SOFTWARES FOR CHEMICAL PROCESS DESIGN – *Computer-Aided Chemical Design*

PERANCANGAN PROSES KIMIA
(*CHEMICAL PROCESS DESIGN*)

Section 2 oleh: Dr. Istadi, ST, MT

Kode Mata Kuliah : TKK 345
Beban : 3 SKS

Literatures:

- Alexandre C. Dimian and Costin Sorin Bildea, 2008, ***Chemical Process Design: Computer-Aided Case Studies***, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim
- Seider, W.D., J.D. Seider, Lewin, D.R., 2004, ***Product & Process Design Principles: Synthesis, Analysis and Evaluation***, John Wiley & Sons, Inc., New York
- Turton, R., Bailie, R.C., Whiting, W.B., Shaeiwitz, J.A., 2003, ***Analysis, Synthesis and Design of Chemical Process***, Prentice Hall PTR, New Jersey

TIK

- Mampu memahami prinsip dasar dan tahap-tahap perancangan proses kimia.
- Mampu memahami dam menjelaskan struktur dan sintesis proses pada flow diagram.
- Mampu memahami dan menjelaskan rule of tumb sintesis proses kimia
- Mampu memilih system separator dan system reactor pada proses kimia
- Mampu menggunakan software/simulator untuk sintesis dan simulasi proses kimia
- Mampu memahami dan menjelaskan dasar-dasar sintesis jaringan pemanas, reaktor, dan separator.
- Mampu mendesain jaringan pemanas, reaktor, dan separator dengan efifiensi yang tinggi.

SILABUS – Section 2

- SOFTWARES FOR CHEMICAL PROCESS DESIGN – Computer-Aided Chemical Design
- Integrated Chemical Process Design
- Reactor-Separation-Heat Integrated Design
- Separation Principles
- Case Study

Simulasi Proses ??

- Suatu usaha untuk melakukan percobaan, analisa, optimasi, dan karakterisasi fenomena-fenomena dalam industri proses tanpa melakukan langsung di lapangan.
- Memindahkan proses yang berlangsung di pabrik ke dalam perangkat lunak komputer.

SEJARAH SIMULATOR

- **Ca 1960 → Research Simulators (PACER from Purdue University)**
- **1965 → Industry in house program (CHEOPS from Chevron)**
- **1970 → FLOWTRAN (from Monsanto)**
  DESIGN/2000 (from Chemshare)
  FLOWPACK, CAPES.
- **1975 → PROCESS (from Simulation Sciences/SimSci)**
- **1980 → ASPEN (from MIT and DOE) → ASPENTECH**
- **1981 → PRO/II (from Simulation Sciences)**
  SPEED UP for dynamic simulation
  QUASILIN ADVENT (from England)
  HYSIM (from Hyprotech)
  CHEMCAD (from Chemstations Inc.)

SEJARAH SIMULATOR (Cont.)

- **Awal 1990 → Advanced application (pinch analysis, conceptual design)**
  ENPRO (for environmental process)
  MAX (from ASPENTECH)
  PROvision (from SimSci)
- **1995 → Pengembangan ASPENPlus dan PRO/II**
  HYSIM became HYSYS
  Vendor-vendor mulai mengembangkan diversifikasi produk
- **Akhir 1990-an → Penggabungan perusahaan-perusahaan software development**
  - SimSci dibeli oleh InvenSys
  - Hyprotech oleh AEATech
  - dan akhirnya diakuisisi oleh ASPENTECH

APA YANG DAPAT DILAKUKAN DENGAN CHEMCAD BIDANG PENDIDIKAN?

PENDIDIKAN

- Memberikan gambaran nyata kepada mahasiswa mengenai karakteristik sebuah proses dan unit operasi.
- Membantu pemahaman mahasiswa terhadap konsep dasar suatu proses melalui simulasi.
- Memberikan gambaran kepada mahasiswa terhadap aspek-aspek praktis industri kimia melalui imulasi suatu industri.
- Mengiring imajinasi mahasiswa pada proses yang sebenarnya terjadi.
- Menarik perhatian mahasiswa karena kecanggihan dan modernitas simulator.
- Sebuah tools untuk melengkapi kompetensi lulusan teknik imia.

