International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

The Effect of the Interfacial Resistance of the Superconducting-Stabilizer Film on the Typical Sector Diffusion Pace For 2g Hts Tapes

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Abstract
High temperature superconducting (HTS) tapes of the second generation have been widely used as energy storage materials, such as in superconducting magnetic energy storage (SMES) devices. In order to enhance the current-carrying characteristics, these systems are typically run close to the critical currents of the coated conductors; as a result, hot spots may develop, which could cause the superconductor to become quenched. In order to prevent the start of hot spots and to reduce the amount of faulting, efforts have been made to raise the normal zone propagation velocity (NZPV) in this manuscript. The interfacial resistance between the superconductor and stabilizer layer, which can act as a current flow diverter during fault circumstances, has been shown to be the key to producing massive NZPV. The tape's architecture has been slightly modified by the addition of a high resistive layer between the superconducting and stabiliser layers, where various interfacial resistances have been utilised to forecast the temperature distribution between 10 cm lengths of HTS tape. A 2D numerical model was created using COMSOL to assess the NZPV and temperature distribution of the 2G superconducting tape. It has been concluded that larger NZPVs can be achieved by using substantial interfacial resistances to prevent superconducting tape quenching.

Keywords: HTS tape, normal zone propagation velocity, interfacial resistance, quench, HTS cables, SFCL, SMES.

1. Introduction

Coated conductors are widely employed in power applications due to their ability to carry huge currents while operating effectively near critical currents. Coated conductors have replaced copper conductors in almost all power applications, including cables, motors, generators, transformers, MRIs, NMRs, fault current limiters, and SMES systems, since they are more efficient at managing current and take up less space than conventional devices. As fault current limiting and energy storage devices operate near critical currents, hot patches may form, resulting in superconductor quench. The development of HTS cables is also gaining attention these days, with current carrying cables being designed with greater load factors (near critical currents) to maximise their current carrying capacity. However, excessive currents can cause unbalance owing to heat generation, and inadequate cooling can lead to hot spots and, ultimately, tape thermal quench. This topic has yet to be addressed, and numerous research groups are working on it theoretically, computationally, and experimentally. When the current 'I' applied to such devices approaches the critical current Ic, hot spots (owing to thermal instabilities) may occur in the weaker zones of the superconducting tape. Inhomogeneities in materials, such as superconducting tape, can arise as a result of micro-scale manufacturing defects that affect the Ic of the tape, or as a result of other phenomena, such as the presence of an external magnetic field, which causes an arbitrary increase in the temperature of the superconducting tape locally, leading to hot spots. Such hot spots can harm the entire system if the local temperature rises above the threshold level. Thus, avoiding hot spots among superconductors utilised in any application is critical to preventing system failure.

Quenching is a phenomenon that occurs when the temperature of a superconducting tape exceeds a certain point, and as previously discussed, it can be caused by hot spots. Hot spot problems exist in all superconducting devices, but they are more evident in SMES and SFCL systems because in the former, the operating currents are frequently chosen as close as Ic to maximise the field generated. The latter's fundamental mechanism of operation is based on superconductor quenching. Studies demonstrate that for coated conductors NZPVs are low, making them sensitive to hot spots, resulting in a rapid increase in the temperature before adequate voltage drop emerges, and detecting the quench in the case of superconducting magnets.

Various solutions have been used to address hot spot issues, including expanding the thickness of the stabiliser or substrate layer to increase thermal mass. However, simply oversizing the tape by increasing the thickness of the copper does not suffice; a marginal current (temperature) is required to provide sufficient time before the detection of the quench and to change or halt the input current before the system fails. As a result, it is preferable to work near 80% of the load factor, which provides sufficient margins to address such concerns. However, this margin clearly limits the current carrying capacity of the cable or the maximum achievable magnetic field inside the magnet.

Increase NZPV as a second technique for reducing temperature rise in hot regions; however, this diminishes the superconducting tape's stability margin. This element is represented by the minimal energy required to induce a quench, which is commonly known as minimum quench energy (MQE). Numerous strategies have been presented by various researchers to improve the NZPV in coated conductors. For example, researchers have recommended using sapphire as a substitute for Hastelloy, which has electrical and thermal qualities that favour big NZPV. Recently, researchers suggested purposely enhancing the interfacial resistance between the stabiliser and superconductor to boost the NZPV in coated conductors. This increases the current transfer length (CTL) between the stabiliser and superconductor. This concept is simple to implement and offers appealing solutions; however, the critical challenges in increasing interfacial resistance are associated with the amount of heat generated at the interface of current leads connections, as the temperature increased dramatically, potentially causing quenching of the superconductor.

