experimental trials, including a control trial (no vest) and five trials with vests of different cooling concepts. Once entering the climatic chamber (ambient temperature: 35 degrees C, relative humidity: 50 %), participants remained seated for 30 min to induce passive heating, after which they donned a cooling vest and started a 2.5-h of walk at 4.5 km.h- 1. During the trial, torso skin temperature (Tsk), microclimate temperature (Tmicro) and relative humidity (RHmicro), as well as core temperature (rectal and gastrointestinal; Tc) and heart rate (HR) were measured. Before and after the walk, participants conducted different cognitive tests and provided subjective ratings throughout the walk. Results: The use of the vests attenuated the increase in HR (103 +/- 12 bpm) when compared to control trial (116 +/- 17 bpm, p < 0.05). Four vests maintained a lower torso Tsk (31.7 +/- 1.5 <degrees>C) compared to control trial (36.1 +/- 0.5 degrees C, p < 0.05). Two vests using PCM inserts attenuated the increase in Tc between 0.2 and 0.5 <degrees>C in relation to control trial (p < 0.05). Cognitive performance remained unchanged between the trials. Physiological responses were also well reflected in subjective reports. Conclusion: Most vests could be considered as an adequate mitigation strategy for workers in industry under the conditions simulated in the present study.

H. Kim.

Investigation of moisture vapor permeability and thermal comfort properties of ceramic embedded fabrics for protective clothing.

JOURNAL OF INDUSTRIAL TEXTILES. 2022;52.

https://doi.org/10.1177/15280837221142231

This study examined the water and moisture vapor permeable and thermal wear comfort of different ceramic imbedded fabrics for workwear protective clothing, and the results are discussed in terms of the thermal radiation and the emissivity characteristics of these fabrics. The water and moisture vapor permeable and thermal wear comfort properties of the ceramic-imbedded fabrics incorporating aluminum oxide (Al2O3)/graphite, zinc oxide (ZnO)/zirconium carbide (ZrC) and ZnO/antimony tin oxide (ATO) were superior to those of the regular polyethylene terephthalate (PET) fabrics due to the greater heat emission of the ceramic-imbedded fabrics. Of three ceramic imbedded fabrics, ZnO/ATO-imbedded fabric exhibited poorer water absorbing and drying properties than those of the Al2O3/graphite and ZnO/ZrC ceramic-imbedded fabrics. The heat retention rate and breathability were also inferior to those of the Al2O3/graphite and ZnO/ZrC ceramic-imbedded fabrics, which were due to the lower far-infrared (FIR) emissivity of the ZnO/ATO-imbedded fabrics. Summarizing the water and moisture vapor permeable and thermal wear comfort properties with heat release characteristics of the different ceramic imbedded PET fabrics, Al2O3 and ZrC ceramic particles imparted a good wear comfort characteristics with superior heat release property, whereas, the ZnO and ATO ceramic particles imbedded fabrics exhibited inferior water and moisture vapor permeable and thermal wear

comfort due to the lower heat release of ZnO particles and the heat shielding effect of ATO particles, which is supposed to impart an uncomfortable feeling while wearing workwear protective clothing in cold/dry environments in cold weather regions. These findings suggest that ZnO and ATO particles need to be mixed with ZrC and Al2O3 particles in the yarns to enhance wear comfort of workwear protective clothing.

D. Fernandez-Lazaro, J. F. Garcia, L. A. Corchete, M. D. Soto, G. Santamaria and J. Seco-Calvo.

Is the Cooling Vest an Ergogenic Tool for Physically Active Individuals? Assessment of Perceptual Response, Thermo-Physiological Behavior, and Sports Performance: A Systematic Review and Meta-Analysis.

BIOENGINEERING-BASEL. 2023;10(2).

https://doi.org/10.3390/bioengineering10020132

Exercise capacity is limited by environmental heat stress because thermoregulatory systems are altered and cannot prevent the elevation of body temperature due to a complex interplay of physiological, physical, and perceptual alterations. Cooling is an effective strategy to attenuate the temperature rise. Based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and the PEDro scale for assessing methodological quality, we systematically reviewed studies indexed in Medline, Web of Science, EMBASE, Science Direct, Sportdiscus, and Scopus, to evaluate the effects of the cooling vest (CVs) on perceptual response, physiological behavior, and sports performance in adult physical activity practitioners under heat stress conditions. Among the 711 studies identified in the search, 10 studies for the systematic review and eight for the meta-analysis met the inclusion and exclusion criteria. Overall, the use of CVs showed improvements in certain sports performance indicators, being significant ($p < 0.05$) in test time and substantial in peak power that could be influenced directly by the significant reduction ($p < 0.05$) in skin temperature and indirectly by the significant improvement ($p < 0.05$) in thermal and exertional perceptual responses, without the involvement of core temperature. In conclusion, the use of CVs is a cooling technique that influences perceptual response, thermo-physiological behavior, and sports performance. However, further studies are needed to elucidate the relevance of its application to CVs.

