Poll Res. 39 (1) : 33-36 (2020)

ISSN 0257–8050

ALTERNATIVE OPTIMIZATION OF ASH WASTE UTILIZATION OF STEAM POWER PLANT (2 X 1,000 MW) IN TERMS OF PRODUCTION, ENVIRONMENTAL AND ECONOMIC ASPECTS

YUWONO BUDI PRATIKNYO[1,3], WAHYONO HADI[2] AND MARITHA NILAM KUSUMA[1]

[1] *Environmental Engineering, Institut Teknologi Adhi Tama Surabaya, Indonesia*
[2] *Environmental Engineering, Institut Teknologi Sepuluh November Surabaya, Indonesia*
[3] *Industrial Engineering, Universitas Surabaya, Indonesia*

(Received 23 June, 2019; accepted 13 August, 2019)

ABSTRACT

The Ministry of Energy and Mineral Resources recorded Indonesia's electricity consumption in 2018 amounting to 1,064 kilo Watt hours per capita. National electricity consumption continues to increase along with the increase in electrification in all regions and changes in people's lifestyles. The government, through the 35,000 MW electricity program, continues to try fulfilling the national electricity needs through the construction of power plants. Steam Power Plant is one of the alternatives due to the large availability of coal in Indonesia. Currently, there are 166 billion tons of coal resources with 37 billion tons reserve. Speaking of burning coal, it will not be separated from waste ash (fly ash and bottom ash). Many studies have been carried out on the utilization of this waste, including the use of this waste to make other products (brick, light brick, paving, etc.). However, until now each Steam Power Plant has not yet been fully integrated in utilizing the ash waste. The Steam Power Plant only carries out the process of stockpiling or paying to third parties who have permission to use B3 waste to be disposed of. The potential for the use of ash waste (fly ash and bottom ash) is very large in Indonesia and spread in various parts of Indonesia. This raises an optimization study and alternative uses of ash waste. The 1,000 MW capacity of Steam Power Plant was chosen because curently it is the largest capacity of Steam Power Plant in Indonesia. The study of optimization and utilization of ash waste is carried out by performing technical calculations, analyzing economic and environmental aspects. From the various alternatives that has been studied, the best alternatives was chosen. In the case of ash waste utilization at a 1,000 MW power plant, the best alternative was to utilize ash waste as Mortar with economic value: NPV Rp. 4,023,813,107398 with IRR reaches 15%. The Payback Period is 0.48 Years and Benevit Cost Ratio is 12.27%.

KEY WORDS : Optimization, Fly ash, Bottom ash, Steam power plant, Hazardous material.

INTRODUCTION

Coal is a source of fly ash waste which, based on ASTM D.388, is grouped into three. The first group is the Lignitic Coal which is the lowest category of coals. It has the ability to produce the lowest heat and the highest water content. It is also often called as "brown coal" because it is rather soft with the color of brown or black and is generally used to produce electricity. The second group is Sub-bitumminous coal which is an intermediate category between lignite and bituminous coal. This type of coal has the ability to generate heat, combustion and moisture content while the dam is used to generate electricity. It has 71% - 77% of carbon contect in dry ash and also possess the ability to generate heat between 8,300 - 13,000 British Thermal Units per pound of coal. It is the most common type of coal and usually called as the black coal. In general, this type of coal has the ability to produce high heat and low humidity which can be used to generate electricity or melt iron ore. The third group is Antrachite coal which is a type of coal that has the highest carbon content as well as the lowest water and ash content and is slow to burn. It has 77% - 87% of carbon content in dry ash and possess the ability to generate heat above 13,000 British Thermal Units per pound of coal.

Fly ash and bottom ash are the waste generated from burning coal at a steam power plant. Fly ash is the flying dust captured using an electrostatic precipitator while bottom ash is the leftover combustion that does not fly. Coal burning wastes are divided into two groups:

a. Bottom ash, which is a heavy ash

b. Fly ash, which is a fly / light ash

Chart of separation & storage of fly ash in the power plant can be explained in the following figure

Class F Fly Ash

Fly ash that contains CaO smaller than 10% which is produced from the burning of anthracite or bitumminous coal.

Levels of (SiO2 + Al2O3 + Fe2O3) > 70%.