In this study, a basic superconducting tape construction with significant interfacial resistances was used to boost NZPV. It has been believed that the interfacial resistance changes over the width of the tape, with one segment having extremely low interfacial resistance and the other having very high interfacial resistance. A 2D numerical model was created using Comsol MultiPhysics, and NZPV was compared across different interfacial resistances.

2. Numerical Modelling

A 2D model was created using Comsol MultiPhysics 5.4, and the Joule heating module was used for the numerical solution. The electrothermal behaviour of the coated conductor was investigated by varying the interfacial resistance between the superconducting and stabiliser layers. The basic geometry and methodology used are discussed in the following sections.

2.1 Geometrical details

Coated conductors were utilised in this work, and their geometry is shown in Figure 1, with the tape length assumed to be 10 mm and other values listed in Table 1. The tape is 12 mm wide and has a 1 µm thick superconducting (SC) layer. In general, SC tape consists of four layers: stabiliser, superconducting layer, substrate, and buffer layers. For the tape used in this work, the stabiliser layer is silver (Ag), the superconducting layer is ReBaCuO, the substrate is Hastelloy, and the buffer layer is MgO. depicts the tape's architecture, which includes a longitudinal arrangement of the several layers. The highlighted arrows represent virtual probe locations that are often used to measure electric field variations over time and are separated by a distance of 1 mm. Multicolors are utilised to distinguish the different layers. signifies that current has been supplied from the left end while the other end is grounded, resulting in a low Jc area at the end of the superconducting tape. The extremely resistant layer can be referred to as a current flow diverter because it is responsible for redirecting current from the SC region to the stabiliser in order to protect the superconducting tape from quenching. The majority of the tape's temperature-dependent properties have been extracted from. There is detailed information available on the characteristics of the buffer layer (MgO), stabiliser (Ag), substrate (Hastelloy), and SC tape (ReBCO for T>Tc). As the tape must cool at 77 K, all property data is recovered at this liquid nitrogen temperature.

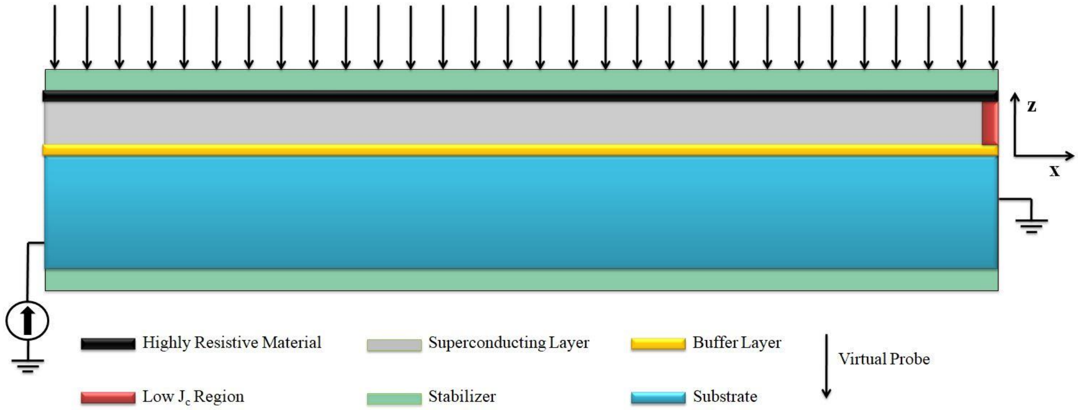

Figure 1 Tape Architecture

In the current investigation, a mathematical model similar to that of Lacroix et al was utilised with a few adjustments; current densities were assumed to be 100 times greater than those in the Lacroix model, and the tape width was assumed to be 12 mm rather than 4 mm. Furthermore, the authors did not investigate how variable interfacial resistance affects the NZPV, as they did in this study. Due to the non-linear behaviour of resistivity below Tc, electrical conductivity behaves similarly, hence the power-law model is used to approximate the electrical conductivity of (Re)BaCuO in the flux creep and flux flow zones. However, the electrical conductivity of the normal state during the transition from the superconducting state can be described by considering two parallel resistances. The following phrases have been utilised for the current simulations.