D. Toma, G. Popescu, A. Popescu, S. Olaru, A. Salistean and I. Badea.

Protective clothing system for interventions in emergency situations.

INDUSTRIA TEXTILA. 2023;74(1):121-9.

https://doi.org/10.35530/IT.074.01.1839

Emergency workers are exposed to many different risks at the same time and possible consequences for their safety and health may be manifold. Many emergency workers suffer from accidents and injuries in the course of their jobs, as well as other negative health effects that lead to severe deterioration of their physical and psychological well-being. The use of specific personal protective equipment (PPE) according to the given risks is of great importance in preventing adverse health effects among emergency workers. This research aimed to develop, for emergency workers, a PPE system, in a modular structure consisting of: i) modular layer 1: the inner layer, in contact with the skin/Underwear PPE, with the function of sensorial and thermophysiological comfort and which ensures thermal protection; ii) modular layer 2: the intermediate (basic) layer/Duty uniform - with the function of limited protection to the specific risk factors of an unpredictable intervention action (thermal risks: convection heat, flame; risks from the external environment: liquid splashes; mechanical risks: cutting,

abrasion, etc); iii) modular layer 3: the outer layer/specialized PPE, with a function of barrier against specific risk factors for fire intervention missions, extreme weather conditions etc. This modular approach provides some advantages, including preserving comfort and flexibility until the intervention mission requires the use of the next level of protection. This helps ensure that emergency responders are not in the position of choosing between their safety or mission effectiveness.

Y. Zhao, M. Su, X. Meng, J. Liu and F. Wang.

Thermophysiological and Perceptual Responses of Amateur Healthcare Workers: Impacts of Ambient Condition, Inner-Garment Insulation and Personal Cooling Strategy.

International Journal of Environmental Research and Public Health. 2023;20(1):612.

https://doi.org/10.3390/ijerph20010612

While personal protective equipment (PPE) protects healthcare workers from viruses, it also increases the risk of heat stress. In this study, the effects of environmental heat stress, the insulation of the PPE inner-garment layer, and the personal cooling strategy on the physiological and perceptual responses of PPE-clad young college students were evaluated. Three levels of wet bulb globe temperatures (WBGT = 15 °C, 28 °C, and 32 °C) and two types of inner garments (0.37 clo and 0.75 clo) were chosen for this study. In an uncompensable heat stress environment (WBGT = 32 °C), the effects of two commercially available personal cooling systems, including a ventilation cooling system (VCS) and an ice pack cooling system (ICS) on the heat strain mitigation of PPE-clad participants were also assessed. At WBGT = 15 °C with 0.75 clo inner garments, mean skin temperatures were stabilized at 31.2 °C, Hskin was 60–65%, and HR was about 75.5 bpm, indicating that the working scenario was on the cooler side. At WBGT = 28 °C, Tskin plateaued at approximately 34.7 °C, and the participants reported "hot" thermal sensations. The insulation reduction in inner garments from 0.75 clo to 0.37 clo did not significantly improve the physiological thermal comfort of the participants. At WBGT = 32 °C, Tskin was maintained at 35.2–35.7 °C, Hskin was nearly 90% RH, Tcore exceeded 37.1 °C, and the mean HR was 91.9 bpm.

L. Lou, Y. Y. Zhou, Y. S. Yan, Y. Hong and J. T. Fan.

Wearable cooling and dehumidifying system for personal protective equipment (PPE).

