- Article
- Published: 29 March 2019

Maleinized Hyperbranched Polyol Polyester: Effect of the Content of Maleic Anhydride in the Structural, Thermal and Rheological Properties

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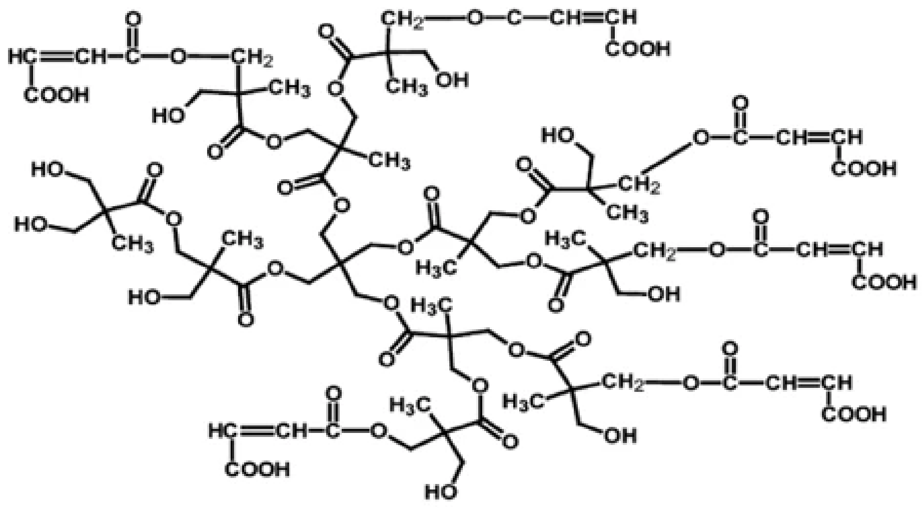
Macromolecular Research **volume 27**, pages 693–702 (2019)Cite this article

Abstract

The aim of this work is to obtain the material that, in the future, may become a better alternative, as a functionalizing agent, to maleic anhydride (MA), or a crosslinking agent with the least amount of functional groups. To achieve that goal, a hyperbranched polyester polyol (HBP) of the second generation (HBP2G) was modified with MA to obtain HBP2GMA. The effects of the proportion of MA in the structural, thermal, and rheological properties of the HBP2GMAs were evaluated. Furthermore, these properties were compared with those of the HBP2G. A reduction in the intensity of peak corresponding to the OH stretching of HBP2G was observed with the increase in the extent of HBP2G modification by the analysis of the infrared (IR). HBP2GMAs showed a peak at 3030 cm^{-1} in their IR spectra, which was due to the -CH=CH- stretching of MA. This was further assessed by ^{1}H NMR analysis. The number of MA units grafted into HBP2G was between 4 and 9, indicating a high degree of functionality. All materials possessed viscosity values below 34.94 Pa·s at 110 °C, which were dependent on the grade of the modification percentage (MP)

and the molar content of MA grafted into HBP2G. Mass spectrometry analysis demonstrated the formation of products by the esterification reaction between the HBP2G and MA. The thermal stability of the HBP2GMAs determined as the decomposition temperature (T_d) was between 258 and 281 °C which was better than that of the HBP2G.

HBP2GMA is a hyperbranched polyester polyol of the second generation (HBP2G) modified with Maleic anhydride (MA). In addition, it is important to study the proportion of the grafted MA into HBP2G, since the structural, thermal and rheological properties depend both on the groups present and the amount of groups in the periphery. Furthermore, the HBP2GMA may be a better alternative to MA, which, due to the latter's functionality (two acid groups and one double bond), has been widely employed in the synthesis of many materials. On the other hand, HBP2GMAs possess a larger number of functional groups compared with MA, suggesting higher reactivity; therefore, they may also participate in the addition and condensation reactions.



HBP2GMA

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References

1. (1)

   Y. Zhu, C. Liang, Y. Bo, and S. Xu, *J. Polym. Res.*, **22**, 35 (2015).

   Article CAS Google Scholar

2. (2)

T. Saki, *Arab. J. Chem.*, **8**, 191 (2015).

Article CAS Google Scholar

3. (3)

S. K. Singh, S. P. Tambe, A. B. Samui, V. S. Raja, and D. Kumar, *Prog. Org. Coat.*, **55**, 20 (2006).

Article CAS Google Scholar

4. (4)

S. Wang, N. Wang, L. Meng, J. Zhao, and Y. Feng, *Macromol. Res.*, **79**, 96 (2011).

Google Scholar

5. (5)

