



Solutions for Instrument Air and Variable Drying Requirements

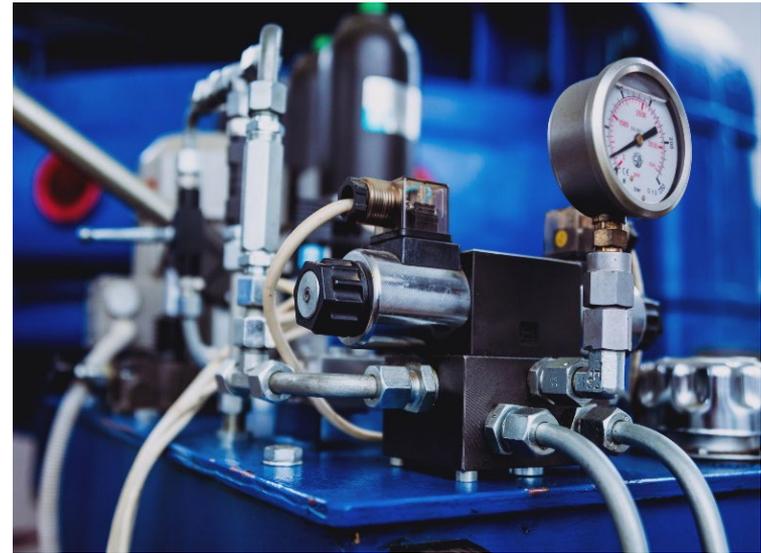
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Compressed air as instrument (or, control) air plays a major role in commercial production and is therefore essential. There are numerous pneumatic applications in production plants, and every one of them must be controlled.

The most common application for instrument air is controlling cylinders, actuators or valves. Instrument air is primarily used as the motive force because it allows for high processing speeds and precise control. Pneumatic control systems are also largely unaffected by environmental influences and can be utilized safely in potentially explosive areas.

- › Instrument-quality compressed air - what / why / where / how
- › Instrument air with variable drying requirements
- › Instrument air for glass factory
- › Instrument air for packaging plant
- › Instrument air for milking robots
- › Instrument air – keep it dry!



Treated compressed air: higher purity level than typical “plant” (general purpose) compressed air

Globally-recognized standard published by International Society of Automation (ISA) – *previously* known as Instrument Society of America:

- › ANSI/ISA-S7.0.01-1996: Quality Standard for Instrument Air
- › This standard defines limits for primary contaminants:
 - › Particulate
 - › Water
 - › Oil



International Society of Automation
Setting the Standard for Automation™

Compressed Air Specifications ANSI/ISA—S7.0.01-1996

Contaminant:	Particles	Water content	Oil content
Limit:	< 40 µm particle diameter	PDP < +39°F	≤ 1 ppm (w/w or v/v)

“Pressure dew point at the dryer outlet shall be at least 10°C (18°F) *below the minimum temperature to which any part of the instrument air system is exposed.* It shall not exceed 4°C (39°F) at line pressure.”



International Society of Automation
Setting the Standard for Automation™

What ISO class for instrument air?

Air quality classes in accordance with ISO 8573-1:2010

Class	Solid particles, max. number of particles per m ³			Pressure dew point °F	Oil content (liquid, aerosol, oil vapor) mg/m ³
	0.1 μm < d ≤ 0.5 μm	0.5 μm < d ≤ 1.0 μm	1.0 μm < d ≤ 5.0 μm		
0	In accordance with the unit operator's or supplier's specifications, stricter requirements than class 1				
1	≤20,000	≤400	≤10	≤-100	≤0.01
2	≤400,000	≤6,000	≤100	≤-40	≤0.1
3	-	≤90,000	≤1,000	≤-4	≤1
4	-	-	≤10,000	≤37	≤5
5	-	-	≤100,000	≤45	>5
6	-	-	-	≤50	-

- Measured in accordance with ISO 8573-4, ref. conditions 14.5 psi [a] absolute, 68 °F, 0% RH
- Measured in accordance with ISO 8573-3
- Measured in accordance with ISO 8573-2 and ISO 8573-5, ref. conditions 14.5 psi [a] absolute, 68 °F, 0% RH

Instrument Air – What Is It?

Compressed Air Specifications ANSI/ISA—S7.0.01-1996			
Contaminant:	Particles	Water content	Oil content
ANSI/ISA limit:	< 40 µm particle diameter	PDP ≤ +39°F	≤ 1 ppm (w/w or v/v)
Recommended ISO class:	[2:-:-]	[-:1-4:-]	[-:-:3]
ISO Class (8573-1:2010)	Max. particles per m ³ (1.0 µm < d < 5.0 µm)	Pressure Dew Point (°F)	mg/m ³ (liquid/aerosol/vapor)
1	≤ 10	≤ -100	≤ 0.01
2	≤ 100	≤ -40	≤ 0.1
3	≤ 1,000	≤ -4	≤ 1
4	≤ 10,000	≤ 37	≤ 5
5	≤ 100,000	≤ 45	> 5

Instrument Air – What Is It?

ANSI/ISA
(S7.0.01-1996)

ISO Class
(8573-1:2010)

PDP
(°F)

