OTTO-VON-GUERICKE-UNIVERSITÄT MAGDEBURG
Faculty of Process & Systems Engineering

Environmental Science Research Project WS 2019/20

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Gas ebullition from lakes? What gases are released? How can the ebullition rate be determined?

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Tuesday, 28 January 2020

ABSTRACT

In freshwater lakes, ebullition is an important pathway for biogenic methane and many other gases which are stated below (NASA Earth Observartory, 2011)to escape from sediment and reach the atmosphere (Liu, et al., 2019).Gas ebullition from lakes is a process where the gases are transported from the lake sediment to atmosphere as a form of bubbling or boiling. The gas which commonly found during ebullition is Methane, Carbon dioxide, Nitrous oxide, Argon, Nitrogen and Oxygen. Most of the researchers are working in finding the various aspects of gas ebullition in various lakes and rivers. The main objective of this research work is to find out the various gases which are released by lakes and rivers and to quantify them.

INTRODUCTION

When there is an escape of gas from the liquid is known as bubbling. This bubbling process helps in various aspects like ambient pressure, the temperature difference between liquid and atmosphere. Ebullition is a general process which occurs in all water bodies like lakes, rivers, reservoirs, ponds and coastal areas. Various ways that vary the ebullition rates are such as pressure in the lakes which is totally dependent on the height of the lakes, the temperature difference between waters which varies from height and volume of the lakes, also the temperature difference between lake water and atmosphere temperature, location of lake i.e., the distance between the bottom of lake and underground volcanoes which makes the difference in temperature of the lake water and the surrounding temperature, the climate changes as well as the external forces like a strong wind which helps to create a waves and water level changes.

WHY EBULLITION IS CONCERN?

Methane

The emission of CH4 from many water bodies contributes the present-day global warming. Build-up of CH4 poses and hazard which can result in evacuation of areas over landfills or mines (SEPA, n.d.). Comparing other volatile organic compounds CH4 does not contribute in formation of ground level ozone or photochemical smog (SEPA, n.d.).CH4 plays a major role in impact is on greenhouse gas. The levels of methane in the environment are relatively low, its high global warming potential is 21 times that of carbon dioxide, ranks it amongst the worst of the greenhouse gases (SEPA, n.d.).

