CO_2 Scrubbing: Sizing, Room Loading and Efficiency

Josh Kreft
Gas At Site
JoshK@GasAtSite.com

Today's talk

- Trend to lower CO_2 may mean you don't have enough installed scrubbing capacity.
- Using an average CO_2 % calculation for your complex may not always be sufficient.
- If you are struggling to maintain CO_2 setpoints check the math but also check your carbon efficiency.

What is a Scrubber?

- Filled Activated Carbon which adsorbs CO_2
- 2 drums & 2 blowers
- Adsorption to remove CO_2 from room
- Regeneration to clean saturated carbon
- One drum always active on a room, while the other drum is being regenerated

Trends to lower CO_2 requires increased Scrubber Capacity

- Less CO_2 in the room means its harder to remove

CO2 Setpoint	Scrubbing Factor
3.0%	1
2.5%	1.2
2.0%	1.5
1.5%	2
1.0%	3
0.5%	7

Trends to lower CO_2 requires increased Scrubber Capacity

CO_2 %	Isolcell Model			
	ECO 850	ECO 700	ECO 500	IS 400
3.00	850	700	500	400
2.50	708	583	417	333
2.00	567	467	333	267
1.50	425	350	250	200
1.00	283	233	167	133
0.50	121	100	71	57

kg CO_2 removed in 24hrs at specified CO_2 level

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8 Room example

- 8 x 1000 bins at 1.5% CO_2
- 380kg apples per bin

We need to:

- Calculate kg apples in the complex
- Calculate kg CO_2 these apples produce
- Choose an appropriate scrubber

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$$\frac{8\ \cancel{rooms}}{1}\ x\ \frac{1000\ \cancel{bins}}{\cancel{room}}\ x\ \frac{380kg}{\cancel{bin}} = 3040\ \text{x}10^3\ kg\ apples$$

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- How much CO_2 will be produced in 24hrs? (at 0˚C)

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- How much CO_2 will be produced in 24hrs? (at 0˚C)

$$\frac{0.066kg\ CO_2}{1\cancel{kg\ apples}}\ x\ \frac{3040\ 000\cancel{kg\ apples}}{1} = 200kg\ CO_2$$

Choosing suitable scrubber

$200kg$

- At 1.5% CO_2:

$$200kg\ x\ 2 = 400kg\ \textit{Scrubbing capacity required}$$

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Matching Scrubbing Capacity

$200\,kg$

CO_2

- At 1.5% CO_2

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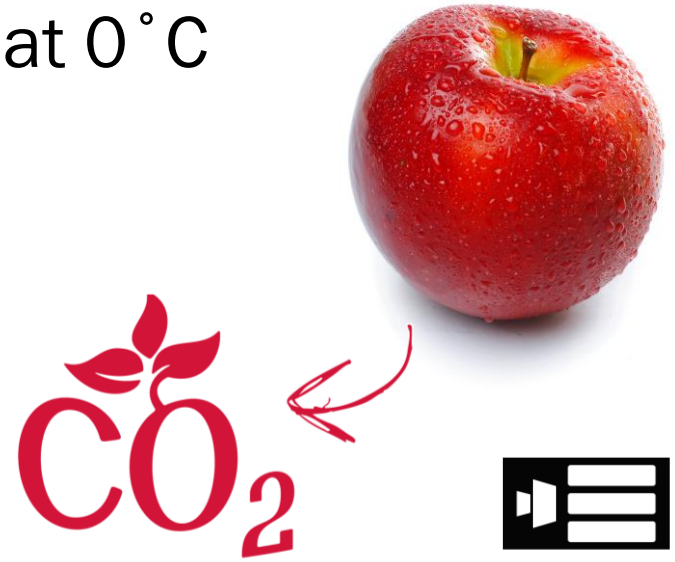
Respiration

- 0.066kg CO_2 produced per kg apples per 24hrs at 0˚C

  (CA Operators Manual Page 15; Table 2 – be careful of units)

- At higher temperatures the amount of CO_2 produced will increase

- Fruit at 21˚C will produce 7 times the CO_2 as fruit at 0˚C



Example at Low CO_2 Levels:

- Looking at **average** CO_2 levels for your complex can be misleading

- 4 rooms Goldens at 2.5% CO_2
- 4 rooms Pink Lady at 0.5% CO_2

- Average 1.5% CO_2

- But remember at lower CO_2 % we need more scrubbing capacity!

