

THE COMMERCIAL CASE FOR SPRAY-DRYING FOR MODERN DRUG PIPELINES

Catalent Pharma Services™

Itay Speicher of **Catalent** highlights how current conditions in the pharmaceutical pipeline, especially the high proportion of poorly soluble drugs in early-stage development and rise in amorphous solid dispersions, along with the cost-efficiency and flexibility of spray-drying, are providing the optimal conditions to maximise the value of spray-drying in drug development and commercial scale-up.

Published estimates now suggest that 70–90% of development-stage drug candidates are poorly soluble, compared with approximately 40% of already-marketed products.[1] Half of all drug molecules are estimated to fail during development due to poor aqueous solubility – not because the molecules lack pharmacological activity, but because they cannot be absorbed reliably after oral administration.

The commercial implications of the solubility challenge are direct. Poor bioavailability forces dose escalation, which increases both the safety risk and the cost of goods. It generates food effects that complicate dosing instructions and erode patient compliance. It introduces pharmacokinetic variability that weakens the clinical evidence base and complicates market-access negotiations. In late-stage programmes, a bioavailability failure represents one of the most expensive outcomes in drug development, consuming years of development investment that cannot be recovered.

Amorphous solid dispersions (ASDs) resolve this problem by converting a crystalline API into a molecularly dispersed amorphous form within a stabilising polymer matrix. The amorphous state, occupying a higher thermodynamic energy level than crystalline drug, exhibits greater apparent solubility and faster dissolution, generating sustained supersaturation in gastrointestinal fluids that drives absorption. Spray-drying is the most commercially proven and regulatory-accepted process for manufacturing these dispersions.[2]

Copyright © 2026 Furness Publishing Ltd

"BY CONTROLLING PROCESS PARAMETERS SUCH AS INLET TEMPERATURE, FEED CONCENTRATION AND ATOMISATION CONDITIONS, MANUFACTURERS CAN REPRODUCIBLY TUNE THE SIZE, DENSITY AND SURFACE CHARACTERISTICS OF THE DRIED PARTICLES."

Another development is pharmaceutical pipeline expansion beyond small molecules into messenger RNA (mRNA) therapeutics, nucleic acids and inhaled biologics. Taken together, these modalities all share a common manufacturing challenge: converting unstable liquid formulations into stable, deliverable solids.

A PLATFORM BUILT ON COMMERCIAL PROOF

A review by Moseson *et al* analysed all ASD drug products approved by the US FDA between 2012 and 2023, identifying 48 approved products comprising 36 unique amorphous drugs across 10 therapeutic categories.[2] Spray-drying was the most common manufacturing process, accounting for 54% of the ASD drug product intermediates, against 35% for hot-melt extrusion (HME). Approvals increased steadily throughout the 12-year period, spanning antiviral agents, antineoplastics, immunosuppressants and metabolic disease treatments, a breadth of therapeutic applications that reflects spray-drying's versatility across diverse chemistries and clinical contexts.

These commercial trends align closely with broader industry observations reported by Swm *et al*, who noted that approximately 70% to 90% of new chemical entities exhibit poor aqueous solubility,[3] with ASDs emerging as one of the most widely adopted enabling technologies to overcome this challenge. As increasingly complex molecules enter development, formulation strategies capable of enhancing solubility and bioavailability have become critical to advancing compounds that might otherwise fail.

61% of the approved amorphous drugs in this dataset had at least one physicochemical property outside the traditional Lipinski Rule of Five parameters, with molecular weight as the most frequently violated. This finding reinforces the trend observed by Swm *et al*: the industry's pipeline is increasingly populated by larger, more lipophilic and more structurally complex molecules. These are precisely the types of compound for which spray-drying often delivers the greatest value, underscoring its role as a strategic platform technology for modern drug development, rather than simply a niche formulation approach.

THE SCIENCE THAT DELIVERS COMMERCIAL RELIABILITY

The commercial reliability of spray-drying begins with its ability to engineer particle properties by design rather than by trial and error. By controlling process parameters such as inlet temperature, feed concentration and atomisation conditions, manufacturers can reproducibly tune the size, density and surface characteristics of the dried particles. The result is a technology that can produce fine, high-surface-area particles optimised for rapid dissolution in one programme, and denser, more slowly dissolving particles suited to controlled release in another. This morphological precision is not incidental to spray-drying's commercial performance; it is the mechanism through which bioavailability targets, stability profiles and downstream processability requirements can be engineered into the product from the outset.

"A MATURE SPRAY-DRYING PLATFORM COMMANDS THE FULL RANGE OF THESE CAPABILITIES AND CAN MATCH THE TECHNOLOGY TO THE MOLECULE, RATHER THAN FITTING THE MOLECULE TO AVAILABLE EQUIPMENT."

