



LABORATORY PLANNING GUIDE

L55 v2 Unit Operations Laboratory

Content

Covered subjects according to the curriculum..... 2

Main concept..... 3

Initial training provided for laboratory personnel 4

Requirements / Utilities 4

Schedule of requirements 5

Laboratory drawing 5



Covered subjects according to the curriculum

Major topics of learning content:

- investigation of diffusion in liquids and gases
- fundamentals of diffusion: Fick's law
- derivation of the calculation formula for the diffusion coefficients for the given experimental conditions
- determination of the diffusion coefficient for the mass transport in gas and in liquid
- investigation of the absorption process during the separation of oxygen from an air flow in a falling film column
- determination of the mass transfer coefficient
- continuous and discontinuous rectification with packed and sieve plate column
 - * in continuous mode
 - * in discontinuous mode
 - * in vacuum mode
 - * with different reflux ratios
 - * with different numbers of plates and inlet heights for the feed flow (sieve plate column)
- fundamentals of solid-liquid extraction
- demonstration of solid-liquid extraction as a continuous and discontinuous process
- investigation of 1-, 2- and 3-stage processes
- influence of solvent flow rate and temperature on the extraction process
- influence of extraction material feed rate and extractor revolving speed on the extraction process
- transition of a component from a two-component liquid mixture into a solvent by extraction
- enrichment of transition component in extract by distillation
- evaluation of separation processes via concentration measurement and mass balances
- influence of different experimental options on separation processes
- thermodynamic principles of the wet cooling tower
 - * changes of state of the air in the h-x diagram
 - * determination of the cooling capacity
- investigation of the absorption process when separating gas mixtures in a packed column
 - * determination of pressure losses in the column
 - * representation of the absorption process in an operating diagram
 - * investigation of the variables influencing the effectiveness of absorption
- fundamentals of filtration: Darcy's equation
- depth filtration with different bulk solids and suspensions
- cake filtration with different suspensions
- fundamental principle of cooling crystallisation
- investigation of the factors influencing crystal growth: oversaturation and saturation time
- fundamental principle of adsorption and desorption
- investigation of the variables influencing adsorption and desorption
 - * air flow rates
 - * air humidity and temperature
 - * bed height of adsorbent
 - * depiction of the processes in a h-w diagram
- fundamental principle of film evaporation for increasing the concentration of temperature-sensitive solutions
 - * investigation of the variables influencing the solid concentration in the solution
 - * influence of pressure and feed flow rate on the separating process

- * influence of flow rate and pressure of the heating steam on the separating process
- * investigation of the variables influencing the energy efficiency of the process
- * energy balances at heat exchangers
- * system cleaning while installed
- multivariable control: vacuum degassing
- coupled level and pressure control with various controller types
- multivariable control: stirred tank
- level control with
 - * PI controller
 - * disturbance feedforward control
- temperature control
 - * with two-point controller
 - * with three-point controller (split range)
 - * with override control
 - * via motorised valve with position feedback
- cascade control
 - * level - flow rate
 - * temperature - flow rate

Main concept

The laboratory is designed for accommodation of 24 students + 2 laboratory staff:

- 2 - 4 students form a team and work together at a workstation / training system
- 14 different workstations
- All workstations are floor standing or on a laboratory table
- 7 of the workstations are equipped with a PC
- Each workstation is equipped with a manual containing technical information, basic theory, experiment instructions, evaluation help and safety advice.
- Student teams are scheduled to change workstations from lab session to lab session in order to perform the entire range of experiments within the course duration.
- Average time per experiment: 90 to 120 minutes.

2 workstations for laboratory staff (with PC and internet access)

1 printer for common use

1 cupboard for small parts, consumables, tools, paper etc.

Initial training provided for laboratory personnel

Trainer: Specialized engineer of G.U.N.T. Gerätebau GmbH, Germany.

To be conducted immediately after installation and commissioning of the equipment.

General topics to be covered for any of the educational systems:

- Basic familiarization with the system.
- Functions and components.
- Overall system configuration aspects.
- Start-up and operational aspects.
- Conduction experiments, including evaluation and calculation.
- Using the system with and without the software (where applicable).
- Trouble shooting and maintenance aspects.
- Hands-on, practical familiarization aspects.
- Seminar participants with the delivered system.
- Details of the manuals.
- Safe operation and preventive maintenance.

Requirements / Utilities

Power supply:

- 230 V / 50 Hz / 1 phase – at least 20 power sockets
- 400 V / 50 Hz / 3 phases – at least 2 power socket

Water:

- 8 x cold water
- 8 x drain

Others:

- Compressed air
- CO₂

Laboratory computer network:

- 2 internet connections for staff
- 7 internet connections for students

Location:

- Laboratory space min 96 m²
- This laboratory could be installed on any floor (e.g. ground floor or 1st floor)

Schedule of requirements

Item No.	Description	Quantity
Item 1	Diffusion in liquids and gases	1
Item 2	Falling film absorption	1
Item 3	Continuous rectification	1
Item 4	Solid-liquid extraction	1
Item 5	Liquid-liquid extraction	1
Item 6	Wet cooling tower	1
Item 7	Gas absorption	1
Item 8	Cake and depth filtration	1
Item 8.1	Precision balance 10100g / 0,1g	1
Item 9	Cooling crystallisation	1
Item 10	Adsorptive air drying	1
Item 11	Rising film evaporation	1
Item 11.1	Electrical steam generator 10kW	1
Item 12	Multivariable control: vacuum degassing	1
Item 13	Multivariable control: stirred tank	1
Item 14	Control of 4 variables from process engineering	1

Laboratory drawing

