Pengendalian suhu dan laju alir pada proses oligomerisasi di Pabrik Ester base oil menggunakan pengendali Multivariable Model Predictive Control (MMPC) = Temperature and flow rate control in the oligomerization process in Ester base oil plant using Multivariable Model Predictive Control (MMPC)

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Abstrak

Ester base oil merupakan pelumas alami yang telah diterima secara luas dikarenakan kemampuan pelumasannya yang tinggi, serta keunggulan seperti kinerja suhu rendah, indeks viskositas yang tinggi, pengurangan gesekan yang sangat baik, dan sifat anti aus. Proses sintesis ester base oil melibatkan dua tahapan utama, yaitu oligomerisasi dan esterifikasi. Penelitian ini bertujuan untuk mendapatkan rancangan serta mendesain pengendalian proses pada proses pre- treatment oligomerisasi pabrik ester base oil dengan multivariable model predictive control (MMPC) 4x4. Metode yang digunakan untuk mendapatkan model first order plus dead time (FOPDT) 4x4 adalah dengan cara dilakukan identifikasi sistem menggunakan metode Smith, metode Wade, dan metode Solver. Selanjutnya, ditentukan model FOPDT terbaik dengan membandingkan nilai root- mean-square error (RMSE) terkecil dari setiap metode. Metode tuning yang digunakan untuk MMPC adalah metode Shridhar-Cooper dilanjutkan dengan fine- tuning untuk mendapatkan nilai parameter P (prediction horizon), M (control horizon), dan T (sampling time). Parameter MMPC tersebut akan diuji berdasarkan respon kinerja pengendali terhadap pengujian set point (SP) tracking dan pengujian disturbance rejection. Kinerja MMPC juga akan dibandingkan dengan kinerja pengendali propotional-integral (PI) dengan perhitungan integral absolute error (IAE) dan integral square error (ISE). Hasil identifikasi sistem didapatkan model FOPDT terbaik menggunakan metode Smith yaitu M1V3, M2V1 ; metode Wade yaitu M1V2, M2V3, M2V4, M4V2 ; metode Solver yaitu M1V1, M1V4, M2V2, M3V1, M3V2, M3V3, M3V4, M4V1, M4V3, M4V4. Metode fine-tuning pada penyetelan MMPC menghasilkan parameter P, M, T terbaik masing-masing sebesar 350, 300, dan 2. Pada pengujian SP ttacking, MMPC menunjukkan kinerja terbaik dalam pengendalian suhu sedangkan kinerja pengendali PI lebih baik dalam pengendalian laju alir. Pada pengujian disturbance rejection, kinerja MMPC lebih baik dibandingkan pengendali PI dengan perbaikan kinerja pengendalian sebesar 7,16% - 61,35% untuk nilai IAE dan 13,96% - 88,60% untuk nilai ISE.

.....Ester base oil is a natural lubricant widely accepted due to its high lubricating ability, as well as advantages such as low-temperature performance, high viscosity index, excellent friction reduction, and anti-wear properties. The synthesis process of ester base oil involves two main stages, namely oligomerization and esterification. This research aims to obtain a design and design process control in the pre-treatment process of oligomerization in the ester base oil plant with multivariable model predictive control (MMPC) 4x4. The method used to obtain the first-order plus dead time (FOPDT) 4x4 model is by identifying the system using Smith's method, Wade's method, and Solver's method. Furthermore, the best FOPDT model is determined by comparing the smallest root-mean-square error (RMSE) values from each method. The tuning method used for MMPC is the Shridhar-Cooper method followed by fine-tuning to obtain the parameter values P (prediction horizon), M (control horizon), and T (sampling time). These

MMPC parameters will be tested based on controller performance responses to set point (SP) tracking testing and disturbance rejection testing. The performance of MMPC will also be compared with proportional-integral (PI) controllers using integral absolute error (IAE) and integral square error (ISE) calculations. The results of the system identification obtained the best FOPDT model using Smith's method, namely M1V3, M2V1; Wade's method, namely M1V2, M2V3, M2V4, M4V2; Solver's method, namely M1V1, M1V4, M2V2, M3V1, M3V2, M3V3, M3V4, M4V1, M4V3, M4V4 .The fine-tuning method in MMPC tuning resulted in the best P, M, T parameters of 350, 300, and 2 respectively. In SP tracking testing, MMPC showed the best performance in temperature control while PI controller performance was better in flow rate control. In disturbance rejection testing, MMPC performance was better than PI controllers with performance improvement ranging from 7.16% to 61.35% for IAE values and 13.96% to 88.60% for ISE values.