Carbon Dioxide

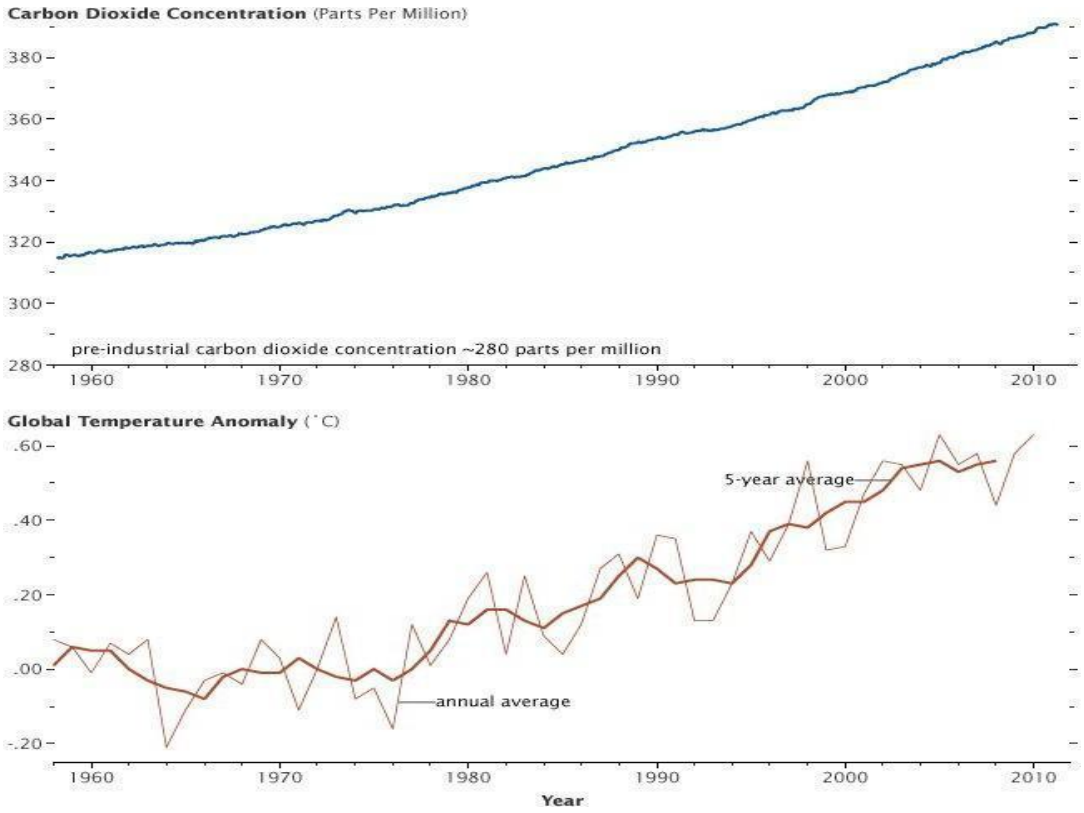

Fig 1. With the seasonal cycle removed, the atmospheric carbon dioxide concentration measured at Mauna Loa Volcano, Hawaii, shows a steady increase since 1957. At the same time, global average temperatures are rising as a result of heat trapped by the additional CO_2 and increased water vapour concentration. (Graphs by Robert Simmon, using CO_2 data from the NOAA Earth System Research Laboratory and temperature data from the Goddard Institute for Space Studies.) (NASA Earth Observartory, 2011)

55 % of extra CO2 is absorbed by plants and oceans which people have put into the atmosphere while about 45% stays in the atmosphere (NASA Earth Observartory, 2011) .The land and oceans will take most of the extra CO2 but 20% may remain in the atmosphere for many thousands of years (NASA Earth Observartory, 2011). CO2, CH4 and halocarbons are greenhouse gases that absorb a wide range of energy includes infrared energy emitted by the Earth and then re-emit it. The emitted energy travels out in all directions and some reach earth which makes the earth surface heat. Without greenhouse gases, the earth would be in 18 degrees Celsius on contrary with too many greenhouse gases it would be like Venus, wherein Venus greenhouse gas keeps the atmosphere at 400 degrees Celsius. Rising in CO2 concentrations is already making the planet heat up (NASA Earth Observartory, 2011). At the same time, greenhouse gases are increasing and the average global temperature has risen 0.8 degrees Celsius, since 1880 (NASA Earth Observartory, 2011).

Nitrous oxide

N2O can absorb heat and stores heat in the atmosphere and it can live in the atmosphere for 114 years according to the EPA. This makes the N2O in a sort of middle ground of super pollutants. Comparing CO2 nitrous oxide will stay less in the atmosphere. Nitrous oxide also processes a threat to the environment while in the stratosphere, nitrous oxide is exposed to sunlight and oxygen which converts the gas into nitrogen oxides. This can be the main cause of ozone depletion, where humans rely on to prevent UV radiation from the sun reaching the earth's surface. One pound of N2O warms the earth about 300 times the amount of one pound of CO2 does over 100-year time scale. Its potency and relatively life make N2O a dangerous for climate change.

Argon

There is no known ecological damage caused by argon. Argon gas will dissipate naturally in the ventilated area it occurs naturally in the environment. The effects of argon in plants are currently unknown and it is not expected to harm any aquatic life (LENNTECH, n.d.). The main point is argon does not contain any ozone-depleting chemicals. Some effects are there to humans if argon gases are inhaled like Dizziness, Headache, Suffocation (LENNTECH, n.d.).

Oxygen

Oxygen is an important gas for all life forms. But too much of anything is not good same as if a human exposed in too much of oxygen the lung damage can occur. Exposing a human 50-100% oxygen at atmospheric pressure over a long period of time will cause lung damage. Those people who are working on this situation where oxygen is more, they have to take lung function tests before beginning employment and after that. Oxygen is preferably in low-pressure storage and under very low temperature therefore always one should wear special suits to prevent the freezing of body tissues. While seeing in environmental side high source of oxygen promotes rapid combustion which leads to fire and explosion hazards in the presence of fuels.

SUMMARY

Literature Review

Ebullition can also be a transport mechanism for other volatile species such as nitrogen, hydrogen, carbon dioxide, radon and hydrogen (Christopher S. Martens, 1989).

