SHERWOOD SCIENTIFIC
FLUID BED DRYER

LAB-SCALE, PROGRAMMABLE & ANALYTICAL

FASTMILDNON-AGGLOMERATING
REPRODUCIBLEHOMOGENEOUS

WITH A LARGE RANGE OF TUB ASSEMBLIES, CONSTRUCTION MATERIALS AND SOFTWARE THE MODEL 501 OFFERS A FLEXIBLE PLATFORM ABLE TO ASSIST WITH;

· STUDIES OF MATERIAL DRYING BEHAVIOUR
· THE OPTIMISING AND SCALE-UP OF DRYING PROCESSES
· PREPARATION OF SMALL SAMPLE BATCHES FOR SUBSEQUENT MATERIAL STUDIES

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WHAT IS FLUID BED DRYING?

By forcing enough gas (air) through a bed of particles, the bed may assume a fluid like state (resembling a boiling liquid). Heating the incoming air and managing air flow rate through the Model 501 provides thorough mixing and maximum contact of solid with moving air.

The result; a process more even and much quicker than conventional drying methods.

FAST

Delivering up to 2.5m^3 per minute of air, the model 501 can break up wet samples, and ensure vigorous mixing and rapid moisture removal.

5Kg of wet, "ideal", sample (80% moisture) can be dried in 15 to 20 minutes (5 litre tub).

MILD

High air flow rate gives:

- high moisture removal rates at relatively low temperatures
- thorough mixing, so no wet spots requiring extra thermal energy to penetrate
- an air cushion between particles to reduce abrasion and particle size alteration.

NON AGGLOMERATING

Air separated particles prevents lumps and caking, both of which make other drying processes much slower.

HOMOGENEITY OF SAMPLE

Static drying methods leave evaporation residues at the sample surface giving a heterogeneous sample. Fluid Bed Drying achieves the opposite mixing during drying gives homogeneous samples making an ideal method of representative sample preparation for subsequent material analyses.

WHY USE THE SHERWOOD SCIENTIFIC FLUID BED DRYER?

PROGRAMMEABLE

The Model 501 can be programmed (via computer interface) to step through unlimited drying stages with the following parameters defined and controlled: Timer, Motor speed and Inlet air temperature. An optional pulse flow module is available for difficult to fluidise samples. Those parameters are monitored and recorded throughout the drying programme. Each programme step may be terminated manually or when a preset time is reached or when a selected outlet temperature or relative humidity has been achieved; whichever condition occurs first.

ANALYTICAL

Downstream air temperature and relative humidity information may be obtained using a probe within the tub assembly (above the sample bed) and fed to a PC. This allows observation of the drying process in real time. All data is logged via RS232 and may be stored for future reference and processing.

REPRODUCIBLE

Microprocessor control of air flow, inlet air temperature and drying period coupled with fluid bed action gives highly reproducible experiments and finished samples. After preliminary experiments, a known moisture content in the final sample (ideal for tablet forming) or removal of external (surface) moisture only, may be achieved. Drying times to required moisture content may be optimised and drying patterns studied to aid scale up and plant design.

Without a PC connected, the Model 501 can run one stored programme of up to 16 steps (previously downloaded from a PC), or may be used as a conventional (manually controlled) FBD. Additional features of this advanced inlab dryer technology include:

- **Precise air flow feed-back control**
- **Membrane sealed controls to prevent ingress of particles into the instrument.**
- **Reduced operating noise.**

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FLUID BED DRYER- SPECIFYING PROCESS

The Sherwood Scientific Model 501 Fluid Bed Dryer is a Lab Scale (Bench top) dryer with a maximum sample capacity of 5Kg. There is a wide variety of drying tubs (volume and material of construction), inlet & outlet filters, and other accessories available; both to handle as wide a range of sample types as possible and enhance the capability of the drying system. Therefore each system requires specifying in some detail to reflect individual customer requirements and sample characteristics in order to prepare an appropriate quotation.

