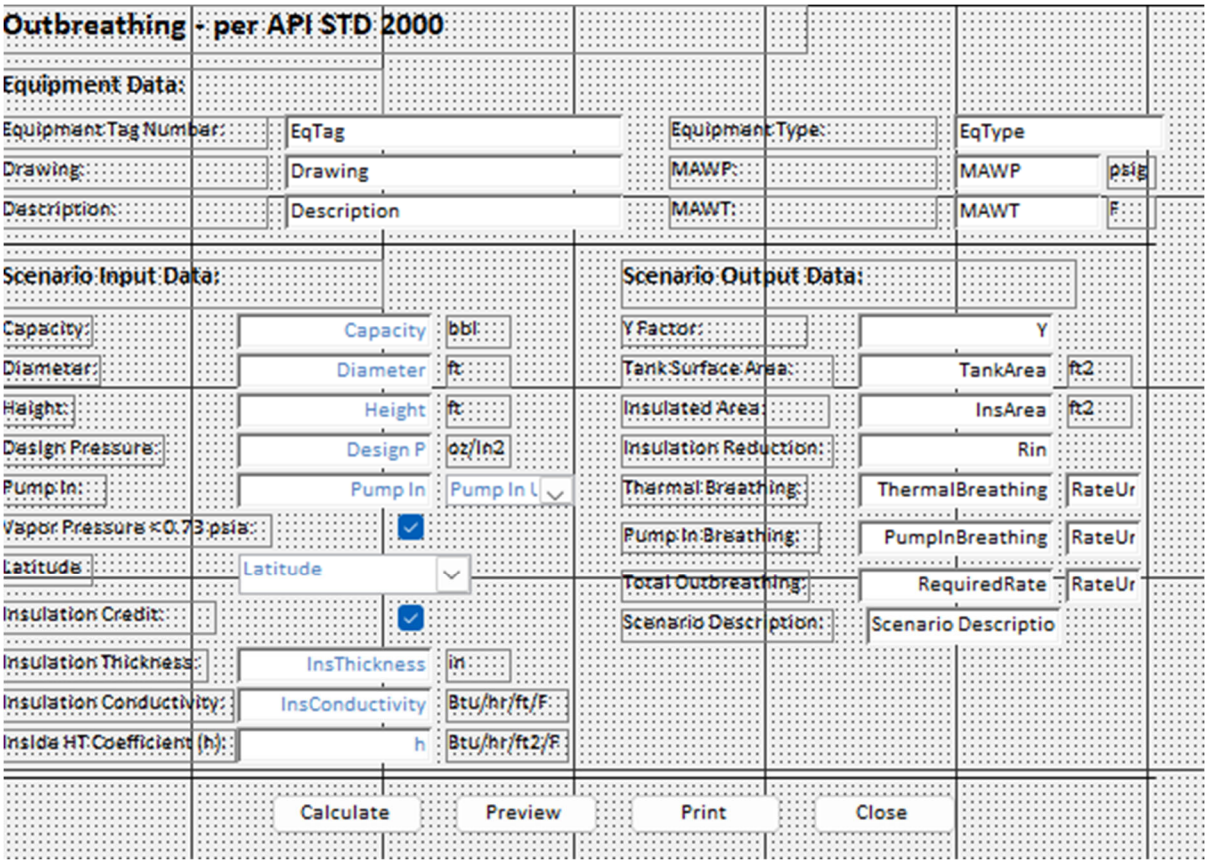
API STD 2000 Outbreathing



Equipment Data:

The six fields under Equipment Data are specified on the Overpressure Scenario Form.

Input Data:

The form fields for inputs are blue and organized under the Scenario Input column. These are described below:

Capacity – Tank nominally rated storage capacity in bbl

Diameter – Tank diameter generally taken as the outer diameter

Height – Tank height from floor to roof connection assumes vertical orientation

Design P – Design pressure in oz/in2

Pump In – Maximum rate of liquid movement into the tank

Pump in Units – Flow units for liquid movement into the tank (gpm or bpd)

Vapor Pressure < 0.73 psia – If yes, calculation per API STD 2000 may proceed. If no, a flash calculation should be performed.

Latitude – Tank location latitude used in determination of thermal breathing requirement. Less than 42° is most conservative

Insulation Credit – Yes will determine the Insulation Reduction Factor based on the input insulation details

InsulationThickness – Insulation thickness inches

InsHeight – Height of insulation above tank floor in feet

Roof Insulated – If yes, roof area is included in the Insulated Area

InsConductivity– Conductivity of insulation material in Btu/hr/ft/F

h = Inside heat transfer coefficient in Btu/hr/ft2/F with a typical default of 0.7

Calculation Method:

The calculation method for outbreathing is the sum of the thermal and pump-in outbreathing requirements both of which are well established in API STD 2000. The thermal outbreathing requirement depends on a constant Y from Table 1 below which is based on the tank location latitude.

