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PROCEEDINGS BOOK

**ISPEC GLOBAL CONGRESS ON INTERDISCIPLINARY SCIENCE AND SCIENTIFIC RESEARCH APRIL
27 APRIL 3 MAY, 2026 ROME, ITALY**

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Editors

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(Abstracts & Full Texts)

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| AUTHOR | TITLE | PAGE NO |
|---|--|---------|
| Süleyman Öner | SHRIMP FOOD | 1 |
| Süleyman Öner | CLAM FOOD | 2 |
| Ömer Büyükbaş Hamdi Ayyıldız | A MULTI-CRITERIA MEDITERRANEAN DIET SUSTAINABILITY INDEX FOR TURKISH HOUSEHOLDS: AN ENTROPY-TOPSIS FRAMEWORK INTEGRATING CARBON, NUTRITION, COST, AND WASTE SENSITIVITY | 3 |
| Pooja Rasal Gaurav Kasar | THE ROLE OF MTOR SIGNALING IN THE BIOLOGY OF AGEING | 5 |
| Zainib Razzaq Samreen Gul Khan Ayesha Riaz Tanzeela Riaz Mehr Un Nisa | “BIO-ORIENTED SYNTHESIS AND MOLECULAR DOCKING STUDIES OF 1,2,4-TRIAZOLE BASED DERIVATIVES AS POTENTIAL ANTI-CANCER AGENTS AGAINST HEPG2 CELL LINE” | 6 |
| Mariami Managadze | THE PROBLEM OF MICROPLASTICS IN ENVIRONMENTAL MEDICINE | 7 |
| Sanjay Kumar Pintu Das | TIME-DEPENDENT ADVECTION–DISPERSION MODELING OF GROUNDWATER CONTAMINATION DYNAMICS | 8 |
| Denada Ahmeti Olta Llaha | IMPACT OF ARTIFICIAL INTELLIGENCE ON IMPROVING TEACHING PROCESSES IN HIGHER EDUCATION: A REVIEW | 9 |
| Mounir Boutarbouch Khadija El-Moustaqim Jamal Mabrouk1 | INTEGRATED MODELING AND OPTIMIZATION OF ELECTROCOAGULATION PROCESS FOR CONTROLLED HYDROGEN GENERATION AND EFFICIENT TREATMENT OF FRACTURING FLOWBACK FLUID | 10 |
| Elmehdi Majdi Hamza Marouani Soufiane Zerraf | SYNTHESIS, CRYSTALLOGRAPHIC CHARACTERIZATION, AND THEORETICAL STUDY OF A NOVEL (C ₇ H ₈ NO ₂) ₂ H ₂ P ₂ O ₇ SINGLE CRYSTAL | 11 |

| | | |
|---|--|----|
| Rizwan Rasheed | TAURINE-MEDIATED MITIGATION OF ARSENIC AND MICROPLASTIC TOXICITY IN BROCCOLI VIA FUNCTIONAL AND MICROSTRUCTURAL REPROGRAMMING | 34 |
| Addoun Rayan Ikram | CONTROL AND STABILISATION OF STRONGLY COUPLED HYPERBOLIC SYSTEMS WITH KINETIC BOUNDARY CONDITIONS AND IMPLICIT MEMORY EFFECTS | 35 |
| Taha-Amine Miri Aissa Kerkour Elmiad Aziz Oukaira | TOWARD LIGHTWEIGHT INTRUSION DETECTION: A HYBRID QUANTUM-CLASSICAL ARCHITECTURE FOR EDGE DEPLOYMENT | 36 |
| Mounaim Bencheikh Larbi El Farh | TENSILE STRAIN-INDUCED ELECTRONIC PROPERTIES OF A THALLIUM SELENIDE MONOLAYER: A FIRST-PRINCIPLES STUDY | 37 |
| Carla Santos Cristina Dias | REPRESENTATION SYSTEMS AND THE MITIGATION OF PROBABILISTIC FALLACIES | 38 |
| Olena Sierikova Vadym Babakin Andrii Derecha Larysa Derecha Yevheniia Kovkina | EXPERT EXAMINATION OF LIQUID HYDROCARBON STORAGE TANK DAMAGE | 39 |
| Olena Sierikova Olexander Yeysiukov Elena Strelnikova Kyryl Degtyariv | ENVIRONMENTAL PROTECTION FROM TECHNOGENIC OBJECTS UNDER EARTHQUAKE AND EXPLOSION EFFECTS | 41 |
| | “DIGITAL CONNECTIVITY AND WOMEN’S REPRODUCTIVE AUTONOMY IN BANGLADESH: MEDIATING ROLES OF PARTNER COMMUNICATION AND HOUSEHOLD DECISION-MAKING” | 43 |
| Milos Rabrenovic Monika Stojanova | DIGITAL MARKETING STRATEGIES FOR THE PROMOTION OF GASTRONOMIC AND DANCE FESTIVALS | 44 |
| | | |

