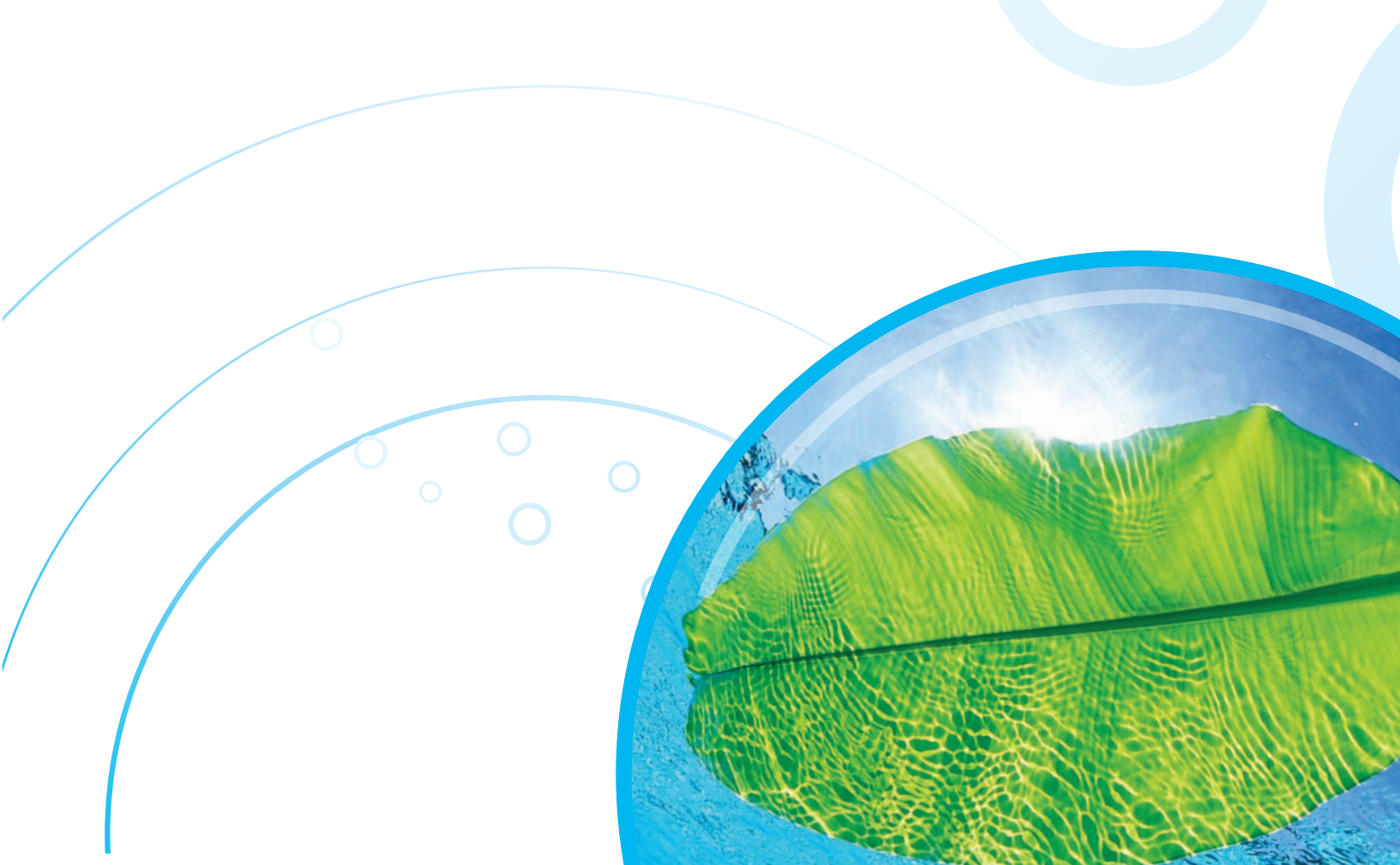


ENVIRONMENTAL ENGINEERING

In today's environmentally aware world, it is essential to equip students with knowledge in environmental engineering. The **SOLTEQ**[®] Environmental Engineering equipment covers both air pollution control, and water and waste water treatment study. The Air pollution Control section introduces students to basic principles and operation of cyclone system, scrubber, bag filter system and electrostatic precipitator. In water and waste water treatment, our products focus on sedimentation study, flocculation and coagulation, various types of filtration, membrane technology, aerobic and anaerobic digester, and activated sludge sewage treatment.





