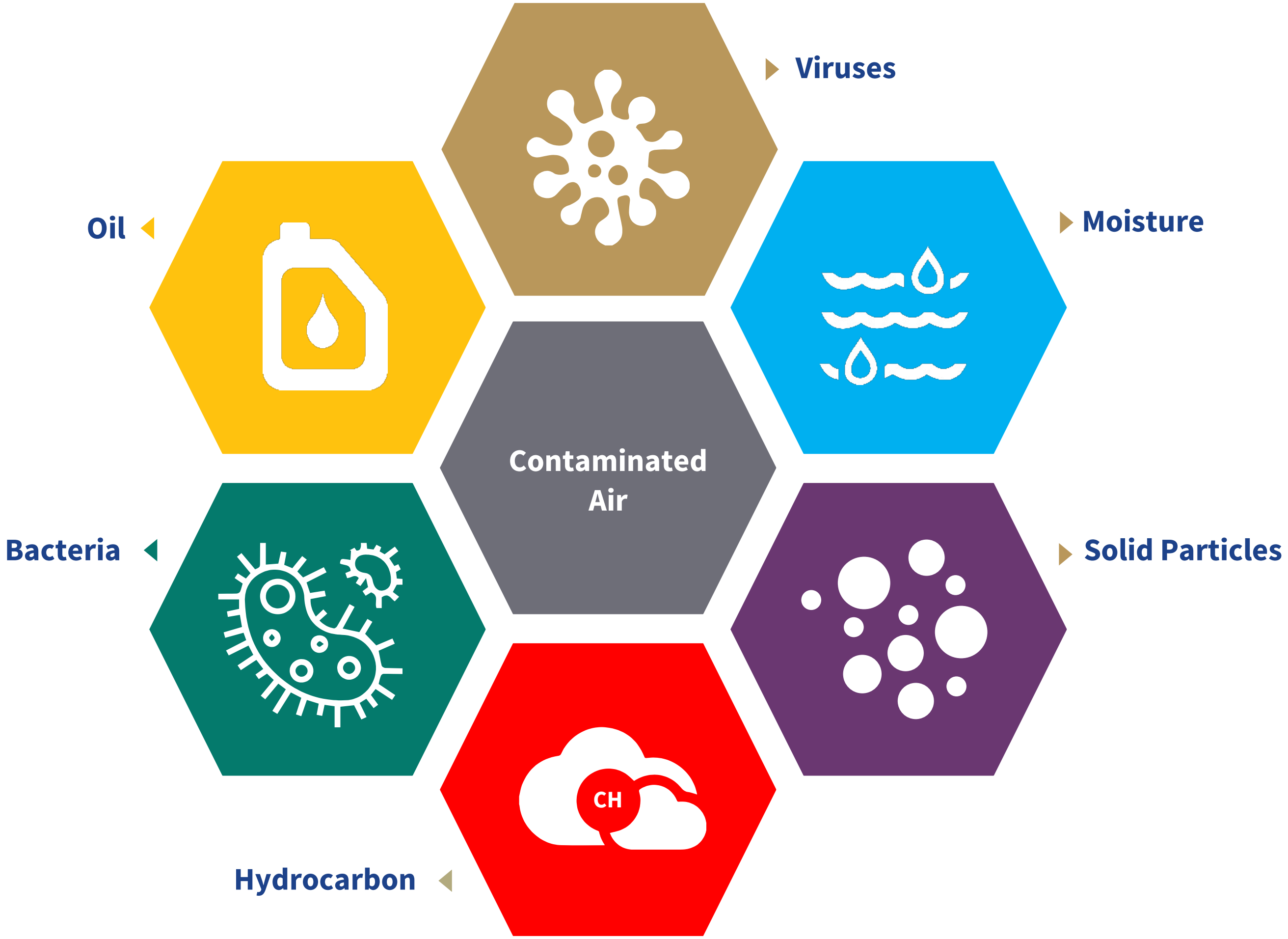
Better Plants
U.S. DEPARTMENT OF ENERGY

In-Plant Trainings

8 – Session Virtual Platform

Air Treatment

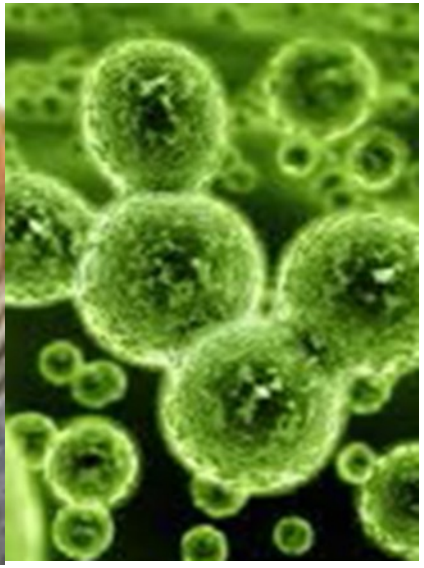
What is in your compressed air?



Wet Compressed Air

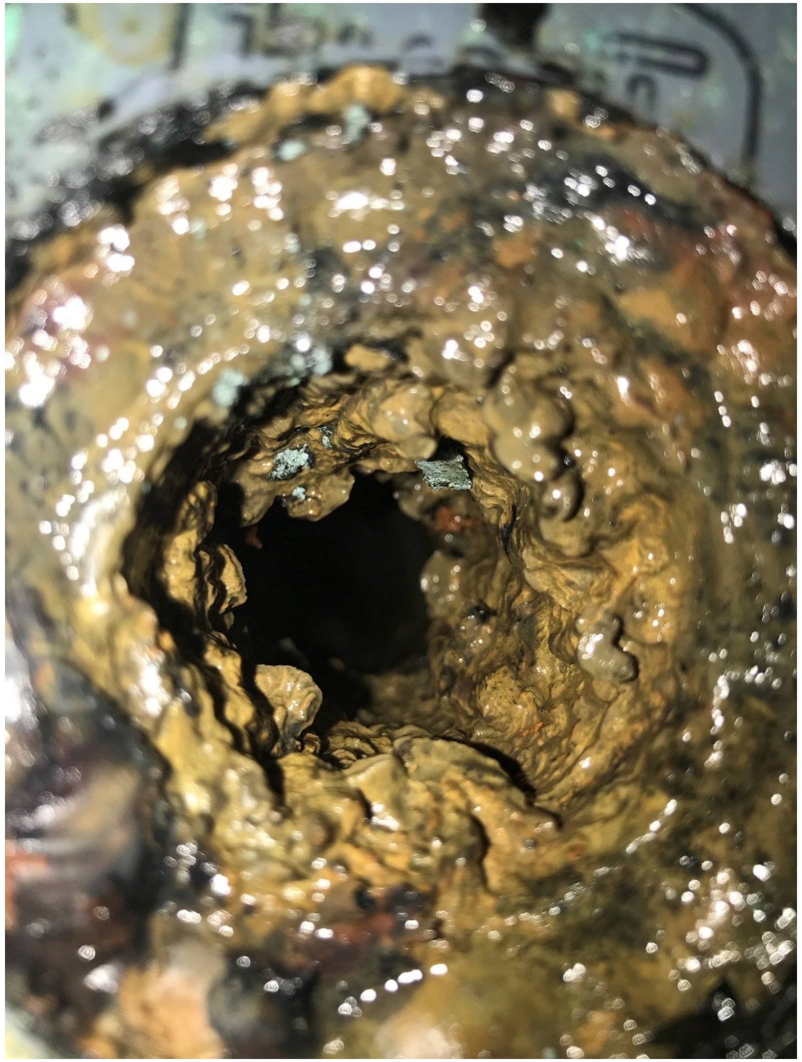
- Compressed air must be dried. This is an undeniable statement of fact.
  - Today's modern industry can no longer tolerate the problems of wet, dirty compressed air.
  - Wet air causes rust, pitting, blockages, and freeze-ups, with resultant component failure and product rejection.
  - Wet air is a major contributor of downtime, causing millions of dollars of lost production.
  - Measuring dew point in industrial settings is the only way to ensure that downstream production equipment does not undergo corrosive damage and the quality of end products is not affected by any moisture contaminant.

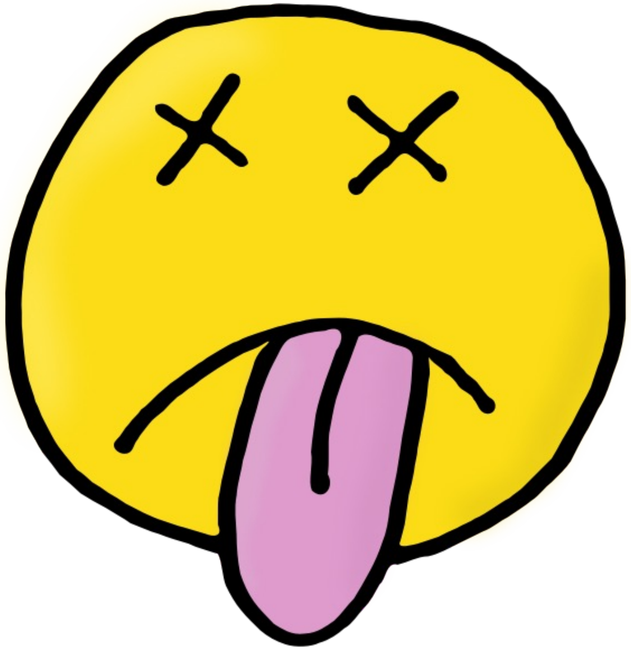
EFFECTS OF WATER CONTAMINATION



- Washing away required lubricants.
- Causing rust and scale to form within pipelines.
- Increased wear and maintenance of pneumatic devices.
- Sluggish and inconsistent operation of air valves and cylinders.
- Malfunction and high maintenance of control instruments and air logic devices.
- Product spoilage by spotting in paint and other types of spraying.

EFFECTS OF WATER CONTAMINATION





Wet Compressed Air

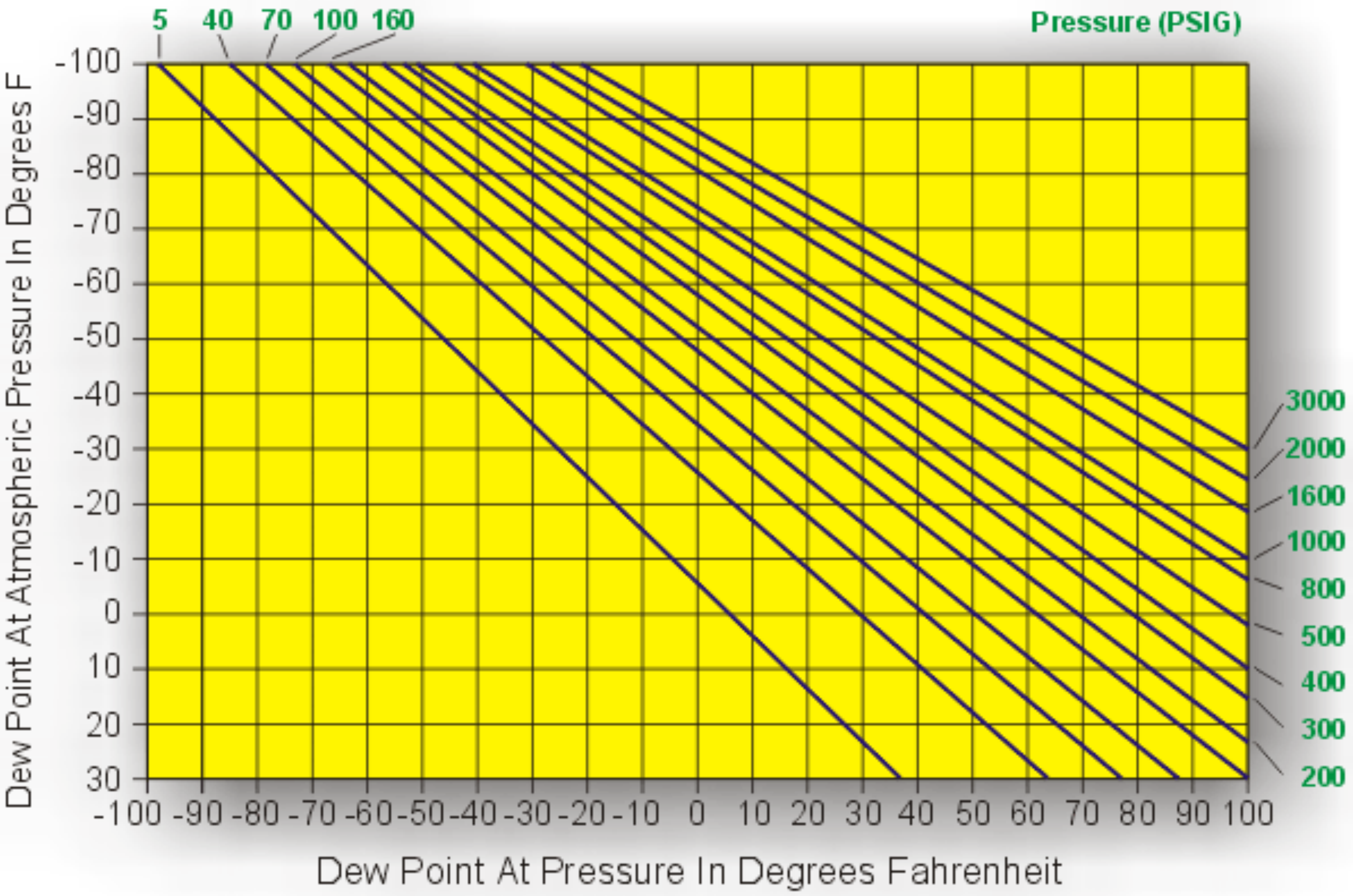
- All atmospheric air contains a certain quantity of water vapor which is mixed with other gases, such as nitrogen, oxygen and carbon monoxide.
  - This water vapor is drawn into the air compressor with the incoming air during the compression cycle.
  - Water is present in the air which is drawn into the compressor.
  - The water is gaseous – invisible and completely mixed with the air.
  - The exact amount of water is called the “humidity” of the air.

Definitions

- **Relative Humidity**
  - The amount of water vapor present in air expressed as a percentage of the amount needed for saturation at the same temperature.
  - Hot air can hold more water (as vapor) than cold air.
    - Just a 20 degree increase in saturated air temperature allows twice the moisture to be held in vapor form.
- **Dewpoint**
  - The dew point is the temperature to which air must be cooled to become saturated with water vapor.
  - When further cooled, the water vapor will condense to form liquid water.

