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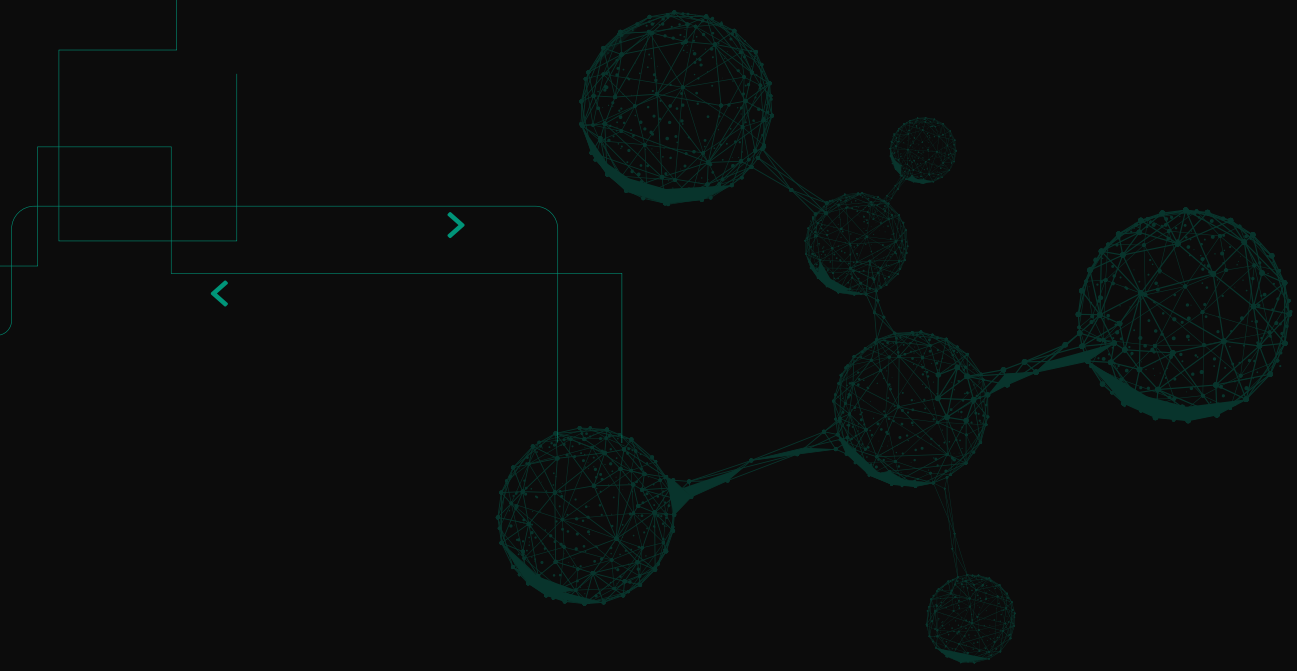

REDUCING GAS CONSUMPTION BY 20% DURING THE MICRONIZATION PROCESS WITH THE COAXIAL JET MILL

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ABSTRACT

PHARMACEUTICAL COMPANIES AND FINE CHEMICAL COMPANIES HAVE FOUND THE RIGHT EQUIPMENT TO HELP CREATE A MORE EFFICIENT, STREAMLINED PROCESS DURING THE MICRONIZATION PHASE BY USING THE COAXIAL JET MILL TO ADDRESS THE MULTIPLE CHALLENGES THAT WOULD TYPICALLY ARISE.

CONTENT

MOST DRUG DEVELOPERS, PHARMACEUTICAL, AND FINE CHEMICAL COMPANIES HAVE TROUBLE WITH GETTING THE RIGHT PARTICLE SIZE DISTRIBUTION THE WAY IT NEEDS TO BE DURING MICRONIZATION. NOT ONLY BECAUSE OF DIFFERENT CHALLENGES FACED DURING THE PROCESS, BUT OTHER OUTSIDE FACTORS AS WELL. RANGING FROM ISSUES LIKE COST AND TIME THROUGHOUT THE MICRONIZATION PROCESS, MACHINE SAFETY AND GAS CONSUMPTION CAN ALSO BE PROBLEMATIC DURING THIS PHASE.