$$\sigma_{sc}(T) = \frac{J_c(T)}{E_0}\left(\frac{\|E\|}{E_0}\right)^{\frac{1-n(T)}{n(T)}} \qquad (1)$$

$$J_c(T) = \begin{cases} J_{c0}\left(\dfrac{T_c - T}{T_c - T_0}\right) & for\, T < T_c \\ 0 & for\, T_c \leq T \end{cases} \quad (2)$$

$$n(T) = \begin{cases} (n_0 - 1)\left(\dfrac{T_c - T}{T_c - T_0}\right)^{1/4} + 1 & for\, T < T_c \\ 1 & for\, T_c \leq T \end{cases} \quad (3)$$

Table 1 Nomenclature

J_{c0}	Critical current density at T_0
T_0	Liquid nitrogen temperature
$\|E\|$	Norm electric field
T_c	Critical temperature
n_0	Fitting parameter
d	Width of the low J_c region
A	Amplitude of the low J_c region
l	Position of the low J_c region
$I(t)$	Applied transport current
Ω	Represents the surface at one end of the tape
$\mathbf{n}$	Local unit vector perpendicular to the external surfaces of the tape
$\sigma(T)$	Electrical conductivity
ρ_m	Mass density of the tape
$C_p(T)$	Heat capacity
$k(T)$	Thermal conductivity

2.2 Electro-thermal modelling

To initiate normal zone propagation, a low Jc region has been integrated into the tape architecture, as shown in Figure 1, highlighted in red. The same model as that of Lacroix et al has been mimicked in the current work, as shown in Figure 2, where reduction in the critical current has been considered by the following relation:

$$J_{c0} \rightarrow J_{c0}\left[1 - Ae^{\frac{-(x-l)^2}{2d^2}}\right] \quad (4)$$

It has been built in such a way that when the current density through the superconducting tape is surpassed, heat is generated at the low Jc region, which in turn forms the normal zone, which is projected to expand with time. The electro-thermal model of the superconducting tape has two variables: potential V and temperature T. The governing equations for electro-thermal modelling are as follows.:

Electrical part

$$\nabla.(-\sigma(T)\nabla V) = 0 \qquad within\, the\, tape \quad (5)$$

$$\int_{\Omega} -\mathbf{n}.(-\sigma(T)\nabla V)\,\mathrm{d}S = I(t) \qquad at\, left\, end\, of\, the\, tape \quad (6)$$

$$V = 0 \qquad \textit{at the other end of the tape} \qquad (7)$$

$$\mathbf{n}.\nabla V = 0 \qquad \textit{at the remaining boundaries of the tape} \qquad (8)$$

Thermal part

For the thermal analysis, heat equation can be written as

$$\rho_m C_p(T)\frac{\partial T}{\partial t} + \nabla.(-k(T)\nabla T) = Q_j \qquad \textit{in the tape} \qquad (9)$$

Joule heating losses can be evaluated using following coupled correlation:

$$Q_j = \sigma(T)(-\nabla V)^2 \qquad \textit{in the tape} \qquad (10)$$

For the present study, it has been assumed that the temperature gradient at the both ends of the tape is zero as described by following equation:

$$\mathbf{n}.\nabla T = 0 \qquad \textit{at the both ends of the tape} \qquad (11)$$

Regarding the remaining boundaries, as superconducting tape is assumed to be through liquid nitrogen at 77 K therefore, the cooling power required by the nitrogen can be evaluated though the following relation:

$$\mathbf{n}.(k\nabla T) = h(T - T_0) \qquad \textit{at the remaining boundaries} \qquad (12)$$

2.3 Numerical Approximations

For the 2D analysis, infinitely thin domains are used to represent buffer layers and interfacial resistance layers which further implies that in-plane (J_x and J_y) current densities are taken as negligible and only normal component of current density (J_z) has been considered. Therefore, after such approximations (6) becomes:

$$J_z = \sigma(T)\frac{\partial V}{\partial z} = \sigma(T)\left(\frac{V_2 - V_1}{t}\right) \qquad (13)$$

