

DAFTAR ISI

| | |
|---|-------|
| LEMBAR PENGESAHAN | iv |
| PERNYATAAN BEBAS PLAGIASI PENULIS 1 | v |
| PERNYATAAN BEBAS PLAGIASI PENULIS 2 | vi |
| PRAKATA | vii |
| DAFTAR TABEL | xvii |
| DAFTAR GAMBAR | xxiii |
| INTISARI | xxv |
| ABSTRACT | xxvi |
| BAB I PENDAHULUAN | 1 |
| 1.1 Latar Belakang | 1 |
| 1.2 Tinjauan Pustaka | 2 |
| 1.2.1 Deskripsi Metanol | 2 |
| 1.2.2 Teknologi Produksi Metanol | 3 |
| 1.3 Analisis Pasar Metanol | 6 |
| 1.3.1 Potensi Pasar | 6 |
| 1.3.2 Permintaan dan Segmentasi Pasar | 7 |
| 1.3.3 Pabrik Metanol di Dunia | 10 |
| 1.4 Penentuan Lokasi Pabrik | 12 |
| 1.4.1 Lokasi Pendirian Pabrik | 12 |
| 1.4.2 Pertimbangan Pemilihan Lokasi | 13 |
| 1.5 Penentuan Kapasitas Produksi | 18 |
| BAB II URAIAN PROSES | 21 |
| 2.1 Tahap Desulfurisasi | 21 |
| 2.2 Tahap Reforming | 21 |
| 2.3 Tahap Sintesis Metanol | 23 |

| | |
|---|-----------|
| 2.4 Tahap Distilasi | 24 |
| BAB III SPESIFIKASI BAHAN | 25 |
| 3.1 Bahan Baku | 25 |
| 3.1.1. Gas Alam..... | 25 |
| 3.2 Bahan Pembantu | 25 |
| 3.2.1. Oksigen | 25 |
| 3.2.2. Air | 26 |
| 3.3 Produk Utama..... | 26 |
| 3.3.1 Metanol | 26 |
| BAB IV DIAGRAM ALIR KUALITATIF DAN KUANTITATIF | 27 |
| 4.1 Diagram Alir Kualitatif | 27 |
| 4.2 Diagram Alir Kuantitatif..... | 28 |
| 4.3 <i>Process Flow Diagram</i> | 29 |
| BAB V NERACA MASSA | 30 |
| 5.1 Neraca Massa Total..... | 30 |
| 5.1 Neraca Massa Tiap Alat..... | 31 |
| 5.2.1 <i>Flash Separator</i> (FS – 01)..... | 31 |
| 5.2.2 <i>Mixing Point</i> (MIX – 01) | 31 |
| 5.2.3 <i>Desulfurizer</i> (DS – 01)..... | 32 |
| 5.2.4 <i>Mixing Point</i> (MIX – 02) | 32 |
| 5.2.5 <i>Prereformer</i> (REF – 01)..... | 33 |
| 5.2.6 <i>Autothermal Reformer</i> (ATR – 01)..... | 33 |
| 5.2.7 <i>Flash Separator</i> (FS – 02)..... | 34 |
| 5.2.8 <i>Mixing Point</i> (MIX – 03) | 34 |
| 5.2.9 Reaktor Metanol (R – 01) | 35 |
| 5.2.10 <i>Expansion Vessel</i> (EV – 01)..... | 35 |

