ReductionTech Inc. GHG Offsetting System and Accompanying Measurement Methodology.

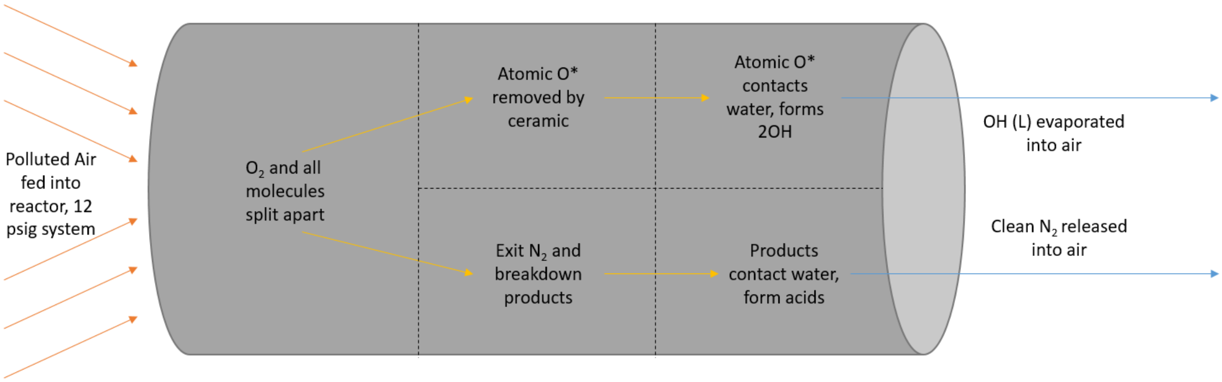
ReductionTech's proven oxide radical generating system is paired either with ambient moisture or artificial steam to produce a concentrated stream of hydroxyl radicals. The hydroxyl is widely known as mother nature's magic bullet atmospheric cleanser, which includes the full range of GHGs, CH4, PFC-CFCs, SLCPs, CO2, O3, N2O and Nox. It also reacts with VOCs and particulate matter, which means that apportionment of each gas or constituent is necessary for carbon offsetting accuracy. Hydroxyl permanently removes by oxidation/reduction all of these constituents, and thus is a sound GHG removal method.

In an accompanying spreadsheet there is a calculator which provides a framework for apportionment to the various GHGs, in ppm units. The average background levels of hydroxyl are calculated as well in order to ensure that clarity of the full dose in the atmosphere can be determined. Concentrated streams are emitted from elevated points, known as stacks, so that human exposure is safely controlled.

Simple Calculator of *OH Needs		
Airshed Constituents in ppm		
CAP	**ppm**	
CO	0.871	
Sox	0.0004	
CH4	1.867	
PM 2.5	0.0246	
O3	0.0246	
Nox	0.0155	.010-.045
CO2 0>0006x 410ppm	0.42	.01% of 420ppm buffered by *OH in H2O
VOC	0.0593	
SGHG basket	0.018638	synthetic GHGs or CFC gases
Total Reactant Flux	**3.301038**	
(*)OH	**ppm over an hour**	
PPB-PPM (*)OH natura	0.0108	0.006*1800seconds per 3600 s)
added PPM (*)OH	0	1.1 , 2.2, 1.5,3
.25 assist	0.0027	25% builds up in air
Total Flux 24 hour	**0.0135**	sample every 2 seconds
	24	H
DEFICIT OF OH	3.287538	PPM per 24 H.
OH produced in 24 H	0.5184	based on steady state, 2 s extinction
24 hour OH deficit	2.639538	

Please view attached spreadsheet file.

The recyclable heated ceramic used overcomes the kinetic barrier for PFC-CFC gases as air is taken into the system to harvest oxide radicals from the 21.8% oxygen fraction of air. While the cell runs at 950’C, the catalysis in the system enables the cleaving of the PFC-CFC and other gases while harvesting oxide from air.



The cells are arrayed in clusters of eight, scalable to hundreds of thousands, and have mass flow meters on the oxide output stream. This mass flow meter provides the precise amount of oxide/hydroxyl emitted to the atmosphere, where diffusion and meteorological processes cause full mixing and contact. From the mass flow meter, a very accurate stoichiometric projection of GHG removal can be made. The key is for authorities to review the baseline atmospheric constituent levels and agree on what is present, and what is reacting with hydroxyl and what has been found to react inside the cells. Once that exercise is undertaken, a standardized knowledge of the offsetting impacts of hydroxyl open air carbon capture are formalized. Automated Mass flow meters on the equipment provide up to the second measurements of gas flow in various units of mass and volume, which are recorded for the offsets purchaser. The accompanying spreadsheet document is submitted for consideration of the precise apportionment that will be used as determined by a scientific review.

