

Valimet Aluminum/ Aluminum Alloy Powders for Cold Spray Applications

Cold Spray Action Team

Worcester Polytechnic Institute

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Presentation Summary:

- ▶ Introduction to Valimet
- ▶ Defining Aluminum Base Cold Spray Powders
- ▶ Valimet's Experience in Supplying Cold Spray Powders
- ▶ Valimet's Production Technology
- ▶ Understanding Relationship between Atomization/Size Specification/Yield/Sizing/Alloy Type/Cost
- ▶ Conclusions

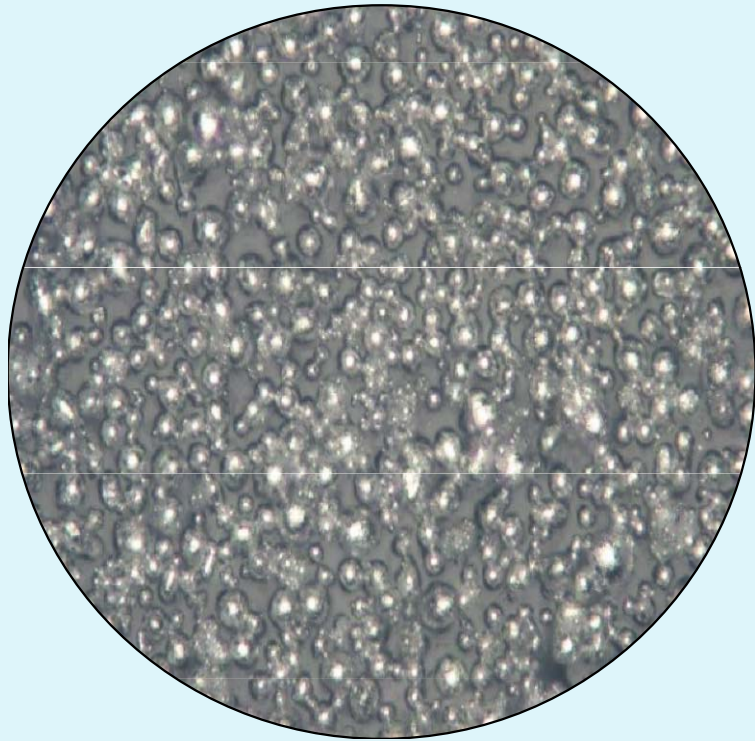


Introduction to Valimet

- ▶ Manufacturer of Spherical Metal Powders (Aluminum and Aluminum Alloys, others) by Gas Atomization
- ▶ Operating at Stockton, California, site since 1960s
- ▶ Major Applications for Powders:
 - Rocket Propellant
 - Thermal Sprays
 - Packed Bed Diffusion Coatings
 - Heat Management for Micro-Processors
 - EM Shielding
 - Automotive Pigments
 - Photovoltaics
 - Refractories for Steel Industry
 - Aluminum Metal Matrix Composites



What Defines Aluminum Base Cold Spray Powders?



Valimet H-15 Aluminum

- ▶ Size Specifications
- ▶ Morphology
- ▶ What PSD Specifications can be used for Cold Spray?
- ▶ What is the best PSD for Cold Spray Applications?



Physical Characteristics of Valimet Spherical Aluminum Powders

Specification	H-2	H-3	H-5	H-10	H-12	H-15	H-30	H-50	H-60	H-95
Microtrac Analysis:										
90 %	7.5	10.5	15.0	26.0	30.0	40.0	58.0	92.0	112.0	160.0
50 %	3.5	4.5	8.0	12.0	15.0	20.0	31.0	59.0	71.0	108.0
10 %	1.8	2.0	4.0	6.0	6.5	9.0	15.0	38.0	44.0	73.0

Typical Particle Size Distributions of
Standard Valimet Powders



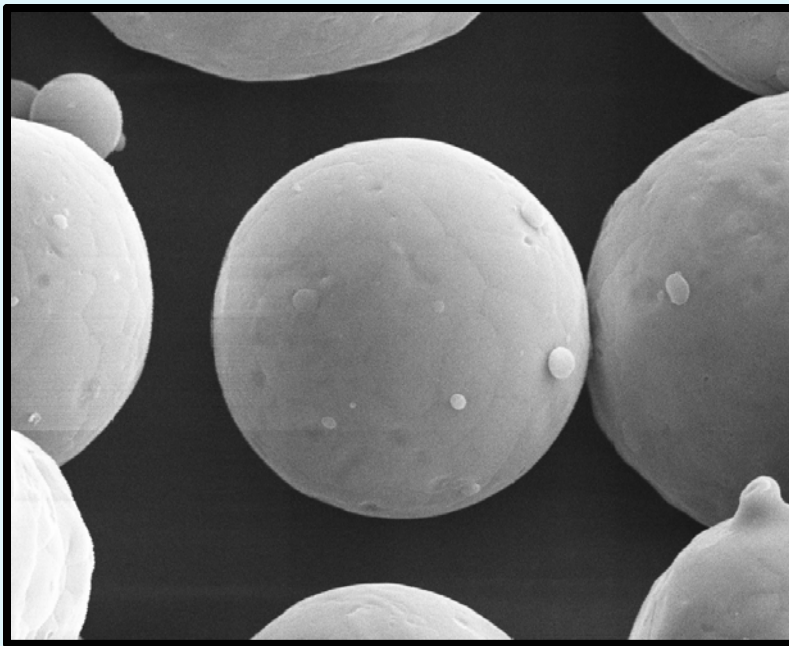
Valimet's Experience Supplying Cold Spray Aluminum and Aluminum Alloys Since 2000

