BAB III

METODE PENELITIAN

3.1 Desain Penelitian

Penelitian merupakan salah satu cara untuk mendapatkan hasil dari data yang diolah sehingga mendapatkan kesimpulan yang logis. Penelitian yang dilaksanakan harus berdasarkan dengan kaidah-kaidah keilmuan, antara lain: rasional, empiris, dan sistematis.

Pada skripsi ini, metode yang akan digunakan adalah metode eksperimental. Metode esperimental merupakan metode penelitian yang digunakan untuk mencari pengaruh perlakuan tertentu terhadap yang lain dalam kondisi yang terkendalikan (Sugiyono, 2006).

3.2 Lokasi dan Batas Uji

3.2.1 Lokasi Penelitian

Lokasi penelitian yang dipilih oleh peneliti adalah di perusahaan Indonesia Power UBP PLTP Kamojang unit Darajat 1 yang beralamatkan di Kampung Cileuleuy Desa Padaawas Kecamatan Samarang Kotak Pos 125 Garut 44101.

3.2.2 Batasan Uji

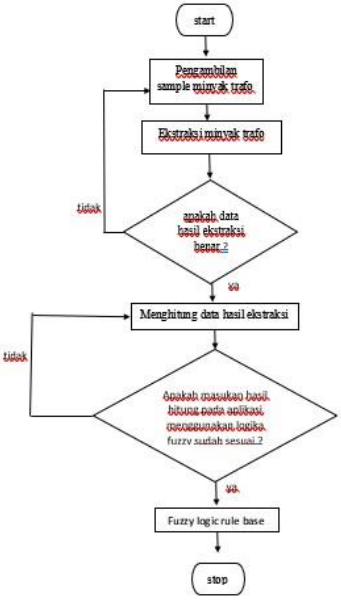
Batasan uji yang digunakan adalah uji DGA minyak transformator pada generator transformator utama di PLTP Kamojang Unit Darajat 1.

3.3 Prosedur Penelitian

Penelitian ini menggunakan data hasil ekstraksi minyak pada transformator menggunakan peralatan *dissolved gas* analysis dan diperoleh dari PT. Indonesia Power UBP PLTP Kamojang Unit Darajat. Tahap – Tahap perhitungan data ekstraksi gas antara lain sebagai berikut :

1. Pengambilan sampel minyak transformator selanjutnya diekstraksi.
2. Mendapatkan data hasil ekstraksi minyak pada transformator menggunakan metode *dissolved gas analysis.*
3. Menganalisa data hasil ekstraksi gas dan dihitung sesuai dengan stndar IEC, CEGB dan ASTM.

4. Memasukan hasil perhitungan pada Matlab menggunakan logika *fuzzy*.



Gambar 3.13 Diagram alur proses penelitian

3.4 Metode Pengumpulan Data

Dalam penelitian ini ada beberapa kegiatan yang telah dilakukan penulis berkaitan dengan pengumpulan data, adapun kegiatan tersebut adalah:

a. Observasi

Pengambilan data dengan menggunakan metode observasi dilakukan dengan cara mencari data-data teknis yang dibuthkan secara langsung. Penulis melakukan observasi langsung ditempat penelitian.

b. Wawancara

Pengambilan data dengan metode wawancara dilakukan dengan cara konsultasi dengan pelaku langsung yang mana disini adalah karyawan PT. Indonesia Power UBP Kamojang dan PLTP kamojang Unit Darajat. Penulis melakukan wawancara kepada narasumber dengan maksud agar mendapatkan informasi lebih lengkap dan akurat.

c. Diskusi

Melakukan konsultasi dan bimbingan dengan dosen pembimbing di Departemen Pendidikan Teknik Elektro Universitas Pendidikan Indonesia dan pihak-pihak lain yang membatu.

d. Studi literatur

Pengambilan data dengan metode literature dilakukan dengan mengumpulkan data dan materi yang berhubungan dengan penelitian, baik berasal dari buku, jurnal, internet, atau buku panduan dari PT. Indonesia Power.

e. Simulasi

Melakukan simulasi hasil dari perhitungan *dissolved gas analysis* dengan 3 standar *roger ratio* mengunakan logika *fuzzy* untuk mengetahui hasil uji.

