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A Low Cost and Sustainable Method to Mitigate Carbon Dioxide

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Abstract: ***The escalating impact of fossil fuel usage on global warming has led to dire environmental consequences, including erratic weather patterns, floods, cyclones, and rising temperatures. While electric vehicles EVs have emerged as a promising alternative, their effectiveness in reducing carbon emissions is often overstated, as a significant portion of electric power is generated from fossil fuels. This paper presents a novel, low-cost, and sustainable method for mitigating carbon dioxide emissions in fossil fuel power plants. By employing chemical reactions involving Potassium Manganate and Potassium Permanganate, this process efficiently absorbs carbon dioxide while producing reusable chemicals. This self-sustaining approach not only reduces wastage but also offers a practical solution for fossil fuel-based power plants to significantly reduce their carbon footprint, making a substantial contribution to global greenhouse gas reduction efforts. The scalability and potential impact of this method underscore its relevance in combating climate change in fossil fuel-dependent regions worldwide.***

Keywords: carbon dioxide mitigation, fossil fuel emissions, sustainable solution, Potassium Manganate, Potassium Permanganate

1. Introduction

It is an established fact that use of fossil fuels is a major culprit in global warming which is showing unprecedented and violent natural reaction in terms of untimely rains, flooding in unexpected areas, cyclones, hotting up of weather to name a few. Unfortunately, use of fossil fuels has gone to such a level that it would be impossible to roll back.

This is an era which has seen a conscious effort to embrace electric vehicles. Common people feel that use of electric vehicles instead of those using fossil fuels would reduce carbon emissions. However, this is a myth. About 70% electric power is generated in India using fossil fuels (See Fig. 1). Globally too, the figures are similar.

So, what happens really is that source of carbon emission shifts from its usage to the location of the thermal power generation plant. Therefore, by the usage of EVs we are only shifting the place of emission. This in no way is going to reduce the carbon footprint substantially. Moreover, diesel / petrol (gasoline) and CNG vehicles are not going to be redundant too soon.

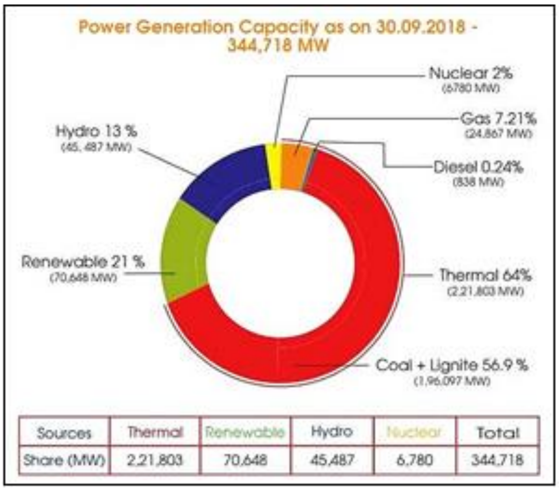

Figure 1
Source: *Economic Time*

Is There A Way Out?

Even if we use solar, wind and other renewable sources, what are we going to do with the reserves of fossil fuels? In some form or the other fossil fuel burning is going to stay for a long time, it seems. If we could find a way of using fossil fuels and still get rid of carbon dioxide it would be more than a boon.

Well, There Is A Way Out

A couple of chemical reactions will show that we can easily absorb carbon dioxide and generate a chemical that can be recycled in the process. In fact, the main chemical used in the reaction can be produced easily and its regeneration is possible. This makes the process self-sustaining. If carbon dioxide gas is bubbled into a solution of potassium manganate, carbon dioxide gas will be absorbed and potassium permanganate will be generated.

$$3K_2MnO_4 + 2CO_2 \rightarrow 2KMnO_4 + MnO_2 + 2K_2CO_3$$

Potassium manganate solution is green in colour while potassium permanganate is a purple coloured chemical. In this reaction, not only carbon dioxide gas gets absorbed but potassium permanganate is generated which can be utilized to produce potassium manganate which can be used again to absorb carbon dioxide. This makes the process sustainable. Besides two important chemicals viz. manganese dioxide and potassium carbonate are produced as by-products. Again, manganese dioxide can be used to manufacture potassium permanganate. It will be seen that if the chemical reactions are used judiciously there will be minimal wastage and absorption of carbon dioxide will become very easy on large scale.

Regeneration

It will be seen that potassium manganate is the key chemical here. Now this itself can be regenerated by heating potassium permanganate to a temperature above 200^0C.

$$2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$$

Potassium permanganate is produced in the above carbon dioxide absorption reaction. This is how the chemicals can be recycled with almost no wastage. This makes the process highly sustainable.

Application and First Step in the Process

Perhaps the best way to test the efficacy of this process would be to put it to use in a coal-fired power plant. The process, however, can be tested in a pilot plant before scaling it up. The first step in this direction is to heat potassium permanganate till it is converted to potassium manganate (See Fig.2). It must be noted here that while potassium permanganate is deep purple in colour, potassium manganate is dark green. Oxygen is liberated during this reaction shown above. This oxygen can be put to captive use to assist the combustion of coal or other fossil fuel which will ensure complete combustion. Or else it can be stored and put to other uses.