Powder Type	Particle Size/Specification
CP Aluminum (99.8%)	H-10, H-12, H-15, H-20, H-30
High Purity Aluminum (99.95%)	-20 um, 9-40 um
Aluminum Silicon (AA 4047)	S-8, S-10, S-15, S-20
Alloy 6061	-270 mesh, -325 mesh, 270mesh/+15 um, -44/10 microns, -30 um
Alloy 7075, 7090, 7005	-325 mesh, -200 mesh
Alloy 5083, 5356	-325 mesh
Alloy 356, 390	-325 mesh, -200 mesh
Alloy Al/Zn/XXX	-325 mesh

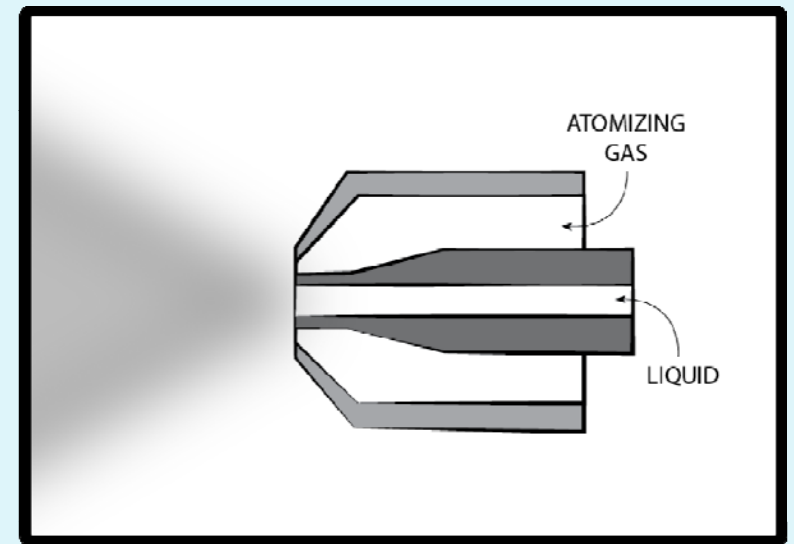


Valimet Production Technology

- ▶ Valimet produces powder by inert gas atomization, which produces powder with a spherical shape



