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A Study of Cylindrical Surface Grinding Under Minimum Quantity Lubrication (MQL) Conditions

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ABSTRACT

Abrasive material removal processes is high power consuming and results in high temperatures. Effective lubrication and cooling is necessary to ensure temperature levels do not become excessive, flood lubrication is used, but this fluid delivery system increase production cost due to fluid purchase and disposal. Moreover, waste fluids have a negative environmental impact. Minimum Quantity Lubrication (MQL) method is effective lubrication method where a small amount of fluid is directed into the machining area in the form of liquid droplets with compressed air. This paper presents a comparative study of three cooling methods: conventional flood cooling, dry grinding and grinding with MQL. AISI/ SAE - 4340 steel will be ground with a general purpose alumina wheel. Results obtained demonstrate that MQL can deliver a comparable performance to flood delivery.

INTRODUCTION

A great amount of energy is required per unit of removed material processes, a large amount of energy is consumed, and this energy dissipates in the form of heat. The heat generated in the contact area between the wheel and the workpiece is the main cause for the deterioration of the metallurgical properties, surface quality and also reduces grinding wheel life. However, if cooling lubricants, such as cutting fluids, are used, the heat can be reduced by decreasing friction. Thus, the forces and the residual stresses on the workpiece will be minimized.
The conventional flood lubrication method cutting fluid is delivered at low velocity high-volume. As a result of use and time the fluid loses its properties to finally become a waste. It has been found that cooling costs can be as high as 17% of a total part manufacturing cost, whereas depreciation and waste disposal contributes for around 54% of cooling costs. Hence, thereby reducing the fluid used can considerably increase economic benefits.

To reduce environmental impacts of the manufacturing processes, as well as the costs associated with cutting fluids minimum quantity lubrication (MQL) can be used. MQL refers to the delivery of small volumes of
fluid via an aerosol to the cutting region. The air and oil mixture can be produced either in a reservoir or at the nozzle tip. The general guide for conventional fluid usage is 1 l/min of fluid per 1 mm of wheel width. In contrast, MQL fluid consumption is typically 250–500 ml/h.

Therefore, MQL has the potential replace the conventional lubrication which use of large amount of cutting fluids, generating several benefits to industries through a reduction in expenses, improved handling, and the disposal of cutting fluids while reducing environmental and human health impacts. (Vasanthy and Jeganathan 2007, Vasanthy et.al., 2008, Raajasubramanian et.al., 2011, Jeganathan et.al., 2012, 2014, Sridhar et.al., 2012, Gunaselvi et.al., 2014, Premalatha et.al., 2015, Seshadri et.al., 2015, Shakila et.al., 2015, Ashok et.al., 2016, Satheesh Kumar et.al., 2016).

MINIMUM QUANTITY LUBRICATION

Minimum quantity lubrication (MQL) is a technique that uses a spray of small oil droplets in a compressed air jet. The lubricant is sprayed directly into the cutting zone, avoiding the huge flows of conventional flood coolant methods. The air jet carries the oil droplets directly in the cutting area, it provides efficient lubrication. One of the advantages of MQL is the fact that after grinding runs, chips, workpieces and tools have less impregnated fluid, making cleaning easier and cheaper. Furthermore, during grinding runs, since the workpiece is not fully covered with fluid, visual monitoring is possible. The general guide for conventional fluid usage is 1 l/min of fluid per 1 mm of wheel width . In contrast, MQL fluid consumption is typically 200–500 ml/h. (Manikandan et.al., 2016, Sethuraman et.al., 2016, Senthil Thambi et.al., 2016).

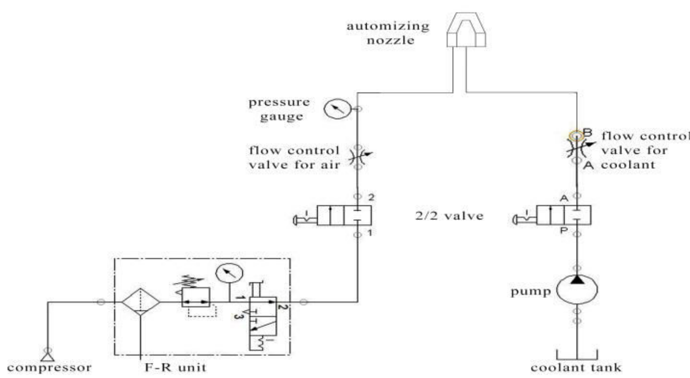

Figure 1

EXPERIMENTAL SETUP

The purpose of this experiment was to measures the performance of MQL in the case of cylindrical grinding. This was achieved by studying the effects of MQL in comparison with the conventional flood delivery and dry grinding situations. The following parameters were taken as input: grinding wheel speed, workpiece speed, depth of cut and fluid flow rate. The surface roughness was taken as the output result of experiment.