ENVIRONMENTAL ENGINEERING

Equipment List

MODEL NO.

EQUIPMENT NAME

Air Pollution Control

AP 01	Multi Cyclone System	1
AP 02	Venturi Scrubber System	1
AP 03	Spray Chamber System	2
AP 04	Pulse-Jet Bag Filter System	2
AP 05	Electrostatic Precipitator	3
AP 11	Basic Cyclone Unit	3

Water and Waste Water Treatment

TR 01	Sedimentation Study Apparatus	4
TR 02	Ion Exchange Unit	4
TR 04	Activated Sludge Sewage Treatment Pilot Plant	5
TR 05	Filterability Index Unit	5
TR 06	Aeration Apparatus	6
TR 08	Reverse Osmosis Unit	6
TR 09	Sedimentation Tank	7
TR 10	Flocculation Test Unit	7
TR 13	Deep Bed Filtration Unit	8
TR 14	Membrane Test Unit	8
TR 15	Batch Settling Filtration Column	9
TR 16	Membrane Filtration Unit	9
TR 18	Reverse Osmosis Unit	10
TR 24	Plate and Frame Filter Press	10
TR 25	Plate and Frame Filter Press Pilot Plant	11
TR 26	Anaerobic Digester	11
TR 28	Aerobic Digester	12
TR 31	Membrane Fabrication Unit	12
BP 01	Corrosion Study Kits	13

AIR POLLUTION CONTROL

Multi Cyclone System (Model : AP 01)

SOLDAS SOLCAL EI



This **Multi Cyclone System** is designed to demonstrate principles of gas cleaning device in air pollution control. The cyclone separator utilises centrifugal force for dust separation.

This unit consists of:

- Cyclone separator - 2 (ss) + 1 (glass) cyclones
- Air blower - high pressure, high capacity
- Dust feeder - cylindrical container + air pump
- Outlet dust filter - stainless steel wire mesh
- DP measurement for each cyclone
- Flow measurement for gas stream
- Inverter for regulating blower speed

Experimental capabilities:

- Determination of cyclone separation efficiency
- Effects of cyclone dimension
- Single and series cyclone operations

Venturi Scrubber System (Model : AP 02)

SOLDAS SOLCAL EI



This **Venturi Scrubber System** is designed to demonstrate principles of gas cleaning device in air pollution control. Water droplets are created at the venturi throats to trap dust particles from gas stream

This unit consists of:

- Cylindrical venturi - made of clear PVC
- Separation chamber - made of clear PVC
- Water circulation system - ss tank + pump
- Air blower - var. speed, hi-pressure, hi-capacity
- Dust feeder - cylindrical container
- Outlet dust filter - stainless steel wire mesh
- DP measurements for venturi + chamber
- Flow measurements for liquid + gas stream
- Inverter for regulating blower speed

Experimental capabilities:

- Determination of separation efficiency
- Effects of L/G ratio
- Relationship between DP & inlet velocity

Spray Chamber System

(Model : AP 03) **SOLDAS** **SOLCAL** **EI**



This **Spray Chamber System** is designed to demonstrate principles of gas cleaning device in air pollution control. Dust particles in the gas stream are trapped by water droplets generated in the spray chamber.