60 °F —
50 —
45 —
37 —
—4 —
—40 —
—100 —

6
5
4
3
2
1

DRYPOINT® M PLUS

DRYPOINT® RA

DRYPOINT®

Membrane dryer



Refrigeration dryer



Air Flow Rate

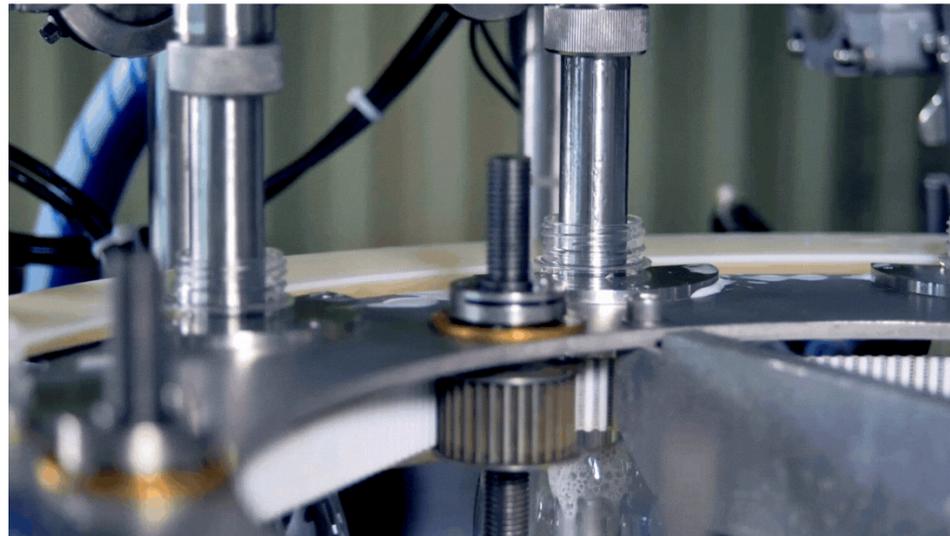


Desiccant dryer



Instrument Air – Where Is It Used?

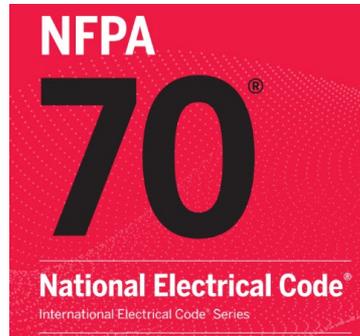
- › Essential to all process-related industries and manufacturing facilities
- › Key utility for processes requiring clean, dry compressed air
- › Common applications for instrument air:
 - › Primary use: Process control – motive force for critical pneumatically-controlled devices:
 - › Valves/Dampers
 - › Cylinders
 - › Other common uses:
 - › Instrument calibration
 - › Sampling
 - › Purge
 - › Cleaning
 - › Drying
 - › Sealing



Instrument Air – Why Is It Needed?

Pneumatic control systems offer various benefits vs. alternatives:

- › Compact – often better power-to-weight ratio vs. electrical
- › Simple
- › Reliable
- › Cost-effective
- › Safe – useful/preferred for hazardous (classified) areas per NFPA Article 500



Instrument Air – Why Is It Needed?

What are the risks associated with *not* using instrument air where it should be used?

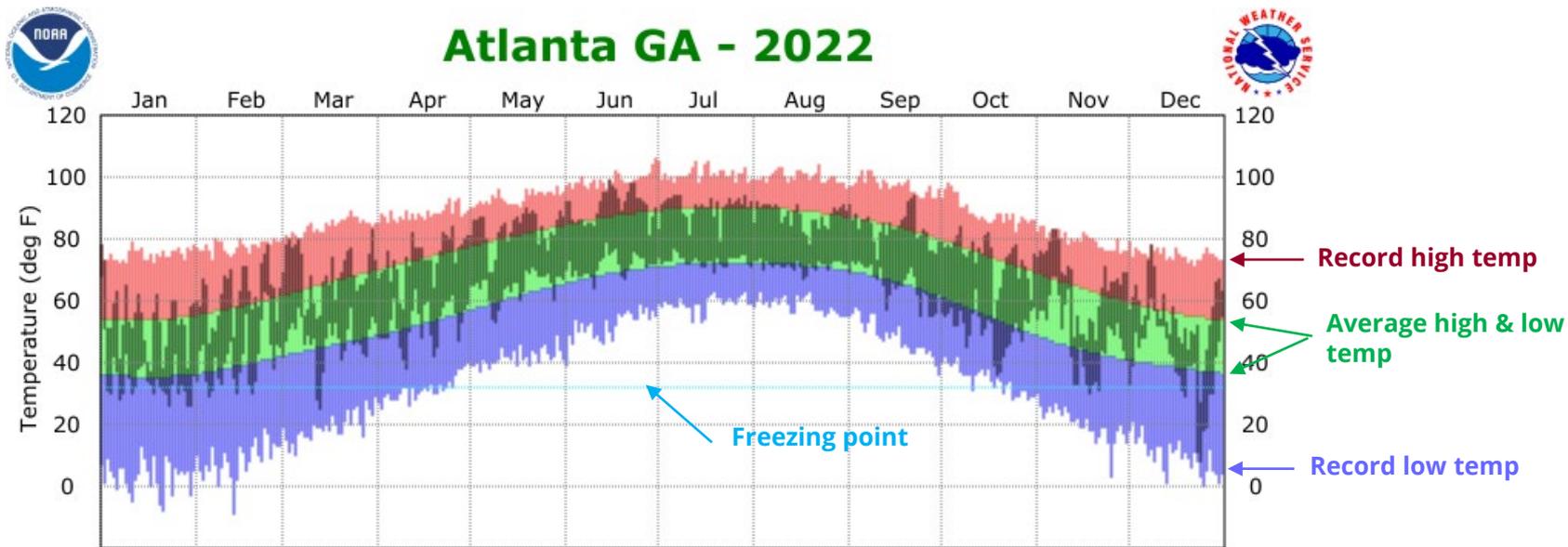
- › When compressed air does not comply with specified requirements:
 - › Pneumatic tools and process machines can malfunction
 - › Excess moisture will cause corrosion in pipework, cylinders and other components
 - › Excess moisture promotes biological growth, which may contaminate end products (food, pharma)
 - › Supply lines and pneumatic devices exposed to outdoor environments subject to freezing



Variable Drying Requirements

Many processes require a fixed or stable pressure dew point – but this is not always the case!

