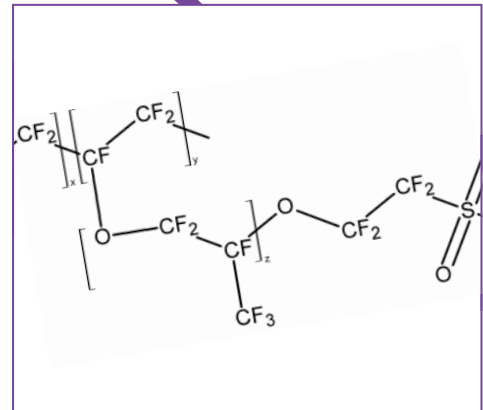


MULTIPLANT / AUTOPLANT ENERGY

Fuel Cell Catalyst Discovery and Optimization



Customer testimonial

"We did 6 years work in 1 year. We can no longer imagine how to do our work without Chemspeed automation."



Robustness and Ease-of-Use by Design

The leading technology in overhead gravimetric dispensing / dosing (patented) combined with our reactor and process excellence, and our user-friendly software, allow you to standardize and accelerate your fuel cell catalysts and membrane discovery and optimization workflows.

Precision – Speed – Accuracy
Performance – Versatility – R&D Cost Savings
High-Output

Key Advantages:

- Decrease in cost per experiment up to 90+ %.
- Increase in productivity by a factor of 10+.
- Up to 36 experiments per run on an *AUTOPLANT*, up to 6 experiments per run on a *MULTIPLANT*.
- Independent control of all process parameters in each reactor.
- Independent and precise temperature and stirring control in each reactor.
- Up to 8 independent gas and liquid feeds per reactor.
- Gravimetric solid and viscous liquid dispensing.
- 4-Needle Head for volumetric liquid handling and sampling.
- Feeding and sampling under reaction conditions.
- Cleaning in place (e.g. automated cleaning, inserts).
- Dispensed amount, stirrer speed, temperature, pressure, time..., and other data are stored in a read only log file.
- Easy access to data with a convenient interface to pull results into Excel or virtually any other software.
- Interface to DOE.



Process research reactor

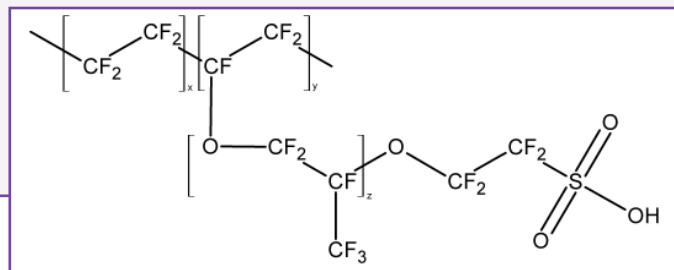


Process development workstation

MULTIPLANT ENERGY workstation

AUTOPLANT ENERGY workstation

Enhance your Efficiency and Productivity with our Workflow Solutions!



Customer testimonial

"The automated synthetic platforms enable us to gain a factor of 5 to 10 in time, speed or new knowledge in polymer and material science. In combination with advanced characterization techniques, Chemspeed's platforms represent the key technologies for the elucidation of structure-property-relationships of polymers and materials. And they form the basis of multiple large grants and industrial research contracts initiated within the last two years."

Assembly of a process research reactor with our unique screwless and self-sealing design up to 100 bar



1 Choose and insert stirrer



2 Mount cylindric magnetic stirrer drive



3 Plug in reactor



4 Screwless closing and self-sealing of reactor



5 Add safety lock



6 Screwless mounting and self-sealing of multiport drawer valve

No screws
No gear wheel
No transmission belt
Self-sealing



Robustness and Ease-of-Use by Design

Technical Details

Chemspeed's **MULTIPLANT/AUTOPLANT ENERGY**'s deck modularity allows the user to execute and perform a variety of fuel cell research workflows in a fully or semi-automated fashion.

MULTIPLANT dimensions:

940 x 600 x 1'920 mm
(3'1" x 2'0" x 5'4")



AUTOPLANT dimensions:

2'350 x 950 x 1'920 mm
(7'70" x 3'2" x 6'4")



Reaction preparation

- Preparation of metal salt solutions and combinatorial mixtures thereof.
- Preparation of homogeneous suspensions of carbon powder and aqueous reducing agent in parallel reactors.
- Addition of liquid reagents and solutions.

