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Research Paper

The Antarctica Ozone Hole Chlorine Oxides Minimize Hole

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ABSTRACT: *Deficiency of Oxygen, Antarctica polar vortex and short half life – time of Ozone primarily as well as collectively cause Ozone hole over the Antarctica. Oxygen derivatives of Chlorine are only temporary reservoir of Oxygen in stratosphere.*
KEYWORDS: *Chapman, Cycle, equilibrium, ODR, NODR, Acid, Rain.*

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CFCs minimize size of Ozone hole: The maximum production and consumption of Ozone Destroying Substances (ODS) was at peak during the late 1980s, (1, Kim, 2011. United Nations Environmental Program 2023 (UNDP-20023) mentioned that consumption of Chlorofluorocarbons (CFCs) have declined by 99 % since 1989, (2, Esteban, 2024). But, sizes of the Ozone holes have shown fluctuations, increase and decrease in sizes revealed in table of annual records of NASA – Ozone Watch. The Ozone hole area over the Antarctica was approximately 19.2 million km^2 in 1990, 24.1 million Km^2 in 1997 1nd 26.5 million Km^2 in 2022, (3, NASA, 2025). If, CFCs form Ozone hole then Ozone hole in year of 2022 must as been 99 % smaller than that of 1990. That is Ozone hole of 2022 should be approximately 0.19 million Km^2 because consumption of CFCs reduced to 99 % till 2023. But increase in size (26.5 million Km^2
) noticed.

Half life-time cause Ozone depletion: Ozone always regularly decomposes in the atmosphere on account of its temperature dependent short half life-time, (4, Absolute Ozone). The Ozone slowly may decomposes during winter (May to August) of the Antarctica at lower temperature (-80^{o}C) of stratosphere. UV radiations greatly accelerate (1000-2000 times) decomposition from late August to September. That is why a larger Ozone hole appears nearby 22 September every year. The half life-time of Ozone at -80^{o}C is not available on Google search. The half life-time of Ozone at -50^{oC} is about 0f 90 days. That is, Ozone concentration decreases from 300 Dobson Units to 150 Dobsons Units by 90th day. A part of Ozone hole may form during winter (May to August) of the Antarctica and a part is formed during spring (September to October) of the Antarctica. The sudden stratospheric warming may disrupt normal process. No role of Chlorine into the Ozone decomposition.

By mid of October temperature rise around to -35 ^{oC} in the stratosphere over the Antarctica, at this temperature (-35 ^{o}C) half life-time of Ozone gas is around 18 days. That is why only few Dobson Units of Ozone remain in the Ozone hole by the late of October, (5, Martin, 2025).

Something is being hid. In my view, a man can only walk slowly at dark night but can run at day light. Similar may be decomposition of Ozone. Quarter decomposition may occur during May to July, a quarter during August, a quarter during September and a quarter by mid of October. Instrumental confirmation needed on this regard. Why scientists could not assessed half life-time of Ozone at -80^{oC} even guessed so far? Scientists have discovered energy of a bond of atoms. What is mystery?

The Ozone hole forms on lower stratosphere: There is 0.06-0.11 % deficiency of Oxygen on the Antarctica, (6, Kanfisher, 1957). The Chapman cycle regularly runs in the atmosphere, when the Ozone decomposes and composes equally at equilibrium state then no depletion of Ozone occurs. Oxygen deficient troposphere is just lower to stratosphere over the Antarctica. The Chapman cycle regularly produces molecular Oxygen and atomic

Oxygen from Ozone, some amount of Oxygen again form Ozone. Rest some amount diffuses down towards troposphere according to concentration gradient. A chain of reactions occur which cause further deficiency of Oxygen in stratosphere. The Chapman cycle undergoes at non-equilibrium state. A reversible reaction always tends to be in state of equilibrium. To maintain an equilibrium state the Ozone breaks down to produce Oxygen, this process continue for long time in months (May to October). The decomposition of Ozone becomes greater than its composition. Consequently, Ozone Deficit Region (ODR) less than 220 Dobson Units is formed in the lower stratosphere over the Antarctica. ODR is traditionally called Ozone hole. No role of Chlorine into the Ozone depletion in lower stratosphere, sole role is of deficiency of Oxygen over the Antarctica. →

The Ozone hole is a confusing phrase with a hollow space while actually is not it. Ozone Deficit Region is more appropriate phrase for Ozone hole. ODR etymologically gestures that some deficiency is of Ozone in a particular region.