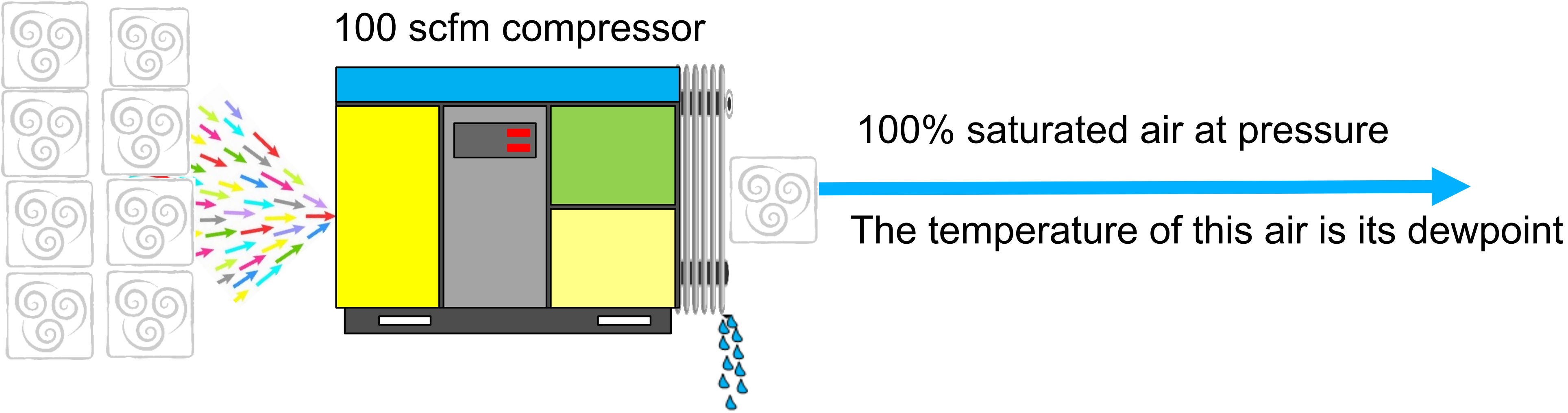
Effects of Pressure & Temperature on Relative Humidity

- A few quick rules of thumb for when you are trying to figure out how humidity will change as conditions change...
- Rule #1
  - As temperature of a gas increases, relative humidity decreases (gas will become drier)
  - As temperature of a gas decreases, relative humidity will increase (gas will become moister)
- Rule #2
  - As pressure increases, relative humidity increases (gas will become moister)
  - As pressure decreases, relative humidity will decrease (gas will become drier)
- Rule #3
  - Dewpoint does not change as temperature of a gas changes
    Relative humidity will change dramatically as temperature of a gas changes (see Rule #1)



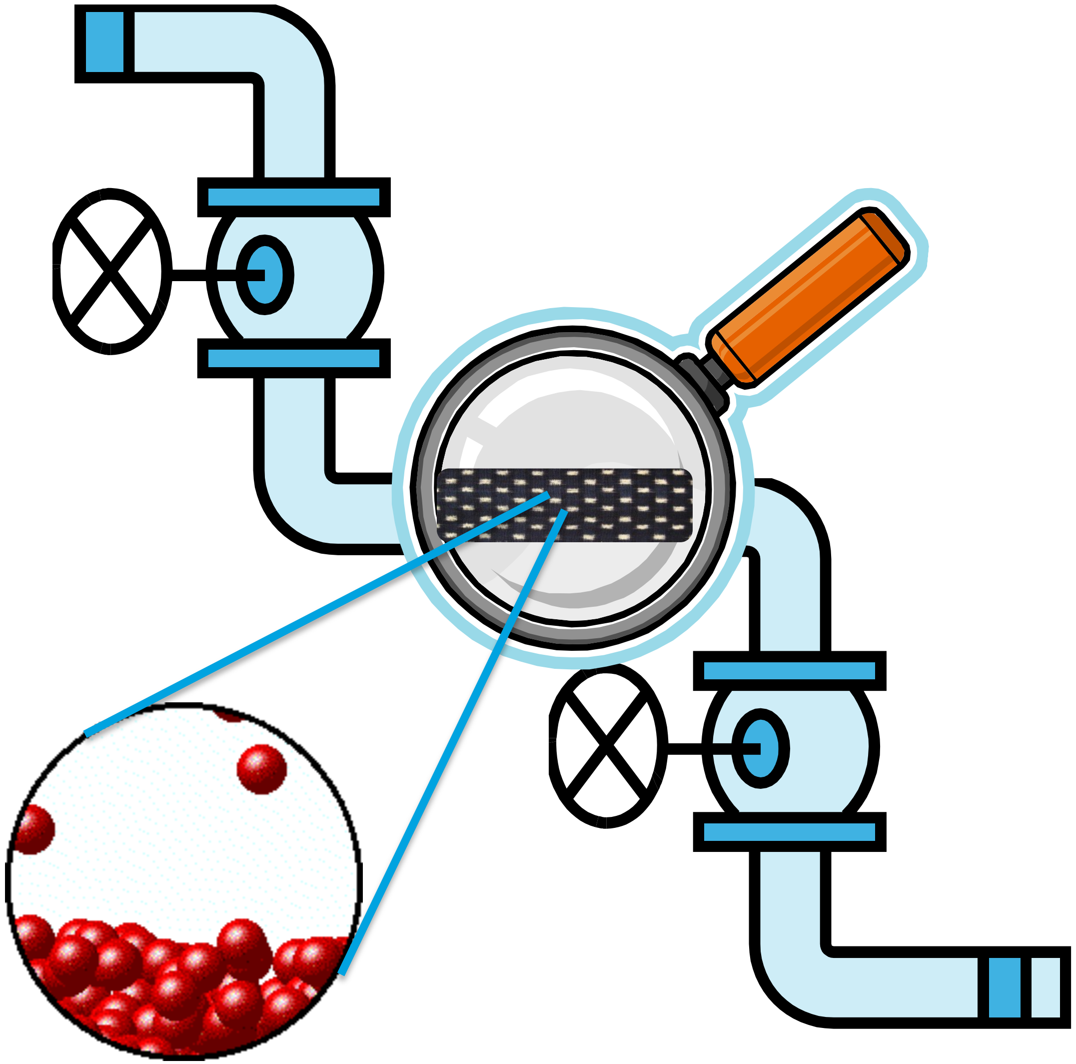
5
40
70
100
160
Pressure (PSIG)
3000
2000
1600
1000
800
500
400
300
200
Dew Point At Atmospheric Pressure In Degrees F
-100
-90
-80
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
-100 -90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100
Dew Point At Pressure In Degrees Fahrenheit

Moisture Content



- 7.8 cubic feet of air is drawn in and compressed to 100 psig and subsequently cooled in an aftercooler.
- The increased temperature of the compressed air increases its vapor holding capacity which, in turn, reduces the relative humidity of the air because the actual water vapor content has remained constant.
- The aftercooler can remove a significant proportion of the water vapor (up to 75%) from the air through the principle of condensation. When leaving the aftercooler, the compressed air is saturated - any further cooling of the air will result in condensation.
- When air is 100% saturated, its temperature equals its dewpoint.

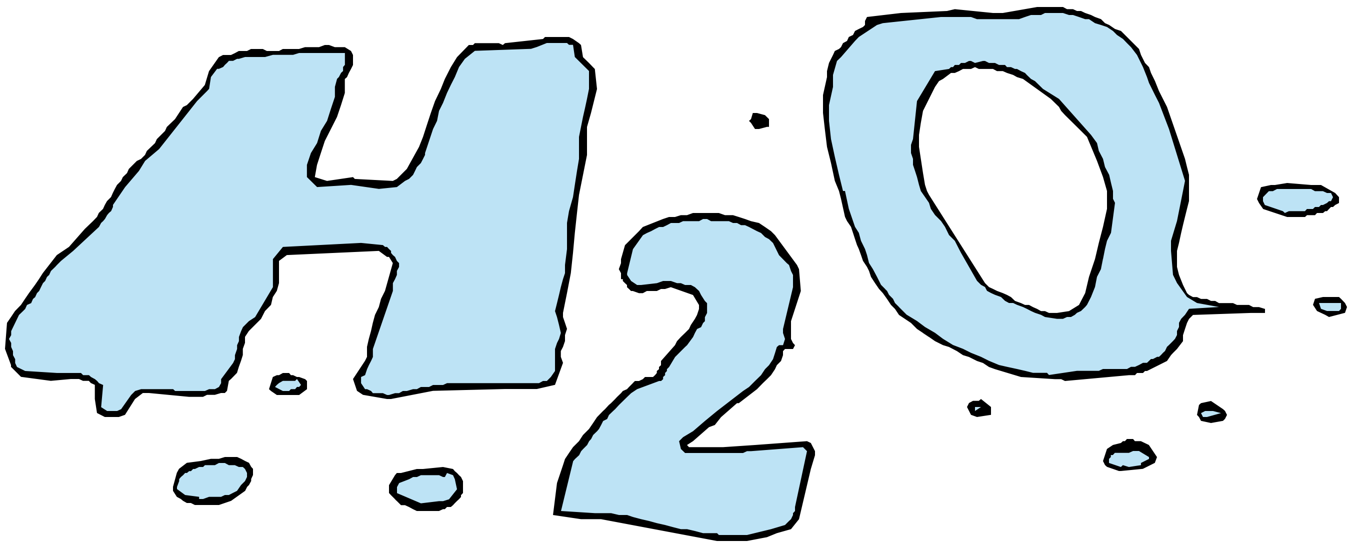
Moisture Content



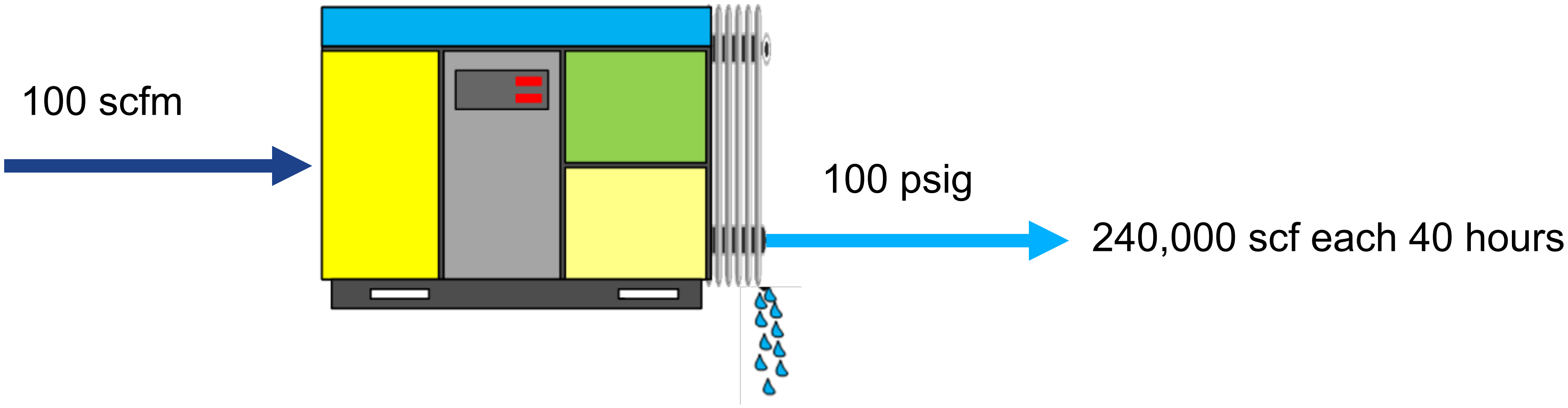
- Vapor Pressure measurements are the basis for all dew point calculations.
- These measurements are then converted to GRAINS PER CUBIC FOOT for each temperature.
- They represent the specific amount of moisture vapor which is contained in a cubic foot of saturated air.

Moisture Content

- 7000 Grains = 1 pound or 1 pint of water

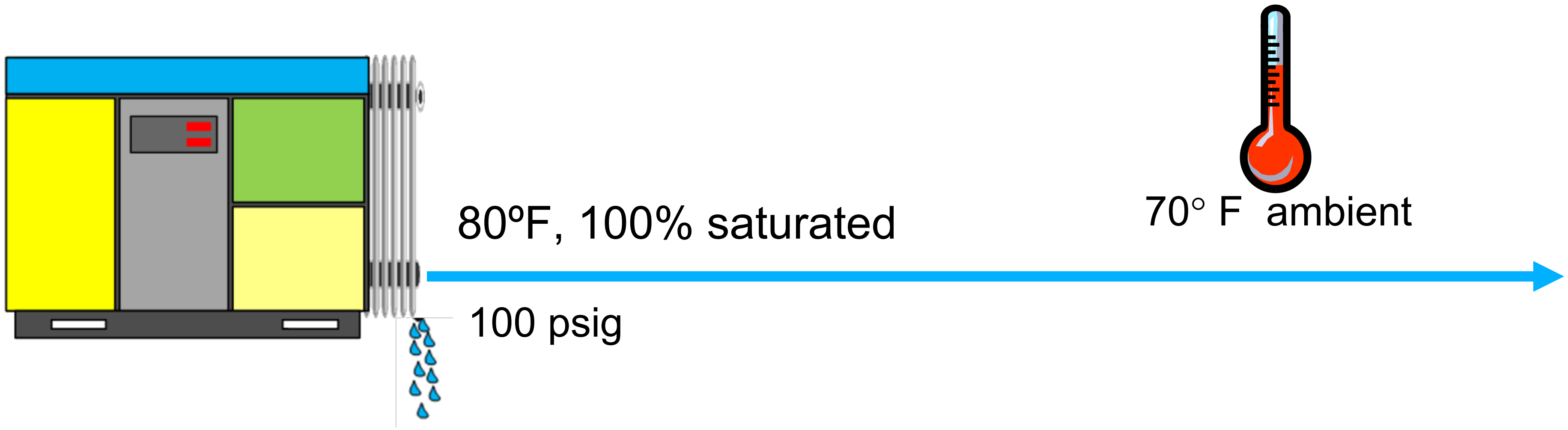


Moisture Content during a 40 HOUR WEEK



- Typical 25 hp compressor produces about 100 SCFM (Standard Cubic Feet Per Minute) at 100 psig.
- During a 40-hour week the compressor would discharge approximately 240,000 SCF into the plant piping system.
- 100 standard cubic feet/min x 60 minutes x 40 hours = 240,000 scf

Moisture Content



- Assume at the aftercooler outlet, the air is 80ºF and saturated.
- Each scf contains 1.42 grains of moisture vapor at 80ºF.
- The air surrounding the airlines is 70ºF.
- Is this 10ºF reduction in temperature enough to cause appreciable condensation ??

MOISTURE CONTENT

- At 80ºF there is 1.42 grains per standard cubic foot.
- At 70ºF a standard cubic foot of free air will still hold 1.03 grains of moisture vapor at 100% relative humidity.
- Making a difference of .39 grains per cubic foot.
- Multiply this by 240,000 standard cubic feet/week.

EQUALS 93,600 GRAINS OF MOISTURE CONDENSING IN ONE WEEK BECAUSE OF A 10 DEGREE REDUCTION IN TEMPERATURE!!