3.5 Metode Pengolahan Data

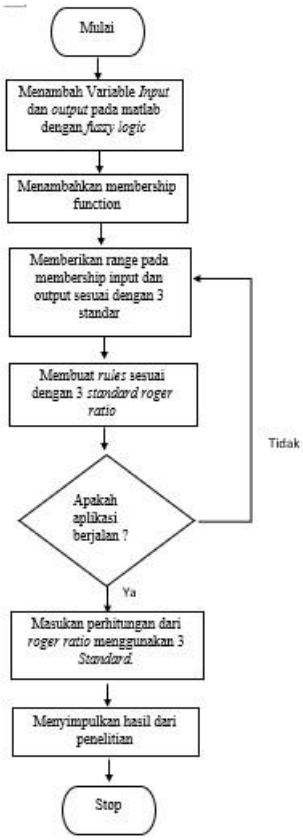
Dalam penelitian ini *instrument* yang digunakan adalah *software* Matlab R2014a bertujuan untuk menganalisis Hasil *Dissolved Gas Analysis* dengan menggunakan logika *fuzzy* untuk mengetahui gangguan pada transformator.

Setelah data dikumpulkan, maka penulis membuat rancangan dan kerangka penelitian ini direncanakan melalui beberapa tahap sebagai berikut :

1. Mencari data *dissolved gas analysis* di PLTP Kamojang dan PLTP kamojang unit Darajat. Akan dilakukan pengambilan sample maupun sudah berupa data hasil dari pengujian, adapun pengambilan sample akan dilakukan dengan metode *photoacoustic spectroscopy*. Dengan metode ini akan diperoleh jenis gas Hidrogen (H_2), Karbon Manoksida (CO), Karbon Dioksida (CO_2), Metana (CH_4), Etana (C_2H_6), Etilen (C_2H_4), Asetilen (C_2H_2), dan Air (H_2O).
2. Setelah melakukan pengambilan data langkah selanjutnya adalah mengalisa hasil ekstraksi gas, analisa ini bertujuan untuk melihat apakah ada kenaikan gas atau tidak dan data hasil analisa inilah yang akan digunakan sebagai input pada aplikasi untuk mendeteksi *fault* pada transformator.
3. Perhitungan data ekstraksi gas dengan menggunakan metode *Roger Ratio Standard ASTM, Standard IEC* dan *Standard CEGB*

pengitungan bertujuan untuk mendapatkan input *fuzzy rules based*, dengan perhitungan sebagai berikut :

a. *ASTM Standard*
   W = [illegible]/[illegible]
   X = [illegible]/[illegible]
   Y = [illegible]/[illegible]
   Z = [illegible]/[illegible]
b. *IEC Standard*
   X = [illegible]/[illegible]
   Y = [illegible]/[illegible]
   Z = [illegible]/[illegible]
c. *CEGB Standard*
   W = [illegible]/[illegible]
   X = [illegible]/[illegible]
   Y = [illegible]/[illegible]
   Z = [illegible]/[illegible]
   V = [illegible]/CO

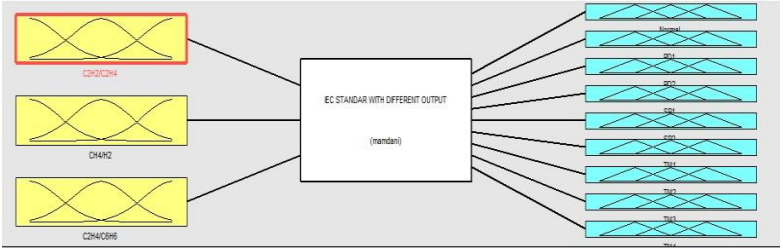


Gambar. 3.14 Diagram alur proses aplikasi fuzzy logic pada matlab

Adapun tahap – tahap penggunaan aplikasi Matlab menggunakan *Fuzzy Logic* adalah sebagai berikut :

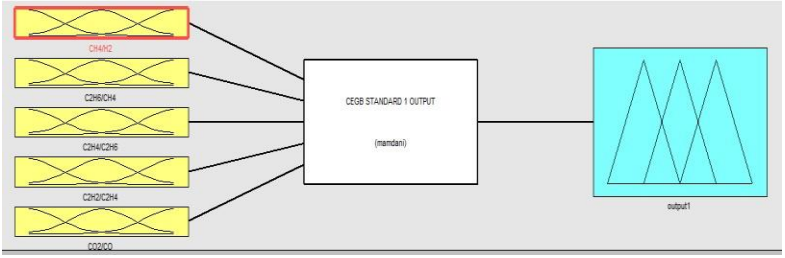
1. Menambahkan variable input dan output pada aplikasi, nilai yang diinput pada variable input dan output adalah sesuai dengan Variable *input Roger Ratio* 3 *standard.*

