The University of Manchester

Centre for Process Integration

Process Integration Research Consortium (PIRC) Training and Resource Catalogue

December 2022

Overview

This catalogue is intended to list all the available archive material held at the centre (from 1999) which can be used by PIRC members for internal training and technology transfer. The catalogue will be updated periodically to reflect the output of the centre. Due to the changes in archiving regulations at the university we do not store copies to the academic output of the researchers as these are obtainable through the university library service.

This material can be obtained by make a request to cpitechsup@manchester.ac.uk . Where possible, electronic versions of the material will be emailed directly to the applicant. If the electronic versions are too large to be emailed, they will be temporarily mounted on a reserved web area for applicant download. The applicant will be emailed the link to this reserved area. The material will be removed from this reserved area after the applicant has confirmed downloading the material or a reasonable period of time has elapsed. If there is no electronic version of the material (Papers, Thesis), copies can be mailed to the applicant.

The type of material available

1. Video technical presentations (WebEx ARF and MP4 formats) (2014-)
2. Video workshop presentations (WebEx ARF and MP4 formats) (2014-)
3. Technical presentations (PDF) (1999-)
4. Poster presentations (PDF) (1999-)
5. Workshop material (PDF) (1999-)
6. Thesis (1985-2005)
7. Technical papers (1990-2012)

If there is a resource that you are seeking and cannot find or require help in identifying suitable material please contact to cpitechsup@manchester.ac.uk for more assistance

Contents

Presentations by topic

The presentations for previous PIRC meetings have been collated by topic to simplify the search for information related to a given technology area. Some of the presentations have the same name in different years but will contain additional material or a different emphasis on the subject

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Heat exchanger models

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Automated Design of Plate-fin Heat Exchanger Networks (2000)

Plate-fin Heat Exchanger Network Design and Retrofit (2002)

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Retrofit of Heat Exchanger Networks (2008)

Heat exchanger retrofit through heat transfer enhancement (2009)

Heat exchanger network retrofit through heat transfer enhancement (2010)

Modelling of Intensified Heat Transfer for the Retrofit of Heat Exchangers (2010)

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Retrofit of Heat Exchanger Networks (2015)

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Low Cost Retrofit Methods for Heat Exchanger Networks (2016)

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Fouling in Heat Exchanger Networks - A Review (2016)

Design and optimization of plate heat exchanger networks (2017)

Fouling Modelling in Crude Oil Preheating Systems (2017)

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Design and Optimization of Energy Systems for Effective Carbon Control (2012)

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Design and Optimization of Energy Systems for Effective Carbon Control (2013)

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Simulation and Optimisation of Integrated Gasification Combined Cycles_ (2015)

Integrating Multi-parallel Organic Rankine Cycles into Total Site for Waste Heat Recovery (2020)

Low temperature systems

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Low Temperature Processes -Two Recent Developments (2000)

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Design of Energy-efficient Mixed Refrigerant Cycles for LNG Production (2020)

Distillation systems

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Multicomponent Azeotropic Distillation Design - Dennis Y-C Thong

Synthesis and Optimisation of Ternary Azeotropic Distillation Flowsheets (2001)

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Molecular Modelling and Analysis of Diesel Hydrotreating Process (2003)

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Design and Synthesis of Chemical Absorption Processes (2004)

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Robust Operational Optimization of Crude Oil Distillation Systems Models (2019)

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Unified Characterisation Framework for Molecular Composition Reconstruction of Bio-Oil and Petroleum Fractions (2022)

Process Development for Crude Glycerol Purification and Process Integration into a Biodiesel Plant (2022)

Water systems

Cooling Water System Design (1999)

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Operational Optimisation of Industrial Cooling Water Systems (2015)

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Synthesis of Reaction/Separation Processes (1999)

Synthesis of Reactive Distillation (2000)

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Synthesis of Continuous Heterogeneous Catalytic Reactors (2002)

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Synthesis of advanced reactive distillation technologies: Early-stage assessment based on thermodynamic properties and kinetic parameters (2021)

Systematic Methodology for the Synthesis of Advanced Reactive Distillation Technologies (2022)

Process Synthesis and Intensification: Methodology for Selection of Advanced Reactive Distillation Technologies (2020)

Other

Integration of Planning and Scheduling for Batch Processes (2000)

Synthesis and Sequencing of Absorption Process (2000)

Value Analysis for Process Network Optimisation (2001)

Integration of Planning and Scheduling of Multi-purpose Batch Plants (2001)

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Integrating Reliability, Availability and Maintainability into Process Synthesis (2005)

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Process Reliability, Availability, Maintainability and Throughput Analysis (2008)

Enterprise-wide optimization of process industries (2014)

A novel approach to select and design target solvents in gas absorption systems (2014)

Software development review 2014 (2014)

Software Development and Distance Learning (2015)

Software Development and Distance Learning (2016)

Software Development and Distance Learning (2017)

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Applications of Data-driven Models in Process Optimisation and Design (2019)

Software Development and Distance Learning (2019)

Liquid Air Energy Storage – Analysis and Outlook (2019)

Process Systems Engineering from an industrial and academic perspective (2020)

A Methodology to Evaluate the Techno-economic and Environmental Sustainability of Solvent Extraction Processes (2020)

Deriving an Optimal Control Policy from Process Data and Reinforcement Learning (2020)

Decision support Framework for Conceptual Design of Sustainable Energy Systems (2021)

Rethinking energy use for a sustainable chemical Industry (2021)

Homotopy Continuation Enhanced Branch and Bound Algorithm for Process Synthesis using Rigorous Unit Operation Models (2021)

A knowledge-guided genetic algorithm for scheduling of multipurpose batch plant (2021)

Integrating techno-economic, environmental and safety criteria in solvent screening for extraction processes (2021)

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Safe Chance Constrained Reinforcement Learning for Batch Process Control (2021)

Industrial data science: A review of machine learning applications for the chemical and process industries (2022)

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Workshops by topic

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Heat Exchanger Networks

Heat exchanger network retrofits (2016) - HEN retrofit workshop highlighting different retrofit techniques

New developments in heat exchanger network targeting and design (2013) - Utility models, targeting, complex utility systems and complexity trade-offs

Heat exchanger network design and retrofit with fouling (2012) - Free format workshop including MER and Simulated Annealing, fouling models and cleaning schedules

Heat exchanger network retrofit with heat transfer enhancement (2011) - Free format workshop including MER and Simulated Annealing with Heat Transfer Enhancement and Sensitivity Analysis

Design of Heat exchanger networks (2009) - Basic pinch design method with multiple utilities and automated design

Energy efficiency and heat recovery (2008) - Basic pinch design method with Network Pinch and Simulated Annealing

Heat exchanger network design (2007) - Free format workshop including MER, Network Pinch and Simulated Annealing

Basic heat integration (2006) - Basic pinch design method

Energy systems (2005) - Free format workshop including MER, Network Pinch and Simulated Annealing (superseded)

Basic heat integration and site utilities (2003) - Pinch design method and total site targeting

Heat exchanger network design (2001) - Basic pinch design and Network Pinch

Energy system design update (2000) - Network Pinch and mixed refrigerant systems

Basic heat integration (2000) (superseded)

Utility Systems

Site utility systems (2016) - Utility system models with steam balancing, optimisation, GT integration and steam pricing

New developments in total site targeting (2014) - Non-isothermal stream profiles and simulation-based power target

Total site targeting and optimization (2012)

Cogeneration targeting and steam system optimization (2011)

Conceptual design of site utility systems (2009) - Energy and power targets data extraction and retrofit with carbon tax

Synthesis of total site utility systems (2007) - Free format workshop with site data extraction and utility system design

Reducing combustion emissions from utility systems (2007) - Fuels, combustion and emissions with decarbonisation

Site utility systems (2006) - Utility system models with steam balancing, optimisation, GT integration and steam pricing (superseded)

Utility system modelling (2006) - Utility system models with steam balancing, Energy audits and optimisation

Site utility systems (2005) - Utility system models with steam balancing, optimisation, GT integration and steam pricing (superseded)

Applications in energy systems (2004) - Free format workshop with basic pinch design and multiple utilities

Site utility systems (2004) - Utility system models with steam balancing, optimisation and steam pricing (superseded)

Basic heat integration and site utilities (2003) - basic pinch design, multiple utilities with total site profiles and targets

Advanced site utility systems (2003) - Steam system elements with top level analysis (withdrawn)

Site utility systems (2002) - Utility system models with steam balancing, optimisation, GT integration (superseded)

Steam system design (2002) - Steam system elements with top level analysis (withdrawn) (withdrawn/superseded)

Site utility systems (2001) - Steam system elements with top level analysis (withdrawn) (withdrawn/superseded)

Energy system design update (2001) - Site Heat-power ratio, R-Curve analysis, cooling water system design

Basic site utility systems (2000) - Utility system models with steam balancing, total site targeting (superseded)

Energy system design update (2000) - Network pinches and mixed refrigerant system (superseded)

Low Temperature Systems

Low temperature separation (2007) - Complex cycle and mixed refrigerants, heat integrated refrigeration systems, integrated refrigeration-separation system

Low temperature separation (2006) - Distillation sequencing with heat integration and refrigerated separation systems

Low temperature processes (2005) - Pure and mixed refrigerants, Compressor driver selection (series /parallel), refrigeration-separation system synthesis

Low temperature processes (2004) - Pure and mixed refrigerants, Compressor driver selection (series /parallel), refrigeration-separation system synthesis and dephlegmator

Integrated energy system design (2003) - Compressor driver selection, pure and mixed refrigerants, gas liquefaction and LNG plants

Distillations Systems

Heat-integrated refinery distillation (2009) - modelling and retrofit of heat integrated refinery columns

Heat-integrated distillation system design (2007) - Temperature-enthalpy analysis, Heat integrated sequencing

Low temperature separation (2007) - refrigeration systems, low temperature separation system design

Heat integrated distillation system design (2005) - Heat integrated sequences with refrigeration and heat pumps

Heat integrated refinery distillation (2005) - Heat integrated refinery distillation

Distillation and absorption (2004) - Retrofit hydraulic analysis, absorption systems

Distillation system design (2004) - Heat integrated sequences and dividing wall systems

Retrofit design for refinery distillation (2002) - Debottlenecking, temperature-enthalpy analysis, refinery distillation retrofit

Distillation (2001) - Heat integrated distillation sequences, refinery distillation, azeotropic distillation, extractive distillation

Advanced distillation (2000) - Debottlenecking, sequencing, dividing wall, refinery and extractive distillation

Refinery and Hydrogen Systems

Refinery hydrogen management (2007) - Hydrogen system targeting and optimisation with piping and design complexity

Refinery hydrogen management (2005) - Hydrogen system targeting and optimisation with multiple impurities

Refinery optimisation and hydrogen (2005) - Process simulation and site wide optimisation with hydrogen networks (withdrawn)

Refinery hydrogen management (2004) - Basic hydrogen system targeting and optimisation (superseded)

Refinery optimisation (2003) - Process simulation and site wide optimisation (withdrawn)

Refinery hydrogen management (2003) - Hydrogen system targeting and design (superseded)

Refinery optimisation and hydrogen management (2001) - Process simulation and site wide optimisation with hydrogen networks (superseded/withdrawn)

Refinery hydrogen management (2000) - Basic hydrogen system targeting and optimisation (superseded)

Refinery optimisation (2000) - Process simulation and site wide optimisation (superseded/withdrawn)

Water Systems

Water network design (2003) - Total Water system design (minimisation and treatment) with data extraction

Water system design (2002) - Water system minimisation design with pipework and complexity

Water network design including energy (2002) - Water system minimisation design with temperature constraints and buffering

Advanced water system design (2000) - Water system minimisation design and treatment system design (superseded)

Reactor Systems

Reaction - separation system design (2004) - Simulation and optimisation of Continuous reaction system with batch design and model building and discrimination and reaction-separation systems

Reaction system design (2002) - Simulation and optimisation of Continuous heterogeneous catalytic reaction system with batch crystalliser design and model building and discrimination

Reaction system design (2001) - Simulation and optimisation of Continuous heterogeneous catalytic reaction system

Reactor design (2000) - Optimisation framework for multiphase systems

Reaction and reaction separation system design (2000) - Optimisation framework for isothermal and non-isothermal systems with batch reactor design and reaction separation system

Other

Reliability, Availability and Maintainability (RAM) in process design (2008)

Video Courses

These courses are designed to be a standalone introduction to a giving technology area and form the basis for some of the more advanced workshop and presentation material

Basic pinch technology

Heat Integration and Pinch Technology

Session 1 - Energy Targets	ARF in ZIP (51 Mb)	MP4 in ZIP (11 Mb)
Session 2 - Heat Recovery Pinch	ARF in ZIP (37 Mb)	MP4 in ZIP (8 Mb)
Session 3 - HEN Design	ARF in ZIP (49 Mb)	MP4 in ZIP (11 Mb)
Session 4 - Data Extraction	ARF in ZIP (46 Mb)	MP4 in ZIP (11 Mb)

Total Site

Session 1 - Introduction and background	ARF in ZIP (39 Mb)	MP4 in ZIP (11 Mb)
Session 2 - Energy Targets for Total Site	ARF in ZIP (43 mb)	MP4 in ZIP (8 mb)
Session 3 - New Site Profiles	ARF in ZIP (40 Mb)	MP4 in ZIP (11 Mb)
Session 4 - Discrete Site Profiles	ARF in ZIP (36 Mb)	MP4 in ZIP (11 Mb)

Automated design of HEN

Session slides	ARF in ZIP	MP4 in ZIP
Session 1 - Automated Design for New Heat Exchanger Networks – I Optimisation of Superstructures	ARF in ZIP (24 Mb)	MP4 in ZIP(13 Mb)
Working session 1 - Optimisation of Superstructures	ARF in ZIP (29 Mb)	MP4 in ZIP (13 Mb)
Session 2 - Automated Design of New Heat Exchanger Networks – II Stochastic Optimisation	ARF in ZIP (24 Mb)	MP4 in ZIP (13 Mb)

Working session 2 - Stochastic Optimisation	N/A	N/A

Refinery hydrogen network targeting

Session 2 - Lecture slides	Datafiles	Solutions
Session 1 - Lectures 1-3 Video	ARF in ZIP (28 Mb)	MP4 in ZIP (13 Mb)
Session 2 - Lectures 4-8 Video	ARF in ZIP (39 mb)	MP4 in ZIP (18 mb)
Session 3 - Lectures 9-13 Video	ARF in ZIP (40 Mb)	MP4 in ZIP (19 Mb)
Session 4 - Working sessions Video	ARF in ZIP (27 Mb)	MP4 in ZIP (11 Mb)

Technical presentations

Heat Exchanger Network Retrofit with a Fixed Network Structure	ARF in ZIP (27.7Mb)	MP4 in ZIP (7.8MB)
Optimisation of Heat-Integrated Crude Oil Distillation Systems	ARF in ZIP (21.8Mb)	MP4 in ZIP (8.4MB)
Process Utility Systems Conceptual Design by Graphical Method	ARF in ZIP (24.9Mb)	MP4 in ZIP (10MB)

Getting started

To assist new member companies or employees, key training material has been selected from the significant available resource to ease the learning curve.

The training material is either: -

I) Video lecture series (usually 4 x 1hr) that give condensed technical presentations and software demonstrations

ii) 1 day taught course (approx 7hr) with a series of lectures and working sessions with solutions.

Basic heat integration

Basic heat integration (2014) - Basic pinch technology video presentation (4 x 1 hr videos)

Basic heat integration (2006) - Basic pinch design method. (1 day).

Heat exchanger network design

Automated design of Heat Exchanger Networks (2015) - HEN design for new and retrofit video presentation (4 x 1 hr videos)

Heat exchanger network design (2001) - Automated new design (1 day)

Heat exchanger network design (2007) - Automated retrofit design (1 day)

Heat exchanger network retrofit with heat transfer enhancement (2011) - Automated retrofit design with heat transfer enhancement technologies (1 day)

Utility systems

Total Site (2014) Total Site video presentation (4 x 1 hr videos).

