TECHNICAL REPORTS
Modulating Steam Coils vs. Marlo Stratomizers

The Marlo Stratomizer coil is a system for preheating and tempering fresh makeup air using steam or hot water. The benefits of the Stratomizer are:

MAXIMUM FREEZE PROTECTION - Achieved by maintaining constant steam pressure to distributing steam tubes or full hot water flow to circuited tubes in the coil at all times.

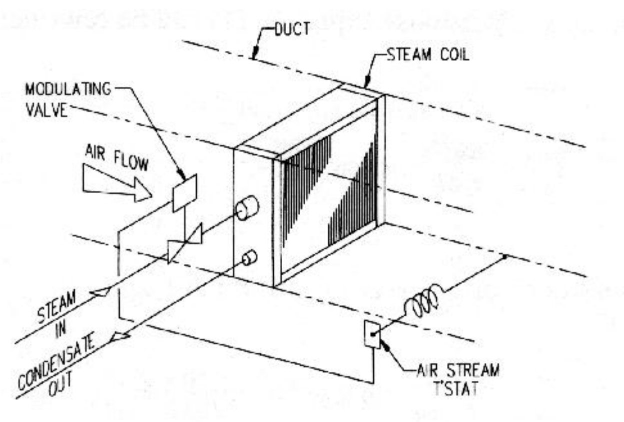
MINIMUM AIR STRATIFICATION - By heating small alternating layers of air, complete mixing is achieved in a short distance downstream of the coil.

ACCURATE TEMPERATURE CONTROL - Discharge airstream thermostat repositions the dampers to maintain a constant leaving air temperature independent of changes in the entering air temperature.

CONSTANT AIR VOLUME - The dampered coil and bypass sections are properly designed to maintain a constant air pressure drop resulting in constant air volume through the system.

Of all these, the primary benefit is that the Stratomizer offers *maximum coil freeze protection.* This freeze protection is achieved by not modulating the steam or hot water to control the coil leaving air temperature. It is this modulation that adds to the potential freezing of coils that are heating 100% outside air.

To illustrate this, a 100 % makeup air steam heating coil of the conventional type using a modulating valve and airstream thermostat will be analyzed. A schematic of the heating coil system is shown as follows:



For this analysis the coil will be sized for a 60°F temperature rise (-10°F to 50°F) using 5 psig steam.

The coil leaving air temperature will be controlled by a modulating steam pressure valve, which is adjusted by the air stream thermostat measuring the coil leaving air temperature. The thermostat will be set at 50°F and will modulate the steam valve, throttling the steam pressure (and corresponding steam temperature). The leaving air temperature of 50°F will then be maintained, independent of the coil entering air temperature (outside air temperature).

Heating coils are sized for the lowest design entering air temperature to insure the required heating performance. Any coil, when selected, has a fixed efficiency for the application to which it is applied. For a steam heating coil this efficiency can be defined by:

$$E = \frac{LAT - EAT}{TSAT - EAT} \quad (1)$$

Where: E = Efficiency
LAT = Leaving Air Temperature
EAT = Entering Air Temperature
TSAT = Steam Temperature at Saturation

To illustrate how this coil will perform at varying outside air temperatures, the required steam temperature must be calculated (as a function of entering air temperature) to maintain the desired leaving condition of 50°F. It can be assumed that as the outside air temperature increases, the amount of heat to be added to the air stream will decrease in order to maintain the leaving air temperature of 50°F. This will. be accomplished by throttling close the steam valve, thus reducing the steam pressure and the corresponding steam temperature. To see what steam temperature and pressure would be required at other than design (new conditions), equation (1) can be rewritten:

$$E = \frac{LAT - EAT}{TSAT - EAT} \ DESIGN \quad = \quad E = \frac{LAT - EAT}{TSAT - EAT} \ NEW \quad (2)$$

For the design conditions of -10°F EAT, 50°F LAT and 5 psig steam (TSAT = 227.2°F).

$$\frac{50 - (-10)}{227.2 - (-10)} \ DESIGN \quad = \quad \frac{50 - EAT}{TSAT - EAT} \ NEW$$

Rearranging this equation to solve for the required new steam temperature (TSAT) needed to maintain 50°F LAT for various entering air temperatures.

$$TSAT = 197.6 - 2.95\ EAT \tag{3}$$

The following table can then be created showing entering air temperature, leaving air temperature, required steam saturation temperature and corresponding steam pressure.