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Example at Low CO_2 Levels:

- 4 rooms Goldens at 2.5% CO_2

$$100kg\ x\ 1.2 = 120kg\ Scrubbing\ capacity\ required$$

$200kg$

CO_2

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Example at Low CO_2 Levels:

- 4 rooms Goldens at 2.5% CO_2

$$100kg\ x\ 1.2 = 120kg\ Scrubbing\ capacity\ required$$

- 4 rooms Pink Lady at 0.5% CO_2

$$100kg\ x\ 7 = 700kg\ Scrubbing\ capacity\ required$$

$200kg$

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Example at Low CO_2 Levels:

$200kg$

- 4 rooms Goldens at 2.5% CO_2

$100kg\ x\ 1.2 = 120kg$ *Scrubbing capacity required*

- 4 rooms Pink Lady at 0.5% CO_2

$100kg\ x\ 7 = 700kg$ *Scrubbing capacity required*

- $820kg$ *Total Scrubbing capacity required*

1 x ECO 850

Managing Rooms at Low CO_2 Levels:

8 x 1000 bins

Producing 200kg CO_2 per day

- 8 rooms at 1.5% CO_2

400 *kg Total Scrubbing capacity required*

- 4 rooms Goldens at 2.5% CO_2
- 4 rooms Pink Lady at 0.5% CO_2

820 *kg Total Scrubbing capacity required*

Both examples average 1.5% CO_2

1 x IS 400

1 x ECO 850

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Managing Rooms at Low CO_2 Levels:

- Don’t load all the low CO_2 rooms on the same scrubber
- Beware of warm fruit (higher CO_2 production)
- Plan Ahead…

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Scrubber Carbon Efficiency:

- Activated Carbon is an engineering component
- Degrades over time
- Typically ~12000hrs

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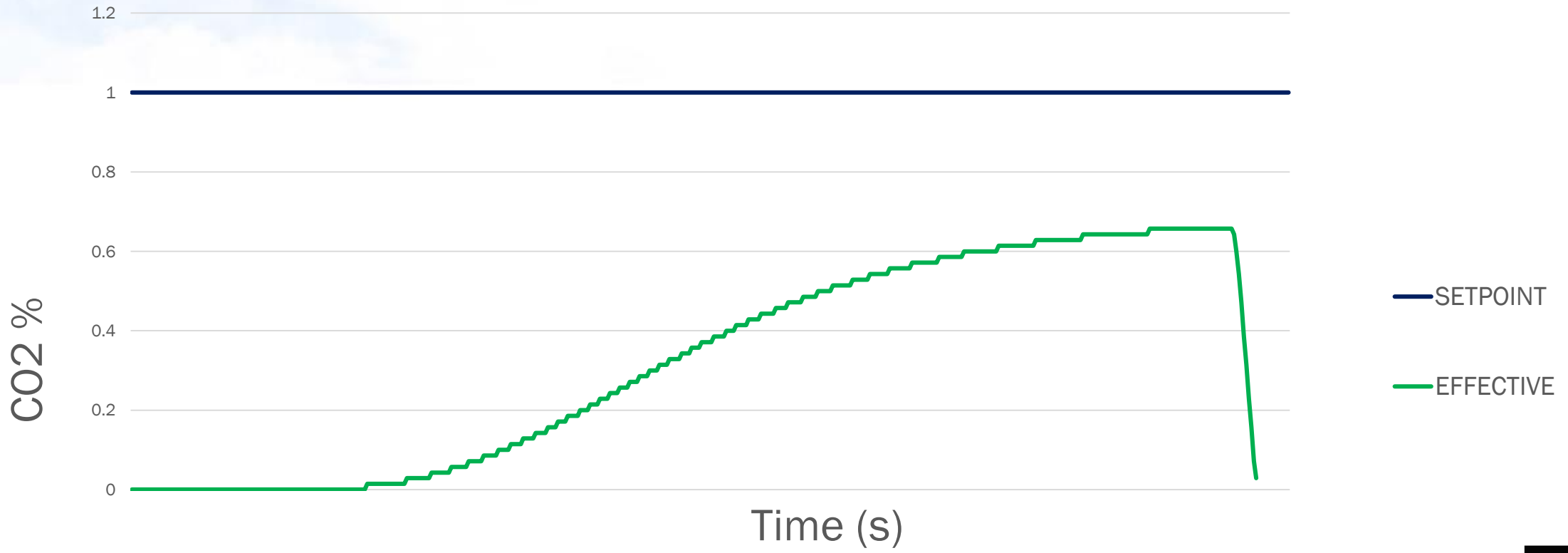
Scrubber Efficiency

- Room at 1.0% CO_2 shown by blue line
- Area under curve shows CO_2 returning to the room