Generally radical Oxygen (O.) has more affinity with other radical than molecular Oxygen. Mostly, Oxygen and Nitrogen are found in molecular form and Chlorine in CFCs form in lower stratosphere whereas as radicals in the upper stratosphere, (Google search).

(i) $O_3 \leftrightarrow O_2 + 0$ (ii) $0 + Cl_2 + N_2 + 0_2 \rightarrow 0_3 + Cl_2 + N_2$ (iii) $0 + 0_2 + Cl_2 + N_2 + 0 \rightarrow 0_2 + Cl_2 + N_2 + 0_2$.

NODR forms in the upper stratosphere: The Nitrogen hole is formed in the upper stratosphere, (7, Laat, 2024). The UV radiations are available from August to October (Google search). The Ozone decomposes due to its temperature dependent short half life-time and accelerated by UV radiations. Oxygen radicals (O.) and Nitrogen radicals (N.) combine to form Nitrogen mono-oxides (NO), later Nitrogen Di-oxides (NO_2) ultimately Nitric acids (HNO_3). In the presence of excessive humidity nitric acid dissolve into water and drops down towards troposphere, called acid rain. Successive, loss of Nitrogen (N) as well as Ozone (O_3) occur from the upper stratosphere over the Antarctica during spring. Consequently, Nitrogen Ozone Deficit Region (NODR) is formed on upper side of the upper stratosphere, earlier called Nitrogen hole / Ozone hole.

Role of Chlorine: The Chlorine nitrate ($ClONO_3$) is a temporary reservoir of Ozone / Oxygen in the upper stratosphere, (8, Thomas, 2018). The reactivity of radicals in decreasing order is: $O_* > Cl_* > N_*$. A Chlorine radical and an Oxygen radical form Chlorine mono-oxide (ClO) unstable later dissociate into Chlorine radical and an Oxygen radical, or react with Nitric acid (HNO_3) to form Chlorine nitrate ($ClONO_3$) which is less soluble in water than to Nitric acid. Chlorine nitrate minimize acid rains onto the Antarctica. Chlorine nitrate prevents formation of Ozone hole as well as Nitrogen hole in the upper stratosphere, these holes may rightly be called as Nitrogen Ozone Deficit Region (NODR). Chlorine mono-oxide and Chlorine nitrate hold Oxygen for some time in the upper stratosphere and work as temporary reservoir of Oxygen. Sufficient availability of Oxygen fosters backward reaction of the Chapman cycle and Ozone formation. Thus, Chlorine minimizes expansion of the Ozone hole in the upper stratosphere, which is beneficial for both the Antarctica and human beings.

(i) $O_3 \leftrightarrow O_2 + O$, (ii) $O + Cl + N + O \rightarrow O_2 + Cl + N$, (iii) $Cl + O + N + O_2 \rightarrow ClO + N + O_2$, (iv) $O + N + O_2 \rightarrow NO + O_2$, (v) $O + NO \rightarrow NO_2$, (vi) $O + O_2 \rightarrow O_3$, $H_2O \rightarrow OH + H$, (vii) $NO_2 + OH \rightarrow HNO_3$, (viii) $ClO + HNO_3 \rightarrow ClONO_3 + H$, (ix) $h + H + O \rightarrow H_2O$.

Outside of the polar vortex: Diffusion and mixing of gases (O2 and O_3) continuously takes place outside of the polar vortex. Availability of Oxygen becomes easy and sufficient. The Chapman cycle runs in equilibrium state. So no Ozone depletion occurs. No deficiency of Oxygen, no non-equilibrium in the Chapman cycle, no Ozone depletion, no Ozone hole formation.

Author has earlier suggested measurements of Oxygen deficiency on the Antarctica, (9, Patel, 2025).

Conclusion: Deficiency of Oxygen cause Ozone hole in the lower stratosphere over the Antarctica. Chlorine minimizes expansion of Ozone hole in the upper stratosphere.

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