KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
College of Petroleum
Engineering & Geosciences

Efficiency of Cerium-modified Palm Oil Fly Ash in Catalytic Ozonation of Phenol

Mustapha Babatunde M.

College of Petroleum Engineering and Geosciences

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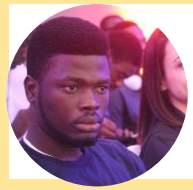
The Research Team

Dr. Bassam Tawabini, KFUPM

Eyad Safi, KFUPM, KSA



Mustapha Babatunde M.

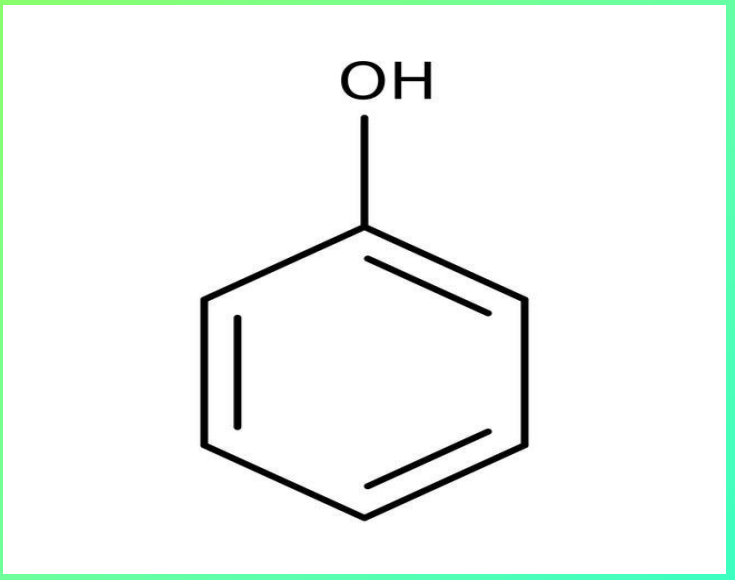
Tajudeen Oyehan, KFUPM, KSA

Introduction

- Water and Water Pollution
- KSA and Water Pollution
- Phenol Water Contamination

Phenol Contamination removal

- Adsorption
- Bioremediation
- Ozonation (Ozone-induced oxidation of phenol)
- Catalytic ozonation



Previous Works

Authors, Year	Methods Used	Remarks
J.A. Zazo, , A.F. Mohedano, J.J. Rodr´ıguez [2006]	Catalytic wet peroxide oxidation of phenol with a Fe/active carbon catalyst	Significant loss of activity of the enzyme due to Fe leaching.
A. Tor, Y. Cengeloglu, M.E. Aydin, M. Ersoz, [2006]	Removal of phenol from aqueous phase by using neutralized red mud, J. Colloid.	They used neutralized red mud as adsorbent for phenol removal, but the yield was relatively slow and time consuming
Dhatwalia, Vinod K. Nanda, Manisha, 2015	Biodegradation of Phenol: Mechanisms and Applications	Reiterated that phenol can be broken down by microbes. However, it' time consuming and Microbial growth could be inhibited by High conc. of phenol
Mahdi Farzadkia et al, 2014	Catalytic Ozonation of Phenolic Wastewater: Identification andToxicity of Intermediates	Ozonation requires high energy consumption.
Bassam Tawabini, Tajudeen Oyehan, Eyad S.I, Mustapha B.(2020)	Catalytic ozonation of phenol using cerium impregnated acid treated POFA	???

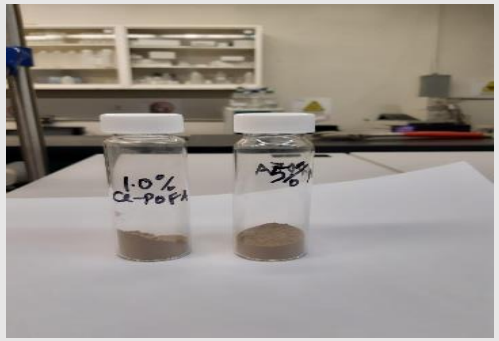
OBJECTIVES OF THE RESEACH

Evaluate the efficiency of Cerium modified Palm oil Fly Ash in the catalytic ozonation of Phenol.

Investigate optimum conditions needed for catalytic ozonation using cerium-based APOFA

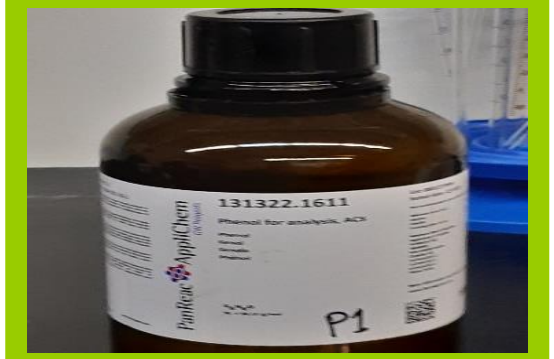
MATERIALS AND METHOD

Materials and Method



Palm Oil Fly Ash

It was prepared from our lab

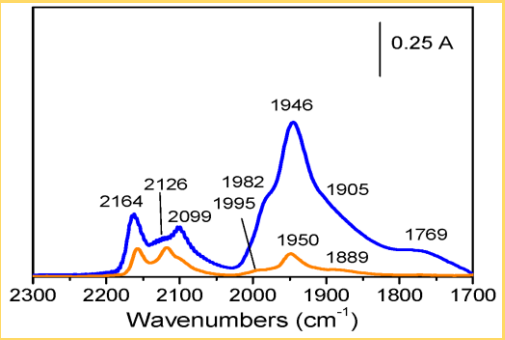


Phenol

Was supplied by Panreac (Germany). Desired concentration was made with serial dilution