The cylindrical gridding machine used was a MASTER RS1, 3-phase motor of 2HP. Castrol Syntilo2000 metal cutting lubricant was used because of its suitability for ferrous material. For the conventional flood delivery at lubricant was used at 5% concentration. Delivery conditions were 1 bar pressure and approximately 48 l/h was the flow rate.

For grinding with MQL, 50% concentrated Castrol Syntilo 2000 was delivered via MQL system. A supply pressure of 2bar delivered approximately 250 ml/h and 500ml/h. The grinding wheel used for the experiment was general purpose aluminium oxidewheel, the flow control valve and nozzle were calibrated.

The material used in these tests was tempered and annealed AISI/ SAE2 4340 steel (0.4% C–1.8% Ni–0.9% Cr–0.3% Mo–0.7% Mn–0.23% Si), 60 HRC. It is employed in the manufacture of automobile components that require a good combination of mechanical strength and toughness. The tests were carried out with aluminum oxide (Al_2O_3)grinding wheel.

Figure 2

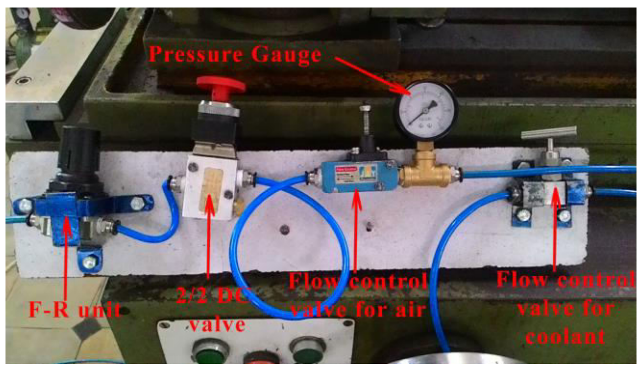

Figure 3

Figure 4

GRINDING CONDITION

Table 1

Grinding mode	External cylindrical plunge grinding
Grinding wheel	Al_2O_3
Grinding machine	Riat son's - Master RS1
Wheel speed (Vg)	
Work speed (Vw)	
Environment	Dry, fluid, MQL
grinding fluid	Water-miscible coolant lubricant Castrol Syntilo 2000
MQL flow rate (Q)	250ml/h and 500 ml/h
Air pressure	2 bar
Workpiece material	SAE 4340 steel (dia 28mm, length 100mm)

EXPERIMENT PROCEDURE

The experimental work was performed in three stages: (1) conventional flood delivery grinding (WET), (2) dry grinding (DRY) and (3) minimum quantity lubrication grinding (MQL). The Regular Two-Level Factorial Design method was used for the experimental design resulting in creation of 8 trial. The process parameters used for this study are given in Table 2. Before each trial fluid flow was calibrated as per the process parameter.

The grinding experiments were conducted on a cylindrical grinding machine. The ground material was AISI/ SAE 4340 steel. The MQL equipment is made of a compressor, pressure regulator, air flow gauge, and mixing nozzle, flow control valve allowed the separate regulation of compressed air and lubricant flows. The surface roughness was measured using Ra on a surface roughness meter.

The results shown are averages of readings in different positions for each of the three workpieces used and for each cooling-lubrication condition.