Achieving this level of control on an industrial scale requires the right tools. Leading CDMOs deploy modelling tools to predict drying kinetics, skin-formation behaviour and final particle morphology from milligram quantities of material, avoiding the costly consumption of expensive API during scale-up optimisation. The choice of atomisation technology matters equally: two-fluid nozzles for formulation versatility, rotary atomisers and pressure nozzles for high-throughput commercial production, and emerging vibrating mesh and ultrasonic systems for submicron particles and thermally sensitive biologics. A mature spray-drying platform commands the full range of these capabilities and can match the technology to the molecule, rather than fitting the molecule to available equipment.

A PLATFORM FOR THE FULL MODERN PIPELINE

The argument in favour of spray-drying becomes more compelling still when considered at the portfolio level rather than the molecule level. Spray-drying is not a single-application technology – it is a platform whose capabilities address the defining manufacturing challenges of the modern pharmaceutical pipeline across multiple modalities.

For poorly soluble small molecules, the ASD application is well-established and commercially validated, as previously discussed. With 70–90% of development candidates exhibiting poor solubility, this application alone justifies platform-level investment.

For mRNA therapeutics and lipid nanoparticles, spray-drying offers a pathway to cold-chain elimination. Current mRNA-based therapeutics typically require ultra-cold storage at temperatures as low as -90°C to -60°C to maintain liquid-state stability. Converting these formulations into spray-dried powders can facilitate room-temperature stability, removing the

Copyright © 2026 Furness Publishing Ltd

"THIS APPROACH COMBINES THE AERODYNAMIC PERFORMANCE REQUIRED FOR DEEP LUNG PENETRATION WITH THE BIOLOGICAL ACTIVITY OF NANOSCALE CARRIERS – A DELIVERY ARCHITECTURE SPECIFICALLY ENABLED BY THE PRECISE PARTICLE ENGINEERING OF SPRAY-DRYING."

logistics bottlenecks and access barriers that have constrained global distribution of cold-chain-dependent vaccines and therapeutics. For organisations with biological pipelines alongside small-molecule assets, spray-drying infrastructure serves both.

For pulmonary drug delivery, CDMOs are increasingly applying a "nano-into-micro" engineering strategy: nanoparticles, which are too small to deposit effectively in the deep lung and are typically exhaled, are embedded within a 1–5 µm microparticle matrix by spray-drying. In the moist environment of the alveoli, the matrix dissolves, releasing the bioactive nanoparticles in their functional state. This approach combines the aerodynamic performance required for deep lung penetration with the biological activity of nanoscale carriers – a delivery architecture specifically enabled by the precise particle engineering of spray-drying.

WHY SPRAY-DRYING LEADS THE TECHNOLOGY SELECTION

For development scientists and chemistry, manufacturing and controls leaders choosing between spray-drying and its primary manufacturing alternative, HME, the evidence across multiple dimensions favours spray-drying as the default option for the broadest range of applications.

Chemical Space

Because the spray-drying process dissolves the API in a volatile organic solvent before processing, it accommodates compounds across a wide range of physicochemical properties, including heat-sensitive molecules, high-melting-point APIs and those with complex polymorphic behaviour. HME, a solvent-free thermal process, is constrained to APIs with adequate thermal stability under extrusion conditions, thereby excluding a meaningful share of the modern development pipeline.

Particle Size and Dissolution Performance

A head-to-head comparison of posaconazole ASDs found that spray-dried dispersions achieved a median particle size (D50) of 22 µm, compared with 157 µm for the equivalent HME product, a seven-fold difference that drives meaningfully faster dissolution and greater gastrointestinal exposure in biorelevant testing.[4]

Physical Stability

A comparative stability study found that, after 60 days under stress conditions, spray-dried formulations demonstrated greater physical stability than equivalent HME products.[5] Both APIs in the study were fully converted to amorphous forms by spray-drying, whereas one remained partially crystalline under HME – a difference with direct implications for product performance and regulatory characterisation. Given the importance of maintaining the amorphous state throughout development and commercialisation, physical stability remains a key consideration for ASDs and should be assessed using appropriate analytical methods capable of detecting early signs of phase separation or recrystallisation.[6]

Early Development Efficiency

Spray-drying accommodates gram-scale API quantities during formulation screening, enabling systematic polymer selection and stability evaluation without depleting constrained early-stage API supplies. Scale-up, when governed by appropriate dimensionless parameters, preserves the formulation performance established at laboratory scale.