Pengembangan SDM

Contoh mata kuliah yang dapat menggunakan simulator

- Azas Teknik Kimia (Neraca Massa dan Energi)
- Termodinamika
- Operasi Teknik Kimia (Pemisahan Difusional, Mekanika Fluida)
- Alat-alat industri Kimia
- Perpindahan panas (HE)
- Teknik Reaksi Kimia
- Pengendalian Proses
- Tugas Akhir --> Prarancangan Pabrik

Azas Teknik Kimia	29%
Operasi Teknik Kimia	31%
Pemisahan Difusional	57%
Mekanika Fluida	7%
Termodinamika Teknik Kimia	36%
Teknik Reaksi Kimia	18%
Pengendalian Proses	52%
Perpindahan Panas	13%
Prarancangan Pabrik	94%

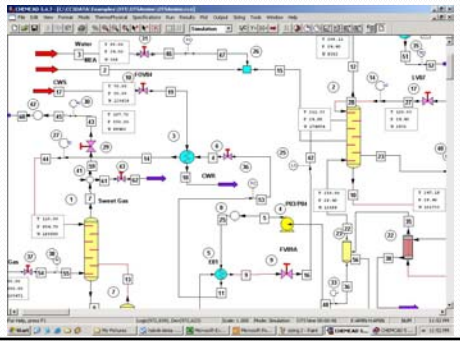
APLIKASI CHEMCAD

- **Distilasi/ekstraksi/absorpsi (Batch dan Kontinyu)**
- **Reaksi (Batch dan Kontinyu)**
- **Proses-proses elektrolitik**
- **Perhitungan sifat fisik dan termodinamika**

- **Perhitungan kesetimbangan fasa uap-cair (VLE), uap-cair-cair (VLLE), cair-cair (LLE).**
- **Perhitungan ukuran peralatan (equipment sizing)**
- **Perhitungan perpindahan panas**

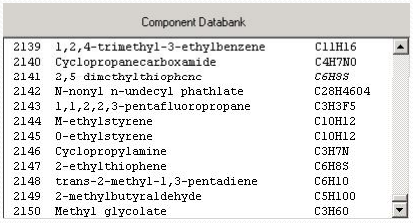
- **Piping system**
- **Heat exchanger network**
- **Utility network**
- **Safety analysis**

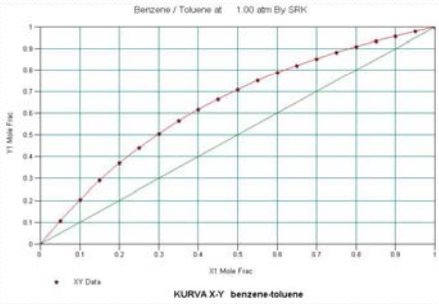
- **Neraca massa dan energi**
- **Plotting**
- **Perkiraan harga peralatan**
- **Solid handling**



DATA-DATA ENGINEERING

- Bank data untuk sifat fisik dan termodinamika (lebih dari 2000 bahan kimia dan elektrolit)
- Bank data BIP's untuk persamaan koefisien aktivitas
- Bank data elektrolit
- Bank data interaksi fasa uap





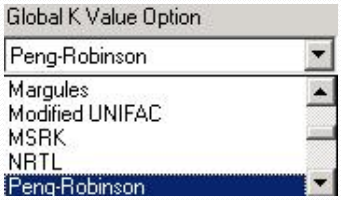
ChemCAD 6.0 (chemicals)

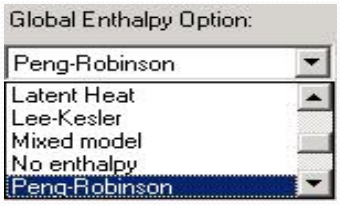
- Lebih dari 2150 senyawa kimia
- Organik, an-organik, elektrolit, bahan kimia formulasi (dengan merk dagang)
- Fasa (gas, cair, padat)
- Dapat ditambahkan senyawa lain (yang belum ada)
- Dapat diedit
- Metode searching → nama (kimia/dagang), rumus molekul, nomor urut (ChemCAD library)

NEW FEATURES OF CHEMCAD 6

METODE TERMODINAMIKA

- **K-Value**
  - > Hidrokarbon : Peng-Robinson, Soave-Redlich-Kwong (SRK), K-chart, API Soave, dll
  - > Chemicals : NRTL, UNIFAC, Wilson, UNIQUAC, Margules, Van Laar, dll
  - > Polymers : UNIFAC for polymers, Florry-Huggins
  - > Sistem khusus/spesial : Amines, sour water, dll
  - > Lain-lain : Henry,s gas law, vapor pressure, K-tables
- **Entalphi**
  - > Hydrocarbon dan petrokimia : BWRS, Peng-Robinson, Soave-Redlich-Kwong (SRK), Lee-Kessler, dll
  - > Chemicals : Latent heat, integral heat of solution
  - > Water : steam tables
  - > Lain-lain : amines, polynomial, H-tables.