This unit consists of:

- Spray chamber - made of clear PVC
- Spray nozzles - ss, five different droplet sizes
- Water circulation system - ss tank + pump
- Air blower - var. speed, hi-pressure, hi-capacity
- Dust feeder - cylindrical container
- Outlet dust filter - stainless steel wire mesh
- DP measurement across spray chamber
- Flow measurements for liquid + gas stream
- Inverter for regulating blower speed

Experimental capabilities:

- Determination of separation efficiency
- Effects of water droplet size and L/G ratios
- Relationship between DP & inlet velocity

Pulse-Jet Bag Filter System

(Model : AP 04) **SOLDAS** **SOLCAL** **EI**



This **Pulse-Jet Bag Filter System** is designed to demonstrate principles of gas cleaning device in air pollution control. Dust particles in gas stream are trapped using fabric bag filters.

This unit consists of:

- Baghouse - upper section (ss), lower section (clear polycarbonate)
- Pulse jet cleaning system - tank, timer, solenoid valve + jet nozzles
- Air blower - varying speed, high pressure and capacity
- Dust feeder - cylindrical container
- Outlet dust filter - stainless steel wire mesh
- DP measurements for across baghouse
- Flow measurements for gas stream
- Inverter for regulating blower speed

Experimental capabilities:

- Determination of separation efficiency
- Effects of filtering area, G/C ratio & cleaning interval
- Relationship between DP & inlet velocity

Electrostatic Precipitator (Model : AP 05)

SOLDAS SOLCAL EI



This **Electrostatic Precipitator** is designed to demonstrate principles of gas cleaning device in air pollution control. The Electrostatic Precipitator ionizes dust particles and the charged particles are attracted to the collecting plates.

This unit consists of:

- Lab scale EP - pre-filter, ionizing / collecting plates, air blower and transformer
- Dust feeder - bellmouth inlet, cylindrical container and air pump
- Flow measurements for gas stream
- Digital balance

Experimental capabilities:

- Determination of collecting efficiency for different dust materials
- Effects of ionization strength

Basic Cyclone Unit (Model : AP 11)

SOLDAS SOLCAL EI



This **Basic Cyclone Unit** is designed to demonstrate operation of a basic gas cleaning device in air pollution control.

This unit consists of:

- Cyclone - borosilicate glass with diameter 100 mm and comes with a dust hopper
- Air blower - 1.3 kW high pressure blower with capacity 200m³ / hr
- Dust feeding system
- Manometer for pressure measurement
- Venturi meter for air flow measurement
- Inverter for blower speed control

Experimental capabilities:

- Determine of overall collection efficiency of a single cyclone operation
- Study the effect of inlet velocity upon collection efficiency
- Study the effect of particle size upon collection efficiency
- Verify theoretical relationship between pressure drop and inlet velocity

WATER AND WASTE WATER TREATMENT

Sedimentation Study Apparatus (Model : TR 01)



This **Sedimentation Study Apparatus** is designed to demonstrate characteristics of gravitational settling (sedimentation)

This unit consists of:

- Glass tube – cylindrical, scales (mm)
- Bench with backpanel and illumination

Experimental capabilities:

- i) Effects on settling rates of the followings:
 - Initial concentration
 - Initial suspension heights
 - Particle size distribution
 - Flocculating agents
- ii) Plots of settling rate curves from single batch run

Ion Exchange Unit (Model : TR 02)



This **Ion Exchange Unit** is designed to demonstrate principles of water softening or demineralization process using ion-exchange resins

This unit consists of:

- Acrylic tubes – removable, filled with cation and anion resins
- Sump tank – made of PVC with separate compartments for test solutions, regenerants and waste
- Metering pump – self priming, diaphragm, capacity 5 L/hr @ 10 bar
- Conductivity meter – range 0 to 200mS/cm
- Liquid flow meter – range 0 to 80ml/min

Experimental capabilities:

- Determine breakthrough point
- Determine exchange capacities of the resin materials

Activated Sludge Sewage Treatment Pilot Plant (Model : TR 04)

SOLDAS SOLCAL EI



This **Activated Sludge Sewage Treatment Pilot Plant** is designed to demonstrate operation of sewage treatment by activated sludge.