Total site targeting and optimization (2012) - Total site heat recovery and cogeneration targeting. (1 day)

Site utility systems (2016) - Modelling and optimisation of site utility systems (1 day)

Refinery hydrogen systems

Refinery Hydrogen network targeting and design (2016) - Hydrogen network design video presentation (under development)

Refinery hydrogen management (2005) - Refinery hydrogen targeting and network design (1 day taught course)

Refinery hydrogen management (2007) - Refinery hydrogen targeting and network design (1 day taught course)

Presentations by year

All research presentations, posters and workshops listed annually from 1999

Pirc 2022

Research presentations (Video)

1. Synthesis and Optimisation of Complex Energy-integrated Distillation Systems - **Qing Li**
2. Automated Heat Exchanger Network Design and Optimisation for New Design and Retrofit - **Zekun Yang**
3. Industrial data science: A review of machine learning applications for the chemical and process industries - **Max Mowbray**
4. Systematic Methodology for the Synthesis of Advanced Reactive Distillation Technologies - **Isabel Pazmiño-Mayorga**
5. A Novel Algorithm for Solving Strongly Nonconvex MINLP Problems in Optimisation-based Process Design - **Chao Liu**
6. Unified Characterisation Framework for Molecular Composition Reconstruction of Bio-Oil and Petroleum Fractions - **Qiong Pan**
7. Process Development for Crude Glycerol Purification and Process Integration into a Biodiesel Plant - **Taha Attarbachi**
8. Multi-scale Design of MOF-based Membrane Separation for CO2/CH4 Natural Gas Mixtures - **Xi Cheng**
9. Surrogate-assisted Hybrid Optimisation of Pressure Swing Adsorption - **Yangyanbing Liao**
10. Process Intensification for a sustainable chemical industry - **Professor Tony Kiss**
11. Chemical Looping Reforming in Gas to Liquid Plants – **Christopher De leeuwe**
12. Optimal Synthesis and Design of Solar-aided Hydrogen Production Integrated with CO2 Utilization - **Wanrong Wang**
13. Integrated Design and Optimization of Solid Oxide Electrolysis Cells and Hydrogen-oxygen Combustion for Carbon Neutrality - **Shuhao Zhang**

Workshops (Video)

1. Towards Zero Carbon Process Utility Systems - **Julia Jimenez-Romero**
2. Synthesis of Heat Integrated Complex Distillation Sequences - **Steve Doyle**

Video presentations

1. SPRINT – A beginners guide Part 1 - **Steve Doyle**
2. SPRINT – A beginners guide Part 2 - **Steve Doyle**
3. SPRINT – A beginners guide Part 3 - **Steve Doyle**
4. SPRINT – A beginners guide Part 4 - **Steve Doyle**
5. Decision support Framework for Conceptual Design of Sustainable Energy Systems - **Julia Jimenez Romero**
6. The integration of multi-parallel ORCs into the total site with automatic working fluid selection - **Zheng Chu**
7. Rethinking energy use for a sustainable chemical industry - **Professor Tony Kiss**
8. Heat exchanger network synthesis with detailed heat exchanger optimisation - **Zekun Yang**
9. Homotopy Continuation Enhanced Branch and Bound Algorithm for Process Synthesis using Rigorous Unit Operation Models - **Yingjie Ma**
10. The Application of Machine Learning to Process Data Analytics - **Dr Dongda Zhang**
11. Synthesis of advanced reactive distillation technologies: Early-stage assessment based on thermodynamic properties and kinetic parameters Distillation Technologies - **Isabel Pazmiño-Mayorga**

Pirc 2021

Research presentations (Video)

1. Decision support Framework for Conceptual Design of Sustainable Energy Systems - **Julia Jimenez Romero**
2. The integration of multi-parallel ORCs into the total site with automatic working fluid selection - **Zheng Chu**
3. Rethinking energy use for a sustainable chemical Industry - **Professor Tony Kiss**
4. Heat exchanger network synthesis with detailed heat exchanger Optimisation - **Zekun Yang**
5. Homotopy Continuation Enhanced Branch and Bound Algorithm for Process Synthesis using Rigorous Unit Operation Models - **Yingjie Ma**
6. A knowledge-guided genetic algorithm for scheduling of multipurpose batch plant - **Dan Li**
7. Synthesis of advanced reactive distillation technologies: Early-stage assessment based on thermodynamic properties and kinetic parameters - **Isabel Pazmiño-Mayorga**
8. Integrating techno-economic, environmental and safety criteria in solvent screening for extraction processes - **Santiago Zapata Boada**
9. The Application of Machine Learning to Process Data Analytics - **Dr Dongda Zhang**
10. Optimal Design of Large-scale Solar-Aided Hydrogen Production Process using Molten Salt Via Machine Learning based Optimisation Framework - **Wanrong Wang**
11. Safe Chance Constrained Reinforcement Learning for Batch Process Control - **Max Mowbray**

Workshops (Video)

1. Power system design including contingency - **Steve Doyle**
2. FODSES: Decision support Framework for Conceptual Design of Sustainable Energy Systems - **Julia Jimenez Romero**

Video presentations

1. Basic Pinch Technology - Energy targeting - **Steve Doyle**
2. Basic Pinch Technology – MER HEN Design - **Steve Doyle**
3. Conceptual Design of Sustainable Utility Systems **- Julia Jimenez Romero**
4. Digitalisation - **Tom Savage**
5. Site steam systems - Steam Pricing **- Steve Doyle**
6. Heat Exchanger Network Synthesis with Detailed Optimization of Heat Exchangers - **Zekun Yang**
7. Optimal Design of Dividing Wall and Extractive Dividing Wall Columns Using a Novel Feasible Path Optimisation Algorithm - **Yingjie Ma**
8. Process Synthesis and Intensification: Methodology for Selection of Advanced Reactive Distillation Technologies - **Isabel Pazmino**

Pirc 2020

Research presentations (video)

1. Conceptual Design of Sustainable Utility Systems - **Julia Jimenez Romero**
2. Integrating Multi-parallel Organic Rankine Cycles into Total Site for Waste Heat Recovery - **Zheng Chu**
3. Process Systems Engineering from an industrial and academic perspective **Professor Tony Kiss**
4. Heat Exchanger Network Synthesis with Detailed Optimization of Heat Exchangers - **Zekun Yang**
5. Design of Energy-efficient Mixed Refrigerant Cycles for LNG Production - **Fernando Almeida-Trasvina**
6. Cyclic Distillation Technology: A new challenger in fluid separations - **Professor Tony Kiss**
7. A Methodology to Evaluate the Techno-economic and Environmental Sustainability of Solvent Extraction Processes - **Santiago Zapata Boada**
8. Process Synthesis and Intensification: Methodology for Selection of Advanced Reactive Distillation Technologies - **Isabel Pazmino**
9. Optimal Design of Dividing Wall and Extractive Dividing Wall Columns Using a Novel Feasible Path Optimisation Algorithm - **Yingjie Ma**
10. Deriving an Optimal Control Policy from Process Data and Reinforcement Learning - **Max Mowbray**

Workshops (video)

1. Workshop on Heat-Integrated Distillation System Design - **Steve Doyle**
2. Workshop on Sustainable Utility Systems - **Julia Jimenez Romero**

Video presentations

1. Reduction of Industrial Energy Demand Through the Integration of Flexible Utility Systems **- Julia Jimenez Romero**
2. Integration of Renewable Energy Sources into Petroleum Refining - **Mohamed Al Jamri**
3. Design of Energy-efficient Mixed Refrigerant Cycles for LNG Production - **Fernando Almeida Trasvina**
4. Refinery Hydrogen Systems **- Steve Doyle**
5. Systematic Development of Adsorption Processes for Gas Separation - **AbdulMalik Ajenifuja**
6. Refrigeration cycles - **Steve Doyle**
7. Optimisation of Shell and Tube Heat Exchanger Network With Detailed Heat Exchanger Models - **Zekun Yang**
8. Advanced distillation - **Professor Tony Kiss**

Pirc 2019

Research presentations

1. Reduction of Industrial Energy Demand Through the Integration of Flexible Utility Systems - **Julia Jimenez Romero**
2. Liquid Air Energy Storage – Analysis and Outlook - **Zhongxuan Liu**
3. Research Review - Advanced Distillation Technologies - **Professor Anton Kiss**
4. Innovative Method for Screening Reactive Distillation Designs - **Rahma Muthia**
5. Systematic Development of Adsorption Processes for Gas Separation - **AbdulMalik Ajenifuja**
6. Design of Energy-efficient Mixed Refrigerant Cycles for LNG Production - **Fernando Almeida Trasvina**
7. Data-Driven Modelling and Optimisation for Novel LNG Refrigeration Cycles - **Thomas Savage**
8. Integration of Renewable Energy Sources into Petroleum Refining - **Mohamed Al Jamri**
9. Robust Operational Optimization of Crude Oil Distillation Systems Models - **Xiao Yang**
10. Software Development and Distance Learning - **Steve Doyle**
11. Modelling and Integration of Process Networks for C4 Hydrocarbons - **Kokil Jain**
12. Optimisation of Shell and Tube Heat Exchanger Network With Detailed Heat Exchanger Models - Zekun Yang

Video presentations

1. Decarbonisation in Power Production and Process Sites **- Yuhang Lou** (PIL)
2. Fouling Modelling and Data Reconciliation in Crude Oil Preheating Systems - **Jose Loyola-Fuente**
3. Design and Optimization of Plate Heat Exchanger Networks - **Kexin Xu**
4. Design of Novel LNG Refrieration Cycles Based on Structural Modifications - **Hector Almeida Trasvia**
5. Distillation sequencing - **Steve Doyle**
6. Real Time Optimization of Crude Oil Distillation Systems Using Adaptive Linear Models - **Xiao Yang**
7. Refinery Fluid Catalytic Cracking Unit - **Mohamed Al Jamri**
8. Water minimisation/Effluent treatment - **Steve Doyle**

Pirc 2018

Research presentations

1. Reduction of Industrial Energy Demand through Integration of Sustainable Energy Hubs - **Julia Jimenez**
2. Design and Optimization of Plate Heat Exchanger Networks - **Kexin Xu**
3. A Novel Mapping Method for Checking the Applicability of Reactive Distillation - **Rahma Muthia**
4. Design of Novel LNG Refrigeration Cycles based on Structural Modifications - **Hector Almeida Trasvia**
5. Fouling Modelling and Data Reconciliation in Crude Oil Preheating Systems - **Jose Loyola-Fuentes**
6. Real Time Optimization of Crude Oil Distillation Systems Using Adaptive Linear Models - **Xiao Yang**
7. Molecular Modelling of Co-processing Biomass Pyrolysis Oil with Vacuum Gasoil in an Oil Refinery Fluid Catalytic Cracking Unit - **Mohamed Al Jamri**
8. Applications of Data-driven Models in Process Optimisation and Design - **Dongda Zhang**
9. Software development and distance learning – **Steve Doyle**

Poster sessions

1. Integration of Renewable Energy Sources into Petroleum Refining **- Mohamed Al Jamri, Robin Smith and Jie Li**
2. A New Optimisation-based Design Methodology for Energy-efficient Crude Oil Distillation Systems with Preflash Units - **Minerva Ledezma-Martínez, Megan Jobson and Robin Smith**
3. A Novel Method for Determining the Optimal Operating Points of Reactive Distillation Processes - **Rahma Muthia , Aloijsius G. J. van der Ham, Anton A. Kiss**
4. Novel Optimization Approach for Process scheduling - **Nikolaos Rakovitis, Jie Li and Nan Zhang**
5. Global Optimization for Scheduling of Gasoline Blending and Delivery Operations with Nonlinear Properties Correlations **- Rahul Kadam, Jie Li, Nan Zhang**
6. Site wise integration of waste heat recovery technologies - **Zheng Chu, Nan Zhang, Robin Smith**

Workshops

1. Steam System Modelling and Optimisation for Operability – **Steve Doyle**

Video presentations

1. Reduction of Industrial Energy Demand through the Integration of Flexible Utility Systems -**Julia Jimenez Romero**
2. Systematic Development of Adsorption Processes for Gas Separation - **AbdulMalik Ajenifuja**
3. Design of Energy-efficient Mixed Refrigerant Cycles for LNG Production - **Fernando Almeida Trasvina**
4. Refinery Hydrogen Systems - **Steve Doyle**
5. Integration of Renewable Energy Sources into Petroleum Refining - **Mohamed Al Jamri**
6. Refrigeration cycles - **Steve Doyle**
7. Optimisation of Shell and Tube Heat Exchanger Network With Detailed Heat Exchanger Models - **Zekun Y**

Pirc 2017

Research presentations

1. Fouling Modelling in Crude oil Preheating Systems - **José Loyola Fuentes**
2. Design and optimization of plate heat exchanger networks - **Kexin Xu**
3. Design and Optimisation of Novel Cascade Refrigeration Cycles for LNG Production - **Fernando Almeida-Trasviña**
4. Hybrid Membrane–Distillation Processes for Low Temperature Separation - **Merve Ceylan**
5. Molecular Characterisation and Modelling of Hydroprocesses **- Luwen Gong**
6. Renewable Energy Sources into Petroleum Refining for Sustainable Production of Transportation Fuels - **Mohamed Al Jamri**
7. Optimal Design of Flexible Heat-Integrated Crude Oil Distillation Units - **Dauda Ibrahim**
8. Design of Crude Oil Distillation Systems with Pre-Separation Units **- Minerva Ledezma-Martínez**
9. Software and distance learning review - **Steve Doyle**

Workshops

1. Heat Exchanger Network Retrofit - **Steve Doyle**

Video presentations

1. Design of Flexible Heat-integrated Crude Oil Distillation Units - **Dauda Ibrahim**
2. Distillation – Targeting and sequencing – Technology Review - **Steve Doyle**
3. Fouling in Heat Exchanger Networks – research review – **Robin Smith**
4. Fouling Modelling in Heat Exchanger Networks - **Jose Loyola Fuentes**
5. Heat Exchanger Networks using detailed models - **Steve Doyle**
6. Low Cost Heat Exchanger Network Retrofit - **Mary Akpomiemie**
7. Refinery Hydrogen Management - **Steve Doyle**
8. Water and Waste Water Minimization - **Steve Doyle**

Pirc 2016

Research presentations

1. Low Cost Retrofit Methods for Heat Exchanger Networks – Mary Akpomiemie
2. Fouling Modelling in Heat Exchanger Networks – Joes Loyola Fuentes
3. Development of Novel Refrigeration Cycles for Small Scale LNG Processes – Fernando Almeida Transvina
4. Optimisation of Petroleum and Petrochemical Planning and Scheduling Operations – Jie Li
5. Fouling in Heat Exchanger Networks - A Review – Robin Smith
6. Operational optimisation of recirculating cooling water systems – Fei Song
7. Simulation and Optimization of Integrated Gasification Combined Cycles (IGCC) – Chengjun Qian
8. Kinetic Modelling and Optimization of Hydrotreating Processes – Luwen Gong
9. Design of Flexible Heat-Integrated Crude Oil Distillation Units – Dauda Ibrahim
10. Software review 2016 – Steve Doyle

Poster sessions

1. Syngas separation process development applying MOF-based adsorbents and membranes; benchmark flowsheet development – Abulmalik, Megan Jobson
2. Integration of bio-based energy sources into petroleum refining for sustainable production of transport fuels – Mohamed Al Jamri, Robin Smith, Jei Li
3. Hybrid membrane-cryogenic distillation processes for air separation – Merve Ceylan, Megan Jobson, Robin Smith
4. Model reduction techniques for optimisation with inequalities and robust linear predictive control – Panagiotis Petsagkourakis, Constantinos Theodoropoulos, William Heath
5. Real time optimisation with robust feasibility and improvement under plant-model mismatch – Xiao Yang, Nan Zhang, Robin Smith
6. Design and optimisation of plate heat exchanger networks – Kexin Xu, Robin Smith, Nan Zhang
7. Design of crude oil distillation systems with pre-separation units – Minerva Ledezma-Matines, Megan Jobson, Robin Smith

Video presentations

Research Presentations

Retrofit of Heat Exchanger Networks	ARF in ZIP (18.2Mb)	MP4 in ZIP (7.8MB)
Conceptual Design of Site Waste Heat Recovery Systems	ARF in ZIP (39Mb)	MP4 in ZIP (13MB)
Heat Exchanger Network Retrofit with a Fixed Network Structure	ARF in ZIP (27.9Mb)	MP4 in ZIP (7MB)

Design and Optimisation of Plate Heat Exchanger Networks	ARF in ZIP (27Mb)	MP4 in ZIP (8MB)
Crude Oil Distillation Systems Networks	ARF in ZIP (57Mb)	MP4 in ZIP (25MB)

Technology and Software Workshops

Automated Design of Retrofit Exchanger Networks – II Stochastic Optimisation	ARF in ZIP (37.7Mb)	MP4 in ZIP (15.3MB)
Process Utility Systems - Steam Pricing and Cost Sensitivity	ARF in ZIP (21.8Mb)	MP4 in ZIP (8.4MB)
Heat exchanger network fouling and cleaning	ARF in ZIP (24.9Mb)	MP4 in ZIP (10MB)

Special Courses

Site utility systems (4 sessions)
Hydrogen management (4 sessions)

Workshops

Heat Exchanger Network Retrofit

Heat Exchanger Network Retrofit			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction		
Lecture 2	Retrofit of Networks Without Changes to the Network Structure	Working session	Solution

Lecture 3	The Network Pinch	Working session	Solution
Lecture 4	Pinch Retrofit Method	Working session	Solution
Lecture 5	Automated Approach to Network Retrofit	Working session	Solution
Lecture 6	Adding Heat Transfer Area in Network Retrofit	Working session	Solution
Lecture 7	Final comments		

Pirc 2015

Research presentations

1. Retrofit of Heat Exchanger Networks (Mary Akpomiemie) (Recording)
2. Design and Optimisation of Plate Heat Exchanger Networks (Kunpeng Guo) (Recording)
3. Operational Optimisation of Low-temperature Energy Systems (Dr. Megan Jobson) (Recording)
4. Operational Optimisation of Industrial Cooling Water Systems (Fei Song) (Recording)
5. Heat Exchanger Network Retrofit - Research Review (Professor Robin Smith) (Recording)
6. Interactions between Hydroprocesses and Hydrogen Networks (Luwen Gong) (Recording)
7. Simulation and Optimisation of Integrated Gasification Combined Cycles (Chengjun Qian) (Recording)
8. A Retrofit Approach for Crude Oil Distillation Systems (Victor Manuel Enriquez Gutierrez) (Recording)
9. Conceptual Design of Site Waste Heat Recovery Systems (Gbemi Oluleye) (Recording)
10. Software Development and Distance Learning (Steve Doyle) (Recording)

Poster sessions

1. Biochemical production of biobutanol from microalgal biomass (Gonzalo Figueroa)
2. Novel Approach for the Design of Flexible Chemical Processes (Dauda Ibrahim)
3. Development novel refrigeration cycle for a small to medium scale LNG processes (Fernando Almeida-Trasvina)
4. Design of Crude Oil Distillation Systems with pre-Separation Units (Minerva Ledezma-Martinez)
5. Hybrid Membrane-Distillation Processes for Air Separation (Merve Ceylan)
6. Multi-criteria screening of solvents via DEA - Application to CO2 capture (Phantisa Limleamthong)

Video presentations

Advanced Targeting for Multiple Utilities

Technical presentation ARF in ZIP25 mb) MP4 in ZIP (12 mb) Presentation slides (PDF) (750 kb)
Workshop ARF in ZIP (36 mb) MP4 in ZIP (15 mb) Workshop slides (PDF) (2.5 mb) Workshop datafiles (ZIP) (122 kb)

Automated Design for New Heat Exchanger Networks – I Optimisation of Superstructures