The blowdown rate varies depending on several factors, such as the pressure drop between the Sediments in the water and in the layers, temperature differences and seasonal or climatic changes. Ebullition can also be caused by environmental factors, e.g. B. oscillating water level changes are triggered in connection with tides in tidal wetlands (Martens & Klump, 1979).

Lakes can produce significant amount of oxygen by ebullition. Oxygen is escape from the lakes through the gas bubbles. Then the analysis of the oxygen bubbles can be generated by algae as well as by the absorption in bubbles of gases. Ebullition rate is high in late summer and early fall compared to the midwinter. After the entire analysis, oxygen ebullition is same in size to oxygen diffusion and effects the lake metabolism estimates (Koschorreck, Hentschel, & Boehrer).

Diffusion, however, is not the only known mechanism for gas exchange between surface waters and the atmosphere. It is generally known that the methane flow (CH4) between lakes and the atmosphere is not only diffuse, but is often also dominated by floods.

The gas is released in the form of bubbles consisting of methane, nitrogen and oxides of nitrogen, argon, oxygen and carbon dioxide. The concentration of methane in the atmosphere has increased by 1% every year during the last century if the level of pollution is a reasonable proportion (Ostrovsky, 2003). Methane is an important product in the anaerobic decomposition of organic substances. Bottom sediment material. Methane is the most common organic compound in the EU. It captures heat 33 times more effectively than a corresponding amount of CO2 (Wik, 2016).

Ebullition is typically observed at water depths of less than 10 m and then dominates the CH4 flow between lake and atmosphere (Bastviken D).O2 is not usually measured in evaporation studies because these studies focus on greenhouse gases and O2 is not analysed with standard gas chromatographs for CH4 analysis.

MATERIALS AND TYPES

Bubble Trap Design

The design and assembly of bubble trap design is shown in Fig. the detailed description of the trap design is given in (Varadharajan, Hermosillo, & Hemond, 2010) research paper. The overall detail is there is a cone which is fitted on collection chamber. The collection chamber is a long PVC hollow pipe which has the ability to store the gas which is transferred by the cone. The cone has direct interaction with lakes water and through that everything goes to collection chamber.