This unit consists of:

- Feed tank – 150 L cylindrical vessel made of polypropylene comes with agitator
- Reactor – 30 L cylindrical vessel made of clear acrylic comes with agitator and air diffuser
- Settling tank – 30 L cylindrical vessel made of clear acrylic
- Collection tank – 50 L rectangular vessel made of polypropylene
- Feed & recycle pump – peristaltic type

Experimental capabilities:

- Operation of activated sludge sewage treatment plant
- Effect of various parameters on performance of activated sludge treatment process

Instruments & control:

- Flow rate measurement of the feed
- Measurement and control for temperature, pH and dissolved O₂ of the liquid in reactor
- Flow rate measurement of air into reactor
- Flow rate measurement of sludge recycle into reactor
- Timer based control for sludge recycle and discharge

Filterability Index Unit (Model : TR 05)

SOLDAS SOLCAL EI



This **Filterability Index Unit** is designed to demonstrate water quality test and water quality test procedure for filtration of a suspension.

This unit consists of:

- Test module – made of PVC, inlet, outlet and manometer connections
- Test module contains the filter media (sand, etc.)
- Vessel – 1.5-L made of PVC, conical in shape
- Accessories: digital balance, stop watch, measuring cylinder
- Liquid flow meter – range 0 to 500 ml/min
- Manometer – 0 to 500 mm of water

Experimental capabilities:

- Principle of filtration
- Water quality test procedure for filtration
- Determine filterability of a given suspension

Aeration Apparatus (Model : TR 06)



This **Aeration Apparatus** is designed to demonstrate the basics of aeration process, which involves the transfer of oxygen from atmosphere into a body of water.

This unit consists of:

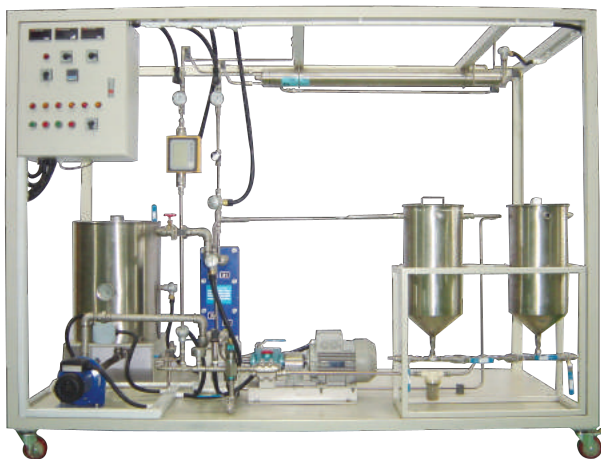
- Aeration tank – 30 L, made of clear acrylic
- Stirrer system – digital display for motor speed, ss paddle impeller
- Air supply system – an air pump, rotameter and a set of diffusers (bar stone, single ball stone and three ball stone)
- DO meter – range 0.00 to 45.00 mg/L of O₂
- Flow meter – range 0 to 20 LPM

Experimental capabilities:

- Effect of these parameters on the aeration process:
 - Water depth and composition
 - Design and arrangement of diffusers
 - Rate of air supply
 - Stirrer speed

Reverse Osmosis Unit (Model : TR 08)

SOLDAS SOLCAL EI



This **Reverse Osmosis Unit** is designed to demonstrate desalination of salt water using RO membrane.

This unit consists of:

- Membrane module – PCI B1 Module with 18 stainless steel perforated tubes
- Membrane type: RO (polyamide, 99% rejection of salt)
- Membrane: 12.7 mm (dia.) x 1.2m (L)
- Tanks – feed and permeate collection
- Feed pump – piston type, capacity: 13 LPM
- Water tank with heat exchanger
- Flow, pressure and temperature measurement

Experimental capabilities:

- Desalination process of salt water
- Effects of feed temperature, flow rate and pressure

Sedimentation Tank (Model : TR 09)



This **Sedimentation Tank** is designed to demonstrate the hydraulic characteristics and settling efficiencies of a settling basin.