R. Kumar, R. Narayan, T. M. Aminabhavi, and K. V. S. N. Raju, *J. Polym. Res.*, **21**, 547 (2014).

Article CAS Google Scholar

6. (6)

E. Zagar and M. Zigon, *J. Chromatogr. A*, **1034**, 77 (2004).

Article CAS PubMed Google Scholar

7. (7)

E. A. Murillo, P. P. Vallejo, and B. L. López, *e-Polymer*, **10**, 1347 (2010).

Article Google Scholar

8. (8)

E. A. Murillo, P. P. Vallejo, L. Sierra, and B. L. López, *J. Appl. Polym. Sci.*, **112**, 200 (2009).

Article CAS Google Scholar

9. (9)

E. Zagar and M. Zigon, *Prog. Polym. Sci.*, **36**, 53 (2011).

Article CAS Google Scholar

10. (10)

E. Zagar, M. Zigon, and S. Podzimek, *Polymer*, **47**, 166 (2006).

Article CAS Google Scholar

11. (11)

E. A. Murillo, P. Vallejo, and B. L. López, *J. Appl. Polym. Sci.*, **120**, 3151 (2011).

Article CAS Google Scholar

12. (12)

D. Yang, Z. Chen, X. Rong, H. Zhang, and F. Qiu, *J. Polym. Res.*, **21**, 331 (2014).

Article CAS Google Scholar

13. (13)

M. Kutyreva, G. S. Usmanova, N. Ulakhovich, and G. Kutyreva, *Russ. J. Gen. Chem.*, **80**, 787 (2010).

Article CAS Google Scholar

14. (14)

N. E. Ikladious, J. N. Asaad, and N. N. Rozik, *Des. Monomers Polym.*, **12**, 469 (2009).

Article CAS Google Scholar

15. (15)

A. R. Gataulina, A. A. Khannanov, O. A. Malinovskikh, O. V. Bondar, N. A. Ulakhovich, and M. P. Kutyreva, *Russ. J. Gen. Chem.*, **83**, 2269 (2013).

Article CAS Google Scholar

16. (16)

Y. M. Al-Roomi and K. F. Hussain, *J. Appl. Polym. Sci.*, **102**, 3404 (2006).

Article CAS Google Scholar

17. (17)

Z. M. O. Rzayev, *I. RE. CH. E.*, **3**, 153 (2011).

Google Scholar

18. (18)

D. Manjula, A. Dhevi, A. Prabu, H. Kim, and M. Pathak, *J. Polym. Res.*, **21**, 503 (2014).

Article CAS Google Scholar

19. (19)

T. Eren, S. H. Küsefoglu, and R. J. Wool, *Appl. Polym. Sci.*, **90**, 197 (2003).

Article CAS Google Scholar

20. (20)

C. A. Ararat and E. A. Murillo, *Ing. Cienc.*, **12**, 127 (2016).

Article Google Scholar

21. (21)

M. Nova, Y. Arévalo, and E. A. Murillo, *J. Appl. Polym. Sci.*, **136**, 46932 (2019).

Article CAS Google Scholar

22. (22)

R. Mesías and E. A. Murillo, *J. Appl. Polym. Sci.*, **132**, 41589 (2015).

Article CAS Google Scholar

23. (23)

G. P. Karayannidis, D. S. Achilias, I. D. Sideridou, and D. N. Bikiaris, *Eur. Polym. J.*, **41**, 201 (2005).

Article CAS Google Scholar

24. (24)

P. P. Vallejo, B. L. López, and E. A. Murillo, *Prog. Org. Coat.*, **87**, 213 (2015).

Article CAS Google Scholar

25. (25)

N. Dayma, H. S. Jaggi, and B. K. Satapathy, *Mater. Des.*, **33**, 510 (2012).

Article CAS Google Scholar

26. (26)

W. Zhang, J. Tabei, M. Shiotsuki, and T. Masuda, *Polym. Bull.*, **57**, 463 (2006).

Article CAS Google Scholar

27. (27)

M. S. Selim, M. A. Shenashen, A. E. A. M. ELSaeed, M. M. Selimd, and S. A. El-Safty, *RSC Adv.*, **7**, 21796 (2017).

Article CAS Google Scholar

28. (28)

J. Vukovic, M. D. Lechner, and S. Jovanovic, *J. Serb. Chem. Soc.*, **72**, 1493 (2007).

Article CAS Google Scholar

29. (29)

S. Haseebuddin, R. Parmar, G. Waghoo, and S. K. Ghosh, *Prog. Org. Coat.*, **64**, 446 (2009).

Article CAS Google Scholar

30. (30)