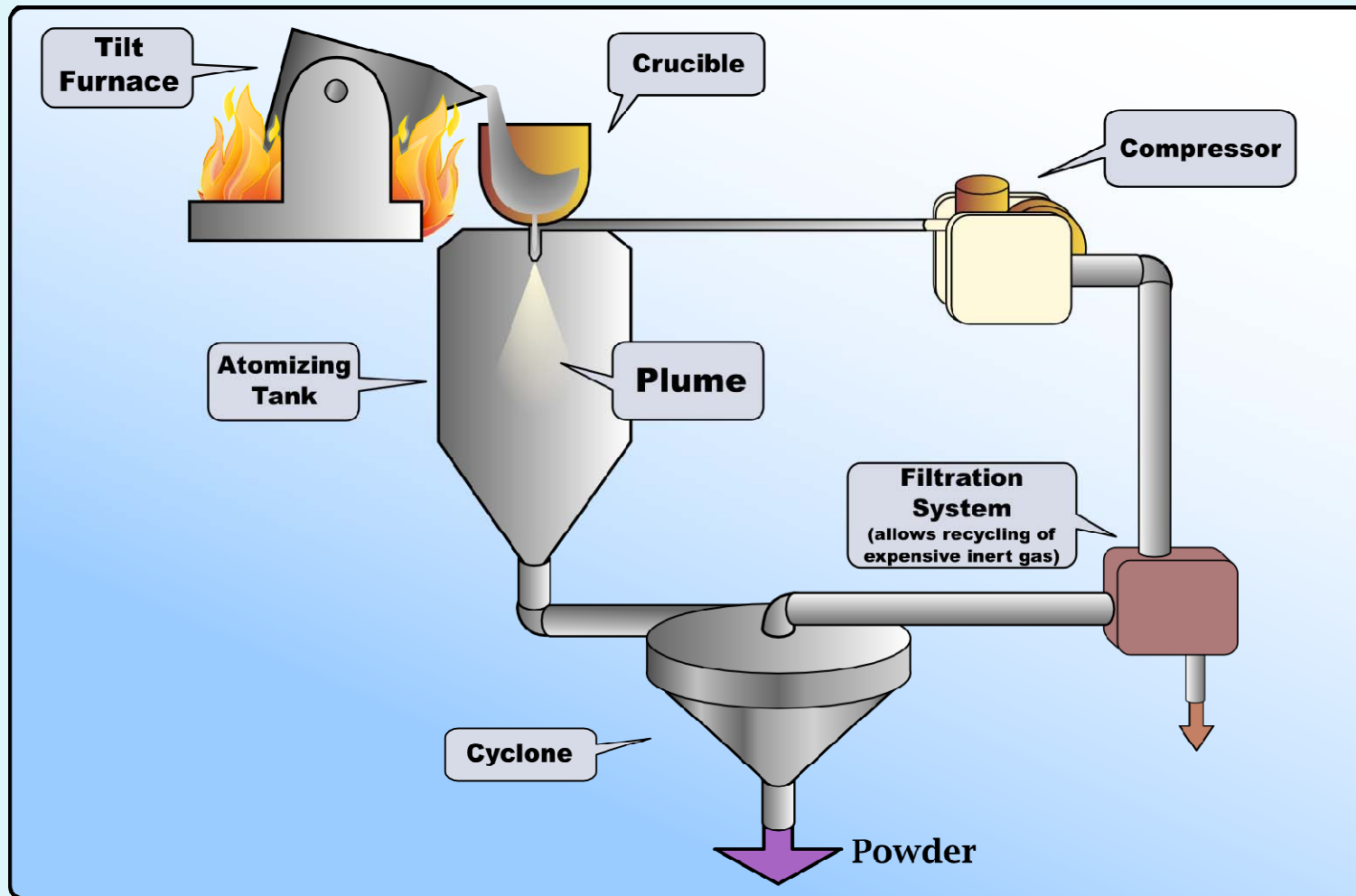
SEM image of Spherical Powder



Inert atomization nozzle



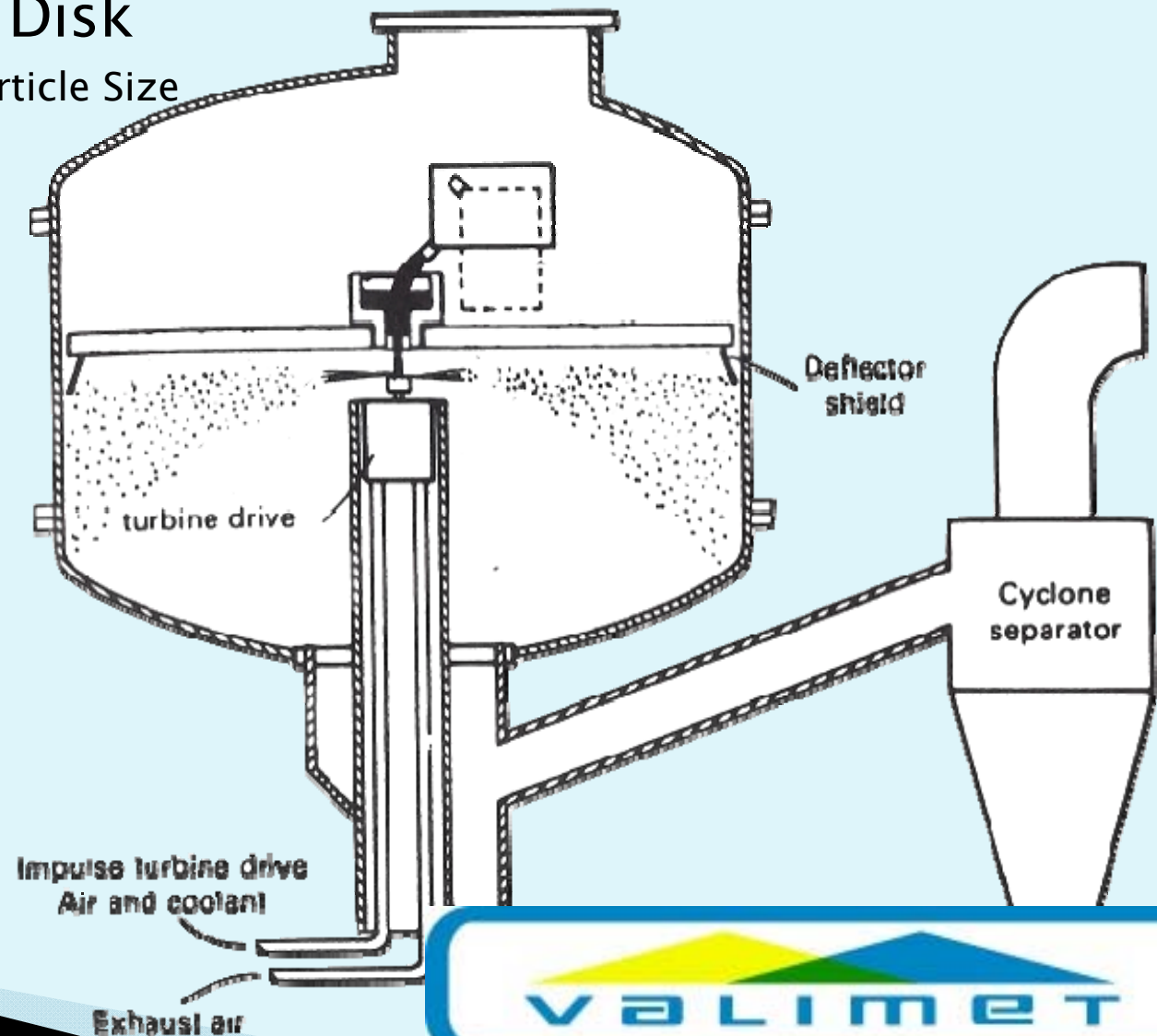
Closed Loop Gas Atomization



Alternative Atomization:

Spinning Cup/Disk

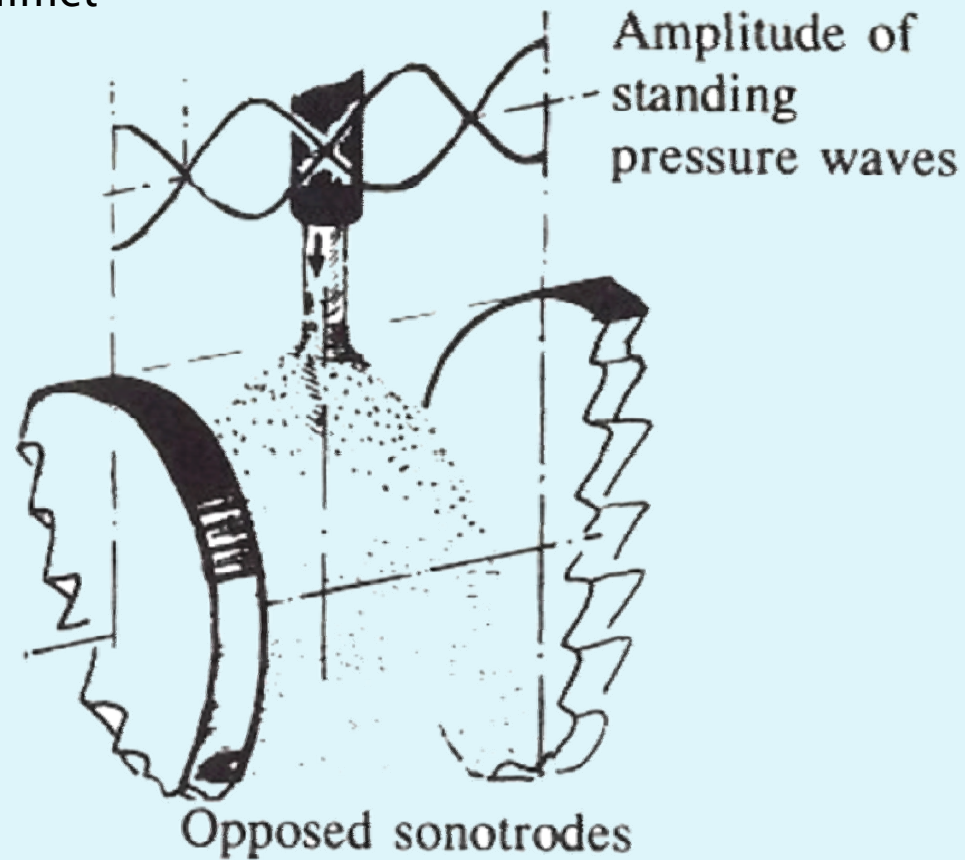
Results in Coarser Particle Size



Alternative Atomization:

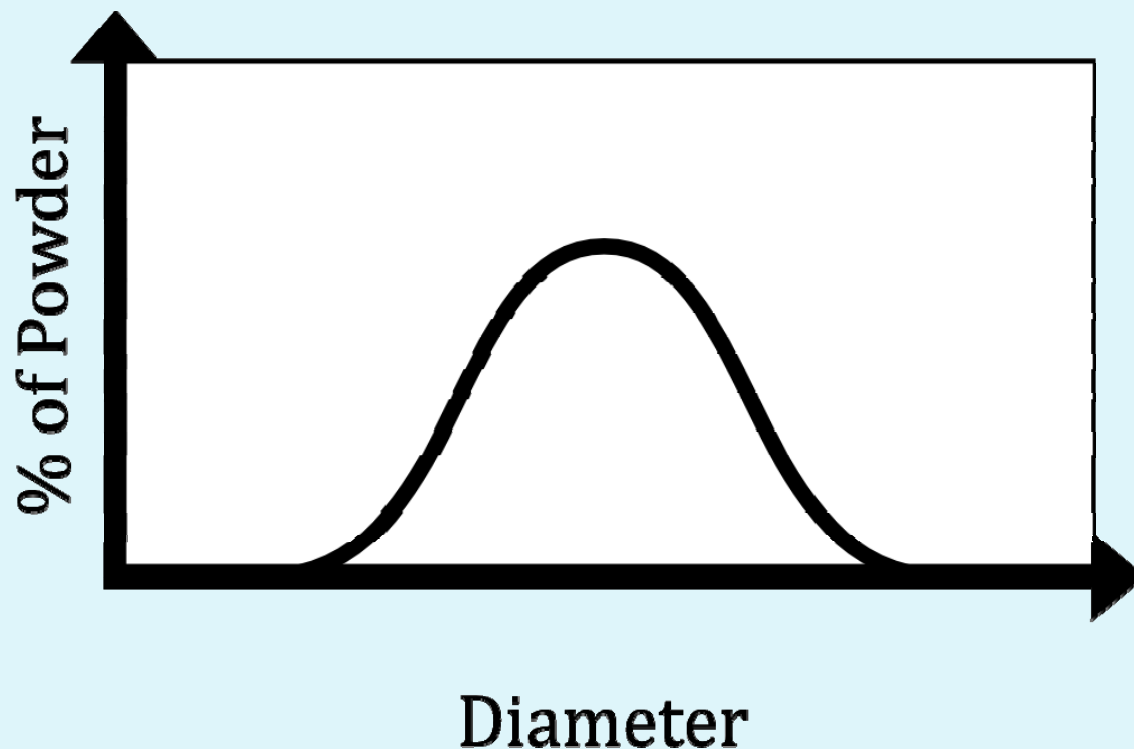
Ultrasonic Atomization

Not practiced by Valimet



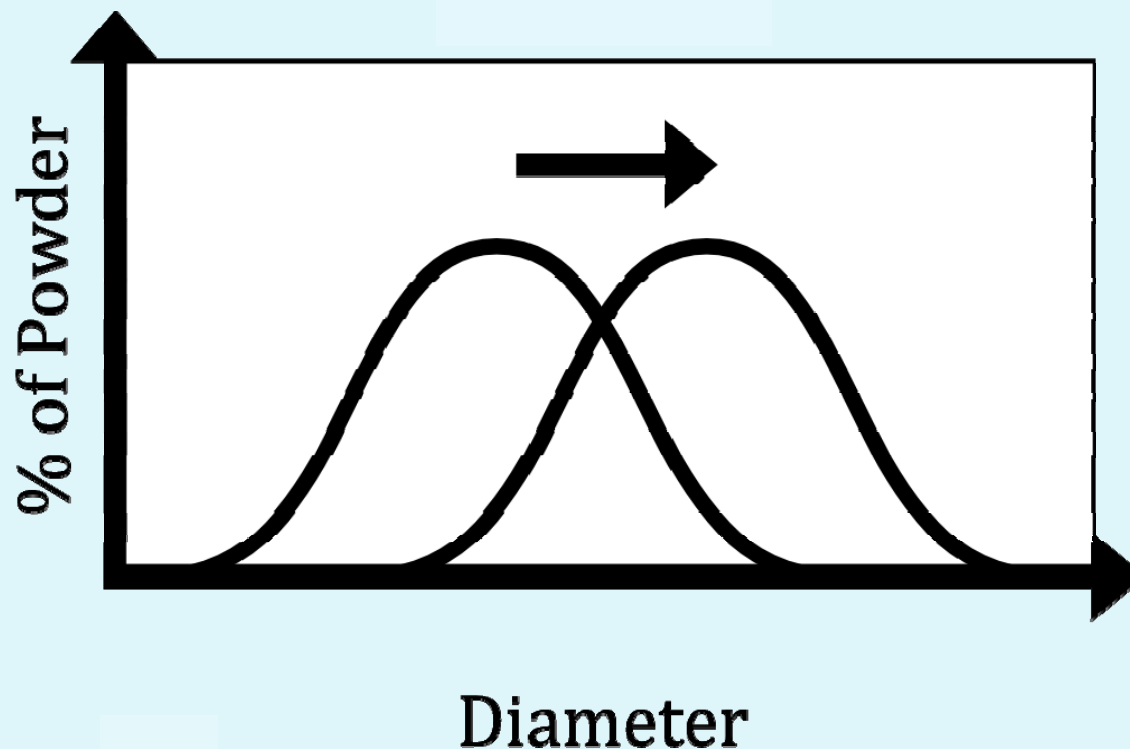
Particle Size Distribution

- ▶ Valimet's atomization process