Table 2

	Factor 1	Factor 2	Factor 3	Factor 4
Run	A:Grinding Wheel Speed	B:Work Piece Speed	C:Depth of Cut	D:Fluid Flow Rate
	m/s	m/s	mm	ml/h
1	29.21	0.952	1	500
2	21.99	0.513	1	500
3	21.99	0.952	0.5	250
4	29.21	0.952	0.5	500
5	21.99	0.513	0.5	500
6	21.99	0.513	1	250
7	29.21	0.513	0.5	250
8	29.21	0.952	1	250

RESULTS AND DISCUSSION:

This section, the experimental results of the output variables for each grinding condition will be presented. The conventional cooling-lubrication system (flood coolant application) was used as a reference because it is the most widely used in industry. The results show the quantity of lubricant used and surface finish obtained in each grinding process, it evident from the results that the MQL gives better result compared to conventional and dry grinding. MQL gives better surface finish and consumes very less lubrication (200 times less than conventional lubrication)

Table 3

	Fluid flow rate (l/h)	**Depth of cut (mm)**	**Surface roughness (µm)**
Dry	_	1	1.018
Flood lubrication	48	1	0.947
MQL	0.25	1	0.676

This section, the experimental results of the output variables for each grinding condition will be presented. The conventional cooling-lubrication system (flood coolant application) was used as a reference because it is the most widely used in industry. The results for the analysed variables are illustrated in bar graphs containing their average measurements.

Table 4

	Factor 1	Factor 2	Factor 3	Factor 4	Response 1
Run	A:Grinding Wheel Speed	B:Work Piece Speed	C:Depth of Cut	D:Fluid Flow Rate	surface roughnrss
Units	m/s	m/s	mm	ml/h	um
1	29.21	0.952	1	500	
2	21.99	0.513	1	500	0.676
3	21.99	0.952	0.5	250	
4	29.21	0.952	0.5	500	0.329
5	21.99	0.513	0.5	500	
6	21.99	0.513	1	250	
7	29.21	0.513	0.5	250	0.630
8	29.21	0.952	1	250	0.456

Conclusions

An analysis of the experimental data of this study led to the following conclusions regarding the cylindrical plunge grinding AISI 4340 steel:

- It is evident from above results that MQL is able to outperform conventional flood cooling delivery.
- The MQL technique can be applied efficiently in the grinding process.
- The Ra values were substantially reduced with the use of the MQL technique, due to excellent properties of lubricity.
- MQL gives better surface finish and consumes very less lubrication (approximately 200 times less than conventional lubrication)
- The significant reduction in coolant used results in reduction in cost of production.

References

1. L.M. Barczak n, A.D.L.Batako,M.N.Morgan, A study of plane surface grinding under minimum quantity lubrication (MQL) conditions.
2. Danilo de Jesus Oliveiraa, Luiz Gustavo Guermandia, Eduardo Carlos Bianchia, Improving minimum quantity lubrication in CBN grinding using compressed air wheel cleaning.
3. Leonardo Roberto da Silvaa, Eduardo Carlos Bianchib, Ronaldo YoshinobuFusse, Analysis of surface integrity for minimum quantity lubricant—MQL in grinding.
4. T. Tawakoli a, M.J.Hadad, Influence of oil mist parameters on minimum quantity lubrication – MQL grinding process
5. M. Emamia, M.H. Sadeghia, Ahmed A.D. Sarhan, Investigating the effects of liquid atomization and delivery parameters of minimum quantity lubrication on the grinding process of Al2O3 engineering ceramics.
6. T. Tawakoli ,M.J.Hadad, M.H.Sadeghi, Investigation on minimum quantity lubricant-MQL grinding of 100Cr6 hardened steel using different abrasive and coolant–lubricant types.
7. R. Alberdi, J.A.Sanchez, I.Pombo, Strategies for optimal use of fluids in grinding. ParashKalita, Ajay P. Malshe,∗, S. Arun Kumar, V.G. Yoganath, T. Gurumurthy, Study of specific energy and friction coefficient in minimum quantity lubricationgrinding using oil-based nanolubricants
8. ParashKalita , Ajay P. Malshe, Kamlakar P. Rajurkar, Study of tribo-chemical lubricant film formation during application of nanolubricants in minimum quantity lubrication (MQL) grinding
9. Vasanthy M and M. Jeganathan. 2007. Ambient air quality in terms of NOx in and around Ariyalur, Perambalur DT, Tamil Nadu. Jr. of Industrial pollution Control., 23(1):141-144.
10. Vasanthy. M ,A.Geetha, M. Jeganathan,and A.Anitha. 2007. A study on drinking water quality in Ariyalur area. J.Nature Environment and Pollution Technology. 8(1):253-256.
11. Ramanathan R ,M. Jeganathan, and T. Jeyakavitha. 2006. Impact of cement dust on azadirachtain dicaleaves – ameasure of air pollution in and Around Ariyalur. J. Industrial Pollution Control. 22 (2): 273-276.
12. Vasanthy M and M. Jeganathan. 2007. Ambient air quality in terms of NOx in and around Ariyalur, Perambalur DT, Tamil Nadu. Pollution Research., 27(1):165-167.