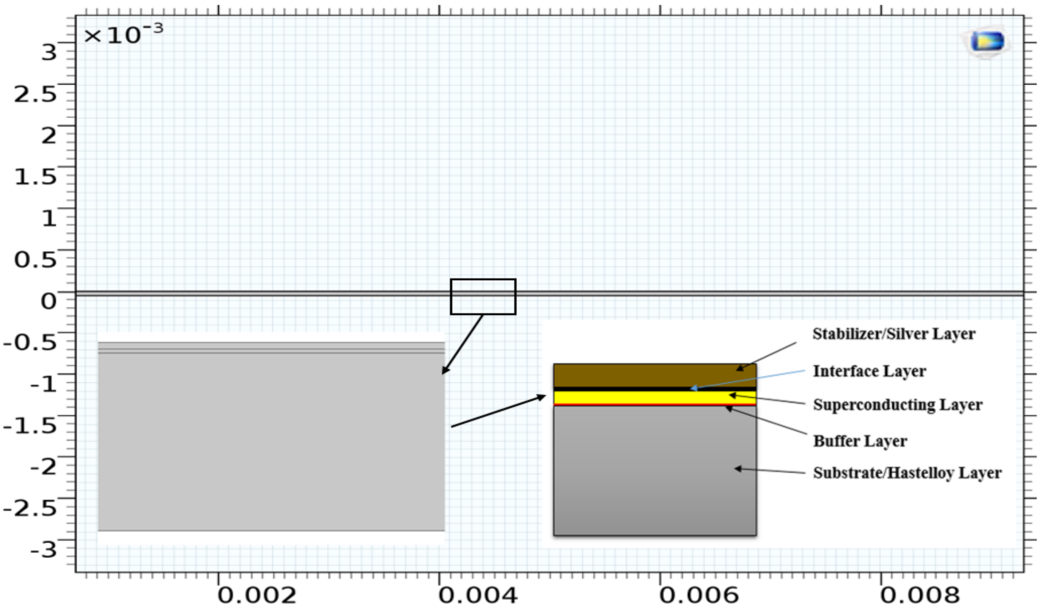

Figure 2 Electro-thermal model details

The potentials on either side of the infinitely thin layer are V2 and V1, and the layer's thickness is t. Similarly, the heat flux (Q_z) circulating across multiple tiny layers can be calculated using following equation:

$$Q_z = k(T)\frac{\partial T_1}{\partial z} = k(T)\left(\frac{T_2 - T_1}{t}\right) \quad (14)$$

Table 2 Modelling Parameters involved in quench analysis

Parameter	Numerical Value
Length	10 cm
Width	12 mm
Substrate thickness	50 μm
Buffer layer thickness	150 nm
Superconducting layer thickness	1 μm
Interfacial layer between superconductor and stabilizer thickness	100 nm
Current flow diverter thickness	100 nm
Stabilizer thickness- top	2 μm
Stabilizer thickness- sides and bottom	1 μm
Substrate thickness	50 μm

The temperatures on either side of the infinitely thin layer are T2 and T1, and its thermal conductivity is k(T). Lacroix et al discovered that in an indefinitely thin layer, both electric potentials and temperatures are discontinuous for such approximations, and the potential and temperature values diverge on either side of the layer. Interface boundary conditions can be used to control the value shift. This is a depiction of the lumped approximation in the continuous situation, and it is strongly dependent on the thin layer's material properties, such as electrical conductivity, thermal conductivity, and layer thickness.

3. Mesh Sensitivity Studies

The computational domain is discretized using mapped meshing, and each layer of the superconducting tape, including the stabiliser, substrate, and superconducting layer, is subdivided into small sub-domains using this technique. depicts a superconducting tape of 10 cm length that is discretized in the transverse direction using 100, 200, 300, 400, and 500 components. Table 3 shows that the maximum temperature rise within the tape for electrical conductivity 1e9 S/m is the same as in cases 4 and 5. However, the computing time elapsed for analysis and the degree of freedoms for case-3 were determined to be lower, hence this meshing was adopted for the remaining experiments. System setups were as follows: Intel Core i5-8250 CPU at 1.6GHz, 8GB RAM, 64-bit operatingsystem with Window 10.