The following basket of gases in Appendix 1 shows the approximate value of One Tonne of oxide when used to treat these GHGs as an example calculation:

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References

1. GC Green Carbon Inc private proprietary work with 6 ceramic cell systems over 9 years. https://drive.google.com/drive/folders/1Xd9wc6J_UewWlwOjsdceBV21YWLkb9hI?usp=sharing

2. International Max Planck Research School on Atmospheric Chemistry and Physics, Part 1: Oxidation and OH radicals", ESPERE Climate Encyclopaedia – www.espere.net - Lower Atmosphere , June 12, 2020

3. Jos Lelieveld, Sergey Gromov, "Global tropospheric hydroxyl distribution, budget and reactivity", Atmos. Chem. Phys., 16, 12477–12493, 2016

4. Erika von Schneidemesser,*,† Paul S. Monks, "Chemistry and the Linkages between Air Quality and Climate Change", Chemical Reviews, pubs.acs.org/CR

5. Matthew Rigbya,1, Stephen A. Montzka, "Role of atmospheric oxidation in recent methane growth", PNAS j May 23, 2017 j vol. 114 j no. 21 j 5373–5377

6. Svetlana Amirova1, Tamara Tulaikova2, "One possibility for atmosphere CO2 purification to get climate recovery", Science Discovery, 2015; 3(2-1): 1-6 Published online November 20, 2014

7. J. Aldabe a,⁎, D. Elustondo a, "Chemical characterisation and source apportionment of PM2.5 and PM10 at rural, urban and traffic sites in Navarra (North of Spain)", Atmospheric Research 102 (2011) 191–205

8. Christa Fittschen1, Mohamad Al Ajami1,"ROOOH: a missing piece of the puzzle for OH measurements in low-NO environments?", Atmos. Chem. Phys., 19, 349–362, 2019
9. Michael J. Prather1, Clare M. Flynn1, "How well can global chemistry models calculate the reactivity of short-lived greenhouse gases in the remote troposphere, knowing the chemical composition", Atmos. Meas. Tech., 11, 2653–2668, 2018

10. Dale E. Lueck l, Clyde F. Parrish t,"A Survey of Alternative Oxygen Production Technologies", https://ntrs.nasa.gov/search.jsp?R=20020000946 2019-02-12T15:31:12+00:00Z

11. Ryan Hossaini1, Martyn P. Chipperfield2,3, "The increasing threat to stratospheric ozone from dichloromethane", Nature Communications, Accepted 16 May 2017 | Published 27 Jun 2017

12. Viva Cundliffe, Dissertation, "REMEDIATING SHORT LIVED AND LONG LIVED CLIMATE POLLUTANTS USING OXYGEN OR HYDROXYL: A CLIMATE MITIGATION STRATEGY", preprint available on ResearchGate at Viva Cundliffe's page.

13. Sasho Gligorovski,*,† Rafal Strekowski, "Environmental Implications of Hydroxyl Radicals (•OH)", Chemical reviews, pubs.acs.org/CR

14. Qing Liang1,2 , Martyn P. Chipperfield3, "Deriving Global OH Abundance and Atmospheric Lifetimes for Long-Lived Gases: A Search for CH3CCl3 Alternatives", Journal of Geophysical Research: Atmospheres, RESEARCH ARTICLE, 10.1002/2017JD026926