Technical presentation ARF in ZIP (40 mb) MP4 in ZIP (12 mb) Presentation slides (PDF) (750 kb)
Workshop ARF in ZIP (57 mb) MP4 in ZIP (12 mb) Workshop slides (PDF) (1.9 mb) Workshop datafiles (ZIP) (84kb)

Automated Design for New Heat Exchanger Networks – II Stochastic Optimisation

Technical presentation ARF in ZIP (42 mb) MP4 in ZIP (12 mb) Presentation slides (PDF) (400 kb)

Pirc 2014

Research presentations

1. Application of heat transfer enhancement in heat exchanger network retrofit (Mary Akpomiemie)
2. Optimisation of Plate-Fin Heat Exchanger Design (Kunpeng Guo)
3. Waste Heat Utilisation (Gbemi Oluleye)
4. Operational optimisation of industrial cooling water systems (Fei Song)
5. Molecular Characterisation of Refinery Gasoline Streams Streams (Luyi Lui)
6. Optimisation of refinery diesel blending (Shixun Jaing)
7. Integrated modelling and optimization of refinery hydrogen networks (Blessing Umana)
8. Retrofit of Crude Oil Distillation Systems (Victor Enriquez)
9. Software development review 2014 (Steve Doyle)
10. A novel approach to select and design target solvents in gas absorption systems (Dr. Maria Gonzalez Miquel)
11. Enterprise-wide optimization of process industries (Dr. Gonzalo Guillen-Gosalbez)
12. Review of Current Research on Site Utility System (Prof. Robin Smith)
13. Refinery Hydrogen Management (Yongwen Wu (PIL)

Poster sessions

1. Biopolymer Production from Glycerol – Modelling Prospects (Chenhao Sun, Cristina Pérez Rivero)
2. Molecular Characterisation of Gasoline Streams Using MTHS Representation (Luwen Gong)
3. Simulation and Optimisation of Integrated Gasification Combined Cycles (IGCC) (Chengjun Qian)
4. Retrofit of Distillation Columns together with their Heat transfer Devices (Mohammad Suleiman)
5. Forthcoming Horizon 2020 Project Applications (Dr. Igor Bulatov)
6. Enterprise-wide optimization of process industries (Dr. Gonzalo Guillén Gosálbez)
7. Multi-scale approach to develop sustainable separation processes solvents (Dr. Maria Gonzalez-Miquel)

Video presentations

Advanced Targeting for Multiple Utilities

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Automated Design for New Heat Exchanger Networks – II Stochastic Optimisation

Technical presentation ARF in ZIP (42 mb) MP4 in ZIP (12 mb) Presentation slides (PDF) (400 kb)

Heat Exchanger Network Retrofit with a Fixed Network Structure	ARF in ZIP (27.7Mb)	MP4 in ZIP (7.8MB)
Optimisation of Heat-Integrated Crude Oil Distillation Systems	ARF in ZIP (21.8Mb)	MP4 in ZIP (8.4MB)
Process Utility Systems Conceptual Design by Graphical Method	ARF in ZIP (24.9Mb)	MP4 in ZIP (10MB)

Pirc 2013

Research presentations

1. Conceptual Design Methodology for Total Site Analysis(Li Sun)
2. Integrated Modelling and Optimization of refinery hydrogen networks(Blessing Umana)
3. Optimisation of Heat-Integrated Crude Oil Distillation Systems (Lluvia Ochoa-Estopier)
4. Retrofit of crude oil distillation systems (Victor Enriquez Gutierrez)
5. Optimisation of Plate-Fin Heat Exchanger Design (Kunpeng Guo)
6. Hybrid membrane-distillation separation (Assma Etoumi)
7. Molecular Characterisation and Modelling for Refining Processes (Luyi Lui)
8. Optimisation of Refinery Diesel Blending (Shixun Jaing)
9. Waste Heat Utilization (Gbemi Oluleye)
10. Design and Optimization of Energy Systems for Effective Carbon Control (Mona Gharaie)

Poster sessions

1. Experimental Design and Scale up of Succinic Acid Production (Aikaterini Rigaki, Colin Webb and Kostas Theodoropoulos)
2. Yeast Microbial Oil: the potential for Biorefinery enhancement (Eleni Karamerou, Colin Webb and Kostas Theodoropoulos)
3. Wastewater Management in Refineries (Fei Song and Nan Zhang)
4. Hydrogen Integration in Oil Refining (Rizwan Ahmed Qamar, Nan Zhang and Robin Smith)
5. Modelling and Optimisation of Integrated Gasification Combined Cycles (IGCC) (Chengjun Qian, Nan Zhang and Robin Smith)
6. Debottlenecking Distillation and its Associated Heat Transfer Equipment (M. Awwal Suleiman, Megan Jobson and Robin Smith)
7. EFENIS: Energy Efficiency Demonstration in Manufacturing Industry (Li Sun, Ning Jiang, Nan Zhang and Robin Smith)

Workshops

New Developments in Total Site Targeting

New developments in Total Site Targeting			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction		
Lecture 2	Data extraction, Total Sites, and Initial Synthesis of Site Utility Systems	Working session	Solution
Lecture 3	Energy Targets for Site Utility Systems	Working session	Solution
Lecture 4	Power Targets for Site Utility Systems	Working session	Solution
Lecture 5	New Site Profiles	Working session	Solution
Lecture 6	New Power Model	Working session	Solution
Lecture 7	Discrete Process Site Profiles	Working session	Solution
Lecture 8	Conclusions		

New Developments in Heat Exchanger network Targeting and Design

New developments in Heat Exchanger network Targeting and Design			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction		
Lecture 2	Utilities – Selection Criteria	Working session	Solution
Lecture 3	Utilities – Models	Working session	Solution
Lecture 4	Utilities targeting	Working session	Solution
Lecture 5	Complex utility models	Working session	Solution
Lecture 6	Complexity –Total cost trade off	Working session	Solution
Lecture 7	Heat Exchanger Network design and multiple utilities	Working session	Solution
Lecture 8	Conclusions		

Summer workshops

Basic heat integration (2006)

Heat exchanger network design (2007)

Utility system modelling (2006)

Targeting and Design for Total Site Utility Systems (2009)

Heat-integrated distillation system design (2007)

Pirc 2012

Research presentations

1. Operational optimisation of crude oil distillation systems (Lluvia Ochoa-Estopier)
2. Intensified Heat Transfer Technologies for Retrofitting Heat Exchanger Networks (Ming Pan)
3. Hybrid membrane-distillation separation process synthesis and design (Asma Etoumi)
4. Operational optimization of low-temperature energy systems (Maria Montanez)
5. Integrating hydroprocessors into refinery hydrogen networks (Blessing Umana)
6. Molecular Characterisation of Petroleum Fractions (Luyi Liu)
7. Design and Optimization of Energy Systems for Effective Carbon Control (Mona Gharie)
8. Off-site process integration (Gbemi Oluleye)

Poster sessions

1. Distillation Retrofit **(**Victor Enriquez, Megan Jobson, Robin Smith)
2. REFFIPLANT project (Efficient Use of Resources in Steel Plants through Process Integration) **(**Robin Smith, Dr Igor Bulatov)
3. EFFENIS Project (Energy efficiency demonstration in manufacturing industry **) (** Li Sun, Ning Jiang)
4. Scheduling of refinery diesel blending **(**Nan Zhang, Shixun Jiang)
5. Hydrogen Integration in Oil Refining Along Inc. Light end recovery (Rizwan Qamar, Nan Zhang, Robin Smith)
6. Multi-scale modelling of backspillover process in CO Electrochemical Oxidation Ioannis S. Fragkopoulos
7. Application of Systems Biology in Biodiesel Manufacture (Liliana Angeles-Martinez, Constantinos Theodoropoulos
8. CAPSOL Project Post combustion CO2 Capture **(**Michael Binns and Nan Zhang)

Workshops

Total Site Targeting and Optimization

Total Site Targeting and Optimization			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction		
Lecture 2	Energy Targets and Total Site Composite Curves	Working session	Solution
Lecture 3	Cogeneration Targets for Total Sites	Working session	Solution
Lecture 4	Optimising Steam Levels	Working session	Solution
Lecture 5	Data extraction and Total	Working session	Solution
Lecture 6	Targeting to Design for Total Sites	Working session	Solution
Lecture 7	Conclusions		

Heat Exchanger Network Design and Retrofit with Fouling

Heat Exchanger Network Design and Retrofit with Fouling			
Objective			
Who should attend			
Skills developed			
Session 1	Heat Exchanger Network Design Using		

	Pinch Analysis		
Session 2	Simulated Annealing and Heat Exchanger Network Design		
Session 3	Simulated Annealing and Retrofit of Heat Exchanger Networks		
Session 4	Fouling Models and Dynamic Simulation of Fouling Networks		
Session 5	Optimization of Cleaning Schedules		
Session 6	Design of Heat Exchanger Networks Undergoing Fouling		
Appendix 1	Targeting with SPRINT		
Appendix 2	Heat Exchangers and SPRINT		
Appendix 3	Automated Design, Optimisation, and SPRINT		
Appendix 4	Simulated Annealing and Heat Exchanger Networks and SPRINT		

Summer workshops

Basic heat integration

Heat exchanger network design

Utility system modelling

Conceptual design of site utility systems

Refinery hydrogen management

Pirc 2011

Research presentations

1. Improving Energy Saving in Heat Exchanger Network with Intensified Heat Transfer (Ming Pan)
2. Heat exchanger network retrofit optimization involving heat transfer enhancement (Yufei Wang)
3. Design of Distributed Energy Centres (Gbemi Oluleye)
4. Design and Optimization of Energy Systems for Effective Carbon Control (Mona Gharaie)
5. Decarbonised Polygeneration from Fossil and Biomass Resources (Kok-Siew Ng)
6. Sustainable Production of Biodiesel (Anestis Vlysidis)
7. Design and Retrofit of Refinery Distillation Systems (Lluvia Ochoa-Estopier)
8. Synthesis and Design of Demethaniser Flowsheets (Muneeb Nawaz)

Poster sessions

1. Using Fenske Equations to Predict Products of Crude Oil Columns (Jing Liu)
2. Multiscale modelling of spillover processes in heterogeneous catalytic systems (Ioannis S. Fragkopoulos, Ioannis Bonis)
3. Molecular characterisation of gasoline streams using modified MTHS matrix (Luyi Liu)
4. Operational Optimisation of Low Temperature Energy Systems (Maria Montanez)
5. CPI Projects Overview (Igor Bulatov)
6. Interactions by Refinery Hydrogen Network and Users For Effective Hydrogen Use (Blessing Umana)

Workshops

Cogeneration Targeting and Steam System Optimization

Cogeneration Targeting and Steam System Optimization			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction		
Lecture 2	Energy Targets and Total Site Composite Curves	Working session	Solution
Lecture 3	Cogeneration Targets for Total Sites	Working session	Solution
Lecture 4	Optimising Steam Levels	Working session	Solution
Lecture 5	Data extraction and Total Sites	Working session	Solution
Lecture 6	Targeting to Design for Total Sites	Working session	Solution
Lecture 7	Conclusions		

Heat Exchanger Network Retrofit with Heat Transfer

Heat Exchanger Network Retrofit With Heat Transfer			
Objective			
Who should attend			
Skills developed			
Session 1	Heat Exchanger Network Design - An intuitive approach		

Session 2	MER approach to Heat Exchanger Networks		Solution
Session 3	Automated Design of Heat Exchanger Networks		
Session 4	Heat Transfer Enhancement		
Session 5	UA Sensitivity Tables	Working session	
Session 6	Optimisation Based Retrofit Design Involving Enhancement		
Appendix 1	Targeting with SPRINT		
Appendix 2	Heat Exchangers and SPRINT		
Appendix 3	Simulated Annealing and Heat Exchanger Networks and SPRINT		

Site Utility System

Site Utility System			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction		
Lecture 2	Steam Boilers	Working session	Solution
Lecture 3	Steam Turbines	Working session	Solution
Lecture 4	Gas Turbines	Working session	Solution
Lecture 5	Gas Turbine Heat Recovery	Working session	Solution
Lecture 6	Steam Balances and Energy Audits	Working session	Solution
Lecture 7	Steam System Optimisation	Working session	Solution
Lecture 8	Steam Pricing		

Summer workshops

Basic heat integration

Heat exchanger network design

Utility system modelling

Conceptual design of site utility systems

Heat-integrated distillation system design

Pirc 2010

Research presentations

1. Reliability Considerations in the Operations of Site Utility Systems (Zixin Lin)
2. Methodology for Design of Distributed Energy Centres (Leorelis Vasquez)
3. Heat exchanger network retrofit through heat transfer enhancement (Yufei Wang)
4. Modelling of Intensified Heat Transfer for the Retrofit of Heat Exchangers (Ming Pan)
5. Hydrogen Management for Refinery Applications (Nan Jia)
6. Molecular characterisation and octane prediction of gasoline streams blending (Yongwen Wu)
7. Modelling and Optimisation of Demethanizer Flowsheets (Muneeb Nawaz)
8. Site analysis for low grade heat transfer (Ankur Kapil)

Poster sessions

1. Techno-economic Analysis of Bio-oil platform for Polygeneration (Kok Siew Ng)
2. Design and Optimisation of Water Systems with Uncertainty (Szu-Wen Hung)
3. Retrofit of Energy Systems Considering CO2 Emissions (Mona Gharaie)
4. Synthesis of Hybrid Membrane-distillation Separations (Asma Etoumi)
5. Integrated Biorefinery Design and Optimisation (Elias Martinez Hernandez)

Workshops

Design of heat exchanger networks for multiple utilities

Design of heat exchanger networks for multiple utilities			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction		
Lecture 2	Energy Targets and the Problem Table Algorithm	Working session	Solution
Lecture 3	The Heat Recovery Pinch	Working session	Solution
Lecture 4	Heat Exchanger Network Design for Maximum Heat Recovery	Working session	Solution
Lecture 5	Stream Splitting	Working session	Solution
Lecture 6	Utilities and Utilities Targeting	Working session	Solution
Lecture 7	Heat Exchanger Network Design and Multiple Utilities	Working session	Solution

Conceptual design of site utility systems

Conceptual design of site utility systems			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction		
Lecture 2	Steam Boilers	Working session	Solution
Lecture 3	Steam Turbines	Working session	Solution
Lecture 4	Gas Turbines	Working session	Solution

Lecture 5	Gas Turbine Heat Recovery	Working session	Solution
Lecture 6	Steam Balances and Energy Audits	Working session	Solution
Lecture 7	Steam System Optimisation	Working session	Solution
Lecture 8	Steam Pricing		

Summer workshops

Basic heat integration

Heat exchanger network design

Utility system modelling

Conceptual design of site utility systems

Heat-integrated distillation system design

Pirc 2009

Research presentations

1. Operational Improvement in Utility Systems (Yuhang Lou and Ching-Chih Lai)
2. Refinery hydrogen network modelling and optimisation (Nan Jia)
3. Reliability Considerations in the Operation and Design of Site Utility Systems (Zixin Lin)
4. Heat exchanger retrofit through heat transfer enhancement (Yufei Wang)
5. Interactions with Hydroprocesses and Hydrogen Networks by Molecular Management (Yongwen Wu)
6. A Novel FCC Regeneration Process for Reduced CO2 Emissions (Yu Rong)
7. Synthesis of Demethanizer Flowsheets for Low Temperature Separation Processes (Muneeb Nawaz)
8. Thermodynamic Optimisation of Distillation Columns (Roger Zemp and Filipe Soares-Pinto)

Poster sessions

1. Distributed Energy System Design (Megan Jobson)
2. Exploitation of Low Grade Heat in Site Utility System (Ankur Kapil)
3. Membrane and Hybrid Separations for Ethylene Separation Asma Etoumi
4. Simulation-based Design Methodology for Retrofit in Gas Processing (Aurora Hernandez Enriquez)
5. Glycerol Utilisation for Platform Chemicals in an Integrated Biorefinery system (Anestis Vlysidis and Michael Binns)
6. Techniques for Linear Model Predictive Control of Large-scale Complex Systems (Weiguo Xie)

Workshops

Design of Heat exchanger networks

Design of Heat Exchanger Networks			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction		
Lecture 2	Setting Energy Targets	Working session	Solution
Lecture 3	The Problem Table Algorithm	Working session	Solution
Lecture 4	The Heat Recovery Pinch	Working session	Solution
Lecture 5	Heat Exchanger Network Representation	Working session	Solution
Lecture 6	Heat Exchanger Network Design for Maximum Heat Recovery	Working session	Solution
Lecture 7	Stream Splitting	Working session	Solution
Lecture 8	Multiple Utilities Targeting and Design	Working session	Solution
Lecture 9	Automated HEN Design with Multiple Utilities	Working session	Solution

Refinery hydrogen management

Conceptual design of site utility systems

Conceptual design of site utility systems			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction		
Lecture 2	Energy Targets for Site Utility Systems	Working session	Solution
Lecture 3	Power Targets for Site Utility Systems	Working session	Solution
Lecture 4	Data extraction, Total Sites, and Initial Synthesis of Site Utility Systems	Working session	Solution
Lecture 5	Site Utility System Design	Working session	Solution
Lecture 6	Retrofit and Site Utility System Design	Working session	Solution
Lecture 7	Conclusions	Working session	Solution

Heat integrated refinery distillation

Heat integrated refinery distillation			
Objective	Methods and tools for developing cost-effective and energy-efficient distillation sequences will be presented. New tools allow distillation sequencing and heat-integration issues to be considered simultaneously. Both above-ambient and low-temperature separations will be considered. A range of separation options, including simple and complex distillation columns, heat-pumped columns, flash units and dephlegmators (reflux condensers), are accommodated. The workshop will use the COLOM software package to carry out short-cut simulations and to generate and evaluate sequence alternatives.		
Who should attend	Process engineers involved with above-ambient and low-temperature distillation design		
Skills developed	Participants in the workshop will develop skills in: • screening alternative separation sequences (including simple, complex and heat-pumped distillation columns and reflux condensers) using optimisation methods • generating conceptual designs for the separation units • identifying heat recovery options • evaluating refrigeration requirements for low temperature separation • conceptual design of heat-pumped columns using short-cut models		
Lecture 1	Introduction		
Lecture 2	Modelling of Refinery Distillation Columns	Working session	Solution
Lecture 3	Operational optimisation of Heat-integrated Refinery Distillation Columns	Working session	Solution
Lecture 4	Retrofit of Heat-integrated Refinery Distillation System	Working session	Solution