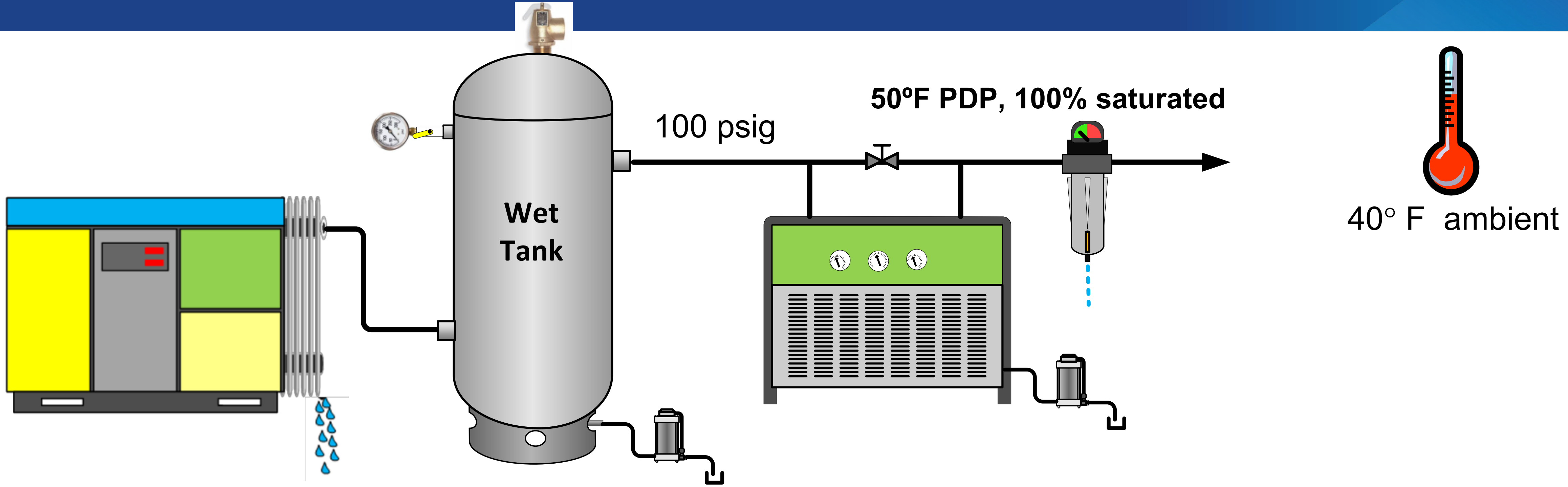
MOISTURE CONTENT

- 7000 grains of water equals one pound or one pint
- 93,600 divided by 7000 equals 13.4 pounds or 13 pints

Just a 10° F drop in temperature will allow 13 pints (1.625 gallons) of water to condense into the piping system in 40 hours!

Even with this amount of water removed, the RH is still 100% and the dew point down stream of the aftercooler is now 70° F

Moisture Content



- The dryer has chilled the air to 50°F which creates a 50°F PDP.
- Each scf contains .523 grains of moisture vapor at 50ºF.
- The air surrounding the dryer outlet piping is 40ºF.
- Is this 10ºF reduction in temperature enough to cause appreciable condensation ??

MOISTURE CONTENT

- At 50ºF there is .523 grains per standard cubic foot.
- At 40ºF a standard cubic foot of free air will still hold .3654 grains of moisture vapor at 100% relative humidity.
- Making a difference of .1576 grains per cubic foot.
- Multiply this by 240,000 standard cubic feet/week.

EQUALS 37,824 GRAINS OF MOISTURE CONDENSING IN ONE WEEK BECAUSE OF A 10 DEGREE REDUCTION IN TEMPERATURE!!

MOISTURE CONTENT

- 7000 grains of water equals one pound or one pint
- 37,824 divided by 7000 equals 5.4 pounds or 5.4 pints

Just a 10° F drop in temperature below the dewpoint will allow 5.4 pints (.675 gallons) of water to condense into the piping system in 40 hours!

Even with this amount of water removed, the RH is still 100% and the dew point down stream of the aftercooler is now 40° F

Water Remaining in Compressed Air

Capacity	100	cfm
	102	psi (g)
	80	°F
Air Usage	100	cfm

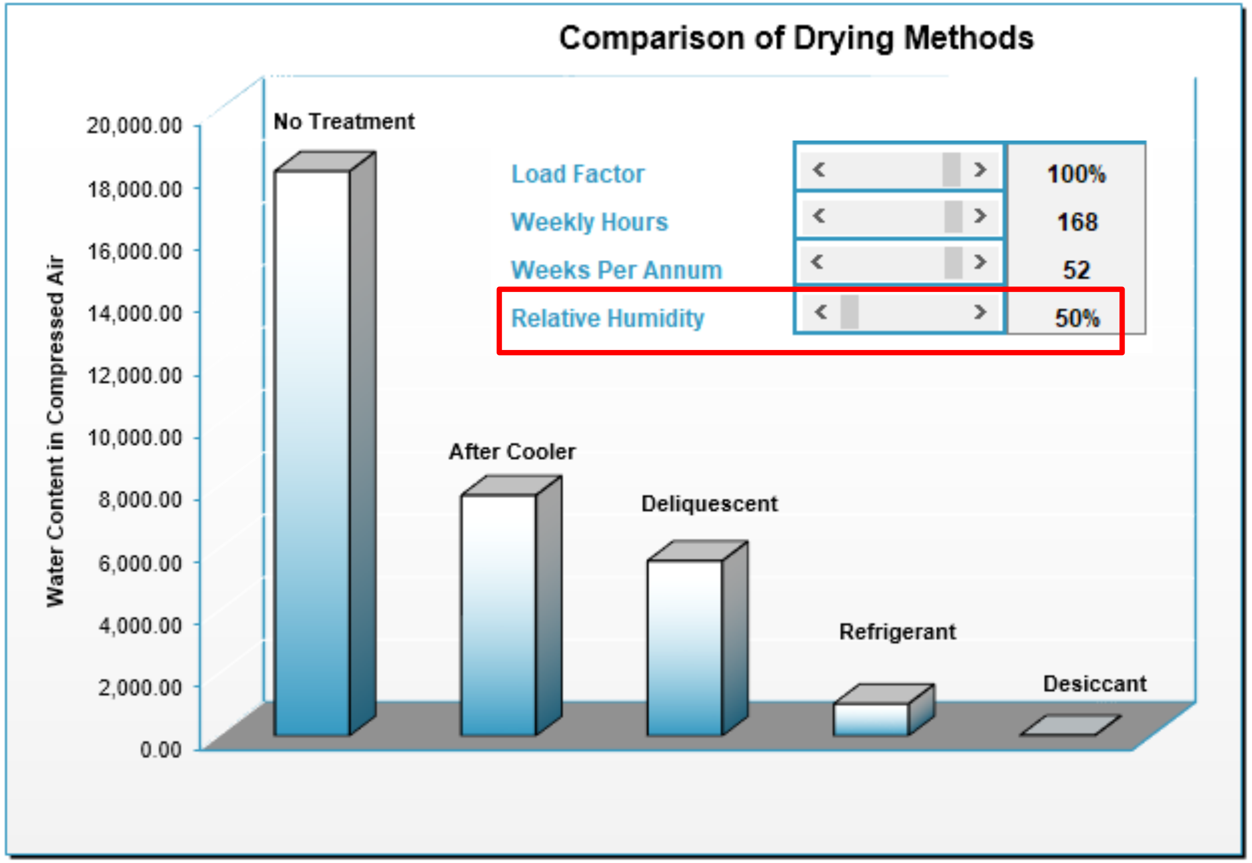
Water Remaining in Compressed Air

Imperial Units

Drying Method	Dewpoint	Gallons Week	Gallons Annum
No Treatment	127°F	76.4	3975.0
After Cooler	98°F	32.6	1693.0
Deliquescent	87°F	23.7	1232.8
Refrigerant	37°F	4.3	225.9
Desiccant	-40°F	0.09	4.8

Metric Units

Drying Method	Dewpoint	Litres Week	Litres Annum
No Treatment	53°C	347.5	18068.2
After Cooler	37°C	148.0	7695.4
Deliquescent	26°C	107.8	5603.7
Refrigerant	3°C	19.7	1026.6
Desiccant	-40°C	0.4	22.0



Water Remaining in Compressed Air

Capacity	100	cfm
	102	psi (g)
	80	°F
Air Usage	100	cfm

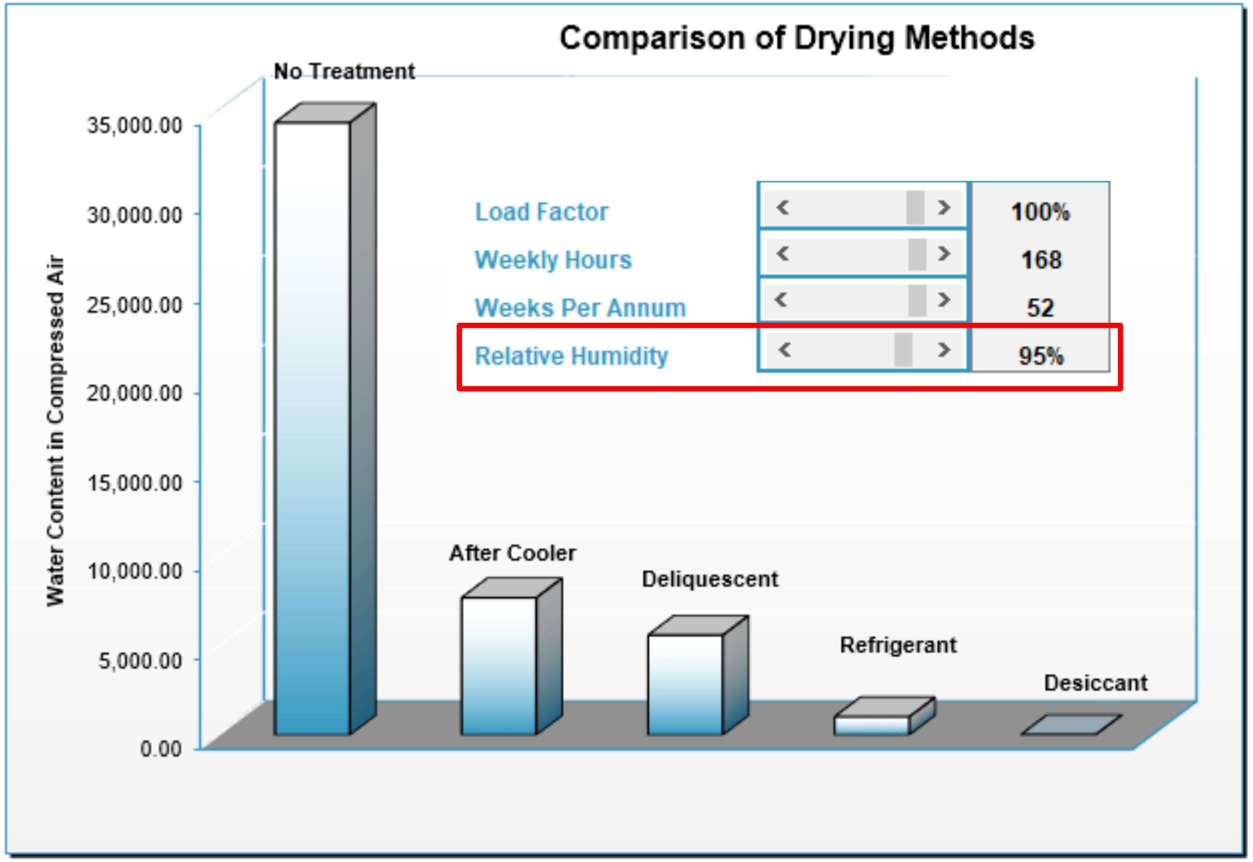
Water Remaining in Compressed Air

Imperial Units

Drying Method	Dewpoint	Gallons Week	Gallons Annum
No Treatment	154°F	145.2	7552.5
After Cooler	98°F	32.6	1693.0
Deliquescent	87°F	23.7	1232.8
Refrigerant	37°F	4.3	225.9
Desiccant	-40°F	0.09	4.8

Metric Units

Drying Method	Dewpoint	Litres Week	Litres Annum
No Treatment	68°C	660.2	34329.5
After Cooler	37°C	148.0	7695.4
Deliquescent	26°C	107.8	5603.7
Refrigerant	3°C	19.7	1026.6
Desiccant	-40°C	0.4	22.0



Water Basics

- Water vapor will always move from an area of high relative humidity to an area of low relative humidity, regardless of the direction of air flow.
  - Yes, an air leak can allow water vapor into your piping.
- Liquid water will always drain down by gravity, regardless of the direction of air flow.
  - This sounds like common sense, but many people forget this when evaluating or installing piping and draining systems.
- Liquid water left to stand in air receivers, filter housings, etc., will evaporate into the dry air.
  - This will raise the relative humidity and pressure dew point within the system, and carry liquids throughout the system

Water Basics

- Water will be carried past drain locations if the pipe diameter is too small.
  - The key is to use a large enough pipe diameter to slow the air velocity below 20 fps, which makes it easier for liquids to drop out of the air flow.
- Always use level activated drains at condensation drain locations.
  - This provides the best opportunity for immediate and continuous removal of liquids.

Wet Compressed Air

- The tough question you must answer is which type of dryer is the best choice for your application.

Specifying the Right Dryer

- In specifying the right dryer for a compressed air installation, keep the following information in mind
  - Do not over specify - Drying the entire compressed air supply in a factory to dewpoints less than -40°F (-40°C) is wasteful.
    - It is more sensible to subdivide the compressed air supply by application, treating each end use point as needed to provide appropriately dry air for the downstream application served.
  - Do not underspecify - Damage caused by wet air costs money in maintenance time and supplies, downtime, and lost production.

Specifying the Right Dryer

versus

- Do not dry compressed air more than is required by the application.
- Consider initial drying with a refrigerant type dryer then drying further only to meet the requirement at a specific point of use.
- Leaks in the piping can degrade the Pressure-Dewpoint.

So How Do I Measure My Dewpoint?