Level of CaO <10% (ASTM 20%, CSA 8%)

Carbon content (C) ranges from 5% -10%

Class F fly ash is also called low-calcium fly ash which does not have cementitious properties and is only pozzolanic.

Class C Fly Ash

Fly ash that contains CaO above 10% which is produced from burning lignite or sub-bituminous coal (young / sub-bitumminous coal).

Levels of (SiO2 + Al2O3 + Fe2O3) > 50%.

CaO level> 10% (ASTM 20%, CSA sets the percentage to range between 8-20% for CI type and above 20% for CH)

Carbon content (C) is around 2%

Class C Fly ash is also called as a high-calcium fly ash

Due to its high CaO content, type C fly ash has cementitious properties as well as pozolan properties. Since it contains high level of CaO and has cementitious properties, it will hydrate and harden in about 45 minutes if it is exposed to water or moisture.

Class N Fly Ash

Natural pozzolan or combustion products which can be classified are diatomaceous earth, opaline cherts, shales, tuff and volcanic ash. These types are processed through combustion or not through the combustion process. Besides that, they also have good pozzolanic qualities.

RESEARCH METHOD

The optimization system for utilizing ash waste is arranged to ease the determination of the type of ash waste, the selection of alternative uses of ash waste, and the optimization of the use of ash waste. This large system is further divided into smaller sub-systems, namely:

1. Sub System I: Determination of the type of Steam Power Plant ash waste based on ash characteristics
   a) Sub system I is a system that functions to determine the type of ash waste, whether it is included in the category of fly ash or bottom ash.
   b) Input: Chemical content in ash waste. Determination of the types of fly ash or bottom ash waste is carried out by looking at the chemical content in the ash waste.
   c) Output: Type of ash waste, including fly ash or bottom ash.
2. Sub System II: Selection of alternative utilization of ash waste.
   a) Sub system II is a system that funtions to select alternative utilization of ash waste.
   b) Input: the output produced in sub-system I becomes the input to sub-system II. The selection of alternative utilization of ash waste can be seen in the following chart:
3. Sub System III: Calculation of economic and environmental values.

Calculation of economic aspects is done by calculating several parameters related to economic values, namely:

a) Net Present Value (NPV) which has the greatest value.

b) Internal Rate of Return (IRR) which has the greatest value.

c) Payback Period which has the smallest value.

d) Benefit Cost Ratio which has the greatest value

The stages of research are arranged in a flowchart so that the problems raised in this paper can be resolved and the desired objectives can be achieved. Research flowcharts are arranged as follows:

RESULTS AND DISCUSSION

Fly Ash is a waste material that is mostly produced

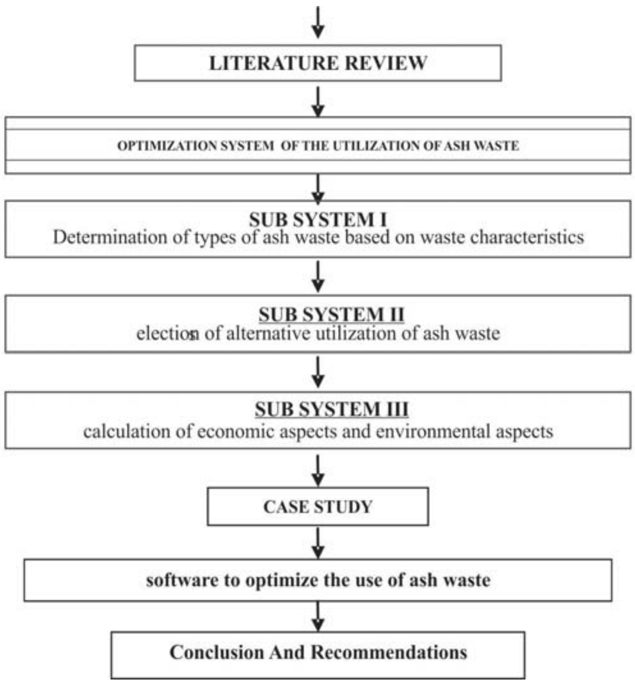


Fig. 2. Research Flowchart

in electricity production (Escheetz *et al.*, 1998). Fly ash has good potential for the use in construction industry which can increase CBR values quite highly and can be used as adsorbent media (Ahmaruzzaman, 2010; Karthik *et al.*, 2014). High CBR values mean that the stabilization potential of cement and fly ash mixtures produces concrete with higher density and strength (Amu *et al.*, 2005; Misra, 1998; Swamy, 1990). Moreover, adding phosphogypsum can provide cheap and profitable construction products (Degirmenci *et al.*, 2007). Besides, the addition of fly ash increases the pH value so that heavy metal immobilization will occur in the materials which are about to be solidified (Dermatas *et al.*, 2003; Fernández-Jiménez and Palomo. 2003; Xenidis *et al.*, 2002; Bertocchi *et al*. 2010). Fly ash mixed with benyinite has permeable ($k<1.00 \times 10^{-7}$ cm/s) which can be used as a geopolymer in a waste treatment (Mollamahmutoðlu, 2001). This geopolymer is made by mixing fly ash, kaolinite, sodium silicate solution, NaOH, and water (Swanepoel and Strydom, 2002; Ram *et al.*, 2010; Van Jaarsveld *et al.*, 1999; Van Jaarsveld *et al.*, 1999). Application of fly ash on agricultural land provides additional supply of Ca, S, B, Mo, and Se to the soil (Adriano *et al.*, 1980; Mittra *et al.*, 2005; Pandey *et al.*, 2010).

The utilization of ash waste in the Steam Power Plant is carried out in the 2 x 1,000 MW Power Plant. Production of ash per day is around 1,350 tons with

Table 1. Economic Value of Utilizing 2 x 1,000 MW of Steam Power Plant Ash Waste

No	Alternative Utilization	Economic Aspects			
		NPV ($)	IRR (%)	PP (Year)	BCR (%)
1	Filtration membranes	247.205.00	15	2,3	2,28
2	Concrete blocks	640.810.31	15	5,4	1,1
3	Light bricks	93.748.58	15	5,44	1.16
4	Paving Blocks	1.235.734.38	15	5,44	1.16
5	Ready Mix	2.400.591.68	15	5,65	2,18
6	Mortar	284.201.919.78	15	0,48	12,27
7	Raw Fly Ash	522.043.99	15	1	3,28

NPV= Net Present Value, (IRR)=Internal Rate of Return () yang memiliki nilai terbesar, (PP)=Payback Period, (BCR)=Benefit Cost Ratio.

ash quality as follows: Levels of ($SiO2 + Al2O3 + Fe2O3$) = 70%, Level of CaO = 8%, Carbon content (C) = 9%, Judging from the ash quality, it can be classified into class F fly ash. It has several alternative choices of ash waste utilization including filtration membranes, concrete blocks, light brick, paving blocks, ready mix, mortar and raw fly ash. The economic value of the utilization of 1 x 1,000 MW Steam Power Plant ash waste is carried out by calculating the feasibility study of several alternative uses of ash waste which can be economically seen in Table 1 below:

In the alternative use of ash waste, mortar products have the highest economic value. Besides, the consumption of fly ash for mortar products also experiences market prospects which are increasing from year to year. By using the results of the regression equation obtained, then in 2033 or in the next 15 years start from 2018, the market value for mortar reaches 7953.8 billion tons.

CONCLUSION

Some conclusions that can be drawn from the study of optimizing the utilization of 2 x 1,000 MW Steam Power Plant ash waste are as follows:

1. Mortar products are the most optimal alternative utilization of waste for 2 x 1,000 MW Steam Power Plant.
2. Judging from the economical side of the utilization of ash waste for Mortar products, it has NPV value = Rp 4,023,813,107,398, -, IRR = 15%, Payback Period = 0.48 Years and BCR = 12.27%.
3. Judging from the environmental side of ash waste utilization, it can reduce the effect of ash waste disposal by 492,750 tons / year.

REFERENCES

Adriano , D.C., Page, A. L., Elseewi, A. A., Chang, A. C and Straughan, I. 1980. Utilization and Disposal of Fly Ash and Other Coal Residues in Terrestrial Ecosystems: A Review. *Journal of Environmental Quality.* 9(3) : 333-344.

Ahmaruzzaman, M. 2010. A review on the utilization of fly ash. *Progress in Energy and Combustion Science.* 36 (3) : 327-363.

Amu, O.O., Fajobi, A.B. and Afekhuai, S.O. 2005. Stabilizing Potential of Cement and Fly Ash Mixture on Expansive Clay Soil. *Journal of Applied Sciences.* 5 (9) : 1669-1673.