Outlined below are prompts about the sample type and required process and hence implications for component selection:

SAMPLE TYPE	SYSTEM "REQUIREMENTS"
Sample quantity (weight and/or volume)	A wet sample should occupy about 1/3 of the tub assembly volume. As a sample dries and its density drops, its apparent volume will increase to about ½ the volume. Tubs should be purchased that are 3 x the volume of the sample size. The mini tubs are 250ml in capacity and can be used effectively on samples weighing from 5 to 50 grams per tub. Four tubs can be dried simultaneously.
Moisture content at start of drying process	The 501 is designed for damp materials not slurries with free water.
Flammable Solvents present	The 501 is not spark or explosion proof. It is not suitable for the removal of flammable solvents with low flash points.
Particle size—minimum to maximum (not just average)	You need to know the minimum particle size in the sample in order to choose a suitable mesh/pore size for inlet and outlet filters to prevent sample falling out the bottom of the tub or being blown out the top.
Tub made from glass or metal	Glass is ideal for developing drying processes; you can observe the material's behaviour as it dries. The optimum flow rate is easy to select judging by the fluidised samples appearance. The operator may estimate the state of dryness, shape and particle size distribution by the appearance of the sample flowing in the tub. Stainless Steel could be useful in the food industry where regulations may not permit use of glass items within food production or preparation areas.
Sealed tub or filter bag	Samples with a wide or bi-modal particle distribution are difficult to fluidise without sample overflow into the bag. A sealed top cap is advisable for such samples and any sample with a particle size less than 40 microns. 3 micron polyester filters can be used for mini tubs, 2 and 5 litre tubs. These filters are effective for 5 to 25 micron particles but greatly reduce air flow rate through the sample. Drying times normally occurring between 10 to 30 minutes can take up to several hours. Many of the main advantages of fluid bed drying may be lost.

DRYING PROCESS	ACCESSORIES REQUIRED
Simple dryer	None
Multistep drying process	Add software and RS232 cable
In-time drying progress feedback	Add Moisture/Humidity Probe which means you have to select a tub with a GL32 side port. Only the 5 litre glass tub assemblies, 500 35 010, 501 35 020 and 501 35 000 can have an inlet for the outlet humidity and temperature probe. Only these tubs can fully utilise all the features on the M501.
Data collection	Add software and RS232 cable
Data manipulation with drying curve generation.	Add software and RS232 cable
Add sample to dryer without removing outlet filter	Specify DMA tub (501 35 020)

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DRYER CONFIGURATION: A FEW EXAMPLES AND HOW TO SPECIFY

1] Model 501 shown with 5 litre glass tub 500 35 009 and large filter bag. Remember to specify tub inlet filter and bag material requirements

The user has to specify; the tub, the inlet and outlet filters required for their application as follows:
Material of construction: Glass or Stainless Steel Tub Volume: 5 litre, 2 litre or Mini tub (use with multi-tub adapter)
Tub Type: Ordinary (Bags), Sealed, Analytical (GL32 side port) DMA, Classifier, Mini, Custom
Inlet Filter: Material type, pore size, Outlet Filter: Bag, Top Cap, Material type, pore size

2] Model 501 shown with 5 litre glass tub 500 35 010 with GL32 side port, temperature /humidity probe and large filter bag. Please specify tub inlet filter and bag material required and remember to order the temperature humidity probe 501 86 500.

3] Model 501 shown with 5 litre glass DMA* tub 501 35 020 with sealed top cap assembly and GL32 side port and temperature/humidity probe plus side port for samples. Please specify tub inlet and top cap filter requirements and remember to order the temperature humidity probe 501 86 500. *Dynamic Mositure Analysis

4] Model 501 shown with multi tub unit 500 35 011 and glass minitubs with fixed top caps and bags for drying of small batches of sample.
(Image 4 for illustration only -real systems should be all bag or all top-caps)

5] Model 501 shown with low density classifier 500 35 049 which allows for fractionation of samples with wide particle size/density distribution and collection of fractions within that range. It also allows separation of desirable sample elements from bulk samples, for example, removal of tree seed "wings" from the seeds.