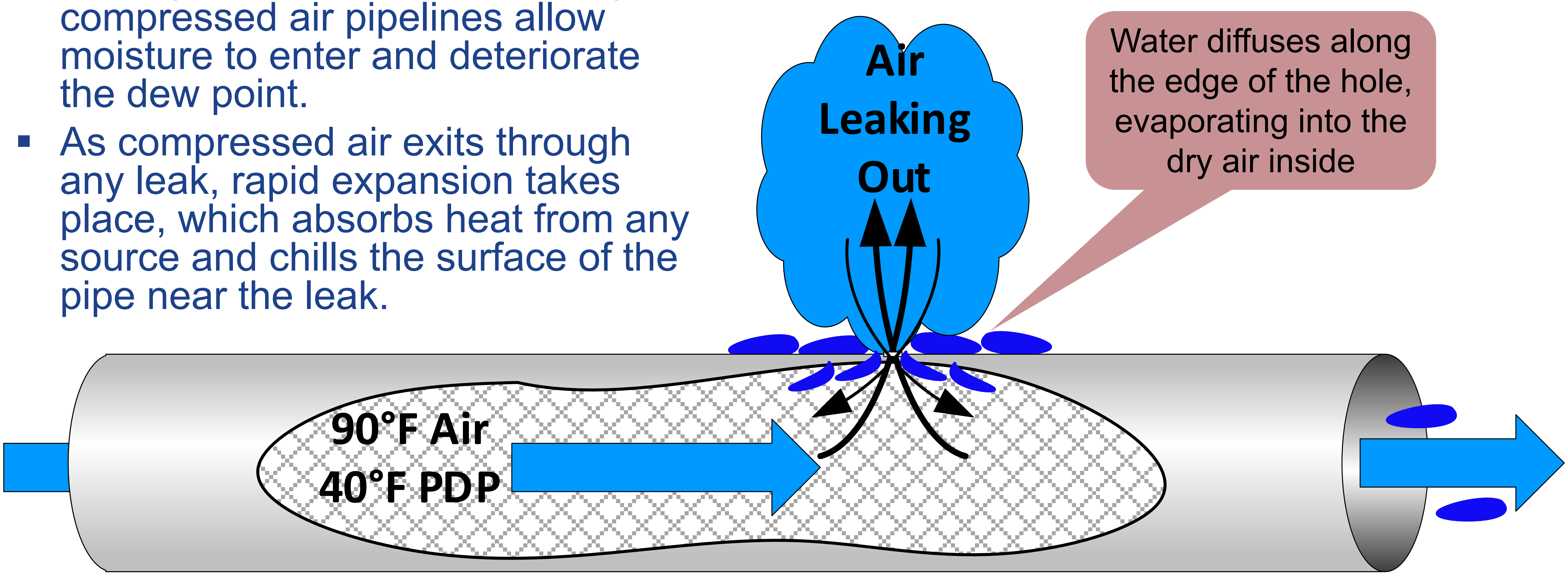
- Maintaining the dew point of your air or gas system will prolong the lifetime of your equipment and reduce maintenance costs.
- For dew points related to production processes, guarding the dew point is critical for the end-product and key in preventing costly production losses.
- Permanent monitoring enables you to detect and prevent problems quickly and may provide visibility that a change in dew point is capacity or maintenance related.

So How Do I Measure My Dewpoint?

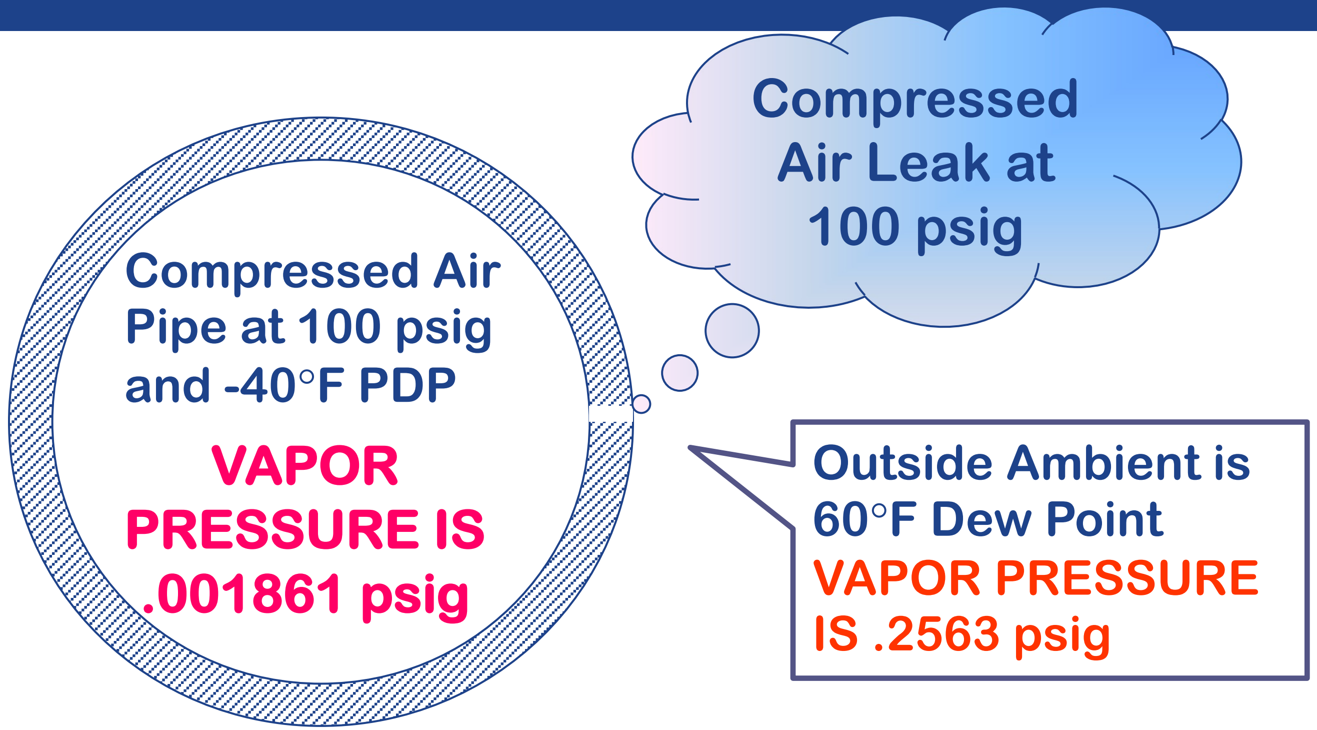
- Always choose a Dew Point Sensor with multiple outputs, alarm LED, and built-in autocalibration.
- Some sensors are for Extreme Dry Air is for measuring dewpoints as low as (-100ºC) -148°F
- Protect your dew point sensor from fouling and failure by using a sampling block, e.g., for protection against a high process temperature, against water spikes, and for ease of servicing

Deterioration of Dew Point Through Compressed Air Leaks

- Small pinhole leaks that develop in compressed air pipelines allow moisture to enter and deteriorate the dew point.
- As compressed air exits through any leak, rapid expansion takes place, which absorbs heat from any source and chills the surface of the pipe near the leak.



Deterioration of Dew Point Through Compressed Air Leaks (Ficks Law)



- Water and air will always seek to reach equilibrium.
- Any dryer will create an unstable gas that will aggressively seek water vapor.
- If the entire compressed air supply is dried to -20 F or below, the piping must be completely free of any leaks, or the dewpoint will degrade.
- Maintaining such a dry air condition would involve welding every connection throughout the entire pipeline.

Vapor Pressure Differential

Ratio (VPDR) for -40°F is .2563/.001861 = 138

Moisture Driving Force Into Compressed Air is 138 times!

At a -100°F VPDR it would be 11,192 times!

Instrument Air

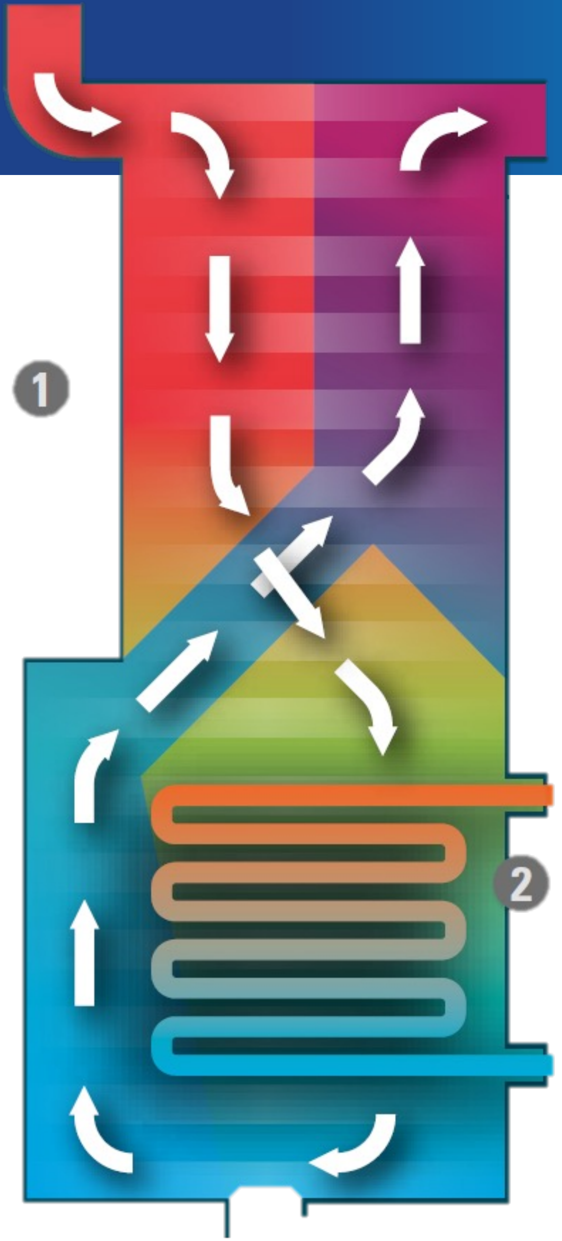
- The Specification for Instrument air quality is governed by ANSI/ISA-7.0.01-1996 "Quality Standard for Instrument Air". This specification stipulates the following:
  - **Pressure Dew Point:** "The pressure dew point as measured at the dryer outlet shall be at least 10°C **(18°F) below the minimum temperature to which any part of the instrument air system is exposed.** The pressure dew point shall not exceed 39°F (4°C) at line pressure".
  - **Particle Size:** "A **maximum 40-micron particle size** in the instrument air system is acceptable for a majority of pneumatic devices".
  - **Lubricant Content:** "The lubricant content should **be as close to zero as possible** and under no circumstances shall it exceed **1 ppm**.
  - **Contaminants:** "Instrument air should be free of corrosive contaminants and hazardous gases which could be drawn into the instrument air supply".

Now “The Instrumentation, Systems, and Automation Society” Formally “Instrument Society of America”

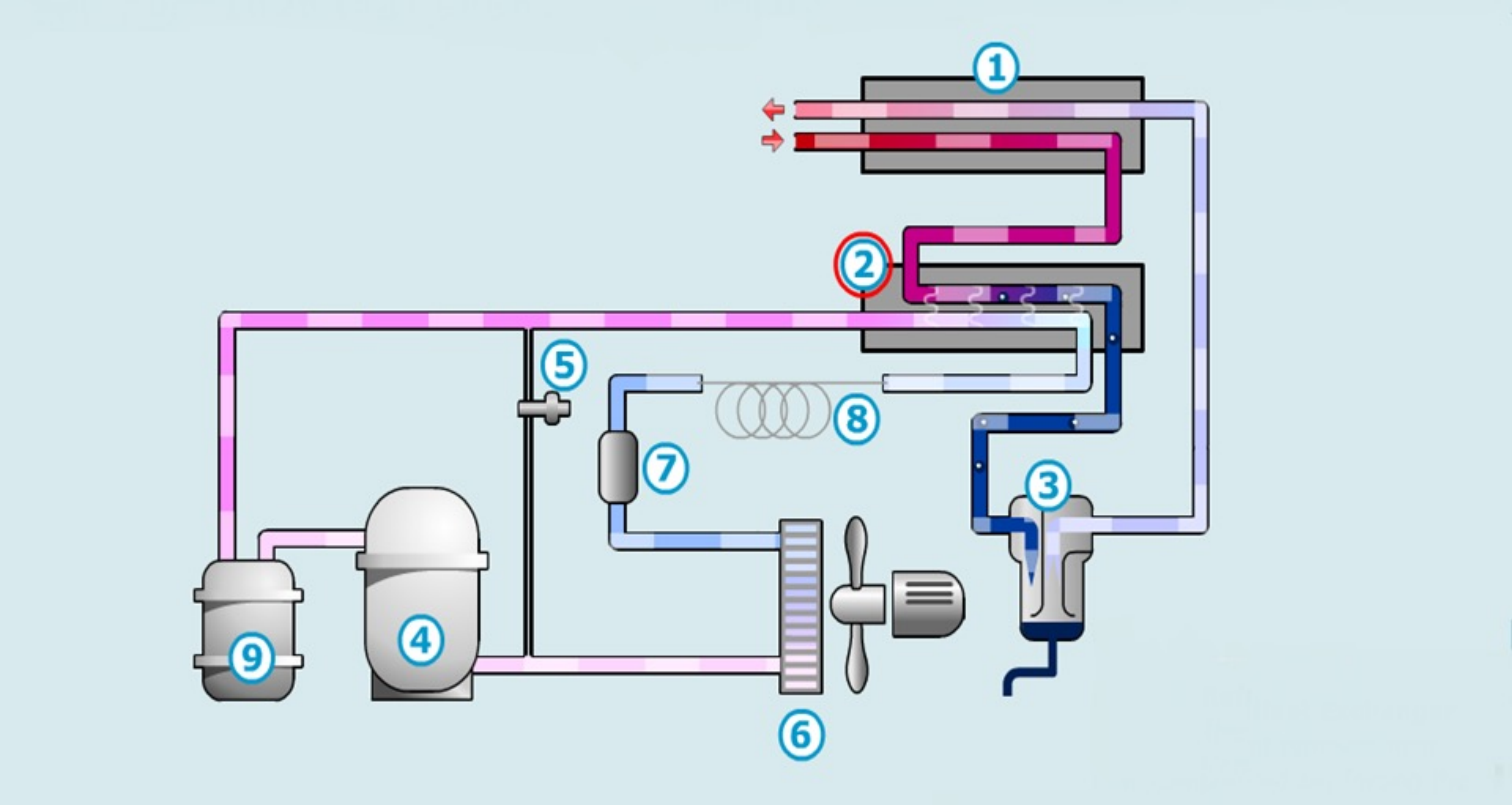
Refrigerant Dryer

1. Air section (Air to Air Heat Exchanger)
   - Hot wet air at the inlet is precooled
   - Cold dry air is reheated when leaving the heat exchanger
2. Evaporator (Air to Refrigerant Heat Exchanger
   - Air is further cooled down by the refrigerant at low pressure.
   - Typical PDP of 35°F to 39°F

- **The power requirement, including the effect of pressure drop through the dryer, is 0.80 kW/100 cfm.**



Refrigerant Dryer



3-100 Rule

C_1 – Inlet Air Pressure Correction Factor

Pressure (PSIG)	40	60	80	100	120	140	150	180	200
C_1	.67	.83	.94	1.00	1.03	1.05	1.08	1.09	1.11

C_2 – Inlet Air Temperature Correction Factor

Temp °F	60	70	80	90	100	110	120
C_2	2.73	1.94	1.50	1.21	1.00	0.84	0.69

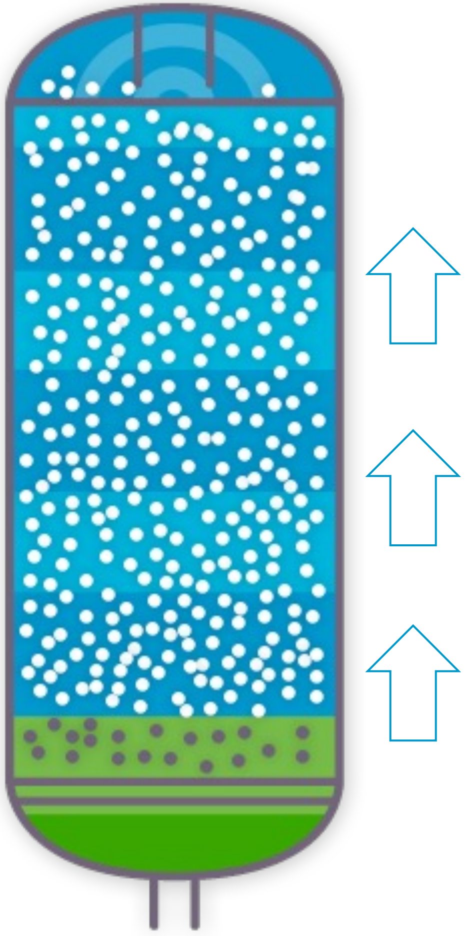
C_3 – Ambient Air Temperature Correction Factor (air cooled unit only)