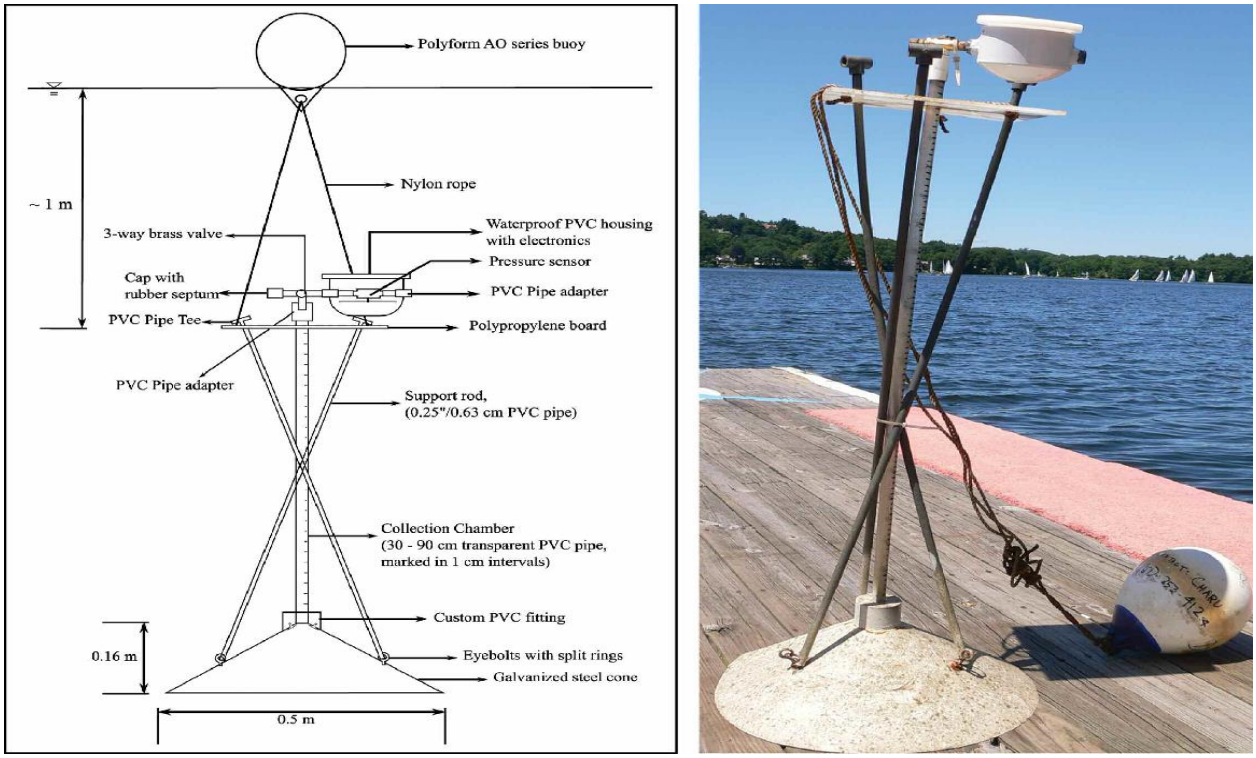

Fig 2: Bubble Trap Design (Varadharajan, Hermosillo, & Hemond, 2010)

When the collection chamber is filled with gases (which formed by ebullition) there is an automatic valve which opens the gate of the collection chamber only when the chamber is full. Then the gas travels through a PVC adapter which is horizontally connected to the collection chamber. This horizontal pipe acts as a passage pipe for gas from collection chamber to waterproof PVC housing which contains circuit unit. In that waterproof housing there are many components which is pressure sensor. This pressure sensor is used to sense the pressure difference between the water, which is contact with the equipment. There is polyform A series buoy, which gives this device a structural stiffness to the assembly. The circuit unit plays a

major role in finding the gases. The circuit measures the difference in fluid pressure between the top of the gas collection chamber the outside water column as the pressure is proportional to the height of the gas collected in the chamber and can be converted to a gas volume using the chamber cross section area (Varadharajan, Hermosillo, & Hemond, 2010) As we don't have accurate dimensions, the Fig 3 is rough diagram. The circuit which has been made are listed below There are many electronics are used in this equipment. The details of the equipment are shown in Table 1.

