ICGTD 2020

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BOOK OF ABSTRACT

INTERNATIONAL CONFERENCE ON GREEN TECHNOLOGY AND DESIGN 2020

A Smart Deliberation in Green Technology and Design Towards New Normal Mitigation

Bandung 2 - 3 December 2020

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HUAWEI

The Climate Reality Project
INDONESIA

BOOK OF ABSTRACT

INTERNATIONAL CONFERENCE ON GREEN TECHNOLOGY AND DESIGN 2020

Bandung, 2 – 3 December 2020

Institut Teknologi Nasional Bandung
West Java - Indonesia

penerbit itenas

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Address:
Jl. P.K.H. Mustapha No. 23, Bandung 40124 Telp: +62 22 7272215, Fax: +62 22 7202892
Email: penerbit@itenas.ac.ID

CONFERENCE PROGRAM

Time	PROGRAM	
Day 1 (2nd December 2020, Wednesday) ***Link:*** **https://bit.ly/ICGTD2020** **Meeting ID: 942 8505 6144** **Passcode: ICGTD2020**		
08:30 – 08:40	**Opening Ceremony (zoom plenary session)** Welcome remark by master of ceremony	
08:40 – 08:50	**Opening remark (zoom plenary session)** Rector of Insitut Teknologi Nasional Bandung (Itenas) Prof. Meilinda Nurbanasari, Ph.D.	
08:50 – 09:30	**Panel 1 (zoom plenary session)** **Keynote speaker 1: Dr Abdul Salam** (AIT, Thailand) Moderator: Dr. Eng. DIDin Agustian Permadi	
09:30 – 10:10	**Panel 2 (zoom plenary session)** **Keynote speaker 2: Amanda Katili Niode, Ph.D** (Climate Reality Project Indonesia) Moderator: Dr. Eng. Chandra Nugraha	
10:10 – 10:20	**Break Session**	
	PARALLEL SESSION	
Zoom Link	***Link Room 1:*** **https://bit.ly/ICGTDParallel1** **Meeting ID: 958 4648 1102** **Passcode: ICGTD2020**	***Link Room 2:*** **https://bit.ly/ICGTDParallel2** **Meeting ID: 976 1232 2146** **Passcode: ICGTD2020**
10:20 – 10:50	**Parallel session 1 (**zoom room PES-1**)** **Moderator:** Vibianti Dwi Pratiwi, M.T. Power and Energy Storage 1 (PES-	**Parallel sesson 2 (**zoom room GHB-1**)** **Moderator:** *Wahyu* Buana Putra, S.T., MSc. Green hollistic building 1 (GHB-1)
10:50 – 12:00	**Parallel session 3 (**zoom room GSA-1**)** **Moderator:** Febrian Hadiatna, M.T. Green and smart automation 1 (GSA-1)	**Paralllel sesson 4 (**zoom room ST-1**)** **Moderator:** Kurnia Ramadhan Putra, M.T. Smart Transportation 1 (ST-1)
12:00 – 13:00	**BREAK**	
13:00 – 14:30	**Parallel session 3 (**zoom room GSA-1**)** **(Continue)** **Moderator:** Lita LIdyawati, M.T. Green and smart automation 1 (GSA-1)	**Paralllel sesson 4 (**zoom room ST-1**)** **(Continue)** **Moderator:** Fery HIdayat, M.T. Smart Transportation 1 (ST-1)
14:30 – 16:00	**Parallel session 5 (**zoom room IEP-1**)** **Moderator:** Alif Ulfa Afifah, S.T., M.T Infrastructure and Environmental Planning 1 (IEP-1)	**Paralllel sesson 6 (**zoom room IICT-1**)** **Moderator:** Irma Amelia Dewi, M.T. Intelligent Information and Communication Technology 1 (IICT-1)
16:00 – 17:00	**Parallel session 7 (**zoom room GID-1**)** **Moderator:** Maharani Dian P, Ph.D Green Innovation Design 1 (GID-1)	

Day 2 (3rd December 2020, Thursday)