A FRAMEWORK FOR COMMERCIAL DECISION-MAKING

Define the Build-Versus-Partner Strategy

Internal capability delivers cost-of-goods-sold advantages on a commercial scale but requires substantial upfront capital and sustained technical investment. CDMO partnerships provide speed, flexibility and access to state-of-the-art equipment without needing to commit significant capital, but require rigorous partner selection. When evaluating CDMOs, move beyond equipment lists to assess scaling logic – specifically, whether the organisation uses dimensionless engineering parameters (Reynolds, Stokes and Euler numbers) to ensure that lab-scale formulation performance is preserved at commercial throughput, alongside quality by design maturity, risk management based on failure mode and effects analysis, and high-potency containment capability.

Invest in Formulation Science First

Polymer selection is the single most consequential decision in ASD development. Hydroxypropylmethylcellulose acetate succinate and copovidone account for nearly 80% of all polymer selections in FDA-approved ASD products,[2] a concentration that reflects accumulated evidence about their stabilisation performance across diverse chemical spaces. Systematic polymer screening, supported by characterisation, establishes the physical stability foundation upon which commercial product reliability depends. Compressing this investment in the name of development speed is the most reliable path to late-stage failure.

Design the Downstream Process in Parallel

The spray-dried intermediate is not the finished product. Granulation strategy, compression performance, film-coating compatibility and packaging requirements must be designed alongside the spray-drying process, not after it. Integrated formulation-to-finished-dosage-form development planning is the standard that distinguishes programmes that reach commercial launch on schedule from those that encounter late-stage manufacturing surprises.

Copyright © 2026 Furness Publishing Ltd

Cost Efficiency and Operational Flexibility at Commercial Scale

Beyond its scientific and regulatory validation, spray-drying delivers a set of economic and operational advantages that reinforce its position as a platform technology. These advantages are not secondary considerations; they are central to why spray-drying is increasingly embedded early in development strategy rather than deployed as a reactive approach.

From a cost perspective, spray-drying reduces overall development and manufacturing expenditure through process efficiency. It is an inherently continuous operation, enabling high throughput with lower labour intensity than batch-based alternatives. More importantly, it consolidates multiple unit operations, such as solvent evaporation, particle formation and drying, into a single step. This integration eliminates intermediate handling, reduces material loss and shortens processing timelines, all of which contribute directly to a lower cost of goods.

Material efficiency is particularly critical in early- and mid-stage development, where API availability is constrained and expensive. The ability of spray-drying to operate effectively at a small scale, while preserving a clear pathway to commercial scale, minimises API consumption during formulation screening and process optimisation. This reduces both direct material costs and the opportunity cost associated with limited supply.

Energy use further contributes to cost performance. While spray-drying is often perceived as energy-intensive, modern systems incorporating heat recovery, optimised airflow design and closed-loop solvent handling can significantly reduce the energy consumption per unit output.

> "A SINGLE SPRAY-DRYING PLATFORM CAN ACCOMMODATE A WIDE RANGE OF FORMULATIONS, INCLUDING SOLUTIONS, SUSPENSIONS AND EMULSIONS, ACROSS SMALL MOLECULES, BIOLOGICS AND ADVANCED DELIVERY SYSTEMS."

In solvent-based ASD manufacturing, solvent recovery systems can also mitigate raw material costs and support regulatory compliance, aligning economic and environmental objectives.

Flexibility is another major commercial advantage of spray-drying. A single spray-drying platform can accommodate a wide range of formulations, including solutions, suspensions and emulsions, across small molecules, biologics and advanced delivery systems. Process parameters can be rapidly adjusted to meet different product specifications, enabling the same equipment train to support multiple programmes without extensive reconfiguration.

This flexibility extends to commercial-scale production and lifecycle management. Spray-drying systems can be deployed from gram-scale development through pilot and commercial manufacturing using consistent engineering principles, reducing scale-up risk and avoiding the need for process reinvention. For organisations managing diverse pipelines, this creates a unified manufacturing approach that simplifies technology transfer, workforce training and facility design.

From a portfolio perspective, these characteristics translate into strategic optionality. Development teams can progress multiple API candidates through a common platform, reprioritise assets without incurring significant switching costs and respond more rapidly to clinical or market signals. In an environment where pipeline agility is increasingly a competitive differentiator, this operational flexibility is as valuable as the underlying science.

Taken together, the cost efficiency and adaptability of spray-drying do not merely support its technical strengths but amplify them. The result is a technology that improves not only the probability of technical success but also the economic viability and speed of bringing new therapies to market.

> "WHAT REMAINS IS AN ORGANISATIONAL QUESTION: WHETHER PHARMACEUTICAL LEADERS TREAT SPRAY-DRYING AS A REACTIVE PROBLEM-SOLVING CAPABILITY DEPLOYED WHEN FORMULATIONS FAIL, OR AS A PROACTIVE PLATFORM EMBEDDED IN DEVELOPMENT STRATEGY FROM THE MOMENT A CANDIDATE ENTERS THE PIPELINE."