Bertocchi, Anna F., Ghiani, Marcello, Peretti, Roberto and Zucca, Antonio, 2006. Red mud and fly ash for remediation of mine sites contaminated with As, Cd, Cu, Pb and Zn. *Journal of Hazardous Materials.* 134 (1-3) : 112-119.

Degirmenci, Nurhayat., Okucu, Arzu andTurabi, Ayse. 2007. Application of phosphogypsum in soil stabilization. *Building and Environment.* 42, Issue 9, September 2007, Pages 3393-3398

Dermatas, Dimitris and Meng, Xiaoguang. 2003. Utilization of fly ash for stabilization/solidification of heavy metal contaminated soils. *Engineering Geology.* 70 (3-4) : 377-394

Escheetz, Barry and Earle, Russell. 1998. *Current Opinion in Solid State and Materials Science.* Current Opinio in Solid Stateand Materials.

Fernández-Jiménez, A. and Palomo, A. 2003. Characterisation of fly ashes. Potential reactivity as alkaline cements. *Fuel.* 82 (18) : 2259-2265

Karthik, Kumar, Ashok, Elango, Gowtham and Thangaraj, Gokul, 2014. Soil Stabilization By Using Fly Ash. *IOSR Journal of Mechanical and Civil Engineering* (IOSR-JMCE). 10 (6) : 20-26, e-ISSN: 2278-1684,p-ISSN: 2320-334X.

Misra, Anil. 1998. Stabilization Characteristics of Clays Using Class C Fly Ash. Transportation Research Record: Journal of the Transportation Research Board. First Published January 1, 1998

Mittra, B.N., Karmakar, S., Swain, D.K and Ghosh, B.C. 2005. Fly ash-a potential source of soil amendment and a component of integrated plant nutrient supply system. *Fuel.* 84 (11) : 1447-1451.

Mollamahmutoðlu, Murat dan Yilmaz, Yüksel. 2001. Potential use of fly ash and bentonite mixture as liner or cover at waste disposal areas. *Environmental Geology.* 40 (11-12) : 1316-1324

Pandey, Vimal Chandra Pandey and Singh, Nandita. 2010. Impact of fly ash incorporation in soil systems. *Agriculture, Ecosystems & Environment.* 136 (1-2): 16-27.

Ram, Lal C and Masto, Reginald E. 2010. An appraisal of the potential use of fly ash for reclaiming coal mine spoil. *Journal of Environmental Management.* 91 (3): 603-617.

Swamy , R.N. 1990. Fly ash concrete-potential without misuse. *Materials and Structures.* 23 (6) : 397-411.

Swanepoel, J.C. and Strydom, C.A. 2002. Utilisation of fly ash in a geopolymeric material. *Applied Geochemistry.* 17 (8) : 1143-1148.

Van Jaarsveld, J.G.S., Van Deventer J.S.J and Schwartzman, A. 1999. The potential use of geopolymeric materials to immobilise toxic metals: Part II. Material and leaching characteristics. *Minerals Engineering.* 12 (1) : 75-91.

Xenidis, Anthimos, Mylona, Evangelia and Paspaliaris, Ioannis, 2002. Potential use of lignite fly ash for the control of acid generation from sulphidic wastes. *Waste Management.* 22 (6) : 631-641.

ISSN 0257 - 8050

POLLUTION RESEARCH

EM INTERNATIONAL

VOL. 30 (2) : 2011

Pollution Research

COUNTRY	SUBJECT AREA AND CATEGORY	PUBLISHER	H-INDEX
India Universities and research institutions in India	Environmental Science Pollution Water Science and Technology	EM International	23

PUBLICATION TYPE	ISSN	COVERAGE	INFORMATION
Journals	02578050	1997-2020	Homepage How to publish in this journal

SCOPE

POLLUTION RESEARCH is one of the leading enviromental journals in world and is widely subscribed in India and abroad by Institutions and Individuals in Industry, Research and Govt. Departments.

