

**PENGEMBANGAN SISTEM PENGATURAN SUHU BERBASIS *FUZZY*  
*LOGIC* PADA PROSES DISTILASI ETHANOL TETES TEBU**

**TESIS**

Karya Ilmiah sebagai salah satu syarat untuk menyelesaikan jenjang strata dua (S-2)  
di Departemen Teknik Elektro, Fakultas Teknik, Universitas Andalas



**Program Studi Magister  
Departemen Teknik Elektro Fakultas Teknik  
Universitas Andalas  
2025**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                          |                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|----------------------|
| Judul                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Pengembangan Sistem Pengaturan Suhu Berbasis <i>Fuzzy Logic</i> Pada Proses Distilasi Ethanol Tetes Tebu | Maulana Naseem Hamed |
| Program Studi                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Magister Teknik Elektro                                                                                  | 2320952003           |
| Fakultas Teknik Universitas Andalas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                          |                      |
| <p style="text-align: center;"><b>ABSTRAK</b></p> <p>Proses distilasi tetes tebu menjadi bioetanol memerlukan pengendalian suhu yang presisi agar menghasilkan produk dengan kualitas optimal. Sistem pemanas konvensional yang tidak adaptif terhadap perubahan kondisi operasional sering kali menyebabkan ketidakstabilan suhu, yang berdampak pada efisiensi dan hasil distilasi. Penelitian ini bertujuan mengembangkan sistem pengendalian suhu berbasis logika fuzzy untuk meningkatkan kinerja proses distilasi ethanol dari tetes tebu. Sistem dirancang menggunakan sensor suhu thermocouple type J, mikrokontroler Arduino Due, dan dimmer AC sebagai aktuator yang dikendalikan melalui sinyal PWM. Dua parameter input—yaitu error dan delta error—digunakan sebagai dasar inferensi fuzzy Mamdani, dengan metode defuzzifikasi centroid untuk menentukan besaran sinyal kontrol. Pengujian dilakukan melalui simulasi dan realisasi sistem nyata, dengan evaluasi terhadap waktu respon dan kestabilan suhu. Hasil menunjukkan bahwa sistem fuzzy mampu mencapai setpoint dalam waktu sekitar 30 menit dan mempertahankan suhu sesuai set point. Implementasi sistem ini menunjukkan bahwa pendekatan logika fuzzy mampu menjalankan pengendalian suhu secara adaptif terhadap dinamika proses distilasi</p> <p>Kata Kunci : Distilasi Tetes Tebu, Logika Fuzzy, Kendali Suhu, Arduino Due, Sensor Thermocouple</p> |                                                                                                          |                      |

|                                                |                                                                                                          |                             |
|------------------------------------------------|----------------------------------------------------------------------------------------------------------|-----------------------------|
| <i>Title</i>                                   | <i>Development of Fuzzy Logic-Based Temperature Control in the Molasses Ethanol Distillation Process</i> | <i>Maulana Naseem Hamed</i> |
| <i>Mayor</i>                                   | <i>Master Degree of Electrical Engineering Department</i>                                                | <i>2320952003</i>           |
| <i>Engineering Faculty Universitas Andalas</i> |                                                                                                          |                             |

### **ABSTRACT**

*The distillation process of sugarcane molasses into bioethanol requires precise temperature control to ensure optimal product quality. Conventional heating systems that are not adaptive to changing operational conditions often result in temperature instability, affecting the efficiency and outcome of the distillation. This study aims to develop a fuzzy logic-based temperature control system to enhance the performance of the ethanol distillation process from molasses. The system is designed using a type-J thermocouple temperature sensor, an Arduino Due microcontroller, and an AC dimmer as the actuator controlled via a PWM signal. Two input parameters—error and delta error—are used as the basis for Mamdani fuzzy inference, with the centroid defuzzification method applied to determine the control signal magnitude. Testing was carried out through simulation and real system implementation, with evaluations focusing on response time and temperature stability. The results show that the fuzzy system is able to reach the setpoint within approximately 30 minutes and maintain the temperature at the setpoint. The system implementation demonstrates that the fuzzy logic approach is capable of adaptively controlling temperature in response to the dynamic nature of the distillation process.*

*Keywords: Molasses Distillation, Fuzzy Logic, Temperatur Control, Arduino Due, Thermocouple Sensor*