T. T. Hsieh, C. Tiu, and G. P. Simon, *Polymer*, **42**, 1931 (2001).

Article CAS Google Scholar

31. (31)

E. Zagar, M. Huskic, and M. Zigon, *Macromol. Chem. Phys.*, **208**, 1379 (2007).

Article CAS Google Scholar

32. (32)

N. E. Ikladious, S. H. Mansour, J. N. Asaad, H. S. Emira, and M. Hilt, *Prog. Org. Coat.*, **89**, 252 (2015).

Article CAS Google Scholar

33. (33)

M. Xu, X. Yan, R. Cheng, and X. Yu, *Polym. Int.*, **50**, 1338 (2001).

Article CAS Google Scholar

34. (34)

S. Alfei and S. Castellaro, *Macromol. Res.*, **25** 1172 (2017).

Article CAS Google Scholar

35. (35)

J. Vukovic, D. Steinmeier, M. D. Lechner, S. Jovanovic, and B. Bozic, *Polym. Degrad. Stab.*, **91**, 1903 (2006).

Article CAS Google Scholar

36. (36)

Y. Ishida, K. Yokomachi, and M. Seino, *Macromol. Res.*, **15**, 147 (2007).

Article CAS Google Scholar

37. (37)

M. Rogunova, T. Y. S. Lynch, W. Pretzer, M. Kulzick, A. Hiltner, and E. Baer, *J. Appl. Polym. Sci.*, **77**, 1207 (2000).

Article CAS Google Scholar

38. (38)

E. Malmstrom, M. Johansson, and A. Hult, *Macromol. Chem. Phys.*, **197**, 3199 (1996).

Article Google Scholar

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Acknowledgments: The authors thank to the Fondo de Investigaciones Universitarias (FINU) de la Universidad Francisco de Paula Santander for the financial support of this work.

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Cite this article

Ararat, C.A., Quiñonez, W. & Murillo, E.A. Maleinized Hyperbranched Polyol Polyester: Effect of the Content of Maleic Anhydride in the Structural, Thermal and Rheological Properties. *Macromol. Res.* **27,** 693–702 (2019). https://doi.org/10.1007/s13233-019-7089-1

Download citation

- Received: 11 September 2018
- Revised: 15 November 2018

- Accepted: 28 November 2018
- Published: 29 March 2019
- Issue Date: July 2019
- DOI: https://doi.org/10.1007/s13233-019-7089-1

Keywords

- hyperbranched polyol polyesters
- maleic anhydride
- macromonomers
- modification
- properties

1. Y. Zhu, C. Liang, Y. Bo, and S. Xu, *J. Polym. Res.*, **22**, 35 (2015).

Article CAS Google Scholar

2. T. Saki, *Arab. J. Chem.*, **8**, 191 (2015).

Article CAS Google Scholar

3. S. K. Singh, S. P. Tambe, A. B. Samui, V. S. Raja, and D. Kumar, *Prog. Org. Coat.*, **55**, 20 (2006).

Article CAS Google Scholar

4. S. Wang, N. Wang, L. Meng, J. Zhao, and Y. Feng, *Macromol. Res.*, **79**, 96 (2011).

Google Scholar

5. R. Kumar, R. Narayan, T. M. Aminabhavi, and K. V. S. N. Raju, *J. Polym. Res.*, **21**, 547 (2014).

Article CAS Google Scholar

6. E. Zagar and M. Zigon, *J. Chromatogr. A*, **1034**, 77 (2004).

Article CAS PubMed Google Scholar

7. E. A. Murillo, P. P. Vallejo, and B. L. López, *e-Polymer*, **10**, 1347 (2010).

Article Google Scholar

8. E. A. Murillo, P. P. Vallejo, L. Sierra, and B. L. López, *J. Appl. Polym. Sci.*, **112**, 200 (2009).

Article CAS Google Scholar

9. E. Zagar and M. Zigon, *Prog. Polym. Sci.*, **36**, 53 (2011).

Article CAS Google Scholar

10. E. Zagar, M. Zigon, and S. Podzimek, *Polymer*, **47**, 166 (2006).

Article CAS Google Scholar

11. E. A. Murillo, P. Vallejo, and B. L. López, *J. Appl. Polym. Sci.*, **120**, 3151 (2011).

Article CAS Google Scholar

12. D. Yang, Z. Chen, X. Rong, H. Zhang, and F. Qiu, *J. Polym. Res.*, **21**, 331 (2014).

Article CAS Google Scholar

13. M. Kutyreva, G. S. Usmanova, N. Ulakhovich, and G. Kutyreva, *Russ. J. Gen. Chem.*, **80**, 787 (2010).

Article CAS Google Scholar

14. N. E. Ikladious, J. N. Asaad, and N. N. Rozik, *Des. Monomers Polym.*, **12**, 469 (2009).

Article CAS Google Scholar

15. A. R. Gataulina, A. A. Khannanov, O. A. Malinovskikh, O. V. Bondar, N. A. Ulakhovich, and M. P. Kutyreva, *Russ. J. Gen. Chem.*, **83**, 2269 (2013).