- › Compressed air systems are often exposed to ambient temperatures that can fluctuate over a wide range (freezing possible)



Variable Drying Requirements

Large industrial manufacturing complexes often have compressed air lines/consumers exposed to outdoor conditions

- › From ANSI/ISA, PDP should always be maintained 18°F *below the minimum temperature to which any part of the instrument air system is exposed*



Variable Drying Requirements

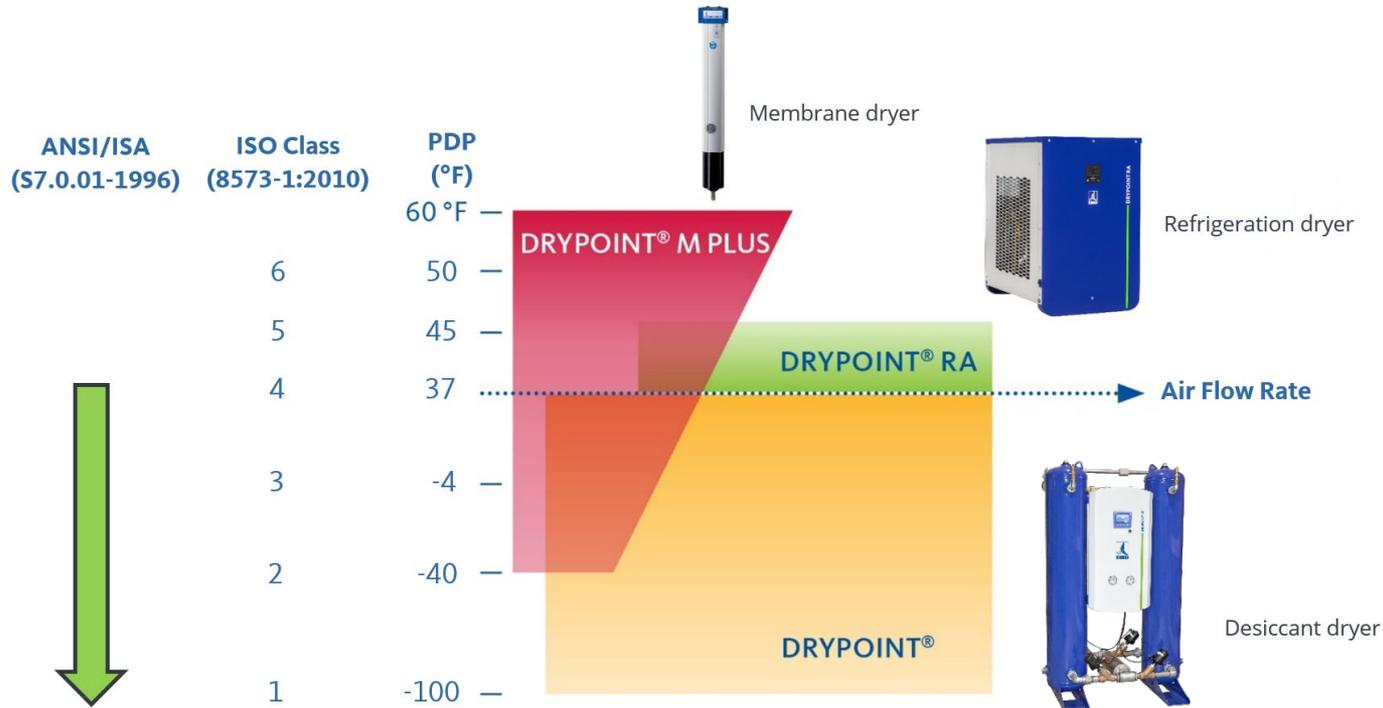


Compressed Air Specifications ANSI/ISA—S7.0.01-1996		
Contaminant:	Water	
ANSI/ISA limit:	*PDP $\leq +39^{\circ}\text{F}$	* <i>Minimum</i> – may be lower! (see below)
Recommended ISO class:	[-*4:-]	Min. <i>Ambient</i> Temp. by ISO class (PDP +18°F)
ISO Class (8573-1:2010)	Pressure Dew Point (°F)	
1	≤ -100	≥ -82
2	≤ -40	≥ -22
3	≤ -4	≥ 14
4	≤ 37	≥ 55
5	≤ 45	≥ 63

Variable Drying Requirements

General rule: for optimal process efficiency, *only treat the air to the extent required* for the process

What does this mean when PDP requirement is driven by ambient temperature that fluctuates over a wide range?



Variable Drying – Outdoor Equipment

Common usage case: air pollution control application

- › Fabric filter dust collectors, i.e. “baghouses” used throughout all industries to capture particulate matter emissions
 - › Dust collection is required in most food processing plants, particularly in grain handling/milling operations
 - › Fugitive dust emissions must be controlled for environmental and safety reasons



Image courtesy Camfil APC

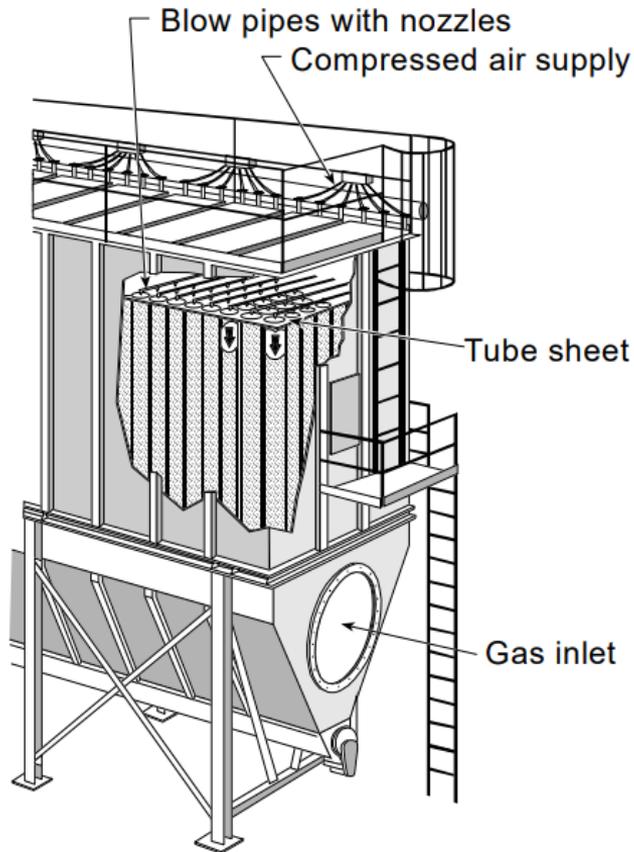


Image courtesy NC State University

Dust collectors and baghouses for air pollution control:

- › Pulse-jet type systems use compressed air for automatic filter cleaning
- › Large dust collectors are often located outdoors, hence exposed to wide range of ambient conditions
- › For outdoor installations, drying requirements may vary by season:
 - › ISO class 4-5 (PDP 37-45°F – refrigerant dryer) required at minimum during warm weather periods
 - › *ISO class 2-3 (PDP -40 to -4°F – desiccant dryer) may be needed during winter

*the only practical alternative to drying is protecting exposed compressed air equipment from freezing is to insulate and heat *all* exposed surfaces



Image courtesy Compressed Air Best Practices

Outdoor compressed air systems exposed to sub-freezing temperatures:

- › Why not use desiccant dryers year-round?
 - › Potentially over-drying air during warm weather = inefficient use of energy
 - › Refrigeration dryers are typically the most efficient method of drying compressed air, therefore preferred when application only requires ISO class 4-5 (general/plant air is sufficient)

› Recommendation: implement a *seasonal* drying plan:

- › Warm weather – refrigeration dryer



- › Cold weather – desiccant dryer



Production site:

- › 130+ year old German producer of fine glassware
- › Annual deliveries of 35 million units to 45+ countries
- › Existing user of CLEARPOINT® filters, BEKOMAT® drains, QUIKPURE® oil-water separators



Two primary applications:

- 1) Instrument air for process controls
- 2) Point-of-use instrument air for laser cutting machine

Application 1:

- › Combustion air - dry compressed air is the most critical energy element within the manufacturing facility
- › Automated production system controlled by numerous valves and cylinders
- › Why dry air is needed: moisture contamination would result in fouling of pneumatic control devices, resulting in component failure and expensive process downtime



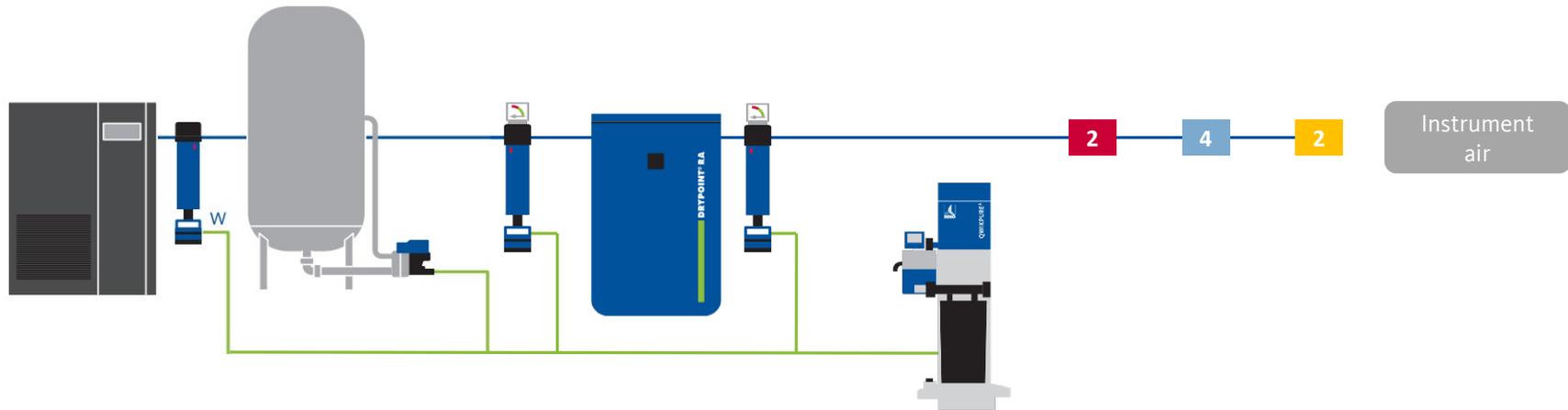
Application 1 drying challenge:

- › High outlet temperature ($> 140^{\circ}\text{F}$) from compressor, especially during hot summer months
- › Old refrigeration dryer couldn't meet demand:
 - › Unacceptably high outlet PDP during summer – risking process downtime
 - › PDP challenge exacerbated by extensive piping network – various branches run through different areas (including basement) exposed to different ambient temperatures



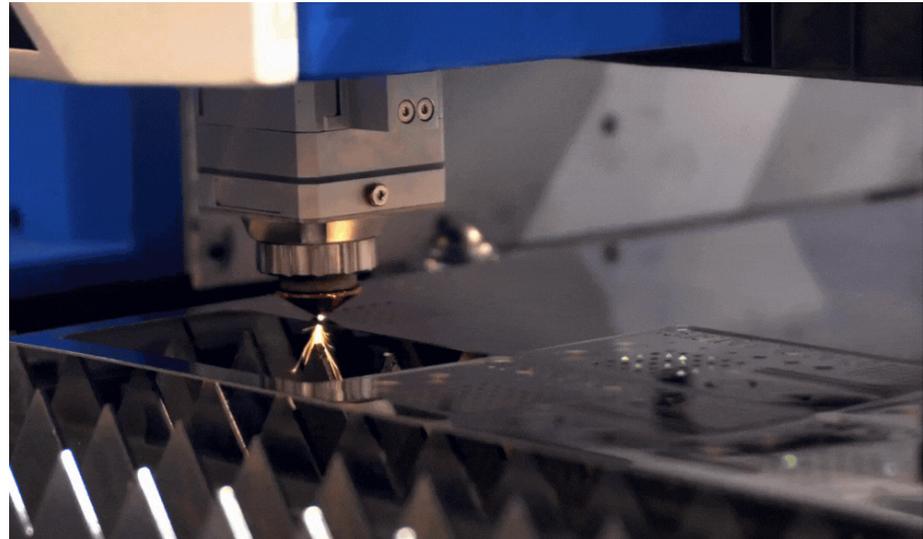
Application 1 solution:

- › DRYPOINT® RA VSD series refrigeration dryer
- › Correctly-sized dryer easily handled high compressor outlet temperature
- › Highly efficiency variable speed dryer reduced operating cost reduced by ~50% vs. old dryer, ~6 mo. ROI on new dryer



Application 2:

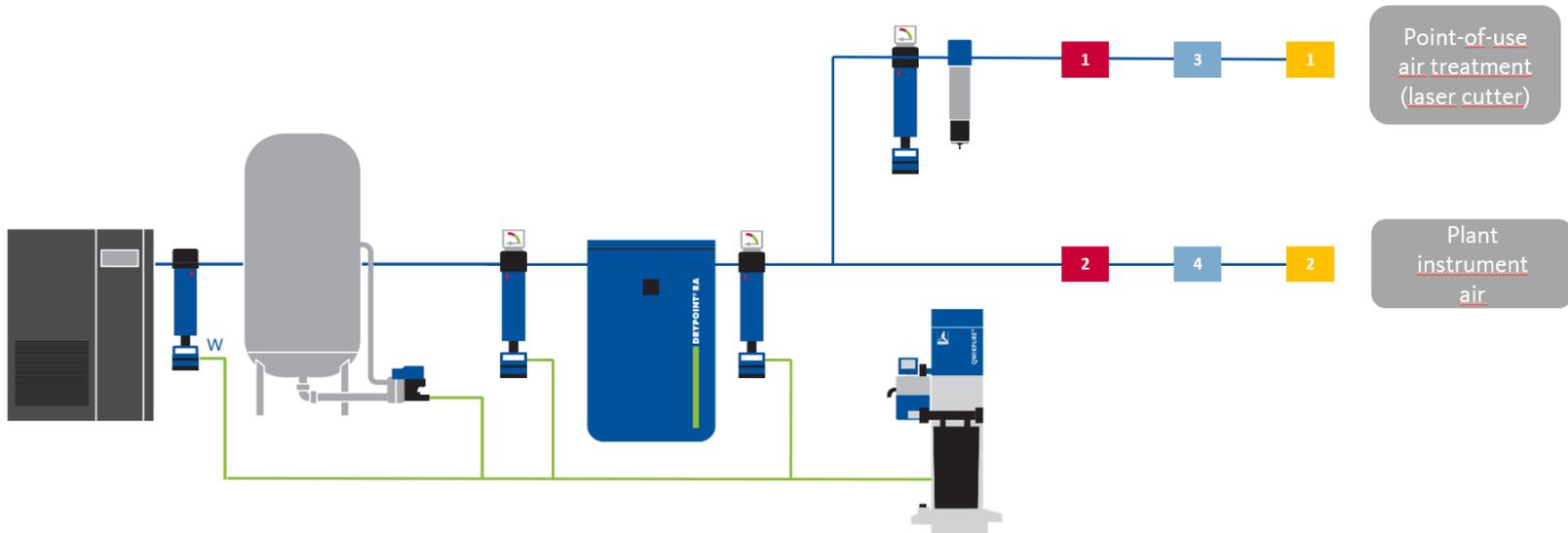
- › Precision laser cutting machine
 - › Requires clean purge gas for cooling of cutting head and beam deflection mirrors
 - › Factory had previously used expensive nitrogen gas for this purpose (>\$700/week)
- › Customer interested in using purified compressed air instead of nitrogen purge gas as cost-reduction effort



Instrument Air - Glassmaking

Solution Application 2:

- › DRYPOINT® M with CLEARPOINT® Fine (1 μm) and Superfine (0.01 μm) pre-filters
- › Substituting nitrogen with purified compressed air yielded significant cost savings with no downsides



Instrument Air – Packaging Manufacturer

Production Site:

- › 130+ year old German packaging producer: corrugated cardboard and expanded polystyrene
 - › Dry compressed air is critical for their operations:
 - › Instrument air: process control (e.g. valves, actuators)
 - › Process air: humid compressed air detrimental to finished products
 - › Compressed air treatment needs evolved significantly over time



Historically, the plant relied only on desiccant dryers to ensure sufficiently dry compressed air – a very conservative approach for their application

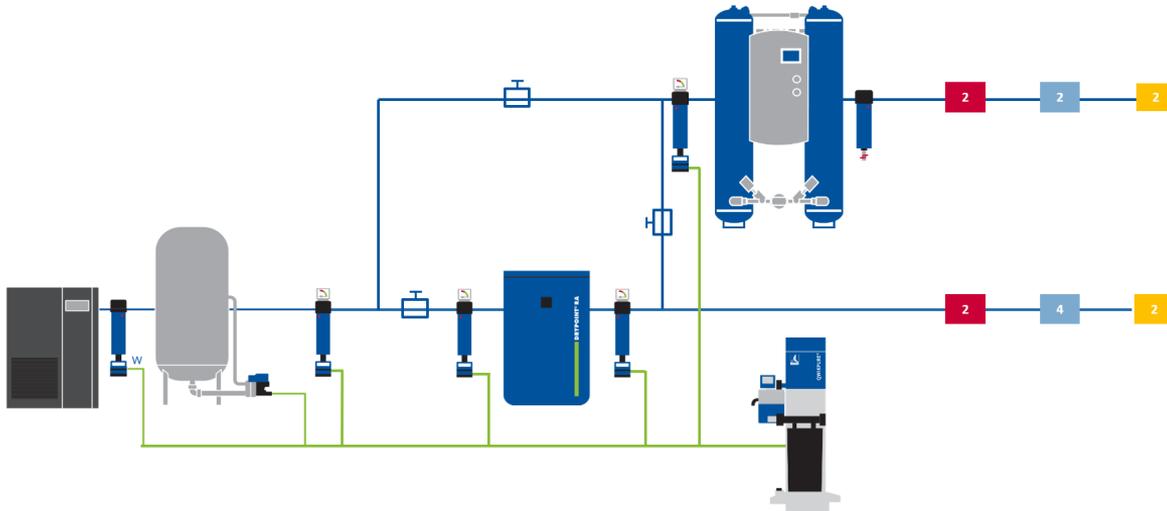
- › Customer required new, more efficient compressed air dryers:
 - › Customer trusted BEKO's expertise as a specialist in compressed air treatment systems and solutions
 - › Refrigeration dryers were appealing for their efficiency, but the extensive compressed air network included a large amount of piping exposed to outdoor conditions (freezing in winter)
 - › Variable PDP requirement: ISO class 4 during warm weather, ISO class 2-3 during cold weather



Instrument Air – Packaging Manufacturer

Solution:

- › BEKO recommended a redundant / combined system consisting of both refrigeration and desiccant dryers
- › This drying system allows the plant ideal flexibility to adapt to their conditions (seasonally)
 - › Customer can operate dryers as needed for the most cost-effective scenario:
 - › Combined refrigeration + desiccant
 - › Independent operation of either type, as needed



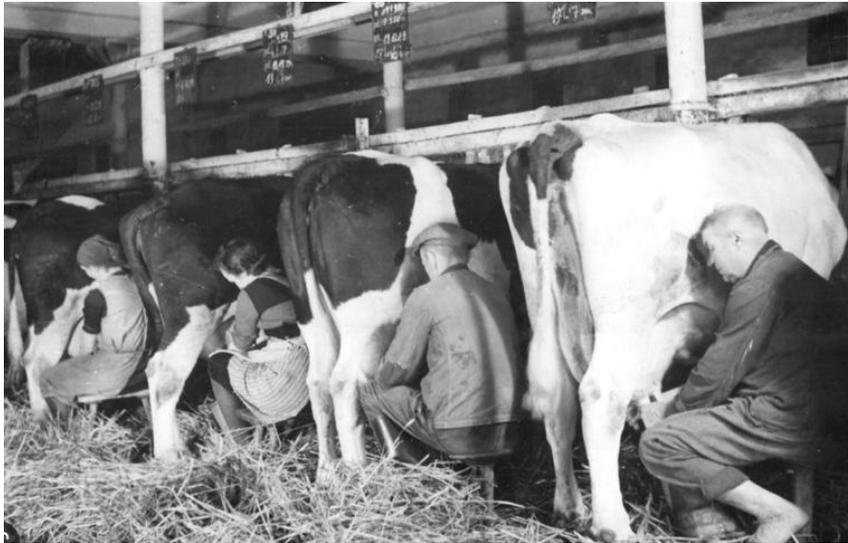
Variable Drying - Milking Robots

Instrument air for dairy industry

THEN



NOW



Variable Drying – Milking Robots

Automation has revolutionized the dairy industry

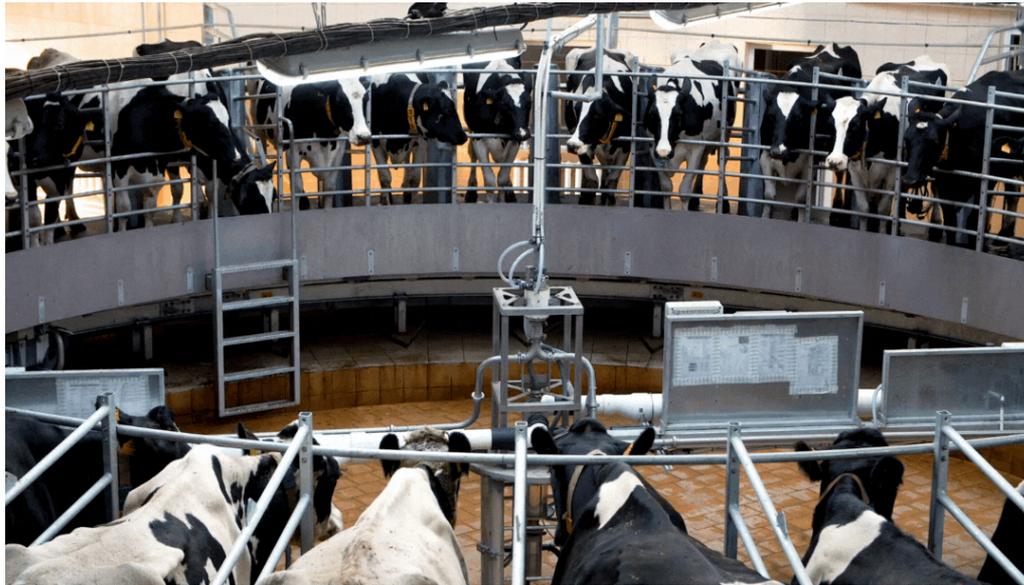
- › 3D scanners and sensors enabled the latest generation of autonomous milking processes:
 - › Positioning of cow in milking pen
 - › Positioning and applying milking apparatus on cow
 - › Cleaning of milking equipment after each cow is milked



Variable Drying – Milking Robots

Automated milking systems rely on an array of typical utilities (electricity, water), but of these, only compressed air is generated on-site!

- › Typical instrument air uses for milking robots:
 - › Drive equipment (valves/cylinders for positioning)
 - › Conveying processes
 - › Purging chemicals following cleaning cycle