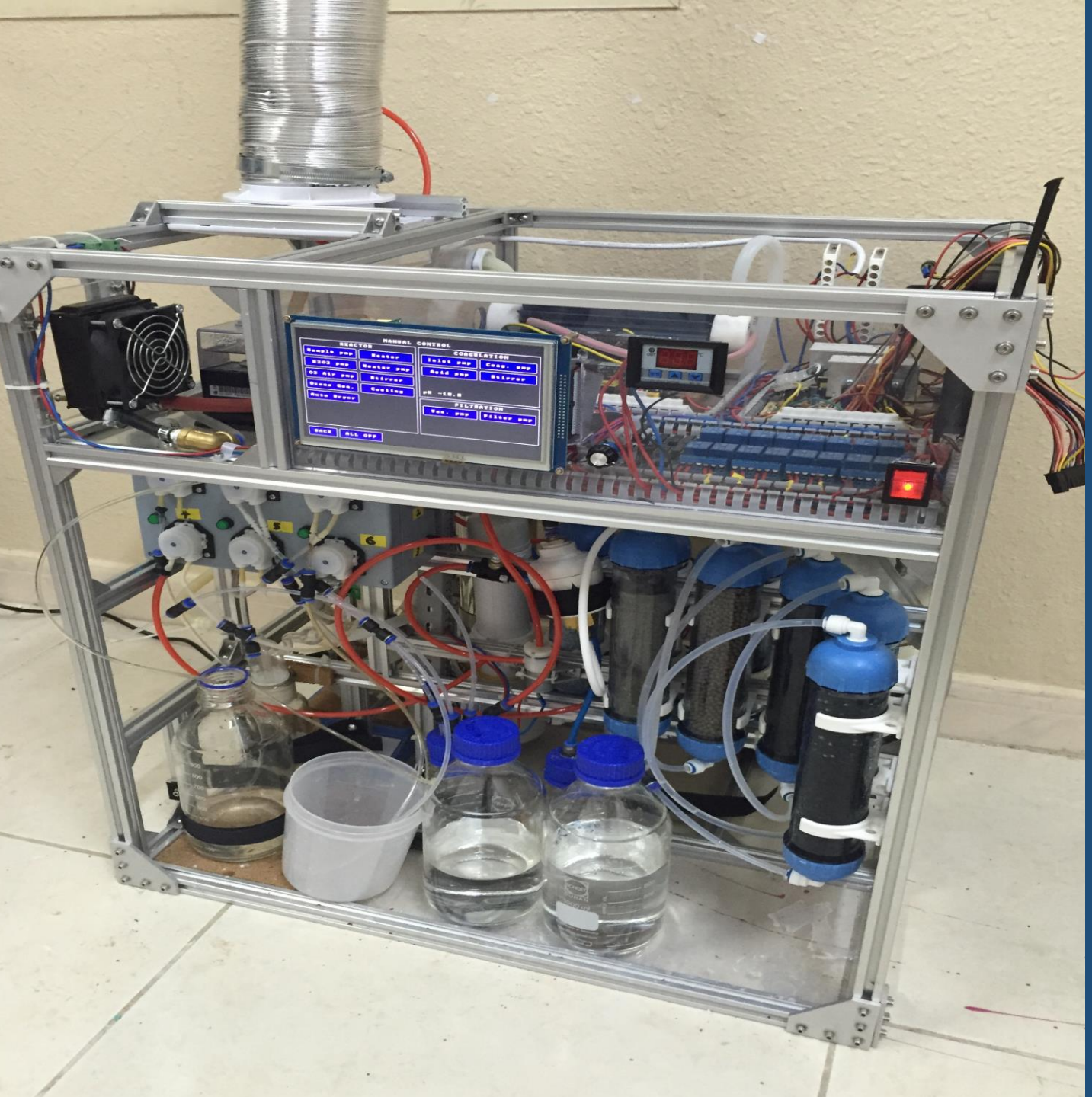
Cerium Oxide

Cerium nitrate ($Ce(NO_3)_2.6H_2O$) was obtained from Sigma-Aldrich. Nitric acid (HNO3) was supplied by Sigma Aldrich(Germany).