13. Vasanthy M and M. Jeganathan. 2008.Monitoring of air quality in terms of respirable particulate matter – A case study. Jr. of Industrial pollution Control.,24(1):53 - 55.
14. Vasanthy M, A.Geetha, M. Jeganathan, and M. Buvaneswari. 2008. Phytoremediation of aqueous dye solution using blue devil (Eichhornia crassipes). J. Current Science. 9 (2): 903-906.
15. Raajasubramanian D, P. Sundaramoorthy, L. Baskaran, K. Sankar Ganesh, AL.A. Chidambaram and M. Jeganathan. 2011. Effect of cement dust pollution on germination and growth of groundnut (*Arachis hypogaea* L.). IRMJ-Ecology. International Multidisciplinary Research Journal 2011, 1/1:25-30 : ISSN: 2231-6302: Available Online: http://irjs.info/.
16. Raajasubramanian D, P. Sundaramoorthy, L. Baskaran, K. Sankar Ganesh, AL.A. Chidambaram and M. Jeganathan. 2011. Cement dust pollution on growth and yield attributes of groundnut. (*Arachis hypogaea* L.). IRMJ-Ecology. International Multidisciplinary Research Journal 2011, 1/1:31-36.ISSN: 2231-6302. Available Online: http://irjs.info/
17. Jeganathan M, K. Sridhar and J.Abbas Mohaideen. 2012. Analysis of meterological conditions of Ariyalur and construction of wind roses for the period of 5 years from January 2002. J.Ecotoxicol.Environ.Monit., 22(4): 375-384.
18. Sridhar K, J.Abbas Mohaideen M. Jeganathan and P Jayakumar. 2012. Monitoring of air quality in terms of respirable particulate matter at Ariyalur, Tamilnadu. J.Ecotoxicol.Environ.Monit., 22(5): 401-406.
19. Jeganathan M, K Maharajan C Sivasubramaniyan and A Manisekar. 2014. Impact of cement dust pollution on floral morphology and chlorophyll of *healianthus annus* plant – a case study. J.Ecotoxicol.Environ.Monit., 24(1): 29-34.
20. Jeganathan M, C Sivasubramaniyan A Manisekar and M Vasanthy. 2014. Determination of cement kiln exhaust on air quality of ariyalur in terms of suspended particulate matter – a case study. IJPBA. 5(3): 1235-1243. ISSN:0976-3333.
21. Jeganathan M, S Gunaselvi K C Pazhani and M Vasanthy. 2014. Impact of cement dust pollution on floral morphology and chlorophyll of *healianthus annus.*plant a case study. IJPBA. 5(3): 1231-1234. ISSN:0976-3333.
22. Gunaselvi S, K C Pazhani and M. Jeganathan. 2014. Energy conservation and environmental management on uncertainty reduction in pollution by combustion of swirl burners. J. Ecotoxicol. Environ.Monit., 24(1): 1-11.
23. Jeganathan M, G Nageswari and M Vasanthy. 2014. A Survey of traditional medicinal plant of Ariyalur District in Tamilnadu. IJPBA. 5(3): 1244-1248. ISSN:0976-3333.
24. Premalatha P, C. Sivasubramanian, P Satheeshkumar, M. Jeganathan and M. Balakumari.2015. Effect of cement dust pollution on certain physical and biochemical parameters of castor plant (*ricinus communis*). IAJMR.1(2): 181-185.ISSN: 2454-1370.
25. Premalatha P, C. Sivasubramanian, P Satheeshkumar, M. Jeganathan and M. Balakumari.2015. Estimation of physico-chemical parameters on silver beach marine water of cuddalore district. Life Science Archives. 1(2): 196-199.ISSN: 2454-1354.
26. Seshadri V, C. Sivasubramanian P. Satheeshkumar M. Jeganathan and Balakumari.2015. Comparative macronutrient, micronutrient and biochemical constituents analysis of *arachis hypogaea.* IAJMR.1(2): 186-190.ISSN: 2454-1370.
27. Seshadri V, C. Sivasubramanian P. Satheeshkumar M. Jeganathan and Balakumari.2015. A detailed study on the effect of air pollution on certain physical and bio chemical