ENERGY AND BUILDINGS. 2022;276.

https://doi.org/10.1016/j.enbuild.2022.112510

While PPE prevents the health care personnel from exposing to the harmful surroundings, it creates a barrier to the dissipation of body heat and perspiration, leading to severe heat stress during prolonged exposure. Here, we report a lightweight wearable cooling and dehumidifying system capable of extracting 51.7 W heat and 26.3 g/hour moisture within protective coverall without compromising the protection. The system could continuously operate for 6 h without taking off the PPE. Compared with the available commercial cooling garments with different cooling methods, the system could provide about 3.2 -5.0 times mean cooling power per unit weight in a prolonged working condition. In a simulated hospital environment, the optimum cooling effect was equivalent to 3.5 degrees C drop in ambient temperature and 6 % decrease in ambient relative humidity. It will not only enhance user's comfort and performance but potentially reduce the heating, ventilation and air conditioning (HVAC) energy consumption by 12 % -30 % in building environments.(c) 2022 Elsevier B.V. All rights reserved.

Outils et capteurs de mesure

H. Z. Lu, S. Aratake, H. Naito, M. Nogawa, T. Nemoto, T. Togawa and S. Tanaka.

Development of a Core Body Thermometer Applicable for High-Temperature Environment Based on the Zero-Heat-Flux Method.

SENSORS. 2023;23(4).

https://doi.org/10.3390/s23041970

Monitoring core body temperature (CBT) allows observation of heat stress and thermal comfort in various environments. By introducing a Peltier element, we improved the zero-heat-flux core body thermometer for hot environments. In this study, we performed a theoretical analysis, designed a prototype probe, and evaluated its performance through simulator experiments with human subjects. The finite element analysis shows that our design can reduce the influence of external temperature variations by as much as 1%. In the simulator experiment, the prototype probe could measure deep temperatures within an error of less than 0.1 degrees C, regardless of outside temperature change. In the ergometer experiment with four subjects, the average difference between the prototype probe and a commercial zero-heat-flux probe was +0.1 degrees C, with a 95% LOA of -0.23 degrees C to +0.21 degrees C. In the dome sauna test, the results measured in six of the seven subjects exhibited the same trend as the reference temperature. These results show that the newly developed probe with the Peltier module can measure CBT accurately, even when the ambient temperature is higher than CBT up to 42 degrees C.

H. R. Liu, Y. C. Li, W. J. Xie, X. Y. Zhou, J. S. Hong, J. F. Liang, Y. H. Liu, W. Li and H. Wang.

Fabrication of Temperature Sensors with High-Performance Uniformity through Thermal Annealing.

MATERIALS. 2023;16(4).

https://doi.org/10.3390/ma16041491

It is considered to be of great significance to monitor human health and track the effect of drugs by measuring human temperature mapping through flexible temperature sensors. In this work, we found that the thermal annealing of flexible temperature sensors based on graphite-acrylate copolymer composites can not only improve the temperature coefficient of resistance (TCR) values of the devices, but also greatly improve the uniformity of the performance of the devices prepared in parallel. The best results were obtained when the devices were annealed at 100 degrees C, which is believed to be due to the rearrangement of graphite particles to generate more uniform and numerous conductive channels within the conductive composite. We believe this finding might promote the practical development of flexible temperature sensors in body temperature sensing for health maintenance and medical applications.

Y. B. Wang, N. X. Sun, H. G. Cheng, S. Zhou, X. Ouyang, X. Y. Zhang and N. Ma.

Highly Sensitive Flexible Thermal Sensors Based on a Kind of MXene/DES Inks.

ACS APPLIED ELECTRONIC MATERIALS. 2023;5(2):1252-61.

https://doi.org/10.1021/acsaelm.2c01710

Extremely hot weather has emerged more and more frequently in recent years, which has caused some serious disasters such as forest fires, heat-related illnesses, machine breakdowns, and so on. Flexible thermal sensors will be an efficient solution to achieve large area coverage of thermal alarm systems, due to their merits of low cost, portability, and easy processing. In the preparation of flexible sensors, the printing method stands out for its efficient and inexpensive characteristics. In this work, just by combining the high-NIR photothermal conversion material MXene (Ti3C2Tx) and thermosensitive substance metal salt (FeCl3)-based deep eutectic solvents (DES), conductive thermally sensitive inks were prepared. The MXene/DES-based ink with a suitable viscosity can be smoothly screen-printed on A4 paper. The as-prepared sensors can quickly generate heat even up to over 200 degrees C and simultaneously respond to the temperature change under near-infrared light (NIR, 808 nm). The type of metal salt can be replaced with other common metals, such as AlCl3, ZnCl2, SnCl2, and CuCl2, and some of them also presented good photothermal conversion ability. These inks are easy to synthesize, and the printed sensors are portable and easy to integrate, which make them a good candidate for building flexible thermal alarm systems.