ACCESSORIES:

ALSO TO BE SPECIFIED INCLUDE,
- Pulse flow module (501 86 001)
- Humidity/Temperature Probe (501 86 500)
- RS232 cable (926 09 052)
- Software (501 86 700)

BAG MATERIAL SELECTION
(NYLON OR TERYLENE ARE NORMALLY CHOSEN)
Nylon is resistant to alkali vapours
Terylene shows greater resistance with acids
Polypropylene is resistant to most chemicals but degrades more rapidly (than the other two) over 100°C
Nomex is an alkali tolerant material suited to sustained high-temperature drying, e.g. ~200°C

Pulse flow module helps to interrupt airflow and help breakup agglomerated "wet" samples e.g. "wet" tea. Can be used manually or controlled via software which offers a greater variety of pulse lengths and the option to reduce or switch off as the material being dried becomes more free flowing.
RS232 Cable for connection between PC and base unit.
Software for control of variable functions, data monitoring and feedback and creation of multistep drying programmes design to dry samples in the most efficient manner and taking into account the changes in the material's behaviour as its moisture content changes.
Humidity/temperature probe for in-tub, above sample, real-time feedback of temperature and relative humidity

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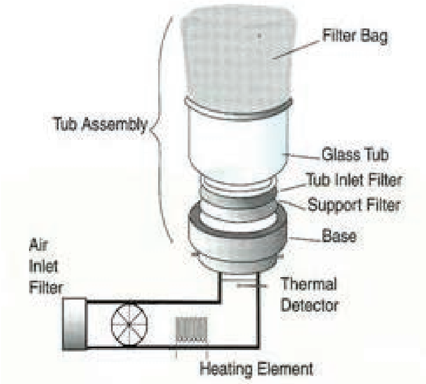
The basic Model 501 incorporates an air pump, heating coil, and temperature measurement (with control and timer). Air is drawn through an inlet filter, passed over a heating element and forced through a support filter (which holds the weight of the sample) and a Tub inlet filter (selected for pores smaller than the sample particle size). The air passes through the sample contained within a tub (glass or stainless), and finally through an Outlet filter which can be a Filter Bag. Bag material is selected to be chemically inert to emitted sample vapours. Alternately, "sealed" tub assemblies are available, where a filter plate (which has an outlet filter and support filter) seals onto a flanged tub with a silicon "0" ring and clamp (for particles less then 40 microns in size).



BAGS

Material	Sample particle size	Top Temp°C Dry	Top Temp°C Wet	Chemical Tolerance
Nylon	Not suitable for less then 35µm	115	115	Good—alkali vapours
Polypropylene		100	100	All
Terylene		150	80	Good—acid vapours
Nomex		240	240	Good—alkali vapours

FILTERS

FILTERS	Sample size	Top Temp°C	Chemical Tolerance
Nylon 45µm	≥45µm	115	Good—alkali vapours
Stainless Steel 60 mesh	≥250µm	1500	All
Stainless Steel 250 mesh	≥60µm	1500	All
Stainless Steel 500 mesh	≥30µm	1500	All
Polyester	≥3µm	230	Good—alkali vapours