Table 3 Mesh sensitivity studies for electro-thermal analysis of the HTS tape

Sr. No.	Number of elements	Number of domain elements	Number of domain boundaries	Degree of freedom	Time (s)	Max. Temp. (K)
1.	100	3000	460	25327	22m 56s	95
2.	200	6000	860	50527	42m 47s	94.9
3.	*300*	*9000*	*1260*	*75727*	*1h 4m 37s*	*94.7*

4.	400	12000	1660	100927	1h 48m 32s	94.7
5.	500	15000	2060	126127	1h 56m 39s	94.7

4. Results and Summary

The parameters involved in the quench dynamics are tabulated in the Table 2 where 2G HTS coated conductors have been tested for various interfacial resistance amid the superconducting and stabilizer layer. For the modelling purposes, electrical conductivity has been used as input material property instead of resistivity. The right end of the tape is grounded and the effect of this has been tested for various electrical conductivities of the interface. More NZPV is required which implies the information regarding the fault has to dispersed uniformly to the left end so that uniform temperature distribution can be obtained in order to avoid instant gradients.

$$\text{Normal zone propagation velocity} = \frac{1}{\text{Time elapsed}} \quad (15)$$

5. Conclusions

The electro-thermal analysis of the superconducting tape revealed that increasing the interfacial resistance of the superconducting-stabilizer layer can improve the NZPV and help manage the tape's quenching. The study discovered that a NZPV of 666.67 cm/s is possible with an electrical conductivity of 1 S/m. This research will aid in understanding the quench protection systems and how the NZPV affects the HTS coated conductor tape protection unit.

References

1. John B, A., Jeyan, J. V. M. L., NT, J., Kumar, A., Assessment of the Properties of Modified Pearl Millet Starch. *Starch.* 2022, 2200160. https://doi.org/10.1002/star.202200160
2. Suman Rana,Bhavin Soni,Dr. P. Ebby Darney,Jyothi NT, "EFFECTS OF T4 HORMONES ON HUMANBODY AND THEIR ANALYSIS", International Journal of Creative Research Thoughts (IJCRT), ISSN:2320-2882, Volume.10, Issue 10, pp.d332-d339, October 2022,
3. Ashika Parveen, JV Muruga Lal Jeyan[2], Jyothi NT[3] International Study on Application of Value Stream Mapping to Identify the Necessity of Lean System Implementation , International Journal of Scientific Research in Engineering and Management (IJSREM) Volume: 06 Issue: 09 | September - 2022 Impact Factor: 7.185 ISSN: 2582-3930
4. JV Muruga lal Jeyan, Jyothi NT Rashi Kaushik Systematic Review and Survey on Dominant Influence of Vedas and Ignorance Transpired in Space Science and Aviation", International Journal of Emerging Technologies and Innovative Research (www.jetir.org), ISSN:2349-5162, Vol.9, Issue 7, page no.b490-b493, July-2022,
5. JV Muruga lal Jeyan, Jyothi NT , Boopesh Raja, Rajarajan G "THEORY STRATEGY OF SUBSONIC WIND TUNNEL FOR LOW VELOCITY ", International Journal of Emerging Technologies and Innovative Research (www.jetir.org), ISSN:2349-5162, Vol.9, Issue 6, page no.j572-j580, June-2022, Available :http://www.jetir.org/papers/JETIR2206973.pdf
6. JV Muruga lal Jeyan, Jyothi NT, Reshmitha Shree, Bhawadharanee S, Rajarajan, THEORETICAL STUDY OF HYPERSONIC WIND TUNNEL TEST FACILITY IN INDIA ", International Journal

of Emerging Technologies and Innovative Research (www.jetir.org), ISSN:2349-5162, Vol.9, Issue 6, page no.j512-j518, June-2022, Available