1.1 Input dan output *IEC Standard*



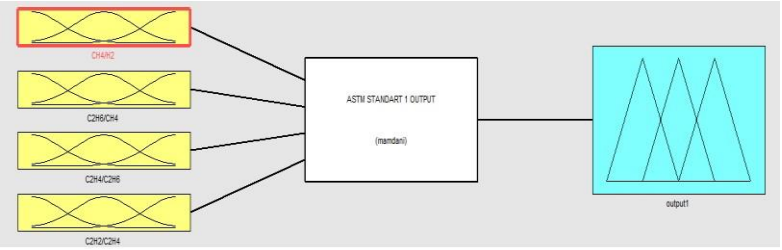
Gambar 3.15 Input dan Output standar IEC

1.2 Input dan Output *CEGB Standard*



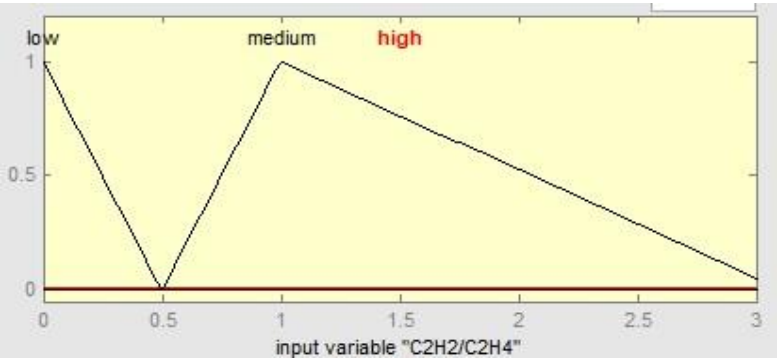
Gambar 3.16 Input dan Output Standar CEGB

1.3 Input dan Output ASTM *Standard*



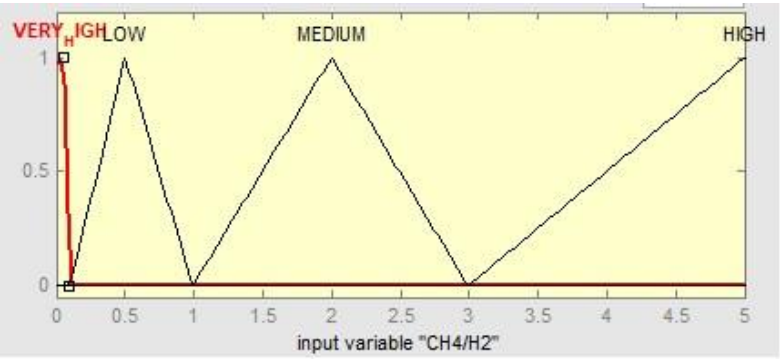
Gambar 3.17 Input dan Output Standar ASTM

2. Menambahkan *membership function* pada input *Roger Ratio* 3 *standard* menggunakan 2 metode yaitu metode 1 output dan metode output beragam. Memberikan *range data input* pada *membership function*, variable pada metode *Roger Ratio menggunakan* range data yang berkisar [0,5], [0.3], [0,4] dan [0,1].
   a. *Membership function input* pada ASTM



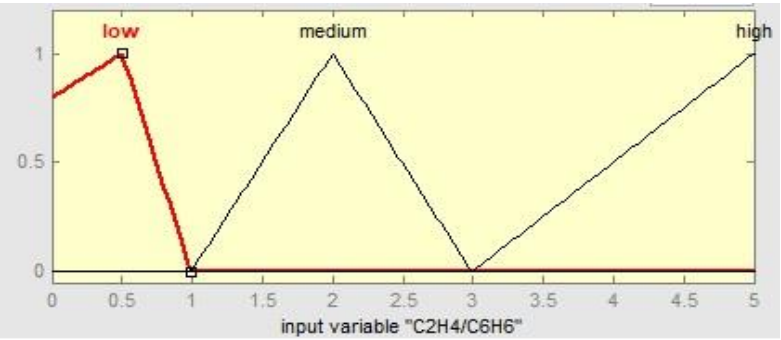
Gambar 3.18 Membership function input ASTM dengan variable C2H2/C2H4