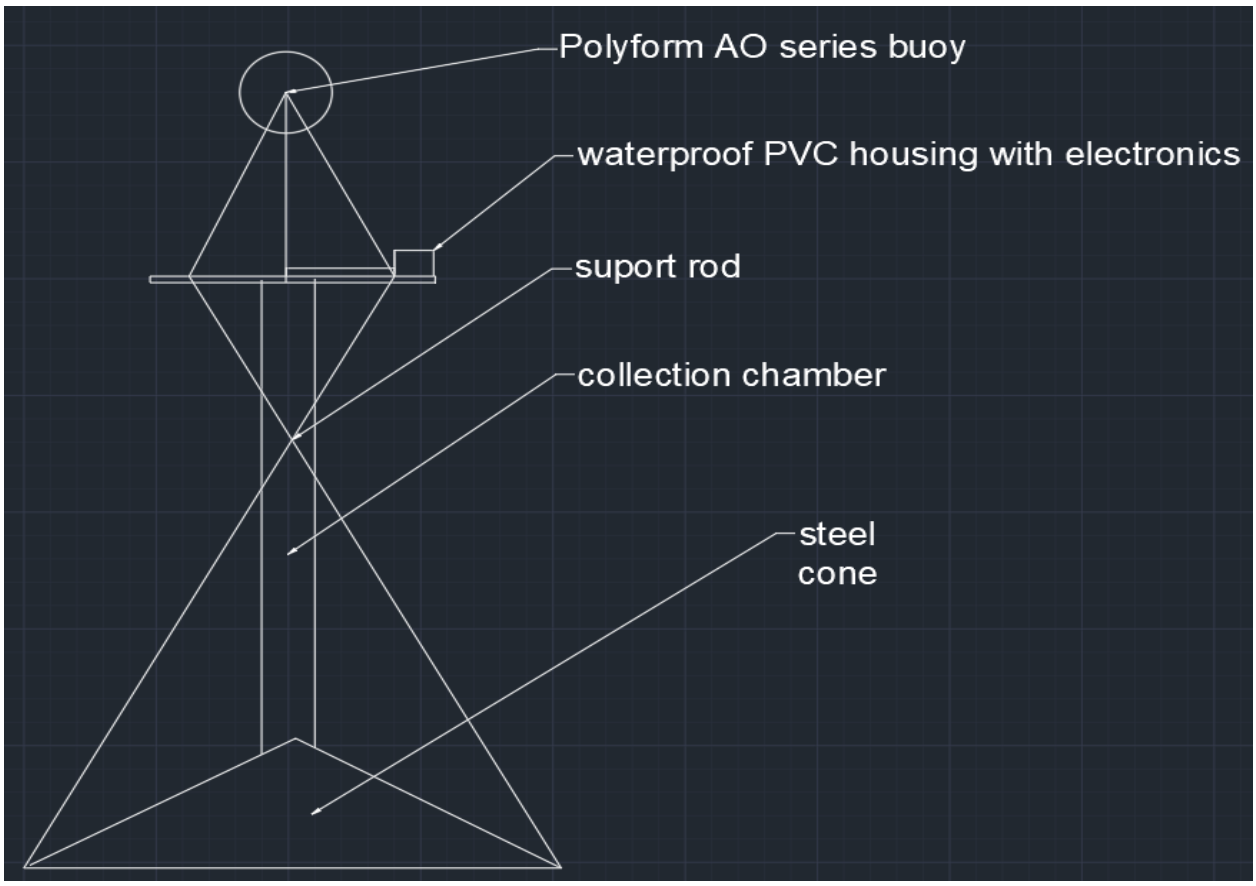

Fig 3: Trap Design

Table 1: Details of the electronics used in the circuit (Varadharajan, Hermosillo, & Hemond, 2010)

Circuit component	Manufacturer	Model	Current Consumption	Approximate unit price in 2008
Differential pressure sensor	Honeywell	26PCAFA6D	0.13 mA	$15-20
Data logger	Onset Systems	HOBO H08-002-02 Temperature/External logger		$45-65
Quad Op-amp chip	Texas instruments	TLV2404	1 µA	$3
Instrumentation amplifier	Texas instruments	INA126	175 µA	$3
Voltage regulator	National Semiconductor	LP2952	130 µA for a 1mA load	$2
2 high capacity 3.6V lithium batteries	Tadiran	TL-5903		$7
PC Board	ExpressPCB	TL-5903		$20

Methods:

Glaciers have a huge impact due to temperature fluctuations. Glaciers provide us many scientific clues about global warming. There are many ancient evidences has been found from alps mountains across the world showing our humanity culture, ways the human has evolved, etc from past thousands of years. Which shows that the glaciers are there from past thousands of years which has been preserve our fossils. Many of ice glaciers has been disappeared till now from past decades. It is not far that still many will get vanish within years. The main cause of glaciers melting process is because of humans. There are some photos shown below to show the difference.

Fig 4; Solheimajokill, Iceland, has retreated by 625 m (2050 ft) between 2007(left) and 2015(right) [Lonnie Thompson]

Fig 5: Columbia glacier, Alaska, has retreated by 6.5 km(4 miles) between 2009(left) and 2015(right) [James Balog and the Extreme Ice Survey]

Fig 6: Mendenhall Glacier, Alaska, has retreated by 550 m (1800 ft) between 2007(left) and 2015(right) [James Balog and the Extreme Ice Survey]

By seeing the above diagram, the ice glaciers are rapidly melting, what we are seeing now will won't be the same when we compare after 10 years. Which makes the clear statement that glaciers which are melting are commonly forming a lake near to the mountain areas. Many lakes are newly formed and will form.

RESULT

In this study we are assuming a lake which will be formed after 10 years due to the melting of ice in alps mountains. With that assumed lakes we will be conducting a test of ebullition from lakes. In this paper we will be taking three lakes and compared. This test results are purely assumed by comparing the previous results which are conducted by many scientists. The complete details of the lakes will be shown in Table 1.

Table 1: Assuming lakes physical and Chemical properties.

Lakes	Latitude	Longitude	Summer temperature	Winter temperature
Lake 1	27.757072	88.481866	10-25	-5-10
Lake 2	27.643690	88.353431	10-25	-5-10
Lake 3	35.205159	77.056911	6-25	-7-5

This result is assumed that it is fully derived from bubble trap design method. Working of this method is fully explained in above pages. In this method the readings are derived directly form the equipment. Where the circuit board is present, the readings can be downloaded form that circuit.