Appendix 1 Example Valuation of Dose of Oxide versus Basket of GHGs

Common Name Equation Global Warming Potential ($CO_{2}e$) Destroyed 1 ton of each of these GHGs with the appropriate O2- dose			
Inputs Outputs Net Reduction GWP			
	CO2 e	lbs of Oxide	
1 Methane $CH_4 + H_2O + 3O_{2-}$ $CO_2 + 3H_2O$ 1t CH_4 = GWP 21 2.44t	18	2531.25	
2 Nitrous Oxide $N_2O + 3O_{2-} + H_2O$ $N_2O_4 + H_2O$ $2HNO_3 + O$ 1t N_2O = GWP 310 0t CO_2e 310	310		
3 Perflouromethane $CF_4 + 6O_{2-}$ $CO_2 + 2OF_2$ 1t CF_4 = GWP 6,500 0.50t CO_2e 6,499	6499	3860	
4 Perflouroethane $C_2F_6 + 7O_{2-}$ $2\ CO_2 + 3OF_2$ 1t C_2F_6 = GWP 9,200 0.64t CO_2e 9,199	9199	811	
5 Sulphur Hexaflouride $SF_6 + 5O_{2-}$ $SO_2 + 3OF_2$ 1t SF_6 = GWP 23,900 0t CO_2e 23,900	23900	547.94	
6 HFC-23 $CHF_3 + 6\ O_{-2}$ $CO_2 + H_2O + 2OF_2$ 1t HFC -23 = GWP 11,700 0.63t CO2e 11,699	11699	1371	
7 HFC-134a $CHF_3CH_2F + 8\ O_{-2}$ $2CO_2 + 2OF_2 + 2H_2O$ 1t HFC-134a = GWP 1,300 0.85t CO2e 1,299	1299	1242.7	
8 HFC-152a $CH_3CHF_2 + 8\ O_{-2}$ $2CO_2 + 2H_2O + OF_2$ 1t HFC-152a = GWP 140 0.66t CO2e 139	139	1939.39	
9 CFC-11 CFCl3 + 9 O_{-2} CO2+ OF2 +3CLO2 1t CFC-11 = 3,800 0.32t CO2e 3,799	3799	1090.9	
10 Nitrogen Triflouride $2NF_3 + 6O_{2-}$ $2NO_2 + 2OF_2$ 12t NF_3= GWP 12,300 0t CO_2e 12,300	12300	1352	
11 CFC-12 $CCl_2F_2 + 5O_{2-}$ $CO_2 + Cl_2 + 2OF_2$ 1t CCl_2F_2 = GWP 8,100 0.36t CO_2e 8,099.64	8099.64	667	
12 CFC-13 $CF_3Cl + 6\ O_{-2}$ $CO_2 + 2OF_2 + ClO_2$ 1t CFC-13 = GWP 10,800 0.42t CO2e 10,799	10799	905.7	
13 CFC-113 $CF_2ClCFCl_2 + 11\ O_{-2}$ $2CO_2 + 2OF_2 + 2ClO_2$ 1t CFC-113 = GWP 4,800 0.47t CO2e 4,799	4799	946.24	
14 CFC-114 $CF_2ClCF_2Cl + 10\ O_{-2}$ $2CO_2 + 2ClO_2 + 2OF_2$ 1t CFC-114 = GWP 8,040 0.51t CO2e 8,049	8049	941.18	
15 CFC-115 $CF_3CF_2Cl + 9\ O_{-2}$ $2CO_2 + ClO_2$, + $2OF_2$ 1t CFC-115 = GWP 5,310 0.57t CO2e 5,309	5309	935	
16 Carbon Tetrachloride $CCl_4 + 9\ O_{-2}$ $CO_2 + 2ClO_2$ 1t CCl4 = GWP 1,400 0.28t CO2e 1,399	1399	947.37	
17 Methyl Chloroform $CH_3CCl_3 + 12\ O_{-2}$ $2CO_2 + 2H_2O$, + $2ClO_2$ 1t CH3CCl3 = GWP 506 0.66t CO2e 505	505	1454.55	
18 HCFC-22 CH3CFCl2 + 11 O_{-2} $2CO_2 + 2H_2O + OF_2 + 2ClO_2$ 1t HCFC – 22 =GWP 1,500 0.75t CO2e 1,499	1499	1517.24	
19 HCFC-141b $CH_2CF_2Cl + 9\ O_{-2}$ $2CO_2 + 2H_2O + OF_2 + ClO_2$ 1t HCFC-141b = GWP 2,250 0.76t CO2e 2,249	2249	919.54	
20 HCFC-142b $2CHClF_2 + 5O_{2-}$ $CO_2 + ClO + OF_2 + H_2O$ 1t HCFC-142b = GWP 1,800 0.25t CO2e 1,799	1799	597.01	
21 Halon-1211 $CF_3Br + 6\ O_{-2}$ $CO_2 + 2OF_2 + BrO_2$ 1t Halon-1211 = GWP 4,750 0.29t CO2e 4,749	4749	644.3	
22 Halon-1301 $CF_2BrCF_2Br + 10\ O_{-2}$ $2CO_2 + OF_2 + 2BrO_2$ 1t Halon-1301 = GWP 5,400 0.16t CO2e 5,399	5399	754.72	
23 Halon-2402 $CF_2ClBr + 7\ O_{-2}$ $CO_2 + OF_2 + ClO_2 + BrO_2$ 1t Halon-2402 = GWP 3,680 0.27t CO2e 3,679	3679	678.79	
CO2 e total	127495.64	24123.57	lbs Oxide used in 22 t of LLGHG
Per ton CO2 equivs	**5795.2563636**	12.061785	tons Oxide per 22 tons of these gases
	480.46424005	CO2 eq per ton	
	528.51066405	CO2 eq per Tonne	
	13212.766601	$ per Tonne @ $20 per tonne	
	6606.3833006	50% efficiency	
	$6,606.38	**per Tonne value**	
	264.25533203	CO2e per Tonnes	