creates a distribution of particle sizes



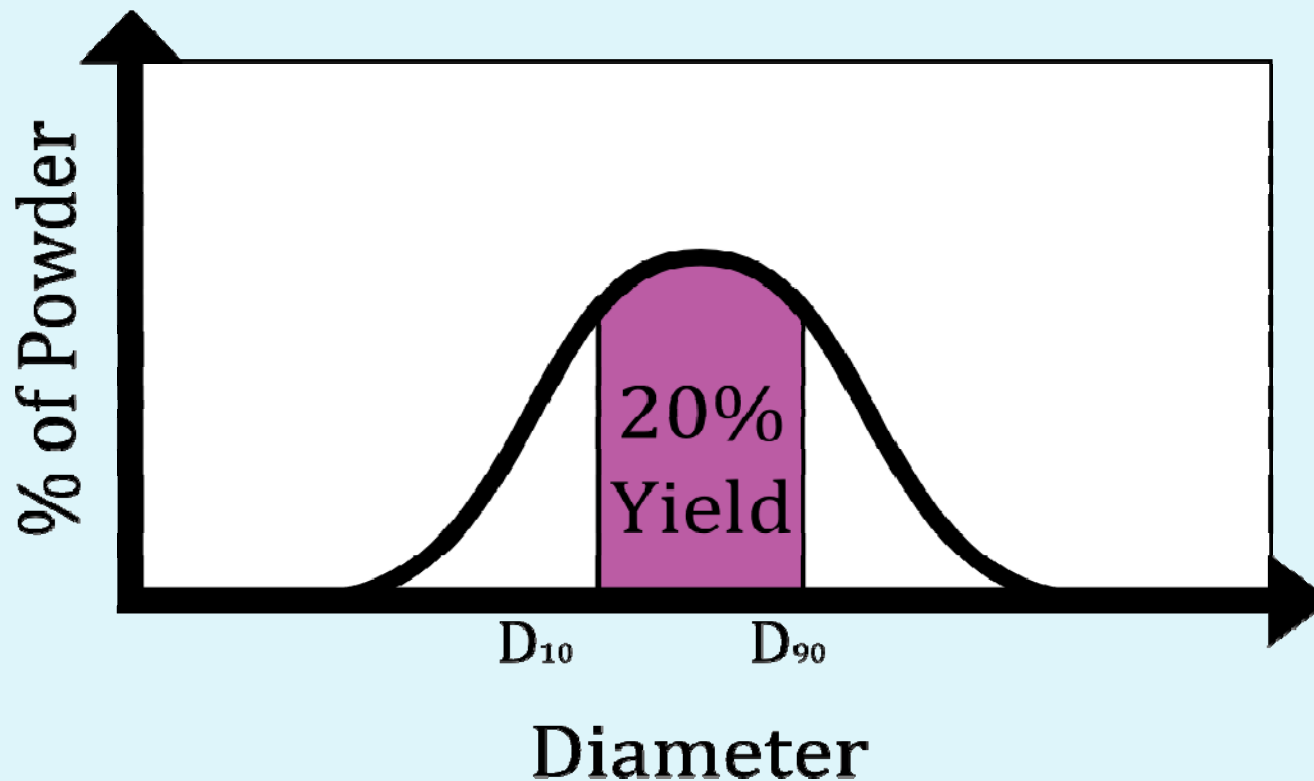
Variations in Particle Size

- ▶ Changes in process can move the center of the distribution, but not the width