Summer workshops

Basic heat integration

Heat exchanger network design

Utility system modelling

Heat-integrated distillation system design

Pirc 2008

Research presentations

1. Retrofit of Heat Exchanger Networks (Lu Chen)
2. Process Reliability, Availability, Maintainability and Throughput Analysiss (Zixin Lin)
3. Decarbonisation in Power Production and Process Sites (Yuhang Lou)
4. Integration Design of Power Systems and Carbon Capture (Xuesong Zheng)
5. Refinery Optimization Based on Molecular Management (Yongwen Wu)
6. Multi-period Design of Refinery Hydrotreating Processes (Imran Ahmad)
7. Heat-integrated Crude Oil Distillation System Design (Lu Chen)
8. Heterogeneous Azeotropic Distillation Column Design (Paritta Prayoonyong)

Poster sessions

1. Integration of Waste & Renewable Energy Sources (S. Perry, J.Klemes, I. Bulatov, J-K Kim)
2. Cost of Steam & Power Production (Ching-Chih Lai, Yuhang Lou, R. Smith)
3. CO2 Minimisation in FCC Regeneration (Yu Rong, N Zhang, M. Jobson)
4. Hydrogen Network Integration and Optimisation (Nan Jia, N Zhang, R. Smith)
5. Synthesis & Optimisation of Demethanizer Flowsheet (Muneeb Nawaz, M Jobson)
6. Data Reconciliation & Online Monitoring (Shi-yu Li, N Zhang, R. Smith)
7. Design of Chilled Lean Oil Absorption in Natural Gas Processing (P Suntharasamai, J-K Kim & MWK Ltd)

Workshops

Energy Efficiency and Heat Recovery

Energy Efficiency and Heat Recovery			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction	Working session	Solution
Lecture 2	Setting Energy Targets	Working session	Solution
Lecture 3	The Heat Recovery Pinch	Working session	Solution
Lecture 4	Heat Exchanger Network Design for Maximum Energy Recovery	Working session	Solution
Lecture 5	Additional complexity in HEN MER Design	Working session	Solution
Lecture 6	Automated Design of New Heat Exchanger Networks	Working session	Solution
Lecture 7	Retrofit of Heat Exchanger Networks	Working session	Solution

Refinery Hydrogen Management

Process Energy and Site Utility Systems

Reliability, Availability and Maintainability in Process Design

Reliability, Availability and Maintainability in Process Design			
Objective			
Who should attend			
Skills developed			
Lecture 1	Reliability General Knowledge		
Lecture 2	System Maintenance Strategy and Shutdown Planning		
Lecture 3	System Maintenance Strategy and Shutdown Planning		
Lecture 4	Incorporating RAM into Conceptual Design		

Summer workshops

Heat exchanger network design

Utility system modelling

Heat integrated distillation system design

Low temperature processes

Reducing combustion emissions from utility systems

Pirc 2007

Research presentations

1. Optimal Design of Separation and Refrigeration Systems (Sonia Farrokhpanah)
2. Design of Refrigeration and Power Systems (Xuesong Zheng)
3. Decarbonisation in Process Sites (Yuhang Lou)
4. Transient Analysis of Site Utility Systems (Donghui Zheng)
5. Process Reliability, Availability Maintainability and Throughput Analysis (Zixin Lin)
6. Molecular Management for Refinery Product Blending (Sourabh Gupta)
7. Heterogeneous Azeotropic Distillation Column Design (Paritta Prayoonyong)
8. Heat integrated Crude Oil Distillation System Design (Lu Chen)Poster sessions

Poster session

1. Developing a Framework for the Design of Integrated Biorefineries (Fernan Mateos-Salvador)
2. Systematic Design of Absorption and Low-Temperature Separation Systems (Margarita Martin)
3. Integrated Diesel Hydrotreater Design Separation Modelling (Imran Ahmad)
4. Modelling and design of Solid Oxide Fuel Cell Systems (Kostas Tseronis)
5. CO2 Minimisation in FCC Refrigeration (Yu Rong)
6. Pharmacophore-Based Techniques for Construction of Biochemical Reaction networks (Michael Binns)

Workshops

Synthesis of total site utility systems

Synthesis of total site utility systems			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction		
Lecture 2	Targets for Total Site Utility Systems		
Lecture 3	Data Extraction, Targets, and First Step Synthesis		Solution
Lecture 4	Utility System Design		
Lecture 5	Conclusions		
Appendix 1	Cogeneration Targets for Total Site Utility Systems		
Appendix 2	Setting Energy Targets - STAR implementation		
Appendix 3	Utilities and Utility Targeting		
Appendix 4	Utilities Targeting with STAR		

Reducing combustion emissions from utility systems

Reducing combustion emissions from utility systems	
Objective	
Who should attend	
Skills developed	

Lecture 1	Introduction		
Lecture 2	Fuels, Combustion and Emissions	Working session	Solution
Lecture 3	Utility System Optimisation	Working session	Solution
Lecture 4	Decarbonisation with Post-Combustion	Working session	Solution
Lecture 5	Decarbonisation with Pre-Combustion	Working session	Solution
Lecture 6	Decarbonisation with Oxy-Combustion	Working session	Solution
Lecture 7	Conclusions		

Refinery hydrogen management

Reducing combustion emissions from utility systems			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction		
Lecture 2	Modelling and Simulation of Hydrogen Consumers	Working session	Solution
Lecture 3	Modelling and Simulation of Hydrogen Distribution Systems	Working session	Solution
Lecture 4	Modelling Hydroprocessors as Both Sinks and Sources	Working session	Solution
Lecture 5	Hydrogen Composite Curves and Hydrogen Pinch	Working session	Solution
Lecture 6	Hydrogen Purification		
Lecture 7	Placement of Purification Units	Working session	Solution
Lecture 8	Moving from Targeting to Design	Working session	Solution
Lecture 9	Advanced Network Modelling	Working session	Solution
Lecture 10	Optimal Network Design		
Lecture 11	Concluding remarks		

Low temperature separation

Low temperature separation			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction		
Lecture 2	Refrigeration Basics	Working session	Solution
Lecture 3	Complex Refrigeration Cycles and Mixed Refrigerants	Working session	Solution
Lecture 4	Heat Integration in Refrigeration Systems	Working session	Solution
Lecture 5	Low-temperature Separation System Design	Working session	Solution
Lecture 6	Integration of Refrigerated Separation Systems	Working session	Solution

Summer workshops

Heat exchanger network design

Heat exchanger network design			
Objective	The last ten years has seen the Centre for Process Integration markedly extend concepts and methodologies in the design of heat exchanger networks from established Pinch Technology. These developments have included Network Pinch and the use of simulated annealing for the retrofit of Heat Exchanger Networks. The new concepts and methodologies have combined thermodynamics and optimization into an integrated systematic approach to the design and retrofit of Heat Exchanger Networks. This workshop will address the application of these tools, combined with other widely available knowledge tools, to a broad-based application problem. The workshop will begin with a problem to be solved in the retrofit of Heat Exchanger Networks. Delegates will work together in groups, on different aspects of this problem, using methodologies and tools developed in Process Integration, and combining these with other more widely available systems and understanding. The groups will then combine findings to produce an overall solution to the problem.		
Who should attend	Process engineers with background knowledge of energy design, and preferably some familiarity with SPRINT.		
Skills developed	• Heat integration targeting methodologies • Heat integration design methodologies • Retrofit of heat exchanger networks • Heat exchanger network design and retrofit using stochastic optimisation • Application of SPRINT software		
Session 1	Heat Exchanger Network Design - An intuitive approach		
Session 2	MER approach to Heat Exchanger Networks		
Session 3	Automated Design of Heat Exchanger Networks		
Session 4	Simulated Annealing and Heat Exchanger Network Design		
Session 5	Retrofit of Heat Exchanger Networks - Loops and Paths		
Session 6	Simulated Annealing and Retrofit of Heat Exchanger Networks		
Appendix 1	Targeting with SPRINT		
Appendix 2	Heat Exchangers and SPRINT		
Appendix 3	Automated Design, Optimisation, and SPRINT		
Appendix 4	Simulated Annealing and Heat Exchanger Networks and SPRINT		

Utility system modelling

Utility system modelling			
Objective	The essential issue for the design of a site utility system is how to satisfy the heat and power demand of the site with minimum operating costs. This requires an understanding of the trade-offs between fuel, power, and heat recovery. This workshop presents a systematic approach to the analysis of site utility systems giving the highest emphasis to retrofit. The workshop will provide understanding of the trade-offs between fuel, power and heat recovery and present a systematic approach for utility system optimisation and management using the STAR software		
Who should attend	The workshop is intended for process engineers involved with energy management, site utility systems and heat exchanger network design. The workshop will provide the necessary background.		
Skills developed	• understanding of total site infrastructures • modelling of utility systems • optimisation of utility configurations (including steam and gas turbines) • gas turbine cogeneration system design • steam costing • steam level switching		
Lecture 1	Introduction		
Lecture 2	Boilers	Working session	Solution
Lecture 3	Steam Turbines	Working session	Solution
Lecture 4	Gas Turbine	Working session	Solution
Lecture 5	Gas Turbine Heat Recovery	Working session	Solution
Lecture 6	Steam Balances and Energy Audits	Working session	Solution
Lecture 7	Steam System Optimisation	Working session	Solution
Lecture 8	Conclusions		

Heat-integrated distillation system design

Heat-integrated distillation system design	
Objective	Methods and tools for developing cost-effective and energy-efficient distillation sequences will be presented. New tools allow distillation sequencing and heat-integration issues to be considered simultaneously. Both above-ambient and low-temperature separations will be considered. A range of separation options, including simple and complex distillation columns, heat-pumped columns, flash units and dephlegmators (reflux condensers), are accommodated. The workshop will use the COLOM software package to carry out short-cut simulations and to generate and evaluate sequence alternatives.
Who should attend	Process engineers involved with above-ambient and low-temperature distillation design.
Skills developed	• screening alternative separation sequences (including simple, complex and heat-pumped distillation columns and reflux condensers) using optimisation methods • generating conceptual designs for the separation units • identifying heat recovery options • evaluating refrigeration requirements for low temperature separation • conceptual design of heat-pumped columns using short-cut

	models steam costing • steam level switching		
Lecture 1	Introduction		
Lecture 2	Heat Integration of Distillation Columns	Working session	Solution
Lecture 3	Temperature-Enthalpy Analysis of Distillation	Working session	Solution
Lecture 4	The distillation sequencing problem	Working session	Solution
Lecture 5	Evaluating alternative distillation sequences		
Lecture 6	Sequence synthesis	Working session	Solution
Lecture 7	Synthesis of heat-integrated distillation sequences	Working session	Solution

Low temperature processes

Low temperature processes			
Objective			
Who should attend			
Skills developed			
Lecture 1	The distillation sequencing problem	Working session	Solution
Lecture 2	Evaluating alternative distillation sequences		
Lecture 3	Sequence synthesis	Working session	Solution
Lecture 4	Synthesis of heat-integrated distillation sequences	Working session	Solution
Lecture 5	Refrigeration system design	Working session	Solution
Lecture 6	Synthesis of refrigerated separation systems	Working session	Solution

Refinery optimisation and hydrogen

Heat recovery data extraction

Heat recovery data extraction			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction		
Appendix 1	Data Extraction		
Appendix 2	Setting Energy Targets		
Appendix 3	Setting Energy Targets - SPRINT implementation		
Appendix 4	Utilities and Utilities Targeting		
Appendix 5	Utilities and Utilities Targeting - SPRINT implementation		
Appendix 6	Total Site Composite Curves		
Appendix 7	Total Site Composite Curves - STAR implementation		
Appendix 8	Cogeneration Targets for Steam Turbine Systems		

Appendix 9	Cogeneration Targets for Steam Turbine Systems - STAR implementation		
Solution 1	Process Data Extraction		
Solution 2	Data Extraction for Total Sites (New Design)		
Solution 3	Data Extraction for Total Sites (Retrofit)		

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Research presentations

1. . Synthesis and Optimisation of Catalytic Reactors (Kamlesh Ghodasara)
2. Decarbonisation In Energy Production (Yuhang Lou)
3. Low Temperature Processes (Sonia Farrokhpanah)
4. Design of Refrigeration Power Systems (Xuesong Zheng)
5. Integrated Modelling for Refinery Fluid Catalytic Cracking Units (Juan Gomez Prado)
6. Planning and Scheduling of Refinery Operations (Sourabh Gupta)
7. Data Reconciliation and Rigorous Optimisation of Refinery Hydrogen Networks (Bhari Bhujan Singh)
8. Operability of Site Utility Systems (Donghui Zheng)

Poster sessions

1. Design of Cost Effective Absorption Schemes (Margarita Martin)
2. Integrated Processing of Heavy Crude Oils (Yadira Lopez)
3. CO2 Minimisation in FCC Regeneration (Yu Rong)
4. Heat integrated Refinery Distillation System Design (Lu Chen)
5. Heterogeneous Azeotropic Distillation System Design (Paritta Prayoonyong)
6. Modelling and Design of Solid Oxide Fuel Cell Systems (Kostas Tseronis)
7. Integrated Diesel Hydrotreater Design (Imran Ahmad)
8. Catalyst Design for Intensified Processes (Shrikant Bhat and Ankur Kapil)
9. Developing Tools for the Design of Integrated Wheat-based Biorefineries (Mustafa and Fernan Mateos-Salvador)
10. Model Building for Multiphase Reaction Systems (Rameshwar Hiwale)

Workshops

Heat exchanger network design

Heat recovery data extraction

Utility system modelling

Low temperature separation

Summer workshops

Heat integrated distillation system design

Basic heat integration

Basic heat integration	
Objective	This workshop provides an introduction to the principles of heat integration. The ability to predict achievable energy targets for the energy consumption which have a sound scientific basis is fundamental to the approach. Such targets can be used to scope and screen many

	design options effectively without having to carry out repeated design. The workshop also gives an introduction to the systematic procedures which have been developed to allow the targets to be achieved in practice.		
Who should attend	The course is intended for process designers who have had no exposure or only a brief exposure to pinch analysis. It is a foundation workshop which is a prerequisite for other workshops on energy integration and the design of cogeneration and site utility systems.		
Skills developed	• setting energy targets • identification of the heat recovery pinch • design for maximum energy recovery • selection of utility options • screening process changes • data extraction		
Lecture 1	Introduction	Working session	Solution
Lecture 2	Setting Energy Targets	Working session	Solution
Lecture 3	The Problem Table Algorithm	Working session	Solution
Lecture 4	The Heat Recovery Pinch		
Lecture 5	Heat Exchanger Network Representation	Working session	Solution
Lecture 6	Heat Exchanger Network Design for Maximum Heat Recovery	Working session	Solution
Lecture 7	Stream Splitting	Working session	Solution
Lecture 8	Utilities and Utilities Targeting	Working session	Solution
Lecture 9	Data Extraction	Working session	Solution

Site utility systems

Site utility systems			
Objective	The essential issue for the design of a site utility system is how to satisfy the heat and power demand of the site with minimum operating costs. This requires an understanding of the trade-offs between fuel, power, and heat recovery. This workshop presents a systematic approach to the analysis of site utility systems giving the highest emphasis to retrofit. The workshop will provide understanding of the trade-offs between fuel, power and heat recovery and present a systematic approach for utility system optimisation and management using the STAR software.		
Who should attend	The workshop is intended for process engineers involved with energy management, site utility systems and heat exchanger network design. The workshop will provide the necessary background.		
Skills developed	• understanding of total site infrastructures • modelling of utility systems • optimisation of utility configurations (including steam and gas turbines) • gas turbine cogeneration system design • steam costing • steam level switching		
Lecture 1	Introduction		

Lecture 2	Steam Boilers	Working session	Solution
Lecture 3	Steam Turbines	Working session	Solution
Lecture 4	Gas Turbines		
Lecture 5	Gas Turbine Heat Recovery	Working session	Solution
Lecture 6	Steam Balances and Energy Audits	Working session	Solution
Lecture 7	Steam System Optimisation	Working session	Solution
Lecture 8	Steam Pricing		

Applications in energy systems - utility system

Applications in energy systems - utility system			
Objective	The last ten years has seen the Centre for Process Integration markedly extend concepts and methodologies in the design of energy based systems from the established Pinch Technology. These developments have included Network Pinch for the retrofit of Heat Exchanger Networks, Cogeneration and Site Utility system modelling, simulation, and design, and HEN optimisation. The new concepts and methodologies have combined thermodynamics and mathematical modelling into an integrated systematic approach to the design and analysis of energy based systems. The conceptual understanding of these energy-based systems and the tools developed to exploit these new design methodologies have been extensively covered by workshop training. However, as yet the Centre for Process Integration have not provided workshops on the application of these tools, combined with other widely available knowledge tools, to a broad based application problem. This workshop is the first to address this area. The workshop will begin with a problem to be solved in the energy area. Delegates will work together in groups, on different aspects of this problem, using methodologies and tools developed in Process Integration, and combining these with other more widely available systems and understanding. The groups will then combine findings to produce an overall solution to the problem.		
Who should attend	Process engineers with a knowledge of energy design, and preferably familiar with STAR and SPRINT.		
Skills developed	• Problem solving • Integration energy system design methodologies • Application of STAR and SPRINT software • Group Working		
Lecture 1	Introduction		
Lecture 2	Datasheets		
Appendix 1	Capital Energy Trade-offs		
Appendix 2	Automated Design of Heat Exchanger Networks		