Catalyst Characterization

Particle size analysis
SEM-EDX



Materials and Method

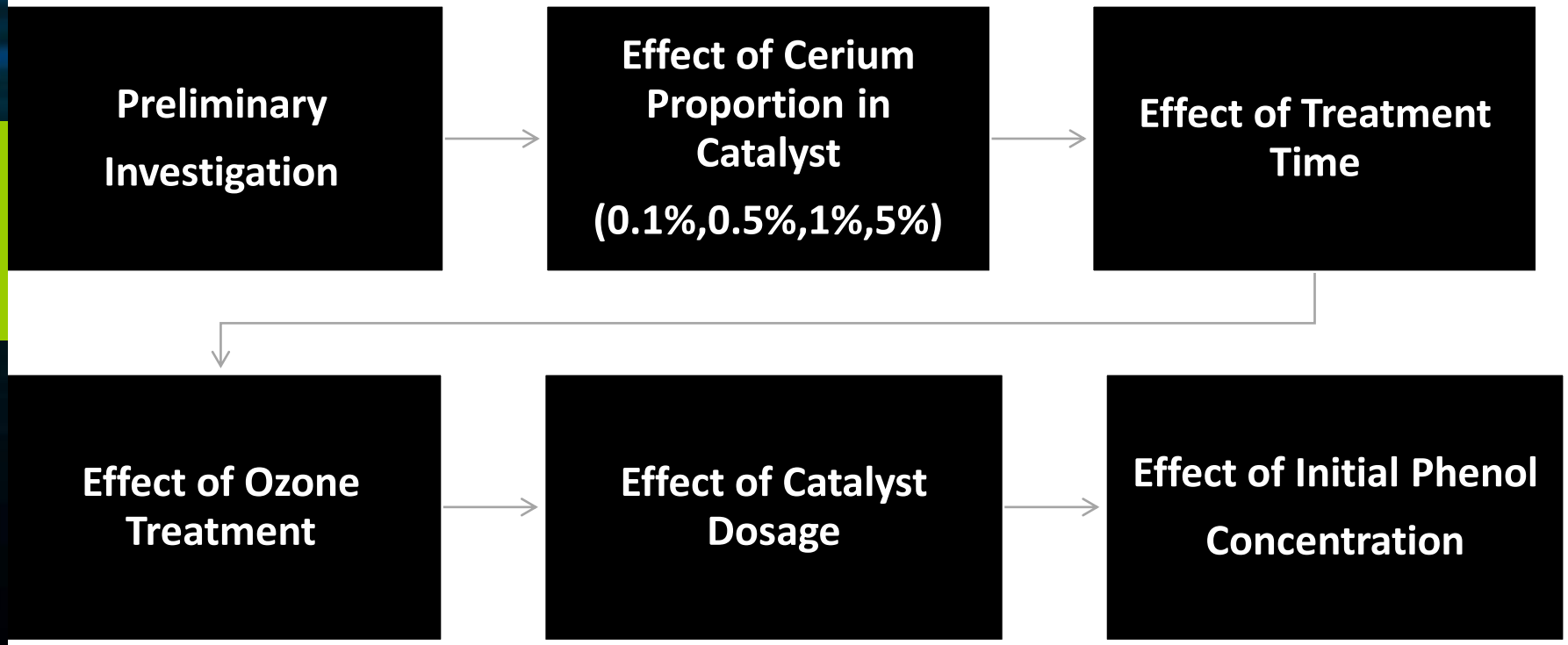
Analytical tools

Lab-assembled Ozone Reactor

TOC Analyzer

Materials and Method

EXPERIMENTAL LAYOUT



RESULTS AND DISCUSSION

Results and Discussion

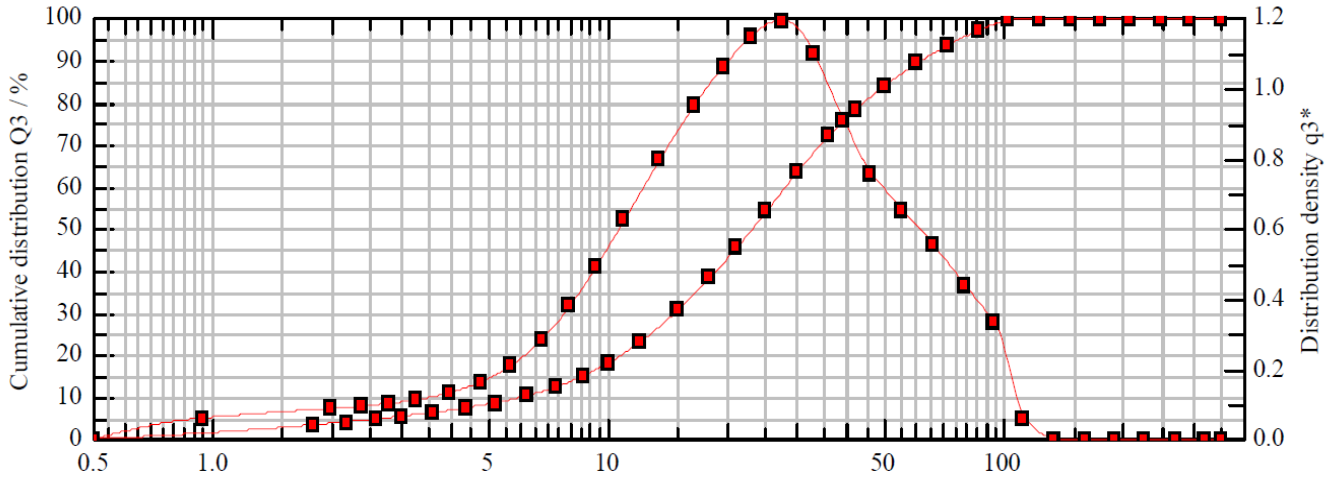
Characterization Results:

particle size analysis

5% Ce-POFA particle analysis showed that most of the particles are around 15.52

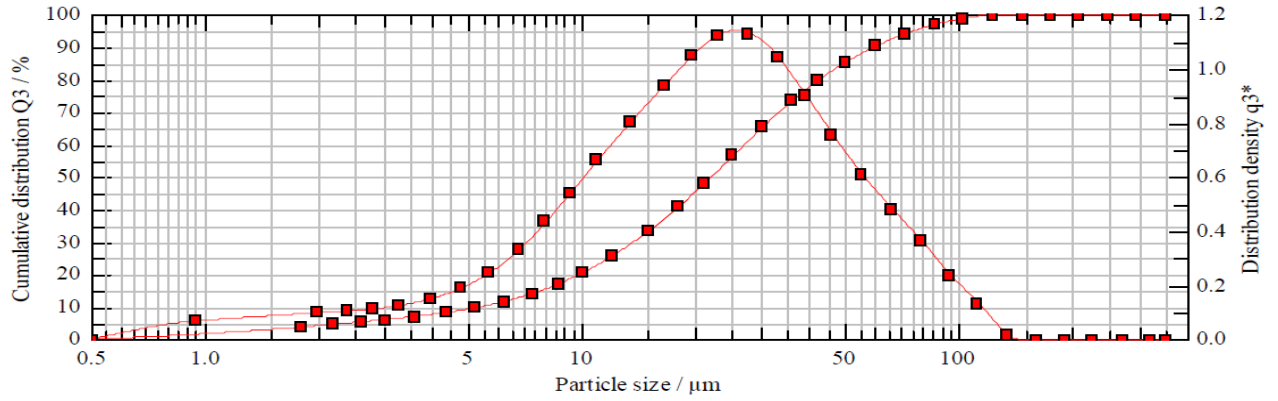
- **0.1 % CE-POFA**

x_{10} = 6.07 µm	x_{50} = 23.08 µm	x_{90} = 61.90 µm	SMD = 10.89 µm	VMD = 28.90 µm
x_{16} = 9.08 µm	x_{84} = 49.81 µm	x_{99} = 98.51 µm	S_V = 0.55 m²/cm³	S_m = 2343.72 cm²/g