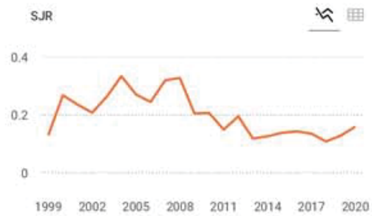
Join the conversation about this journal

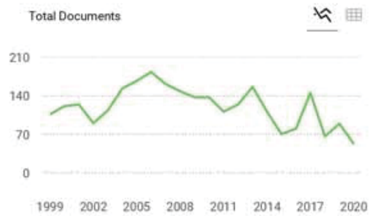
Quartiles

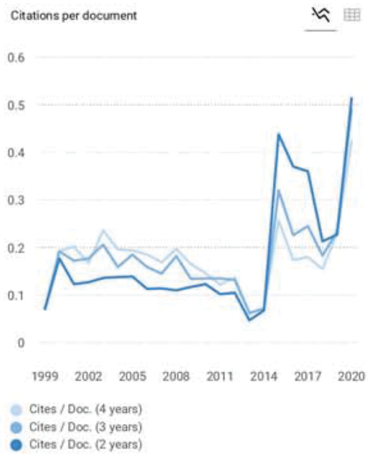
FIND SIMILAR JOURNALS

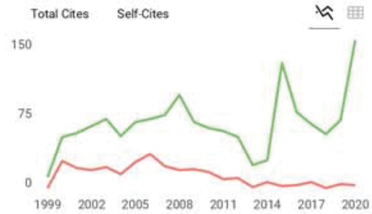
options

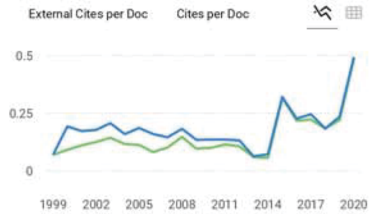
1	2	3	4	5
Nature Environment and Pollution Technology	**International Journal of Environmental Research**	**International Journal of Environmental Science and**	**Indian Journal of Environmental Protection**	**Journal of Environmental Management**
IND	CHE	IRN	IND	USA
62% similarity	61% similarity	60% similarity	58% similarity	54% similarity

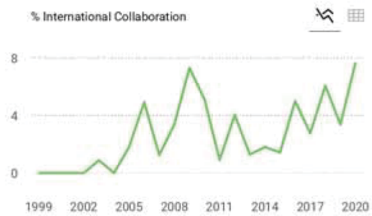


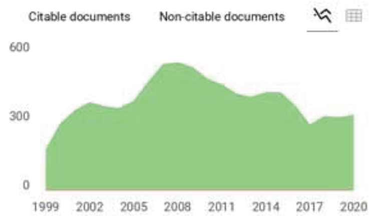


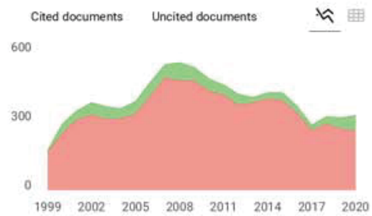












← Show this widget in your own website

Just copy the code below and paste within your html code:

<a href="https://www.scim

Metrics based on Scopus® data as of April 2021

P **Prof PK Gupta** 1 month ago

Is Pollution Research j is Scopus covered for 2021??

reply

SCImago Team

Melanie Ortiz 1 month ago

Dear Prof PK Gupta,
Thank you very much for your comment.
All the metadata have been provided by Scopus /Elsevier in their last update sent to SCImago, including the Coverage's period data. The SJR for 2020 was released on 17 May 2021. We suggest you consult the Scopus database directly to see the current index status as SJR is a static image of Scopus, which is changing every day.
Best Regards, SCImago Team

L

Lycia Gitirana 1 year ago

I would like to know why the works published in this magazine seem to have no "doi". In my country, this indication is fundamental. Is there any forecast by the journal to have this indicator in its works?

reply

SCImago Team

Melanie Ortiz 1 year ago

Dear Lycia, thank you very much for your comment. Unfortunately, we cannot help you with your request, we suggest you contact the journal's editorial staff so they could inform you more deeply. Best Regards, SCImago Team

P

PIJU DAS 1 year ago

DEAR SIR/MADAM
I AM NOT ABLE TO FIND THE ARTICLE IN SCOPUS WEB PUBLISHED IN POLLUTION RESEARCH JOURNAL WHICH IS SCOPUS INDEXED.

reply

R

Ranata 1 year ago

I experienced something similar to you, my article in the journal Pollution Research Issue: Vol 38, Issue 3, 2019, until now I can not trace / not detected in Scopus, very sad to see this condition