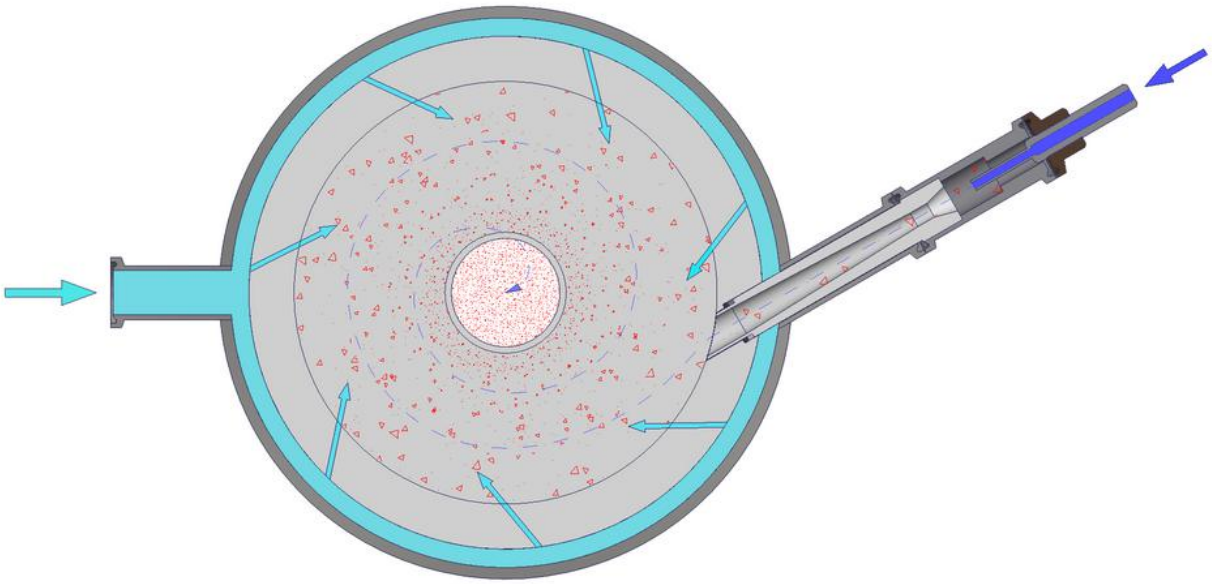
To address some of these challenges, pharmaceutical, fine chemical companies, and drug developers are looking for solutions to get the particle size distribution, just right. Along with addressing safety and gas consumption issues to help foster saving energy and a more sustainable environment for micronization.

Providing solutions for micronization challenges, the coaxial jet mill, a state-of-the-art technology, supersedes the latest industry and safety regulations and requirements. The Coaxial Jet Mill equipment is innovative and high-quality for the pharmaceutical and fine chemical industries, designed and built at the highest levels and standards.

MAIN CHALLENGES DURING MICRONIZATION

Industry estimates indicate that more than 80% of new chemical entities exhibit low solubility, low bioavailability and / or low or inconsistent dissolution rate. Micronization is one of the most utilized solutions for particle size reduction and consequently bioavailability enhancement or drug substance vehiculation to lungs. It is a process that requires a pressurized gas (e.g., compressed air or nitrogen) in order to collide particles against each other.

The performances of the jet mill machine, strongly vary according to powder properties (flowability, hardness, etc.) and it is therefore necessary to be able to adapt the process to each products characteristic. Spiral jet mills are devices widely used in the particle size reduction process of powders, as they allow to obtain an excellent degree of particle size distribution while keeping an easy to clean set up. The powders are introduced into the micronization chamber where, once accelerated by the swift expansion of gas (air or nitrogen), they fragment due to the collision between themselves. The larger particles remain in the milling chamber while the smaller particles are evacuated through an outlet in the center.



Micronization Happening

CHALLENGES

During micronization with spiral jet mill machines, some problems and challenges can occur throughout the process

Spiral Jet Mill

CHALLENGE #1: USE OF THE STANDARD JET MILL LIMITS THE RANGE OF PARTICLE SIZE DISTRIBUTION

While most spiral jet mills for micronization are standardized and not flexible in their configuration, it makes it difficult for them to be adapted to the challenges of each single product. In the jet mill, dry powder is pushed through the machine from the pressure of the gas during the process. After that, the product becomes micronized and then output into its final form. In standard jet mills, the problems occur on a particular run through point on the machine called the venturi tube (venturi element). With the combination of dry powder and heavy gas pressure, a multitude of factors start to cause issues during micronization, which can affect your end product and process

CHALLENGE #2: NOISE OF MACHINES DURING MICRONIZATION

Some countries restrict some use of machines to certain decimals. While the noise can be reduced by silencers, that still may not be enough. A venturi tube, which creates a vacuum to transport particles into the chamber, produces a lot of noise that is also amplified by the cone where the powder is introduced.

