



Indigenous Autoclave Technology



Industrial Grade, High temperature (350°C) and High Pressure (15 barg) Autoclaves for Demanding Applications



Council of Scientific & Industrial Research
National Aerospace Laboratories, Bangalore, India

Presenting

World-class Autoclave Technology

Indigenously Developed By CSIR - National Aerospace Laboratories



Council of Scientific and Industrial Research-National Aerospace Laboratories (CSIR-NAL), Bangalore, India has an acknowledged capability in building large, computer controlled, state-of-the-art autoclaves along with the associated subsystems.

CSIR-NAL's expertise in designing and building autoclaves is evident from the number of autoclaves that are operational in CSIR-NAL itself, namely Mark I, Mark II, Mark III and Mark IV, catering to various requirements. While Mark III is a high temperature (350°C) and high pressure (15 barg) autoclave, Mark IV is built to be an industrial workhorse with operating space as much as 4.4m in diameter and 9m in length. This is the largest autoclave in the Indian aerospace sector.

Earlier, CSIR-NAL has supplied an autoclave with a working space of 4m dia x 8m length, to Hindustan Aeronautics Ltd., Bangalore, India, which has been

functioning satisfactorily over the years. CSIR-NAL has also revamped a few autoclaves for Vikram Sarabhai Space Centre, Trivandrum, India.

CSIR-NAL has signed a Memorandum of Understanding (MoU) with Unique Chemoplant Equipments (UCE), Mumbai, India, for manufacture and marketing of autoclaves. UCE will operate as a work sharing partner for fabrication of electro-mechanical systems. UCE is an ISO 9001:2000, ASME 'U', 'U2' and 'R' stamp certified designer and manufacturer of coded process equipment for a variety of applications.

CSIR - NAL has also signed an MoU with Datasol, Bangalore for fabrication of Electrical, Control and Instrumentation Systems for the Autoclaves. Datasol is an ISO 9001:2000 certified Product Realisation company for Aerospace & Industrial automation applications.



Specifications of NAL Autoclaves

Sl.No	Specifications	Mark-IV	Mark-III	Mark-II	Mark-I
1	Diameter (for working space)	4400 mm	2000 mm	2800 mm	1800 mm
2	Length (for working space)	9000 mm	4000 mm	5200 mm	4000 mm
3	Maximum Charge (equivalent Steel)	12 Tonnes	2 Tonnes	3 Tonnes	2 Tonnes
4	Door handling systems	Davit Arm, electromechanically operated swivel door with steering mechanism and lock less ring design		Hydraulically operated hinged door with lock ring	
5	Door seal	Inflatable Seal	Lip Seal		
6	Maximum Pressure	7 Barg	15 Barg	7 Barg	
7	Pressurization medium	Nitrogen			
8	Maximum Temperature	250°C	350°C	250°C	200°C
9	Heating rate	0 to 5°C	0 to 4°C		0 to 5°C
10	Cooling rate	0 to 3°C			
11	Number of K-Type (Chromel/Alumel thermocouples)	45	15	20	15
12	Temperature uniformity	± 2°C (In the working space under steady state operating pressure)			
13	Number of vacuum Lines	50 Suction lines and 10 measurement lines	20 Suction lines and 4 measurement lines	14 Suction lines and 4 measurement lines	14 Suction lines and 3 measurement lines
14	No of discrete controllable vacuum levels at given time	Two	One	Two	One
15	Modes of operation	Auto, Semi-auto and Manual			
16	Control system	Dual Computer system with SCADA software, PLC, Recorder and Programmable PID controllers for temperature pressure and vacuum profile control. Intranet based monitoring facility.		Single Computer system with SCADA software, PLC, Recorder and Programmable PID controllers for temperature pressure and vacuum profile control.	
17	Data acquisition system	Digital Chart Recorder and Graphic recorder (total of 64 channels)	Digital Chart - Recorder (Up to 24 Channels)		
18	Alarm, Safeties, Interlocks and Status	Through PLC & Mimic display			
19	Air circulation system	Pressure sensitive Variable Speed Blower		Fixed Speed Blower	
20	Blower motor rating	110KW	55KW	37KW	30KW
21	Heater power (3 Phase. 415 V (typical))	1050KW (10 banks)	225KW (5 banks)	210KW (6 banks)	75KW (5 banks)
22	Total power rating (3 Phase. 415 V (typical))	1230KW	292KW	277KW	123KW

Mark IV

India's Largest Autoclave for Airworthy Composites Processing

Specifications

Dia. of working space	: 4,400 mm
Length of working space	: 9,000 mm
Working pressure	: 7.14 kg/cm ²
Working temperature	: 250°C
Working capacity	: 2,14,000 litres
Operating weight	: 90,000 kg
Maximum charge	: Equivalent to 12,000 kg of steel
Temperature uniformity	: ± 2°C
Rate of heating	: 0-5°C/min
Rate of cooling	: 0-3°C/min
Control system	: Dual computer, Recorder, PLC & PID controller based; In-house developed software



