AirTest™
Sensors That Make Buildings Smart!

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Psychometric and Energy Formulas Used For DOAS MRE Calculations

To Calculate Dew Point & Mixing Ratio From Temperature, RH and Altitude — **SI Example**

Inputs:		**Inputs**		
T=	ºC temperature	Temp=	32.2	ºC
RH=	% relative humidity	RH=	55.0	%
El=	Elevation in meters (Not required for Dew Point)	El=	198	m

Other Terms

Td= dew point temperature ºC
w= mixing ratio in g/kg (multiply by 7 for grains/lb)
e= vapor pressure in mb (millibars)
es= saturated vapor pressure (mb)
Psta= station pressure (mb)

1 Calculate The Saturated Vapor Pressure

es= 6.11X10^((7.5xT)/(237.7+T)) — es= 47.95 mb
http://www.weather.gov/media/epz/wxcalc/vaporPressure.pdf

2 Calculate The Dew Point

Td= (237.3*LN(es*RH/611))/((7.5*LN(10))-(LN(es*RH/611))) — Td= 22.0 ºF Td
http://www.weather.gov/media/epz/wxcalc/wetBulbTdFromRh.pdf

3 Calculate Mixing Ratio

3.1 Calculate Vapor Pressure

e= 6.11*10^((7.5XTd)/(237.3+td)) — e= 26.4 mb

3.2 Calculate Station Pressure

Three methods: 1) use pressure sensor on TR4601 sensor
2) Calculate based on temp and altitude
3) Calculate based on altitude

3.2.1 Psta Using Temperature and Altitude (This will be used)

Psta= Pb x [(Tb/(Tb + Lb x (h - hb))^((g0*MR) / (R* x Lb))] — Psta= 99100.5 Pa
https://en.wikipedia.org/wiki/Barometric_formula — Psta= 991.0 mb

Pb=	Static Pressure at sea level (Pa) divide by 100 to convert Pa to mb	Pb=	101325
ºC=	Temp Celsus	ºC=	32.2
Tb=	Convert ºC to ºK	Tb=	305.35
Lb=	Temp Laps Rate (0-11000m)(K/m)	Lb=	-0.0065
h=	height above sea level (m)	h=	198
hb=	height a bottom of layer b (m)	hb=	0
R*=	universal gas constant	R*=	8.3144598
g0=	gravitational acceleration (m/s2)	g0=	9.80665
M=	molar mass of Earths Air (kg/mol)	M=	0.0289644

3.2.2 Psta Using Altitude

Psta= 101325 x (1 - 2.25577 10-05 x El)^5.25588 — Psta= 98968.9 Pa
http://www.engineeringtoolbox.com/air-altitude-pressure-d_462.htn — Psta= 989.7 mb

3.3 Calculate Mixing Ratio

w= 621.97X(e/(psta-e)) — w= 17.01 g/kg
https://www.weather.gov/media/epz/wxcalc/mixingRatio.pdf — w= 119.0 gr/lb (IP)

Note pressure values are in mb
Multiply by 7 to get gr/lb

4 Energy & Efficiency Values

4.1 Calculating True Power (3 Phase)

kW= (V (avg) X A (Avg) X PF X 1.732)/1000 — kW= 34.4 kW

Vave=	Voltage: Measured once =(469+469+470)/3	Vave=	469.0	volts (constant)
Aave=	Amps: Measured in real time by minute example =(57.1+57.4+47.1)/3	Aave=	52.9	amps (used me
PF=	Power Factor: assumed to be 80%	PF=	0.80	% (constant)

4.2 Calculate Dehumidifican Removal Efficiency (DRE)

DRE= (cfm x delta grains x 0.0006429) — DRE= 296.6 lbs/hr

cfm=	Real time measured value	cfm=	7410	measured
OA MR=	Outdoor Mixing Ratio (gr/lb) real time measured/calculated value	gr/lb=	118.8	measured/Ca
SA MR=	Supply air Mixing Ratio (gr/lb) real time measured/calculated value	gr/lb=	56.5	measured/Ca

4.3 Calculating Moisture Removal Efficiency (MRE)

MRE= DRE/kW — MRE= 8.6 lbs/kWh

New Brunsfelt TX Location

Real Time Measured and Calculated Data

Type	Abrev	SI Value	IP Values
Measured Values			
OA Air Intake			
Temp	Toa	ºC	ºF
RH	RHoa	%RH	% RH
Pressure	Poa	mb	in WC
Supply Air 1			
Temp	Tsa1	ºC	ºF
RH	RHsa1	%RH	% RH
Pressure	Psa1	mb	in WC
Supply Air 2			
Temp	Tsa2	ºC	ºF
RH	RHsa2	%RH	% RH
Pressure	Psa2	mb	in WC
Amps			
Line 1	A1	amps	
Line 2	A2	amps	
Line 3	A3	amps	
Average Amps	Aave	amps	
Volts			
Line 1	V1	469 VAC	
Line 2	V2	469 VAC	
Line 3	V3	470 VAC	
Average Amps	Vave	469 VAC	
Power Factor			
Power Factor	PF	80 %	
AirFlow			
Real time cfm	AF1	cfm	
Hourly cfm average	AF2	cfm	
Altitude			
Altitude above sea level	El	198 m	650 ft