parameters of *mangifera indica* plant.Life Science Archives. 1(2): 200-203.ISSN: 2454-1354.
28. Shakila N, C. Sivasubramanian, P. Satheeshkumar, M. Jeganathan and Balakumari.2015. Effect of municipal sewage water on soil chemical composition- A executive summary. IAJMR.1(2): 191-195.ISSN: 2454-1370.
29. Shakila N, C. Sivasubramanian, P. Satheeshkumar, M. Jeganathan and Balakumari.2015. Bacterial enumeration in surface and bottom waters of two different fresh water aquatic eco systems in Ariyalur, Tamillnadu. Life Science Archives. 1(2): 204-207.ISSN: 2454-1354.
30. Ashok J, S. Senthamil kumar, P. Satheesh kumar and M. Jeganathan. 2016. Analysis of meteorological conditions of ariyalur district. Life Science Archives. 2(3): 579-585.ISSN: 2454-1354. DOI: 10.21276/lsa.2016.2.3.9.
31. Ashok J, S. Senthamil Kumar, P. Satheesh Kumar and M. Jeganathan. 2016. Analysis of meteorological conditions of cuddalore district. IAJMR.2 (3): 603-608.ISSN: 2454-1370. DOI: 10.21276/iajmr.2016.2.3.3.
32. Satheesh Kumar P, C. Sivasubramanian, M. Jeganathan and J. Ashok. 2016. South Indian vernacular architecture -A executive summary. IAJMR.2 (4): 655-661.ISSN: 2454-1370. DOI: 10.21276/iajmr.2016.2.3.3.
33. Satheesh Kumar P, C. Sivasubramanian, M. Jeganathan and J. Ashok. 2016. Green buildings - A review. Life Science Archives. 2(3): 586-590.ISSN: 2454-1354. DOI: 10.21276/lsa.2016.2.3.9.
34. Satheesh Kumar P, C. Sivasubramanian, M. Jeganathan and J. Ashok. 2016. Indoor outdoor green plantation in buildings - A case study. IAJMR.2 (3): 649-654.ISSN: 2454-1370. DOI: 10.21276/iajmr.2016.2.3.3.
35. Manikandan R, M. Jeganathan, P. Satheesh Kumar and J. Ashok. 2016. Assessment of ground water quality in Cuddalore district, Tamilnadu, India. Life Science Archives. 2(4): 628-636.ISSN: 2454-1354. DOI: 10.21276/lsa.2016.2.3.9.
36. Manikandan R, M. Jeganathan, P. Satheesh Kumar and J. Ashok. 2016. A study on water quality assessment of Ariyalur district, Tamilnadu, India. IAJMR.2 (4): 687-692.ISSN: 2454-1370. DOI: 10.21276/iajmr.2016.2.3.3.
37. Sethuraman G, M. Jeganathan, P. Satheesh Kumar and J. Ashok. 2016. Assessment of air quality in Ariyalur, Tamilnadu, India. Life Science Archives. 2(4): 637-640.ISSN: 2454-1354. DOI: 10.21276/lsa.2016.2.3.9.
38. Sethuraman G, M. Jeganathan, P. Satheesh Kumar and J. Ashok. 2016. A study on air quality assessment of Neyveli, Tamilnadu, India. IAJMR.2 (4): 693-697.ISSN: 2454-1370. DOI: 10.21276/iajmr.2016.2.3.3.
39. Senthil Thambi J, C. Sivasubramanian and M. Jeganathan. 2018. Ambient Air quality monitoring in terms of (Nitrogen di oxide in and around Ariyalur District, Tamilnadu, India. IAJMR.4 (3): 1414-1417.ISSN: 2454-1370. DOI: 10.22192/iajmr.2018.4.3.2.
40. Senthil Thambi J, C. Sivasubramanian and M. Jeganathan. 2018. Study of Air pollution due to vehicle emission in Ariyalur District, Tamilnadu, India. Life Science Archives. 4(4): 1409-1416.ISSN: 2454-1354. DOI: 10.22192/lsa.2018.4.4.3.
41. Ashok J, S.Senthamil kumar, P.Satheesh kumar and M.Jeganathan. 2018. Estimation of Cement kiln exhaust on Air quality of Ariyalur in terms of suspended particulate matter - A Case Study. International Journal Of Civil Engineering And Technology. 9 (12): Scopus Indexed Journal ISSN: 0976 – 6316.

