A STANDARDIZED FAÇADE UNIT FOR HANOK WITH THE MICROALGAL ENERGY PRODUCTION SYSTEM

SEUNG-HOON HAN

School of Architecture, Chonnam National University, Korea
Email: hshoon@jnu.ac.kr

Abstract—Currently, there has been a growing interest in energy issues in the world. In addition, the energy problem has occurred in the building. Such energy can solve the problem, energy to be applied to algae façade system that can be produced in a building. By utilizing the algae, it is possible to produce energy environmentally friendly, can be utilized culture system and color of algae, giving a color change of the building. Algae Façade system will be able to serve for changing the health and sensitivity of environmental change and people in the building chamber greatly affects the energy savings and comfort of the building. The purpose of this paper in order to research and applications in microalgae culturing on large scale become more and more common in many fields including Hanok industry in Korea: functional food production and environment treatment, so using modified medium culture to improve lipid content in microalgae cells is really feasible.

Index Terms—Hanok,Microalgae, Algae Cultivation, Algae Façade, Algae Flocculation, Energy Conversion

I. INTRODUCTION

Nowadays, mankind has begun to be interested in global important issues such as typical environmental problems and energy crisis. For the environment, the warming of the Earth is one of core issues and is well known that using fossil fuels is the main cause of the trouble. Naturally, finding a clean energy source to reproduce from alternative resources like biomass fuels is vital, and interestingly, plaster is essential to reducing CO2 emissions. Moreover, energy crisis caused oil price changes unstably that affects the planning of energy consumption from the nation widely to the household narrowly.

Currently, many options are being studied and included in the analyses that have achieved various degrees of success in multiple stages of researches and different experiments, including energy resources such as solar, including heat and solar, hydroelectric, geothermal, wind, biofuels, and the carbon sequestration, and other. Each type has its own advantages. However, problems also exist simultaneously, depending on the areas of application and different conditions that will have better coverage for each method. One of the most important aims for the finding is to suggest a system for reducing CO2 emissions from buildings, for example, by replacing fossil fuel sources gradually with renewable raw materials like biofuels. It is considered as a plus factor and real contributor to achieve these goals, particularly in the near future.

The Earth is gradually getting warmer due to greenhouse concentration in the atmosphere. This problem has been identified as the most important issue in the environment. The first task to reduce the greenhouse effect is to reduce the formation of CO2 in the atmosphere that can be done in three methods:

- Reducing the use of fossil fuels
- Decreasing CO2 from the atmosphere
- Utilizing CO2 from fossil fuels to be emitted for conversion to another energy production

To solve global energy shortages, identify biological materials to produce biodiesel lipid-rich high efficiency is attracting a lot of attention. The microbial oils can be expected due to a short growth cycle, high lipid content and easy to be breeding by means of biotechnology. Various species of microalgae are listed as oil-rich microorganisms suitable for lipid production needs. Microalgae are considered objects which potential to produce a lot of fuel because the advantage is as high photosynthetic efficiency, greater biomass and a higher level of student leader when compared with other types of energy production plants [1][8].

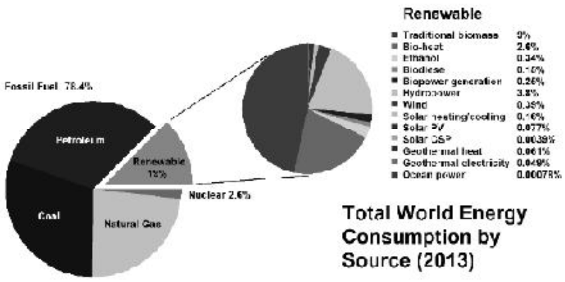

Figure1. Total World Energy Consumption (2013)

In this sense, algae façade system will be able to serve for changing the health and sensitivity of environmental change and people in the building chamber greatly affects the energy savings and comfort of the building. The purpose of this paper in order to research and applications in microalgae culturing on large scale become more and more common in many fields: functional food production and environment treatment, so using modified medium culture to improve lipid content in microalgae cells is really feasible.