CHEMCAD applications include:

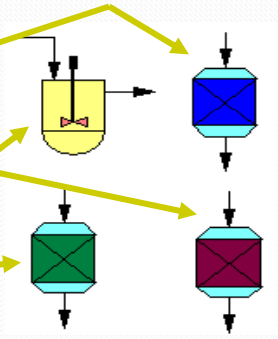
- Research and Development
- Project/Process Design
- Project/Process Redesign and Optimization
- Operations/Maintenance
- Safety and Hazard Analysis
- Environmental Study and Analysis
- Project and Product Sales
- Education

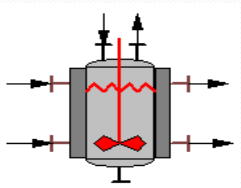
Industries that use CHEMCAD include:

- Exploration and Production
- Refining
- Commodity Chemicals
- Fine and Specialty Chemicals
- Pharmaceuticals
- Custom and Toll Manufacturing
- Engineering and Construction
- Consulting
- Process Equipment Manufacturing
- Academic University Programs

Satuan Operasi

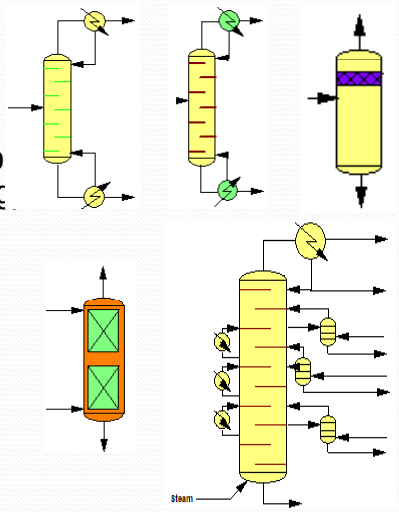
- **Reaktor**
  - **Reaktor stoikiometri**
  - **Reaktor kesetimbangan**
    - General
    - Metanasi
    - Shift konversi
  - **Reaktor Gibbs**
  - **Reaktor kinetik**
    - CTSR
    - PFR
  - **Reaktor batch**





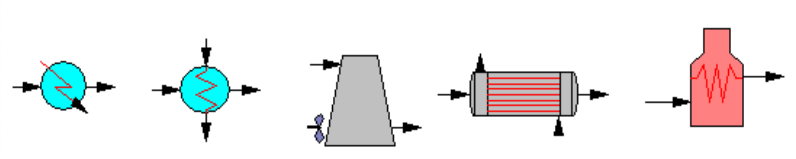
Gas/Vapor-Liquid Separation

- **Distilasi**
  - Shortcut
  - Rigorous
  - Tower plus (side stream, multip feed, pump around, intercooling
  - Distilasi reaktif
- **Absorpsi**
- **Flash**
- **Component separator**



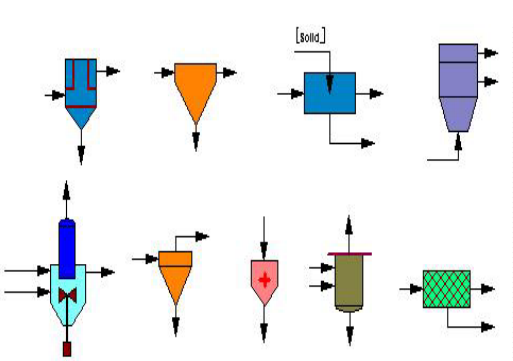
Perpindahan Panas

- Heat Exchanger (one-sided, two sided)
- Heat Exchanger (shell and tube, double pipe, air-colled, plate and frame)
- Heat exchanger (sensible heat, latent heat, condensation, evaporation)
- Furnace



