

Estimated O₂ Savings by reBreather

The advantage of the Closed-Circuit system comes from the significant difference between the volume of O₂ a patient with respiratory distress inhales and the actual volume of O₂ the body picks up.

For reference, a healthy person breathes in ~5L/min of air (80% N₂, 20% O₂) which corresponds to ~1L/min of O₂. Of this 1L/min inhaled, the healthy human body picks up only about 250mL/min [1] or 0.25L/min of O₂. Hence the remaining 750mL/min of O₂ is exhaled out unused and is lost to the environment. This O₂ wastage can be more dramatic for ARDS patients: Covid-19 patients in intensive care can be given 50 L/min of O₂ with only 1-1.5 L/min actually being utilized.

In a closed-circuit system, this lost oxygen is captured and recycled within the system. This allows the caregiver to send in fresh Oxygen only to make up for the O₂ that is actually taken up by the human body.

A comparison of the number of cylinders consumed by a single patient when using non-closed-circuit systems like NRM/HFNO etc., versus our closed-circuit design is shown in the table below. The calculations for each of those numbers are shared after.

Scenarios	Open Loop (cylinders/day)	Closed Loop (10% purge) cylinders/day
Nasal Cannula, 6L/min*	1.1	~0.28 (74% ↓)
Nonrebreathing mask, 15L/min*	2.8	~0.44 (84% ↓)
High Flow Nasal Cannula (HFNC), 50L/min*	9.2	~1.09 (89% ↓)
*Cylinder consumption shown for 1 patient 1 cylinder = 7800L of pure O ₂		

Scenarios:

1) Mild COVID patient treated at low-flow [6L/min O₂] (Nasal Cannula)

Actual O₂ Uptake by the body = 0.5L/min (assumed)

Open Loop:

O₂ consumption from cylinder [L/min] = 6*60*24 = 8,640 L/day ~ 1.11 cyl/day

Closed Loop:

O₂ consumption from cylinder [L/min] = $0.5 \times 60 \times 24 = 720$ L/day ~ 0.09 cyl/day (without purge).

With 10% purge through a PEEP valve, this becomes 0.278 cyl/day.

2) Serious COVID Patient treated at 15L/min O₂ (Nonrebreathing mask)

Actual O₂ Uptake by the body = 1L/min (assumed)

Open Loop:

O₂ consumption from cylinder [L/min] = $15 \times 60 \times 24 = 21,600$ L/day ~ 2.77 cyl/day

Closed Loop:

O₂ consumption from cylinder [L/min] = $1 \times 60 \times 24 = 1,440$ L/day ~ 0.2 cyl/day. (without purge).

With 10% purge through a PEEP valve, this becomes 0.445 cyl/day.

3) Very Serious COVID Patient treated at 50L/min O₂ (High flow nasal oxygen)

Actual O₂ Uptake by the body = 1.5L/min (assumed)

Open Loop:

O₂ consumption from cylinder [L/min] = $50 \times 60 \times 24 = 72,000$ L/day ~ 9.23 cyl/day

Closed Loop:

O₂ consumption from cylinder [L/min] = $1.5 \times 60 \times 24 = 2,160$ L/day ~ 0.3 cyl/day (without purge).

With 10% purge through a PEEP valve, this becomes 1.09 cyl/day.

References

[1] Leach RM, Treacher DF. The relationship between oxygen delivery and consumption. *Dis Mon.* 1994 Jul;40(7):301-68. PMID: 8020386.