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Satisfying NFPA 99 (2002) Dew Point Requirements With Refrigerated Dryers

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NFPA 99 (2002) requires that dryers used in medical air source equipment be designed to produce a maximum dew point of 32°F. Since refrigerated dryer manufacturers rate their products to produce a pressure dew point of approximately 38°F, the 32°F requirement appears at first glance to preclude the use of refrigerated dryers. But this is not the case.

Although the text in the NFPA standard may appear to place the 32°F requirement on the dryer itself, the intent of the requirement is to ensure that the air leaving the medical air source equipment, as opposed to the air leaving the dryer, is at 32°F dew point maximum. This interpretation of the intent is supported by the text in the NFPA 99 (2002) Handbook which states under paragraph 5.1.3.5.7 "This more stringent requirement *[the 32 °F dew point]* in the 2002 edition still permits all the earlier dryer technologies...". Additional Handbook text under paragraph 5.1.3.5.15 discusses methods for ensuring that refrigerated dryers are utilized appropriately to meet the 32°F requirement, further supporting this interpretation.

The ability to reduce the dew point from 38°F as it exits the dryer to 32°F as it enters the distribution piping relies on the expansion of the air that occurs between the dryer exit and the source equipment isolation valve. This expansion occurs primarily across the final line regulator. This dew point reduction process can be illustrated by the following example.

Example: Air exits a refrigerated dryer at 80 psig with a dew point of 38 °F. What is the dew point after the air is regulated to 55 psig?

Dalton's Law of Partial Pressures states that as the total pressure of a gas mixture changes, all of the partial pressures comprising the total pressure change in the same ratio. So for an air mixture containing water vapor,

$$\left(\frac{Pv1}{Pt1}\right)=\left(\frac{Pv2}{Pt2}\right) \qquad \text{or} \qquad Pv2 = Pv1\left(\frac{Pt2}{Pt1}\right)$$

where Pv1 is the vapor pressure at condition 1 (in psia)
Pv2 is the vapor pressure at condition 2 (in psia)
Pt1 is the total pressure at condition 1 (in psia)
Pt2 is the total pressure at condition 2 (in psia)

For this example, Pt1 is 94.7 psia (80+14.7) and Pt2 is 69.7 psia (55+14.7). From Vapor Pressure Tables,

Pv1 (vapor pressure at 38 °F) = 0.1126 psia

Then Pv2 can be calculated as

$$Pv2 = (0.1126)\left(\frac{69.7}{94.7}\right) = 0.0829\,psia$$

From Vapor Pressure Tables (over ice), at a vapor pressure of 0.0829 psia, the Dew Point temperature is 30.6 °F. (This is actually a Frost Point, since the temperature is below 32 °F.)

In this example, the Dew Point was lowered from 38 °F to 30.6 °F by reducing the pressure from 80 to 55 psig.

The controls for duplex, triplex, and quadruplex medical air compressor systems manufactured by Squire-Cogswell/Aeros Instruments, Inc. are configured to ensure that the normal air pressure supplied to the dryer does not drop below 80 psig, thereby ensuring that the dew point requirement will be met.