Variable Drying – Milking Robots

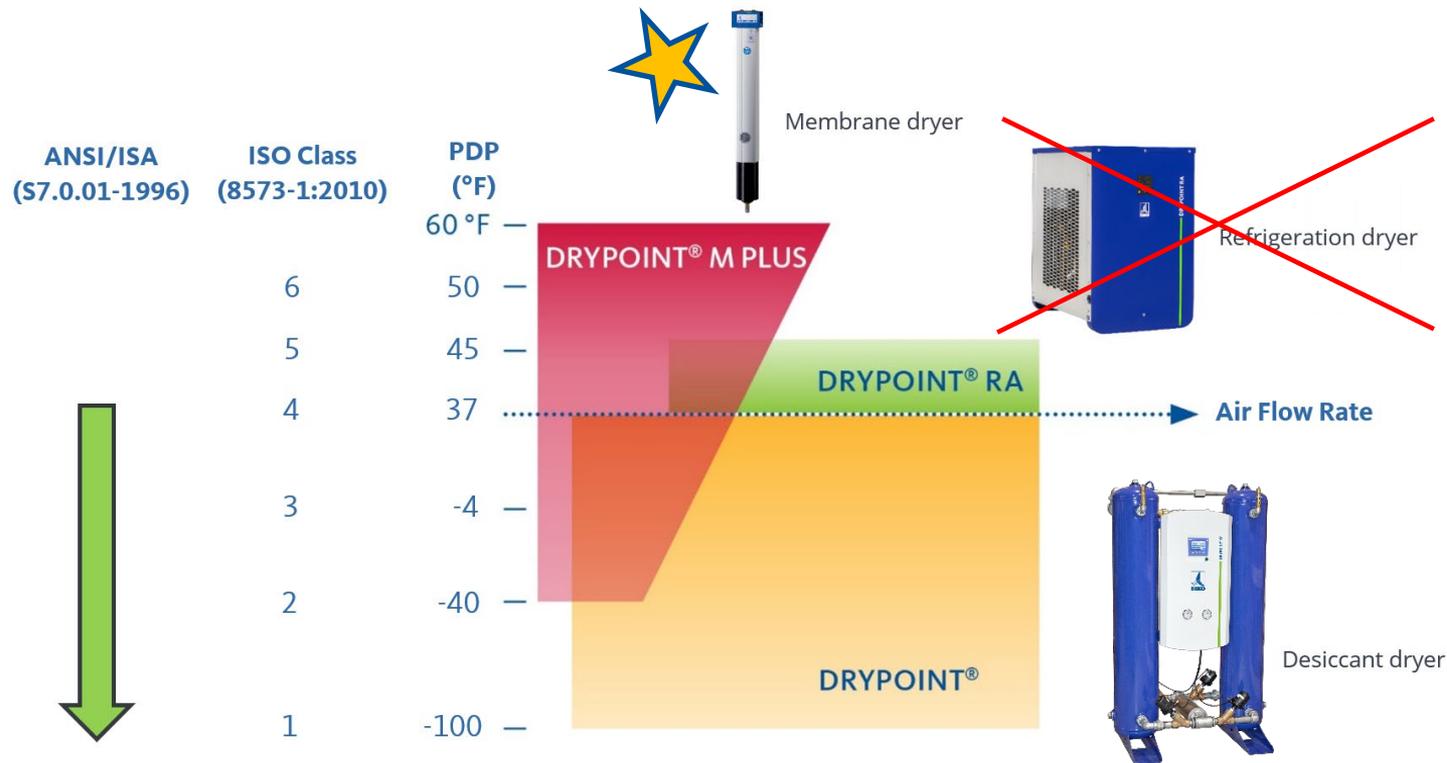
Considerations for compressed air treatment in automated dairies:

- › Compressor room is typically remote (often 150' or more) from the milking parlor
- › Compressor room is typically a warm environment, yet the compressed air lines running to milking parlor may be exposed to extreme ambient temperatures
- › Many milking parlors are open sheds, subject to seasonal low ambient temperatures



Variable Drying – Milking Robots

Instrument air requires PDP to be at least 18°F *below the minimum ambient temperature* to which any part of the process is exposed!

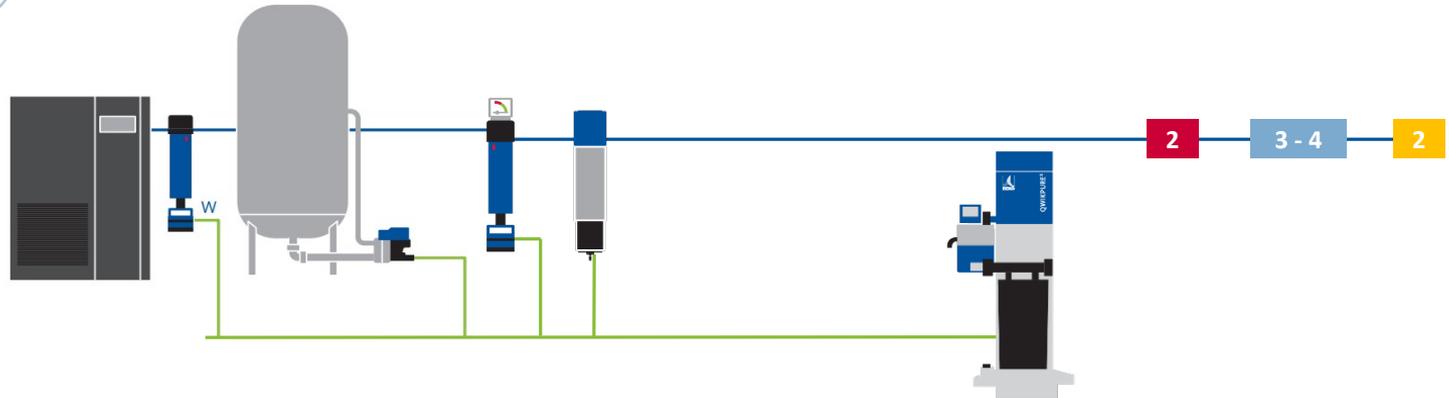


Variable Drying – Milking Robots



DRYPOINT® MDi is the world's only membrane dryer with *selectable* outlet pressure dew point!

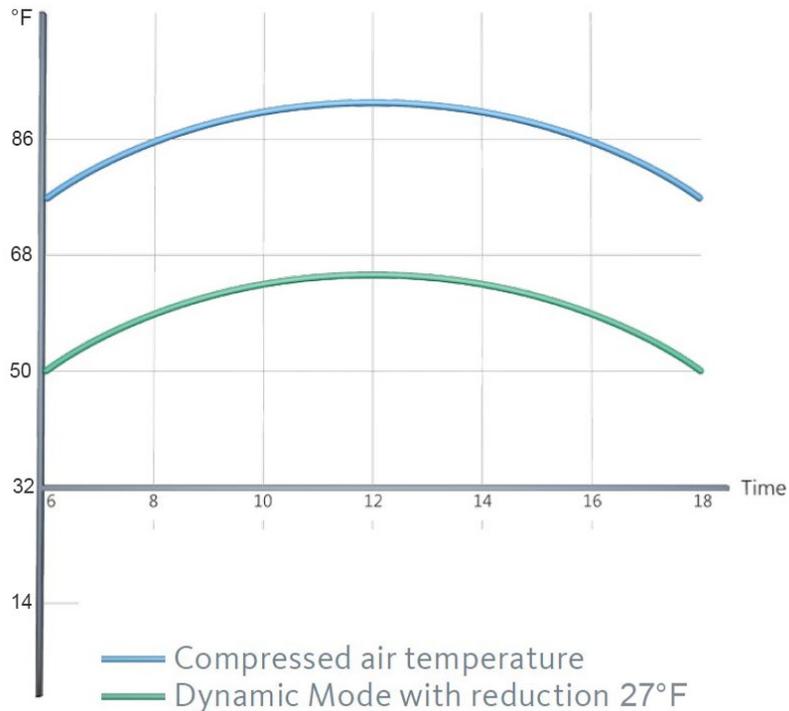
- › Dryer capacity is ideal for typical robotic milking systems
- › Dryer functions to continually suppress the outlet pressure dew point – the perfect drying solution for applications such as milking robots where instrument air drying requirement varies with the ambient temperature