Link:
https://bit.ly/ICGTD2020
Meeting ID: 942 8505 6144
Passcode: ICGTD2020

08:25 – 08:30	**Registration and Opening Day 2**	
08:30 – 09:10	**Panel 1** **Keynote speaker 3: Maharani Dian P, Ph.D** (ITENAS, Indonesia) Moderator: Maugina Havier, M.Ds.	
09:10 – 9:50	**Panel 2** **Keynote speaker 4: Herman Zhu** (Huawei, Indonesia) Moderator: Lisa Kristiana, Ph.D.	
9:50 – 10:15	**Break Session (VIDeo Itenas dan Huawei)**	
	Parallel session	
	Link Room 1: **https://bit.ly/ICGTD2020Parallel1Day2** **Meeting ID: 914 2131 3313** **Passcode: ICGTD2020**	***Link Room 2:*** **https://bit.ly/Parallel2ICGTD2020day2** **Meeting ID: 927 2582 5390** **Passcode: ICGTD2020**
10:15 – 12:00	**Parallel session 1 (**zoom room IEP-2 A**)** **Moderator:** Nico Halomoan, M.T. Infrastructure and Environmental Planning 2A (IEP-2)	**Parallel session 2 (**zoom room IEP-2 B**)** **Moderator:** Dr. Eng. DIDin Agustian Permadi Infrastructure and Environmental Planning 2B (IEP-2)
12:00 – 13:00	**BREAK**	
13:00 – 14:00	**Paralllel sesson 3 (**zoom room IICT-2 **Moderator:** Lisa Kristiana, Ph.D. Intelligent Information and Communication Technology 1 (IICT-2)	**Parallel session 4 (**zoom room GID-1**)** **Moderator:** Maugina Havier, M.Ds. Green Innovation Design 1 (GID-1)
14.00 – 15.00	**Plenary session & Closing** ***Link:*** **https://bit.ly/ICGTD2020** **Meeting ID: 942 8505 6144** **Passcode: ICGTD2020** **Award announcement** **1. Best Paper** **2. Best Presenter** **3. Best Participant** **4. Best Selfie Unique** **5. Lucky Draw**	

PRESENTATION SCHEDULE

Session name	Presenter / paper title	Time	Insititution
DAY 1			
LINK PES-1: https://bit.ly/ICGTDParallel1 ; Meeting ID: 958 4648 1102; Passcode: ICGTD2020			
Power and Energy Storage 1 (PES-1)	ID51 - Waluyo Et Al. - Iot-Based Control System Implementation For Air Conditioning Electrical Energy Saving	10.20	Institut Teknologi Nasional Bandung
	ID60 - Dini Fauziah - HybrID Lighting System For Room Without Light Ventilation As Energy Saving Using Solatube	10.35	Institut Teknologi Nasional Bandung
Link Ghb-1: https://bit.Ly/ICGTDParallel2 ; Meeting ID: 976 1232 2146; Passcode: ICGTD2020			
Green Holistic building 1 (GHB-1)	ID65 – Erwin Yuniar Rahadian Et Al. – Digital Documentation Of Heritage Buildings Using The Principles Of Heritage Building Information Modeling : Case Study: Cirebon City Hall	10.20	Institut Teknologi Nasional Bandung & Sekolah Tinggi Teknologi Cirebon
	ID58 – Putra – IDentification And Analysis Of Community Household Structure Components In Jalur Sesar Lembang	10.35	Institut Teknologi Nasional Bandung
Link Gsa-1: https://bit.ly/ICGTDParallel1 ; Meeting ID: 958 4648 1102; Passcode: ICGTD2020			
Green and Smart Automation 1 (GSA-1)	ID5 – Daulay Et Al. – Implementation Of Wireless Sensor Network In Taekwondo Sport Branch Kyorugi Kategory	10.50	Institut Teknologi Nasional Bandung
	ID35 – Saraswati – Particulate Emissions Characteristics Of Mixed Coal-Biomass Derived Fuel Burned In An Industrial Boiler	11.05	Institut Teknologi Nasional Bandung & Indonesian Institute of Sciences (LIPI)
	ID32 – Nurhayati – Gas Emissions From Mixed Coal-Biomass Derived Fuel Burned In An Industrial Boilers	11.20	Institut Teknologi Nasional Bandung & Indonesian Institute of Sciences (LIPI)
	Break		
	ID18 – Manurung – Modeling Of A Small Educational Thermal Device	13.00	Universitas Pertamina & Institut Teknologi Nasional Bandung
	ID7 – Husada – Fuzzy Logic Implementation In Water Quality Monitoring And Controlling System For Fishwater Cultivation	13.15	Institut Teknologi Nasional Bandung
	ID66 – Suciaty Et Al. – Hydrodynamics Modelling For Dock Layout Planning In Fish Landing Port (Ppi) Api-Api, East Kalimantan	13.30	Institut Teknologi Nasional Bandung & Institut Teknologi Bandung
Link St-1: https://bit.Ly/ICGTDParallel2 ; Meeting ID: 976 1232 2146; Passcode: ICGTD2020			
Smart Transportation 1 (ST-1)	ID59 – Maulana – Dependency Freight Transportation On Roadway	10.50	Institut Teknologi Nasional Bandung
	ID42 – Kristyadi Et Al. – Development Of LiquID Cooled Axial Bldc Motor	11.05	Institut Teknologi Nasional Bandung

