

## BAB V PENUTUP

### 5.1 KESIMPULAN

1. Hasil ini menunjukkan bahwa pendekatan grafting–aminasi–modifikasi TMAH merupakan metode yang sesuai untuk menghasilkan katalis heterogen berbasis polimer dengan di tandai perubahan warna dan permukaan pada PP nonwoven.
2. Hasil karakterisasi pada analisis BET menunjukkan terjadinya perubahan ukuran volume pada polipropilena nonwoven setelah proses grafting dan modifikasi, yang ditandai dengan perubahan mikropori akibat terbentuknya lapisan hasil grafting dan imobilisasi gugus fungsional. Sementara itu, hasil FTIR mengidentifikasi kemunculan pita serapan khas gugus karbonil (C=O) dan cincin epoksi dari GMA, gugus amina hasil aminasi, serta gugus kuarterner amonium dan regangan C–N yang berkaitan dengan kation tetrametilamonium. Temuan ini membuktikan bahwa proses grafting, aminasi, dan imobilisasi TMAH pada PP-GMA telah berlangsung secara berhasil.
3. Katalis TMAH dan Dea-TMAH yang telah dimodifikasi pada PP-GMA menunjukkan kinerja katalitik yang baik dalam reaksi transesterifikasi. Namun pada katalis PP-GMA-Dea-TMAH terjadi leaching. Keberadaan gugus basa kuat yang terimobilisasi secara stabil pada substrat polimer mampu memfasilitasi reaksi antara alkohol dan trigliserida, yang ditandai dengan terbentuknya dua lapisan produk reaksi. Pada kondisi reaksi optimum, katalis ini menghasilkan yield optimum sebesar 95,6% pada katalis PP-GMA-TMAH dengan waktu 120 menit dan yield 36,41% pada katalis PP-GMA-Dea-TMAH dengan waktu 180 menit.

### 5.1 SARAN

1. Katalis PP-GMA-Dea-TMAH menunjukkan terjadinya perubahan sifat fisik material hasil aminasi menjadi lunak serta *leaching* selama reaksi transesterifikasi, penelitian selanjutnya disarankan untuk mengoptimalkan kondisi aminasi, konsentrasi, dan kondisi reaksi, guna meningkatkan kestabilan struktur polimer serta mencegah terlepasnya spesies katalitik selama proses reaksi.

2. Sehubungan dengan perbedaan signifikan karakteristik pori dan kinerja katalitik antara PP-GMA-TMAH dan PP-GMA-Dea-TMAH yang diamati pada analisis BET dan uji reaksi, disarankan dilakukan pengujian lanjutan berupa uji kestabilan katalis dan penggunaan ulang (reusability) untuk mengevaluasi ketahanan katalis terhadap pelindian serta perubahan struktur selama siklus reaksi berulang.
3. Mengingat katalis PP-GMA-TMAH menunjukkan yield biodiesel yang jauh lebih tinggi dibandingkan sistem berbasis dietilamina pada kondisi reaksi tertentu, penelitian selanjutnya perlu mengkaji pengaruh variasi bahan baku minyak dan kondisi reaksi yang lebih luas untuk menilai konsistensi aktivitas katalitik serta potensi penerapan katalis pada skala yang lebih besar

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