Catalyst preparation optimization in tank reactor:

- Variation of feeding rates / ratios.
- Stirrer speed / geometry.
- Temperature profiles.
- Refluxing.
- Hydrogen pressure (optional).
- Up to 36 fuel cell catalysts per run.

Conditioning:

- Defined particle sizes by applying a dip-in sonifier probe.
- Dip in titanium sonifier probe.
- 100 W total power output.
- Dynamic rinse station.

Work-up:

- Filtration and washing.
- Evaporation to dryness.
- Mixing with Nafion solution and electrolyte to prepare catalyst ink.
- Reformatting into output vials or microtiter-plates.

Testing:

- Option for integrated galvanostat / potentiostat.



Sonifier probe



Process development workstation for 6 X 100 mL, 3 X 250 mL, 3 X 1'000 mL

The cutting edge **Process Development Workstation Technology** allows scientists to truly mimic the final industrial production process and provides all the flexibility to optimize integrated reaction sequences, even if a complex configuration of reactors and feed vessels required.



Materials of choice: glass, stainless steel (PEEK, PTFE or glass inserts available), Hastelloy, others on request

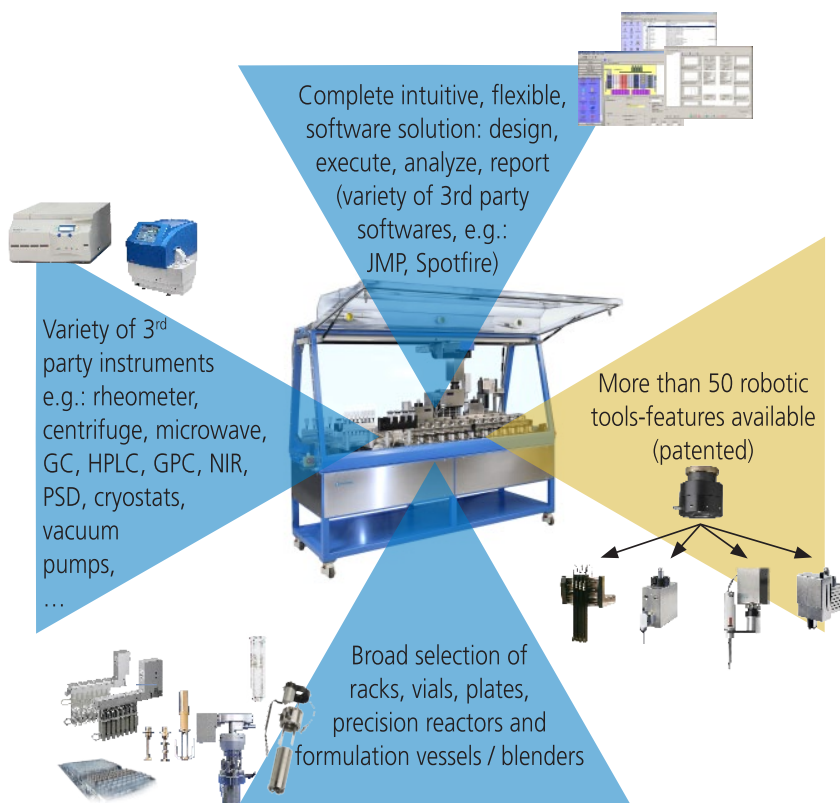
Process reactor assembly, individually controlled tank reactors (reactor volumes 100, 250, 1'000 mL) with precise, continuous feeds.

- Flexible and precise continuous feeds, down to 10 μL / min.
- Up to 8 continuous liquid and / or gas feeds per reactor and additional unlimited overhead access.
- Accurate and reproducible temperature control, 0.1 $^{\circ}\text{C}$.
- Pressure up to 100 bar over the entire temperature range up to 250 $^{\circ}\text{C}$ with corresponding safety installations.
- Parallel high-performance calorimetry data.
- Viscosity data.



Easily exchangeable stirrer designs (anchor, twisted blade, gas entrainment stirrers...). Powerful mixing for viscosities up to 80 Pa·s at 300 rpm and 30 Pa·s at 900 rpm with an anchor stirrer.

4 Dimensions of Modularity and Flexibility



– Off-the-Shelf-Design –

- Individual platform configuration tailored to your workflow with market-proven off-the-shelf components.
- Robotic platforms which can easily be integrated with one another to enable multi-workflow processes (e.g. Formulation, Application and Testing procedures all integrated in a single platform).