42. Ashok J, S.Senthamil kumar, P.Satheesh kumar and M.Jeganathan.2018. Air quality assessment of Neyveli in Cuddalore District, Tamilnadu, India. International Journal Of Civil Engineering And Technology. 9 (12): Scopus Indexed Journal ISSN: 0976 – 6316.
43. Senthilkumar M, N. Nagarajan, M. Jeganathan and M. Santhiya. 2018. Survey of Medicinal Plants diversity on Bodha Hills in Salem District, Tamil Nadu, India. Indo – Asian Journal Of Multidisciplinary Research (IAJMR) ISSN: 2454-1370.
44. Senthilkumar M, N. Nagarajan, M. Jeganathan and M. Santhiya. 2018. Survey of Traditional Medicinal Plants in and around Ariyalur in TamilNadu, India. Life Science Archives (LSA) ISSN: 2454-1354. DOI: 10.22192/lsa.2018.4.6.5.
45. Sundar S and M.Jeganathan. 2019. A study on physico-chemical characteristics of Noyyal river water quality in Tirupur, Tamilnadu, India. Journal Of Emerging Technologies And Innovative Research (JETIR), ISSN: 2349-5162. Impact factor – 5.87.
46. Anandan V, S Senthamilkumar, V Sundararajulu S Gunaselvi and M Jeganathan. 2019. "Comparative study on the behavior of conventional ferrocement and modified ferrocement wrapped columns". International Journal Of Advanced Research In Engineering And Technology (IJARET). 10(6): 22-29, ISSN Print: 0976-6480 and ISSN Online: 0976-6499. Impact factor - 10.22.
47. Anandan V, S Senthamilkumar, V Sundararajulu S Gunaselvi and M Jeganathan . 2019. "Comparative study on the behavior of modified ferrocement columns and CFRP wrapped columns". International Journal Of Advanced Research In Engineering And Technology (IJARET). 10 (6): 41 - 48, ISSN Print: 0976-6480 and ISSN Online: 0976-6499. Impact factor - 10.22.
48. Murugavel S, Vasanthy Muthunarayanan, Jeganathan M and Santhiya. M. 2019. "A study on vermicomposting from different proportion of flower waste using earth worm species (*Eisenia foetida*)". Journal of Interdisciplinary Cycle Research (JICR). ISSN NO: 0022 – 1945. 11(12): 113-124. Impact factor – 6.2.
49. Satheesh kumar P , M Jeganathan, M Santhiya and S Gunaselvi. 2019. " A study on climatological condition with reference to urban and town areas of tamilnadu, India". Journal of Interdisciplinary Cycle Research (JICR). ISSN NO: 0022 – 1945. Impact factor – 6.2.
50. Arokiaswamy.I, Arumugam.D, Satheesh Kumar.P and Jeganathan.M. 2019. Manora Tower - A Case Study. Journal Of Interdisciplinary Cycle Research (JICR). ISSN NO: 0022 – 1945. Impact factor – 6.2.
51. Gomathi.P, Jayakumar.S and Jeganathan.M. 2019. " A study on morphological and chemical characterization of pollen grains of gamma rays induced tomato (*solanum lycopersicum)* mutants using sem-eds and ftir analysis". Journal of Interdisciplinary Cycle Research JICR/2283. ISSN NO: 0022 – 1945. Impact factor – 6.2.
52. Gomathi.P, Jayakumar.S and Jeganathan.M. 2019. Induced mutagnesis on some morphological characters of tomato (solanum lycopersicum l.) by using gamma rays and EMS. Journal Of Information And Computational Science (JOICS). ISSN: 1548-7741.
53. Gunaselvi.S, Sivasankar.R, Ajith.M and Jeganathan.M. 2020. "A case study on bacteria mixed concrete frame with conventional concrete frame". Adalya Journal. ISSN NO: 1301-2746. 9 (1): Index-3.
54. Gunaselvi.S, Sivasankar.R, Manivel.M, Jeganathan.M, Satheesh Kumar.P and Ashok.J. 2020. "Analytical study on hybrid behaviour of cold formed and hot rolled section as a compression member". Adalya Journal. ISSN NO: 1301-2746. 9 (1): Index-3.