| | | |
|----------------------------------|--|-----------|
| 5.2.11 | Menara Distilasi (MD – 01) | 36 |
| BAB VI NERACA PANAS | | 37 |
| 6.1 | Penentuan Asumsi | 37 |
| 6.2 | Neraca Panas Tiap Alat | 38 |
| 6.2.1 | <i>Flash Separator</i> (FS – 01)..... | 38 |
| 6.2.2 | Kompresor (C – 01) | 38 |
| 6.2.3 | <i>Mixing Point</i> (MIX – 01) | 39 |
| 6.2.4 | <i>Heat Exchanger</i> (HE – 01)..... | 39 |
| 6.2.5 | <i>Desulfurizer</i> (DS – 01)..... | 40 |
| 6.2.6 | <i>Mixing Point</i> (MIX – 02) | 40 |
| 6.2.7 | <i>Heat Exchanger</i> (HE – 02)..... | 41 |
| 6.2.8 | <i>Prereformer</i> (REF – 01)..... | 41 |
| 6.2.9 | <i>Heat Exchanger</i> (HE – 03)..... | 42 |
| 6.2.10 | <i>Autothermal Reformer</i> (ATR – 01) | 42 |
| 6.2.11 | <i>Heat Exchanger</i> (HE – 04)..... | 43 |
| 6.2.12 | <i>Flash Separator</i> (FS – 02)..... | 43 |
| 6.2.13 | <i>Mixing Point</i> (MIX – 03) | 44 |
| 6.2.14 | Kompresor (C – 02) | 44 |
| 6.2.15 | <i>Heat Exchanger</i> (HE – 05)..... | 45 |
| 6.2.16 | Reaktor Metanol (R – 01) | 45 |
| 6.2.17 | <i>Heat Exchanger</i> (HE – 06)..... | 46 |
| 6.2.18 | <i>Expansion Vessel</i> (EV – 01)..... | 46 |
| 6.2.19 | Menara Distilasi (MD – 01) | 47 |
| 6.2.20 | <i>Heat Exchanger</i> (HE – 07)..... | 47 |
| 6.2.21 | <i>Heat Exchanger</i> (HE – 08)..... | 48 |
| 6.2.22 | <i>Heat Exchanger</i> (HE – 09)..... | 48 |

| | |
|--|-----------|
| BAB VII SPESIFIKASI ALAT | 49 |
| 7.1 Separator..... | 49 |
| 7.1.1 Flash Separator (FS – 01)..... | 49 |
| 7.1.2 Flash Separator (FS – 02)..... | 51 |
| 7.1.3 Flash Separator (FS – 03)..... | 53 |
| 7.1.4 Expansion Vessel (EV – 01)..... | 55 |
| 7.2 Reaktor..... | 58 |
| 7.2.1 Desulfurizer (DS – 01)..... | 58 |
| 7.2.2 Prereformer (REF – 01)..... | 61 |
| 7.2.3 Autothermal Reformer (ATR – 01)..... | 63 |
| 7.2.4 Reaktor Metanol (R – 01)..... | 66 |
| 7.3 Menara Distilasi..... | 68 |
| 7.3.1 Menara Distilasi (MD – 01)..... | 68 |
| 7.4 Kompresor..... | 70 |
| 7.4.1 Kompresor (C – 01)..... | 70 |
| 7.4.2 Kompresor (C – 02)..... | 72 |
| 7.5 Pompa..... | 73 |
| 7.5.1 Pompa (P – 01)..... | 73 |
| 7.6 Tangki..... | 74 |
| 7.6.1 Tangki Metanol (TK – 01)..... | 74 |
| 7.7 Heat Exchanger..... | 76 |
| 7.7.1 Heat Exchanger (HE – 01)..... | 76 |
| 7.7.2 Heat Exchanger (HE – 02)..... | 77 |
| 7.7.3 Heat Exchanger (HE – 03)..... | 79 |
| 7.7.4 Heat Exchanger (HE – 04)..... | 80 |
| 7.7.5 Heat Exchanger (HE – 05)..... | 81 |