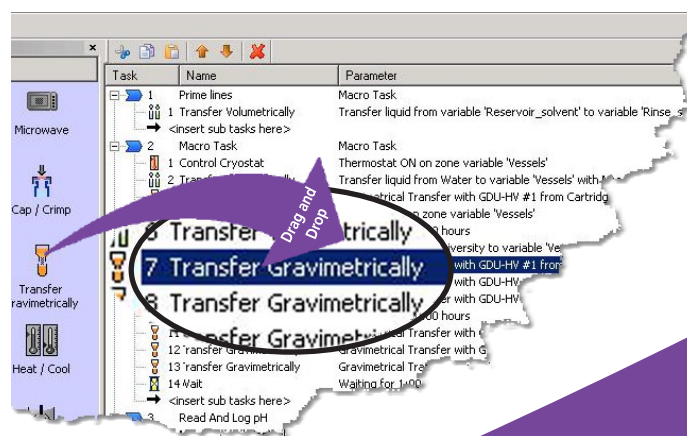


Complete Software Solution: Design, Execute, Analyze, Report

Chemspeed's AutoSuite User Interface & Executor software packages execute and control all modules of the entire product development cycle. They control all Chemspeed robotic platforms and any other integrated 3rd party software and hardware.

AutoSuite *MULTIPLANT / AUTOPLANT* is a software with a user friendly interface which allows easy workflow oriented programming. Many features such as gravimetric dispensing are automatically calibrated, eliminating tedious optimization steps.

- The AutoTeaching tool simplifies dispensing applications without manual trials and is applicable to e.g. solids eliminating the need for manual optimization before the dispenses are done.
- **Easy programming: drag-and-drop workflow steps or just execute standard workflow protocols.**
- Barcode tracking.
- Easy integration with virtually any LIMS or ELN software.
- AutoSuite Application Programming Interface (API) for 3rd party software and hardware integration.
- Optional, Chemspeed VLab for DoE and Data Analysis / Reporting. It includes a full document management system (electronic lab-journal) and is 21 CFR Part 11 compliant. The software scales from a single PC to large network installations with multiple hardware and clients.