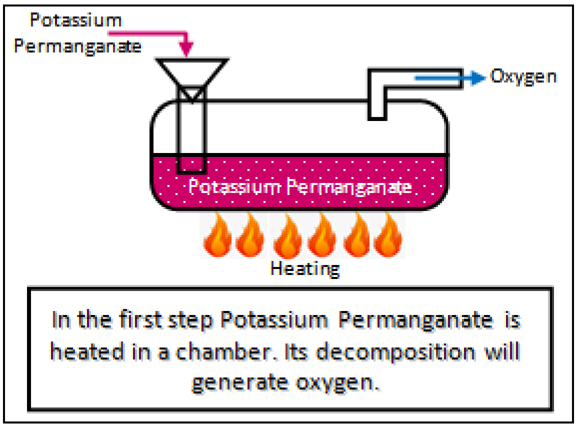

Figure 2

Second Step

In the second step potassium manganate produced thus is to be dissolved in water. When it is completely dissolved, carbon dioxide which is formed by the combustion of coal, should be bubbled through the solution (See Fig. 3). After the reaction with carbon dioxide is complete the green solution of potassium manganate will turn purple, indicating formation of potassium permanganate. Manganese dioxide and potassium carbonate are the by-products and manganese dioxide can be used to manufacture potassium permanganate. Potassium permanganate can be heated again to produce oxygen and potassium manganate the latter to be used for carbon dioxide absorption. Thus, from second step we can go to first step and all over again. This is how the entire process becomes sustainable.

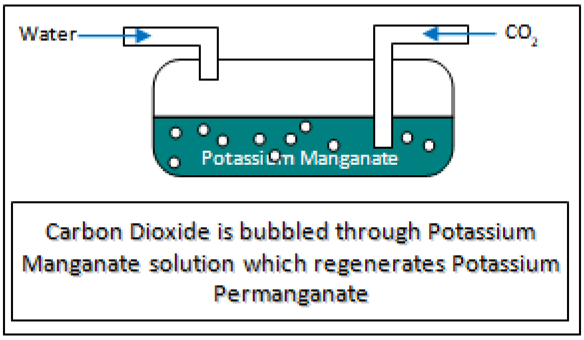

Figure 3

Set-up for Coal Based Power Plant

A set-up to mitigate carbon dioxide produced in a thermal power plant is shown in Fig. 4. As described above, potassium permanganate is heated above 200^0C when potassium manganate is generated while liberating oxygen. This oxygen can be utilized to assist combustion of fuel as shown in the figure. This would result in complete combustion eliminating the possibility of carbon monoxide generation and minimizing the presence of carbon soot in the flue gases. However, oxygen produced thus can be stored ant utilized for other uses too. Manganese dioxide is produced as a bye product. Water is then introduced in the chamber to dissolve potassium manganate. Manganese dioxide must be filtered out. Carbon dioxide from the flue chimney then can be bubbled in the potassium manganate solution till the green solution turns into purple indicating the formation of potassium permanganate. Manganese dioxide and potassium carbonate produced in the reaction should be removed before proceeding to the next step After this the chamber is heated again to produce oxygen and potassium manganate along with manganese dioxide. The entire process of dissolving potassium manganate and filtering out manganese dioxide as well as bubbling carbon dioxide is repeated. Carbon dioxide introduced in manganate solution should always be filtered to remove soot and carbon monoxide and any other gases which might interfere in the reaction.

Multiple chambers can be used to make the process smooth and continuous. For a large thermal plant, a calculated amount of potassium permanganate will be required. By-product - manganese dioxide can be used to produce larger quantities of Potassium Permanganate. By-product – potassium carbonate can be sold or utilized for some other purpose. Flow chart of the entire process is shown in Fig. 5.