Noise levels increase as the jet mill sizes increase, to sometimes reaching decibels up to 100 or more. In some countries, even with ear protection, jet mill machines may be restricted because decibels could be 75 or more.

Logarithmic Scale - Sound Intensity/Decibels

Power Ratio	Decibels (dB)
P	**10*log(P)**
1000	30.00
100	20.00
10	10.00
2	3.01
1	0.00
0.5	-3.01
0.1	-10.00
0.01	-20.00
0.001	-30.00

https://devopedia.org/decibel

CHALLENGE #3: ENORMOUS AMOUNT OF GAS USAGE

The standard jet mill consumes a lot of gas during micronization. **The venturi element of the standard jet mill machine generally consumes on average 23-24% of the total gas consumption of the machine.**

Jet mills consume a lot of gas, which is the main operating cost of the machine, as the machine itself does not have rotating or quickly abrading parts which reduce its shelf life.

CHALLENGE #4: ISSUES WITH BLOWBACK

Blowback happens either because of clogging or because of wrong set up. This problem can begin when the venturi is not properly sized according to powder flow and to the pressures' set up. It consists of powder coming back from the milling chamber through the cone, and blowing it out. This may result in powder everywhere with open jet mill set ups, or with machine stops with closed jet mills set ups, which causes a huge error with particle distribution size.

With clogging, watch for the amount of powder flowing into the chamber. As constant powder flow into the chamber is key to a consistent final particle size distribution, it becomes a quality problem that should be avoided at all costs. In these cases, the operator has to stop the machine and clean the venturi before restarting.

With no constant flow of powder in the jet mill, there is a risk of particle size distribution being different, which cannot be used for final pharmaceutical product output. This can lead to restarting the process all over again and waste of product.

THE COAXIAL JET MILL IS THE NEW SOLUTION FOR MICRONIZATION

The Coaxial Jet Mill is innovative, high-quality machinery for the pharmaceutical and fine chemical industries designed and built at the highest levels and standards. Schedio is working on this prototype and it's now being tested on APIs, in order to optimize it for pharmaceutical and fine chemical companies.

The coaxial jet mill is not only used to reach the same particle size distribution of a spiral jet mill, but it has several advantages, providing different solutions and solving all the challenges that would come from using the standardized jet mill.

Coaxial Jet Mill Vs Spiral Jet Mill

HOW CAN THE COAXIAL JET MILL HELP IMPROVE THE MICRONIZATION PROCESS?

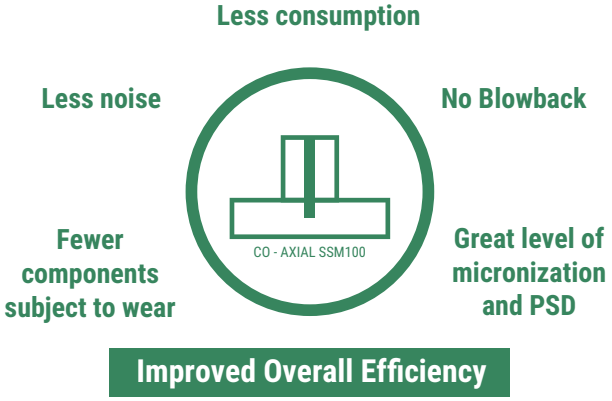
With micronization being one of the most utilized solutions for particle size reduction, the coaxial jet mill differs greatly from conventional spiral jet-mills because the powder is axially fed to the mill at the center of the vortex and is expelled by an extraction conduit positioned coaxially with the powder inlet conduit. The structure of the coaxial jet mill allows for better processing of larger particles and improves micronization by reaching same particle size distribution for final product output for oral solid dosage forms.

As opposed to the standard jet mill, the coaxial jet mill does not require an inlet venturi. The venturi is where most issues arise in a normal jet mill with issues such as clogging and intense gas pressure. With coaxial jet mill, not having the venturi tube, it is able to process large particles, as well as sticky, abrasive compounds. An important part of the coaxial configuration is the vacuum and suction effect that is maintained at any pressure. It helps with “no blow-back” that subsequently leads to a more efficient mill and powder injection process and less wear and tear.