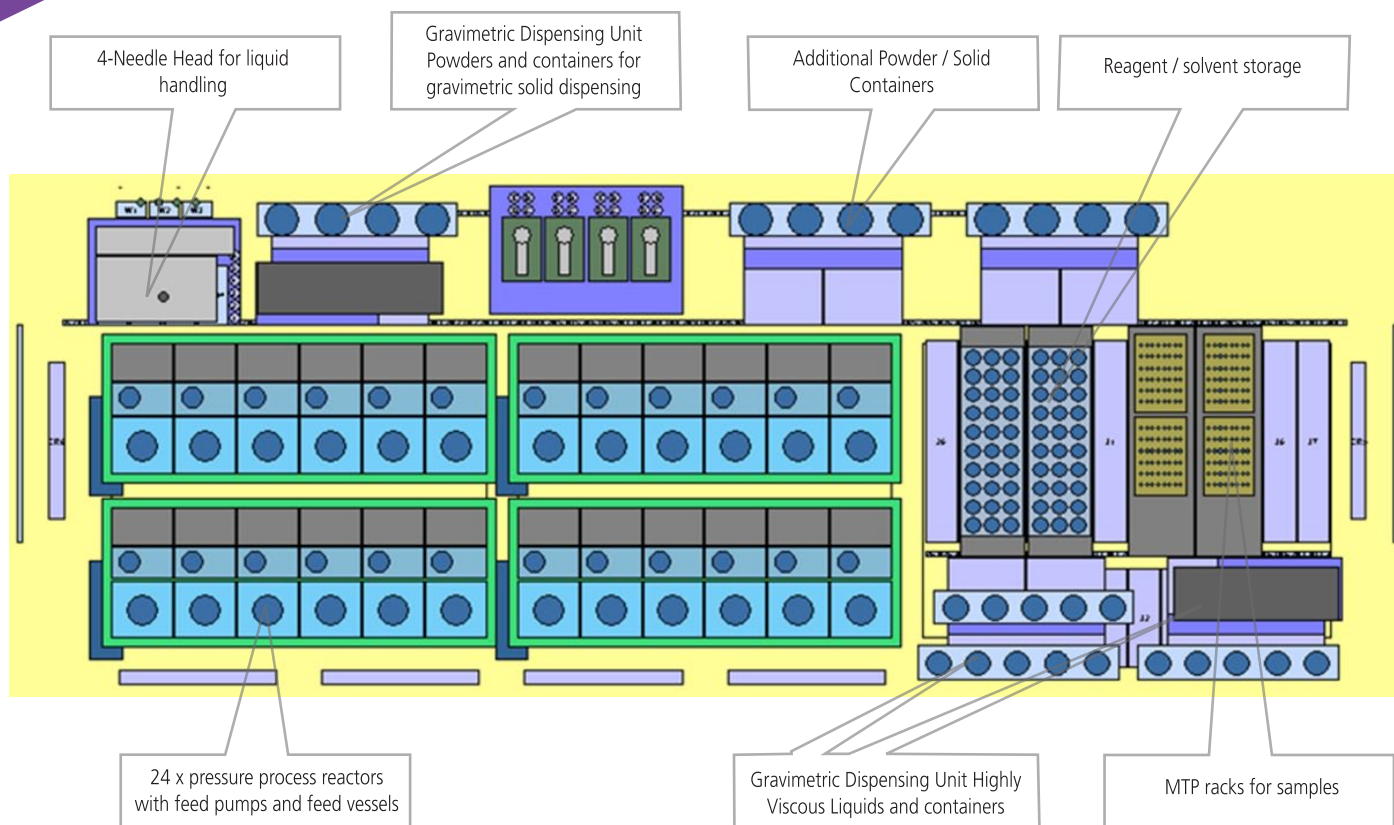


Easy Programming – Intuitive interface



Platform Configuration Example

A typical **AUTOPLANT ENERGY** deck consists of up to 36 independently controlled tank reactors, along with reagent / sample and solid dispensing container racks. Tools include a 4-Needle Head for liquid additions, Solid Dispensing Unit for liquid additions, Solid Dispensing Unit for the addition of solid reagents.



All tools and accessories from Chemspeed's **SWING, ISYNTH, FORMAX, APPLICATOR** and **INVESTIGATOR** platforms are fully compatible with the **MULTIPLANT / AUTOPLANT ENERGY** platforms and vice versa.

Example upgrade options:

- Various reactor materials and coatings are available (glass, hastelloy, Teflon, PEEK,...).
- Multiple stirrer designs and materials.
- Large choice of sample, reagent, and customized racks.
- Integrated centrifuge for washing.

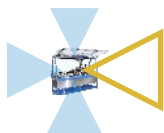


Variety of Plug-in (3rd Party) Solutions

Chemspeed integrates a large number of 3rd party components either on and / or off the deck.

Available upgrade options:

- Testing module, galvanostat / potentiostat.
- Cleaning module.



Robotic Tool-Features


More than 50 robotic tool-features can be integrated with Chemspeed's unique robotic tool exchange technology, including unrivaled overhead gravimetric dispensing, which can operate while mixing, heating, refluxing and cooling. Virtually any combination of these robotic tools is possible.

Highlighted are the most common and recommended robotic tool-features for the **AUTOPLANT ENERGY** robotic platform.

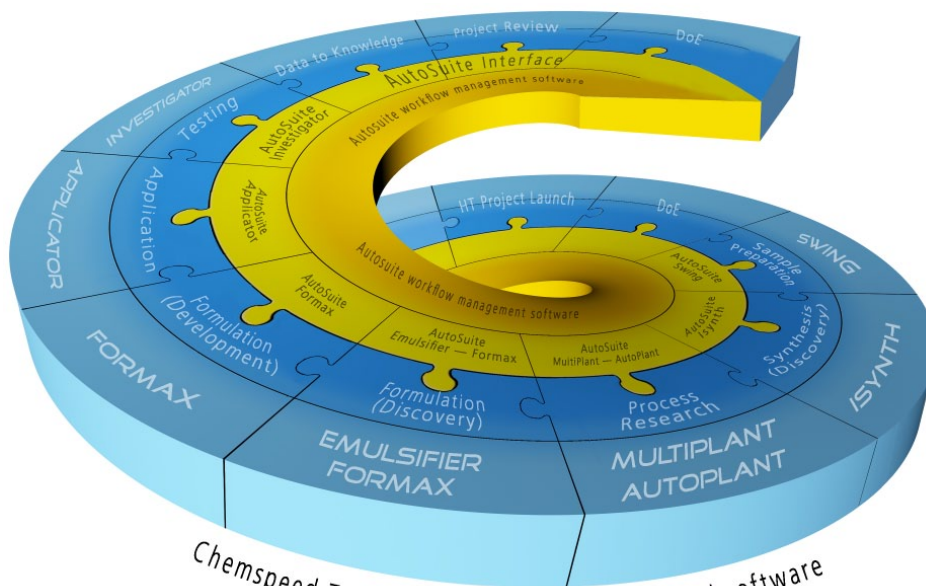


Robotic tool exchange interface (proprietary)