   b. *Membership function input* pada *CEGB*



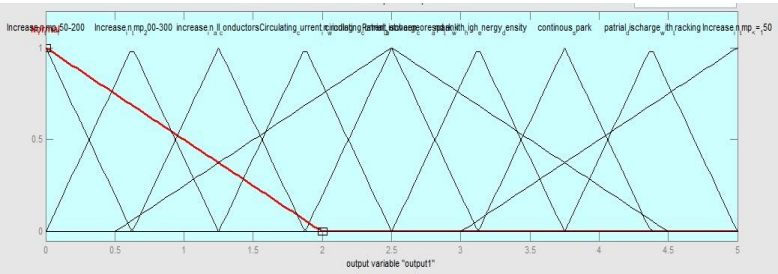
Gambar 3.19 Membership function input CEGB dengan variable CH4/H2

c. *Membership function input* pada IEC



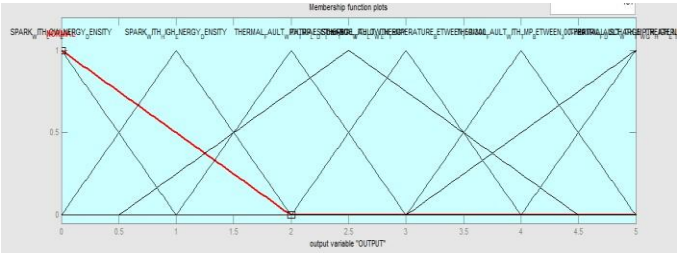
Gambar 3.20 Membership function input IEC dengan variable C2H4/C6H6

3. Memberikan *range data output* pada *membership function*, variable pada metode *Roger Ratio menggunakan* range data yang berkisar [0,5], [0.3], [0,4] dan [0,1].
   a. *Membership function output* pada ASTM dengan satu *output*



Gambar 3.21 Membership function output standar ASTM

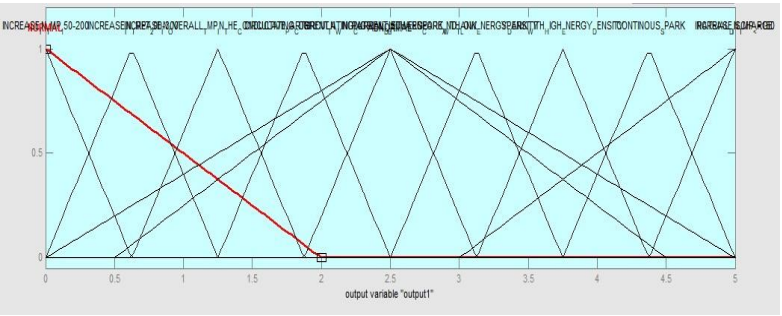
   b. *Membership function output* pada ASTM dengan lebih dari satu *output*
   c. *Membership function output* pada IEC dengan satu *output*



Gambar 3.22 Membership function output standar IEC

d. *Membership function output* pada IEC dengan lebih dari satu *output*

e. *Membership function output* pada CEGB dengan satu *output*



Gambar 3.23 Membership function output standar CEGB

f. *Membership function output* pada CEGB dengan lebih dari satu *output*

4. Memberikan *rule based*, pemberian *rule based* adalah untuk menjalankan program *fuzzy logic* agar dapat melakukan analisis indikasi gangguan pada transformator.