Session name	Presenter / paper title	Time	Insititution
	ID41 – Kristyadi – Analysis Of Electric Car Front Chassis In Crash Test Using Fea Software	11.20	Institut Teknologi Nasional Bandung
	ID36 – Muhamad Et Al. – Collecting IndivIDuals' Intention Of Travel-Activity Changes During New Normal Period In Indonesia	11.35	Institut Teknologi Nasional Bandung
	ID28 – Kharis Rahman – Behavior Study Of Motorcyclist On RIDing Safety Based On Gender In City Of Bandung	11.50	Institut Teknologi Nasional Bandung
	Break		
	ID26 – Saputra – Motorized Or Non-Motorized: Potential Of Bicycles Use For Daily Transportation: Motorized Or Non-Motorized: Potential Of Bicycles Use For Daily Transportation	13.00	Institut Teknologi Nasional Bandung
	ID9 – Muhammad Fajar Rahman – Analysis Due To The Traffic Noise Level Of Motor Vehicles And Trains And Mitigation Recommendations For The Coming Time (Case Study: Sd Negeri 001 Merdeka, Bandung City)	13.15	Institut Teknologi Nasional Bandung
	ID3 – Lisa Kristiana – The Implementation Of Visible Light Communication On Two-Wheeled Vehicle	13.30	Institut Teknologi Nasional Bandung
	ID77 – Suteja – Analysis Of The Characteristics Of Young RIDe-Sourcing Users Based On Previous Modes: Case Of Bandung City	13.45	Institut Teknologi Nasional Bandung
	ID76 – Pribadi Et Al. – RigID, Semi RigID, And Flexible Diaphragms For Horizontally Asymmetric Building	14.00	Institut Teknologi Nasional Bandung
Link Iep-1: https://bit.ly/ICGTDParallel1; Meeting ID: 958 4648 1102; Passcode: ICGTD2020			
Infrastructure and Environmental Planning 1 (IEP-1)	ID1 – Zulri – A Strategy For Improving 3r-Based SolID Waste Services In Jatihandap Village Through The Application Of The Contingent Valuation Method "Cvm"	14.30	Institut Teknologi Nasional Bandung
	ID67 – Hernawati Et Al. – The Impact Of Built-Up Area On Land Surface Temperature Derived From Cloud-Computing Landsat 8 Imagery	14.45	Institut Teknologi Nasional Bandung
	ID62 – Darmawan – Investigation Of Classification Algorithm For IDentification Of Oil Palm Plantation Using Multiscatter And Multiresolution Sar Data	15.00	Institut Teknologi Nasional Bandung
	ID63 – Halomoan - The Potential For Implementing Zero Waste Practices Based On The Composition Of Domestic Waste In The Hospital (Case Study: Bandung Adventist Hospital).	15.15	Institut Teknologi Nasional Bandung
	ID56 – Nugraha – Characterization Study Of Coal-Combustion Ash For AcID Mine Drainage Prevention	15.30	Institut Teknologi Nasional Bandung
	ID55 -Kameswara Et Al. – Relationship Between Changes In Agricultural Land Use Land Cover Change And Sustainable Agricultural Land Control Policy In Magelang Area	15.45	Institut Teknologi Nasional Bandung
Link Iict-1: https://bit.Ly/ICGTDParallel2 ; Meeting ID: 976 1232 2146; Passcode: ICGTD2020			
Intelligent Information and Communication Technology 1 (IICT-1)	ID16 – Lita Lidyawati – Bi-Directional Data Communication Using Visible Light Technology For Underwater Environment	14.30	Institut Teknologi Nasional Bandung
	ID49 – Irma Amelia Dewi Et Al. – Feature Extraction Of Ground Marshall Hand Gestures Using HIDden Markov Model On Aircraft Parking Process	14.45	Institut Teknologi Nasional Bandung