On the other hand, there are huge demands for Hanok, Korean traditional residence, in housing market. As resident lifestyle has changed, the Hanok is not appropriate for modern life. So there has beena huge movement in the field of market and inquisition. Many trialsfor styling newHanok wereattempted and relevant researches have been performed. [16] This study additionally suggests a new façade system for Hanokhaving short eaves and its controlling system and this part remains as an ongoing research.

Figure 2.A Modernized Hanok (Seoul, Korea)

II. ALGAE TECHNOLOGY

Algae cells are filled with oils into droplets that are regarded as promising rich resources. Since oils of algae cells can be converted into biodiesel and algae consume carbon dioxide (CO2) during the culturing process, it is useful touse algae resources for improving the interior comfort with producing oxygen (O2) by converting from CO2. Algae resources can normally be classified into macro algae and microalgae. Macro algae are well known as seaweed having multicellular organs raised from the seawater, and comparatively, the freshwater algae grow up to 60meters in a singular form. Microalgae have a unicellular organization and are grown normally in seawater.

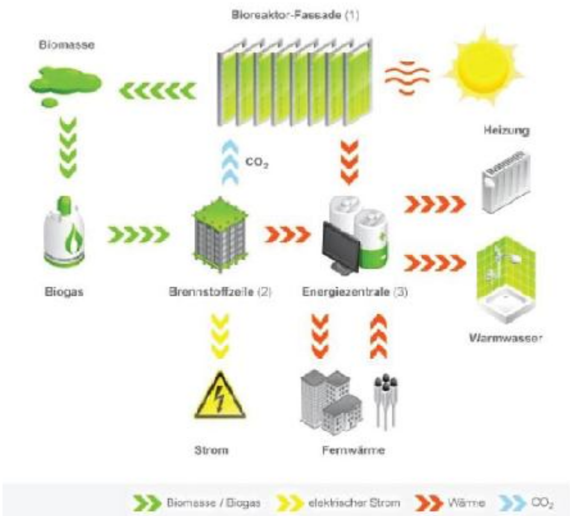

Figure3.EnergyProduction Process Using Algae Façade(Source: Jo and Han, 2016)[9]

Freshwater environment make microalgae grow fast just in the same way by cell division as macro algae, and provides much nutrition to have enough strength. Oil production of microalgae is at least 100 times greater than that of soybeans. Optimal culture conditions according to these microalgae species are varied, and they can be selectively cultured in accordance with the national weather. Consisting of particularly invisible microalgae is superior to be applied to the building and advantageous for visual aspects towards façade systems. [9]

In eco-friendly settings, algae resources have a great possibility to harvest energy sources and relevant researches on the production technology are being performed in a variety of ways for the development of microalgae cultivation and application. It is majorly divided into an open pond systems and a closed photo bioreactor system. Open pond system is an open culture, the cells of the algae in the tank in such a way as to depths of less than 30meters to be passed well in the microalgae PV (Photovoltaics). In general, this process is useful to generate a large scale in the form of energy, but it is necessary to maintain a constant temperature, when the difference in temperature is large, and so this system is difficult to apply.On the other hand, closed photo-bioreactor system is cultured using transparent plate. Its biomass productivity shows 30-fold in average concentration that is much higher than open pond microalgae having 13-fold in average. Therefore, a closed photobioreactor system can easily be applied to the field of architecture and is a suitable algae system for buildings. [9]