<table>
<tr><th colspan="4">Tub Units</th><th rowspan="2">Inlet Filters</th><th rowspan="2">Outlet Filters</th></tr>
<tr><th></th><th></th><th>Sizes</th><th>Materials</th></tr>
<tr><td rowspan="9">Tub Assemblies</td><td rowspan="5">Filter Bag Options</td><td>2 Litre Tub and Base Unit</td><td>Glass 500 35 008
Stainless Steel 500 35 005</td><td rowspan="3">SS 60 Mesh Support Filter 500 35 113 (≡ 250µm) with 45 micron Nylon Inlet Filter (500 35 110) as standard
Also available; SS 250 Mesh 500 35 114 (≡ 60µm) SS 500 Mesh 500 35 115 (≡ 30µm)</td><td rowspan="3">Large Filter Bags
Nomex 500 35 407
Nylon 500 35 400
Polypropylene 500 35 404
Terylene 500 35 402</td></tr>
<tr><td>5 Litre Tub and Base Unit</td><td>Glass 500 35 009
Stainless Steel 500 35 008</td></tr>
<tr><td>5L Tub Assembly with GL32 port supplied with screw fitted blank plate to fit Humidity Probe 501 86 500</td><td>Glass 500 35 010</td></tr>
<tr><td rowspan="2">250 to 300 ml Multi Tub Base Adapter 500 35 011</td><td>Stainless Steel 500 35 012 (x 4)</td><td>SS 60 Mesh Support Filter 500 35 132 fitted as standard</td><td rowspan="2">Small Filter Bags
Nomex 500 35 408
Nylon 500 35 401
Polypropylene 500 35 404
Terylene 500 35 402</td></tr>
<tr><td>Glass 500 35 013 (x 4)</td><td>45µm Nylon filter (500 35 305) fitted as standard with SS 60 Mesh Support 500 35 132</td></tr>
<tr><td rowspan="4">Sealed Tub Options — (GLASS ONLY)
(includes Silicon "o"-ring & ground glass flange with clamp)</td><td colspan="2">5l Sealed Glass Tub & Base with Clamp 500 35 014</td><td rowspan="3">SS 60 Mesh Support Filter (500 35 113) with 45 micron Nylon Inlet Filter (500 35 110) as standard
Also available:
SS 250 Mesh 500 35 114
SS 500 Mesh 500 35 115
and
3 Micron Polyester filter 500 35 120. for smallest particle size Note; Max temp use is 100°C for this material and achievable air flow-rates will be severely reduced. Both those factors mean longer drying times if this material is used)</td><td rowspan="3">Top Cap with 45 Nylon Filter 500 35 020
Top Cap with 250 Mesh Filter 500 35 021
Top Cap with 500 Mesh Filter 500 35 022
Top Cap with Nylon Filter Bag 500 35 023
Top Cap & 3 micron Polyester Filter 500 35 024
500 35 020 fitted as standard to low density classifier</td></tr>
<tr><td colspan="2">5L Moisture Analysis Tub Assembly has ports for sample and Humidity probe.(501 86 500). Both ports supplied with screw fitted blank plates with GL32 port supplied with screw fitted blank plates Glass 501 35 020</td></tr>
<tr><td colspan="2">Low Density Classifier Assembly; Glass 500 35 049</td></tr>
<tr><td>Multi Tub Unit
500 35 011</td><td>Glass 4 x 500 35 033</td><td colspan="2">Sealed Mini Tub Inlet and Outlet Sets
Mini Nylon Filter Set 500 35 310
Mini 3 Micron Polyester Filter Set 500 35 311
Mini 250 Mesh St. St. Filter Set 500 35 312
Mini 500 Mesh St. St. Filter Set 500 35 313
(St.St. Support Filter 60 mesh 500 35 309 and nylon bottom support 500 35 305 fitted as standard)</td></tr>
</table>

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APPLICATION OF SHERWOOD FLUID BED DRYERS:

Sherwood Fluid Bed Dryers have been used on hundreds of different sample drying applications, from 10 gms to 5 Kgs. In addition, they have been used to mix solids, form uniform coatings, determine drying parameters, analyse for moisture by weight loss, form fine granular particles from agglomerates, act as a chemical reactor, and classify (separate) particulates by density, size, and surface texture.