55. Leema Rose.A, Gunaselvi.S and Jeganathan.M. 2020. “Parametric analysis of span to rise ratio of shallow funicular concrete shells with openings large to distrub global stress distribution”. Adalya Journal. ISSN NO: 1301-2746. 9 (1): Index-3.
56. Sundar S, M Jeganathan, P Satheesh Kumar and S Stella Mary. 2020. Evaluation of Building Construction Water Quality and Removal of Total Hardness Using Low Cost Methods. International Journal Of Advanced Research In Engineering And Technology (IJARET). 11 (2): ISSN Print: 0976-6480 and ISSN Online: 0976-6499. Impact factor - 10.22.
57. Manju M, Nagarajan K Satheesh Kumar P and Jeganathan M. 2020. Determination of Heat Resistant In Building Structures - A Case Study. International Journal Of Advanced Research In Engineering And Technology (IJARET). 11 (2): ISSN Print: 0976-6480 and ISSN Online: 0976-6499. Impact factor - 10.22.
58. Manju M, Nagarajan K Satheesh Kumar P and Jeganathan M. 2020. Analysis Of Quantity And Quality Of Light In Schools And Residential Area Of Chennai City, Tamilnadu, India. International Journal Of Advanced Research In Engineering And Technology (IJARET). 11 (2): ISSN Print: 0976-6480 and ISSN Online: 0976-6499. Impact factor - 10.22.
59. Manju M, Nagarajan K Satheesh Kumar P and Jeganathan M. 2020. Environmental Quality And Economical Study On Electrical And Electronic Industry - A Case Study. International Journal Of Advanced Research In Engineering And Technology (IJARET). 11 (2): ISSN Print: 0976-6480 and ISSN Online: 0976-6499. Impact factor - 10.22.
60. Satheeshkumar P, Manju M and Jeganathan M . 2020. “Analysis of Shading Elements in Building Structures” – Paper Submitted for the Research Day in SAID, SRM IST.
61. Jeganathan Muthaiyan, Mohammed Saleh Nusari and Vasanthy Muthunarayanan. 2021. Determination Of Physical And Chemical Materials Of Marine Water. Materials Today: Proceedings- 37, Pp: 284–293. https://ees.elsevier.com/matpr/.
62. Arokiaswamy.I, Arumugam.D, Satheesh Kumar.P and Jeganathan.M.. 2020. Thanjavur maratta painting and fine arts technique – A case study. AEGAEUM JOURNAL. Volume 8, Issue 6, 2020. ISSN NO: 0776-3808 http://aegaeum.com/VOLUME-8-ISSUE-6-2020/. Pp: 1324-1339.
63. Jeganathan Muthaiyan,. 2020. Surface modification of steel by nickel coating in electrochemical process -Journal of New Materials for Electrochemical Systems. Vol.23, No.2, April, 2020, pp. 112-122. http://new-mat.org http://iieta.org/journals/jnmes.(SCIE).
64. Jeganathan Muthaiyan *et.al,*. 2020. A study on vermicomposting from different proportion of leaf waste using earth worm species (eisenia foetida). Journal of Xidian University. Volume 14, Issue 7, 2020, ISSN No:1001-2400:Pp-908- 923. http://xadzkjdx.cn/ https://doi.org/10.37896/jxu14.7/100 .
65. Jeganathan Muthaiyan *et.al,*. 2020. SECOND SERFOJI PERIOD ARTS AT THANJAVUR – A CASE STUDY. Journal of Xidian University. Volume 14, Issue 9, 2020, ISSN No:1001-2400:Pp-1435- 1445. http://xadzkjdx.cn/ https://doi.org/10.37896/jxu14.7/100 .
66. Jeganathan Muthaiyan *et.al,*. 2020. THE SARASVATI MAHAL LIBRARY AND CONTRIBUTION OF RAJAH SERFOJI II. Journal of Xidian University. Volume 14, Issue 9, 2020, ISSN No:1001-2400:Pp-1446- 1453. http://xadzkjdx.cn/ https://doi.org/10.37896/jxu14.7/100 .

