BIO-BASED RIGID POLYURETHANE FOAM AS INSULATION MATERIALS

SRIHANUM ADNAN; NURUL 'AIN HANZAH; TUAN NOOR MAZNEE TUAN ISMAIL; MOHD NORHISHAM SATTAR; NORHAYATI MOHD NOOR; ZUHAIRI ZAINUDIN; ZULHILMY SULAIMAN and YEONG SHOOT KIAN

812

MPOB INFORMATION SERIES • ISSN 1511-7871 • JULY 2019 MPOB TT No. 659

The desire to improve energy efficiency is one of the major driving forces in home appliances, transportation, building as well as in oil and gas industries. There are plenty of insulation materials available in the market today. In addition to fibreglass, mineral wool, cellulose and polystyrene, insulator can also be made from polyurethane foams. In household refrigerators, the performance of polyurethane foam insulation contributes greatly to the appliance's overall energy efficiency. Thermal conductivity value is an important parameter for insulation materials. The thermal conductivity value (K-factor) of polyurethane foam is between 0.02 and 0.03 W/m K, which is almost twice lower than that of other insulation materials such as extruded polystyrene, expanded polystyrene, glass, or mineral wool (Szycher, 1999; Kuranska *et al*., 2016). Rigid polyurethane foams (RPUF) are found to be among the most suitable types of foams for insulation application. Over the years, RPUF have been produced from petroleum-based polyol. Recently, MPOB studies have proven that low density (less than 30 kg m^{-3}) of RPUF could also be produced using palm-based polyols. Polyol from renewable resources such as palm oil has become an alternative to petroleum. In addition, there has been a considerable increase in the demand for high bio-based materials in insulation foams. Thus, there is a need to develop low density palm-based RPUF, particularly for insulation purposes. This technology involves the preparation of RPUF that meets the requirements of low density insulation foam.

METHODOLOGY

Generally, the technical process for preparing RPUF involves three main steps, as illustrated in *Figure 1*. A low density RPUF prepared from a palm-based polyol is shown in *Figure 2*.

Figure 2. Palm-based low density rigid polyurethane foams (RPUF).

NOVELTY OF THE PRODUCT

Bio-based products

Development of polyols from renewable resources such as vegetables oil, is widely reported by researchers due to environmental awareness. A breakthrough synthesis of palm olein-based polyol has been patented by MPOB (Hazimah *et al*., 2011). The present invention relates to the preparation of RPUF from palm-based polyol namely, Pioneer G-360.

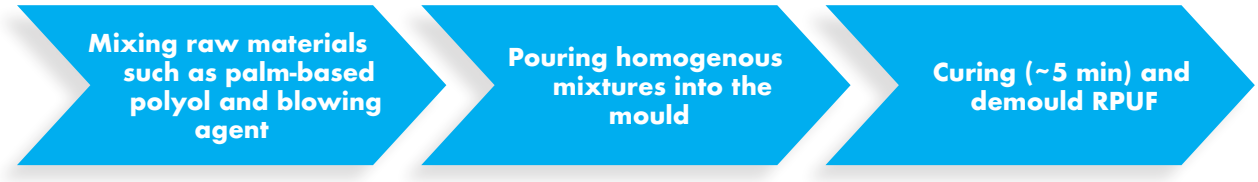


Figure 1. General process of preparing rigid polyurethane foams (RPUF).

ISSN 1511-7871
9 771511 787001

Head of Corporate Implementation and Consultancy Unit, Malaysian Palm Oil Board. 6, Persiaran Institusi, Bandar Baru Bangi, 43000 Kajang, Selangor, Malaysia.
Tel: 03-8769 4574 Fax: 03-8926 1337 E-mail: tot@mpob.gov.my Website: www.mpob.gov.my