Temp °F	60	70	80	90	100	110
C_3	1.34	1.24	1.15	1.07	1.00	0.91

C_4 – Pressure Dew Point Correction Factor

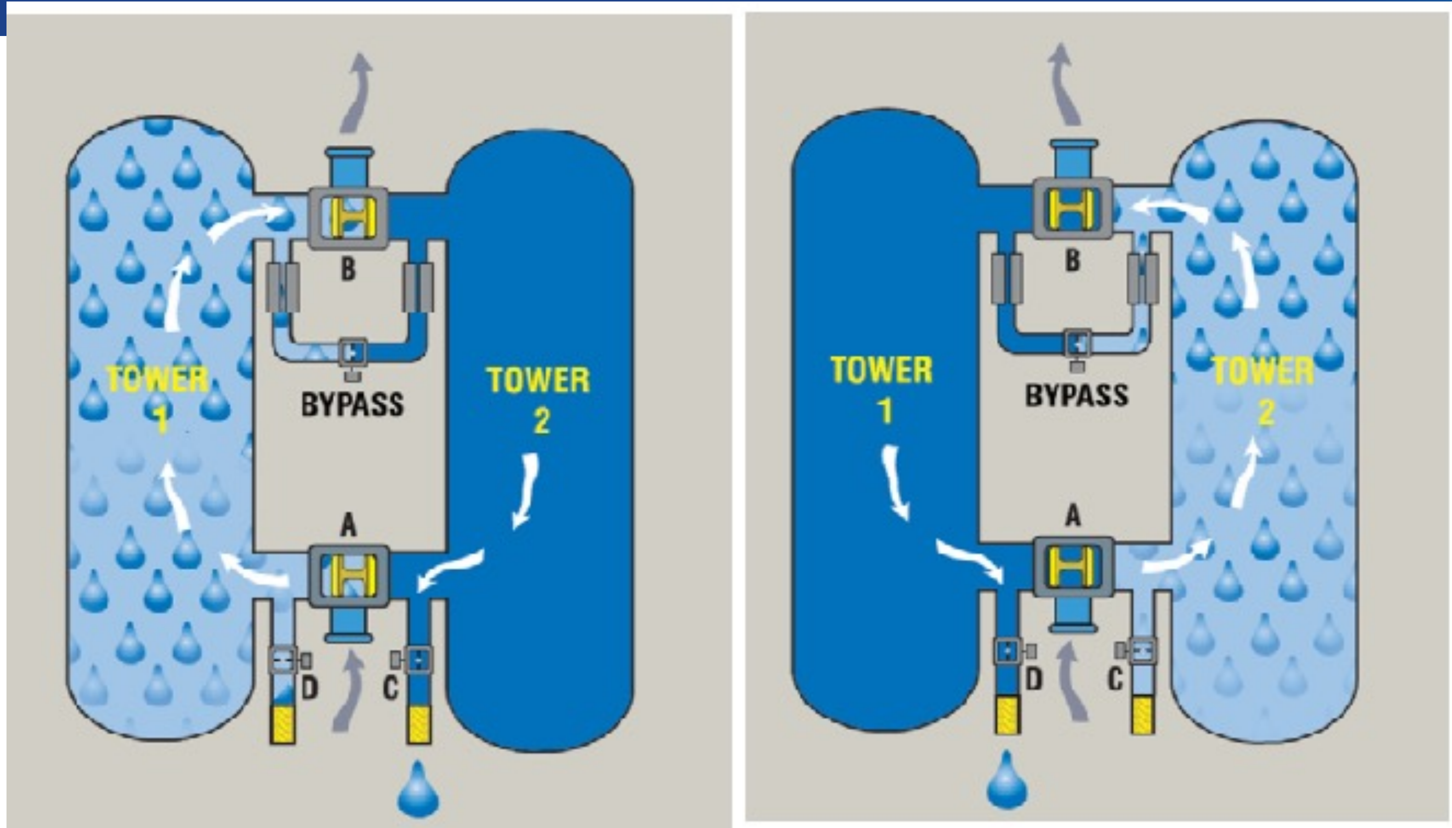
Temp °F	35°F to 39°F	45°F to 50°F
C_3	1	1.2

Adsorption Drying (Heatless, Heated, Blower Purge)



- Water vapor transfers to the desiccant because the water is more attracted to the desiccant than to the air.
- Attraction slowly decays as the desiccant gets wet.
- The beads becomes fully saturated at around 50% of the cycle time.
  - Constant dew point -40ºC/F until that time
- Once saturated, the dew point degrades slowly.
- Positive dew point: hard to regenerate the desiccant.
- **The power requirement, including the effect of pressure drop through the dryer is 2.0-3.0 kW/100cfm.**

Adsorption Dryer - Heatless

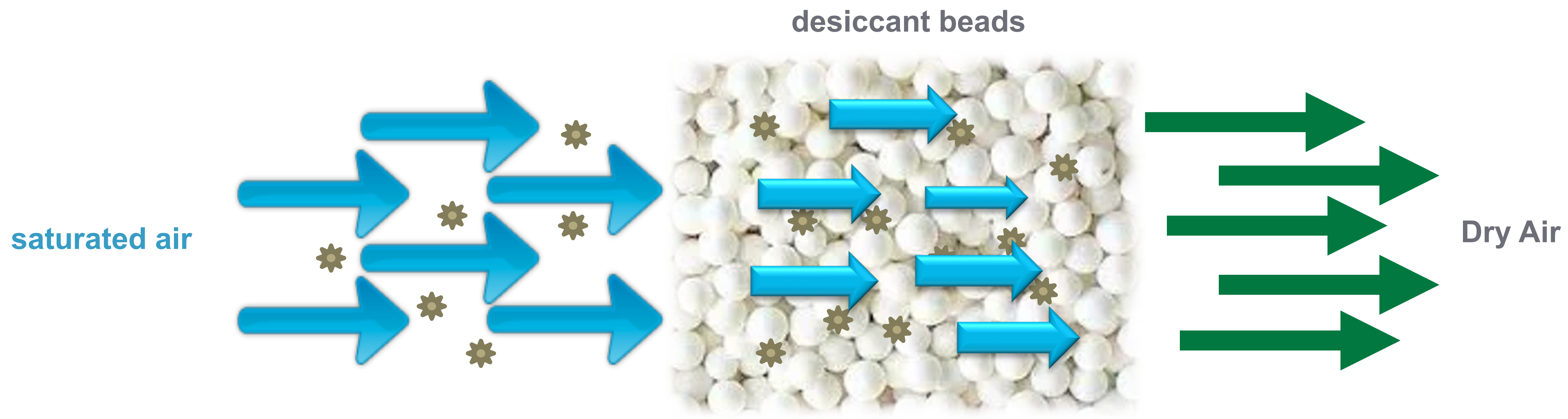


- The power requirement, including the effect of pressure drop through the dryer is 2.0-3.0 kW/100cfm.

Adsorption Drying

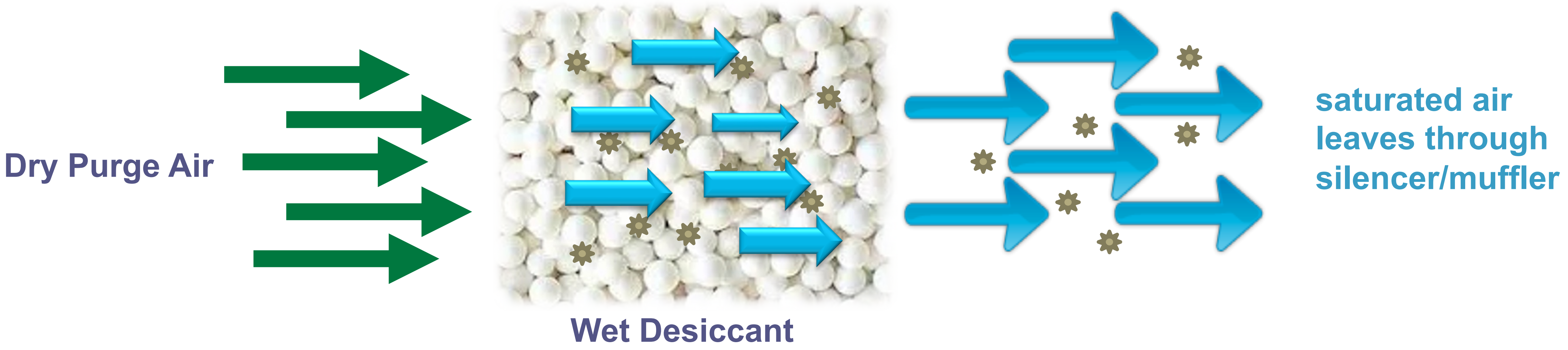
- Water vapor is bound by a physical process.
  (this means the process of adsorption is reversible)
- All materials can adsorb and desorb water.
- One desiccant bead contains more pores than a football field contains blades of grass.
- Typical PDP is -40°F

Typical Cycle Time of 5 to 10 minutes



Adsorption Dryer – Heatless Regeneration

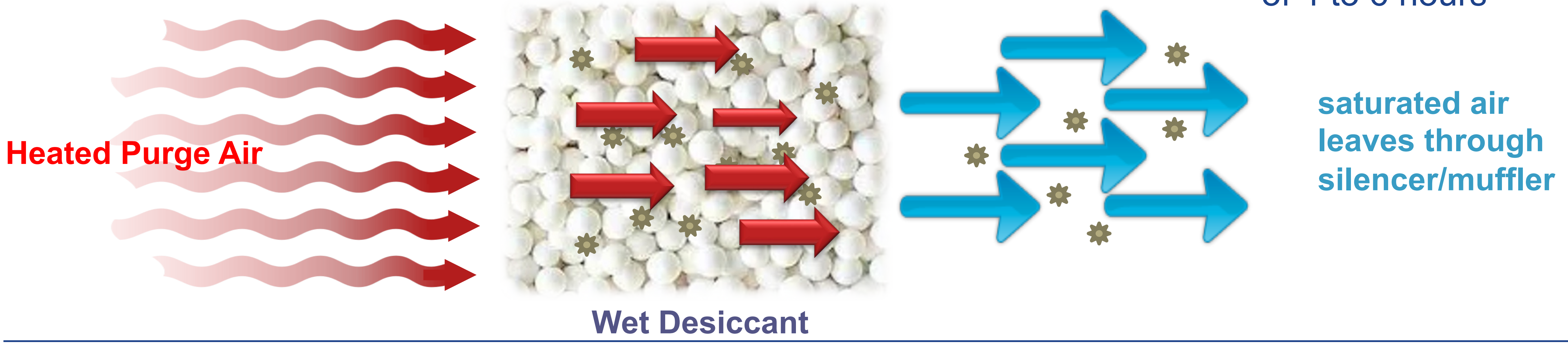
- Regeneration occurs by using 15-18 percent of the dry compressed air.
  - Expanded purge air is much dryer than the desiccant.
  - Water vapor is more attracted to the dry air than to the desiccant.
  - Water detaches from the desiccant and moves into the dry air flow.