a. *Rules* untuk Metode ASTM Standard

1. If (CH4/H2 is HIGH_2) and (C2H6/CH4 is low) and (C2H4/C2H6 is low) and (C2H2/C2H4 is low) then (output1 is Normal) (1)
2. If (CH4/H2 is medium) and (C2H6/CH4 is low) and (C2H4/C2H6 is low) and (C2H2/C2H4 is low) then (output1 is Patrial_Discharge) (1)
3. If (CH4/H2 is very_high) and (C2H6/CH4 is low) and (C2H4/C2H6 is low) and (C2H2/C2H4 is low) then (output1 is Increase_in_tmp_<=_150) (1)
4. If (CH4/H2 is beyone) and (C2H6/CH4 is low) and (C2H4/C2H6 is low) and (C2H2/C2H4 is low) then (output1 is Increase_in_tmp_<=_150) (1)
5. If (CH4/H2 is very_high) and (C2H6/CH4 is medium) and (C2H4/C2H6 is low) and (C2H2/C2H4 is low) then (output1 is Increase_in_tmp_150-200) (1)
6. If (CH4/H2 is beyone) and (C2H6/CH4 is medium) and (C2H4/C2H6 is low) and (C2H2/C2H4 is low) then (output1 is Increase_in_tmp_150-200) (1)
7. If (CH4/H2 is beyone) and (C2H6/CH4 is medium) and (C2H4/C2H6 is low) and (C2H2/C2H4 is low) then (output1 is Increase_in_tmp_200-300) (1)
8. If (CH4/H2 is high) and (C2H6/CH4 is low) and (C2H4/C2H6 is medium) and (C2H2/C2H4 is low) then (output1 is increase_in_all_conductors) (1)
9. If (CH4/H2 is very_high) and (C2H6/CH4 is low) and (C2H4/C2H6 is medium) and (C2H2/C2H4 is low) then (output1 is Circulating_current_in_winding) (1)
10. If (CH4/H2 is very_high) and (C2H6/CH4 is low) and (C2H4/C2H6 is HIGH) and (C2H2/C2H4 is medium) then (output1 is circulating_current_between_core_and_tank) (1)
11. If (CH4/H2 is high) and (C2H6/CH4 is low) and (C2H4/C2H6 is low) and (C2H2/C2H4 is medium) then (output1 is spark_with_high_energy_density) (1)
12. If (CH4/H2 is high) and (C2H6/CH4 is low) and (C2H4/C2H6 is medium) and (C2H2/C2H4 is medium) then (output1 is spark_with_high_energy_density) (1)
13. If (CH4/H2 is high) and (C2H6/CH4 is low) and (C2H4/C2H6 is medium) and (C2H2/C2H4 is high) then (output1 is spark_with_high_energy_density) (1)
14. If (CH4/H2 is high) and (C2H6/CH4 is low) and (C2H4/C2H6 is HIGH) and (C2H2/C2H4 is medium) then (output1 is spark_with_high_energy_density) (1)
15. If (CH4/H2 is high) and (C2H6/CH4 is low) and (C2H4/C2H6 is HIGH) and (C2H2/C2H4 is high) then (output1 is continous_spark) (1)
16. If (CH4/H2 is medium) and (C2H6/CH4 is low) and (C2H4/C2H6 is low) and (C2H2/C2H4 is medium) then (output1 is patrial_discharge_with_tracking) (1)
17. If (CH4/H2 is medium) and (C2H6/CH4 is low) and (C2H4/C2H6 is low) and (C2H2/C2H4 is high) then (output1 is Patrial_Discharge) (1)

Gambar 3.24 Rules standar ASTM

b. *Rules* untuk metode IEC *Standard*

1. If (C2H2/C2H4 is low) and (CH4/H2 is low) and (C2H4/C6H6 is low) then (OUTPUT is NORMAL) (1)
2. If (C2H2/C2H4 is low) and (CH4/H2 is medium) and (C2H4/C6H6 is low) then (OUTPUT is PATRIAL_DISCHARGE_WITH_LOW_ENERGY) (1)
3. If (C2H2/C2H4 is medium) and (CH4/H2 is medium) and (C2H4/C6H6 is low) then (OUTPUT is PATRIAL_DISCHARGE_WITH_HIGH_ENERGY) (1)
4. If (C2H2/C2H4 is not low) and (CH4/H2 is low) and (C2H4/C6H6 is not low) then (OUTPUT is SPARK_WITH_LOW_ENERGY_DENSITY) (1)
5. If (C2H2/C2H4 is medium) and (CH4/H2 is low) and (C2H4/C6H6 is high) then (OUTPUT is SPARK_WITH_HIGH_ENERGY_DENSITY) (1)
6. If (C2H2/C2H4 is low) and (CH4/H2 is low) and (C2H4/C6H6 is medium) then (OUTPUT is THERMAL_FAULT_WITH_TMP_LESS_than_150) (1)
7. If (C2H2/C2H4 is low) and (CH4/H2 is high) and (C2H4/C6H6 is low) then (OUTPUT is THERMAL_FAULT_WITH_TEMPERATURE_BETWEEN_150-300) (1)
8. If (C2H2/C2H4 is low) and (CH4/H2 is high) and (C2H4/C6H6 is medium) then (OUTPUT is THERMAL_FAULT_WITH_TMP_BETWEEN_300-700) (1)
9. If (C2H2/C2H4 is low) and (CH4/H2 is high) and (C2H4/C6H6 is high) then (OUTPUT is THERMAL_FAULT_WITH_TMP_GREATER_THAN_150) (1)