Session name	Presenter / paper title	Time	Insititution
	ID19 – Umaroh – An Evaluating Academic Information System Success: An Empirical Study	15.00	Institut Teknologi Nasional Bandung
	ID17 – Jodi Raina Et Al. – Segmentation-Based Fractal Texture Analysis (Sfta) To Detect Mass In Mammogram Images	15.15	Institut Teknologi Nasional Bandung
	ID57 – Yusup Miftahuddin Et Al. – Implementation Of Mfcc And Lvq Methods For Learning English Pronounciation	15.30	Institut Teknologi Nasional Bandung
	ID70 – Rosmala – Transfer Learning With Vgg16 And Inceptionv3 Model For Classification Of Potato Leaf Disease	15.45	Institut Teknologi Nasional Bandung
Link GID-1: https://bit.ly/ICGTDParallel1 ; Meeting ID: 958 4648 1102; Passcode: ICGTD2020			
Green Innovation Design 1 (GID-1)	ID46 – Fitriany Et Al. – Ethnic-Modern Furniture Design Innovations With Use Of Ntt Ikat Woven Fabrics	16.00	Institut Teknologi Nasional Bandung
	ID44 – Rahim Et Al. – Overview Of Signage At The Itenas Bandung	16.15	Institut Teknologi Nasional Bandung
	ID23 – Agustina Kusuma Dewi Et Al. – Motion Feature In Advertising And Audience' Perception Based On Aio Concept In Digitizing' Era	16.30	Institut Teknologi Nasional Bandung
	ID13 – Rahim - Design of Visual Graphic System for the Itenas Campus Direction Signs	16.45	Institut Teknologi Nasional Bandung
Day 2			
Link Iep-2-A : Https://Bit.Ly/ICGTD2020Parallel1Day2 ; Meeting ID: 914 2131 3313 ; Passcode: ICGTD2020			
Infrastructure and Environmental Planning 2A (IEP-2 A)	ID20 – Nguyen Et Al. – Current And Future Emission Of Air Pollutants And Greenhouse Gases From Thermal Power Plants In Vietnam	10.15	**Asian Institute of Technology**
	ID15 – Ocktafiani Et Al. – A Cassava Peels Waste Becomes Activated Carbon – A Literature Review	10.30	Politeknik Negeri Bandung
	ID14 – Nur Arafah Et Al. – Non Edible Moringa Oleifera Seeds For Environmentally Friendly Biodiesel – A Review	10.45	Politeknik Negeri Bandung
	ID6 – Soni Pratama Et Al. – Methane Emission Estimation And Dispersion Modeling For A Landfill In West Java, Indonesia	11.00	Institut Teknologi Nasional Bandung
	ID4 – Dwi Pratiwi – The Influence Of Amount And Types Of Adhesive On Biobriquettes From Coffee Pulp By Torrefaction	11.00	Institut Teknologi Nasional Bandung
	ID2 – Elvira Rizqita Utami – Drainage City Management Strategies Planning Of Cimahi City Based On 2018 City Sanitation Strategy GuIDeline	11.15	Institut Teknologi Nasional Bandung
	ID64 – Darmawan – IDentification Of Mangrove Forest Area Using Support Vector Machine Algorithm	11.30	Institut Teknologi Nasional Bandung & Universitas Lampung
	ID74 – Aszahra Karimah Astari Putri Et Al. - C.I. Reactive Navy Blue Dye Waste Treatment Using Pvdf/Nanomaterial Membranes: Dye Waste Treatment	11.45	Institut Teknologi Nasional Bandung
	ID75 – Annisaa Hanifah Et Al. – Ozon/Uv Technology Ozon/Uv Technology For Textile Industry Wastewater Treatment: Wastewater Treatment	12.00	Institut Teknologi Nasional Bandung

Session name	Presenter / paper title	Time	Insititution
Link Iep-2-B: Https://Bit.Ly/Parallel2ICGTD2020day2 ; Meeting ID: 927 2582 5390 ; Passcode: ICGTD2020			
Infrastructure and Environmental Planning 2B (IEP-2 B)	ID38 – Dirgawati – An IDentification Of Fluorescence Dissolved Organic Matter In Tropical Raw Water Sources By Parafac Analysis	10.15	Institut Teknologi Nasional Bandung & Institut Teknologi Bandung
	ID43 – Santos – Performance Of Electro-Chemical (Ec) Disinfection In The Treatment Of Septic Tank Effluent Under Plug Flow Condition	10.30	**Unit of Planning, Monitoring and Monitoring and Evaluation Unit (UPMA), Office of Prime Minister, Timor Leste, & Asian Institute of Technology (AIT), Thailand**
	ID80 – Maulana – Satisfaction And Importance Level Of The Ministry Of Environment And Forestry Officer	10.45	Institut Teknologi Nasional Bandung
	ID79 – Yustiana Et Al. – Three R's Aplication Of Domestic Water Consumption In West Antapani District: Three R's Aplication Of Domestic Water Consumption In West Antapani District	11.00	Institut Teknologi Nasional Bandung
	ID54 – Aschuri Et Al. – The Effect Of Compaction Temperatures Of Asphalt Concrete Mixture On Axle Load Repetition	11.00	Institut Teknologi Nasional Bandung
	ID53 – Salafudin – The Indonesia Lithium Resources : Indonesia Lithium Resources	11.15	Institut Teknologi Nasional Bandung
	ID50 – Suryadini Et Al. – Penilaian Kualitas Pergerakan Dan Konektivitas Kecamatan Antapani Berdasarkan Greenship Rating Tools	11.30	Institut Teknologi Nasional Bandung
	ID48 – Parapat - Plant Design For A Production Process Of Nanoasphalt Emulsion From Asbuton Rock	11.45	**Institut Teknologi Nasional Bandung & Technische Universitat Berlin (TUB) Berlin, Germany**
	ID81 – Pratiwi – Mapping Of Land Drought Potential In Cirebon Regency-West Java Based On Geographic Information System And Remote Sensing	12.00	Institut Teknologi Nasional Bandung
Link Iict-2 : Https://Bit.Ly/ICGTD2020Parallel1Day2 ; Meeting ID: 914 2131 3313 ; Passcode: ICGTD2020			
Intelligent Information and Communication Technology 2 (IICT-2)	ID68 – Hermana – Database Shoe Design With 3d Anthropometric Parameters	13.00	Institut Teknologi Nasional Bandung
	ID22 – Premitasari – Multi Criteria Decision Making To Forecast Number Of User On Ip Network	13.15	Institut Teknologi Nasional Bandung
	ID47 – Hermana – An Implementation Of Vgg 16 For Modeling Color Descriptor In Fruit Maturity Classification	13.30	Institut Teknologi Nasional Bandung
Link GID-2: Https://Bit.Ly/Parallel2ICGTD2020day2 ; Meeting ID: 927 2582 5390 ; Passcode: ICGTD2020			
Green Innovation Design 2 (GID-2)	ID12 – Permanasari – Smart Materials In Design And Technology: Study Case: Banana Bark	12.45	Institut Teknologi Nasional Bandung
	ID11 – Anggraeni – Injection Molding Hand-Press Design And Analysis Using SolIDwork	13.00	Institut Teknologi Nasional Bandung