Low temperature processes

Low temperature processes	
Objective	The workshop addresses the technologies used in the design of low temperature processes, such as natural gas liquefaction, industrial gas separation, ethylene production, etc. The workshop aims to explain design guidelines and methods which are required to provide cost-

	effective engineering solutions, especially: • Design of refrigeration cycles for pure and mixed refrigerant systems • Design of power-dominated systems, including driver selection, availability enhancement through parallel compression, and integration of power and steam systems. Also, recent developments and new features in the software, WORK, will be introduced and illustrated through examples and working sessions. Those attending the workshop will use the WORK software package and learn problem-solving skills.		
Who should attend	This workshop is intended for process designers interested in the design of low temperature processes and gas processing systems		
Skills developed	• Review of design and operation of refrigeration cycles • Understanding design aspects and methods for low temperature processes • Hands-on experience of developing models to design and integrate systems involving refrigeration cycles, power systems and gas separation • Developing the techniques of how to synthesise and optimise low temperature processes • Economic evaluation, analysis and trade-offs during the design and selection of low temperature processes		
Lecture 1	Introduction		
Lecture 2	Refrigeration Basics	Working session	Solution
Lecture 3	Complex Cycles Using Pure Refrigerants	Working session	Solution
Lecture 4	Mixed Refrigerants		
Lecture 5	Driver Selection	Working session	Solution
Lecture 6	Steam-based Power System Design	Working session	Solution
Lecture 7	Synthesis of Refrigeration and Separation Processes	Working session	Solution

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Research presentations

1. Design and Integration of Refrigeration and Power Systems (Frank Del Nogal)
2. Integrating Reliability, Availability and Maintainability into Process Synthesis (Qiying Yin)
3. Heat integrated Separation Sequence Synthesis (Sonia Farrokhpanah)
4. Design and Synthesis of Chemical Absorption Processes (Prashant Patil)
5. Data Monitoring and Rigorous Optimisation of Refinery Hydrogen Networks (Bhari Bhujan Singh)
6. Integration of Fuel Cells and Process Utility Systems (Bin Wang)
7. Synthesis of Heterogeneous Azeotropic Reaction-separation Systems (Priti Vanage)
8. Modelling and Optimisation of Multiphase Batch and Semi-batch Reactors (Xiaoping Zheng)
9. Integrated Modelling and Feedstock Characterisation for Refinery FCC Units (Juan Gomez Prado)
10. Heat-integrated Crude Oil Distillation System Design (Vikas Rastogi)

Poster sessions

1. Design and Optimisation of Process Utility Systems (Donghui Zheng)
2. Detailed Solid Oxide Fuel Cell Modelling (Kostas Tseronis)
3. Synthesis and Design of integrated Reaction-Separation Processes (Guido Daniel)
4. Design of Catalytic Reactors (Kamlesh Ghodasara)
5. Planning and Scheduling of Refinery Operations under Uncertainty (Sourabh Gupta)
6. Making Bioprocesses Competitive through Process Integration (Fernán Mateos-Salvador)
7. Kinetic Modelling of Chemical and Biochemical Networks (Michael Binns)
8. Design of Gas Separation Networks (Margarita Martin)
9. Software Developments (Chris Sutton and Steve Doyle)

Workshops

Energy systems

Applications in energy systems - utility system	
Objective	The last ten years has seen the Centre for Process Integration markedly extend concepts and methodologies in the design of heat recovery systems from the established Pinch Technology. These developments have included Network Pinch and the use of simulated annealing for the retrofit of Heat Exchanger Networks. The new concepts and methodologies have combined thermodynamics and optimization into an integrated systematic approach to the retrofit of Heat Exchanger Networks. This workshop will address the application of these tools, combined with other widely available knowledge tools, to a broad based application problem. The workshop will begin with a problem to be solved in the retrofit of Heat Exchanger Networks. Delegates will work together in groups, on different aspects of this problem, using methodologies and tools developed in Process Integration, and combining these with other more widely available systems and understanding. The groups will then combine findings to produce an overall solution to the problem.
Who should attend	Process engineers with a knowledge of energy design, and preferably familiar with SPRINT.
Skills developed	- Problem solving - Heat integration design methodologies - Retrofit of heat exchanger network - Application of SPRINT software

	- Group Working		
Lecture 1	Heat Exchanger Network Design - An intuitive approach	Working Session	Solution
Lecture 2	MER approach to Heat Exchanger Networks	Working Session	Solution
Lecture 3	Automated Design of Heat Exchanger Networks	Working Session	Solution
Lecture 4	Simulated Annealing and Heat Exchanger Network Design	Working Session	Solution
Lecture 5	Retrofit of Heat Exchanger Networks - Loops and Paths	Working Session	Solution
Lecture 6	Network Pinch and Retrofit of Heat Exchanger Networks	Working Session	Solution
Lecture 7	Simulated Annealing and Retrofit of Heat Exchanger Networks	Working Session	Solution
Appendix 1	Targeting with SPRINT	Working Session	Solution
Appendix 2	Heat Exchangers and SPRINT	Working Session	Solution
Appendix 3	Automated Design, Optimisation, and SPRINT	Working Session	Solution

Refinery hydrogen management

Refinery hydrogen management			
Objective	The aim of this workshop is to present a systematic method for analysing hydrogen distribution systems. Several trends in the petroleum industry are leading to an increased demand for hydrogen and can lead to a deficit in the hydrogen balance. The new method sets targets for the minimum flowrate of fresh hydrogen required before any system design, identifies the existence of bottlenecks in the distribution system, and provides insights as to the benefits of installing hydrogen purification capacity. The workshop will also present a method for designing hydrogen distribution networks to achieve the targets, incorporating issues such as design constraints, impurity composition and capital costs. The software package HYDRO will be used in the workshop.		
Who should attend	Refinery managers, planners and process engineers involved with hydrogen system design and optimisation		
Skills developed	- Understanding hydrogen networks - Simulating existing hydrogen network operations - Using graphical tools to target the minimum hydrogen utility - Optimise the size and placement of hydrogen purifiers - Design optimal hydrogen networks - Hands-on experience of using HYDRO, a software package for hydrogen network design and optimisation		
Lecture 1	Introduction		
Lecture 2	Hydrogen Consumers	Working session	Solution
Lecture 3	Hydrogen Producers	Working session	Solution
Lecture 4	Hydrogen Distribution Systems	Working session	Solution
Lecture 5	Modelling Hydroprocessors as Both Sinks and Sources	Working session	Solution
Lecture 6	Hydrogen Composite Curves and Hydrogen Pinch	Working session	Solution

Lecture 7	Choice of Utility Purity	Working session	Solution
Lecture 8	Hydrogen Purification	Working Session	Solution
Lecture 9	Placement of Purification Units	Working Session	Solution
Lecture 10	Mathematical Programming for Minimising Hydrogen Utility	Working Session	Solution
Lecture 11	Advanced Network Design	Working Session	Solution
Lecture 12	Rigorous Network Simulation and Optimisation with Impurity Considerations	Working Session	Solution
Lecture 13	Conclusions		

Heat integrated distillation system design

Heat integrated distillation system design			
Objective	Methods and tools for developing cost-effective and energy-efficient distillation sequences will be presented. New tools allow distillation sequencing and heat-integration issues to be considered simultaneously. Both above-ambient and low-temperature separations will be considered. A range of separation options, including simple and complex distillation columns, heat-pumped columns, flash units and dephlegmators (reflux condensers), are accommodated. The workshop will use the COLOM software package to carry out short-cut simulations and to generate and evaluate sequence alternatives.		
Who should attend	Process engineers involved with above-ambient and low-temperature distillation design.		
Skills developed	- screening alternative separation sequences (including simple, complex and heat-pumped distillation columns and reflux condensers) using optimisation methods - generating conceptual designs for the separation units - identifying heat recovery options - evaluating refrigeration requirements for low temperature separation - conceptual design of heat-pumped columns using short-cut models		
Lecture 1	The distillation sequencing problem	Working session	Solution
Lecture 2	Evaluating alternative distillation sequences		
Lecture 3	Sequence synthesis	Working session	Solution
Lecture 4	Synthesis of heat integrated distillation sequences	Working session	Solution
Lecture 5	Synthesis of refrigeration and separation processes	Working session	Solution
Lecture 6	Heat-pumping in a distillation sequence	Working session	Solution
Lecture 7	Concluding remarks		
Lecture 8		Working Session	Solution

Heat integrated refinery distillation

Heat integrated refinery distillation	
Objective	Methods for design and retrofit design of crude oil distillation systems will be presented. Recent developments in the methods and tools in SPRINT use stochastic methods for design and optimisation of heat recovery systems. The tools apply to both new design and retrofit of heat

	exchanger networks. The workshop will also consider the simultaneous design and optimisation of the distillation columns and heat exchanger network for crude oil distillation. Short-cut distillation models for atmospheric and vacuum crude oil distillation columns will be used for column design and retrofit design. The heat exchanger network and column can now be designed and optimised simultaneously within COLOM to allow interactions to be exploited for energy-efficient operation. The workshop will use the COLOM software package to carry out short-cut simulations and optimisation of the heat-integrated distillation system and SPRINT for heat exchanger network design.		
Who should attend	Process engineers interested in refinery distillation.		
Skills developed	Participants in the workshop will develop understanding of: - automated design of heat exchanger networks using stochastic optimisation - interactions between key distillation design variables - interactions between the distillation processes and heat recovery system and will develop skills in: - heat exchanger network design and optimisation for new design and retrofit - short-cut simulation of crude oil distillation columns - optimisation of new and existing heat-integrated refinery distillation systems		
Lecture 1	Heat Integration: Introduction	Working session	Solution
Lecture 2	Heat Exchanger Network Design	Working session	Solution
Lecture 3	Retrofit of Heat Exchanger Networks	Working session	Solution
Lecture 4	Short-cut Modelling of Distillation Columns	Working session	Solution
Lecture 5	Design of Refinery Distillation Columns	Working session	Solution
Lecture 6	Optimisation of Heat-integrated Refinery Distillation System	Working session	Solution

Summer workshops

Site utility systems

Site utility systems			
Objective	The essential issue for the design of a site utility system is how to satisfy the heat and power demand of the site with minimum operating costs. This requires an understanding of the trade-offs between fuel, power, and heat recovery. This workshop presents a systematic approach to the analysis of site utility systems giving the highest emphasis to retrofit. The workshop will provide understanding of the trade-offs between fuel, power and heat recovery and present a systematic approach for utility system optimisation and management using the STAR software.		
Who should attend	The workshop is intended for process engineers involved with energy management, site utility systems and heat exchanger network design. The workshop will provide the necessary background.		
Skills developed	The following skills will be developed: • understanding of total site infrastructures • modelling of utility systems • optimisation of utility configurations (including steam and gas turbines) • gas turbine cogeneration system design • steam costing • steam level switching		

Lecture 1	Introduction		
Lecture 2	Steam Systems	Working Session	Solution
Lecture 3	Steam Turbines	Working session	Solution
Lecture 4	Gas Turbines	Working session	Solution
Lecture 5	Steam and Power Balances	Working session	Solution
Lecture 6	Steam System Optimisation	Working session	Solution
Lecture 7	Gas Turbine Integration	Working Session	Solution
Lecture 8	Steam Pricing	Working Session	Solution
Lecture 9	Conclusions		

Applications in energy systems

Distillation system design

Low temperature processes

Low temperature processes			
Objective	The workshop addresses the technologies used in the design of low temperature processes, such as natural gas liquefaction, industrial gas separation, ethylene production, etc. The workshop aims to explain design guidelines and methods which are required to provide cost-effective engineering solutions, especially: - Design of refrigeration cycles for pure and mixed refrigerant systems - Design of power-dominated systems, including driver selection, availability enhancement through parallel compression, and integration of power and steam systems. - Design of low temperature gas separation, including modelling of gas separation, synthesis of refrigeration and separation, and synthesis of a dephlegmator with refrigeration. Also, recent developments and new features in the software, WORK, will be introduced and illustrated through examples and working sessions. Those attending the workshop will use the WORK software package and learn problem-solving skills.		
Who should attend	This workshop is intended for process designers interested in the design of low temperature processes and gas processing systems.		
Skills developed	• Review of design and operation of refrigeration cycles • Understanding design aspects and methods for low temperature processes • Hands-on experience of developing models to design and integrate systems involving refrigeration cycles, power systems and gas separation • Developing the techniques of how to synthesise and optimise low temperature processes • Economic evaluation, analysis and trade-offs during the design and selection of low temperature processes • Insights into the application of design methods to selected industrial low temperature processes		
Lecture 1	Pure and mixed refrigerant systems		
Lecture 2	Driver selection with series and parallel compression	Working session	Solution
Lecture 3	Steam-based power system design		
Lecture 4	Synthesis of Refrigeration and Separation Processes	Working session	Solution

Refinery optimisation and hydrogen

Refinery optimisation and hydrogen			
Objective	The aim of this workshop is to present a systematic method for analysing hydrogen distribution systems. Several trends in the petroleum industry are leading to an increased demand for hydrogen and can lead to a deficit in the hydrogen balance. The new method sets targets for the minimum flowrate of fresh hydrogen required before any system design, identifies the existence of bottlenecks in the distribution system, and provides insights as to the benefits of installing hydrogen purification capacity. The workshop will also present a method for designing hydrogen distribution networks to achieve the targets, incorporating issues such as design constraints and capital costs. The software package HYDRO will be used in the workshop		
Who should attend	Refinery managers, planners and process engineers involved with hydrogen system design and optimisation.		
Skills developed	The following skills will be developed: • Understanding hydrogen networks • Simulating existing hydrogen network operations • Using graphical tools to target the minimum hydrogen utility • Optimise the size and placement of hydrogen purifiers • Design optimal hydrogen networks • Hands-on experience of using HYDRO for hydrogen network design and optimisation		
Lecture 1	Introduction		
Lecture 2	Process Optimisation	Working session	Solution
Lecture 3	Plant-wide Simulation	Working session	Solution
Lecture 4	Site-Flow Optimisation	Working session	Solution
Lecture 5	Integrated Optimisation	Working session	Solution
Lecture 6	Hydrogen Networks	Working session	Solution
Lecture 7	Minimising Hydrogen Utility	Working session	Solution
Lecture 8	Advanced Hydrogen Network Optimisation	Working Session	Solution
Lecture 9	Hydrogen Network Retrofit with Purification Units	Working Session	Solution
Lecture 10	Concluding Remarks		

Pirc 2004

Research presentations

1. Synthesis of Low Temperature Processes (Frank Del Nogal)
2. Design and Operation of Flexible Utility Systems (Oscar Aguilar)
3. Optimisation of Heat-Integrated Crude Oil Distillation Systems (Vikas Rastogi)
4. Synthesis of Batch Distillation Processes (Santosh Jain)
5. Impact of Gas Phase Impurities on Refinery Hydrogen Network Design (Bhari Bhujan Singh)
6. Integrated Production of Oil Refineries and Petrochemical Plants (Shuhaimi Mahadzir)
7. Modelling and Optimisation of Batch and Semi-batch Reactors (Xiaoping Zheng)
8. Synthesis of Ternary Heterogeneous Azeotropic Systems (Priti Vanage)
9. Fouling Considerations in the Design and Retrofit of Heat Exchanger Networks (Clemente Rodriguez)
10. Integrated Water and Energy Minimisation (Boondarik Leewongtanawit)

Refinery interest group

1. Design and Synthesis of Chemical Absorption Processes (Prashant Patil)
2. Planning and Scheduling of Refinery Operations (Dhaval Dave)
3. Supply Chain Optimisation (Chong Chen)

Poster sessions

1. Synthesis and Design of integrated Reaction-Separation Processes (Guido Daniel)
2. Design of Catalytic Reactors (Kamlesh Ghodasara)
3. Feedstock Characterisation and Kinetic Modelling of an FCC (Juan Gomez-Prado)
4. A Computational Framework for Input-output Simulator-based Optimization (Eduardo Luna-Ortiz)
5. Integrated Design, Analysis and Dynamic Optimisation of Process Systems (Jhuma Sadhukhan)
6. Al Techniques for Efficient Reaction Kinetics Analysis in the Chemical Industry (Wenling Zhang)
7. European Union Process Integration Projects (Jiri Klemes)
8. Software Update 2004 (Chris Sutton and Steve Doyle)

Workshops

Applications in energy systems

Applications in Energy Systems	
Objective	The last ten years has seen the Centre for Process Integration markedly extend concepts and methodologies in the design of energy based systems from the established Pinch Technology. These developments have included Network Pinch for the retrofit of Heat Exchanger Networks, Cogeneration and Site Utility system modelling, simulation, and design, and HEN optimisation. The new concepts and methodologies have combined thermodynamics and mathematical modelling into an integrated systematic approach to the design and analysis of energy based systems. The conceptual understanding of these energy-based systems and the tools developed to exploit these new design methodologies have been extensively covered by workshop training. However, as yet the Centre for Process Integration have not provided workshops on the application of these tools, combined with other widely available knowledge tools, to a broad based application problem. This workshop is the first to address this area. The workshop will begin with a problem to be solved in the energy area. Delegates will work together in

	groups, on different aspects of this problem, using methodologies and tools developed in Process Integration, and combining these with other more widely available systems and understanding. The groups will then combine findings to produce an overall solution to the problem.		
Who should attend	Process engineers with a knowledge of energy design, and preferably familiar with STAR and SPRINT.		
Skills developed	• Problem solving • Integrating energy system design methodologies • Application of STAR and SPRINT software • Group Working		
Lecture 1	Lecture 01 - Introduction to the Problem		
Appendix 1	Setting Energy Targets		
Appendix 2	Heat Exchanger Network Representations		
Appendix 3	Stream Splitting		
Appendix 4	Multiple Utilities		
Appendix 5	Capital Energy Trade-Offs		
Appendix 6	Automated Design of New Heat Exchanger Networks		
Appendix 7	Steam Systems		
Appendix 8	Steam Turbines		
Appendix 9	Gas Turbines		
Appendix 10	Gas Turbine Integration		
Appendix 11	Steam and Power Balances		
Appendix 12	Optimising Utility Systems		
Appendix 13	Total Site Composite Curves		