| | | |
|--------------------------------|--|-----|
| 7.7.6 | <i>Heat Exchanger (HE – 06)</i> | 83 |
| 7.7.7 | <i>Heat Exchanger (HE – 07)</i> | 84 |
| 7.7.8 | <i>Heat Exchanger (HE – 08)</i> | 85 |
| 7.7.9 | <i>Heat Exchanger (HE – 09)</i> | 87 |
| BAB VIII UTILITAS | | 89 |
| 8.1 | Unit Penyediaan dan Pengolahan Air (<i>Water System</i>) | 89 |
| 8.1.1. | Kebutuhan Air | 89 |
| 8.1.2. | Lokasi Pemilihan Sumber Air | 93 |
| 8.1.3. | Proses Pengolahan Air Laut | 93 |
| 8.1.4. | <i>Block Diagram</i> Pengolahan Air Laut | 77 |
| 8.1.5. | <i>Process Flow Diagram</i> Pengolahan Air Laut | 78 |
| 8.1.6. | Spesifikasi Alat Pengolahan Air Utilitas..... | 79 |
| 8.2 | Unit Pembangkit <i>Steam</i> (<i>Steam Generation System</i>) | 89 |
| 8.2.1. | Penjelasan Unit Pembangkit <i>Steam</i> | 89 |
| 8.2.2. | Spesifikasi Alat Pembangkit <i>Steam</i> | 92 |
| 8.3 | Unit Penyedia Listrik (<i>Power Distribution System</i>) | 104 |
| 8.3.1 | Penjelasan Skema Penyediaan Listrik..... | 104 |
| 8.3.2 | Perhitungan Kebutuhan Listrik | 106 |
| 8.4 | Unit Pengolahan Limbah (<i>Waste Treatment System</i>) | 109 |
| 8.4.1. | Penjelasan Skema Pengolahan Limbah..... | 109 |
| 8.5 | Unit Penyedia Udara Instrumen (<i>Instrument Air System</i>) | 116 |
| 8.5.1 | Penjelasan Unit Udara Instrumen..... | 116 |
| 8.5.2 | Perancangan <i>Air Compressor</i> (ACU – 01) | 117 |
| 8.5.3 | Perancangan Tangki Pengeringan Udara | 118 |
| 8.6 | Unit <i>Cooling Tower</i> | 119 |
| 8.6.1 | Penjelasan Skema Menara Pendingin | 119 |

| | | |
|-------------------------------|---|-----|
| 8.6.2 | Perancangan <i>Cooling Tower</i> | 120 |
| 8.6.3 | Perancangan <i>Fan Cooling Tower</i> | 127 |
| BAB IX ASPEK SHE | | 128 |
| 9.1 | Pentingnya Penerapan <i>Safety, Health, and Environment</i> (SHE) | 128 |
| 9.2 | Konsep SHE | 128 |
| 9.2.1 | <i>Safety</i> | 128 |
| 9.2.2 | <i>Health</i> | 129 |
| 9.2.3 | <i>Environment</i> | 129 |
| 9.3 | Struktur Organisasi Manajemen SHE | 129 |
| 9.4 | <i>Operating Procedures</i> | 132 |
| 9.4.1 | <i>Start – up</i> | 132 |
| 9.4.2 | Operasi Normal | 133 |
| 9.4.3 | Kondisi Darurat | 134 |
| 9.4.4 | <i>Shutdown</i> | 135 |
| 9.5 | Penerapan Umum Konsep SHE di Pabrik Metanol | 136 |
| 9.5.1 | Penerapan <i>safety</i> | 136 |
| 9.5.2 | Penerapan <i>health</i> | 138 |
| 9.5.3 | Penerapan <i>environment</i> | 139 |
| 9.6 | Identifikasi <i>Hazard</i> Bahan | 141 |
| 9.6.6 | Bahan Baku | 141 |
| 9.6.7 | Bahan Pendukung | 143 |
| 9.6.8 | Produk | 146 |
| 9.7 | Identifikasi <i>Hazard</i> Paparan Bahan Kimia | 146 |
| 9.8 | Identifikasi Potensi Paparan Fisis | 149 |
| 9.9 | Identifikasi <i>Hazard</i> Limbah | 150 |
| 9.9.1 | Emisi Gas | 150 |