III. EXPERIMENTS

The use of photosynthetic microalgae helps solar energy be converted into chemical energies with storing in forms of oils, carbohydrates and proteins, and this process is one of the major advantageous technologies to reduce the formation of atmospheric CO2. Algae are frequently found in damp areas or in water with small organs, from single-celled to multicellular that have different complex forms. Like plants, algae require mainly three components to grow: sunlight, carbon dioxide and water. Microalgae can be told as fast-growing beasts with a voracious appetite carbon dioxide and havea potential to produce more oils per acre than any other feedstocks being used to make biodiesel. It can also be grown on land and is unsuitable for food crops. They are categorized into four main classes: diatoms, green algae, blue-green algae and golden algae. And, there are two main populations of algae: filamentous and phytoplankton. Second-generation microalgal systems have the advantage that they can produce a wide range of feedstocks for the production of biodiesel, bioethanol, biomethanol and biohydrogen. Humans have always tried to take advantage of these properties through algal mass culturing. It has been acknowledged that the concept of using microalgae as a source of fuel has been used for years. First, this paper will handle with the system overview producing microalgae. Currently there are three types of industrial reactors used for algal culture: (1) photo-bioreactor, (2) open ponds and (3) closed and hybrid systems.In the production system, this research attempts to generalize the application of harvesting methods for microalgae. Then, analyses for optical reactors will be performed, and its reviews for overall concepts will include that how they work and manufacture optical reactor and charts showing the operation of the reactor. Subsequently, thisstudy will analyze the open-pond systems in which algae farms were introduced in an Arial view of a raceway pond. In addition, the conclusion of this researchwill cover discussion about some general concepts of large-scale microalgal productions of biomass and some improved methods for the implementation.

Then there will be detailed contents on the support of hybrid systems for the production of microalgae, referring to a number of outstanding issues as well as compared to other harvesting methods.The aim of this study, finally, is to introduce the concept of harvesting microalgae, the system structure for cultivation, and the pros and cons of each system. Based on these studies, it is expected to find a way to overcome the shortcomings of the system and improve old methods to guarantee their efficiencies as well as find out manufacturing methods to enhance productivity to lead the cost of microalgae to the lowest level for the future.

A quantity of species of microalgae lipid accumulation could reach 75% (w / w) of dry biomass, nonetheless low productivity, as Botryococcusbraunii. A number of other species of microalgae are common for the production of lipid that is Chlorella, Crypthecodinium, Cylindrotheca, Dunaliella, Isochrysis, Nannnochloris, Nannochloropsis, Neochloris, Nitzschia, Phaeodactylum, Porphyridum, Schizochytrium, Tetraselmis for yield birthhigh mass yields much higher lipid although volumes lipid content only from the 20-50% of dry biomass. In the biodiesel production process, one can use lipid sources from oil plant, animal fats or waste oils. However, for the production of biodiesel reached fuel standards and characteristics of raw materials is very important, since the process initial research for the next stage of production, because of the quality of biodiesel depends on the quality of raw materials [7][2].

The most common ingredient in biodiesel ester is the ester of palmitic acid, stearic acid, oleic acid, linoleic acid and linolenic acid. Among them, methyl oleate are considered key components of ideal for the production of biodiesel [1].Oil productivity of microalgae is volume of oil is produced per unit volume of microalgae cultivation school each day, depending on the degree of algae growth and lipid content in biomass. Consider a few research results, we can see that the content and characteristics of lipids in microalgae cells are varied, depending on the change of growth conditions (such as temperature and intensity projection light) or nutritional composition of the culture medium (such as the concentration of nitrogen, phosphate and iron).

Temperature: Temperature deeply affected the accumulation born leader and biochemical components in microalgae cells, especially the accumulation of lipid composition and changes in intracellular lipid [5][2]. Consider adding the results from other studies as may prove that the temperature has a significant impact range during microalgae culture. Each species of microalgae to adapt to a certain temperature threshold and at different temperatures, the components in the cell biochemistry are different [6].

Environmental components: Microalgae lipid level possibly will increased under the various culture conditions such as nitrogen deficiency, high light intensity, low heat, high salt concentrations, and high iron content. Under the stimulation conditions, many species of microalgae can respond by increasing lipid content, typically from 30% to 60% (w / w) dry cells [3][4][5][6][7].

After overall experiments, this study has proposed an eco-façade of the modular system applied with integrative functions of vertical kinetic louver and algae façade. The suggested system can change the shape by the position of the sun. This unique combination has the distinction from the existing kinetic façade systems.