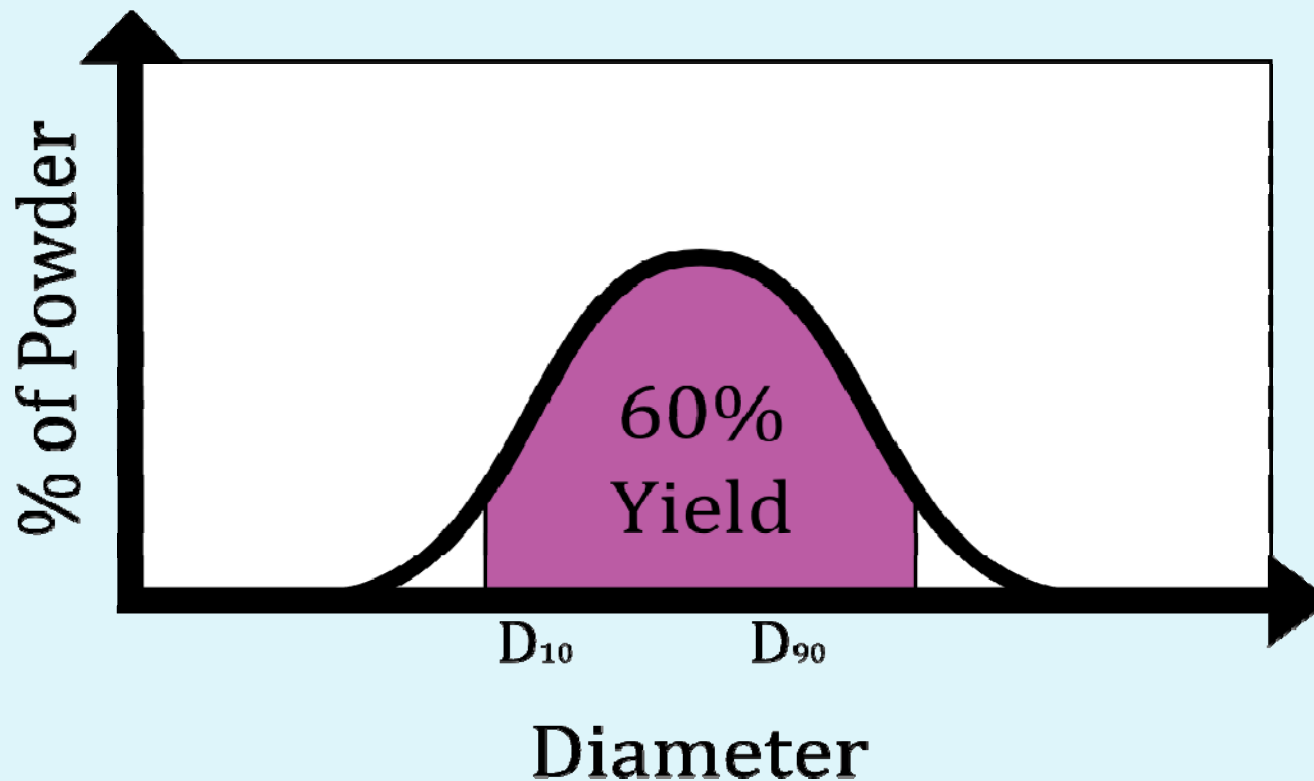
Narrow Size Specification

- ▶ Results in a low yield of useable product



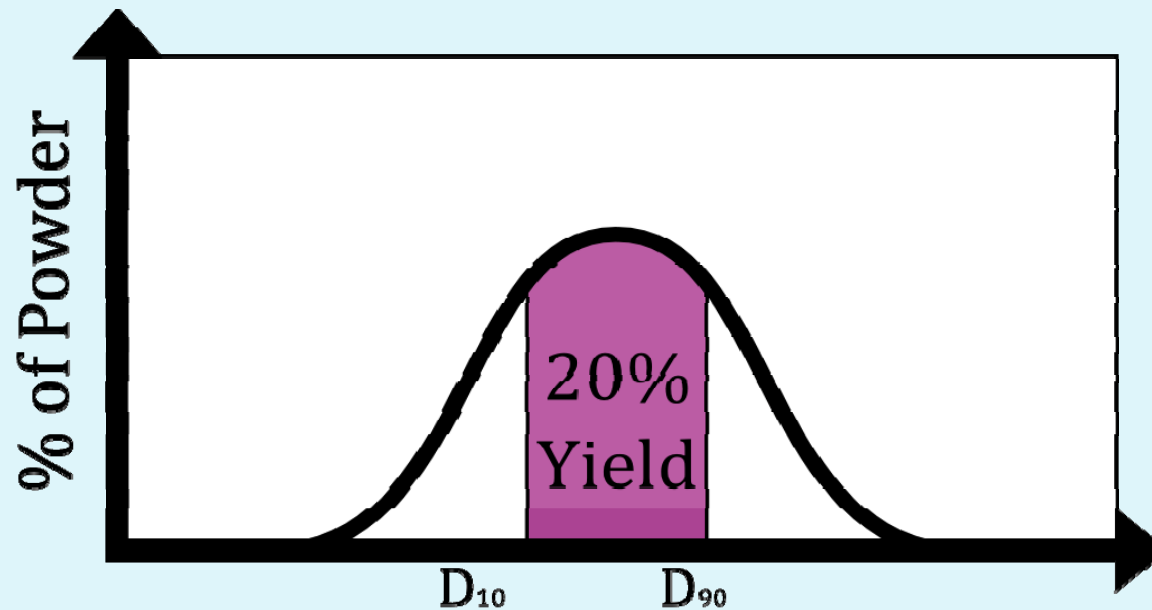
Wider Size Specification

- ▶ Results in a higher yield of useable product



Sizing Technology and Yield Loss

- ▶ Cold Spray powder sizing cannot be achieved by traditional screens
- ▶ Centrifugal classification leads to further losses