Gambar 3.25 Rules standar IEC

c. *Rules* untuk metode CEGB *Standard*

1. If (CH4/H2 is LOW) and (C2H6/CH4 is LOW) and (C2H4/C2H6 is LOW) and (C2H2/C2H4 is LOW) then (output1 is NORMAL) (1)
2. If (CH4/H2 is VERY_HIGH) and (C2H6/CH4 is LOW) and (C2H4/C2H6 is LOW) and (C2H2/C2H4 is LOW) then (output1 is PATRIAL_DISCHARGE) (1)
3. If (CH4/H2 is MEDIUM) and (C2H6/CH4 is LOW) and (C2H4/C2H6 is LOW) and (C2H2/C2H4 is LOW) then (output1 is INCREASE_IN_TMP_<=150) (1)
4. If (CH4/H2 is HIGH) and (C2H6/CH4 is LOW) and (C2H4/C2H6 is LOW) and (C2H2/C2H4 is LOW) then (output1 is INCREASE_IN_TMP_<=150) (1)
5. If (CH4/H2 is MEDIUM) and (C2H6/CH4 is MEDIUM) and (C2H4/C2H6 is LOW) and (C2H2/C2H4 is LOW) then (output1 is INCREASE_IN_TMP_150-200) (1)
6. If (CH4/H2 is HIGH) and (C2H6/CH4 is MEDIUM) and (C2H4/C2H6 is LOW) and (C2H2/C2H4 is LOW) then (output1 is INCREASE_IN_TMP_150-200) (1)
7. If (CH4/H2 is LOW) and (C2H6/CH4 is MEDIUM) and (C2H4/C2H6 is LOW) and (C2H2/C2H4 is LOW) then (output1 is INCREASE_IN_TMPT_200-300) (1)
8. If (CH4/H2 is LOW) and (C2H6/CH4 is LOW) and (C2H4/C2H6 is MEDIUM) and (C2H2/C2H4 is LOW) then (output1 is INCREASE_IN_OVERALL_TMP_IN_THE_CONDUCTIVE_PARTS) (1)
9. If (CH4/H2 is MEDIUM) and (C2H6/CH4 is LOW) and (C2H4/C2H6 is MEDIUM) and (C2H2/C2H4 is LOW) then (output1 is CIRCULATING_CURRENT_IN_WINDING) (1)
10. If (CH4/H2 is MEDIUM) and (C2H6/CH4 is LOW) and (C2H4/C2H6 is HIGH) and (C2H2/C2H4 is LOW) then (output1 is CIRCULATING_CURRENT_BETWEEN_CORE_AND_TANK) (1)
11. If (CH4/H2 is LOW) and (C2H6/CH4 is LOW) and (C2H4/C2H6 is LOW) and (C2H2/C2H4 is MEDIUM) then (output1 is SPARK_WITH_LOW_ENERGY_DENSITY) (1)
12. If (CH4/H2 is LOW) and (C2H6/CH4 is LOW) and (C2H4/C2H6 is not LOW) and (C2H2/C2H4 is not LOW) then (output1 is SPARK_WITH_HIGH_ENERGY_DENSITY) (1)
13. If (CH4/H2 is LOW) and (C2H6/CH4 is LOW) and (C2H4/C2H6 is MEDIUM) and (C2H2/C2H4 is MEDIUM) then (output1 is CONTINOUS_SPARK) (1)
14. If (CH4/H2 is VERY_HIGH) and (C2H6/CH4 is LOW) and (C2H4/C2H6 is LOW) and (C2H2/C2H4 is not LOW) then (output1 is PATRIAL_DISCHARGE) (1)
15. If (CO2/CO is normal) then (output1 is NORMAL) (1)
16. If (CO2/CO is Abnormal) then (output1 is ABNORMAL) (1)

Gambar 3.26 Rules metode standar CEGB

5. Selanjutnya aplikasikan pada Simulink, langkah ini bertujuan untuk memastikan program berjalan sesuai dengan *rules* yang telah di*input*.

6. Merekap hasil dari percobaan *fuzzy logic*, dengan memasukan nilai-nilai dari hasil perhitungan *roger ratio* sesuai dengan 3 standar. Selanjutnya perhatikan bagaimana hasil dari penggunaan logika *fuzzy* tersebut.