| | | |
|-----------------------------|---|------------|
| 9.9.2 | Limbah Cair | 151 |
| 9.9.3 | Limbah Padat | 152 |
| 9.10 | Identifikasi <i>Hazard</i> Alat | 152 |
| 9.11 | Identifikasi <i>Hazard Plant Layout</i> dan Lokasi Proses | 155 |
| 9.12 | HAZOP Alat Utama | 158 |
| 9.12.1 | Pertimbangan Pemilihan Alat | 158 |
| 9.12.2 | Analisis HAZOP | 160 |
| 9.12.3 | <i>Layer Protection Analysis</i> (LOPA) | 167 |
| BAB X | TATA LETAK PABRIK | 171 |
| 10.1 | <i>Layout</i> Pabrik Keseluruhan | 171 |
| 10.2 | <i>Layout</i> Peralatan Pabrik | 172 |
| BAB XI | ORGANISASI PERUSAHAAN | 173 |
| 11.1 | Bentuk Perusahaan | 173 |
| 11.2 | Struktur Organisasi | 174 |
| 11.3 | Tugas dan Wewenang | 176 |
| 11.4 | Pembagian Jam Kerja Karyawan | 183 |
| 11.5 | Perhitungan Kebutuhan Jumlah Operator | 185 |
| 11.6 | Penggolongan Gaji Karyawan | 186 |
| 11.7 | Kesejahteraan Sosial Karyawan | 187 |
| 11.8 | Manajemen Produksi | 189 |
| BAB XII | ANALISIS EKONOMI | 192 |
| 12.1 | Perhitungan Indeks Harga | 193 |
| 12.2 | Perhitungan Ekonomi | 195 |
| 12.3 | Analisis Kelayakan | 208 |
| BAB XIII | KESIMPULAN | 215 |
| DAFTAR PUSTAKA | | 216 |

| | |
|---|------------|
| LAMPIRAN..... | 220 |
| L.1 <i>Standard and Code</i> | 220 |
| L.2 Pembagian Perancangan Alat | 221 |
| L.3 Perancangan Alat Proses | 221 |
| L.3.1 <i>Desulfurizer</i> (DS – 01) | 221 |
| L.3.2 <i>Prereformer</i> (REF – 01) | 243 |
| L.3.3 <i>Autothermal Reformer</i> (ATR – 01) | 263 |
| L.3.4 Reaktor Metanol (R – 01) | 283 |
| L.3.5 <i>Flash Separator</i> (FS – 01) | 309 |
| L.3.6 <i>Flash Separator</i> (FS – 02) | 318 |
| L.3.7 <i>Flash Separator</i> (FS – 03) | 330 |
| L.3.8 <i>Expansion Vessel</i> (EV – 01) | 343 |
| L.3.9 Menara Distilasi (MD – 01) | 352 |
| L.3.10 Kompresor (C – 01) | 365 |
| L.3.11 Kompresor (C – 02) | 373 |
| L.3.12 Pompa (P – 01) | 381 |
| L.3.13 Tangki (TK – 01) | 389 |
| L.3.14 <i>Heat Exchanger</i> (HE – 01) | 394 |
| L.3.15 <i>Heat Exchanger</i> (HE – 02) | 406 |
| L.3.16 <i>Heat Exchanger</i> (HE – 03) | 408 |
| L.3.17 <i>Heat Exchanger</i> (HE – 04) | 409 |
| L.3.18 <i>Heat Exchanger</i> (HE – 05) | 411 |
| L.3.19 <i>Heat Exchanger</i> (HE – 06) | 412 |
| L.3.20 <i>Heat Exchanger</i> (HE – 07) | 413 |
| L.3.21 <i>Heat Exchanger</i> (HE – 08) | 415 |
| L.3.21 <i>Heat Exchanger</i> (HE – 09) | 416 |

L.4 Perancangan Alat Utilitas..... 417