- **0.5 % CE-POFA**

x_{10} = 5.32 µm	x_{50} = 21.89 µm	x_{90} = 59.06 µm	SMD = 10.08 µm	VMD = 27.83 µm
x_{16} = 8.16 µm	x_{84} = 47.73 µm	x_{99} = 104.94 µm	S_V = 0.60 m²/cm³	S_m = 2533.56 cm²/g



Results and Discussion

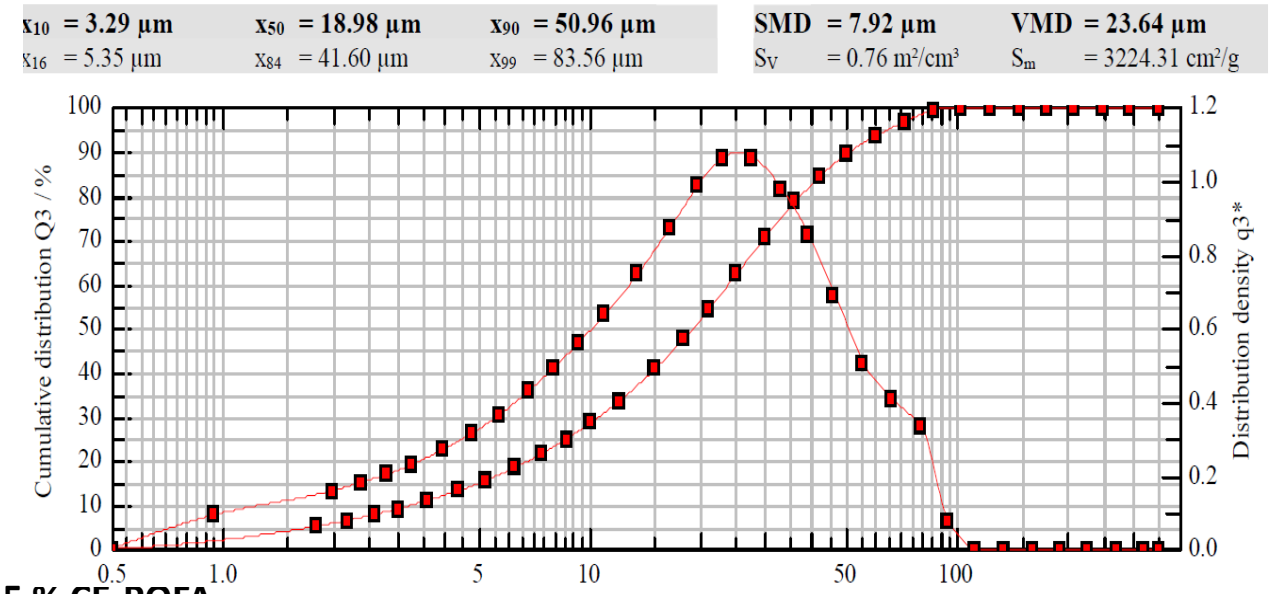
Characterization Results:

particle size analysis

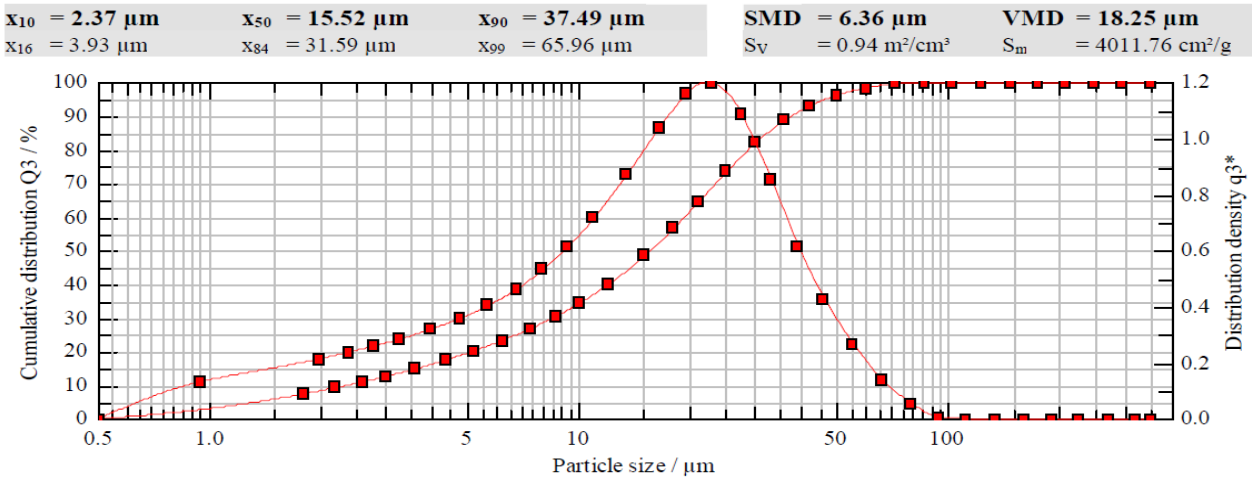
The result shows a clear disparity between the variants of the catalyst which is a manifestation of the lab modifications