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	ID10 – Sumirat – Effect Of Tempering At 500 ºc Temperature With 1 Hour Holding Time On White Cast Iron Material Properties Applied To Grinding Ball On Ball Mills For Cement Production	13.15	Universitas Pendidikan Indonesia & Institut Teknologi Nasional Bandung
	ID71 – Sulistyo Setiawan - The The Learning Medium Design Of Language Intelligence For Elementary Students Based On Used Oil Bottle Upcycling: The Learning Medium Design Of Language Intelligence For Elementary Students Based On Used Oil Bottle Upcycling	13.30	Institut Teknologi Nasional Bandung
	ID85 – Waskito - A Utilization Of Digital Modeling Techniques To Improve Shape Quality And Ergonomics On Shoe Last	13.45	Institut Teknologi Nasional Bandung

OPENING REMARK

Assalamualaikum wr wb

Ladies and gentlements, colleagues, and students,

It is our privilege to welcome you all to our 2nd International Conference on Green Technology and Design (ICGTD2020) hosted by Institut Teknologi Nasional Bandung (ITENAS), Bandung, Indonesia. We would like to thank our 4 keynote speakers and more than 65 presenters who made their efforts to contribute to this conference. Last year, we hosted the first edition of ICGTD 2019 in a business as usual way, but this year we encounter an un-usual, unique and difficult moment due to a world-wide COVID-19 pandemic. This situation brings us here to meet each other virtually. This year conference topic of "A Smart Deliberation of Green Technology and Design Towards New Normal Mitigation" is delivered with a big hope to rebuild strength to face post-pandemic period by enhancing collaborative research and outreach.

We appreciate the hard work of the organizing committee to bring in of more than 70 articles to be presented in this conference, submitted by our international and domestic participants. All articles were then divided into 7 parallel session themes: power and energy storage, green holistic building, green and smart automation, smart transportation, infrastructure and environmental planning, intelligent information and communication technology, and green innovation design. Several of them were selected to be published in our national accredited journals: Elkomika and Rekayasa Hijau, and the rests will be published in the international conference proceeding of ICGTD 2020.

Ladies and gentlements,

We realize current difficult situation and at the same time we prepare our readiness to welcome awakening era for better future through increasing research quantity and quality as well as catalizing more collaborative efforts.

I sincerely hope you will enjoy all of the conference sessions, and hope that we can continue learning each other. Someday, we hope to host you all directly in our beautiful campus and city.

Thank you all for your presence and participation. And you are the very important part of the Conference success.

Wassalamualaikum wr wb,

Rector of Itenas
Prof. Meilinda Nurbanasari, PhD

FOREWARD

On behalf of the organizing committee, it is our great pleasure to welcome you all to the 2nd International Conference in Green Technology and Design (ICGTD) 2020 which is held here, in the Institut Teknologi Nasional (Itenas) Bandung, Indonesia. ICGTD is an annual conference organized by the Lembaga Penelitian dan Pengabdian kepada Masyarakat (LPPM) Institut Teknologi Nasional Bandung. Currently, this is the second time we hold ICGDT .

The 2nd ICGTD 2020 aims to provide a platform for all researchers, academics and industries to exchange and collaborate multidisciplinary ideas and knowledge and push them further into actions. The outreach of this collaboration is the smart deliberation in Green Technologies and Design towards the New Normal Mitigation during the pandemic era.

Acknowledging all these excellent works of all committee members, we would like to express our gratitude to the all authors, the international reviewers, the keynote speakers from the Asian Institute of Technology (AIT) Thailand, the Indonesia Climate Reality Project, Huawei, and Itenas that are willing to share the valuable knowledge and experiences in this conference.

We strongly hope that this event brings the inspiring atmosphere for finding new ideas and contacts for future co-operations.