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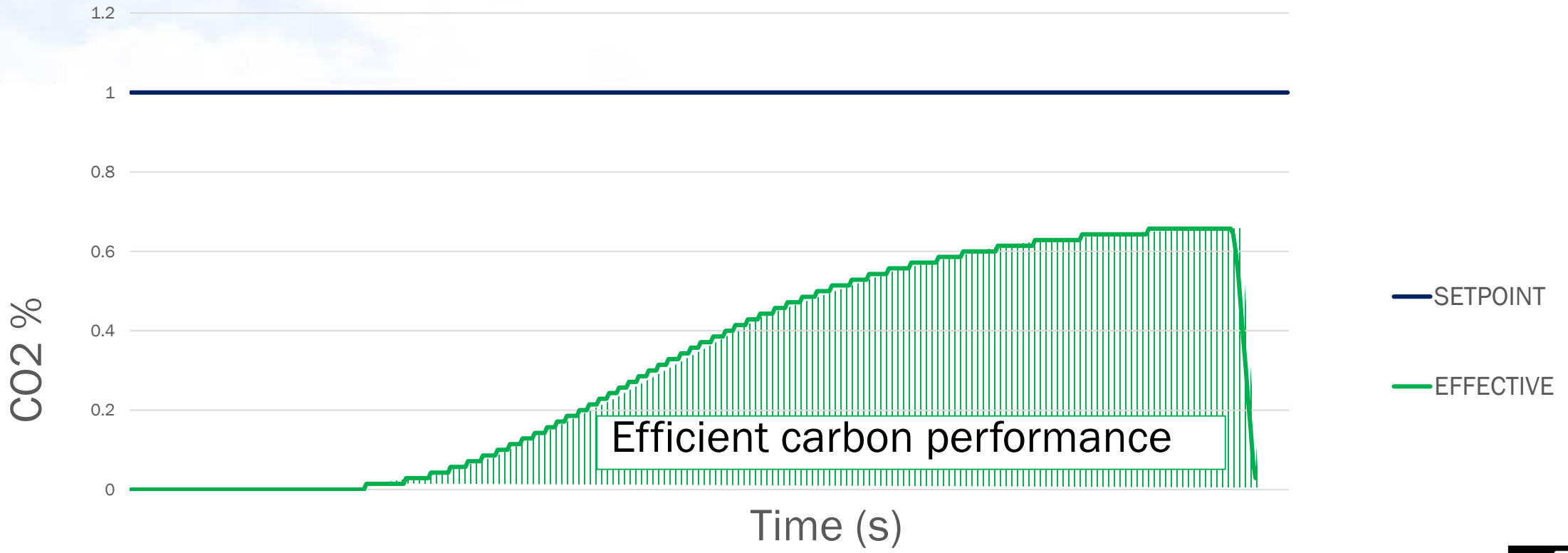
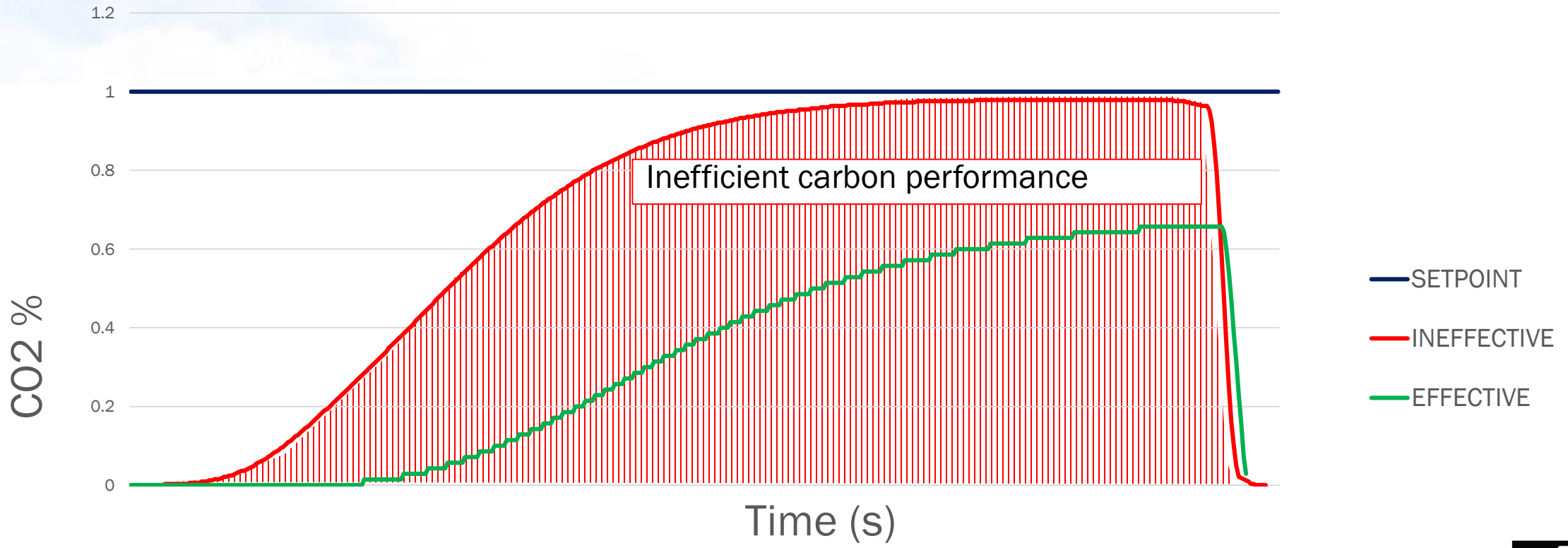


Scrubber Efficiency

- The smaller the area the better.



Conclusion

- Using an **average** CO_2 % calculation for your complex may not always be sufficient
- Consider calculating the scrubbing capacity required per room
- Don’t load all the low CO_2 rooms on the same scrubber
- Scrubber carbon efficiency needs to be checked every ~12000hrs
- Plan ahead…

Thank You for your attention.

Josh Kreft

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JoshK@GasAtSite.com