SOLID HANDLING

- **Crystallizer**
- **Centrifugal filter**
- **Cyclone**
- **Washer**
- **Venturi Scrubber**
- **Baghouse filter**
- **Screen**
- **Hydrocyclone**
- **Vaccum filter**
- **Electrolitic Precipitator**
- **Dryer**
- **Sedimentation separator**
- **Crusher/grinder**

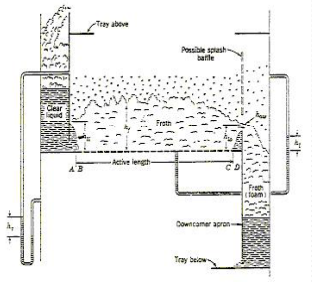


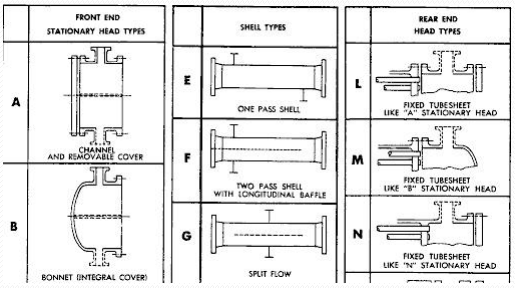
Pengaliran Bahan

- Pompa
- Feed and Product
- Kompresor/Ekspander
- Pipe
- Stream
- Valve
- Mixer/divider

EQUIPMENT SIZING

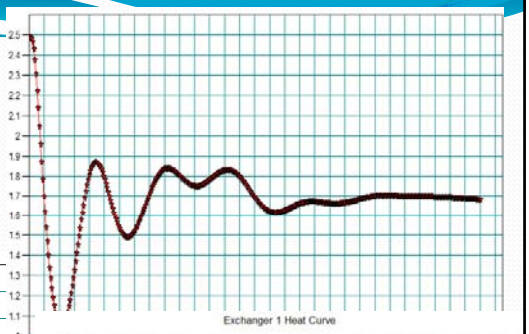
- Tray (sieve, valve, bubble cap)
- Packing (random and stuctured)
- Pipes
- Heat Exchanger (Shell and Tube, Air-cooled, Plate and Frame, double pipe)
- Pressure vessels
- Orifices
- Control valves
- Relief valves

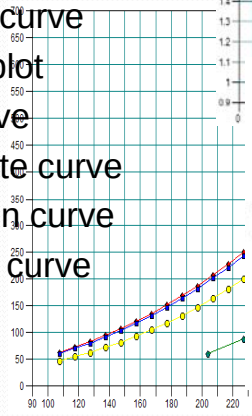


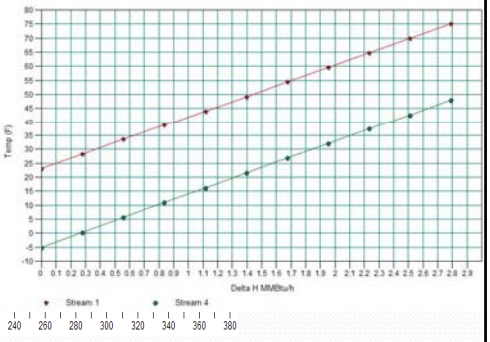


Plotting

- TP-xy diagram
- Phase envelope
- Residue curve
- Binodal plot
- Heat curve
- Composite curve
- Distillation curve
- Dynamic curve

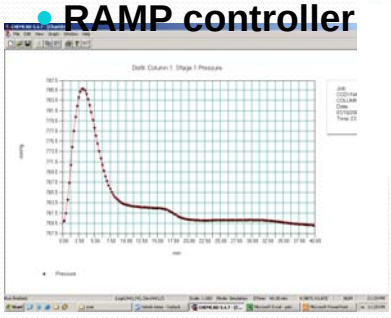


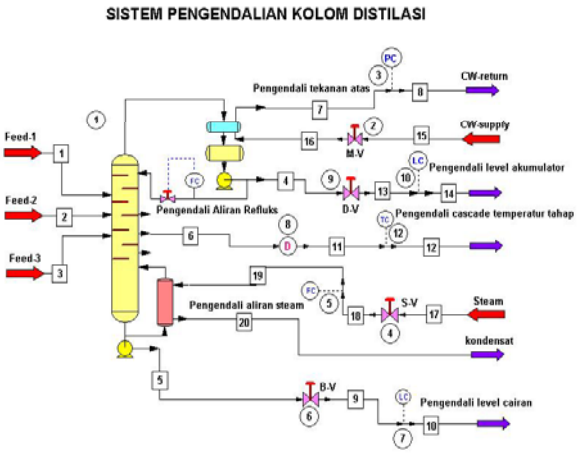




DYNAMIC SIMULATION

- Batch distillation
- Batch reactors
- PID controller
- Control valve
- Dynamic vessel
- RAMP controller