Design Drivers

- Simplicity
- Fail-safe & fault-tolerant
- Open communication system (non-proprietary)
- Easy Maintainability

Mechanical System – Salient Features

- Davit arm door with innovative steering mechanism & bearing design
- Lock ring-less door locking system
- Optimized spherical dished door
- Air circulation duct on the entire circumference for better temperature uniformity
- Heat exchanger with variable heat transfer area & extruded finned tubes for maximum heat transfer
- Gland-less pressurized blower motor
- 3-level loading trolley with pneumatic bridge & electromechanical loading system
- Nitrogen gas pressurization system with proportional control valves & exhaust silencer with 276 m³ at 17 barg storage capacity
- Thermal insulation system with ceramic fibre blankets
- 3-tier layout of sub-systems





C & I System and electrical system – Salient Features

- Fail-safe design (Redundancy)
- PC, PLC, PID controller and Recorder based
- Auto, semi-auto and manual modes of operation
- Master and stand-by computer control
- Redundant control sensors for temperature and pressure
- DC power supplies with redundancy
- Identification and management of single point failures
- Remote monitoring through Local Area Network
- Stand-by system for vacuum pump, cooling pumps, hot water pumps, blower drive, SCR controller etc.,
- Blower operation through Speed Drive or Star-Delta starter
- Heater power steering logic
- Modular and expandable LTPMCC



Power Panel

Safeties

- Man-in-clave
- Fool-proof door lock safety device with alarm
- Emergency dump and shut off switches
- Separate Earth leakage trip for each heater bank
- Interlocking of door operation and pressure application.
- Health checking
- Auto-hold in case of higher temperature gradient
- Multiple modes including manual override if the computer, PLC and the control system fails
- Fire (Nitrogen gas for pressurization)
- Over pressure (Pressure switch, emergency exhaust & safety valves)
- Power failure management
- Over temperature
- Fault alarms
- Fault diagnostics



Fool-Proof Door Lock Safety Devices



Control Panel

Mark III

High Pressure and High Temperature Autoclave

Specifications

Dia. of working space	: 2000 mm
Len. of working space	: 4000 mm
Max. Temperature	: 350°C
Max. Pressure	: 15 Barg
Temperature uniformity	: $\pm 2^\circ\text{C}$
Rate of heating	: 0 to 4°C/min
Rate of cooling	: 0 to 3°C/min
Control system	: Dual computer, PLC & PID controller based software exclusively developed in-house



Design Drivers

- Simplicity
- Fail-safe & fault-tolerant
- Open communication system (non-proprietary)
- Easy Maintainability

Mechanical System – Salient Features

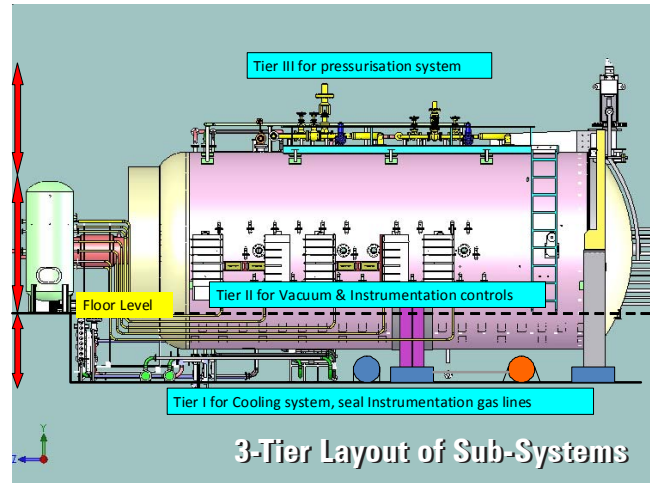
- Davit arm door with innovative steering mechanism & bearing design
- Lock ring-less door locking system
- Optimized spherical dished door
- Air circulation duct on the entire circumference for better temperature uniformity
- Heat exchanger with variable heat transfer area & extruded finned tubes for maximum heat transfer
- Innovative sealing system to withstand high temperatures
- Gland-less pressurized blower motor
- 3-level loading trolley with pneumatic bridge & electromechanical loading system
- Nitrogen gas pressurization system with proportional control valves & exhaust silencer with 276 m³ at 17 barg storage capacity
- Thermal insulation system with ceramic fibre blankets
- 3-tier layout of sub-systems