Food Products & Technology	Minerals & Mining	Chemical & Biochemical	Plastics & Resins	Pharmaceuticals
Germinated barley	Coal, Coke	Chenodeoxycholic Acid	Diakon acrylic polymer	Lithium carbonate
Brewer's yeast	Copper Sulphate	General chemicals	Granular polymer (Nibs)	Cystein chioralose
Cereals	Feldspar	Drying Agents	Hydrophobic polymers	Salicylic Acid
Coffee	Ferrous Sulphate Hydrous	Ion exchange Resins	Hydrophilic polymers	Pancreatic Bile
Grains	Limestone	Sephadex Mol. Sieve	Propylene-ethylene	acid and salts
Animal food	Magnesium Sulphate hydrate	Dyes & Pigments	copolymers	5 sulphosalicylic acid
Rice	Peat	Phosphors & fine silica	Spherical polymers	Plant extracts
Tea	Potassium Fluoride			
Sodium Alginate	Sand			

If your particular drying application is not listed please contact; info@sherwood-scientific.com

Substances take up water in two ways

External moisture is on the surface of particles and evaporates just like liquid water

Internal moisture is absorbed into the matrix of the particles and takes more time and energy to be released

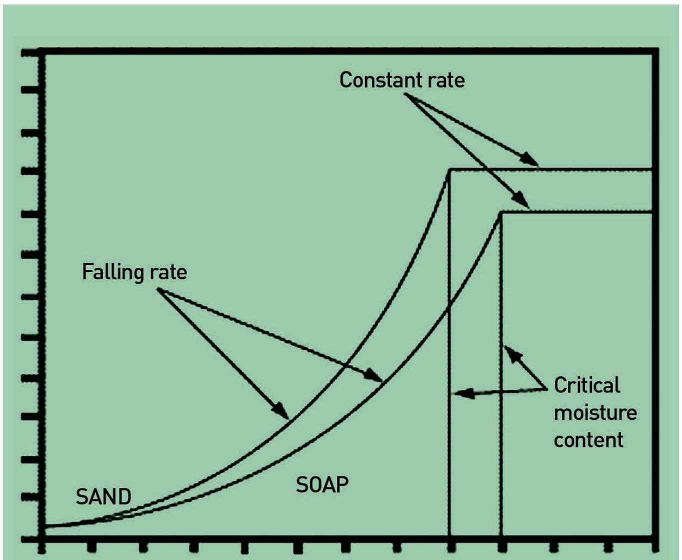

Figure 1 Rate of Drying vs Moisture Content

DRYING TECHNOLOGY

Drying occurs in two stages: firstly removal of surface water, which occurs at a constant rate and secondly loss of moisture from within a particle which is usually diffusion dependent.

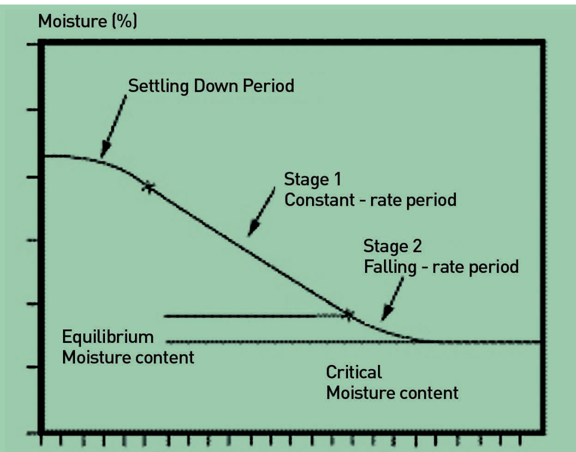

Figure 2 Moisture Content vs Time

THE DRYING CURVE

Generated by measuring weight loss over time while drying

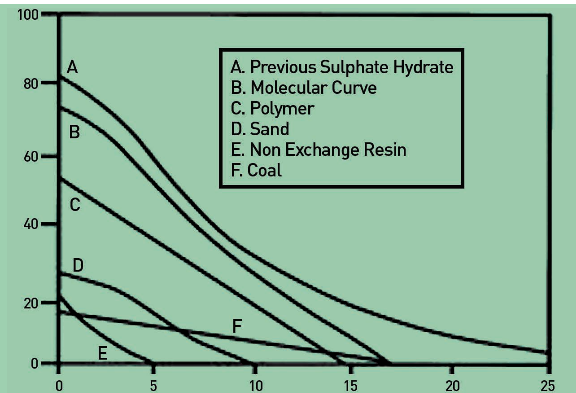

Figure 3 Typical Drying Curves Time (minutes)