The Coaxial Jet Mill’s micronization reaches the same particle size distribution as the standardized jet mill, but with a more efficient, streamlined process, saving time on cost and errors. With compounds coming through a top inlet of the machine, there is less peripheral movement of the particles, which means the powder can’t stick in the injection part of the mill (cone, feeding nozzle, or venturi).

The coaxial jet mill set up can be assembled on current spiral jet mills and can help your micronization process by:

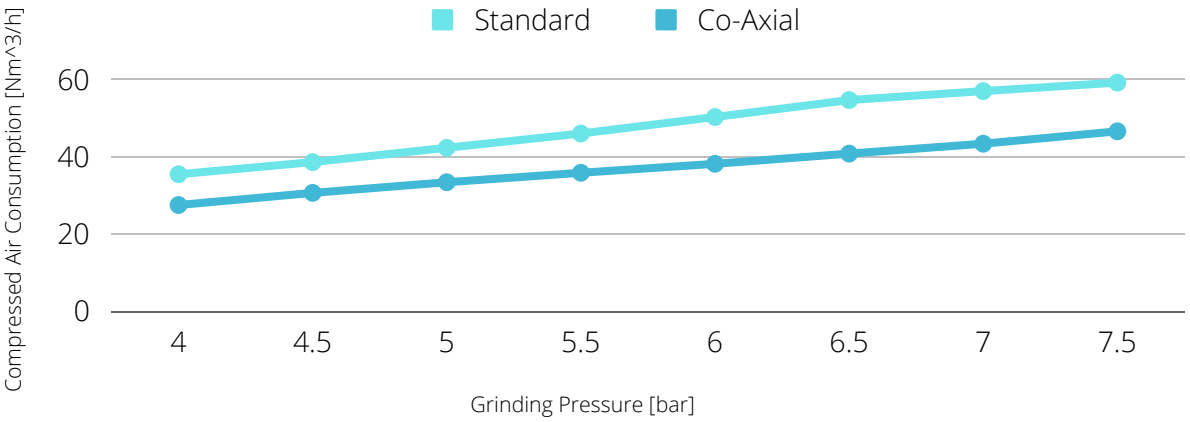
- Micronizing powders with the least expenditure of energy, while maintaining a diffusion of the powders inside the flow that are uniform as possible.
- Improving the distribution of the material inside the flow
- Reduced noise
- Removing the possibility to clog the injection pipe



SUMMARY

Tests and evaluation results confirm that the coaxial injection mill consumes on average 23% less compressed gas than the standard venturi injector mill. This clearly leads to more efficiency in terms of lower operating costs and a clear reduction in energy costs and consumption, especially in cases where different types of gas are used (nitrogen, argon, etc.).

Gas Consumption Graph



Noise levels are greatly reduced with the coaxial mill with operating results showing that it generates on average 4.27 dB less than the standard model at the same grinding pressure. This is equivalent to a reduction in noise intensity of over 50%. Decibels follow a logarithmic scale, which means that a reduction of few dB, especially in the upper part of the scale, actually corresponds to a strong variation in terms of noise intensity

PSD - Stardard vs. Co-axial

Feeding Rate: 900 g/h	Standard			Co-axial		
Grinding Pressure [bar]	D10 [µm]	D50 [µm]	D90 [µm]	D10 [µm]	D50 [µm]	D90 [µm]
6	1.84	4.15	8.49	1.09	3.51	8.1
6.5	1.84	4.37	9.19	1.02	3.3	7.07
7	1.72	3.81	7.74	1.88	4.66	10.6
7.5	1.68	3.69	7.49	1.83	4.49	10.2

Grinding tests on the machine verified that the coaxial mill produces finer values for D10, D50 and D90 and always with value D90 < 10 [µm], when grinding at the same pressure as the standard mill and configuration (+0.5Bar of Feeding Pressure in standard configuration).

As shown, the coaxial mill has a wide range of technical and economic advantages including sustainability, efficiency leading to lower operating costs and reduction in energy consumption, improved grinding process with no blow-back and a significant reduction in noise levels.

Coaxial Jet Mill

IMPROVED OVERALL EFFICIENCY

The Coaxial Jet Mill has technical and economic advantages that help to improve the efficiency of production processes in all types of aspects, producing high-quality and improved reproducibility of the final particle size distribution. Schedio is helping pharmaceutical, fine chemical companies, and drug developers to get the particle size distribution, just right, while addressing safety and gas consumption issues to help foster saving energy and a more sustainable environment for micronization.

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