

## **Response to comments from Anonymous Referee #2 on manuscript egosphere2022-565: “Development of an automated pump efficiency measuring system for ozonesonde utilizing the airbag type flowmeter”**

We appreciate your valuable comments on our paper.

Line 25: Replace- “flew up” with “flown”

Line 27: Replace- “chemical” with “electrochemical”

Line 27: Replace- “The downlink of the data is taken care of by the radiosonde - also providing pressure, temperature, humidity and position measurements – the ozonesonde is coupled with.

with

“The downlink of the data, through the coupled radiosonde transmission, also provides pressure, temperature, humidity and position measurements.

We will replace as you stated.

Lines 33-34: Reference – If available, please add a publication reference on the KI Carbon electrode type (KC) ozonesonde.

We will add “(Kobayashi et al., 1966a; Kobayashi and Toyama, 1966b, 1966c; Hirota and Muramatsu, 1986)” after lines 33-34.

We will add references as follows to Reference.

“Kobayashi, J., Kyozuka, M., and Muramatsu, H.: On various methods of measuring the vertical distribution of atmospheric ozone ( I ) – Optical-type ozone sonde, Pap. Meteor. Geophys., 17, 76–96, 1966a.

Kobayashi, J., and Toyama, Y.: On various methods of measuring the vertical distribution of atmospheric ozone ( II ) – Titration type chemical ozonesonde, Pap. Meteor. Geophys., 17, 97–112, 1966b.

Kobayashi, J., and Toyama, Y.: On various methods of measuring the vertical distribution of atmospheric ozone ( III ) –Carbon iodide type chemical ozonesonde–, Pap. Meteor. Geophys., 17, 113–126, 1966c.

Hirota, M., and Muramatsu, H.: Performance characteristics of the ozone sensor of KC79-type ozonesonde, J. Meteorol. Res., 38, 115-118, (in Japanese), 1986.”

Line 37: Replace- “with take the ambient air into” with “with bubble the ambient air into”

Line 39: Replace- “sampling air” with “sampled ambient air”

We will replace as you stated.

Line 39: The flow rate is also needed to calculate concentration of ozone. Please add this in the last sentence to make it: “The ozone concentration is calculated from this electric current and the volumetric flow rate of the piston

pump.”

We will add the sentence as you suggested.

Line 46: Replace “(4). Then again, the force of the piston takes the ambient air into the pump.” with “(4). The piston draws in a fresh sample of ambient air.”

Line 46: Replace “During the ozonesonde observation, this cycle is repeated” with “The cycle is repeated for each pump rotation. The steady pump speeds typically range from 2400-2600 rotations per minute (RPM).”

We will replace as you stated.

Lines 47-48: I am having difficulty in understanding the first part of this sentence. I believe this is saying the back pressure is always the same from ground level to low pressure while ambient pressure is decreasing.

We replace lines 47-48 with

“The hydraulic head pressure, which is the main factor that causes the back pressure, could be assumed nearly identical regardless of the ambient air pressure, but ~”.

In addition, since the influence of the Teflon rod is not important here in explaining the concept that pump efficiency arises, so we will replace lines 42-43 with

“Firstly, the ambient air taken into the pump is compressed until its pressure is balanced with the back pressure due to the hydraulic head pressure of the reaction cell (1).”.

Line 63: Replace “silicone membrane” with “bubble” contraction

Line 67: Replace “airbag contraction” with “airbag evacuation”

We will replace as you stated.

Line 67: Remove this part of the sentence “and a gear pump with high pump efficiency” The gear pump (nearly 100% pump efficiency) was only used at NOAA to confirm the accuracy of the oil bubble flow meter.

We will remove as you stated.

Line 70: Replace “The system was designed to perform the entire series of measurement automatically, in order to be able to obtain pump efficiency with uniform quality.” with “The system was automated in order to obtain pump efficiency measurements with uniform quality.”

Line 73: Replace “we could build up a” with “we accrued a”

Line 104: Replace “exhaust limit” with “minimum pressure”

Line 117: Replace “Flowmeter controller” with “The flowmeter controller”

Line 118: Replace “flow values of them” with “flow data”

We will replace as you stated.

Line 121: Just a question on what is time-dense control?

We will replace Line 121 with “Due to the flowmeter controller taking charge of real-time measurement control on the millisecond order, the load of the control PC is largely reduced.”

Lines 130-133: Figure 6 text: Replace “The bag is made of polyethylene in a volume of 140 ml.” with “The 140 ml. bag is made of polyethylene.”

Replace “in thermometers with “by thermometers”

Replace “measured in optical instrument” with “measured by an optical instrument”

Line 202: replace “back pressure” with “back pressure (load)”. This is a suggestion since back pressure and load are both used in the next sections. I assume they refer to the same thing so it would be good to include both in the title of section 3.3.

Lines 227-229: Figure 8 text: Suggest replacing “reaction solution” with “silicon oil” to be consistent with the text that notes silicon oil was used to represent the head pressure instead of actual sensor solution – which would create very large errors due to boiling of the KI/water solution.

Line 245: Replace “(sucked out)” with “pushed out”

We will replace as you stated.

Line 245: Please add the typical pump temperature observed during a test. For example, it would be helpful to know what the typical pump temperature at surface (beginning of test) and at the lowest pressure (3 hPa).

We will add a table follows and add “Table X shows the averaged pump temperature during pump efficiency measurements measured by JMA from 2009 to 2022. Measurements start after 30 minutes of warm-up measurements, and the pump temperature typically increases by 5-6°C as the measurement progresses.” to the end of section 4.1.

**Table X: Pump temperature measurement results in Sapporo, Naha from 2009 to 2018, and Tateno from 2009 to 2022.**

Pressure (hPa)	Pump Temperature (°C) [JMA 2009 - 2022]
3	37.0 ± 2.2
4	36.7 ± 2.2
5	36.4 ± 2.2
7	36.1 ± 2.1
10	35.7 ± 2.1
20	35.4 ± 2.1
30	35.1 ± 2.1
50	34.6 ± 2.1
100	33.9 ± 2.1
200	33.1 ± 2.0
1000	31.1 ± 2.0

Lines 335-336: It appears that “reaction solution” is being used for referring to more than one thing. It is used early in the paper when referring to the actual sensor solution (the KI salt water solution) and then in line 335 it looks like in this text “reaction solution” is referring to head pressure simulation of the sensor solution for NOAA/CMDL pump efficiency measurements, when NOAA/CMDL actually used non-evaporative oil to replace the reaction solution. Then in Line 336, I believe JMA is using extra tubing length to create a simulated back pressure of the 3cc of reaction solution.

It would be helpful to be clear where “reaction solution” is actually back pressure or simulated head pressure of the 3cc of reaction solution.

We replace line 335 with

“~, and NOAA/CMDL has made measurements with exhaust-side loading by non-evaporative oil to replace the reaction solution (Johnson et al., 2002).”,

and line 336 with

“We did that using extra tubing length to create a simulated back pressure of the 3ml of the reaction solution.” .

Figure 12: Replace “UMYO 2002” with “UWYO 2002” within the graph for Univ of Wyoming (blue line).

We will replace as you stated.

Figure 16: The figure text letters (a) (b) and (c) should be in front of the data being described. For example: (a) Variation over time of pump flow rate.

We will correct the position of letters (a) (b) (c) in line 398.