Table 2: Total annual Emission of CH4 from assumed lakes by trap design

Lakes	Ebullition summer	Ebullition winter
Lake 1	0.02	0.0
Lake 2	0.04	0.01
Lake 3	0.059	0.025

Table 3: Total annual Emission of Co2 from assumed lakes by trap design

Lakes	Ebullition in summer	Ebullition in winter
Lakes 1	0.004	0.001
Lakes 2	0.0045	0.002
Lakes 3	0.005	0.003

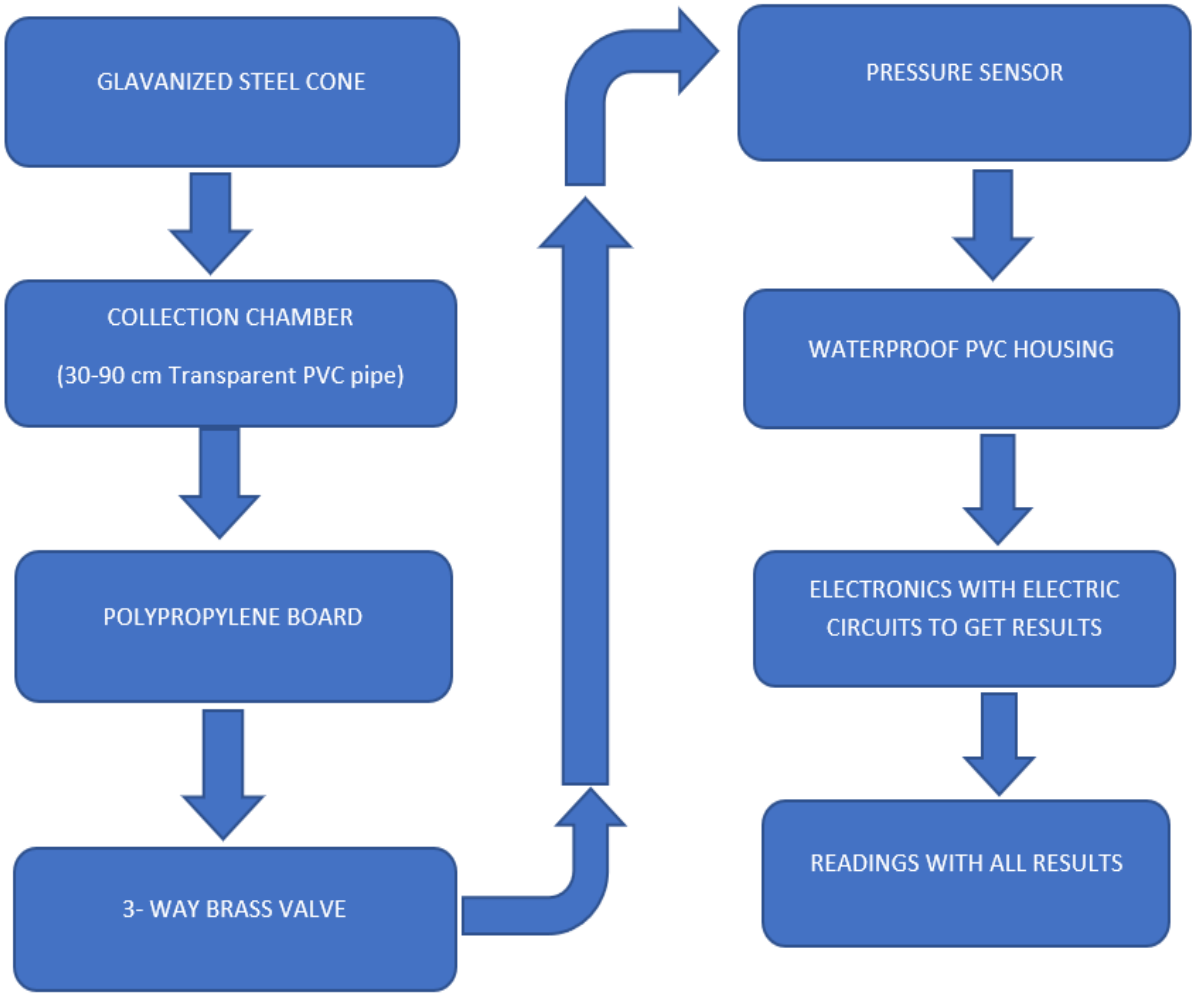

Fig 7: Flow Chart of the Process

The temperature rising reading is taken from NASA website. It is shown that every year the temperature rise is 2-5 degree Celsius. So, we are considering it as 3 degree Celsius overall.