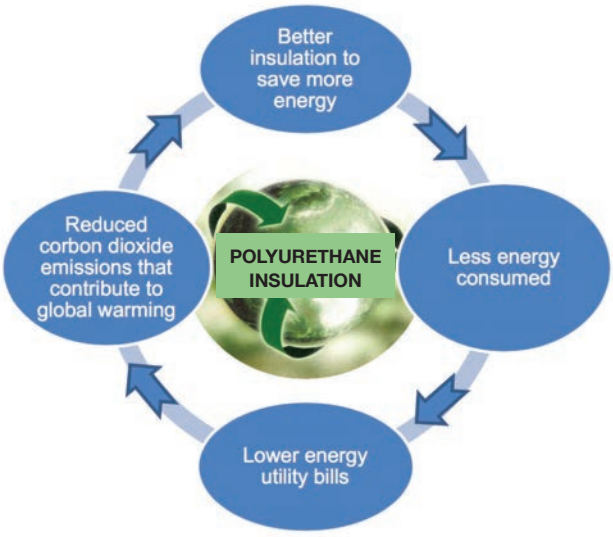
Environmentally blowing agent

Production of RPUF uses environmental-friendly blowing agent to substitute chlorofluorocarbon (CFC) blowing agents that have been banned since 1996. CFC is known to contribute to the depletion of the stratospheric ozone layer (Lim *et al*., 2010; Kim *et al*., 2014). Thus, this technology has been developed using a non-ozone depleting compound.

Low thermal conductivity

Incorporation of palm olein-based polyol as a proportionate replacement of petroleum-based polyol in the formulation is able to produce RPUF with a low K-factor (0.02 W/m K). Thermal conductivity value of RPUF produced is classified as insulation material according to ASTM C 518 and EN 253.

ADVANTAGES



ECONOMIC ANALYSIS

Estimated capital investment (CAPEX) of RM 550 000 and average operating expenditure (OPEX) of RM 2.75 million are calculated based on a production capacity of 50 000 PU unit yr^{-1}:

Economic analysis	Value
Net present value (NPV) @ 10%, RM	1.1 million
Internal rate of return (IRR), %	32
Discounted payback period, years	4
Discounted benefit cost ratio (B:C)	1.28

CONCLUSION

Insulation material from palm-based polyol with lower thermal conductivity value offered a better alternative to the commercial insulation products. The bio-based polyol in this study was produced from renewable and sustainable raw materials.

REFERENCES

Hazimah, A H; Tuan Noor Maznee, T I; Mohd Norhisham, S; Hoong, S S; Ooi, T L; Salmiah, A; Kosheela Devi, P P and Cheong, M Y (2011). Process to produce polyols. US Patent 7 932 409 B2.

Kirpluks, M; Cabulis, U and Avots, A (2016). Flammability of bio-based rigid polyurethane foams as sustainable thermal insulation material. *Insul Mater Context Sustain*., InTech. p. 85-111.

Kim, S H; Lim, H; Song, J C and Kim, B K (2014). Effect of blowing agent type in rigid polyurethane foam. *J. Macr Sci, Part A: Pure and App Chem., Vol. 45*: 323-327.

Kuranska, M and Prociak, A (2016). Bio-based polyurethane foams for heat-insulating applications. *Nano and Biotech Based Materials for Energy Building Efficiency* (Pacheco Torgal, F; Buratti, C; Kalaiselvam, S; Granqvist, C G and Ivanov, V eds.). Springer International Publishing. p. 357-373.

Lim, H; Kim, E Y and Kim, B K (2010). Polyurethane foams blown with various types of environmentally friendly blowing agents. *Plastic, Rubber and Compos., Vol. 39*: 364-369.

Szycher, M (1999). Scycher's handbook of polyurethanes. First edition. Boco Raton, USA: CRC Press. 696 pp.

For more information, kindly contact:

Head of Corporate Implementation and Consultancy Unit, MPOB
6, Persiaran Institusi,
Bandar Baru Bangi,
43000 Kajang, Selangor, Malaysia
Tel: 03-8769 4574
Fax: 03-8926 1337
E-mail: tot@mpob.gov.my
www.mpob.gov.my