67. Gomathi.P, Jayakumar.S and Jeganathan.M. 2020. "A study on morphological and chemical characterization of pollen grains of gamma rays induced tomato (*solanum lycopersicum)* mutants using sem-eds and ftir analysis". Kala Sarovar. ISSN NO: 0975-4520. Volume-26, No.2 (XV) : 2020-2021.Pp:86-92.Pp:88-93.
68. Gomathi.P, Jayakumar.S and Jeganathan.M. 2019. Induced mutagnesis on some morphological characters of tomato (solanum lycopersicum l.) by using gamma rays and EMS. Kala Sarovar. ISSN NO: 0975-4520. Volume-26, No.2(XV) : 2020-2021.Pp:86-92.Pp:94-100.
69. Arokiaswamy.I, Arumugam.D, Satheesh Kumar.P and Jeganathan. 2020. Second Serfoji Period Arts at Thanjavur – A Case Study. Kala: The Journal of Indian Art History Congress, ISSN No: 0975-7945. Volume-26, No.2(XV) : 2020-2021.Pp:86-92.
70. Arokiaswamy.I, Arumugam.D, Satheesh Kumar.P and Jeganathan. 2020. The Sarasvati Mahal Library and Contribution of Rajah Serfoji II. Kala: The Journal of Indian Art History Congress, ISSN No: 0975-7945. Volume-26, No.2(XV) : October-December 2020. Pp:57-64.
71. Ganesh Babu KN, Vasanthy Muthunarayanan, Jeganathan M and Sangeetha M. 2020. Air quality monitoring in Bangalore – A case study. Kala Sarovar. ISSN NO: 0975-4520. Volume-23, No.4 (VI) : 2020-2021.Pp:57-64.
72. Ganesh Babu KN, Vasanthy Muthunarayanan, Jeganathan M and Sangeetha M. 2020. A study on review of air pollutants with the impact on human health and the conceptual design based improvement for well being of the society. Kala Sarovar. ISSN NO: 0975-4520. Volume-23, No.4 (VI) : 2020-2021.Pp:129-146.
73. Malarvannan J, C. Sivasubramanian, R. Sivasankar, M. Jeganathan and M. Balakumari. 2016. Shading of building as a preventive measure for passive cooling and energy conservation – A case study. Indo – Asian Journal of Multidisciplinary Research (IAJMR): ISSN: 2454-1370. Volume – 2; Issue - 6; Year – 2016; Page: 906 – 910. DOI: 10.21276.iajmr.2016.2.6.10.
74. Malarvannan J, C. Sivasubramanian, R. Sivasankar, M. Jeganathan and M. Balakumari. 2016. Assessment of water resource consumption in building construction in tamilnadu, India. Life Science Archives (LSA) ISSN: 2454-1354 Volume – 2; Issue - 6; Year – 2016; Page: 827 – 831 DOI: 10.21276/lsa.2016.2.6.7.
75. Sivasankar R, C. Sivasubramanian, J. Malarvannan, M. Jeganathan and M. Balakumari. 2016. A Study on water conservation aspects of green buildings. Life Science Archives (LSA),ISSN: 2454-1354. Volume – 2; Issue - 6; Year – 2016; Page: 832 – 836, DOI: 10.21276/lsa.2016.2.6.8.
76. Ashok J , S. Senthamil Kumar , P. Satheesh Kumar and M. Jeganathan. 2016. Analysis and design of heat resistant in building structures. Life Science Archives (LSA), ISSN: 2454-1354. Volume – 2; Issue - 6; Year – 2016; Page: 842 – 847. DOI: 10.21276/lsa.2016.2.6.10.