Two comparative functions such as penetrating natural daylight and blocking the solar radiation are embodied and optimized into the system, and the proposed mechanism has provided to support relatively enhanced environmental controls.

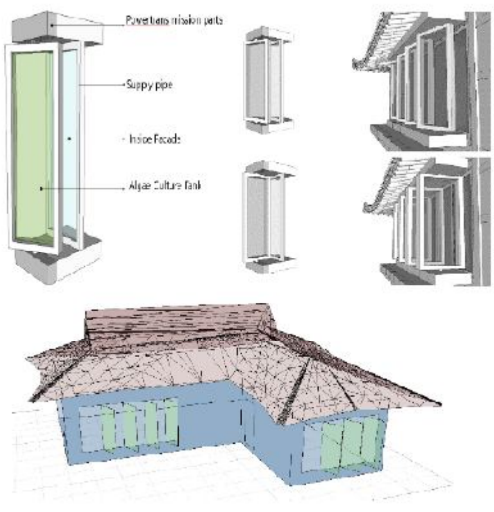

Figure 4.Proposed Algae Façade System for Hanok (Source: Kim, Kim and Han, 2015) [16]

IV. RESULTS AND DISCUSSION

Raw materials for producing biodiesel from microalgae is lipid. Therefore lipid productivity is the main goal when culturing algae N.oculata, a Nannochloropsis (N) algae for biodiesel production purposes. When sufficient nutrition conditions, N first tend to transform carbon into protein. However, under the conditions vary, microalgae cells irritation, there will be much carbon is transformed into lipids and carbohydrates. The influence of environmental factors will affect the lipid composition and fatty acids in microalgae cells.

Based on a study in 2009 by AttilioConverti and colleagues, is a type of algae Nannochloropsis quite sensitive to the temperature of the environment are significantly reduced or increased impact for the growth of algae used to extract lipids. The optimal temperature for the production of algae is 20 degrees Celsius, nonetheless the temperature increase or decrease the culture, production of microalgae lipid accumulation significantly increased, almost doubled compared to the 200C.

Temperature changes affect not first-rate to typical growth levels but have a positive impact on the synthesis and accumulation of lipids in the cell microalgae. Therefore lipid productivity of N.oculata cultured in the air different again is almost the same, not much different than the poor. The results show that, at 250C, of N.oculata lipid yield reached the highest value, can be up to 12.19mg / L/ day [1][8].

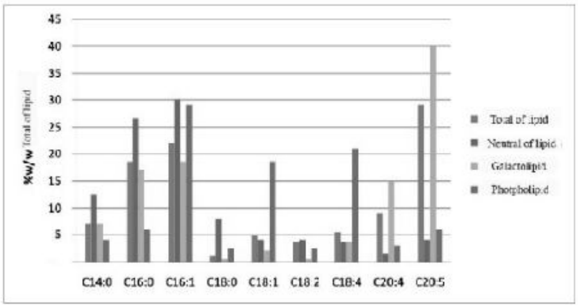

Figure 5.Fatty Acid Composition in Nannochloropsis

CONCLUSION

Based on research of AttilioConverti and colleagues, we propose a computer software program that has the ability to recognize the growth rate and temperature control suitable for algae growth rate of Nannochloropsis. The name is an abbreviation system called ISTCAP, Identification Systems Temperature Control Algae propagate.

This system has the function of nourishing the cells of algae-based N and growth duration and amount of algae, the system will be programmed to recognize a software growth rate, to a number and time specified time is programmed, the system will transmit to adjust the temperature department and we have the task to change the temperature according to the time period recorded in line with the rapid growth rate of algae N. slow software this required adding a prediction software support for maintaining a nourishing algae optimum N least.

Software predicts placed a temporary name is the LYP (Lipid yield predictions), is operated with support ISTCAP predicting algal lipids N yield gain much value mg / per liter a day. LYP has an important role in the prediction, depending on the temperature of LYP ISTCAP previous system will adjust the temperature to suit low high yield algae produce lipids of N. This process means that predictions of LYP and ISTCAP system will adjust the temperature changes per minute of algae growth N.
This study has suggested a futuristicalgae façade system applied with the above results and there are still some issues to be resolved and they remain as an ongoing project.