7. JV Muruga lal Jeyan, Jyothi NT , V S Devika Thampuratty, B Nithin, Rajarajan, CONCEPT DESIGN AND DEVELOPMENT OF SUPERSONIC WIND TUNNEL ", International Journal of Emerging Technologies and Innovative Research (www.jetir.org | UGC and issn Approved), ISSN:2349-5162, Vol.9, Issue 6, page no. ppj209-j217, June-2022, Available at :
8. Muthu Venkatesh, Rajarajan G Jyothi NT JV Muruga Lal Jeyan "Systematic Survey of Wind Tunnel Test facility in India", International Journal of Emerging Technologies and Innovative Research (www.jetir.org), ISSN:2349-5162, Vol.9, Issue 6, page no.h830-h840, June-2022, Available :http://www.jetir.org/papers/JETIR2206795.pdf
9. Ashika Parveen, JV Muruga Lal Jeyan, Jyothi NT "Investigation Of Lean Developments And The Study Of Lean Techniques Through Event Studies" Internation Journal for Science and Advance Research In Technology, 8(4)
10. P Gopala Krishnan, JV Muruga Lal Jeyan, Jyothi NT "Novel Evaluation Of Aircraft Data Structure Optimization Techniques And Opportunities" International Journal for Science and Advance Research In Technology, 8(4)
11. Suryansh Upadhyay, JV Muruga lal Jeyan, Jyothi NT Preliminary Study on Brain Computer Interface © August 2021| IJIRT | Volume 8 Issue 3 | ISSN: 2349-6002 IJIRT 152537 INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN TECHNOLOGY 720
12. Sruthi.s.kumar, Jyothi Nt , Jv Muruga lal jeyan . Computational Turbine Blade Analysis with Thermal Barrier Coating International Journal of Engineering Research and Applications www.ijera.com ISSN: 2248-9622, Vol. 12, Issue 4, (Series-I) April 2022, pp. 01-08, DOI: 10.9790/9622-1204010108
13. Systematic Survey, Performance Evaluation, and Truth Flow Analysis of Two Subsonic Wind Tunnels with Two-Hole Spherical Flow Analyzer - Akhila Rupesh and J. V. Muruga Lal Jeyan In Production Pub Date: October 2022 Hardback Price: $159.95 USD | £124.00 Hard ISBN: 9781774911303 https://www.appleacademicpress.com/optimization-methods-for-engineering-problems-/9781774911303
14. K.S. Priyanka, J.V.M.L. Jeyan and S. Vihar. 2022. Investigation of Flow Separation Over NACA 24015 and 24021 Airfoils using Flow Injection Method, Int. J. Vehicle Structures & Systems, 14(3), 300-305. doi: 10.4273/ijvss.14.3.02.
15. P. S. RAMESH, J. V. MURUGA LAL JEYAN, *Comparative Analysis of Fixed-Wing, Rotary-Wing and Hybrid Mini Unmanned Aircraft Systems (UAS) from the Applications Perspective*, pp. 137-151, https://doi.org/10.13111/2066-8201.2022.14.1.12- INCAS BULLETIN, Volume 14, Issue 1/ 2022, pp. 137 – 151 Published: March 2022
16. P. S., R., & J. V. Muruga Lal, J. (2022). Hover performance analysis of coaxial Mini unmanned aerial vehicle for applications in mountain terrain. Aviation, 26(2), 112–123. https://doi.org/10.3846/aviation.2022.16901
a. Published in Issue Jun 21, 2022
17. P.S., R. and J.V., M.L.J. (2022), "Evaluation of design criteria for mini unmanned aircraft systems (UAS) applications", Aircraft Engineering and Aerospace Technology, Vol. 94 No. 3, pp. 327-335. https://doi.org/10.1108/AEAT-03-2021-0089 Issue publication date: 10 February 2022
18. Aishwarya Dhara and Jeyan Muruga Lal 2021 IOP Conf. Ser.: Earth Environ. Sci. 889 012068