Chair,

Lisa Kristiana S.T., M.T., Ph.D

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Development of Liquid Cooled BLDC Motor

Tarsisius Kristyadi, Marsono, Syahril Sayuti
Institut Teknologi Nasional Bandung
Jl. PHH. Mustofa no 23 Bandung Indonesia
Corresponding Author Email:kristyadi@itenas.ac.id

***Abstract*— Brushless Direct Current (BLDC) Motor is an electromagnetic device that converts electrical energy into mechanical energy. BLDC motor is a type of motor used in electric cars and does not need brush for magnetic field replacement (commutation), but is carried out electronically commutated. In BLDC motor, temperature in the motor play important role on motor performance such as maximum power and efficiency. In this research the development of liquid cooling of BLDC motor is described. Development starts from the design, computation using software and the realization of the motor design results. The construction of a brushless DC motor is very similar to that of an ac motor, known as permanent magnet synchronous motor. The stator consisting of a core and copper windings forming a core and armature unit. There are 2 identical stators to form the BLDC.**

Keywords—Radial, BLDC, rotor, stator, windings

1. INTRODUCTION

Brushless Direct Current (BLDC) Motor is an electromagnetic device that converts electrical energy into mechanical energy. BLDC motor is a type of motor used in electric cars and does not need brush for magnetic field replacement (commutation), but is carried out electronically commutated. BLDC motors have many advantages over DC motors and ordinary induction motors and ideal choice for system applications requiring high reliability and high efficiency. In general BLDC motors are considered high performance motors capable of delivering large amounts of torque over a wide speed range.

Cooling of the main components is an important aspect in maintaining the work resistance of these components. Each component that operates will produce heat losses, including the Brushless Direct Current (BLDC) Motor. If the heat is not discharged, it will affect the performance of the BLDC Motor, even if this is allowed to continue, the temperature will increase and an overheat occurs. Overheating of an electric motor causes detrimental effects such as degradation of coil insulation, demagnetization, increased heat loss, decreased motor efficiency and reduced motor life time [1]..

The heat generated due to the current through the windings causes an increase of temperature in various parts of the electric machine [2]. The increase in temperature reduces the insulation resistance of the windings, generates thermal stress, reduces efficiency [3] and further causes machine failure [4]. Hence to develop high power and efficiency of BLDC motor, the cooling of the motor have to be considered.

This paper describes the design and realization of liquid cooled of BLDC motor. The process of the design is analytical and model method.

2. MOTOR CONSTRUCTION DESIGN

The construction of a brushless DC motor is very similar to that of an ac motor, known as permanent magnet synchronous motor. The stator winding is similar to that of a polyphase ac motor, and the rotor is composed of one or more permanent magnets. A brushless DC motor is a distinct fr ac synchronous motor in which the former combines several ways to detect the position of the rotor (or magnetic poles) to generate a signal to control electronic switches.

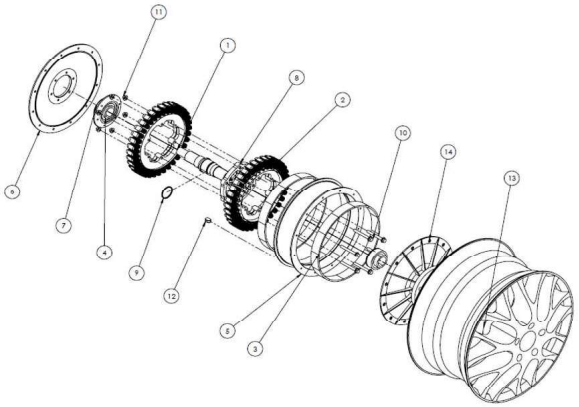

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Fig. 1. BLDC motor construction.

Figure 1 show the motor construction that consist of shaft (1), stator winding (2), rotor magnet (3), bearing (4), middle casing (5), left casing (6), bearing house (7), hub (8), clip ring (9), bolt (10), nut (11), keyway (12), wheel rim (13) and right casing (14).

The stator consisting of a core and copper windings forming a core and armature unit. There are 2 identical stators to form the BLDC that is analyzed.

3. DESIGN PROCEDURE

3.1 Motor Design Calculation

In the design process, the independent or "input" variables are dimensions, winding and properties of the magnetic material whereas the dependent variable (output variable) is the performance such as torque, current, efficiency, temperature rise, etc. In fact, there are many independent variables involved in process design and most of them are assigned their values by repetition. That is, the design procedure must be carried out to make certain assumptions, determine the test values for the independent variables and calculate the dependent values. If the performance is not satisfactory, the process continues until the desired performance is achieved. Another method for designing is, the dependent variable is fixed and thus the independent variable is derived with the help of the equation:

In this section, a general procedure for designing BLDCs, either having the dependent variable extension or arriving independent variable or vice versa is proposed. Before BLDC motor design can begin, several important decisions must be made about the features of different types of brushless motors and the availability of different magnetic materials.

To do the design, the following equations are used [5]:

Torque:

The force on the current carrying conductor of the magnetic field is given by [5]

$F = IL \times B$

where, L is the length of the conductor, B is the magnetic flux density, and the current through the conductor.