Modulating Coil Performance Example					
EAT	LAT	TSAT	PSIG	PSIA	Comments
-10	50	227.2	5.0	19.7	Design (Base)
-5	50	212.4	0	14.7	(Atmospheric Pressure)
0	50	197.6	-4.2	10.5	(Below Atmospheric Pressure!)
10	50	168.1	-8.9	5.8	(Below Atmospheric Pressure!)
Table 1					

As can be seen in Table I above, the modulating steam valve will be driven shut in order to maintain the desired leaving air temperature of 50°F when the entering air is slightly below 0°F. At this point a vacuum is created inside the coil preventing condensate from draining. A <u>potentially hazardous freeze situation</u> is created with sub-freezing air, low temperature condensate and a vacuum within the heating coil.

Even if the coil doesn't freeze at this point, air temperature control will be lost due to condensate in the tubes of the coil. A vacuum breaker can and should be added to the system to reduce the risk of this condition. However, a vacuum breaker is a safety device to protect a system from operating extremes... and not normal operating occurrences.

The Stratomizer System controls leaving air temperature while full steam pressure (or hot water flow) is maintained in the coil at all times. The leaving air temperature is held constant regardless of changes in the inlet air temperature.

Stratomizer Performance Example					
EAT	LAT	TSAT	PSIG	PSIA	Comments
-10	50	227.2	5.0	19.7	Design (Base)
0	50	227.2	5.0	19.7	
10	50	227.2	5.0	19.7	
25	50	227.2	5.0	19.7	
70	72	227.2	5.0	19.7	
Table 2					

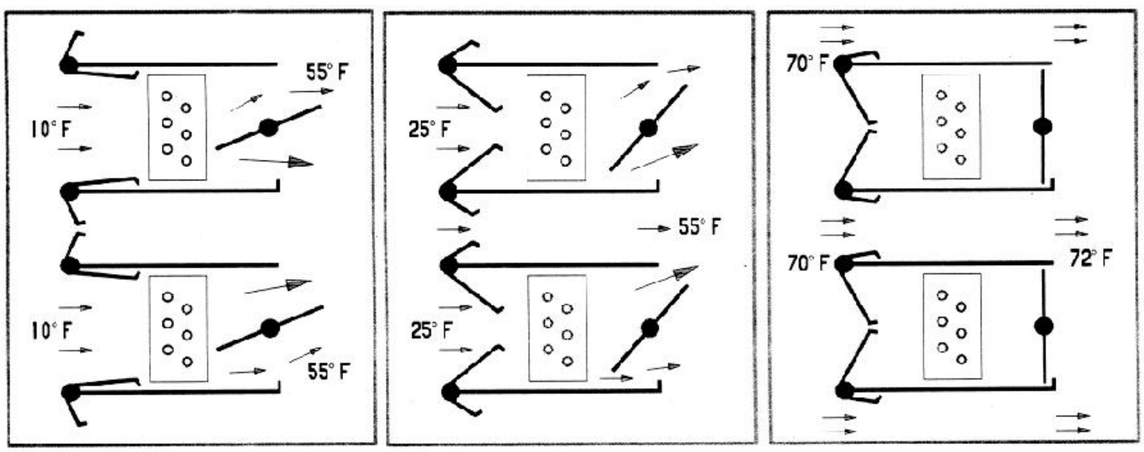
Table 2 illustrates how the Stratomizer System significantly reduces the risk of coil freezing. The steam pressure remains constant, regardless of inlet air temperature, eliminating the vacuum problem associated with modulating steam coils.

Conclusion:

Conventional modulating steam coils may be capable of preheating air in 100% make-up air systems. However, the disadvantages of using them potential freezing and inadequate temperature control, make modulating steam coils an unattractive alternative for these applications.

Marlo Stratomizer coils are designed to provide a safe and reliable method of preheating make-up air. Accurate temperature control is easily achieved regardless of entering air temperatures. The Stratomizer also provides maximum freeze protection which means reduced system down time.

STRATOMIZER OPERATION



When entering air temperature conditions require maximum heating, the dampers fully open and the upstream dampers direct all the entering air through the heating coil face.

As the entering air temperature increases, the dampers are automatically repositioned, proportioning the correct amount of entering air through both the heating coil faces and bypasses.

When no heating is required, the dampers are closed and the upstream dampers direct all the entering air through the coil bypasses. The rear dampers enclose the heating cores minimizing temperature override.