ENVIRONMENTAL PROTECTION FROM TECHNOGENIC OBJECTS UNDER EARTHQUAKE AND EXPLOSION EFFECTS

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Preservation of ecological balance and safety of the population is becoming an integral part of society sustainable development. In the context of global climate change, increased seismic activity and the threat of terrorist acts and military influences, technogenic objects, objects of critical infrastructure, are becoming potential sources of environmental disasters.

Earthquakes can cause infrastructure destruction, which leads to pollution of air, water and soil. Explosions, in turn, can cause not only instant physical destruction, but also the possibility to spread pollution over a long distance. This threatens not only the surrounding area, but also the population health.

Thus, the development and implementation of measures to protect the environment from the likely negative consequences caused by earthquakes and explosions is becoming critically important in the context of preventing environmental disasters. A systematic approach to risk assessment, engineering solutions, and environmental monitoring can significantly reduce the likelihood of negative impacts. This, in turn, contributes not only to environmental conservation, but also to ensure human life and safety.

The aim of this paper is to study the effectiveness of tuned liquid dampers to mitigate structural vibrations under loading. The tuned liquid dampers have been considered as rigid tanks, partially filled with liquids. The tank is rigidly connected to an elastic structure. The developed numerical model incorporates the interaction between the structure and the tuned liquid damper. The structure has been assumed as a single degree of freedom system. To obtain the fundamental frequencies of tuned liquid damper, the boundary element method has been used. The novelty of the proposed method consists in analyze the mitigation of structure vibrations equipped with tuned liquid damper.

Single degree of freedom elastic system equipped with tuned liquid dampers, designed to control oscillations induced by external loads, liquid mass has been considered. The tuned liquid dampers absorbs energy by moving the liquid within the tank in opposition to the structure's response to dynamic loads. Figure 1. illustrates this concept schematically, showing the motion of the liquid relative to the structure.

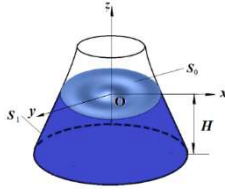


Fig. 1. Structure with Tuned Liquid Damper

A comparison of numerical and analytical results from (Raynovskyy 2020) for $l=0$ (axisymmetric modes) for different modes k has been provided in Table 1.

Table. 1. Axisymmetric sloshing frequencies, Hz, $L=0$.

| k | Conus |
|-----|---------------------------|
| | <i>Numerical solution</i> |
| 1 | 5.3534 |
| 2 | 7.8068 |
| 3 | 9.6034 |
| 4 | 11.1044 |
| 5 | 12.4246 |
| 6 | 13.6180 |

The results demonstrate the accuracy of the proposed numerical method.

The sloshing frequencies of conical shells have presented in Table 2.

Table 2. The sloshing frequencies of conical shells

| k | Conus |
|-----|---------------------------|
| | <i>Numerical solution</i> |
| 1 | 5.3534 |
| 2 | 7.8068 |
| 3 | 9.6034 |
| 4 | 11.1044 |
| 5 | 12.4246 |
| 6 | 13.6180 |

The results demonstrate the accuracy of the proposed numerical method. The sloshing frequencies of conical and cylindrical shells are different, but this difference decreases as the frequency number increases [1,2].

The method is based on the use of singular integral equations to find the frequencies and vibration modes of the tuned liquid damper. The effective numerical procedure is elaborated to numerical estimation for the singular integrals.

It has been established that the use of the proposed liquid damper leads to a significant reduction in the vibration amplitude of the elastic element over the entire load range examined. The liquid dampers implementation will allow the development of effective practical solutions to ensure the stability of buildings and critical infrastructure facilities and reduce environmental threats under the influence of seismic loads, military explosions, and emergencies.

Keywords: environmental protection, earthquake, explosion, tuned liquid dampers.