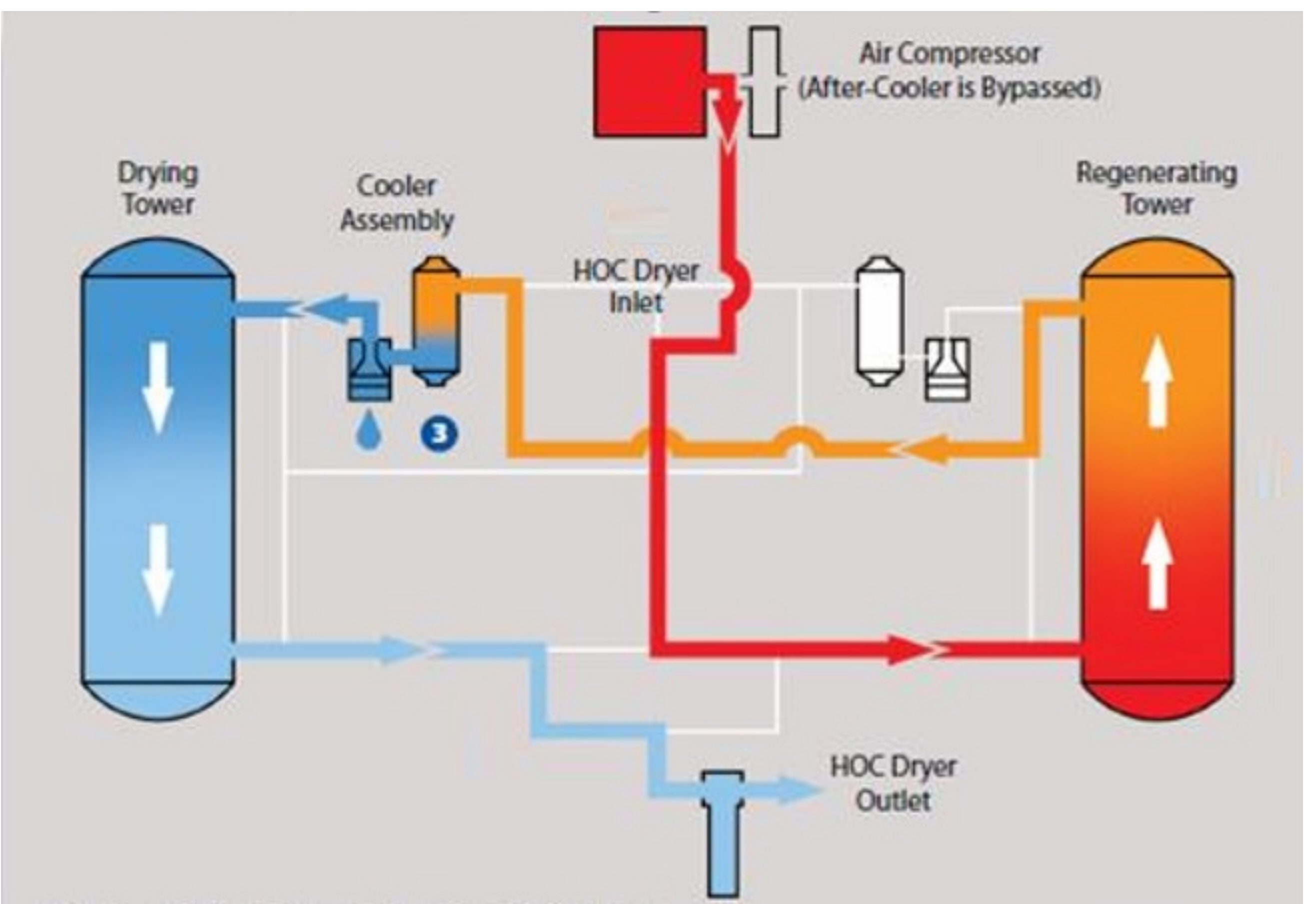
Adsorption Dryer – Heated Regeneration

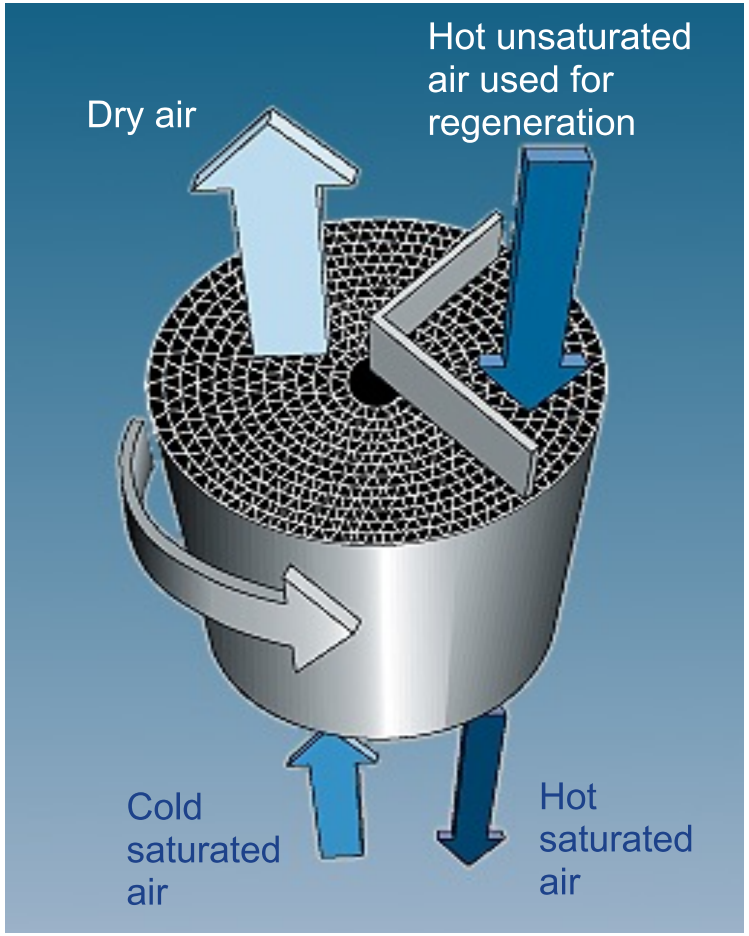
- Regeneration is enhanced by adding energy (heat).
- This causes the water molecules in the desiccant beads to vibrate and move around frantically, which triggers the reverse physical action of adsorption.
- The surface tension is reduced…. and the water retaining forces – the so-called Van der Waals forces – are broken down, setting the water free in the form of vapor that we can then discharge.

Typical Cycle Time of 4 to 6 hours



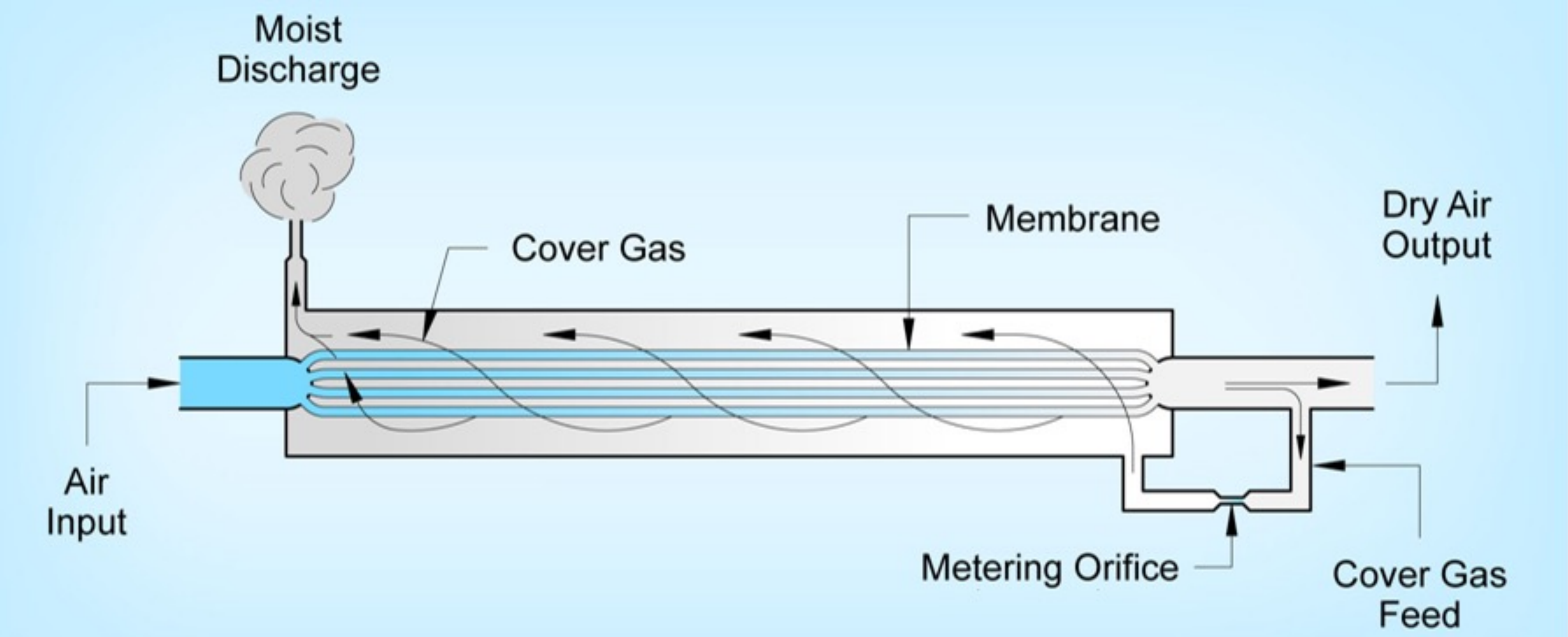
Heat of Compression Dryer





- The power requirement, including the effect of pressure drop through the dryer, is approximately **0.80 kW/100 cfm.**

Membrane Dryer

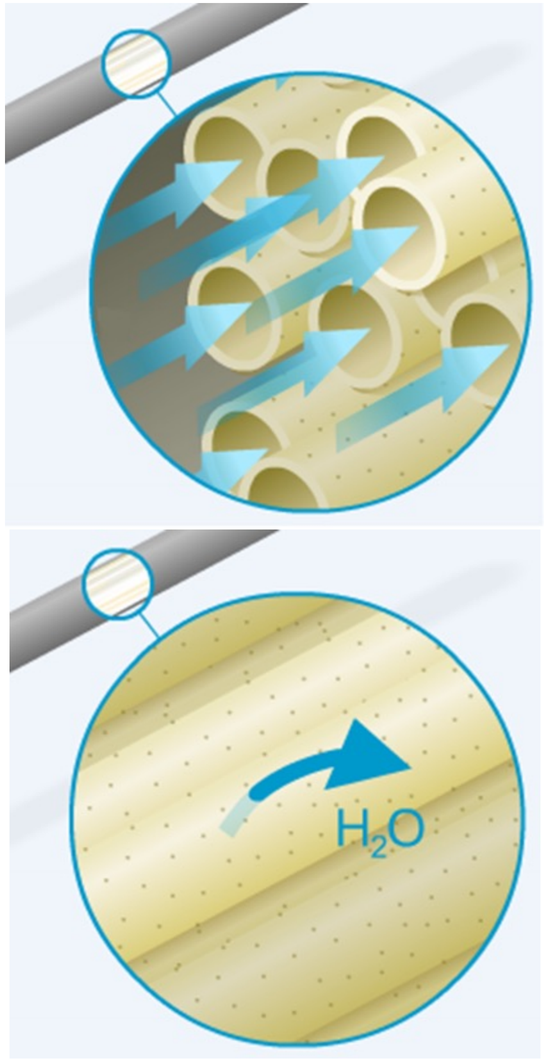


- A membrane dryer suppresses the dew point.
- The dew point achieved normally is 40°F but lower dew points to -40°F can be achieved at the expense of additional purge air loss.
- The power requirement, including the effect of pressure drop through the membrane dryer is **3 – 4 kW/100cfm**

Membrane Dryer

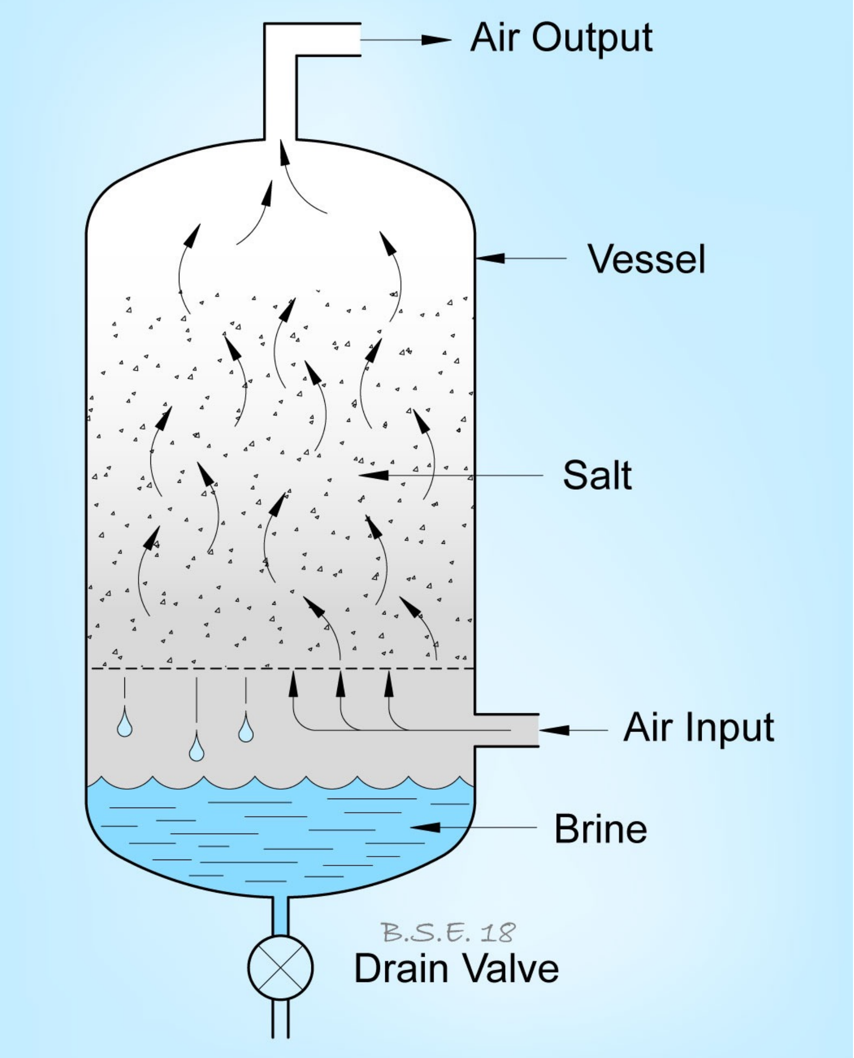
- Wet compressed air enters the inside of the hollow fibers.
- Water vapor permeates through the fibre. wall, into the space in-between the fibres.
- The power requirement, including the effect of pressure drop through the dryer, is approximately 3-4 kW/100 cfm

The purge nozzle is a small but vital component in the dryer.
It determines the amount of purge and thus the Dew Point performance



Deliquescent Dryer

- A deliquescent dryer is basically a tank full of salt tablets.
- As the compressed air passes through the salt, the salt attracts water and dissolves into a brine that can be drained off.
- Provide a pressure dew point suppression of around 20°F below the inlet temperature.
- These are the least expensive dryers to purchase and maintain because they have no moving parts and require no power to run.
- The power requirement, including the effect of pressure drop through the dryer is **.8 kW/100cfm**



CAGI Refrigerated Compressed Air Dryer Performance Verification Program

- The Compressed Air and Gas Institute (CAGI) sponsors the Performance Verification Program for Refrigerated Compressed Air Dryers.
- The program provides a uniform and commercially practical means of verifying participants' claimed ratings

CAGI Refrigerated Compressed Air Dryer Performance Verification Program

- The following manufacturers of refrigerated compressed air dryers are currently participating in the CAGI Performance Verification Program
  - Atlas Copco
  - Parker Hannifin
  - Ingersoll Rand
  - Mikropor
  - SPX
  - Zeks

Date	Model Number	Rated Flow	Rated Outlet Pressure Dew Point	Result
1-15	RD-400	400	39.5	Passed
7-15	RD-500	500	39.5	Passed
3-16	RN325	325	39.5	Passed
3-16	RN250	250	39.5	Passed

CAGI Refrigerated Compressed Air Dryer Performance Verification Program

- Participation in the Program is voluntary and is open to all manufacturers of standalone refrigerated compressed air dryers from 200 – 1000 SCFM.
- On a regular and random basis, the Program Administrator, Intertek Testing Services, selects and tests samples of equipment to verify that actual performance meets the manufacturer's certified published performance ratings.