Distillation and absorption

Low temperature processes

Low temperature processes	
Objective	The workshop addresses the technologies used in the design of low temperature processes, such as natural gas liquefaction, industrial gas separation, ethylene production, etc. The workshop aims to explain design guidelines and methods which are required to provide cost-effective engineering solutions, especially: - Design of refrigeration cycles for pure and mixed refrigerant systems - Design of power-dominated systems, including driver selection, availability enhancement through parallel compression, and integration of power and steam systems. - Design of low temperature gas separation, including modelling of gas separation, synthesis of refrigeration and separation, and synthesis of a dephlegmator with refrigeration. Also, recent developments and new features in the software, WORK, will be introduced and illustrated through examples and working sessions. Those attending the workshop will use the WORK software package and learn problem-solving skills.
Who should attend	This workshop is intended for process designers interested in the design of low temperature processes and gas processing systems.
Skills developed	• Review of design and operation of refrigeration cycles • Understanding design aspects and methods for low temperature processes • Hands-on experience of developing models to design and integrate systems involving refrigeration cycles, power systems and gas separation

	• Developing the techniques of how to synthesise and optimise low temperature processes • Economic evaluation, analysis and trade-offs during the design and selection of low temperature processes • Insights into the application of design methods to selected industrial low temperature processes temperature processes • Economic evaluation, analysis and trade-offs during the design and selection of low temperature processes • Insights into the application of design methods to selected industrial low temperature processes		
Lecture 1	Pure and mixed refrigerant systems	Working session	Solution
Lecture 2	Driver selection with series and parallel compression	Working session	Solution
Lecture 3	Steam-based power system design	Working session	Solution
Lecture 4	Synthesis of refrigeration and separation processes	Working session	Solution
Lecture 5	Synthesis of dephlegmator and refrigeration systems	Working session	Solution

Reaction - separation system design

Reaction - separation system design	
Objective	This workshop focuses on the design and optimisation of homogeneous (isothermal and non-isothermal) reactors, catalytic reactors including novel catalyst designs and batch and semi-batch chemical reactors. Methods for obtaining feasible reaction schemes and chemical kinetic information will also be addressed. Finally, a framework for designing combined reaction and separation systems exploring a wide range of options will be presented. A robust simulation and optimisation framework has been developed aimed for the synthesis and design of reaction and separation systems. Optimal process conditions are reliably computed in order to maximise process parameters such as yield, selectivity, economic potentials, etc. Furthermore a large number of design options can be easily explored such as type of reactor (batch or PFR, homogeneous, multi-phase or catalytic) type of separator, separation sequence, flow rates, feed compositions, recycles and heat transfer arrangements. Using the software, feasible reaction schemes can be constructed and the most probable kinetic mechanisms can be selected from a large number of possible choices. Thus reactors with complex kinetics can be simulated and optimised. The software can efficiently handle both mass and energy balances, multiple phases, heterogeneous catalytic reactions with various types of non-uniform catalyst distributions, batch systems and recycles. Also separation units such as distillation columns, absorbers etc. can be simulated. The aim of this workshop is to provide the latest advances in REACTOR software, which contains the computational framework for design and optimisation of reaction and of coupled reaction-separation systems. The key features of the software will be presented and the participants will learn how to set up and solve problems using REACTOR. The software will be used during the working sessions to design homogeneous, non-isothermal and multi-phase continuous reactors, batch reactors and heterogeneous catalytic reactors. Those attending the workshop will also learn how to use REACTOR to build kinetic models and they will be able

	to build and optimise coupled reaction-separation systems.		
Who should attend	Process engineers with an interest in reactor design technology and in the synthesis of flowsheets containing reactors and separators. The workshop will provide all the necessary background for the less experienced engineer.		
Skills developed	The following skills will be developed: • understanding of the complexities and trade-offs in chemical reactor design • optimisation of continuous, batch, multi-phase and heterogeneous catalytic chemical reactors • construction of reaction schemes and kinetic models • synthesis and optimisation of coupled reactor-separator systems		
Lecture 1	Introduction		
Lecture 2	Simulation and Optimisation of Continuous Reaction Systems	Working session	Solution
Lecture 3	Heterogeneous Catalytic Reaction System Design	Working session	Solution
Lecture 4	Batch Reactor Design	Working session	Solution
Lecture 5	Complex Reaction Systems: Model Building and Discrimination	Working session	Solution
Lecture 6	Synthesis of Reaction-Separation Systems	Working session	Solution
Lecture 7	Conclusions		

Summer workshops

Basic heat integration

Site utility systems

Site utility systems			
Objective	Processes most often operate within the context of a site in which a number of processes are linked to a common utility system. Not only do the individual processes interact with the utility system, but the processes interact with each other through the utility system. The utility system consumes fuel in central boilers, supplies steam at different pressures and generates power. Power might also be imported. The workshop presents an introduction to total site integration using the STAR software.		
Who should attend	The workshop is intended for process engineers involved with energy management, site utility systems and heat exchanger network design.		
Skills developed	The following skills will be developed: • Understanding of total site infrastructures • steam and power balances • energy targeting for the total site • targeting cogeneration potential from steam turbines • optimisation of steam mains pressures • steam turbine network design • gas turbine integration		
Lecture 1	Introduction		
Lecture 2	Steam Systems	Working Session	Solution
Lecture 3	Steam Turbines	Working session	Solution

Lecture 4	Gas Turbines	Working session	Solution
Lecture 5	Gas Turbine Integration	Working session	Solution
Lecture 6	Steam and Power Balances	Working session	Solution
Lecture 7	Optimising Utility Systems	Working Session	Solution
Lecture 8	Steam Pricing	Working Session	Solution

Distillation system design

Distillation system design			
Objective	This workshop addresses distillation sequencing. Both simple and complex columns, such as thermally coupled and prefractionator arrangements will be considered. Screening methods are introduced for selecting promising distillation sequences comprising simple and complex columns and their operating pressures. Design of dividing wall columns are also examined in some detail. This workshop will use the COLOM software package to carry out the calculations.		
Who should attend	Process engineers involved with distillation design		
Skills developed	In the workshop, we will show how to: • screen alternative distillation sequences of simple and complex columns using optimisation methods • determine the appropriate operating pressures for the columns in the sequence • explore heat integration of different sequences • design dividing wall distillation columns		
Lecture 1	The sequencing problem	Working session	Solution
Lecture 2	Evaluating alternative distillation sequences	Working session	Solution
Lecture 3	Sequence synthesis	Working session	Solution
Lecture 4	Heat integration of distillation columns	Working session	Solution
Lecture 5	Modelling of heat-integrated distillation sequences	Working session	Solution
Lecture 6	Synthesis of heat-integrated distillation sequences	Working session	Solution
Lecture 7	Dividing wall distillation: Design and optimisation	Working session	Solution

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Refinery hydrogen management

Refinery hydrogen management	
Objective	The aim of this workshop is to present a systematic method for analysing hydrogen distribution systems. Several trends in the petroleum industry are leading to an increased demand for hydrogen and can lead to a deficit in the hydrogen balance. The new method sets targets for the minimum flowrate of fresh hydrogen required before any system design, identifies the existence of bottlenecks in the distribution system, and provides insights as to the benefits of installing hydrogen purification capacity. The workshop will also present a method for designing hydrogen distribution networks to achieve the targets, incorporating issues such as design constraints and capital costs. The software package HYDRO will be used in the workshop.

Who should attend	Refinery managers, planners and process engineers involved with hydrogen system design and optimisation.		
Skills developed	The following skills will be developed: · Understanding hydrogen networks · Simulate existing hydrogen networks · Using graphical tools to target the minimum hydrogen utility · Optimise the size and placement of hydrogen purifiers · Design optimal hydrogen networks · Hands-on experience of using HYDRO, a new software package for hydrogen network design and optimisation		
Lecture 1	Introduction	Working session	Solution
Lecture 2	Hydrogen Consumers	Working session	Solution
Lecture 3	Hydrogen Producers	Working session	Solution
Lecture 4	Hydrogen Distribution Systems	Working session	Solution
Lecture 5	Modelling Hydroprocessors as Both Sinks and Sources	Working session	Solution
Lecture 6	Hydrogen Composite Curves and Hydrogen Pinch	Working session	Solution
Lecture 7	Choice of Utility Purity	Working session	Solution
Lecture 8	Hydrogen Purification	Working Session	Solution
Lecture 9	Placement of Purification Units	Working Session	Solution
Lecture 10	Mathematical Programming for Minimising Hydrogen Utility	Working Session	Solution
Lecture 11	Advanced Network Design	Working Session	Solution
Lecture 12	Concluding Remarks		

Refinery optimisation

Pirc 2003

Research presentations

1. Synthesis of Continuous Heterogeneous Catalytic Reactors - Sungwon Hwang
2. Molecular Modelling and Analysis of Diesel Hydrotreating Process - Jianjun Sun
3. Synthesis and Optimisation of Low Temperature Gas Separation- Jiaona Wang
4. Synthesis of Power Systems for Power Dominated Processes - Frank del Nogal
5. Mitigation of Fouling in Heat Exchanger Networks - Clemente Rodriguez
6. Scheduling of Refinery Operations - Dhaval Dave
7. Synthesis of Batch Distillation Processes - Santosh Jain
8. Synthesis of Multicomponent Azeotropic Distillation Sequences - Guilian Liu
9. Efficient Use of Energy in Water System Design - Boondarik Leewongtanawit
10. Synthesis of Site Utility Systems - Petar Varbanov

Refinery interest group

1. Reaction Model Building for Refinery Heterogeneous Catalytic Reactions - Wenling Zhang
2. Molecular Modelling of FCC Reaction Systems Part 1 - Nan Zhang
3. Molecular Modelling of FCC Reaction Systems Part 2 - Nan Zhang

Chemical interest group

1. Synthesis of Reactive Distillation Processes- Ramona Manuela Dragomir
2. Reactive Rescheduling for Chemical Batch Plants - Sangdae Park
3. Supply Chain Optimisation - Chong Chen

Poster sessions

1. Design and Synthesis of Reactive Absorption Processes - Prashant Patil
2. Heat-integrated Refinery Distillation Systems - Vikas Rastogi
3. Synthesis of Reaction-Separation Systems for Continuous Processes- Priti Vanage
4. Framework for Integrated Production of Refineries and Petrochemical Plants - Shuhaimi Mahadzir
5. Retrofit Design of Distillation Sequences - Walter Castillo-Perez
6. Distributed Cogeneration Systems - Oscar Aguilar
7. Model-Reduction-Based Optimisation Method for Efficient Design of Large Systems - Eduardo Luna-Ortiz
8. Simulation and Optimisation of Batch and Semi-Batch Reactors - Xiaopeng Zheng
9. Software Update 2003 - Chris Sutton and Steve Doyle

Company presentations

1. Exxon: Global Energy Management System - Kirtan Trivedi
2. MCC: Site Modelling and its Applications in ECO project - Kentaro Hirata
3. MWK: Design Methodology for Steam-Power Utility Systems - Bill Townsend
4. Saudi Aramco: Energy Management at Saudi Aramco - J D Kumana and Y Y Al-Abdullah
5. Shell Global Solutions: Hydrogen Pinch, experiences - G. Grootveld
6. The International Energy Agency (IEA)
7. Intint Project: An Innovative Approach to Optimise Reactive Separations - Eugene Kenig

Workshops

Integrated Energy System Design

Integrated Energy System Design			
Objective	This workshop focuses on the design of utility systems required for processes with high power demands. These processes require drivers to run large process machines such as gas compressors. Gas turbines, electric motors, and steam turbines can be employed to provide the mechanical power requirement. In some circumstances the cost of the water system may not be justified for these processes. The workshop will emphasise the choice of driver and electricity generation for such processes. Natural gas liquefaction will be used as a vehicle to demonstrate the technology, but the approach is suitable for other processes, such as ethylene and cryogenic air separation. Because processes with a high-power demand are often sub-ambient, an understanding of refrigeration processes is also necessary to ensure the optimal integration of the systems involved at minimum cost. The operability of these systems is also considered. Those attending the workshop will use the WORK software package.		
Who should attend	The workshop is intended for process engineers involved with energy management and the design of energy and utility systems.		
Skills developed	· Modelling of gas turbines and steam turbines · Selection and integration of mechanical drivers · Optimisation of power generation systems · Evaluation of power costs · Targeting refrigeration power demands		
Lecture 1	Introduction		
Lecture 2	Driver Options		
Lecture 3	Driver Selection		
Lecture 4	Refrigeration Systems I - Pure Refrigerants		
Lecture 5	Refrigeration Systems II - Mixed Refrigerants		
Lecture 6	Introduction to Liquid Gas Liquefaction		
Lecture 7	Power Systems in LNG Plants		
Lecture 8	Further Improvements in LNG Plant Design		
Lecture 9	Conclusions		

Refinery hydrogen Management

Reaction System Design

Water Network Design

Water Network Design	
Objective	The workshop addresses the design and synthesis of water systems. The design of water systems in the process industries is most often carried out in two steps. First the water-using system is designed. The water-using system then discharges to the effluent treatment system, which is designed second. Yet the design of the water-using and effluent treatment systems interact with each other.

	Escalating freshwater and effluent treatment costs are forcing an integrated approach for designing complete water networks. A simultaneous approach is then needed to explore synergies between the water-using and water-treating systems. The methodology that integrates water-using and effluent-treatment systems within a single system is called a "Total Water System Design". This approach provides simultaneously the optimal distribution of water re-use and optimal configuration of effluent treatment, where minimum cost is achieved while satisfying environmental regulations. Also, the strategic use of effluent treatment for regeneration recycling and regeneration re-use is considered to improve the efficiency of total water systems. Automatic design procedures enable a wide range of constraints and costs to be included in the approach. The economic trade-offs of water-using and effluent treatment systems are systematically analysed. The design complexities and interactions between components of the system are also explained. New aspects of the design software, WATER, will be introduced and illustrated through examples and working sessions. Those attending workshop will use the WATER software package and learn problem-solving skills for the design of water systems.
Who should attend	This workshop is intended for process designers interested in the design of water systems and effluent treatment systems.
Skills developed	· Understanding of water-using systems and water-treating systems · Automated design of a total water system · Automated design for water re-use, regeneration re-use and regeneration recycling · Economic trade-offs of water and treatment systems · Implementation of practical constraints

Lecture 1	Introduction		
Lecture 2	Automated Design of Water Networks		
Lecture 3	Total Water System Design with Water Re-use		
Lecture 4	Total Water System Design with Regeneration Re-use / Recycling		
Lecture 5	Design Issues of Total Water System		
Lecture 6	Data Extraction and Application		
Lecture 7	Final Comments		

Summer workshops

Advanced Site Utility Systems

Site utility systems	
Objective	The essential issue for the design of a site utility system is how to satisfy the heat and power demand of the site with minimum operating costs. This requires an understanding of the trade-offs between fuel, power, and heat recovery. This workshop presents a systematic approach to the analysis of site utility systems giving the highest emphasis to retrofit. The workshop will provide understanding of the trade-offs between fuel, power and heat recovery and present a systematic approach for utility system optimisation and management using the STAR software.
Who should attend	The workshop is intended for process engineers involved with energy management, site utility systems and heat exchanger network design. The workshop will provide the necessary background.