SCImago Team

Melanie Ortiz 1 year ago

Dear Piju,
thank you very much for your comment, unfortunately we cannot help you with your request. We suggest you contact Scopus support: https://service.elsevier.com/app/answers/detail/a_id/14883/kw/scimago/supporthub/scopus/
Best Regards, SCImago Team

T

Thivyanathan Nirmala 1 year ago

is it approved by University Grants Commission. If this journal is approved by UGC, then i can publish papers in it. ans.pl.

reply

SCImago Team

Melanie Ortiz 1 year ago

Dear Thivyanathan,
Thank you for contacting us. SJR is a portal with scientometric indicators of journals indexed in Elsevier/Scopus. Unfortunately, we cannot help you with your request referring to the index status. We suggest you to consult Scopus database (see the current status of the journal) or other databases (like WoS, UGC, etc.) for further information. You can also check that information in the journal's website or contact directly with the editorial staff.
Best Regards, SCImago Team

M

meysam.noori 3 years ago

Re: Cancer Risk Assessment from Benzene exposure for Gas Station's employees

As a Volatile Organic Compound (VOC), benzene is a carcinogen affecting the circulatory, respiratory, reproductive, and nervous systems. The main purpose of this research was to determine the risks of occupational exposure to benzene for the employees at Resālat Gas Station in the City of Tehran and people living in its vicinity. Thereby calculating the quantitative rates of cancer and non-cancer risks of benzene in the work place. In this empirical and analytical study, 8 air samples from Resālat Gas Station were randomly selected at 3 different times during: morning, noon, and at night. The air samples were collected by using a sampling pump (SKC Co., England) at a flow rate of 0.3 l/min based on the National Institute for Occupational Safety and Health (NIOSH) standards. The samples were analyzed using a Gas Chromatography-Flame Ionization Detector (GC-FID). Cancer risk for the employees exposed to benzene was quantitatively calculated to be 6.271×10-6 .the non-cancer risk was 0.00225 which is significantly below 1. The results were indicative of a relatively high cancer risk for the individual's exposure to benzene at Resālat Gas Station.

reply

eddiwan kamaruddin 3 years ago

This journal is very interesting to me, because this journal mission matches my background. For that I plan to contribute to this journal.
Please provide information, is this journal still active in 2018? Thank you

reply

K **Karthick j** 2 years ago

Please check for the scopus status at scopus website and proceed for the publication. Because in scopus site, the scopus period seems to be end up by 2018. After publishing if its not scopus indexed, then your research paper will not be recognized

SCImago Team

Elena Corera 3 years ago

Dear Eddiwan,

articles published in 2018 are not over yet (we are in September). 2018 indicators will not be available until June 2019. We cannot see what will happen in the future with this journal. SCImago receives the data from Scopus / Elsevier annually and does not have the authority to include, exclude or modify the data provided by Scopus.

Best Regards,
SCImago Team

A **Abhiashek Sharma** 3 years ago

Good morning sir,
I am interested in research in water pollution , so please join me sir.
Thank you sir.

reply

SCImago Team

Elena Corera 3 years ago

Dear Abhiashek Sharma,

thank you very much for your comment. If you need bibliographic information or full text, we suggest you do a Scopus research or contact your librarian.

Best Regards,
SCImago Team

Leave a comment

Name

Email
(will not be published)

I'm not a robot

reCAPTCHA
Privacy - Terms

Submit

The users of Scimago Journal & Country Rank have the possibility to dialogue through comments linked to a specific journal. The purpose is to have a forum in which general doubts about the processes of publication in the journal, experiences and other issues derived from the publication of papers are resolved. For topics on particular articles, maintain the dialogue through the usual channels with your editor.