C & I System and electrical system – Salient Features

- Fail-safe design (Redundancy)
- PC, PLC, PID controller and Recorder based
- Auto, semi-auto and manual modes of operation
- Master and stand-by computer control
- Redundant control sensors for temperature and pressure
- DC power supplies with redundancy
- Identification and management of single point failures
- Remote monitoring through Local Area Network
- Stand-by system for vacuum pump, cooling pumps, hot water pumps, blower drive, thyristor controller etc.,
- Remote monitoring through LAN

Safeties

- Fool-proof door lock safety device with alarm
- Earth leakage (industry standard) trip
- Interlocking of door operation and pressure application
- Health checking
- Auto-hold in case of higher temperature gradient
- Multiple modes including manual override if the computer, PLC and the control system fails
- Fire (Nitrogen gas for pressurization)
- Nitrogen flushing
- Over pressure (Pressure switch, emergency exhaust & safety valves)
- Power failure management
- Over temperature
- Fault alarms
- Fault diagnostics
- Emergency exhaust



Mark II

First Indigenous Computer Controlled Autoclave



Mark II Autoclave

Specifications

Diameter of working space	: 2800 mm
Length of working space	: 5200 mm / 7500 mm (Variable)
Maximum Temperature	: 250°C
Heating Rate	: 0 to 4°C per min
Cooling Rate	: 0 to 3°C per min.
Maximum Pressure	: 7 Barg
Number of vacuum lines	: 14 suction lines and 4 measurement lines
Maximum vacuum at source	: 2 Torr (~3 mbar)
Modes of operation	: Auto, Semi-auto and Manual
Control System	: PC, PLC, PID and Recorder based
Air circulation system	: Fixed speed Blower
Heater Power	: 3 phase, 415V, 210KW

Features

- Variable working volume autoclave with unique twin door technology
- Integrated Door with Loading crab
- Gas and Water cooling medium adapted for optimum temperature control rate



Mark I

First Indigenous Autoclave Built in 1986 & in Use Till Date



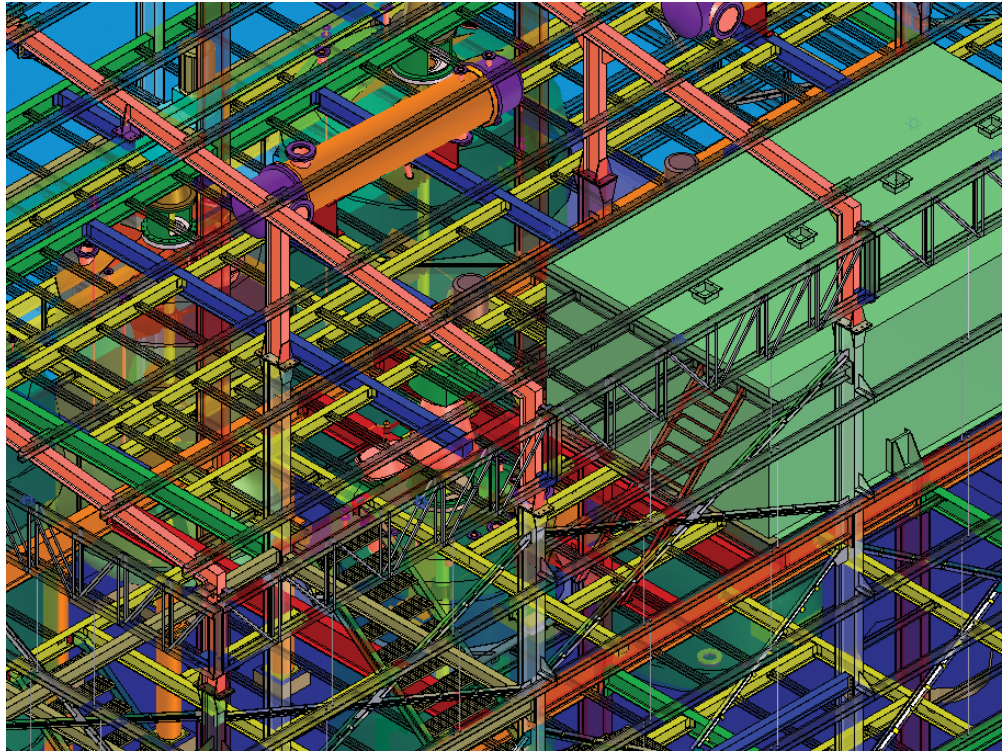
Specifications

Diameter of working space	: 1800 mm
Length of working space	: 4000 mm
Autoclave Door	: Hinged Door
Maximum Temperature	: 200°C
Maximum Pressure	: 7 Barg
Number of Thermocouples	: 15
Modes of operation	: Auto, Semi-auto and Manual
Control System	: PC, PLC, PID controller and Recorder based
Air circulation system	: Fixed speed Blower
Heater Power	: 3 phase, 415V, 75KW (In 5 banks: 5KW x 15)
Total Power Rating	: 123 KW

Unique Chemoplant Equipments

Harnessing Process Engineering Expertise Since 1981

Having worked with hundreds of demanding global and Indian clients since last three decades, we at Unique Chemoplants Equipments (UCE) understand chemical process engineering challenges. We put our deep knowledge and experience to design coded process equipment and world class plants, skids and systems for a variety of industries including pharmaceutical, chemical and fertilizers plants, oil & gas, petrochemical, aviation, steel, dyes & pigments, water and food & dairy industries among others.