a. https://iopscience.iop.org/article/10.1088/1755-1315/889/1/012068/meta
19. R. Sabari VIHAR, J. V. Muruga Lal JEYAN, K. Sai PRIYANKA, *Effect of camber on the flutter characteristics of different selected airfoils*, pp. 215-223, Published: September 2021 https://doi.org/10.13111/2066-8201.2021.13.3.18
20. R. Balaji and M. L. Jeyan, "Performance analysis on varies bluff bodies at hypersonic speed," 2020 International Conference on Interdisciplinary Cyber Physical Systems (ICPS), 2020, pp. 62-67, doi: 10.1109/ICPS51508.2020.00017. https://ieeexplore.ieee.org/document/9434600
21. A. Rupesh, J. V. Muruga Lal Jeyan, , "Aerodynamic Design and Flow Analysis of Two Taping Spherical Flow Analyser and Mirror Edge Flow Analyser for Subsonic Wind Tunnel Calibration," 2021 International Conference on Advances in Electrical, Computing, Communication and Sustainable Technologies (ICAECT), Bhilai,India,2021,pp.1-6,doi:10.1109/ICAECT49130.2021.9392535, https://ieeexplore.ieee.org/document/9392535
22. Ramesh, P.S. and MurugaLalJeyan, J.V. (2021), "Terrain imperatives for Mini unmanned aircraft systems applications", International Journal of Intelligent Unmanned Systems, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/IJIUS-09-2020-0044
23. Akhilarupesh, JV Muruga lal jeyan Experimental and Computational Evaluation of Five Hole Five Probe Flow Analyzer for Subsonic Wind Calibration - International Journal of Aviation, Aeronautics, and Aerospace , Published by Scholarly CommonsEmbry-Riddle Aeronautical University Volume 7 Issue 4 Article 3 2020
24. Ramesh PS, JV Muruga lal jeyan Mini Unmanned Aerial Systems (UAV) - A Review of theParameters for Classification of a Mini UAV - International Journal of Aviation,Aeronautics, and Aerospace , Published by Scholarly CommonsEmbry-Riddle Aeronautical University Volume 7 Issue 3 Article 5 2020
25. K.SaiPriyanka , J V MurugaLalJeyan*, R.SabariVihar. (2020). A Review on a Reassess Swot up on Airfoil Stall and Flow Separation Delay for a Range of Limitations Associated with Aerodynamics and Wing Profile. International Journal of Advanced Science and Technology, 29(06), 7659-7668.
26. R. SabariVihar, J. V. MurugaLalJeyan, K. SaiPriyanka. (2020). A Review on Aerodynamic Parameters, Methodologies and Suppression Techniques Explored in Aircraft Wing Flutter. International Journal of Advanced Science and Technology, 29(04), 3494
27. AkhilaRupesh, Dr. J V MurugaLalJeyan. (2020). Performance Evaluation of a Two Hole and Five Hole Flow Analyzer for Subsonic Flow. International Journal of Advanced Science and Technology, 29(05), 7512-7525
28. JV Murugalaljeyan Kavya S nair Amit Kumar Thakur Deepak Kumar Aerodynamic stability on piezoelectric multi Rotor UAV with numerical case learning European Journal of Molecular & Clinical Medicine, 2020, Volume 7, Issue 7, Pages 1558-1568 https://ejmcm.com/article_4636.html
29. J V MurugalalJeyan , Dr. M. Senthil Kumar, "Performance Evaluation of Yaw Meter With the Aid of Computational Fluid Dynamic" , International Review of Mechanical Engineering (IREME). ISSN: 1970-8734, Vol No. 8,Issue 02 .
30. J V MurugalalJeyan ,Dr. M. Senthil Kumar , "Performance Evaluation for Multi-Hole Probe With the Aid of Artificial Neural Network" International Journal of Theoretical and Applied Information Technology (JTAIT). ISSN 1992-8645Vol No: 65 , Issue 3 , PP: 665 July 31, 2014
31. A. S. Kumar, J. V. M. L. Jeyan, J. N. T, S. Annamalai and N. V. Kousik, "Lossless Video Compression Using Reinforcement Learning in UAV Applications," 2023 International Conference

on Data Science and Network Security (ICDSNS), Tiptur, India, 2023, pp. 1-6, doi: 10.1109/ICDSNS58469.2023.10245784.