DRYER DATA SHEET
Refrigerant Dryers

MODEL DATA				
1	Manufacturer	[illegible]		
2	Date	13 03 2017		
3	Model Number	[illegible]		
4	Cycling / Non-Cycling	NON-CYCLING		
5	Refrigerant Type	R134a		
6	Air/Water Cooled	Air Cooled		
7	Voltage	230 V		
	DESCRIPTION	FULL FLOW	10% FLOW	UNITS
6	Tested Flow [a]	200	20	scfm [b]
7	Outlet Pressure Dewpoint	42,9	39,0	°F
8	Pressure Drop	2,2	1	psi(d)
9	Total Dryer Input Power	2,42	2,15	kW
10	Specific Package Power [c]	1,21	10,77	kW/100 scfm

DRYER DATA SHEET
Refrigerant Dryers

MODEL DATA				
1	Manufacturer	[illegible]		
2	Date	12/29/16		
3	Model Number	[illegible]		
4	Cycling/Non-Cycling	Cycling		
5	Refrigerant Type	R-404A		
	DESCRIPTION	FULL FLOW	10% FLOW	UNITS
6	Tested Flow	200	20	scfm [b]
7	Outlet Pressure Dewpoint	40.5	40.5	°F
8	Pressure Drop	2.8	0.7	psi(d)
9	Total Dryer Input Power	2.1	.63	kW
10	Specific Package Power [c]	1.05	3.15	kW/100 scfm

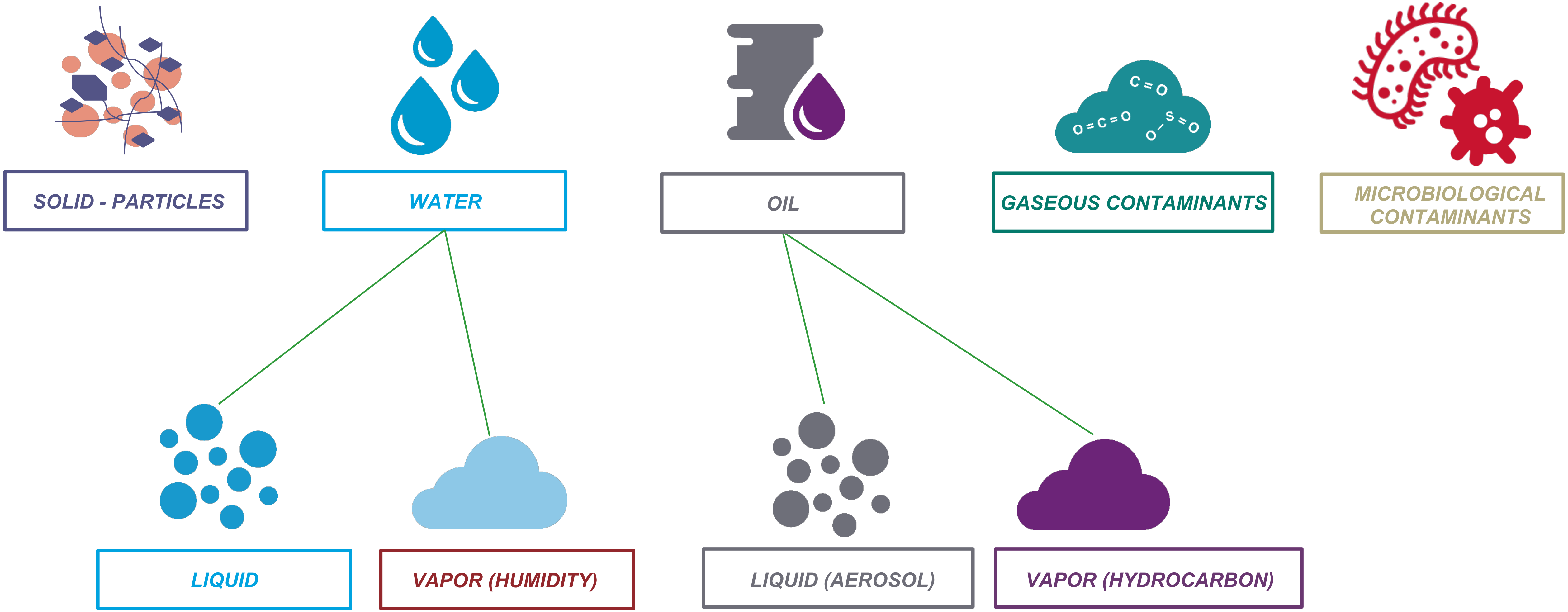
Notes:

10. Total Dryer Input Power/tested flow x 100

WHY DO YOU NEED A FILTER?

U.S. DEPARTMENT OF ENERGY

Which Contaminants do we find in compressed air?



ISO 8573-1 Compressed Air Quality Classes Simple Chart

ISO 8573-1:2010 Compressed Air Quality Classes

Class	Max. Particle Size		Pressure dewpoint		Max Oil Content
	(µm)	(mg/m^3)	(°C/°F)	(g/m^3)	(mg/m^3)
0	Specified by the equipment manufacturer/supplier and greater than class 1				
1	0.1	0.1	-70/-94	0.003	0.01
2	1	1	-40/-40	0.12	0.1
3	5	5	-20/-4	0.88	1
4	15	8	3/37	6	5
5	40	10	7/45	7.8	25
6	--	--	10/50	9.4	--
7	--	--	Not Specified		--

Note: the Class 0 certification was created in response to industry needs for oil-free air. Stating Class 0 without an agreed specification will mean it is not in accordance with the standard. Class 0 air purity is best achieved at the point of use to minimize cost.

ISO 8573-2010 - Contaminants and purity classes

International standard for compressed air purity classification

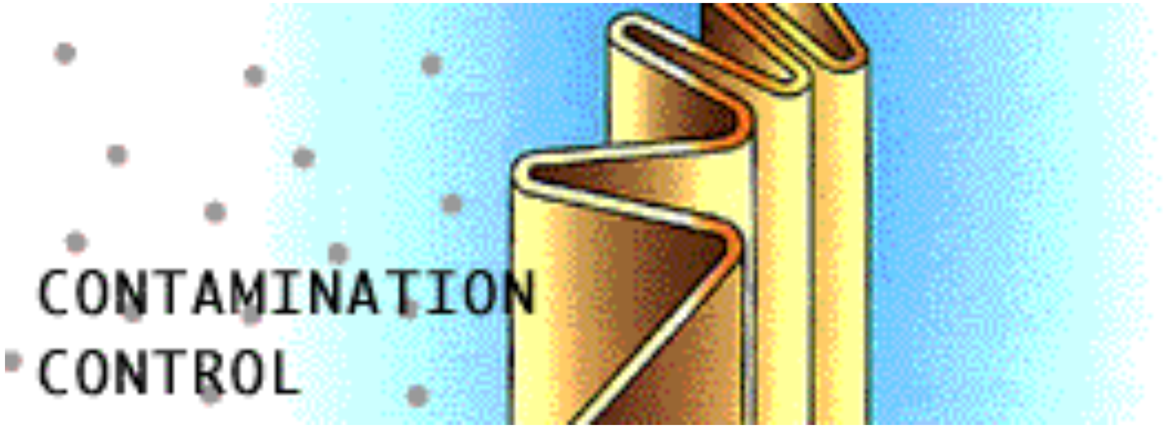
ISO 8573-1:2010	Dirt				Water		Oil
	Maximum number of particles per m³			Mass concentration mg/m³	Vapor pressure dewpoint	Liquid g/m³	Total oil (aerosol liquid and vapor) mg/m³
	0.1 - 0.5 micron	0.5 - 1 micron	1 - 5 micron				
0	As specified by the equipment user or supplier and more stringent than Class 1						
1	≤ 20000	≤ 400	≤ 10	-	≤ -70°C/-94°F	-	0.01
2	≤ 400000	≤ 6000	≤ 100	-	≤ -40°C/-40°F	-	0.1
3	-	≤ 90000	≤ 1000	-	≤ -20°C/-4°F	-	1
4	-	-	≤ 10000	-	≤ +3°C/+37.4°F	-	5
5	-	-	≤ 100000	-	≤ +7°C/+44.6°F	-	-
6	-	-	-	≤ 5	≤ +10°C/+50°F	-	-
7	-	-	-	5 - 10	-	≤ 0.5	-
8	-	-	-	-	-	0.5 - 5	-
9	-	-	-	-	-	5 - 10	-
X	-	-	-	> 10	-	> 10	> 10

ISO 22000

- The Safe Quality Food Institute (SQFI) has introduced a new Safe Quality Food Manual (ISO 22000) in the U.S. last year.
- It includes a significant change regarding compressed air and other compressed gases such as nitrogen and carbon dioxide.
- Previously, there had been no statement regarding how or when to monitor compressed air quality.
- Going forward, food processors must test (at least) annually for factors including particulate, water, oil, microbiological and relevant gaseous testing in compressed air or other gases.
- A verification of the effectiveness of compressor maintenance and filtration that a management facility has in place should also be conducted.

Compressed Air Filters

- Compressed Air Filters
  - Particulate
  - Coalescing
  - Adsorption



FACTS

- 1 cubic foot contains approximately 4,000,000 particles.
- 80% are 2 micron in size or less.
- 40 micron is the smallest the human eye can see.

ATMOSPHERIC CONTAMINATION

- Dirt
- Water
- Hydrocarbon vapor from unburnt fuels and industrial processes

AFTER THE COMPRESSOR....

- Dirt
- Oil
- Water
- Carbon
- Wear particles

IN THE PIPEWORK.....

- Dirt
- Water / oil emulsion
- Pipe scale
- Rust

COALESCING FILTERS

- Removes
  - Dirt particles down to 0.01 micron
  - Oil aerosol content down to 0.01 ppm

THIS PREVENTS.............

- Rust and corrosion
- Sticking valves and cylinders
- Damage to air operated equipment
- Damage to finished products
- Increased costs due to lost production

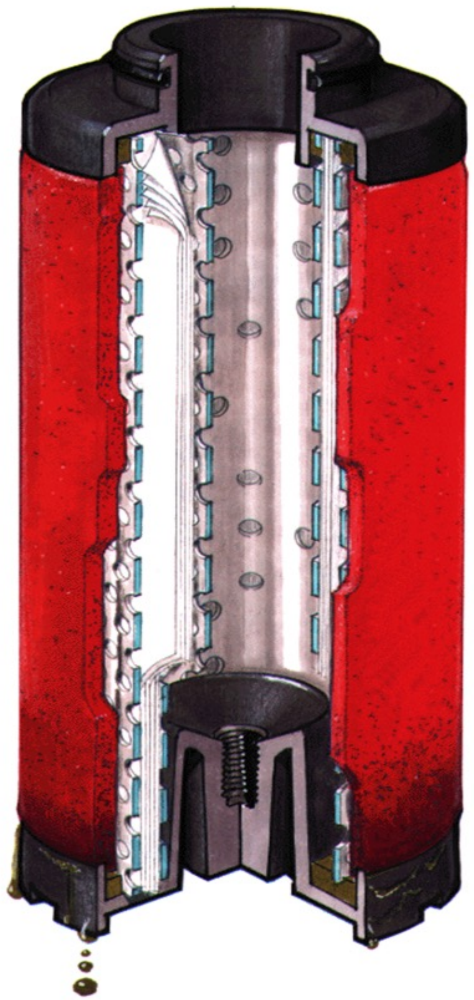
BENEFITS.............

- Longer tool life
- Less maintenance
- Clean pipework
- Reduced running costs / down time
- Consistent quality of finished product

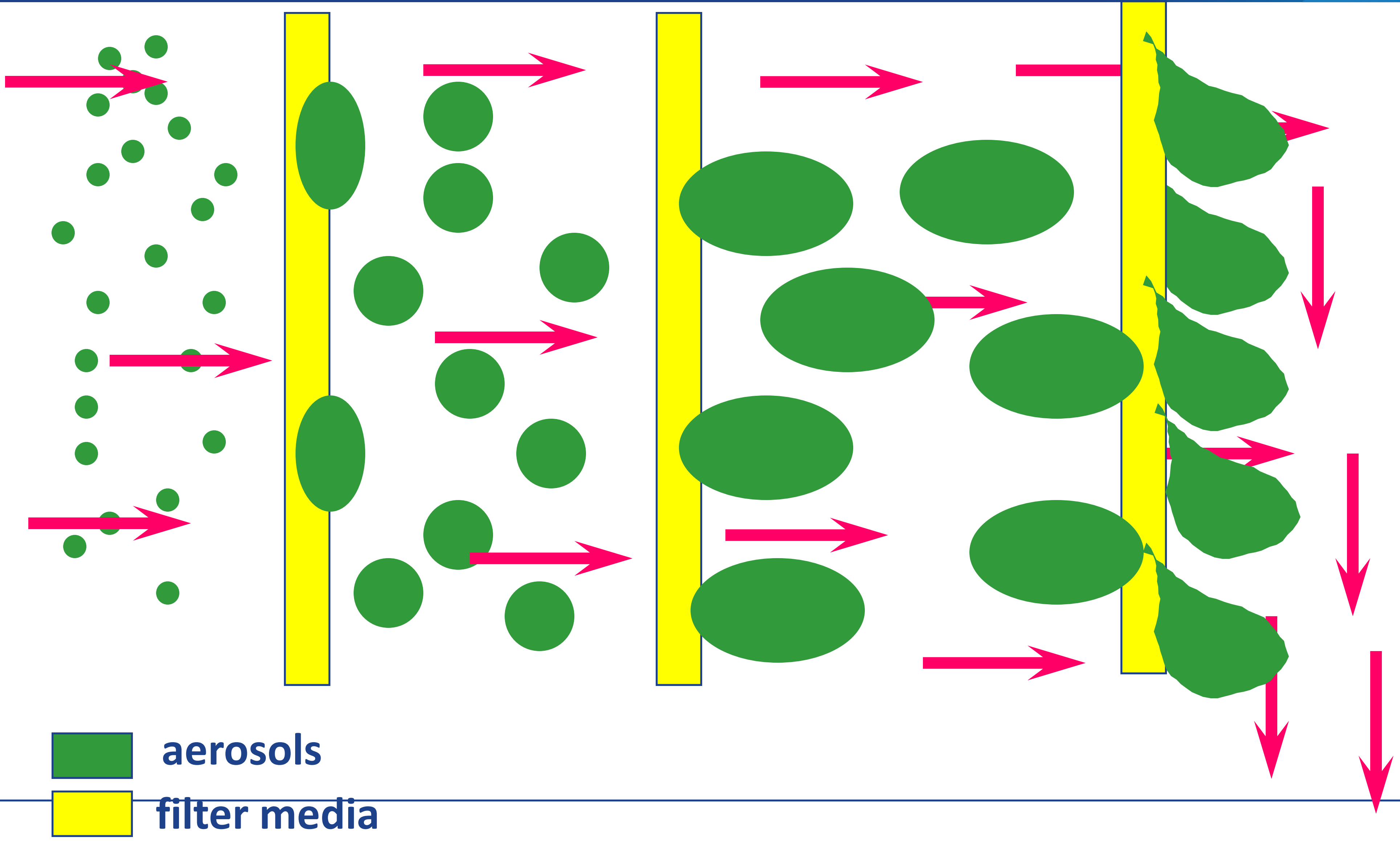
Filters

COALESCING ELEMENT

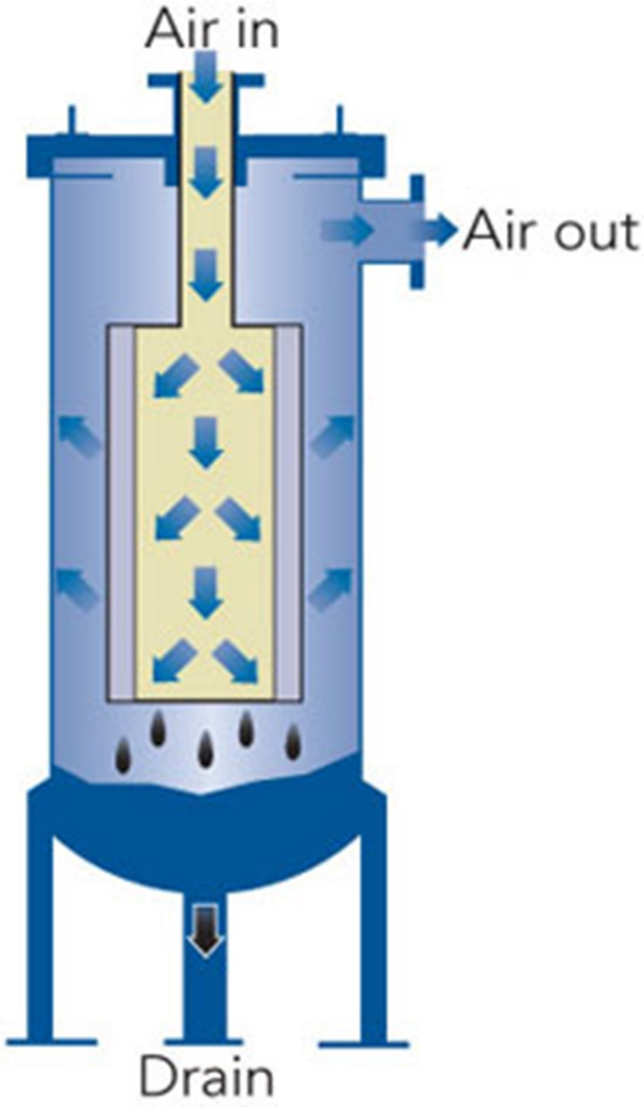
- High efficiency borosilicate microfiber filter media
- Anti re-entrainment barrier improves drainage
- Compatible with mineral and synthetic lubricants