Material	X50(µm)
0.1% Ce-POFA	23.08
0.5% Ce-POFA	21.89
1% Ce-POFA	18.89
5% Ce-POFA	15.52

- **1 % CE-POFA**

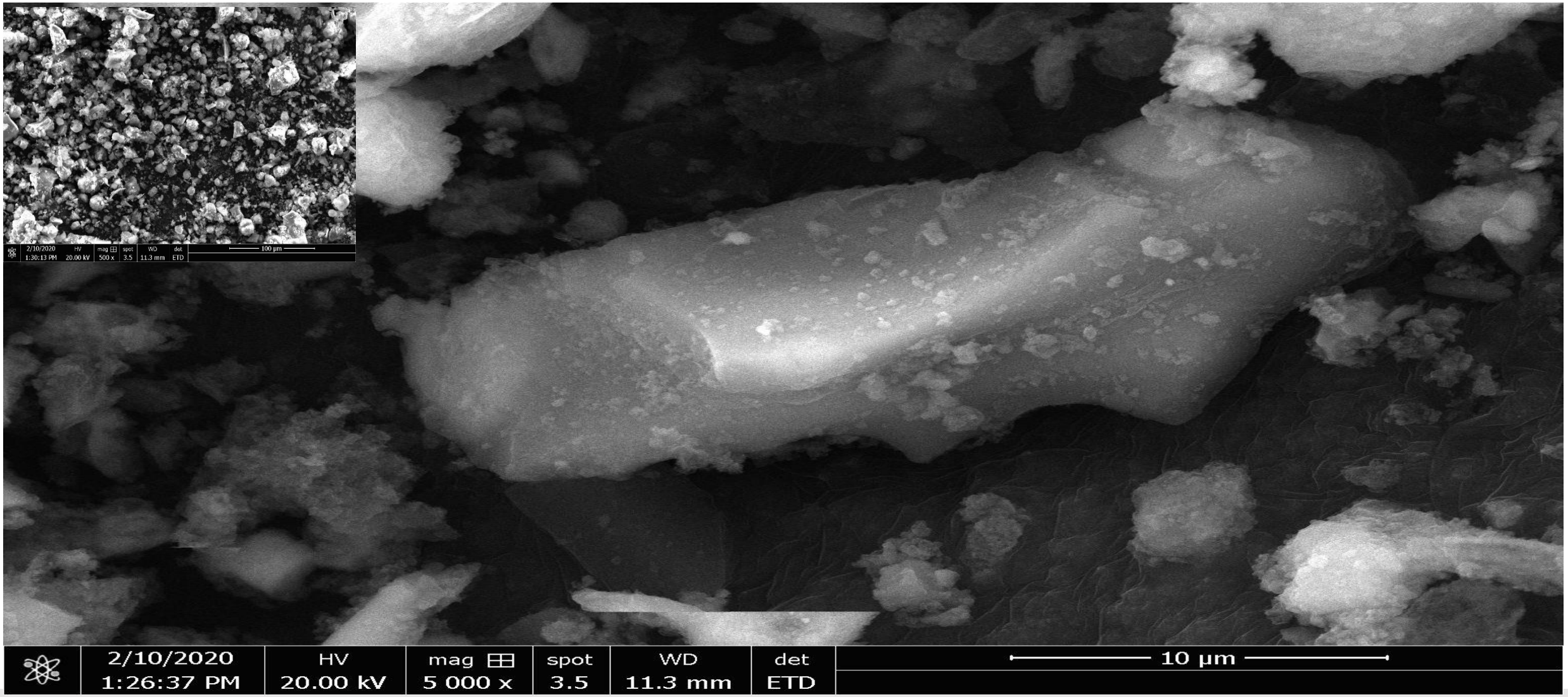


- **5 % CE-POFA**



Characterization Results:

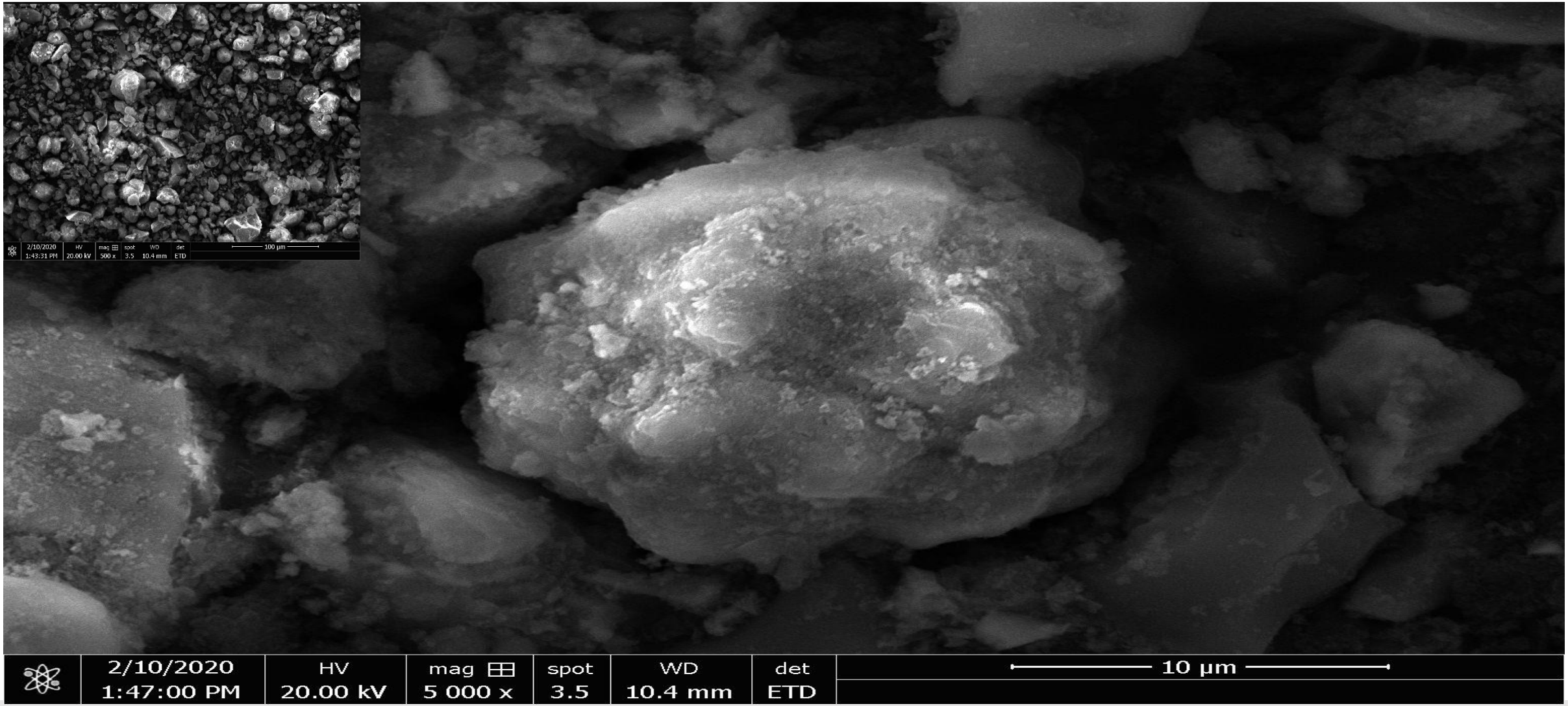
SEM, POFA



Results and Discussion

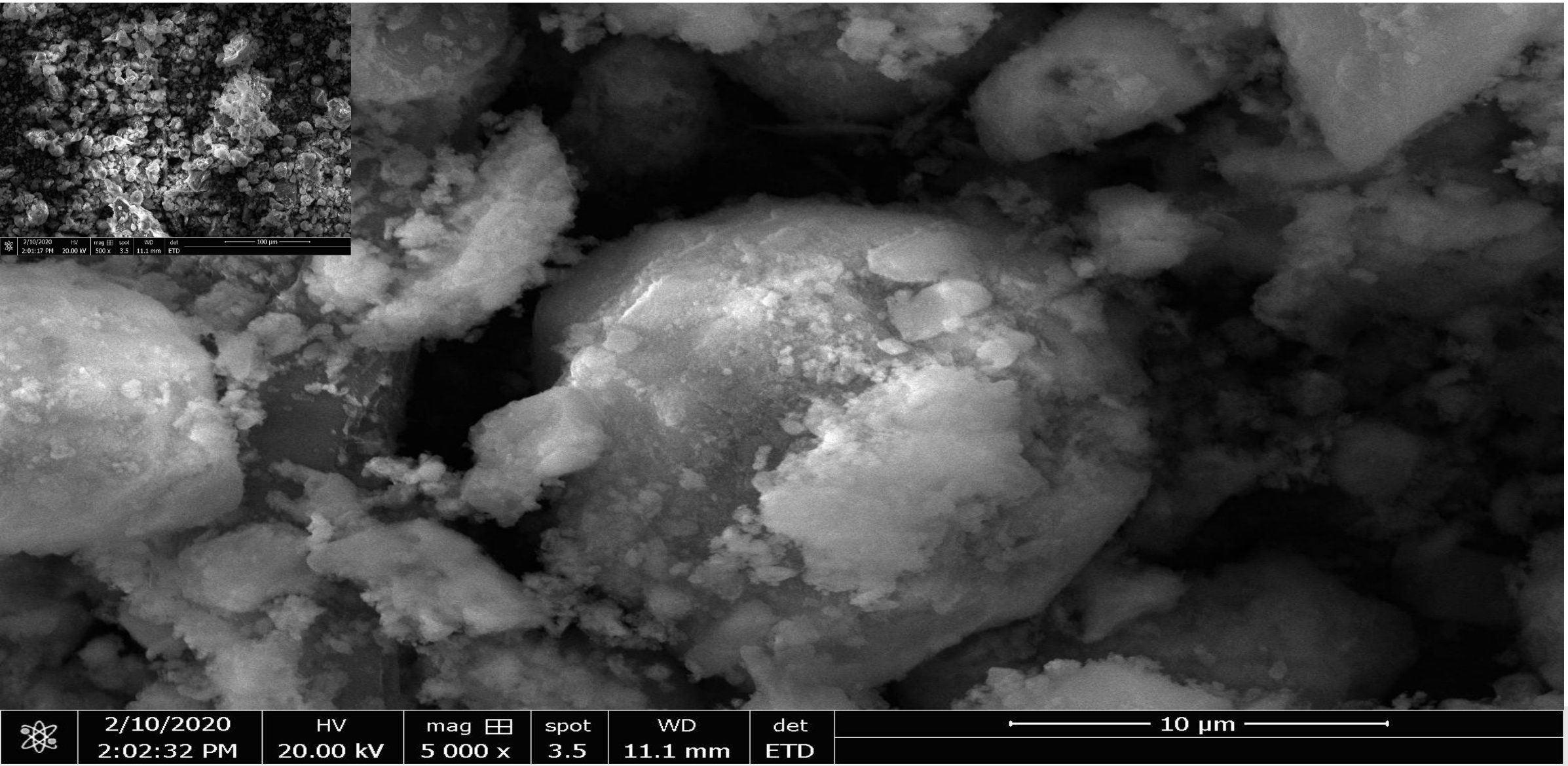
Characterization Results:

SEM, 1% Ce-POFA



Characterization Results:

SEM, 5% Ce-POFA



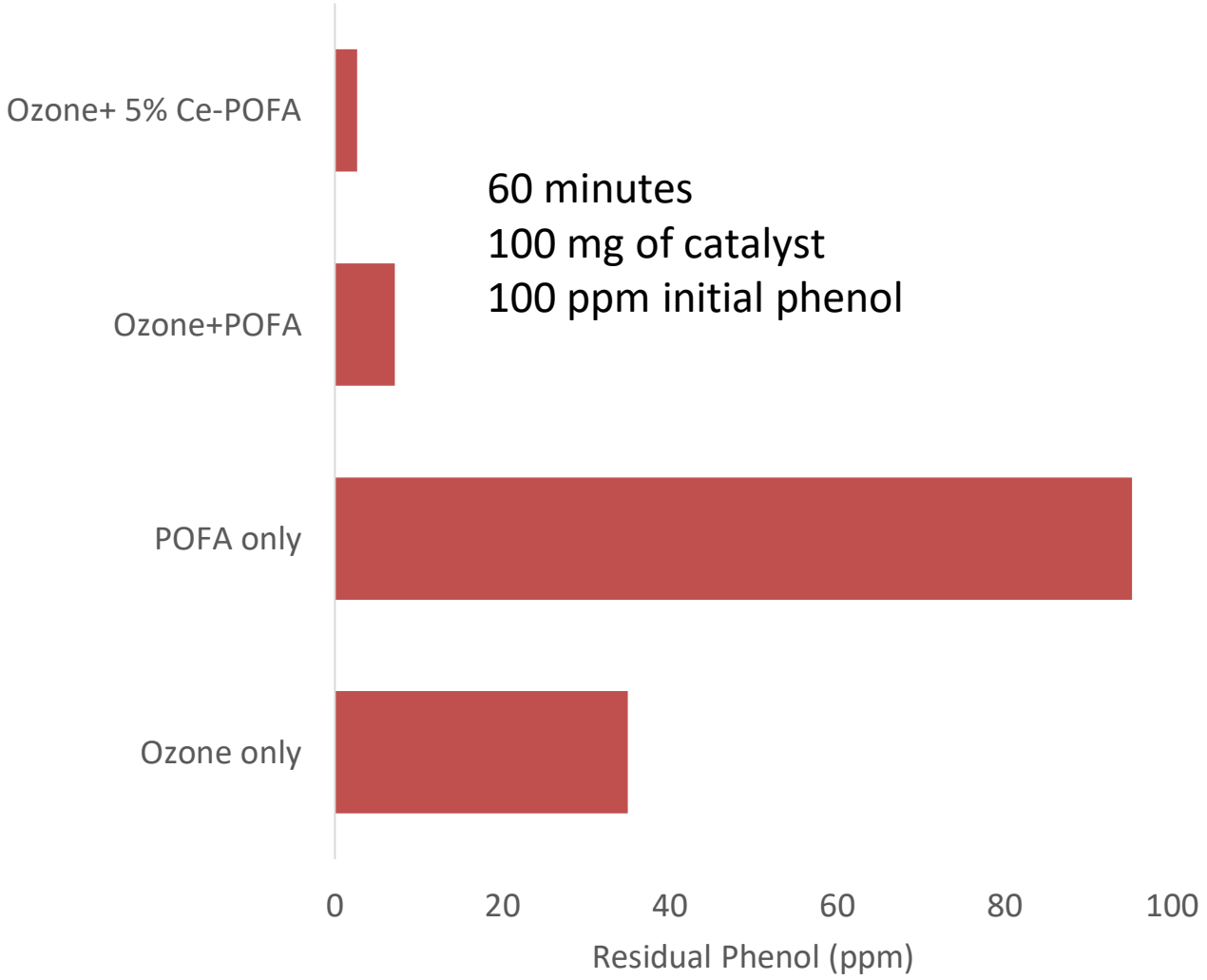
Results and Discussion

Characterization Results:

EDEX

Column1	POFA	1%	5%
Oxide	% composition		
Si	89.8	18.7	19
Al	3.5	1.4	0.6
K	3.2	0.8	0.6
Fe	2	2.7	0.6
Mg	0.8	0.3	0.2
Ti	0.6	0.3	0
Ce	nil	0.4	2