This unit consists of:

- Settling tanks
- Sediment sump tank
- Dye injection system
- Flow measurement

Experimental Capabilities:

- To measure flow short-circuiting and dead space
- To compare actual flow regimes with idealised flow
- To study effect of flow rate, inlet water temperature and baffle position on dispersion
- To measure efficiency of sediment removal and its relationship with hydraulic characteristics.

Flocculation Test Unit (Model : TR 10)



This **Flocculation Test Unit** is designed to demonstrate basic principles of coagulation and flocculation.

This unit consists of:

- Vessels – 1000 ml cylindrical vessel made of borosilicate glass
- Stirrers – 250 rpm range with digital display and stainless steel shaft and blade
- Speed sensor with digital display
- Handheld pH Tester with digital display

Experimental capabilities:

- Determine optimum pH and coagulant dosage
- Study effects of mixing time and speed intensity on aggregation
- Coagulation tests in conjunction with activated carbon

Deep Bed Filtration Unit (Model: TR 13)



This **Deep Bed Filtration Unit** is designed to demonstrate the operations of a pilot scale granular filter.

This unit consists of:

- Filtration column
- Sump tanks
- Pump service system
- Flow meter

Experimental capabilities:

- Effect of filtration run on total head loss
- Pressure drop against bed height
- Suspension concentration against bed height
- Fluidization study
- Backwashing
- Column readily adapted for adsorption and ion-exchanger studies

Membrane Test Unit (Model: TR 14)

SOLDAS SOLCAL EI



This **Membrane Test Unit** is designed to demonstrate separation technique using membrane. This unit is supplied with different types of membrane, namely Reverse Osmosis, Nanofiltration, Ultrafiltration and Microfiltration.

This unit consists of:

- Membrane test module – PCI Membrane Test Module with 6 stainless steel perforated tubes with 6 individual channels for permeate collection
- Tanks – feed and permeate collection
- Feed pump – piston type, capacity 13 LPM
- Flow, pressure and temperature measurement

Experimental capabilities:

- Compare different types of membranes
- Effects of feed temperature, flow rate and pressure

Batch Settling Filtration Column (Model : TR 15)



This **Batch Settling Filtration Column** is designed to demonstrate basic principle of granular filtration.

This unit consists of:

- Filtration column
- Effluent tank
- Feed tank
- Flow meter
- Pressure drop measurement

Experimental capabilities:

- Effect of filtration run on total head loss
- Pressure drops against bed height
- Suspension concentration against bed height
- Fluidization study
- Backwashing

Membrane Filtration Unit (Model : TR 16)

SOLDAS SOLCAL EI



This **Membrane Filtration Unit** is designed to demonstrate separation technique using membrane, which is suitable for heat sensitive materials.

This unit consists of:

- Membrane modules
- Feed and permeate tanks
- Feed pump
- Hot water bath with circulation pump
- Plate heat exchanger
- Flow, pressure and temperature measurement

Experimental capabilities:

- To study the effect of the following process parameters on separation performance
 - Product flow rate
 - Process pressure
 - Process temperature

Reverse Osmosis Unit

(Model: TR 18)

SOLDAS

SOLCAL

EI



This **Reverse Osmosis Unit** is designed to demonstrate desalination of salt water using membrane technique.