SUMMARY

The modern pharmaceutical pipeline has, by its composition, created the conditions for the emergence of spray-drying as a platform technology. Up to 90% of new molecular entities having solubility limitations, a biologics landscape demanding cold-chain-free formulations and a growing category of inhaled and sterile biologic products have collectively elevated spray-drying from a specialist tool to a commercial necessity.

The abundance and variety of peer-reviewed evidence has settled the scientific question. The FDA's approval record has settled the regulatory question. The CDMO sector's capital commitments have settled the infrastructure question. What remains is an organisational question: whether pharmaceutical leaders treat spray-drying as a reactive problem-solving capability deployed when formulations fail, or as a proactive platform embedded in development strategy from the moment a candidate enters the pipeline.

The organisations that answer that question correctly, by building or partnering for robust spray-drying capability now, will move faster, waste less and put more molecules in front of patients. That is the commercial case. It is

Copyright © 2026 Furness Publishing Ltd

straightforward, it is evidence-based and the window for competitive advantage from early commitment is narrowing.

REFERENCES

1. *Kumari L et al, "Advancement in Solubilization Approaches: A Step towards Bioavailability Enhancement of Poorly Soluble Drugs". Life (Basel), 2023, Vol 13(5), art 1099.*
2. *Moseson DE et al, "Trends in amorphous solid dispersion drug products approved by the U.S. Food and Drug Administration between 2012 and 2023". Int J Pharm X, 2024, Vol 7, art 100259.*
3. *Li Y et al, "Processing Impact on In Vitro and In Vivo Performance of Solid Dispersions-A Comparison between Hot-Melt Extrusion and Spray Drying". Pharmaceutics, 2021, Vol 13(8), art 1307.*
4. *Swm AM, Mita SR, Huysni P, "Spray Drying for Pharmaceutical Raw Materials: A Systematic Review on Enhancing Bioavailability and Stability". Drug Des Devel Ther, 2025, Vol 19, pp 11433–11463.*
5. *Kelleher JF et al, "A comparative study between hot-melt extrusion and spray-drying for the manufacture of anti-hypertension compatible monolithic fixed-dose combination products". Int J Pharm, 2018, Vol 545(1-2), pp 183–196.*
6. *Kawakami K et al, "Long-term physical stability of amorphous solid dispersions: Comparison of detection powers of common evaluation methods for spray-dried and hot-melt extruded formulations". J Pharm Sci, 2025, Vol 114(1), pp 145–156.*



Itay Speicher

Itay Speicher is a Senior Account Director at Catalent's Clinical & Specialty Services. He has over a decade of experience in business development and sales in the pharmaceutical and biotech space. He started his career at Pion Inc and, as North America Director of Sales, supported analytical instrumentation and CRO services sales of physical chemistry property measurements. Following that, he served as Head of Business Development for Averica Discovery (now Neopharm Labs), and later on joined digiM Solution to spearhead its commercial team, supporting characterisation of drug products and drug substances with artificial intelligence-based image analysis.

T: +1 617 922 7898
E: itay.speicher@catalent.com

Catalent, Inc
190 Everett Ave, Chelsea, MA 02150, United States
www.catalent.com

DISCOVER TOMORROW'S DRUG DELIVERY INDUSTRY TODAY

www.ondrugdelivery.com/subscribe

ON drugDELIVERY

Copyright © 2026 Furness Publishing Ltd

ON diagnostics

Launching 2027



A brand new publication for the global diagnostics industry, connecting diagnostics innovators and manufacturers with clinical and commercial partners.

www.on-diagnostics.com



Issue Topics

- Point-of-Care and Rapid Dx
- Companion Diagnostics & Precision Medicine
- Consumables, Components & Sample Prep
- Immunodiagnostics
- Molecular Diagnostics
- Digital Diagnostics, AI & Connected Diagnostics

In which issue could *your* company appear?

Expertise & proven success in oral spray dry dispersions

SPRAY DRYING

ENCAPSULATION & BLISTERING

CHARACTERIZATION



- Formulation expertise for poorly soluble small molecules
- End-to-end development & manufacture of oral spray-dried dispersions dosage form
- Scale up from lab to commercial
- Commercial-scale oral spray drying
- A trusted partner for clinical programs

Contact us

US +1 888 SOLUTION (765-8846) **EUR** 00800 88 55 6178

catalent.com/inhalation



©2026 Catalent, Inc. All rights reserved.

Catalent®
Pharma Services