Precision balance Overhead gravimetric dispensing robotic tools (proprietary)	Volumetric dispensing robotic tools	Action robotic tools	Analytic robotic tools
<ul style="list-style-type: none"> Overhead gravimetric dispensing of solids & powders (0.1 mg to 20 g) Dispensing container volume: 15 mL or 30 mL resolution: 0.1 mg (or 0.01 mg with a second balance) 	<ul style="list-style-type: none"> Liquid handling powered by 4 syringe pumps (syringe volumes: 1, 10, or 25 mL) for viscosities from 1 mPa·s to 100 mPa·s <p>Special options:</p> <ul style="list-style-type: none"> Disposable tips (1'200 µL) Disposable syringes Heated needles (up to 100°C) Spray needles pH and temperature measurement and control Coated needles, PEEK needles... 	<ul style="list-style-type: none"> Multigrripper for vial and MTP transport and much more Automated barcode scanner 	<ul style="list-style-type: none"> Online density measurement (aspiration technology), on the fly resolution: 1 mg (or 0.01 mg with second balance) 
<ul style="list-style-type: none"> Overhead gravimetric dispensing of solids & powders (1 mg to 100 g, larger volumes are available) Dispensing container volume: 100 mL resolution: 1 mg (or 0.01 mg with a second balance) 	<ul style="list-style-type: none"> Liquid gas dispensing with gravimetric control resolution: down to 0.1 mg 	<ul style="list-style-type: none"> Screw capper Vial diameter range: from 10 mm to 50 mm Larger ranges available Torque range: from 0.1 Nm to 1 Nm 	<ul style="list-style-type: none"> Brookfield Viscosimeter (RVDV-II+ Pro BK) 
<ul style="list-style-type: none"> Overhead gravimetric dispensing of highly viscous liquids, pastes and creams (1 mg to 100 g) with viscosities from 1 mPa·s to 500'000 mPa·s (based on Newtonian substances) resolution 1 mg (or 0.01 mg with a second balance) Optional aspiration feature Optional transfer of hot (up to 90 °C) substrates via heatable cartridges (e.g. for waxes) 	<ul style="list-style-type: none"> Overhead gravimetric / volumetric aspiration and dispensing of viscous liquids (0.1 µL to 12.5 mL) with viscosities from 1 mPa·s to 15'000 mPa·s via disposable positive displacement syringes, resolution: down to 1 µL 	<ul style="list-style-type: none"> Capping, crimping (N8 / N11 / N13 / N20) Decapping (N8 / N11 / N13 / N20) 	<ul style="list-style-type: none"> Tri gloss measurement Thickness measurement Color measurement Precision tack-cure 
<ul style="list-style-type: none"> Overhead gravimetric aspiration and dispensing of viscous liquids (1 mg to 100 g) with viscosities from 1 mPa·s to 15'000 mPa·s via disposable positive displacement syringes, resolution: 1 mg (or 0.01 mg with a second balance) 		<ul style="list-style-type: none"> High shear homogenization (11'000 to 30'000 rpm) 	<ul style="list-style-type: none"> Camera Observation of dissolution Particle size distribution and dynamic light scattering
		<ul style="list-style-type: none"> Overhead stirrer (20 to 200 rpm) Different stirrer types available 	
		<ul style="list-style-type: none"> Ultrasonic dispersion (100 W) 	
		<ul style="list-style-type: none"> Vacuum / Degassing Reflux condenser Evaporation Filtration 	
		<ul style="list-style-type: none"> High speed injection molding Foam formation 	
		<ul style="list-style-type: none"> Draw-down with disposable or reusable precision spiral and / or gap bars Free film generation Dip coating Spray coating Wet-on-wet coating 	
		<ul style="list-style-type: none"> Robotic transfer arm to serve 3rd party instruments e.g. centrifuge 	

15+ Years of Experience in Automated Chemistry.
 Customized Workflow Solutions.
 Swiss Quality Products.
 An International Team of Highly Experienced Chemists.

Chemspeed Technologies AG is the leading provider of high-throughput and high-output research & development workflow-solutions from single bench-top / standalone automated workstations (powder dispensing - sample preparation- synthesis - process development - formulation - application - testing) up to complete and integrated product development workflows for the entire product development processes in the chemical, material science, renewables & energy, pharmaceutical, agro-chemical, specialty chemical, home care, cosmetics and nutrition industries, as well as academia.



Chemspeed Technologies offers hardware and software for every step in the product development cycle

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