Skills developed	The following skills are developed: • understanding of total site infrastructures • gas turbine cogeneration system design • top level analysis of total sites • marginal steam costing • steam level switching • optimisation of utility configurations (including steam and gas turbines) • analysis of refrigeration systems		
Lecture 1	Introduction		
Lecture 2	Major Components		
Lecture 3	Steam Systems	Working session	Solution
Lecture 4	Power Generation	Working session	Solution
Lecture 5	Operating Scenarios for Utility Systems	Working session	Solution
Lecture 6	Optimising Utility Systems	Working session	Solution
Lecture 7	Sensitivity - Top-Level Analysis	Working Session	Solution
Lecture 8	Top-Level Analysis by Stepwise Optimisation	Working Session	Solution
Lecture 9	Conclusions		

Basic Heat Integration and Site Utilities

Basic Heat Integration and Site Utilities			
Objective	This workshop provides an introduction to the principles of heat integration. The ability to predict achievable energy targets for the energy consumption which have a sound scientific basis is fundamental to the approach. Such targets can be used to scope and screen many design options effectively without having to carry out repeated design. The workshop also gives an introduction to the systematic procedures which have been developed to allow the targets to be achieved in practice.		
Who should attend	The course is intended for process designers who have had no exposure or only a brief exposure to pinch analysis. It is a foundation workshop which is a prerequisite for other workshops on energy integration and the design of cogeneration and site utility systems.		
Skills developed	The following skills are developed: • setting energy targets • identification of the heat recovery pinch • design for maximum energy recovery • selection of utility options • screening process changes • data extraction		
Lecture 1	Introduction	Working session	Solution
Lecture 2	Setting Energy Targets	Working session	Solution
Lecture 3	The Problem Table Algorithm	Working session	Solution
Lecture 4	The Heat Recovery Pinch	Working session	Solution
Lecture 5	Heat Exchanger Network Representation	Working session	Solution
Lecture 6	Heat Exchanger Network Design for Maximum Heat Recovery	Working session	Solution
Lecture 7	Stream Splitting	Working Session	Solution
Lecture 8	Multiple Utilities	Working Session	Solution
Lecture 9	Total Site Composite Curves	Working session	Solution
Lecture 10	Cogeneration Targets For Total Sites	Working session	Solution

Retrofit Design for Refinery Distillation

Refinery Optimisation

Refinery Optimisation			
Objective	The aim of this workshop is to present a novel method for overall refinery optimisation. It will address major aspects in refinery operation, which include selection of feeds and products, distribution of intermediate products and how to determine connections between different processes and allocations of utilities. Furthermore, it will consider the integration of these site level decisions with operation parameters associated with each process (e.g. temperatures, pressures). Some techniques for refinery scheduling will also be introduced. The software package REFOPT will be used in the workshop.		
Who should attend	Refinery managers, planners and process engineers involved with refinery design and optimisation		
Skills developed	The following skills are developed: • Understanding refinery infrastructures and interactions • Simulation and optimisation of site-wide refinery flow distribution • Assessing options in refinery operations • Scheduling of refining operations • Using graphical tools for overall refinery network design • Hands-on experience of using REFOPT, a new software package for refinery simulation/optimisation		
Lecture 1	Introduction	Working session	Solution
Lecture 2	Process Simulation	Working session	Solution
Lecture 3	Process Optimisation	Working session	Solution
Lecture 4	Plant-wide Simulation	Working session	Solution
Lecture 5	Site-flow Optimisation	Working session	Solution
Lecture 6	Integrated Optimisation	Working session	Solution
Lecture 7	Conclusions		

Refinery Hydrogen Management

Refinery hydrogen management			
Objective	The aim of this workshop is to present a systematic method for analysing hydrogen distribution systems. Several trends in the petroleum industry are leading to an increased demand for hydrogen and can lead to a deficit in the hydrogen balance. The new method sets targets for the minimum flowrate of fresh hydrogen required before any system design, identifies the existence of bottlenecks in the distribution system, and provides insights as to the benefits of installing hydrogen purification capacity. The workshop will also present a method for designing hydrogen distribution networks to achieve the targets, incorporating issues such as design constraints and capital costs. The software package REFOPT will be used in the workshop.		
Who should attend	Refinery managers, planners and process engineers involved with hydrogen system design and optimisation.		
Skills developed	· Understanding hydrogen networks · Simulate existing hydrogen networks · Using graphical tools to target the minimum hydrogen utility · Optimise the size and placement of hydrogen purifiers · Design optimal hydrogen network Hands-on experience of using REFOPT, a new software package for hydrogen network design and optimisation		
Lecture 1	Introduction		
Lecture 2	Hydrogen Consumers	Working session	Solution
Lecture 3	Hydrogen Producers	Working session	Solution
Lecture 4	Hydrogen Distribution Systems	Working session	Solution
Lecture 5	Hydrogen Composite Curves and Hydrogen Pinch	Working session	Solution
Lecture 6	Choice of Utility Purity	Working session	Solution
Lecture 7	Hydrogen Purification	Working session	Solution
Lecture 8	Placement of Purification Units	Working Session	Solution
Lecture 9	Mathematical Programming for Minimising Hydrogen Utility	Working Session	Solution
Lecture 10	Advanced Network Design	Working Session	Solution
Lecture 11	Concluding Remarks		

Pirc 2002

Research presentations

1. Synthesis of Continuous Heterogeneous Catalytic Reactors - Sungwon Hwang
2. Model Building for Chemical Reaction Systems - Wenling Zhang
3. Analysis and Optimisation of Site Utility Systems - Petar Varbanov
4. Plate-fin Heat Exchanger Network Design and Retrofit - Igor Bulatov
5. Retrofit Design of Heat-integrated Crude Oil Distillation Systems - Mamdouh Gadalla
6. Synthesis of Multicomponent Azeotropic Distillation Sequences - Guilian Liu
7. Exploitation of Interactions Between Hydroprocessors and Hydrogen Networks - Jianjun Sun
8. Molecular Characterisation of Blending streams and Products in Refineries - Mi Mi Saine Aye
9. Optimal Operation of Batch Crystallisation Processes - Kah Loong Choong
10. Synthesis for Batch Distillation Process - Santosh Jain

Chemical interest group

1. Rescheduling for Multi-purpose Chemical Batch Processes- Sangdae Park
2. Synthesis of Reactive Distillation Processes - Ramona Dragomir

Refinery Interest group

1. Operation and Maintenance Scheduling for Power Generation - Effie Dimou
2. Genetic Algorithms for Refinery Optimisation - Dhaval Dave

Poster sessions

*** under development ***

Workshops

Steam System Design

Steam System Design	
Objective	This workshop focuses on analysis and optimisation of steam systems. The principal components of steam systems are steam boilers, gas turbines, steam turbines and the steam distribution system. The steam system configuration usually allows a number of degrees of freedom to be optimised. Significant cost reduction is often possible without the requirement for capital investment. A steam system model not only allows optimisation of the existing duties, but infrastructure investment to be planned for the future. Moreover, such a model is necessary to determine the true value of steam for energy reduction projects. Those attending the workshop will use the STAR software package and learn problem-solving skills for steam systems.
Who should attend	The workshop is intended for process engineers involved with energy management and the design of energy and utility systems.
Skills developed	The following skills are developed: · Simulation of steam and gas turbines · Steam and power balances · Simulation of steam and power generation systems · Optimisation of steam and power generation systems · Evaluation of steam costs

Lecture 1	Introduction		
Lecture 2	Major Components		
Lecture 3	Steam Systems		
Lecture 4	Power Generation		
Lecture 5	Operating Scenarios for Utility Systems		
Lecture 6	Optimising Utility Systems		
Lecture 7	Sensitivity - Top-Level Analysis		
Lecture 8	Top-Level Analysis by Stepwise Optimisation		
Lecture 9	Conclusions		

Water Network Design

Water Network Design			
Objective	The workshop addresses the design and synthesis of water systems. Conceptual design insights as well as superstructure-based optimisation methods are reviewed. The design complexities and interactions between components of the system are also explained. The design of water systems in the process industries is most often carried out in two steps. First the water-using system is designed. The water-using system then discharges to the effluent treatment system, which is designed second. During the workshop, design methods for building the network of water-using processes and effluent treatment processes are presented. Using the automatic design procedures allows a wide range of constraints and costs to be included. The economic trade-offs and design complexity in water system design are systematically explored New aspects of the design software, WATER, will be introduced and illustrated through examples and working sessions. Those attending the workshop will use the WATER software package and learn problem-solving skills for the design of water systems.		
Who should attend	This workshop is intended for process designers interested in the design of water systems and effluent treatment systems.		
Skills developed	The following skills are developed · Understanding of water-using systems and water-treating systems · Automated design of water re-use networks · Automated design of wastewater treatment networks · Economic trade-offs of water and treatment systems · Assessment of design options for water systems · Hands-on experience of using water system design software, WATER		
Lecture 1	Introduction		
Lecture 2	Automated design of water-using systems		
Lecture 3	Mass transfer models of water-using processes		
Lecture 4	Water system design with temperature constraints		
Lecture 5	Simultaneous water and energy minimisation		
Lecture 6	Automated design of treatment systems		
Lecture 7	Design of treatment systems with membrane process		
Lecture 8	Design of buffering capacity for treatment systems		
Lecture 9	Final Comments		

Retrofit Design for Refinery Distillation

Retrofit Design for Refinery Distillation			
Objective	Process design methods and tools for retrofit design of refinery distillation processes will be presented. Particular attention will be paid to crude oil distillation columns. A general discussion of retrofit of distillation columns will look at how changing the column operating conditions can facilitate throughput increase. The working sessions will show how process simulations, together with COLOM, can be used to analyse the hydraulic performance of the column and to identify and evaluate promising process modifications. Temperature-enthalpy analysis is a well-established technique for analysing the energy requirements of distillation columns and for identifying opportunities for increasing the energy efficiency of an existing process by changing operating conditions. The theory behind the approach will be explained, and the working session will demonstrate how simulation results can be used to generate temperature-enthalpy profiles using COLOM for an example problem. The choice of column operating conditions, hydraulic limitations on existing internals and the details of the existing heat exchanger network are all taken into account to improve the performance of the distillation system - the column and the associated heat exchanger network (i.e. preheat train). Lectures will explain the theory, models and procedures underlying the software. The use of COLOM for simulating and optimising the column design and SPRINT for optimising the heat exchanger design will be explained. Working sessions will explore the application of the methods using COLOM and will demonstrate data extraction.		
Who should attend	The workshop is intended for process engineers with an interest in refinery distillation.		
Skills developed	The workshop develops an understanding of modelling and analysis tools for retrofit design, of the trade-offs between key design variables and of the relationship between the heat exchanger network and the distillation column. Those attending the workshop will learn to evaluate and assess the hydraulic performance of a column, identify opportunities to improve heat recovery, and generate design options to achieve retrofit objectives. They will learn to use the distillation design software, COLOM, to develop energy and capital efficient retrofit design options.		
Lecture 1	Debottlenecking Distillation Processes		
Lecture 2	Temperature-Enthalpy Analysis of Distillation		
Lecture 3	Heat Exchanger Network Retrofit		
Lecture 4	Design of Refinery Distillation Columns		
Lecture 5	Modelling for Retrofit of Refinery Distillation Systems		

Reaction System Design

Reaction System Design	
Objective	This workshop is focused on several important aspects of design and optimisation of both homogeneous and catalytic chemical reactors, on methods for building kinetic models for chemical reaction systems and on crystallisation processes. An optimisation framework has been developed that can handle a multitude of design options: type of reactor, flow rates and compositions of feeds and recycles, heat transfer arrangements. This computational framework allows for process optimisation by maximising

	yield, selectivity, profit, etc. Also, a most probable reaction mechanism can be obtained from a large number of possible choices, using optimisation techniques, with minimum experimental measurements. Complex processes with complex reaction kinetics can be simulated and optimised. The developed software can efficiently handle multiple phases, non-isothermal behaviour, heterogeneous catalytic reactions with various types of non-uniform catalyst distributions and batch systems. Crystallisation processes can also be modelled and optimised as reaction processes. The aim of this workshop is to provide the basics for learning how to set up and solve problems using REACTOR and for gaining familiarity with the key features of the software. For this purpose those attending the workshop will use the software during the working sessions to design multi-phase, batch and heterogeneous catalytic reactors and crystallisers and to build kinetic models.
Who should attend	Process engineers with an interest in reactor design technology and the synthesis of basic flowsheets. The workshop will provide all the necessary background for the less experienced engineer.
Skills developed	The workshop develops an understanding of trade-offs and complexities in chemical reactor design. Those attending will be able to grasp design and optimisation concepts and techniques for complex reaction mechanisms, batch reactors, heterogeneous catalytic reactors and crystallisers.

Lecture 1	Introduction		
Lecture 2	Simulation and Optimisation of Continuous Isothermal Reaction Systems		
Lecture 3	Continuous Non-isothermal Reaction Systems		
Lecture 4	Continuous Heterogeneous Catalytic Reaction System Design		
Lecture 5	Batch Crystalliser Design		
Lecture 6	Complex Reaction Systems: Model Building and Discrimination		
Lecture 7	Conclusion		

Summer workshops

Basic Heat Integration

Heat Exchanger Network Design

Refinery Optimisation and Hydrogen Management

Site Utility Systems

Site Utility Systems	
Objective	The essential issue for the design of a site utility system is how to satisfy the heat and power demand of the site with minimum operating costs. This requires an understanding of the trade-offs between fuel, power, and heat recovery. This workshop presents a systematic approach to the analysis of site utility systems giving the highest emphasis to retrofit. The workshop will provide understanding of the trade-offs between fuel, power and heat recovery and present a systematic approach for utility system optimisation and management using the STAR software.
Who should attend	The workshop is intended for process engineers involved with energy

	management, site utility systems and heat exchanger network design. The workshop will provide the necessary background.		
Skills developed	The following skills are developed: ·understanding of total site infrastructures ·steam and gas turbine cogeneration system design ·optimisation of utility configurations ·top level analysis of total sites ·marginal steam costing		
Lecture 1	Introduction		
Lecture 2	Steam Systems		
Lecture 3	Steam Turbines		
Lecture 4	Gas Turbines		
Lecture 5	Steam and Power Balances		
Lecture 6	Optimising Utility Systems		
Lecture 7	Gas Turbine Integration		
Lecture 8	Conclusions		

Water System Design

Water System Design			
Objective	The design of water systems in the process industries is most often carried out in two steps. First the water-using system is designed. The water-using system then discharges to the effluent treatment system, which is designed second. Yet the design of the water-using and effluent treatment systems interact with each other. Simultaneous approach is needed to explore synergies between the water-using and water-treating systems. Automatic design procedures enable a wide range of constraints and costs to be included in the approach. The economic trade-offs of water-using and effluent treatment systems are systematically analysed. This workshop will use the WATER software package to develop systematic methods for the design of both water-using and effluent treatments systems, taking into account the interactions between them.		
Who should attend	This workshop is intended for process designers interested in the design of water systems and effluent treatment systems.		
Skills developed	The following skills are developed: · Automated design of water re-use networks · Cost trade-offs of water and treatment systems · Design to avoid complexity in water networks · Inclusion of piping costs in network design · Automated design for regeneration re-use and recycling · Automated design of treatment systems · Inclusion of waste minimisation options · Interactions between regeneration and treatment · Simultaneous design of water-use and effluent treatment networks		
Lecture 1	Introduction		
Lecture 2	Targeting and Design of Water-using Systems		
Lecture 3	Automated Design of Water Re-use Networks		
Lecture 4	Design to Avoid Complexity in Water Networks		
Lecture 5	Inclusion of Piping Costs in Network Design		
Lecture 6	Automated Design for Regeneration Re-use and Recycling		
Lecture 7	Automated Design of Treatment Systems		
Lecture 8	Inclusion of Waste Minimisation Options		
Lecture 9	Final Comments		

Pirc 2001

Research presentations

1. Design and Optimisation of Non-ideally Mixed Batch Reactors - Jinzhong Zhang
2. Synthesis of Continuous Heteregeneous Catalytic Reactors - Sungwon Hwang
3. Retrofit of Heat Integration Complex Distillation Systems - Mamdouh Gadalla
4. Integrating Purifiers and Hydrogen Plant Into Refinery Hydrogen Networks - Fang Liu
5. Optimal Design of Batch Crystallisation Processes - Kah Loong Choong
6. Design of Gas Permeation Membrane Systems - Ramagopal Uppaluri
7. Integration of Planning and Scheduling of Multi-purpose Batch Plants - Thoko Majozi
8. Value Analysis for Process Network Optimisation - Jhuma Sadhukhan
9. Total Water System Design - Mohan Gunaratnam
10. Optimisation of Refinery Operations for Reduction in Greenhouse Gas Emissions - Celine Chew

Refinery interest group

1. Molecular Modelling of Hydrocracking Unit - Jianjun Sun
2. Synthesis and Optimisation of Ternary Azeotropic Distillation Flowsheets - Sutijan

Poster sessions

1. Clean Coal-fired Plant Operability A Techno-economic Evaluation - Efthymia Dimou
2. Short-term Scheduling for Multi-purpose Batch Plants - Sangdae Park
3. Molecular Modelling for Cleaner Production of Gasoline - Mi Mi Saine Aye
4. Synthesis of Multi-component Azeotropic Distillation Sequences - Guilian Liu
5. Synthesis of Industrial Utility Systems - An Integrated Approach - Petar Varbanov
6. Optimisation of Reflux Heat Exchangers (Dephlegmators) and Refrigeration Process - Jiaona Wang
7. Model Building for Reaction Systems in Speciality Chemicals - Wenling Zhang
8. Software Update- Chris Sutton and Steve Doyle

Workshops

Reaction System Design

Reaction System Design	
Objective	This workshop addresses the design and optimisation of chemical reactors and crystallisation processes. Design options such as the type of reactor, flow rates and compositions of feeds and recycles, heat transfer arrangements, etc. are incorporated in an optimisation framework. The superstructure provides a framework for process optimisation, where yield, selectivity, profit, etc. are maximised. Complex processes can be simulated and optimised, including those with complex reaction mechanisms and kinetics, multiple phases, non-isothermal behaviour, heterogeneous catalytic reactions and batch systems. In addition, crystallisation processes can also be modelled and optimised as reaction processes The workshop reviews various approaches to the design of reactors. The superstructure-based approach to building networks of reactors is explained. The optimisation of rector design variables that vary through space and time is also explained. The ideas are illustrated using examples and working sessions. In the

	working sessions, the software REACTOR is used to optimise reactor and crystalliser designs. Those attending the workshop will use the software during these working sessions to design multi-phase, batch and heterogeneous catalytic reactors and also crystallisers. The workshop thus allows those attending to learn how to set up and solve problems using REACTOR and to gain familiarity with the key features of the software		
Who should attend	Process engineers with an interest in reactor design technology and the synthesis of basic flowsheets. The workshop will provide all the necessary background for the less experienced engineer.		
Skills developed	The workshop develops an understanding of trade-offs and complexities in chemical reactor design. Those attending will learn to assess design options for complex reaction systems, batch reactions, heterogeneous catalytic reactions and crystallisation.		
Lecture 1	Introduction		
Lecture 2	Simulation and Optimisation of continuous isothermal reaction systems		
Lecture 3	Continuous non-isothermal reaction systems		
Lecture 4	Continuous heterogeneous catalytic reaction system design	Working session	Solution
Lecture 5	Batch reactor design		
Lecture 6	Batch crystalliser design		
Lecture 7	Final Comments		

Distillation

Distillation			
Objective	This workshop addresses distillation sequencing including the use of complex columns such as thermally coupled and prefractionator arrangements. Screening methods are introduced for selecting promising distillation sequences comprising simple and complex columns and their operating pressures. Dividing wall columns are also examined in some detail. For some designs, such as refinery distillation, both the column design and heat integration must be considered simultaneously. This will also be explored. This workshop will use the COLOM software package		
Who should attend	Process engineers involved with distillation design. Background from the workshop on Basic Heat Integration will be necessary		
Skills developed	In the workshop, we show how to: · debottlenecking distillation columns · screen alternative distillation sequences of simple and complex columns using new optimisation methods · determine the appropriate operating pressures for the columns in the sequence · explore heat integration of different sequences · dividing wall distillation columns · design refinery distillation columns simultaneously with heat integration		
Lecture 1	Heat integration of distillation columns		
Lecture 2	Modelling and optimisation of heat integrated distillation sequences		
Lecture 3	Synthesis of heat integrated distillation sequences		
Lecture 4	Design of refinery distillation columns	Working session	Solution
Lecture 5	Modelling for retrofit of refinery distillation systems		