ACTUAL DRYING CURVES

from a variety of real samples

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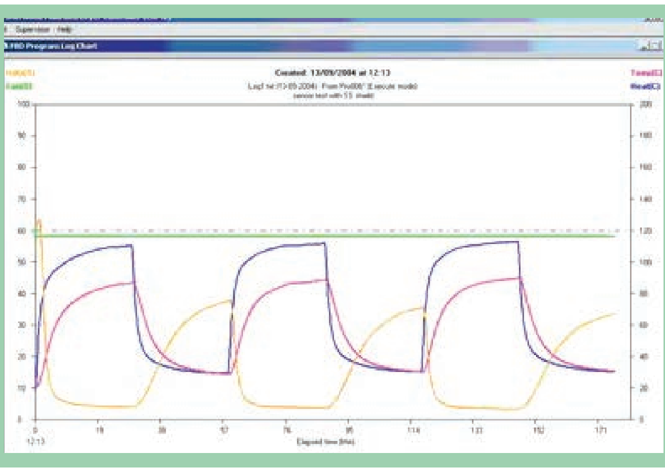
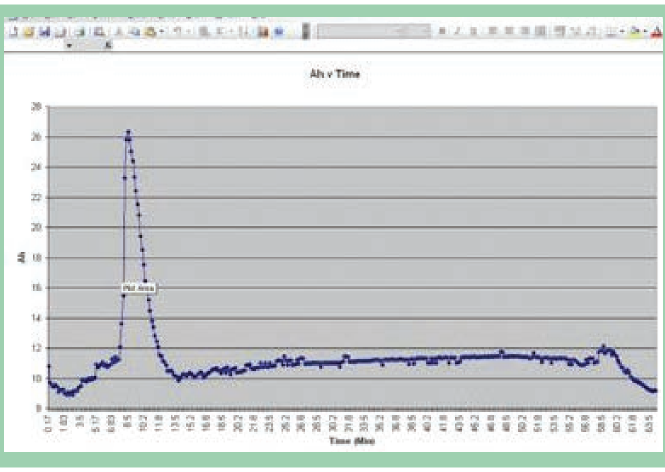
DRYING CURVES

Drying curves were traditionally generated by sequential weighing over time periodically interrupting the drying process.
Using all the features of the 501 fluid bed dryer i.e. in-tub temperature /humidity probe & software, all data can be logged and stored for future reference and subsequent manipulation.

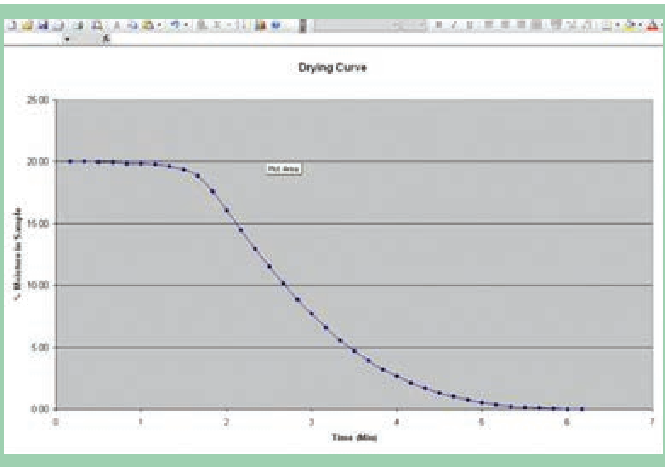
Raw data can be manipulated using software to produce drying curves



Inlet air temperature, blower motor speed, in tub temperature and relative humidity can all be recorded against time (using software and the temperature humidity probe).



Raw data logged can be manipulated using Sherwood software so this can be converted...



...to a Drying Curve without having to interrupt the drying process

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