Coalescing Process

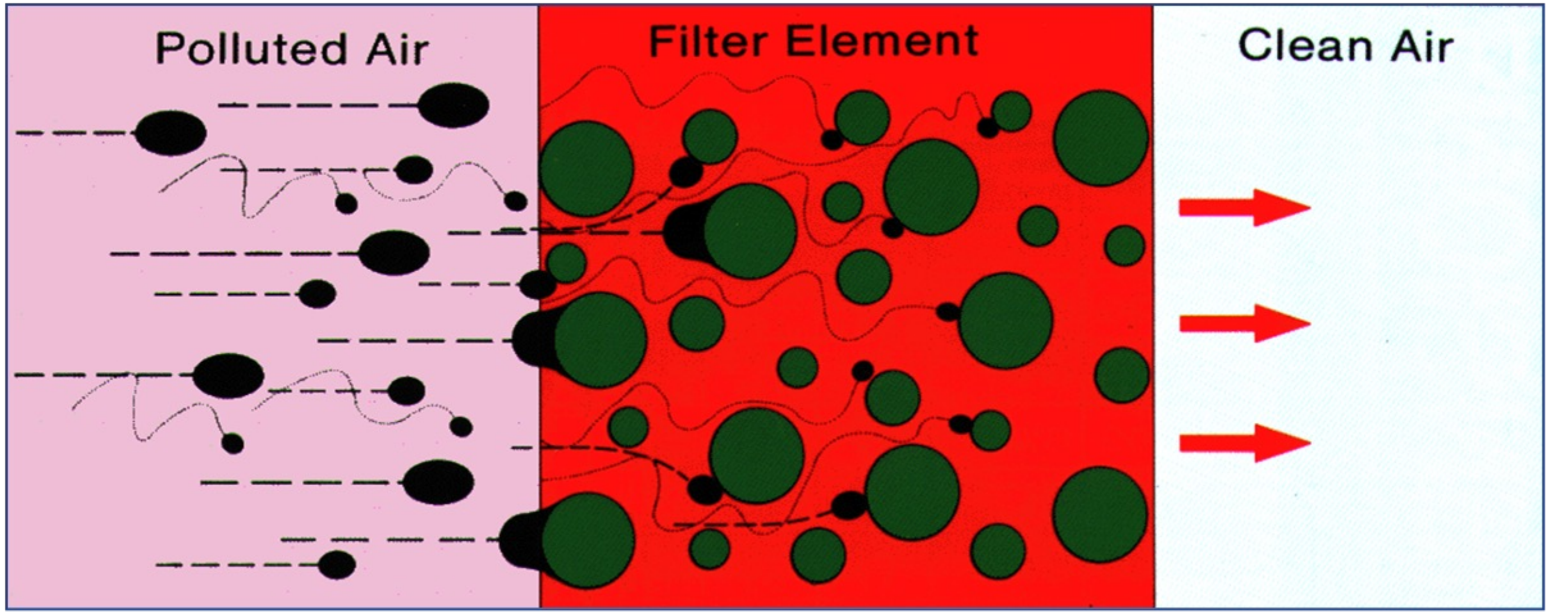


Reduce System Pressure Drop Losses



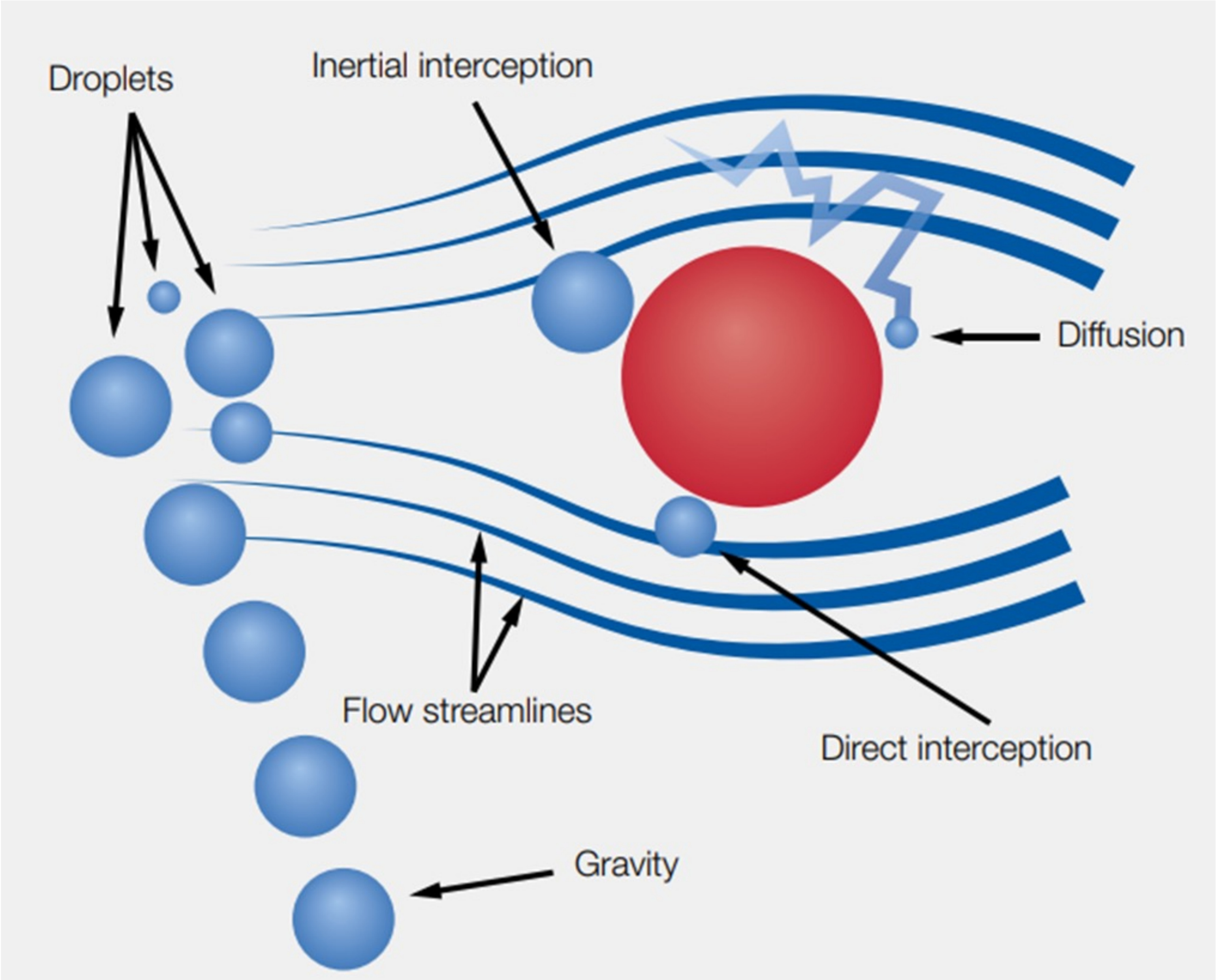
MECHANISMS OF FILTRATION

- **Direct Interception** - affecting particles over 1 micron in size.
- **Inertial Impaction** - affecting particles in the 0.3 to 1 micron size range.
- **Diffusion** (Brownian Movement) affects particles below 0.3 micron in size.



MECHANISMS OF FILTRATION for Mist Eliminator Filter

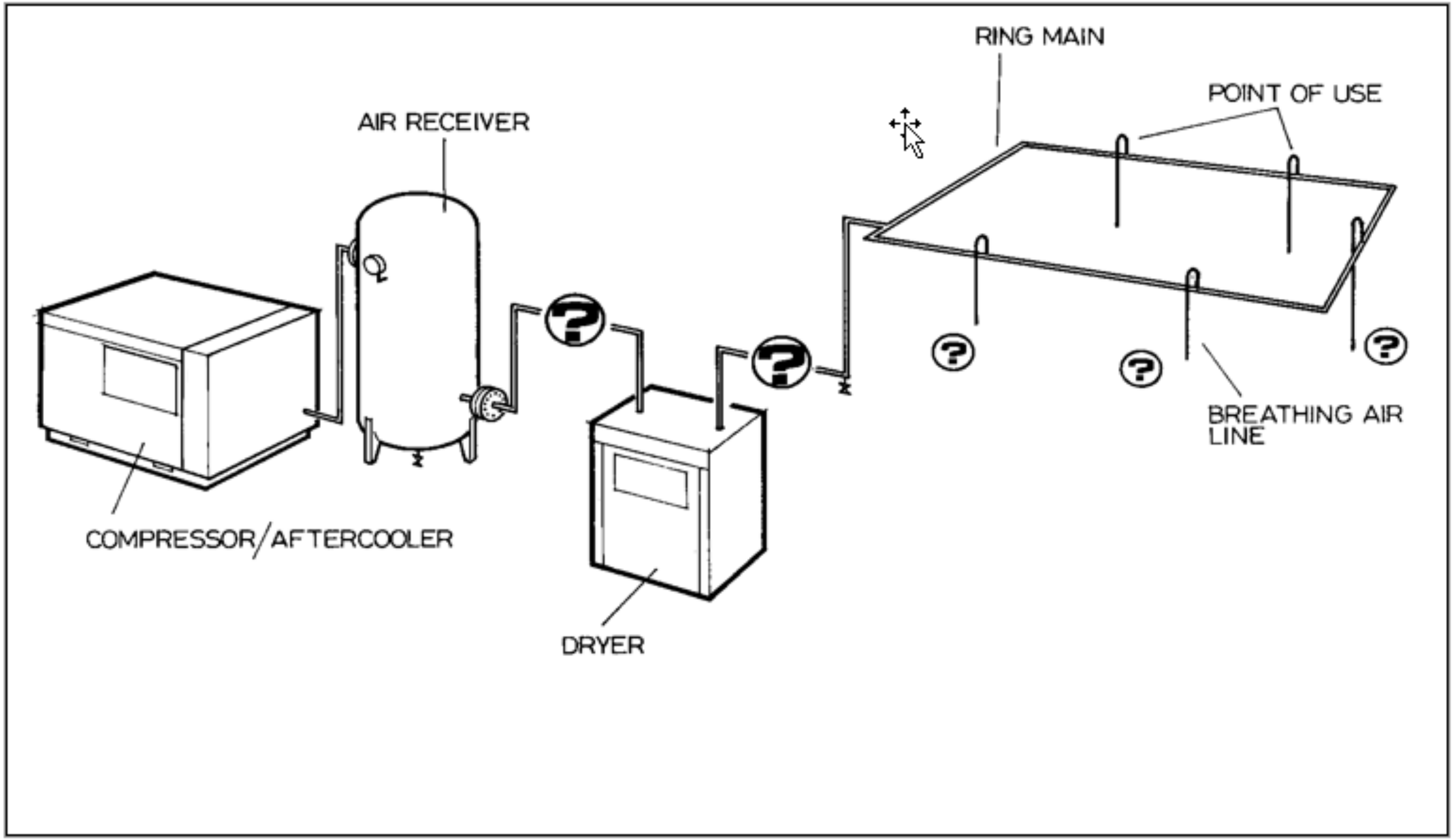
- Assuming that gravity separation can be disregarded as an effective option, the remaining 3 mechanisms provide the design basis for mist elimination equipment:
- **Direct Interception** - affecting particles over 1 micron in size.
- **Inertial Impaction** - affecting particles in the 0.3 to 1 micron size range.
- **Diffusion** (Brownian Movement) affects particles below 0.3



ACTIVATED CARBON ADSORPTION FILTERS

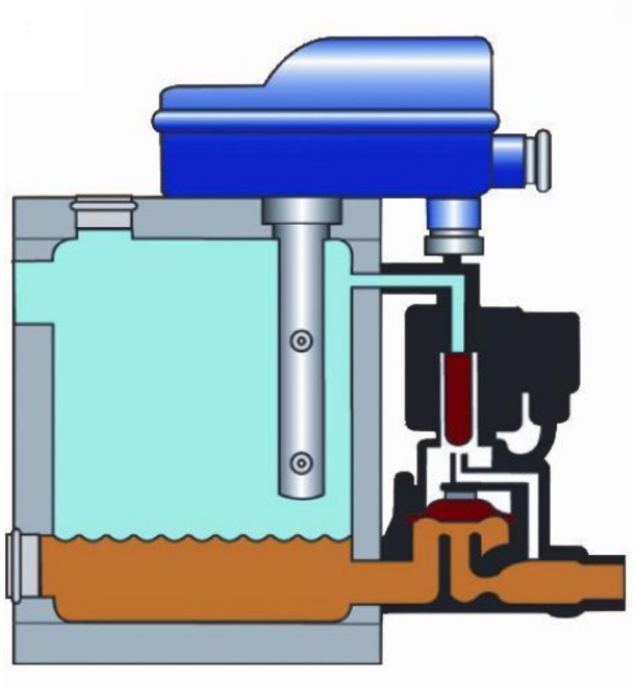
- Removes Oil Vapors and Odors
  - Prevents product Contamination
  - Increased costs due to lost production
  - Offers OSHA compliance for breathing air and pharmaceutical requirements
- This is not a coalescing filter!
  - Removes gaseous hydrocarbons and odors
  - Maximum remaining oil content to 0.003 ppm

Where Are the Filters Installed?



Condensate removal without the loss of compressed air.

- Inspect drain traps regularly and repair as necessary.
- Do not allow open manual drain valves.
- Use drain traps which sense the presence of condensate and drain it without loss of compressed air.



VS

VS

Is the condensate drain even working?

Condensate removal without the loss of compressed air

Condensate removal without the loss of compressed air

Condensate removal without the loss of compressed air

Summary

- The selection of a compressed air dryer should be based on the required pressure dewpoint and ambient conditions.
- Dryer ratings are based upon saturated air at inlet, the geographical location is not a concern.
  - However, the inlet temperature to a dryer is rated at 100F. Higher temperatures will require re-rating of the dryer size.
- Use the correct pre and after filters as applicable. Pressure drop must be taken into account.
- Compressed air should be dried only where necessary and only to the pressure dew point required.
- Compressed air should be filtered only where necessary and only to the quality required for the end use.

Next Week Session 5 - Distribution System

- The purpose of the distribution system is to ensure the right rate of flow of compressed air, at the right pressure, temperature and quality, for each end use application.