Table 1 — Y-factor for various latitudes

Latitude	Y-factor
Below 42°	0,32
Between 42° and 58°	0,25
Above 58°	0,2

If no credit is to be taken for insulation, the thermal outbreathing requirement (V_{OT}) can be evaluated using the following equation and assuming R_i = 1.0.

$$V_{OT} = 1.51\ x\ C\ x\ V_T^{0.9}\ x\ R_i$$

If credit is to be taken for insulation, R_{in} which is the insulation reduction factor for a fully insulated tank can be quantified per the following equation.

$$R_{in} = \frac{1}{\left(1+\frac{h\ x\ l_{in}}{\lambda_{in}}\right)}$$

h – Inside heat transfer coefficient default value 0.7 Btu/hr/ft^2/F

l_{in} – Insulation thickness in ft

λ_{in} – Insulation conductivity in Btu/hr/ft/F

R_I is equal to R_{in} for fully insulated tanks or R_I is calculated for partially insulated tanks as follows:

$$R_i = \frac{A_{inp}}{A_{TTS}} xR_{in} + \left(1 - \frac{A_{inp}}{A_{TTS}}\right)$$

A_{inp} = Insulated surface area of tank ft^2

A_{TTS} = Total surface area of tank including roof ft^2

The required outbreathing rate due to inflow of fluid (pump-in) to the tank (V_{IP}) is then quantified and added to the thermal outbreathing requirement from above to determine the overall outbreathing requirement. Note the below assumes a liquid vapor pressure < 0.73 psia.

$$V_{OP} = 8.02\ x\ V_{oe}$$

V_{pe} = Volume of liquid removal in gpm

Scenario Output Data:

The form fields for scenario-specific outputs are organized under the Scenario Output column. These are described below:

Y – Constant per API STD 2000 Table 1

TankArea – Calculated total tank area including the roof ft^2

InsArea – Calculated total insulated tank area ft^2

Rin – Insulation reduction factor – 1.0 if not insulated

ThermalBreathing – Outbreathing requirement associated with increases in ambient temperature or solar

PumpInBreathing – Outbreathing requirement associated with liquid movement into the tank

RequiredRate – Sum of ThermalBreathing and PumpInBreathing in scfh air

QA/QC Benchmarks:

Given the relative simplicity of the calculations, the thermal and pump-out inbreathing requirements were benchmarked against an internal RKR spreadsheet for a 400 bbl Gasoline Storage Tank was assumed to have 2" of insulation to a height of 19'. Both the thermal and pump-in outbreathing requirements (211 scfh air and 1,604 scfh air, respectively) were identical along with the total outbreathing requirement of 1,1815 scfh air.

Outbreathing - API STD 2000

T-6000 Outbreathing

Equipment Data:

Equipment Tag:	**T-6000**	Type:	API 12F Tank
Drawing:	PID-6000	MAWP:	1 psig
Description:	Gasoline Storage Tank	MAWT:	120 F

Scenario Description:

The 400 BBL storage tank could be subject to overpressure in the event of liquid movement into the tank and/or increases in ambient temperature/solar. The required inbreathing rate was based on API STD 2000.

Scenario Input Data:

Capacity:	400	bbl
Diameter:	12	ft
Height:	20	ft
Vapor Pressure < 0.73 psia:	☑	
Design Pressure:	16	oz/in2
Pump In Rate:	200	gpm
Latitude:	<42 Degrees	
Credit for Insulation:	☑	
Insulation Thickness:	2.00	in
Insulation Height:	19.00	ft
Roof Insulated:	☐	
Insulation Conductivity:	0.05	Btu/hr/ft/F
Inside Heat Transfer Coefficient:	0.700	Btu/hr/ft2/F

Scenario Calculation Results:

Y Factor:	0.32	
Tank Surface Area:	867	ft2
Insulated Area:	716	ft2
Insulation Reduction:	0.422	
Thermal Breathing:	211	scfh air
Pump In Breathing:	1,604	scfh air
Required Rate:	1,815	scfh air

Notes:

API STD 2000 Outbreathing

Thermal Outbreathing

T	90	F
C6+	Yes	
Latitude	30	°
Tank Volume	400	bbl
Tank Diameter	12	ft
Tank Height	20	ft
h	0.7	Btu/(hr*ft^2*F)
l_{in}	2	in
λ_{in}	0.05	Btu/(hr*ft*F)
Ins_{height}	19	ft
Include Roof	No	
Y	0.32	
V_{TK}	2246	ft^3
A_{TTS}	867.1	ft^2
A_{inp}	716.3	ft^2
R_{in}	0.300	
R_{inp}	0.422	
V_{OT}	211.6	scfh air

Pump-In Breathing

Pump-In Rate	200	gpm
V_{op}	1604	scfh air

Total Outbreathing 1815.6 scfh air