Table 3: Temperature and Year (NASA Global Climate Change , n.d.).

Year	Temperature in degree Celsius
2014	14.31
2015	16.35
2016	18.95
2017	20.20
2018	21.95
2019	23.50

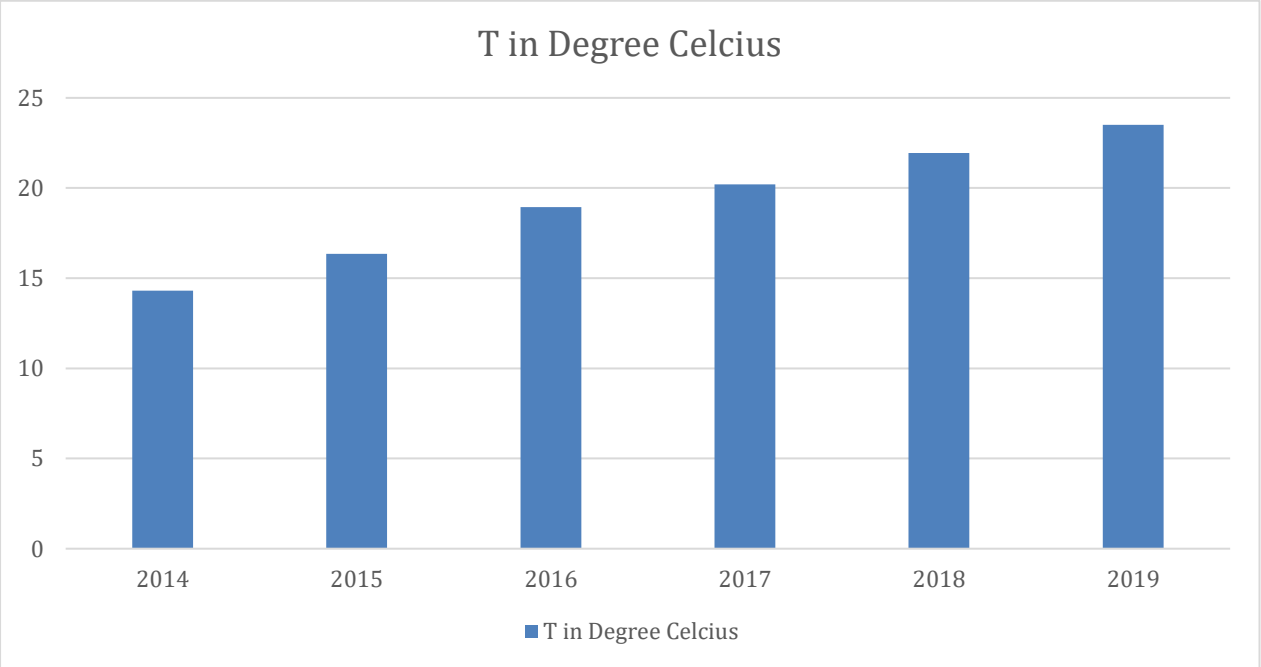

Fig 8. This graph shows the temperature raise in past years

CONCLUSION:

This works deals with the ebullition of rate, from the water bodies such as lakes, ponds, rivers, etc. The ebullition is a natural process where the gases emits from the bottom of the lake which travels to top of the lake through a process called bubbling. From this the sediments are also travelling with this process. Various methods from worldwide are been used to calculate ebullition rate. The ebullition rate differs from various aspects like temperature of the lakes, height and pressure of the lake, etc. in this work we assumed a lake which will form after years near any alps mountains. Because the raising of temperature and other aspects the glaciers are melting rapidly, which leads to formation of new lake and that lakes will be mix with oceans.

DISCUSSION:

This report illustrates high amount of methane and other greenhouses gases coming out from the lakes. This report can be taken for a sample for future work. Through this report we can estimate the values. But the value which is given in this report may be differ from the original values. There should be more experiment has to be conducted in different regions where we can get to know that process very well.

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