PLEASE REMEMBER

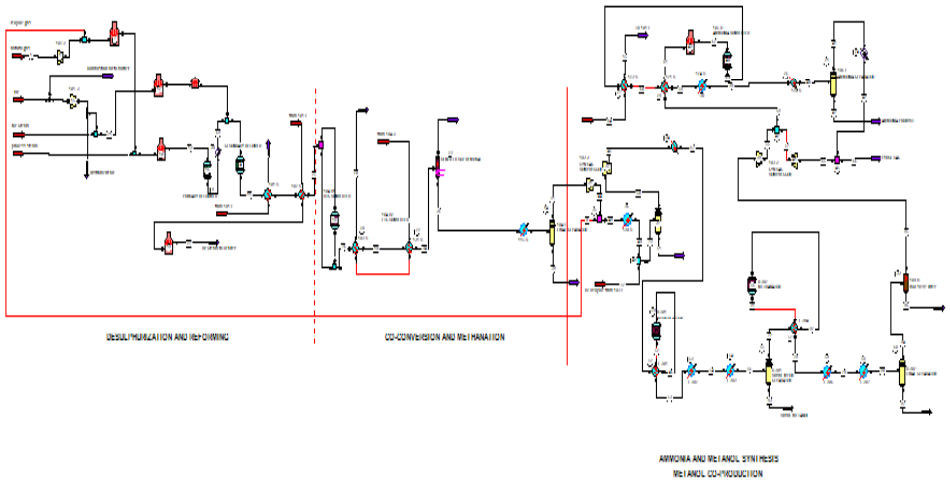
Just TOOLS.....

It's useless to operate without.....
Chemical Engineer's mind and
Sense of engineering