The magnitude of the force is [5]

$F = BIL \sin\theta$

Where θ is

BLDC motors work on the same principle as DC motors in that the armature current and the magnetic field are stored orthogonal to each other in space (θ = 90°). Thus the force on a conductor in the BLDC motor is exerted by [5]

$F_c = B_g I_c L$

The torque in the conductor is given by [5]

$T_c = B_g I_c L R_{si}$

A winding consists of 2 conductors, one above the north pole and the other above the south. Hence it's torque in one winding is [5]

$T_t = 2B_g I_c L R_{si}$

Back Induction

In the same way, the back emf can be calculated as [5]

$E_c = B_g L v$

$E_c = B_g L w_m R_{si}$

$E_t = 2B_g L w_m R_{si}$

$E_{coil} = 2B_g L n_s w_m R_{si}$

$E_{phase} = PBgLn_s w_m R_{si}$

$E_b = 2PB_g L n_s w_m R_{si}$

Where Eb is reverse induction using DC voltage

Stator Winding Design

The conductor will be determined by the maximum current density [5]

$$A_c = \frac{I_c}{J}; \therefore D_c = \sqrt[2]{\frac{A_c}{\pi}}$$

and

$$Ac * = \frac{\pi}{4}(D_c *)^2 ; \therefore A_{cu} = n_s \times A_{cu} = n_s \times A_c *$$

where

$$\tau_c = 2_\pi(R_{si} + \frac{1}{2}d_s)\frac{1}{p}$$

$$l_t = 2L + 2\tau_c$$

Stator Design

Consider that the teeth are uniform and estimate the slot area as the trapezium. The slot area can be calculated using the following equation [5]:

$$A_s = \frac{A_{cu}}{K_{fill}}$$

The slot fill factor takes care of the isolation of the slot entry as well as all available estimates made while selecting the slot area as the trapezoid. Using This area has various dimensions using equations [5]

$$R_{ro} = R_{si} - g; N_s = P \times N_{ph}$$

$$\pi_s = \frac{2\pi R_{si}}{N_s}; \textit{is slot pitch}$$

Loses Calculation

Coper loses [5]:

$$R_t = \rho_{cu}\frac{l_t}{A_{c*}}; R_{ph} = pn_s R_t$$

Because the 2 phases produce current at the same time

$$P_{loss\_cu} = 2I_s{}^2 R_{ph}$$

Core Loses:

Compared to copper losses, core losses are very difficult to compute because they consist of hysteresis losses and eddy currents which vary nonlinearly with frequency and magnetic density flux. Fortunately the manufacturer provides coreloss / kg steel data at various values of flux density and frequency which we can use approximate core losses. Core losses occur only in the stator [5].

$$P_{loss\_core} = coreloss/kg(f_e, B_{max}) \times W_{stator}$$

3.2 Computation

To design this BLDC motor using MAGNET software. MagNet is the most advanced package currently available for the electromagnetic modeling of devices in personal computers. It provides a "virtual laboratory" where users can create models of magnetic materials and coils, view them as plots and field graphs, and
obtain numerical values for quantities such as linkage flux and strength. MagNet users only need a basic knowledge file on the concept of magnets, modeling existing devices, modifying designs, and testing new ideas.

MagNet is designed as a complete 3D modeling tool for solving static magnetic field and circulating problems. Many devices can be represented very well with 20 models, so MagNet offers 20 modeling options, with substantial savings in computing resources and solution time. With 2D modeling, MagNet can also take care of the problem by optimizing and providing automatic thermal simulation design and vibration analysis in additions.

The results of designing a BLDC motor using MAGNET software can be seen in the following figure 2:

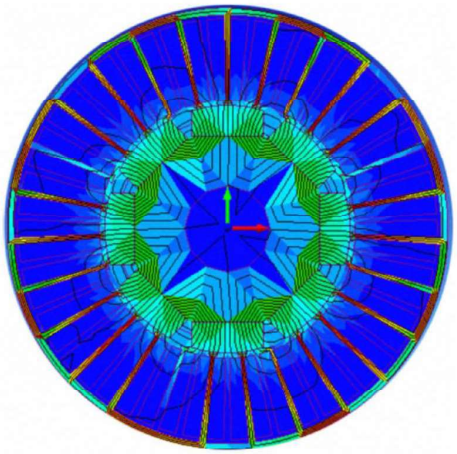

Fig. 2 . Flux magnet distribution

Based on calculation using software parameter at Table 1 below are obtained.

Table 1. Motor dimension

Parameter	Dimension
Outer diameter of stator	620 mm
Stator yoke	20 mm
Height of stator	36 mm
Rotor inner diameter	90 mm
Rotor outer diameter	420 mm
Area of Magnet	25 mm

4. Cooling System

For the effectiveness of BLDC motor cooling in order to produce high efficiency, a cooling system using liquid (liquid cooling) is determined. Furthermore, the coolant is cooled by outside air using a radiator. The scematic of cooling system is shown on Figure below.