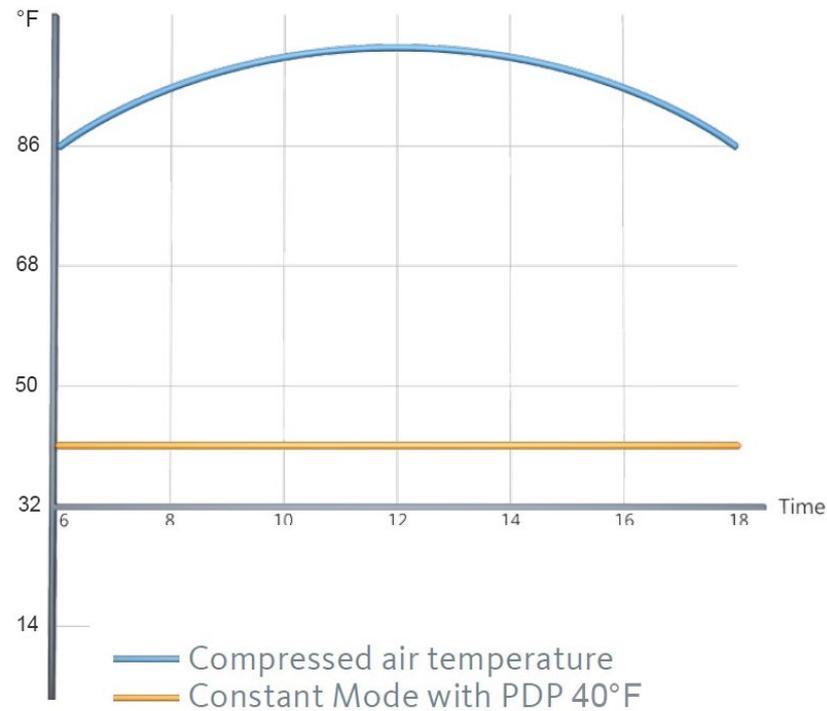
Variable Drying - Milking Robots



Dynamic Mode



Constant Mode

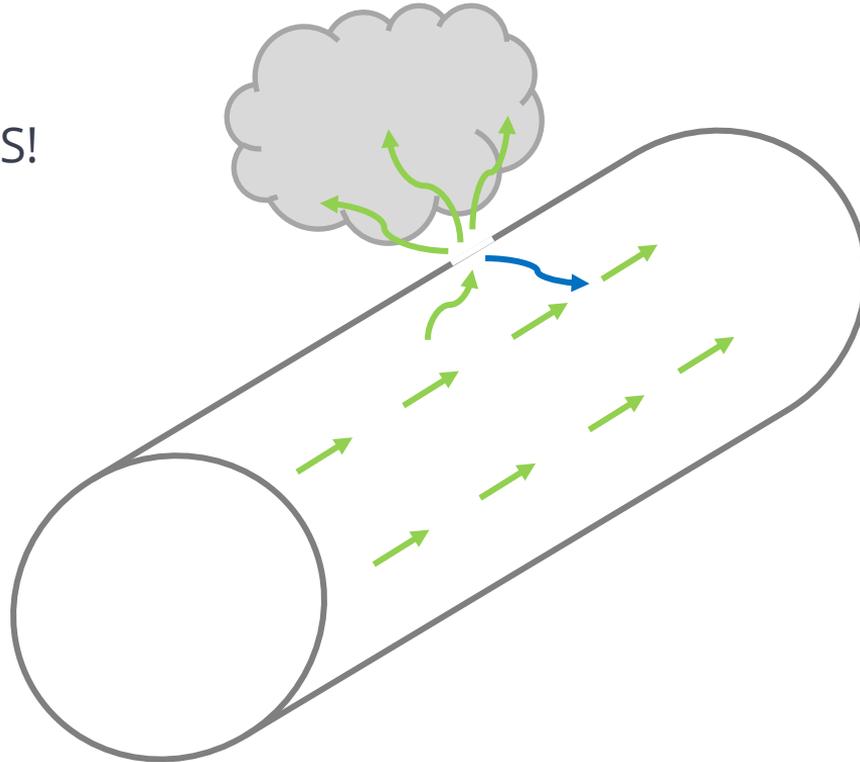


Instrument Air – Keep it Dry

Usage case: instrument air system with dryers for ISO class 3 or better (i.e. PDP of -4°F or lower)

- › Dryer are working correctly - what could go wrong resulting in dry air not reaching the process/consumer?

AIR LEAKS!



Instrument Air – Keep it Dry

If compressed air is *escaping* the system via a leak, how can water *enter* the system?

- › Physical systems always move toward a more balanced state (equilibrium):
- › Reason the compressed air escapes to environment via air leaks (moving from high to low pressure)
- › Dried air is an unstable gas – it aggressively seeks to gain water (equalize the saturation pressure)
 - › Escaping air drops in temperature – if cooled/leaked air temperature drops below ambient dew point, ambient water vapor will condense on surfaces near the air leak
 - › Accumulated condensation will then migrate *into* the compressed air system
 - › A very small amount of moisture will quickly degrade pressure dew point!



Instrument Air – Which Dryer to Use?

ANSI/ISA
(S7.0.01-1996)

ISO Class
(8573-1:2010)

PDP
(°F)

60 °F —

50 —

45 —

37 —

-4 —

-40 —

-100 —

6

5

4

3

2

1

DRYPOINT® M PLUS

DRYPOINT® RA

DRYPOINT®



Membrane dryer



Refrigeration dryer



Desiccant dryer

▶ Air Flow Rate





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