Article CAS Google Scholar

16. Y. M. Al-Roomi and K. F. Hussain, *J. Appl. Polym. Sci.*, **102**, 3404 (2006).

Article CAS Google Scholar

17. Z. M. O. Rzayev, *I. RE. CH. E.*, **3**, 153 (2011).

Google Scholar

18. D. Manjula, A. Dhevi, A. Prabu, H. Kim, and M. Pathak, *J. Polym. Res.*, **21**, 503 (2014).

Article CAS Google Scholar

19. T. Eren, S. H. Küsefoglu, and R. J. Wool, *Appl. Polym. Sci.*, **90**, 197 (2003).

Article CAS Google Scholar

20. C. A. Ararat and E. A. Murillo, *Ing. Cienc.*, **12**, 127 (2016).

Article Google Scholar

21. M. Nova, Y. Arévalo, and E. A. Murillo, *J. Appl. Polym. Sci.*, **136**, 46932 (2019).

Article CAS Google Scholar

22. R. Mesías and E. A. Murillo, *J. Appl. Polym. Sci.*, **132**, 41589 (2015).

    Article CAS Google Scholar

23. G. P. Karayannidis, D. S. Achilias, I. D. Sideridou, and D. N. Bikiaris, *Eur. Polym. J.*, **41**, 201 (2005).

    Article CAS Google Scholar

24. P. P. Vallejo, B. L. López, and E. A. Murillo, *Prog. Org. Coat.*, **87**, 213 (2015).

    Article CAS Google Scholar

25. N. Dayma, H. S. Jaggi, and B. K. Satapathy, *Mater. Des.*, **33**, 510 (2012).

    Article CAS Google Scholar

26. W. Zhang, J. Tabei, M. Shiotsuki, and T. Masuda, *Polym. Bull.*, **57**, 463 (2006).

    Article CAS Google Scholar

27. M. S. Selim, M. A. Shenashen, A. E. A. M. ELSaeed, M. M. Selimd, and S. A. El-Safty, *RSC Adv.*, **7**, 21796 (2017).

    Article CAS Google Scholar

28. J. Vukovic, M. D. Lechner, and S. Jovanovic, *J. Serb. Chem. Soc.*, **72**, 1493 (2007).

    Article CAS Google Scholar

29. S. Haseebuddin, R. Parmar, G. Waghoo, and S. K. Ghosh, *Prog. Org. Coat.*, **64**, 446 (2009).

    Article CAS Google Scholar

30. T. T. Hsieh, C. Tiu, and G. P. Simon, *Polymer*, **42**, 1931 (2001).

    Article CAS Google Scholar

31. E. Zagar, M. Huskic, and M. Zigon, *Macromol. Chem. Phys.*, **208**, 1379 (2007).

    Article CAS Google Scholar

32. N. E. Ikladious, S. H. Mansour, J. N. Asaad, H. S. Emira, and M. Hilt, *Prog. Org. Coat.*, **89**, 252 (2015).

    Article CAS Google Scholar

33. M. Xu, X. Yan, R. Cheng, and X. Yu, *Polym. Int.*, **50**, 1338 (2001).

Article CAS Google Scholar

34. S. Alfei and S. Castellaro, *Macromol. Res.*, **25** 1172 (2017).

Article CAS Google Scholar

35. J. Vukovic, D. Steinmeier, M. D. Lechner, S. Jovanovic, and B. Bozic, *Polym. Degrad. Stab.*, **91**, 1903 (2006).

Article CAS Google Scholar

36. Y. Ishida, K. Yokomachi, and M. Seino, *Macromol. Res.*, **15**, 147 (2007).

Article CAS Google Scholar

37. M. Rogunova, T. Y. S. Lynch, W. Pretzer, M. Kulzick, A. Hiltner, and E. Baer, *J. Appl. Polym. Sci.*, **77**, 1207 (2000).

Article CAS Google Scholar

38. E. Malmstrom, M. Johansson, and A. Hult, *Macromol. Chem. Phys.*, **197**, 3199 (1996).

Article Google Scholar