A. M. Al-Qahtani, S. Ali, A. Khan and A. Bermak.

Performance Optimization of Wearable Printed Human Body Temperature Sensor Based on Silver Interdigitated Electrode and Carbon-Sensing Film.

SENSORS. 2023;23(4).

https://doi.org/10.3390/s23041869

The human body's temperature is one of the most important vital markers due to its ability to detect various diseases early. Accurate measurement of this parameter has received considerable interest in the healthcare sector. We present a novel study on the optimization of a temperature sensor based on silver interdigitated electrodes (IDEs) and carbon-sensing film. The sensor was developed on a flexible Kapton thin film first by inkjet printing the silver IDEs, followed by screen printing a sensing film made of carbon black. The IDE finger spacing and width of the carbon film were both optimized, which considerably improved the sensor's sensitivity throughout a wide temperature range that fully covers the temperature of human skin. The optimized sensor demonstrated an acceptable temperature coefficient of resistance (TCR) of 3.93 x 10(-3) degrees C-1 for temperature sensing between 25 degrees C and 50 degrees C. The proposed sensor was tested on the human body to measure the temperature of various body parts, such as the forehead, neck, and palm. The sensor showed a consistent and reproducible temperature reading with a quick response and recovery time, exhibiting adequate capability to sense skin temperatures. This wearable sensor has the potential to be employed in a variety of applications, such as soft robotics, epidermal electronics, and soft human-machine interfaces.

Travail dans une ambiance thermique extrême

Y. Xu, Z. J. Li, G. Li, S. Jalilinasrabady, X. W. Zhai, Y. Chen and B. Wang.

A thermal environment prediction method for a mine ventilation roadway based on a numerical method: A case study.

CASE STUDIES IN THERMAL ENGINEERING. 2023;42.

https://doi.org/10.1016/j.csite.2023.102733

Thermal environment prediction has become increasingly significant in recent years with its promise of wide application in underground structures. The current work presents a numerical method for the feasible and effective analysis of the airflow and surrounding rock temperatures in ultralong mine ventilation roadways to understand their dynamic heat transfer. To reduce the modeling effort and computation time with satisfactory accuracy, the ventilation roadway is approximated as a one-dimensional (1D) line element. Still, the surrounding rock of the roadway remains three-dimensional (3D). An equivalent heat transfer coefficient calculates the dynamic heat transfer in the radial direction of the roadway. A case analysis of the Sanhejian coal mine ventilation roadways in China is performed, and a comparison between the simulated results and field measurements indicates that the predicted airflow temperature shows good agreement. The change in the underground thermal environment concerning ventilation time is systematically investigated in detail. The surrounding rock of the roadway adjusts the underground thermal environment through heat absorption or heat release, and the temperature distribution of the surrounding rock presents a "V" shape in winter and a "W" shape in summer. The self-compression of air contributes to a remarkable heat source for the increase in airflow temperature in the air intake shaft. A roadway with a low initial temperature of the surrounding rock after long-term ventilation can effectively cool the high-temperature airflow underground in early summer. The reduction in ventilation volume will increase the cooling degree of airflow by the surrounding rock in long-term ventilation roadways in summer. Still, the airflow will be heated more significantly in short-term ventilation roadways. In addition, the increase in the average annual ambient temperature will result in a linear rise in underground airflow temperature.

Q. Y. Han, D. B. Lin, X. J. Yang, K. Q. Li and W. Yin.

Thermal Environment Control at Deep Intelligent Coal Mines in China Based on Human Factors.

SUSTAINABILITY. 2023;15(4).

https://doi.org/10.3390/su15043193

Mechanical cooling of the entire mining tunnel, widely used in deep coal mines, has a significant energy-intensive consumption, particularly for intelligent mining tunnels. Therefore, localized cooling would benefit the intelligent mining industry. Current studies on the temperature, relative humidity, and air velocity under localized cooling for working protection are still unclear. A modified predicted heat strain model that is appropriate for warm and humid conditions is presented in this article and calculated using MATLAB. Results reveal that air temperature was the primary factor affecting underground miners' safety. Increasing air velocity would improve the working environment when the thermal humidity index is lower than 32. Reducing total working time and wet bulb temperature would benefit underground miners' security. For the cooling of intelligent mining tunnels, the recommended air velocity would be 2 m/s, and the maximum wet bulb temperature would be 28 degrees C for the 6-h working period and 26 degrees C for the 8-h working period. Results would be beneficial to the cooling of intelligent mining in China.