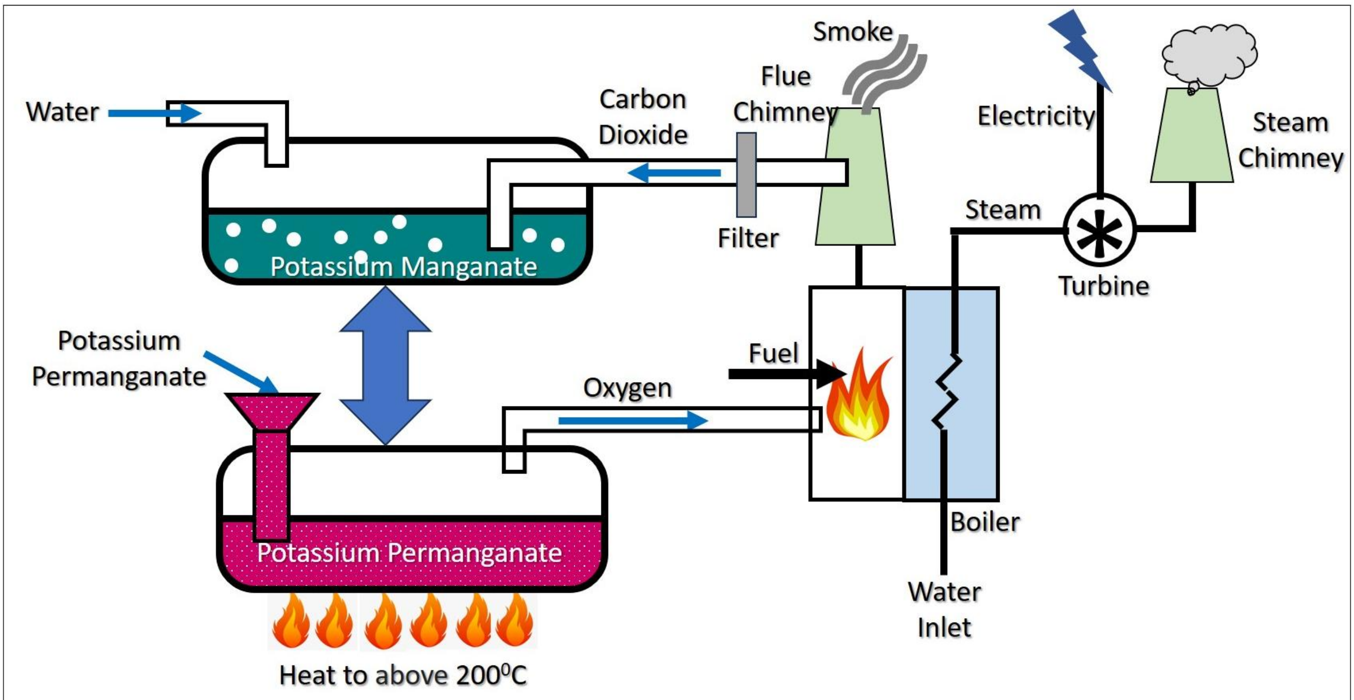

Fig. 4

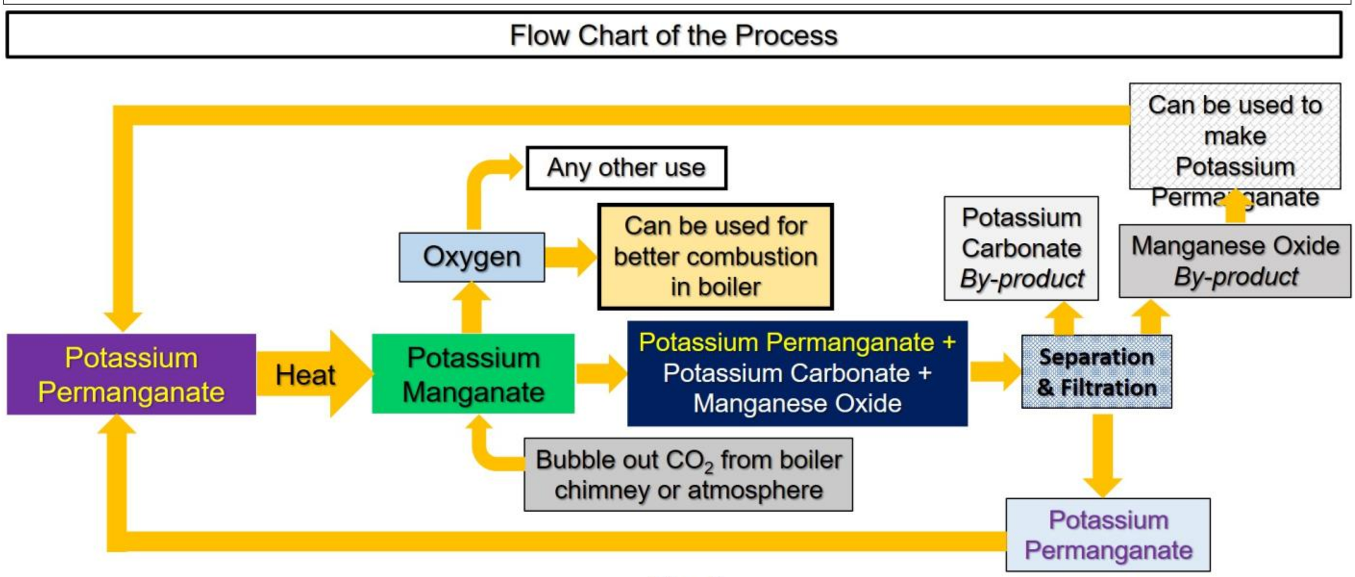

Fig. 5

2. Conclusion

It can be seen that the process described in this paper is highly sustainable and scalable too. The large investments done in fossil fuel power plants will be intact and while continuing to produce power, the process will be able to mitigate carbon dioxide. This will be a major step in reducing greenhouse gases emission. The large carbon footprint of the fossil-fuel based power plants would be certainly reduced. As majority of power plants all over the world are fossil-fuel based, their adoption of this process will go a long way to reduce the global warming and climate change effects. A pilot plant should be made to confirm the efficacy of the process.