Pollution Research Editorial Advisory Board

21. Dr. Prof. A.R. Ghosh, Professor, Department of Environmental Science, Burdwan University, Burdwan, India	apurbaghosh2010@gmail.com
22. Dr. Prof. Deenbandhu Sahoo, Professor, Department of Botany, University of Delhi, India	dbsahoo@hotmail.com
23. Dr. Prof. D.P. Singh,Professor, Dept. of Environmental Sciences, Dr. B.B.A. University, Lucknow, India	dpsingh_lko@yahoo.com
24. Dr. Prof. Toan Vu, Duc, Professor,Thuyli University, Hanoi, Vietnam	toanvd@wru.vn
25. Dr. Suresha, Huta,Senior Environmental Consultant, Environmental Company, Saudi Arabia	vaishnavisureshg@yahoo.com
26. Dr. Duangrat Inthorn,Professor, Department of Environmental Health, Mahidol University, Bangkok, Thailand	phdit@mahidol.ac.th
27. Dr Prof. V. Arutchelvan,Professor, Dept. of Civil Engineering, Annamalai University, Annamalainagar, India	arul.au@gmail.com
28. Dr. Prof. T.N. Singh, Professor(Presently Vice-Chancellor, Kashi Vidyapeeth Univ., Varanasi)Department of Geology, I.I.T, Mumbai, India	vc@mgkvp@ac.in
29. Dr. Vijaya Ilango,Associate Professor Department of Chemistry, Birla Institute of Technology and Science, UAE	vilango@dubai.bits-pilani.ac.in
30. Dr. Prof. R.M. Naraynan,, Professor and head Dept. of Civil Engineering, Dr. M.G.R. Deemed to be Univ., Chennai, India	narayanan.rm@drmgrdu.ac.in
31. Dr. Kudrat-E-Khuda (Babu), Assoc. Prof. & Head, Dept. of Law, Daffodil Intern. Univ., Bangladesh	kekbabu@gmail.com
32. Dr. V.N. Janakirajan, Assoc. Prof., Department of Biochemistry, Govt. Medical College, Erode, India	vnjngeetha@gmail.com

Pollution Research Journal Papers

Issue: Vol 39, Issue 1, 2020

APPLICATION OF EDIBLE COATING KAPPA CARRAGEENAN IN THE QUALITY OF EDIBLE SPOON PRODUCTS
INTAN CHOIRULY AGUSTIN, ANNUR AHADI ABDILLAH, LAKSMI SULMARTIWI, EKA SAPUTRA AND ADRIANA MONICA SAHIDU

Get Abstract Get Paper

THE GROWTH BEHAVIOR OF FRESHWATER AND MARINE MICROALGAE EXPOSED TO CD AND CU
DIANA ARFIATI, DWICANDRA PRATIWI, NIKEN PRATIWI AND QURROTA AY'UNIN

Get Abstract Get Paper

LAKE WATER TREATMENT OF PADENGAN PLOSO VILLAGE, LAMONGAN DISTRICT WITH FILTRATION AND ADSORPTION PROCESS
IRVANDY ANDRIANSYAH, MOHAMMAD RAZIF AND MARITHA NILAM KUSUMA

Get Abstract Get Paper

UTILIZATION OF THE REMAINING PRODUCTION OF THE WOOD PROCESSING INDUSTRY IN KEDIRI REGENCY, INDONESIA
SAIFUDIN, MOHAMMAD RAZIF AND MARITHA NILAM KUSUMA

Get Abstract Get Paper

EVALUATION OF GROUND WATER QUALITY IN BORIGAON AREA, MAHARASHTRA
P.K. GOGARI, S.N. SAVE AND V.S. CHAUDHARI

Get Abstract Get Paper

TREATMENT AND RECYCLING OF WASTE WATER FROM DAIRY INDUSTRY USING SPIRULINA PLATENSIS
PATIL NILAM SARJERAO AND KURHEKAR JAYA VIKAS

Get Abstract Get Paper

PREVALENCE OF WATER BORNE DISEASES AMONG MARBLE MINE WORKERS IN CERTAIN AREAS OF UDAIPUR DISTRICT
J. SONIKA, R. NIDHI, P. ANIL AND A. PANKAJ

Get Abstract Get Paper

HYDROCHEMICAL ANALYSIS OF GROUND WATER QUALITY, IN BORIGAON AREA, MAHARASHTRA
P.K. GOGARI, S.N. SAVE AND V.S. CHAUDHARI

Get Abstract Get Paper

SUITABILITY ASSESSMENT OF GROUND WATER QUALITY IN RURAL AREAS OF HARIDWAR DISTRICT, UTTARAKHAND
MATTA, GAGAN, GAUTAM, RAHUL K., KUMAR, AVINASH AND KUMAR PAWAN

Get Abstract Get Paper