S. Karthick, S. Kermanshachi and K. Loganathan.

Occupational Fatigue and Physical Health of Construction Workers in Extreme Hot Weather.

TRAN-SET 20222022. p. 259-69.

https://doi.org/10.1061/9780784484609.028

Extreme hot temperatures are considered as occupational hazard. Workers performing for a longer duration in extreme heat are prone to develop various health complications. This is also indicated by increasing number of heat related morbidities and mortalities. Workers exposed to extreme temperatures experience serious health issues like heat cramps, heat edema, and mental health problems like depression. Workers are distracted when performing in extreme temperatures leading to workplace accidents, injuries, and lowers productivity. Health challenges experienced by workers differ based on demographic characteristics, and thus construction sites require strategies tailored to address these vulnerable workers. Therefore, this study focuses to assess workers' health challenges based on various demographic features and develops a model for physical fatigue, workplace injuries of workers performing in extreme temperatures through an online survey questionnaire. Logistic regression was performed on the gathered data. The results revealed that Caucasians are more susceptible to adverse effects of hot weather compared to other ethnicities. A link can be suggested, based on the results of the study, among workers' physical exhaustion and type of working environment, and ethnicity of workers in hot weather conditions. The findings of the study will facilitate professionals in construction industry to improve their heat related policies.

J. P. P. Rajakumar and J. H. Choi.

Helmet-Mounted Real-Time Toxic Gas Monitoring and Prevention System for Workers in Confined Places.

SENSORS. 2023;23(3).

https://doi.org/10.3390/s23031590

Occupational health and safety hazards associated with confined places are mainly caused by exposure to toxic gases and oxygen deficiency. Lack of awareness, inappropriate monitoring, and improper evacuation methods can lead to worker fatalities. Although previous studies have attempted to develop systems to solve this issue, limited research is available on their application in confined places. In this study, a real-time helmet-mounted system was developed to monitor major toxic gases (methane (CH4), hydrogen sulfide (H2S), ammonia (NH3), and carbon monoxide (CO)), oxygen, temperature, and humidity. Workers outside and inside confined spaces receive alerts every second to immediately initiate the rescue operation in the event of a hazard. The test results of a confined environment (wastewater treatment unit) highlighted that concentrations of CH4 and H2S were predominant (13 ppm). Compared to normal atmosphere, CH4 concentration was 122- and 130-fold higher in the landfill and digestion tanks, respectively, while H2S was 36- and 19-fold higher in the primary and secondary clarifiers, respectively. The oxygen content (18.2%) and humidity (33%) were below the minimum required limits. This study will benefit future research to target appropriate toxic gas monitoring and alert workers by studying the existing issues and associated factors in confined places.

H. Lee, H. G. Kwon, S. Ahn, H. Yang and C. Yi.

Estimation of Perceived Temperature of Road Workers Using Radiation and Meteorological Observation Data.

REMOTE SENSING. 2023;15(4).

https://doi.org/10.3390/rs15041065

During summer heat waves, road workers are easily exposed to heat stress and faced with a high risk of thermal diseases and death, and thus preventive measures are required for their safety at the work site. To prepare response measures, it is necessary to estimate workers' perceived temperature (PT) according to exposure time, road environment, clothing type, and work intensity. This study aimed to examine radiation (short-wave radiation and long-wave radiation) and other meteorological factors (temperature, humidity, and wind) in an actual highway work environment in summer and to estimate PT using the observation data. Analysis of radiation and meteorological factors on the road according to pavement type and weather revealed that more heat was released from asphalt than from concrete. Regression model analysis indicated that compared with young workers (aged 25-30 years), older workers (aged >= 60 years) showed a rapid increase in PT as the temperature increased. The temperatures that people actually feel on concrete and asphalt roads in heat wave conditions can be predicted using the PT values calculated by the regression models. Our findings can serve as a basis for measures to prevent workers from thermal diseases at actual road work sites.

Travail par fortes chaleurs et périodes de canicule

P. R. Naskar and D. R. Pattanaik.

Observed changes in summer thermal discomfort over Indian region during 1990-2020.