Type	Abrev	SI Value	IP Values
Calculated Values			
Saturated Vapor Pressure (es)			
OA Vapor Pressure	esoa	mb	
SA1 Vapor Pressure	ess1	mb	
SA2 Vapor Pressure	ess2	mb	
Dew Point (Td)			
OA Dew Point	OATd	ºC Td	ºF Td
SA1 Dew Point	SA1Td	ºC Td	ºF Td
SA2 Dew Point	SA2Td	ºC Td	ºF Td
Saturated Vapor Pressure (e)			
OA Saturated Vapor Pressure	OAe	mb	
SA1 Saturated Vapor Pressure	SA1e	mb	
SA1 Saturated Vapor Pressure	SA2e	mb	
Station Pressure (Psta) Calculation For Outside Air Usubg Temperature and A			
Static Pressure at sea level (Pa)	Pb	101325 Pa	
ºC Temp Converted to ºK	Tb	ºK	

Temp Laps Rate (0-11000m)(K/m	Lb	-0.0065	K/m		
height above sea level (m)	El	198	m		
height a bottom of layer b (m)	hb	0	m		
universal gas constant	R	8.31446			
gravitational acceleration (m/s2)	g0	9.80665	m/s2		
molar mass of Earths Air (kg/mol)	M	0.028964	kg/mol		
Station Pressure	Pstat		Pa		
Station Pressure converted to mb	Pstat		mb		
Calculate Mixing Ratio					
OA Mixing Ratio	OAmr		g/kg		gr/lb
SA1 Mixing Ratio	SA1mr		g/kg		gr/lb
SA2 Mixing Ratio	SA2mr		g/kg		gr/lb
Calculate True Power (3 Phase)					
Total unit Kw consumption	kW		kW		
Dehumidification Removal Efficiency (DRE)					
OA - SA1 DRE	DRE1				lbs/hr
OA - SA2 DRE	DRE2				lbs/hr
OA - SA Average DRE	DREave				lbs/hr
Moisture Removal Efficiency (MRE)					
OA - SA1 MRE	MRE1				lbs/kWh
OA - SA2 MRE	MRE2				lbs/kWh
OA - SA Average MRE	MREave				lbs/kWh

Sample Strategy/Formula
60 second sample rate 60 second sample rate 60 second sample rate
60 second sample rate 60 second sample rate 60 second sample rate
60 second sample rate 60 second sample rate 60 second sample rate
60 second sample rate 60 second sample rate 60 second sample rate 60 second calculated
Measurement at Start-up Measurement at Start-up Measurement at Start-up Calculated Constant Average
Assumed value
60 second sample rate real time 60 minute average
Topographical Reference
Sample Strategy/Formula
=6.11X10^((7.5xToa)/(237.7+Toa)) SI =6.11X10^((7.5xTsa1)/(237.7+Tsa1)) SI =6.11X10^((7.5xTsa2)/(237.7+Tsa2)) SI
=(237.3*LN(esoa*RH/611))/((7.5*LN(10))-(LN(esoa*RH/611))) SI =(237.3*LN(ess1*RH/611))/((7.5*LN(10))-(LN(ess1*RH/611))) SI =(237.3*LN(ess2*RH/611))/((7.5*LN(10))-(LN(ess2*RH/611))) SI
=6.11*10^((7.5XOATd)/(237.3+OATd)) =6.11*10^((7.5XSA1Td)/(237.3+SA1Td)) =6.11*10^((7.5XSA2Td)/(237.3+SA2Td))
ltitude Constant = Toa + 283.15 SI - Calculated every 60 sec

Constant
See altitude
Constant
Constant
Constant
Constant
=Pb x [(Tb/(Tb + Lb x (h - hb))^((g0*M) / (R x Lb))] SI every 60sec
mb = Pa x 100 every 60 seconds

= 621.97X(OAe/(Psta-OAe))   SI   X 7.0 for gr/lb
= 621.97X(SA1e/(Psta-SA1e))   SI   X 7.0 for gr/lb
=621.97X(SA2e/(Psta-SA2e))   SI   X 7.0 for gr/lb

(Vavg X Aavg X PF X 1.732)/1000

= (AF2 X (OAmr-SA1mr) X 0.0006429) IP use gr/lb
= (AF2 X (OAmr-SA2mr) X 0.0006429) IP use gr/lb
= (DRE1 + DRE2) / 2

= DRE1 / kW
= DRE2 / kW
= (MRE1 + MRE2) / 2