This unit consists of:

- Reverse Osmosis membrane modules
- Feed and permeate tanks
- High pressure feed pump
- Flow and pressure measurement

Experimental capabilities:

- Desalination of salt water
- Effect of process parameters on separation performance: pressure, temperature and flow rate

Plate and Frame Filter Press Unit

(Model: TR 24)

SOLDAS

SOLCAL

EI



This **Plate and Frame Filter Press Unit** is designed to demonstrate filtration process suitable for pharmaceutical, chemical, cosmetic, and food and beverage industries

This unit consists of:

- Plate and frame filter press – chamber filter press type (open filtrate discharge)
- Feed pump – Diaphragm pump
- Temperature sensor – RTD sensor
- Filtrate flow meter – Turbine flow meter type
- Pressure sensor
- Turbidity sensor – range 0 to 1,000 NTU

Experimental capabilities:

- Demonstration of pre-coat filtration
- Demonstration of Darcy's Law
- Determination of medium and cake resistance
- Filter cake washing and dewatering

Plate and Frame Filter Press Pilot Plant (Model : TR 25)



This **pilot plant** is designed to demonstrate operation of a plate and frame filter press. The filter press is suitable for pharmaceutical, chemical, cosmetic and food & beverage industries

This unit consists of:

- Plates – made of PP material
- -hydraulic hand pump, max. pressure: 7 bar
- Filter media – made of PP cloths
- Slurry tank – cylindrical tank with conical bottom and agitator
- Feed pump – progressive cavity type
- Flow and pressure measurement

Experimental Capabilities:

- Effects of filtration cycle and filtration pressure on the cake quality

Anaerobic Digester (Model : TR 26)



This **Anaerobic Digester** is designed to study effects of various process parameters on performance of anaerobic digestion process for waste water treatment.

This unit consists of:

- Reactors – two 5L vessels made of glass
- Reactor packing – bio-balls
- Temperature control – heating jacket with PID control for both reactors
- Feed pumps – two peristaltic pumps
- Gas collection vessels – two 0.5L vessels made of clear acrylic

Experimental capabilities:

- Preparation, warming and acclimation of an anaerobic reactor
- Demonstration of multistage nature of anaerobic digestion
- Undertaking carbon balances
- Effects of hydraulic loading, feed ratios, temperature, nutrient deficiency and influent strength

Aerobic Digester (Model: TR 28)



This **Aerobic Digester unit** is designed to study effects of various process parameters on performance of aerobic digester

This unit consists of:

- Feed pump – manually calibrated peristaltic pump
- Reactor vessel – 10L vessel made of glass
- Reactor heater – electrical immersion type
- Dissolved oxygen meter and pH meter
- Temperature controller

Experimental capabilities:

- Acclimation of a completely mixed biological reactor
- Measurement of COD and MLSS changes as criteria of performance
- Establishing the stoichiometry and kinetics of aerobic biological processes
- Gas/liquid mass transfer and residence time distributions
- Effect of inflow substrate concentration ('loading rate'), liquid flow rate and reactor volume ('detention time'), air flow rate, temperature, pH stability and nutrients deficiency, on effluent quality

Membrane Fabrication Unit (Model: TR 31)

SOLDAS SOLCAL EI



This **Membrane Fabrication Unit** is designed for students demonstration and research on the fabrication of organic membrane using polymers such as polycarbonate, polyimide, polysulfone, etc.

This unit consists of:

- Dope preparation apparatus
- Membrane casting equipment

Experimental capabilities:

- Formulation of various types of polymer using the Dope Preparation Apparatus
- Membrane casting process capable of producing membrane sheet of approximately 20 x 30 cm size with thickness from 0 to 1000 micron.

Corrosion Study Kits

(Model: BP 01) **SOLDAS** **SOLCAL**



This bench top unit is designed to demonstrate the science of corrosion in industrial processes

This unit consists of:

- Eight test cells made of glass with specially machined lids enabling samples to be mounted
- Test specimen pieces of steel, zinc, brass and copper
- Air pump
- pH meter and electrode
- Low voltage supply

Experimental Capabilities:

- Effect of pH and DO concentration on corrosion rate
- Study of galvanic action, cathodic protection, electrolytic corrosion and chemical inhibition