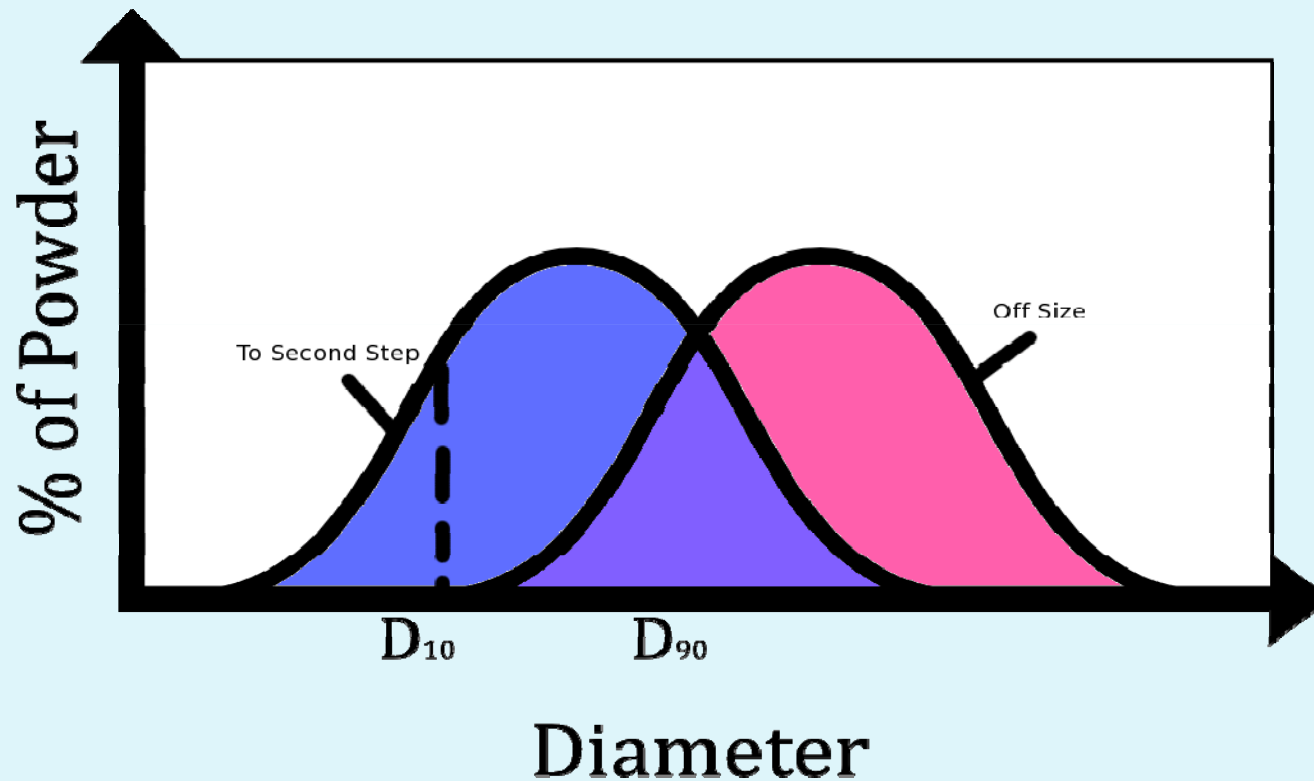


Starting Particle Size Distribution



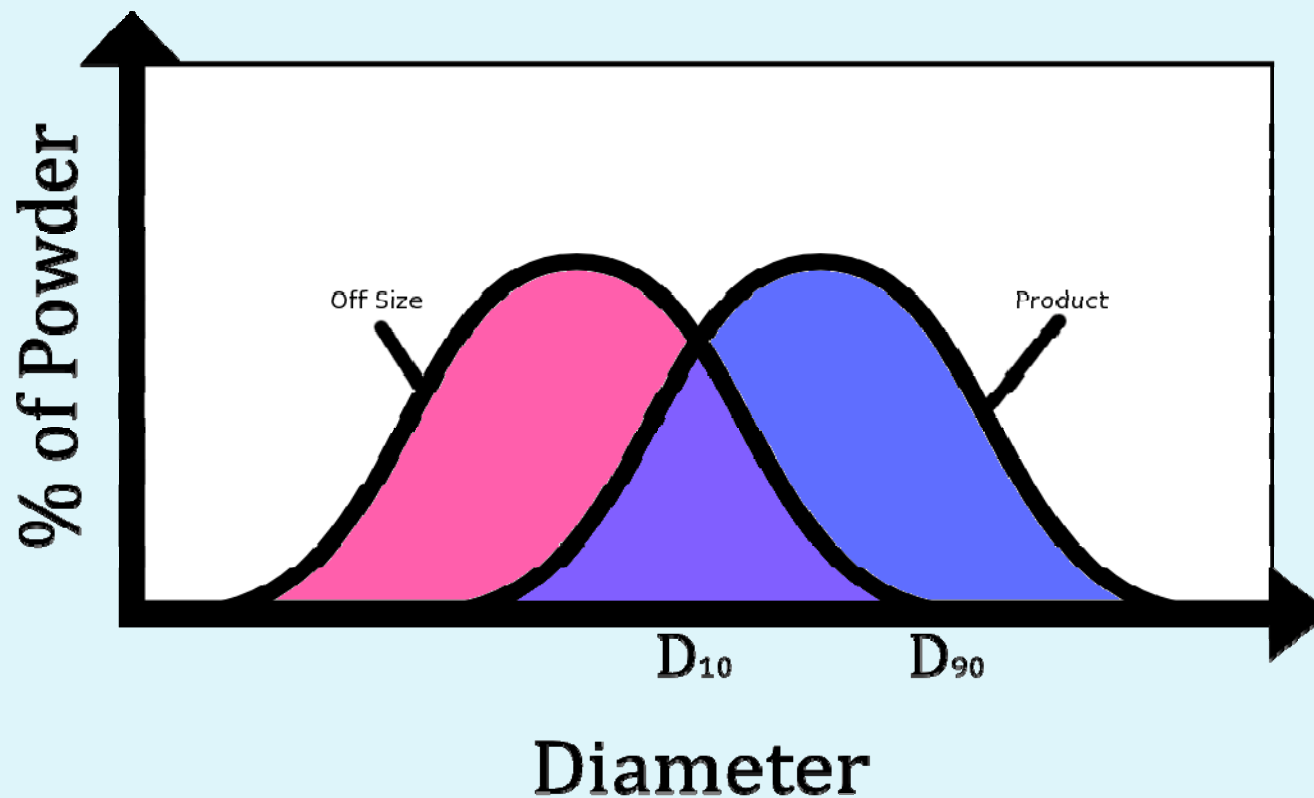
Classification Process

- ▶ Step 1: Remove Oversize Material



Classification Process

- ▶ Step 2: Remove Undersize Material



Relationship between Alloy Type/ Size Specification/Yield/Cost

- Markets exist for Aluminum Powder and Al/Si Powder outside of Cold Spray Requirements
- No current market for most other off-size Aluminum Alloy powders
- Size Specification and Yield greatly impact price
- Price of Cold Spray Powder must reflect all manufacturing costs (Raw Material, Atomization, Sizing, etc.)



Cost: Alloy Type/Size Specification

Type of Powder	Aluminum–Aluminum Silicon Common Production	Other Alloys (6061, etc.) Special Production
Size Specification Results in 20% Yield of Cold Spray Powder	100% Cost of Aluminum metal per pound	500% of Alloy Ingot Cost per pound
	Atomization costs distributed to other products	All atomizing and sizing costs assigned to Cold Spray Powder
	Sizing costs distributed to other products	Possible disposal costs with off-size Cold Spray powder
Size Specification Results in 60% Yield of Cold Spray Powder	100% Cost of Aluminum metal per pound	167% of Alloy Ingot Cost per pound
	Atomization costs distributed to other products	All atomizing and sizing costs assigned to Cold Spray Powder
	Sizing costs may be distributed to other products	Possible disposal costs with off-size Cold Spray powder



Conclusions

- ▶ Cold Spray Powders can be produced by gas atomization and proper sizing
- ▶ The narrower the size specification, the lower the yield of powder in specification and higher the cost/price
- ▶ To realize viable cost, it is important to use the broadest size range compatible with Cold Spray operations
- ▶ Alloy Cold Spray Powder has additional technical/cost problems (no market for off-size powder)
- ▶ Impact of yield (size specification) greater for Alloy Cold Spray Powders
- ▶ Alternative production technology may produce higher yield, but less cost effective