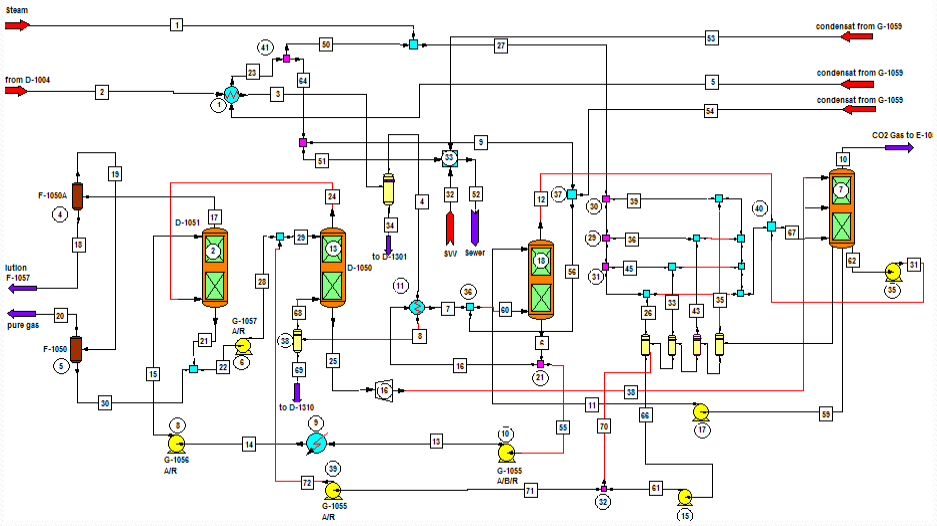
IMPORTANT

Good process knowledge and experiences

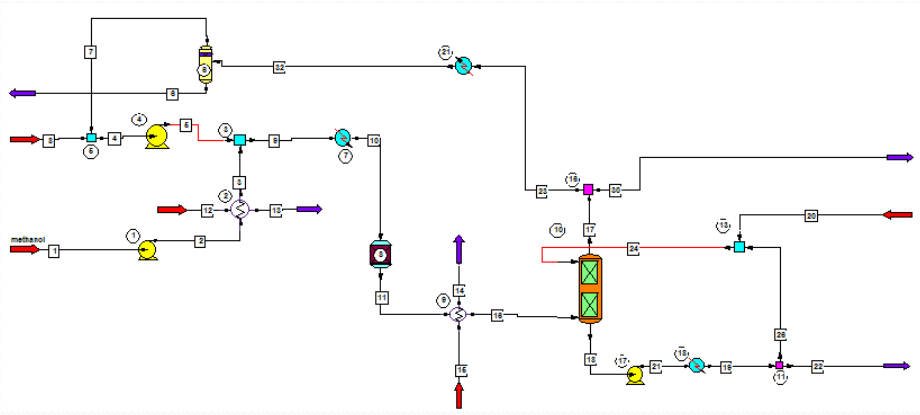
METHANOL CO-PRODUCTION IN AMMONIA PLANT



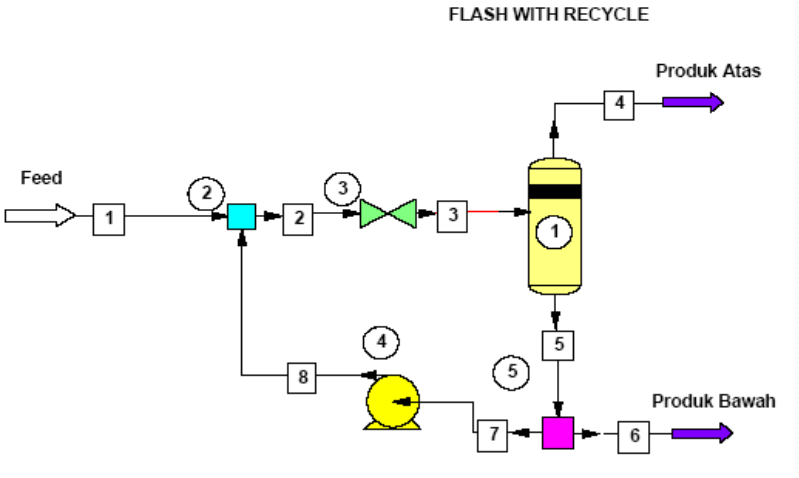
CARBONDIOXIDE REMOVAL WITH LEAN BENFIELD



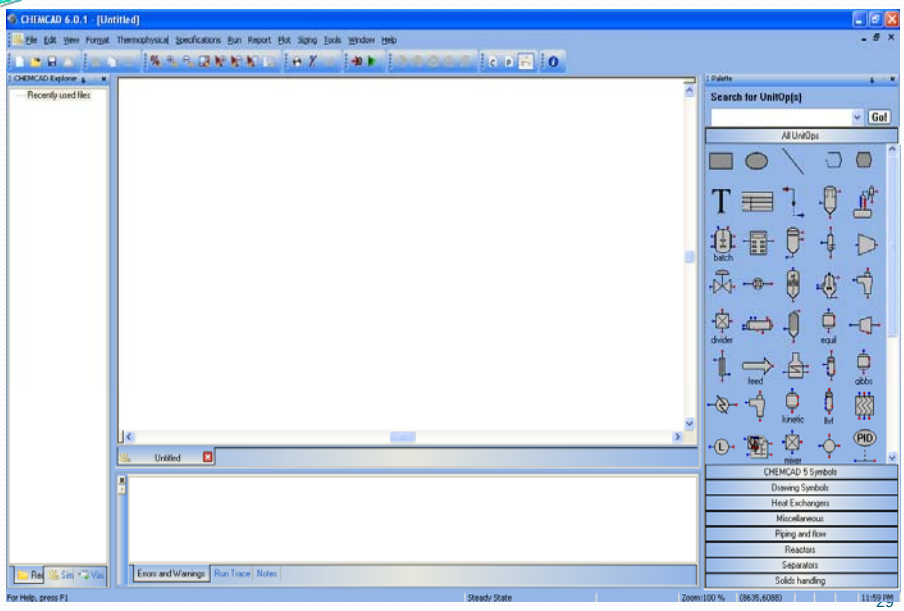
FORMALDEHYDE PRODUCTION FROM METHANOL OXIDATION



Flash & Recycle



DASAR-DASAR PENGGUNAAN CHEMCAD / HYSYS



SAATNYA KITA LATIHAN
DASAR-DASAR CHEMCAD