JOURNAL OF EARTH SYSTEM SCIENCE. 2023;132(1).

https://doi.org/10.1007/s12040-023-02056-7

In the scenario of global warming and climate change, human thermal discomfort is about to rise. A rise in human thermal discomfort will undermine human health and well-being. It will also undermine labour productivity (as workers have to reduce work intensity and take longer breaks from work to prevent heat stress-related illness and injuries) and boost energy demand (as people will have to use more cooling instruments such as ACs, coolers, fan, etc., to get relief from thermal discomfort). Hence an assessment of spatio-temporal variability of thermal discomfort is necessary to develop a national strategy for the sustainable development of the country under changing climate scenarios. In this study, we have tried to analyze spatio-temporal variations of summertime thermal discomfort in India with the help of the Discomfort Index (DI). To calculate the DI, we have used high resolution (0.25 degrees x0.25 degrees) ERA-5 hourly 2-m air temperature and 2-m dewpoint temperature data. It is seen that March is the month of minimum discomfort and June is the month of maximum discomfort. In June, maximum discomfort occurs in the western region. The east coastal region and western region of India, particularly Rajasthan, experience maximum discomfort in terms of severity and prolonged discomfort hours. We have also calculated trends in DI, RH and temperature over the Indian region for March to June and observed a generally increasing trend with some spatial variations across India. It is also observed that the DI trend is more prominent in the western region in March and April, the southern region in May and the eastern region in June. We have also calculated the diurnal variations of thermal discomfort and the number of days with DI greater than 27 degrees C and 29 degrees C for different regions. It is observed that in most of the regions, DI reaches its peak around 09-10Z. Except for the north region, most of the regions show increasing trends in the number of discomfort days in April, May and June.

G. N. Ferrari, G. C. L. Leal, R. C. T. de Souza and E. V. C. Galdamez.

Impact of climate change on occupational health and safety: A review of methodological approaches.

WORK-A JOURNAL OF PREVENTION ASSESSMENT & REHABILITATION. 2023;74(2):485-99.

https://doi.org/10.3233/WOR-211303

BACKGROUND: The working population is exposed daily to unavoidable climatic conditions due to their occupational settings. Effects of the weather such as rain, heat, and air pollution may increase the risk of diseases, injuries, accidents, and even death during labor. OBJECTIVE: This paper aims to summarize the impacts of climate change on workers' health, safety and performance, identifying the risks, affected workplaces and the range of methodological approaches used to assess this problem. METHODS: A thorough systematic mapping was conducted in seven scientific international databases: Emerald, IEEE Xplore, Science Direct, Scielo, Scopus, SpringerLink, and Web of Science. Three research questions guided the extraction process resulting in 170 articles regarding the impacts of climate change on occupational health and safety. RESULTS: We found an accentuated trend in observational studies applying primary and secondary data collection. Many studies focused on the association between rising temperatures and occupational hazards, mainly in outdoor work settings such as

agriculture. The variation of temperature was the most investigated impact of climate change. CONCLUSIONS: We established a knowledge base on how to explore the impacts of climate change on workers' well-being and health. Researchers and policymakers benefit from this review, which explores the suitable methods found in the literature and highlights the most recurring risks and their consequences to occupational health and safety.

Actualités février 2023

- ## Travail par fortes chaleurs et périodes de canicule

Face aux effets du changement climatique sur la santé au travail, « les entreprises ne sont pas suffisamment mobilisées ». Lemonde.fr

Comment la météo influe-t-elle sur notre santé ? Nous deux, 27 février 2023

Climat : le gouvernement lance des travaux sur l'adaptation à un réchauffement présumé à 2° C ou 4° C. Lemonde.fr

Les entreprises au défi de la canicule. Le Parisien Week-end, 24 février 2023

Canicules : des salariés en souffrance, mais des entreprises mal préparées. Leparisien.fr

Regulators refuse to step in as workers languish in extreme heat. Politoco.com

State govt chalks out action plan to curb deaths due to heatwaves. Hindustantimes.com

- ## Outils et capteurs de mesure

Bodycap vise les cinq millions de chiffre d'affaires en 2023. Lejournaldesentreprises.com

US Patent Issued to Biodata Bank on Feb. 7 for "Temperature sensor unit and body core thermometer" (Japanese Inventors). Australian Government News, 8 février 2023

- ## Maladies liées à la chaleur

Climate change is slowly having an impact on human health-expert. Businessmirror.com

Sunny highs to shivering cold: Wild weather swings take a health toll. Washingtonpost.com

Heat Wave Coming Soon! Centre Issues Advisory For Unusual Temp Rise. India.com

- ## EPI, matériaux protecteurs/refroidissants

The Real Risk to Firefighters. Acsh.org