Lecture 6	Graphical tools for azeotropic distillation design - an introduction		
Lecture 7	Modelling and optimisation of extractive distillation flowsheets		
Lecture 8	Conclusions		

Energy System Design Update

Energy System Design Update			
Objective	This workshop focuses on analysis of utility systems based on R-curve concept and design of cooling water systems. The R-curve analysis is a powerful tool in identifying inefficient parts of the overall energy systems and ways to improve them. A project analysis method for generating a project road map will also be presented. For design of cooling water systems, the interactions between cooling tower performance and cooling water network design will be explained and the design method will be introduced. Issues of retrofit analysis are also addressed to give guidelines for debottlenecking of cooling water systems		
Who should attend	The workshop is intended for process engineers involved with energy management, the design of energy systems, and cooling water system design.		
Skills developed	The following skills are developed: ▪ Analysis for utility systems ▪ Project analysis and selection ▪ Design and analysis of cooling water systems ▪ Hands-on experience for industrial projects		
Lecture 1	Introduction		
Lecture 2	Site Heat to Power Ratio		
Lecture 3	Site Heat to Power Ratio - Actual R-Curves		
Lecture 4	Applications of R-Curve Analysis		
Lecture 5	Utility Systems and Process Changes		
Lecture 6	Roadmaps for retrofit project selection		
Lecture 7	Cooling Water System Design		
Lecture 8	Design of cooling systems for effluent temperature reduction		
Lecture 9	Final Comments		

Refinery Optimisation and Hydrogen Management

Refinery Optimisation and Hydrogen Management	
Objective	There are two aims of this workshop. The first is to present a novel method for overall refinery optimisation. It will address major aspects in refinery operation, which include selection of feeds and products, distribution of intermediate products and how to determine connections between different processes and allocations of utilities. Furthermore, it will consider the integration of these site level decisions with operation parameters associated with each process (e.g. temperatures, pressures). The second aim is to present a systematic method for analysing

	hydrogen distribution systems. Several trends in the petroleum industry are leading to an increased demand for hydrogen and can lead to a deficit in the hydrogen balance. The new method sets targets for the minimum flowrate of fresh hydrogen required before any system design, identifies the existence of bottlenecks in the distribution system, and provides insights as to the benefits of installing hydrogen purification capacity. The workshop will also present a method for designing hydrogen distribution networks to achieve the targets, incorporating issues such as design constraints and capital costs. The software package REFOPT will be used in the workshop.
Who should attend	Refinery managers, planners and process engineers involved with refinery design and optimisation
Skills developed	The following skills are developed: · Understanding refinery infrastructures and interactions · Simulation and optimisation of site-wide refinery flow distribution · Assessing options in refinery operations · Using graphical tools for overall refinery network design · Understanding hydrogen networks · Using graphical tools to target the minimum hydrogen utility · Optimise the size and placement of hydrogen purifiers · Design optimal hydrogen networks · Hands-on experience of using REFOPT, a new software package for refinery simulation/optimisation and hydrogen network design and optimisation

Lecture 1	Introduction		
Lecture 2	Process Optimisation		
Lecture 3	Plant-wide Simulation		
Lecture 4	Site-Flow Optimisation		
Lecture 5	Integrated Optimisation		
Lecture 6	Hydrogen Networks		
Lecture 7	Minimising Hydrogen Utility		
Lecture 8	Advanced Hydrogen Network Optimisation		
Lecture 9	Hydrogen Network Retrofit with Purification Units		
Lecture 10	Concluding Remarks		

Summer workshops

Basic Heat Integration

Heat Exchanger Network Design

Heat Exchanger Network Design	
Objective	This workshop focuses on the design of heat exchanger networks. Methods for new heat exchanger network design will be developed. For heat exchanger network retrofit, the concept of network pinch will be briefly reviewed, and the network pinch method will be discussed with the extension of handling segmented streams, multiple operational scenarios etc. The focus will be on practical applications where two cases, energy saving and debottlenecking, will be emphasised.
Who should attend	The workshop is intended for process engineers involved with energy management, heat exchanger network design and the design of energy systems.
Skills developed	The following skills are developed: · Design skills for new heat exchanger networks

	· Design skills for heat exchanger network retrofit · Data handling for segmented streams · Design for multi-operational scenarios		
Lecture 1	Data Requirements	Working Session	Solution
Lecture 2	Heat Exchanger Network Representation	Working Session	Solution
Lecture 3	Automated Design	Working Session	Solution
Lecture 4	The HEN Retrofit Design Problem	Working Session	Solution
Lecture 5	Network Pinch	Working Session	Solution
Lecture 6	Overcoming the Network Pinch	Working Session	Solution
Lecture 7	Network Pinch with Segmentation of Streams	Working Session	Solution
Lecture 8	Procedure for HEN Retrofit	Working Session	Solution
Lecture 9	Applications of Network Pinch	Working Session	Solution
Lecture 10	Summary		

Site Utility Systems

Site Utility Systems			
Objective	The essential issue for the design of a site utility system is how to satisfy the heat and power demand of the site with minimum operating costs. This requires an understanding of the trade-offs between fuel, power, and heat recovery. This workshop presents a systematic approach to the analysis of site utility systems giving the highest emphasis to retrofit. The workshop will provide understanding of the trade-offs between fuel, power and heat recovery and present a systematic approach for utility system optimisation and management using the STAR software.		
Who should attend	The workshop is intended for process engineers involved with energy management, site utility systems and heat exchanger network design. The workshop will provide the necessary background.		
Skills developed	The following skills are developed: ·understanding of total site infrastructures ·steam and gas turbine cogeneration system design ·optimisation of utility configurations ·top level analysis of total sites ·marginal steam costing		
Lecture 1	Introduction		
Lecture 2	Steam Systems		
Lecture 3	Steam Turbines		
Lecture 4	Gas Turbines		
Lecture 5	Steam and Power Balances		
Lecture 6	Optimising Utility Systems		
Lecture 7	Total Site Composite Curves		
Lecture 8	Cogeneration Targets for Steam Turbine Systems		
Lecture 9	Gas Turbine Integration		
Lecture 10	Top Level Analysis - Path Analysis for Steam Systems		
Lecture 11	Final Comments		

Distillation

Refinery Optimisation

Pirc 2000

Research presentations

1. Synthesis of Reactive Distillation Matthias Groemping
2. Design and Optimisation Of Batch Reactors- Jinzhong Zhang
3. Low Temperature Processes -Two Recent Developments - Guang Chung Lee
4. Automated Design of Plate-fin Heat Exchanger Networks - Lee Ming Pua
5. Synthesis of The Heat Integrated Distillation Sequences - Anupam Samanta
6. Synthesis of Membrane Systems - Ramagopal Uppaluri
7. Design of Refinery Hydrogen Networks - Fang Liu
8. Effect of Process Modifications on Site Utility Systems- Lakshmi Vaideeswaran
9. Integration of Planning and Scheduling for Batch Processes - Thokozani Majoz
10. Automated Cooling Water System Design- Jin-Kuk Kim

Refinery interest group

1. Integrated Gasification Combined Cycles (IGCC) in Refineries- Jhuma Sadhukhan
2. Synthesis and Sequencing of Absorption Process - Tjoen Kusardi

Workshops

Refinery Optimisation

Refinery Optimisation			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction		
Lecture 2	Process Simulation	Working Session	Solution
Lecture 3	Process Optimisation	Working Session	Solution
Lecture 4	Plant-wide Simulation	Working Session	Solution
Lecture 5	What-if scenarios for plant-wide simulation	Working Session	Solution
Lecture 6	Site-flow Optimisation	Working Session	Solution
Lecture 7	Integrated Optimisation	Working Session	Solution
Lecture 8	What-if scenarios for integrated optimisation	Working Session	Solution
Lecture 9	Final Comments		

Refinery Hydrogen Management

Refinery Hydrogen Management	
Objective	
Who should attend	

Skills developed			
Lecture 1	Introduction		
Lecture 2	Hydrogen Consumers		
Lecture 3	Hydrogen Producers		
Lecture 4	Hydrogen Distribution Systems	Working Session	Solution
Lecture 5	Targeting Minimum Hydrogen Utility	Working Session	Solution
Lecture 6	Network Design	Working Session	Solution
Lecture 7	Purity/Flowrate Trade-Off	Working Session	Solution
Lecture 8	Placement of Purification Units	Working Session	Solution
Lecture 9	Constrained Design	Working Session	Solution
Lecture 10	Cost Optimisation	Working Session	Solution
Lecture 11	Final Comments		

Reaction and Reaction Separation System Design

Reaction and Reaction Separation System Design			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction		
Lecture 2	Design methodologies for reaction and reaction-separation systems	Working Session	Solution
Lecture 3	Optimisation framework for reaction and reaction separation system design	Working Session	Solution
Lecture 4	Isothermal reaction system design	Working Session	Solution
Lecture 5	Non-isothermal reaction system design	Working Session	Solution
Lecture 6	Batch reactor design	Working Session	Solution
Lecture 7	Introduction to synthesis of reaction-separation systems	Working Session	Solution
Lecture 8	systematic approach for reaction-separation system design	Working Session	Solution
Lecture 9	Final Comments	Working Session	Solution

Energy System Design Update

Energy System Design Update			
Objective			
Who should attend			
Skills developed			
Lecture 1	Introduction		
Lecture 2	Network Pinch	Working session	Solution
Lecture 3	Overcoming Network Pinch	Working session	Solution
Lecture 4	Network Pinch with Segmentation of Streams	Working session	Solution
Lecture 5	Procedure for HEN Retrofit	Working session	Solution
Lecture 6	Applications of Network Pinch	Working session	Solution
Lecture 7	Introduction to Mixed Refrigerant Systems	Working session	Solution
Lecture 8	Multistage Mixed Refrigerant Systems	Working session	Solution
Lecture 9	Final Comments		

Summer workshops

Basic Heat Integration

Basic Heat Integration			
Objective	Pinch analysis is now well established for the design of energy systems. This workshop provides an introduction to the principles of pinch analysis. The ability to predict achievable energy targets for the energy consumption which have a sound scientific basis is fundamental to the approach. Such targets can be used to scope and screen many design options effectively without having to carry out repeated design. The workshop also gives an introduction to the systematic procedures which have been developed to allow the targets to be achieved in practice.		
Who should attend	The course is intended for process designers who have had no exposure or only a brief exposure to pinch analysis. It is a foundation workshop which is a prerequisite for other workshops on energy integration and the design of cogeneration and site utility systems		
Skills developed	The following skills are developed: · setting energy targets · identification of the heat recovery pinch · design for maximum energy recovery · selection of utility options · screening process changes · data extraction		
Lecture 1	Introduction		
Lecture 2	Setting Energy Targets	Working session	Solution
Lecture 3	The Problem Table Algorithm	Working session	Solution
Lecture 4	The Heat Recovery Pinch	Working session	Solution
Lecture 5	Heat Exchanger Network Representation	Working session	Solution
Lecture 6	Heat Exchanger Network Design for Maximum Heat Recovery	Working session	Solution
Lecture 7	Stream Splitting	Working session	Solution
Lecture 8	Multiple Utilities	Working session	Solution
Lecture 9	Process Modifications	Working session	Solution
Lecture 10	Data Extraction		

Basic Site Utility Systems

Basic Site Utility Systems	
Objective	Processes most often operate within the context of a site in which a number of processes are linked to a common utility system. Not only do the individual processes interact with the utility system, but the processes interact with each other through the utility system. The utility system consumes fuel in central boilers, supplies steam at different pressures and generates power. Power might also be imported. The workshop presents an introduction to total site integration using the STAR software.
Who should attend	The workshop is intended for process engineers involved with energy management, site utility systems and heat exchanger network design. The workshop on Basic Heat Integration will provide the necessary background.
Skills developed	The following skills are developed: · understanding of total site infrastructures · steam and power balances · energy targeting for the total site · targeting cogeneration potential from steam turbines · optimisation of steam mains pressures

	· steam turbine network design · gas turbine integration		
Lecture 1	Introduction		
Lecture 2	Furnaces	Working session	Solution
Lecture 3	Steam Systems	Working session	Solution
Lecture 4	Steam Turbines	Working session	Solution
Lecture 5	Gas Turbines	Working session	Solution
Lecture 6	Steam and Power Balances	Working session	Solution
Lecture 7	Total Site Composite Curves	Working session	Solution
Lecture 8	Cogeneration Targets for Steam Turbine Systems	Working session	Solution
Lecture 9	Steam Turbine Network Design	Working session	Solution
Lecture 10	Optimising Steam Levels	Working session	Solution
Lecture 11	Gas Turbine Integration	Working session	Solution

Advanced Water System Design

Advanced Water System Design			
Objective	The design of water systems in the process industries is most often carried out in two steps. First the water-using system is designed. The water-using system then discharges to the effluent treatment system, which is designed second. Yet the design of the water-using and effluent treatment systems interact with each other. This workshop will use the WATER software package to develop systematic methods for the design of both water-using and effluent treatment systems, taking into account the interactions between them.		
Who should attend	The workshop is intended for process designers interested in the design of water and effluent treatment systems. Previous exposure to the design of water systems through the Basic Water Minimisation Workshop will be necessary		
Skills developed	The following skills are developed: · automated design of water re-use networks · design to avoid complexity in water networks · inclusion of piping costs in network design · automated design for regeneration re-use and recycling · automated design of treatment systems · inclusion of waste minimisation options · interactions between regeneration and treatment · simultaneous design of water-use and effluent treatment networks		
Lecture 1	Introduction		
Lecture 2	Automated Design of Water Re-use Networks	Working session	Solution
Lecture 3	Design to Avoid Complexity in Water Networks	Working session	Solution
Lecture 4	Inclusion of Piping Costs In Network Design	Working session	Solution
Lecture 5	Automated Design for Regeneration Re-use and Recycling	Working session	Solution
Lecture 6	Automated Design of Treatment Systems	Working session	Solution
Lecture 7	Inclusion of Waste Minimisation Options	Working session	Solution
Lecture 8	Simultaneous Design of Water-Use and Effluent Treatment Networks	Working session	Solution
Lecture 9	Final Comments		

Advanced Distillation

Advanced Distillation			
Objective	This workshop addresses distillation sequencing including the use of complex columns such as thermally coupled and prefractionator arrangements. Screening methods are introduced for selecting promising distillation sequences comprising simple and complex columns and their operating pressures. Dividing wall columns are also examined in some detail. For some designs, such as refinery distillation, both the column design and heat integration must be considered simultaneously. This will also be explored. This workshop will use the COLOM software package to carry out the calculations.		
Who should attend	Process engineers involved with distillation design. Background from the workshop on Basic Heat Integration will be necessary.		
Skills developed	In the workshop, we show how to: · screen alternative distillation sequences of simple and complex columns using new optimisation methods · determine the appropriate operating pressures for the columns in the sequence · explore heat integration of different sequences · dividing wall distillation columns · design refinery distillation columns simultaneously with heat integration		
Lecture 1	Introduction		
Lecture 2	Debottlenecking Distillation Processes	Working session	Solution
Lecture 3	Sequencing Synthesis with Simple and Complex Columns	Working session	Solution
Lecture 4	Design and Optimisation of the Dividing Wall Distillation Column	Working session	Solution
Lecture 5	Refinery Distillation	Working session	Solution
Lecture 6	Extractive Distillation	Working session	Solution
Lecture 9	Final Comments		

Reactor Design

Reactor design	
Objective	For the design and scale-up of reactors, the most appropriate configuration and mixing pattern, arrangements for feed and recycling of raw materials and arrangements for handling the energy effects in the reaction system have not only a critical effect on the performance of the reactor but the process as a whole. This workshop: · reviews simple and shortcut procedures established to assess design options for simple cases in reactor design · provides hands-on reactor design experience through working sessions using REACTOR, a software development that uses optimisation technology for chemical reactors developed at UMIST over the last four years · explains the interface of REACTOR with the synthesis and optimisation models · illustrates applications of REACTOR in complex reaction systems and multiphase reaction problems considering both isothermal and non-isothermal modes of operation
Who should attend	The workshop is intended for process engineers with an interest in reactor design technology. The workshop will provide all the necessary background for the less experienced engineer.
Skills developed	The following skills are developed: · understanding trade-offs and complexities in chemical reactor design · assessing options in complex reaction systems · familiarisation with optimisation tools for reactor design · familiarisation with reactor network synthesis tools

	· familiarisation with multiphase reactor technology · familiarisation with non-isothermal reactor technology		
Lecture 1	Introduction		
Lecture 2	Design methodologies for reaction and reaction-separation systems	Working session	Solution
Lecture 3	Optimisation framework for reaction and reaction separation system design	Working session	Solution
Lecture 4	Isothermal reaction system design	Working session	Solution
Lecture 5	Non-isothermal reaction system design	Working session	Solution
Lecture 6	Batch reactor design	Working session	Solution
Lecture 7	Introduction to synthesis of reaction-separation systems	Working session	Solution
Lecture 8	A systematic approach for reaction-separation system design	Working session	Solution
Lecture 9	Final Comments		

Pirc 1999

Research presentations

1. Synthesis of Catalytic Chemical Reactor Networks - Antonis Kokossis
2. Synthesis of Reaction/Separation Processess - Patrick Linke
3. Optimal Synthesis of Refrigeration systems - Guang-Chung Lee
4. Multistream Heat Exchanger Network Synthesis- Lee Ming Pua
5. Design of Complex Distillation Systemss - Bunyaphat Suphanit
6. Overall Refinery Debottlenecking- Nan Zhang
7. Debottlenecking Distillation Processes - Zhi-Young Liu
8. Multicomponent Azeotropic Distillation Design - Dennis Y-C Thong
9. Optimal Design and Operation of Plant Utility Systems Under Operational Variation - Zhigang Shang
10. Cooling Water System Design - Jin-Kuk Kim

Thesis 1985-2005

Phd thesis contained in the centres' library (1985-2005)

Electronic versions of some of these theses may be available upon request (2001-2005)

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