32. John B, A., Jeyan, J. V. M. L., **NT, J.**, Kumar, A., Assessment of the Properties of Modified Pearl Millet Starch. *Starch.* 2022, 2200160. https://doi.org/10.1002/star.202200160
33. Suman Rana,Bhavin Soni,Dr. P. Ebby Darney,**Jyothi NT**, "EFFECTS OF T4 HORMONES ON HUMANBODY AND THEIR ANALYSIS", International Journal of Creative Research Thoughts (IJCRT), ISSN:2320-2882, Volume.10, Issue 10, pp.d332-d339, October 2022, Available at :http://www.ijcrt.org/papers/IJCRT2210389.pdf
34. Ashika Parveen1, JV Muruga Lal Jeyan[2], **Jyothi NT[3]** International Study on Application of Value Stream Mapping to Identify the Necessity of Lean System Implementation , International Journal of Scientific Research in Engineering and Management (IJSREM) Volume: 06 Issue: 09 | September - 2022 Impact Factor: 7.185 ISSN: 2582-3930
35. JV Muruga lal Jeyan, **Jyothi NT** Rashi Kaushik Systematic Review and Survey on Dominant Influence of Vedas and Ignorance Transpired in Space Science and Aviation", International Journal of Emerging Technologies and Innovative Research (www.jetir.org), ISSN:2349-5162, Vol.9, Issue 7, page no.b490-b493, July-2022, Available :http://www.jetir.org/papers/JETIR2207158.pdf
36. JV Muruga lal Jeyan, **Jyothi NT** , Boopesh Raja, Rajarajan G "THEORY STRATEGY OF SUBSONIC WIND TUNNEL FOR LOW VELOCITY ", International Journal of Emerging Technologies and Innovative Research (www.jetir.org), ISSN:2349-5162, Vol.9, Issue 6, page no.j572-j580, June-2022, Available :http://www.jetir.org/papers/JETIR2206973.pdf
37. JV Muruga lal Jeyan, **Jyothi NT**, Reshmitha Shree, Bhawadharanee S, Rajarajan, THEORETICAL STUDY OF HYPERSONIC WIND TUNNEL TEST FACILITY IN INDIA ", International Journal of Emerging Technologies and Innovative Research (www.jetir.org), ISSN:2349-5162, Vol.9, Issue 6, page no.j512-j518, June-2022, Available :http://www.jetir.org/papers/JETIR2206967.pdf
38. JV Muruga lal Jeyan, **Jyothi NT** , V S Devika Thampuratty, B Nithin, Rajarajan, CONCEPT DESIGN AND DEVELOPMENT OF SUPERSONIC WIND TUNNEL ", International Journal of Emerging Technologies and Innovative Research (www.jetir.org | UGC and issn Approved), ISSN:2349-5162, Vol.9, Issue 6, page no. ppj209-j217, June-2022, Available at : http://www.jetir.org/papers/JETIR2206925.pdf
39. Muthu Venkatesh, Rajarajan G **Jyothi NT** JV Muruga Lal Jeyan "Systematic Survey of Wind Tunnel Test facility in India", International Journal of Emerging Technologies and Innovative Research (www.jetir.org), ISSN:2349-5162, Vol.9, Issue 6, page no.h830-h840, June-2022, Available :http://www.jetir.org/papers/JETIR2206795.pdf
40. Ashika Parveen, JV Muruga Lal Jeyan, **Jyothi NT** "Investigation Of Lean Developments And The Study Of Lean Techniques Through Event Studies" Internation Journal for Science and Advance Research In Technology, 8(4)
41. P Gopala Krishnan, JV Muruga Lal Jeyan, **Jyothi NT** "Novel Evaluation Of Aircraft Data Structure Optimization Techniques And Opportunities" International Journal for Science and Advance Research In Technology, 8(4)
42. Suryansh Upadhyay, JV Muruga lal Jeyan, **Jyothi NT** Preliminary Study on Brain Computer Interface © August 2021| IJIRT | Volume 8 Issue 3 | ISSN: 2349-6002 IJIRT 152537 INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN TECHNOLOGY 720

43. Sruthi.s.kumar, **Jyothi Nt** , Jv Muruga lal jeyan . Computational Turbine Blade Analysis with Thermal Barrier Coating International Journal of Engineering Research and Applications www.ijera.com ISSN: 2248-9622, Vol. 12, Issue 4, (Series-I) April 2022, pp. 01-08, DOI: 10.9790/9622-1204010108
44. An Intercontinental Study of Employee and Employer Human Factor Issues Put Up in Aerospace and Aviation Industry - Jyothi NT, Hussainar A, Shilpa Rana, Muruga lal Jeyan JV - IJFMR Volume 6, Issue 1, January-February 2024. DOI 10.36948/ijfmr.2024.v06i01.12441
45. Hussainar A, Shilpa Rana, JV Murugalal Jeyan, "Superior Intelligence - A Risk Factor for Psychological and Physiological Hyperactivity", International Journal of Science and Research (IJSR), Volume 12 Issue 12, December 2023, pp. 174-178, https://www.ijsr.net/getabstract.php?paperid=SR231201162339