We have the capability to design and supply equipment that are up to 6000 mm in diameter and 30 meters in length, or tall columns of up to 40 meters in height, or shell thickness of up to 80 mm, capable of working under pressures ranging from full vacuum to 150 Kg/Cm²(g). We have successfully fabricated and supplied pressure piping upto 2800 NB.

In addition, we also supply world-class systems and skids, and turnkey plants, including detailed process engineering, design engineering and supply of equipment, structurals, piping and instrumentation.

Our custom fabrications are constructed in a variety of material and are built in our ASME U, U2, and R Stamp Certified shops. We offer projects under third-party acceptance of Lloyds, TUV, Jacobs H&G, BVIS, AKER, SAIPEM and TCS, and conforming to international Codes & Standards such as ASME/TEMA/PED 5500/ API 620/ API 650/DIN/EEUA Handbook / EJMA.



Given that our engineering capabilities are powered by over 100 highly experienced engineers, and supported by more than 400 skilled technicians – all working out of six well equipped shops and design centers no problem is too complex for us.



Process Reaction Vessels

We provide a range of coded process reaction vessels including autoclaves, Hydrogenators, GMP reactors, and reactors for corrosive applications. These equipment are offered in various materials of construction such as stainless steel, Duplex Steel, Alloy Steel, Carbon Steel, Hastelloy, Inconel, Monel, Titanium with Bare Metal and Explosion Bonded material.



Autoclave with quick opening door



Alloy 20 vessel



Hastelloy clad hydrogenator



High pressure batch reactor

Heat Exchangers/Pressure Vessels/Agitators

We provide a range of special construction heat exchangers and agitators for a variety of applications.

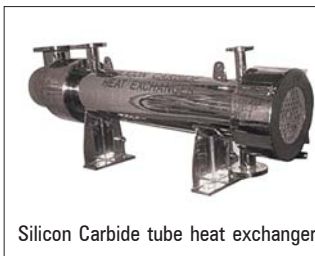
- Custom-designed Agitators
- Pressure Vessels/ Tall Vertical Columns
- Heat Exchangers made of special Alloys
- Silicon Carbide Exchangers



Process heat exchanger



Alloy 20 column



Silicon Carbide tube heat exchanger



Alloy 904L heat exchanger

Dryers and Mixers

We offer proprietary as well as custom-designed dryers and mixers for harsh environments and for C-GMP applications.

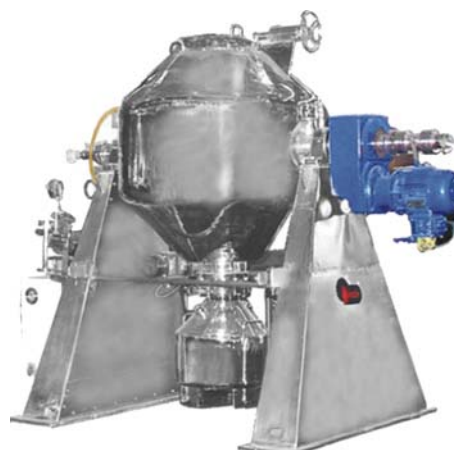
- Rotary Vacuum Paddle Dryers
- Rotocone Vacuum Dryers
- Conical Screw Dryers
- Spherical Paddle Chopper Dryers
- Ribbon Blenders



Rotary Vacuum Paddle Dryer



Spherical Chopper Dryer



Rotocone Vacuum Dryers

Private Public Partnership



An MoU has been signed between CSIR-National Aerospace Laboratories (CSIR-NAL), Bangalore and Unique Chemoplant Equipments (UCE), Mumbai on 28th April 2010 for marketing aerospace class autoclaves.

Dr A R Upadhya, Director, CSIR-NAL and Mr Ketan J Patel, CEO of J. B. Patel Group of Companies, the holding company of UCE along with other senior functionaries are seen here exchanging copies of MoU.

This starts a new era in the manufacturing of high end autoclaves in India, by the industry- CSIR-NAL joining hands together.

For more information, please contact:



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