ACKNOWLEDGMENTS

This research was majorly supported by a grant (G01201406010105) from International Standard Technology Enhancement Program (Project No. 10049462) funded by Korean Agency for Technology and Standards under Ministry of Trade, Industry and Energy of Korean Government.

REFERENCES

[1] Converti, A., Casazza, A., Ortiz, E., Perego, P.and Borghi, M. D., Effect of Temperature and Nitrogen Concentration on the Growth and Lipid Content of NannochloropsisOculata and Chlorella Vulgaris for Biodiesel production, Chemical Engineering and Processing: Process Intensification, v. 48, pp. 1146-1151, 2009.

[2] Hsieh, C. and Wu, W., Cultivation of Microalgae for Oil Production with a Cultivation Strategy of Limitation,Bioresource Technology, v. 100, pp. 921-3926, 2009.

[3] Chisti, Y., Biodiesel from Microalgae,Biotechnol Adv., v. 25, pp. 294–306, 2007.

[4] Li, Y., Horsman, M., Wang, B., Wu, N. and Lan, C.Q., Effects of Nitrogen Sources on Cell Growth and Lipid Accumulation of Green Alga NeochlorisOleoabundans, Appl. Microbiol. Biotechnol, v. 81: pp. 629-636, 2008.

[5] Liu, Z.Y., Wang, G.C., Zhou B.C., 2008. Effect of iron of growth and lipid accumulation in Chlorella vulgaris. Biores. Technol, 99: 4717-4722

[6] Khimchenko, S. V. andYakovleva, I.M., Lipid Composition of the Red Alga TichocarpusCrinitusKhácExposed to Levels of Photon Irradiance,Phytochemistry, v. 66, pp. 73-79, 2005.

[7] Illman,A. M., Scragg, A. and Sales, S.W., Increase in ChlorellStrains Low Calorific Values KhiGrown in Nitrogen Medium, Enzyme Microb. Technol, v. 27, pp. 631-635, 2000.

[8] Chieu,B. N. D., Biodiesel Production from Algae VI, Bach Khoa University,June 2010.

[9] Jo, H. and Han, S., Implementation of Building Colors with the Energy-Oriented Algae Façade System, in Proceedings of 2016 Smart Energy Technologies, Stockholm, Sweden, August 2016.

[10] Pham, G. and Han, S., An Energy Upcycling System for Producing Microalgal Biomass and Harvesting Algae Cells,

in Proceedings of 2016 Smart Energy Technologies, Stockholm, Sweden, August 2016.
[11] Parlak, O., Turner, A., and Tiwari, A., On/Off-Switchable Zipper-Like Bioelectronics on a Graphene Interface, Advanced Materials, Vol. 26, No. 3, pp. 482-486, 2014.
[12] Benemann,J., Augenstein, D. and Weissman, J., Microalgae as a Source of Liquid Fuels, Appendix: Technical Feasibility Analysis, Final Report to the U.S. Department of Energy, 1982.
[13] Benemann, J., Open Ponds and Closed Protobioreators - Comparative Economics, Proceedings of 5th Annual World Congress on Industrial Biotechnology and Bioprocessing, Chicago, U.S.A., April 2008.
[14] Kim, T. and Han, S., Analysis for Energy Efficiency of the Algae Façade, Korea Institute of Ecological Architecture and Environment (KIEAE) Journal, vol. 14, no. 6, pp. 15-21, 2014.
[15] Chaumont, D., Biotechnology of Algal Biomass Production: A Review of Systems for Outdoor Mass Culture, Journal of Applied Phycology, vol. 5, no. 6, pp. 593-604, 1993.
[16] Kim, T., Kim, K. and Han, S., A Futuristic Façade System with Kinetic-Algae Technologies towards Hanok, International Journal of Environmental Engineering, vol. 3, no. 1, pp. 69-73, 2015.

★★★