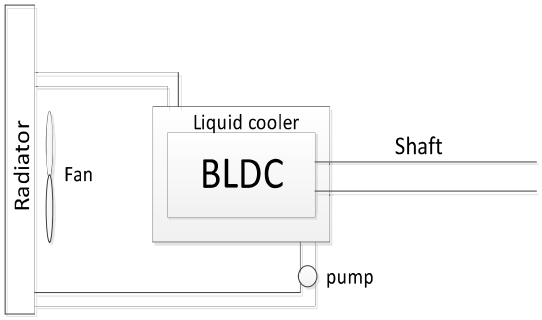

Fig. 3. Schematic of motor cooling system

The main component of cooling system is radiator. The radiator serves to cool water which becomes hot after circulating in the cooling water jacket of the motor. Generally, the radiator is attached to the front of the vehicle. The radiator consists of 2 water tubes located at the top and bottom. The two tubes are connected by a radiator grille. This grid consists of various water channels which are usually in the form of flat pipes. Water from the upper tube flows through this channel to the lower tube. To increase the amount of heat that can be dissipated, a cooler is installed on this grid.

In this case the parameters or design conditions have been determined, then do some thermal analysis first in a radiator design, with the intention of knowing the maximum possible heat transfer (Q_max) and the surface area of the heat transfer. In solving these problems using the LMTD method. A more practical method for solving this problem is to use the effectiveness (Ɛ) and NTU methods.

From the data obtained, starting from the design conditions at the maximum energy absorbed by the radiator up to various calculations to determine the value of the surface area for heat transfer. Where the price can be calculated if the size of NTU, C_min and U is known.

For the NTU value and the C_min / C_max comparison, it can be seen from the effectiveness graph for the cross flow with the two fluids not mixed. This NTU method is used when the prices of NTU, C_min and U have been obtained with the NTU price which is known from the effectiveness of 0.25 with a ratio of C_min / C_max = 0.25.

Based on NTU Methods the radiator dimension is described at Table 2 below.

Table 2. Radiator dimension

No	Description	Size (mm)
1.	Radiator width	475 mm
2.	Radiator height	404 mm
3.	Radiator thick	20 mm
4.	Number of tube	46
5.	Number of fin coloumb	47
6.	Number of fin/coloumb	235
7.	Tube width	15 mm
8.	Tube thick	1.5 mm
9.	Tube height	404 mm

5. MOTOR SPECIFICATION

Based on design and realization the parameter or specification of BLDC motor is described below:
Motor Type : Radial Type of BLDC motor
Rate power : 20 kW
Max speed : 6000 rpm
Electric Power voltage : 72 V
Cooling system : Liquid cooling using radiator

6. PERFORMANCE TEST

The liquid cooling BLDC motor was tested using dynamometer test bed. The dynamometer is equipped with electronic speed sensor, power sensor, temperature sensor based on Arduino. The test bed is illustrated at Figure 4.

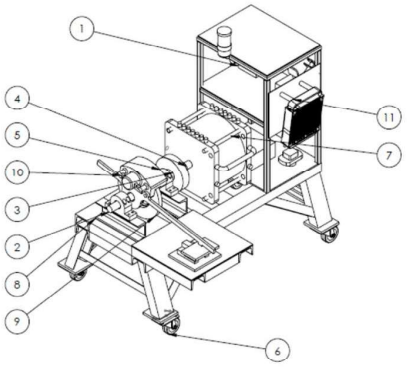

Fig 4. Motor test bed

Where:
1. Load controller
2. Speed sensor
3. 1st Coupling
4. 2nd coupling
5. Pillow block
6. Caster wheel
7. Motor
8. Bearing support
9. Temperature sensor
10. Power meter
11. Panel for instrument

The experimental test investigates the effect of air cooling temperature on BLDC motor power. Motor speed was variated by load variation by dynamometer control. Voltage and current were set of 72 V and 400 A respectively. In liquid cooling case, motor was cooled by water with various temperature from 20°C to 70°C. The result of experiment is described in following figure. In Figure 5, effect of cooling temperature on motor power is described. This figure show that higher cooler temperature cause lower power. This is in line with the theory described in the introduction, that the higher the temperature causes the magnetic strength to decrease, causing the motor power to decrease.

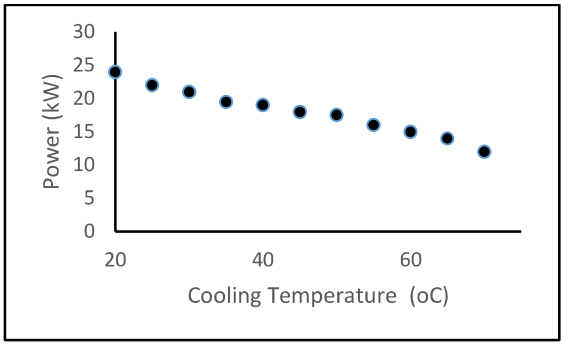

Fig 5. Effect of cooling temperature to motor power.

7. CONCLUSSION

Liquid cooled BLDC motor have been developed. The motor is Radial BLDC motor consist of 2 piece of stator windings and magnetic rotor. The motor is design analytically and numerically. The cooling system consist of radiator as main component. The radiator is designed based on NTU effectiveness method. Both motor and radiator put together to form a motor system and its cooling. Performance of the motor was test on motor test bed. Maximum motor power cooled by water is about 25 kW with rate power about 20 kW. Lowering temperature of cooling give effect on higher power output and vise versa.

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