Results and Discussion



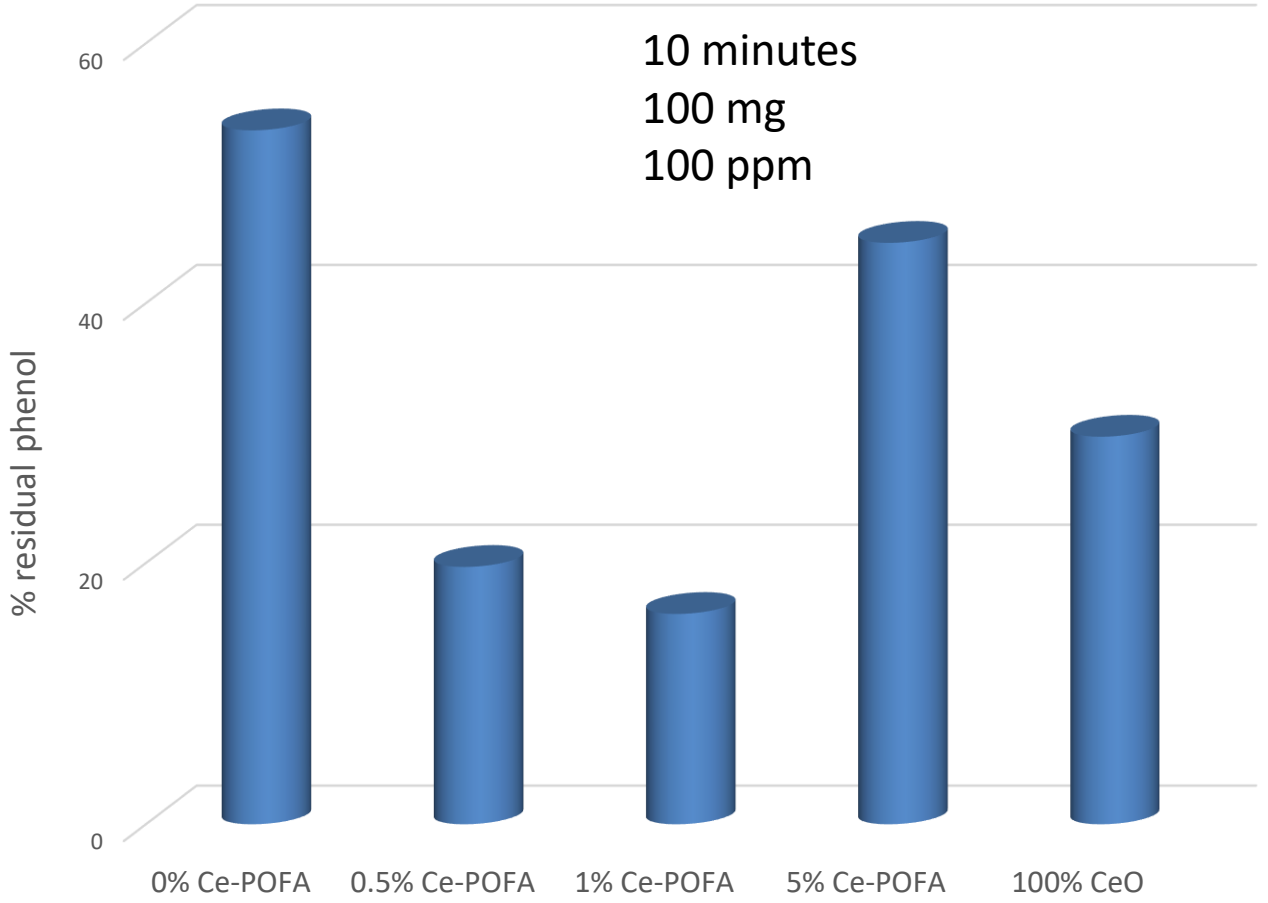
Preliminary investigations

Baseline comparison of removal efficiency of ozone only, POFA only, ozone + POFA, Ozone + cerium-POFA Revealed that the use of the catalyst with ozone has good prospects

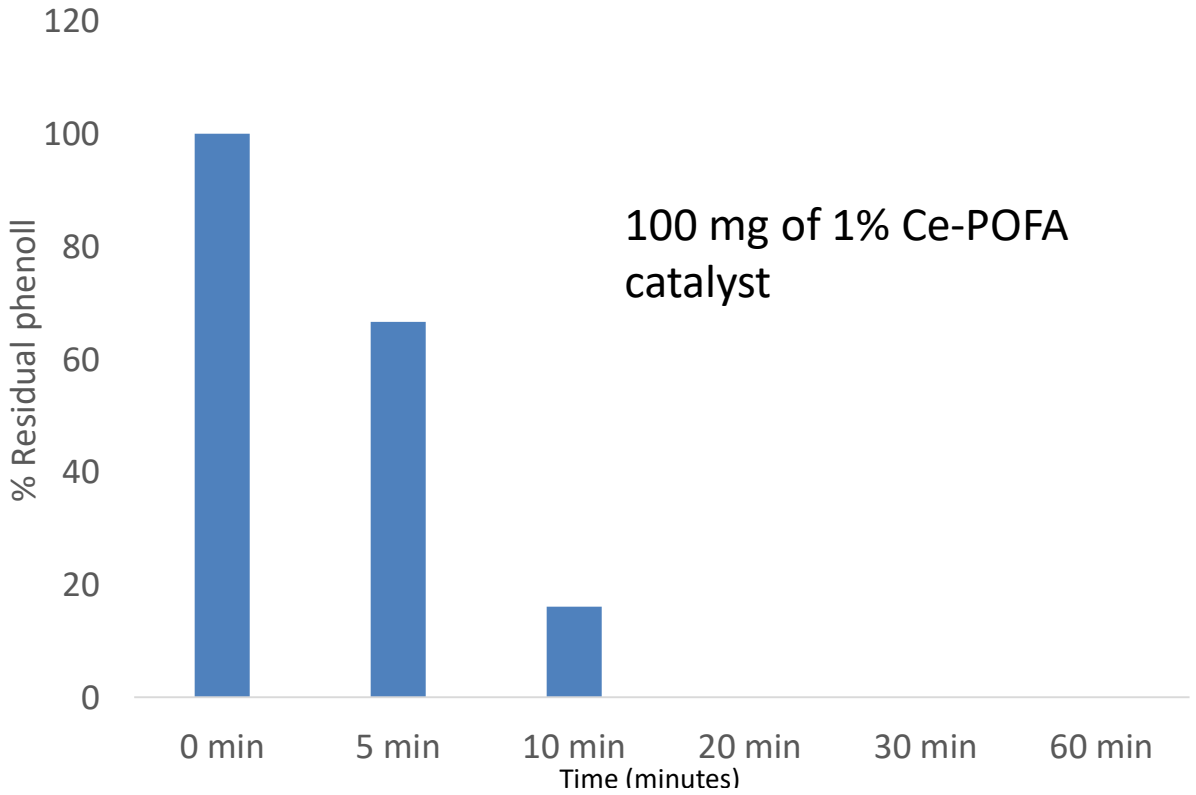
Results and Discussion

Effects of Cerium Proportion in Catalyst

1% Cerium-POFA Combination gave the best removal effect.



Results and Discussion



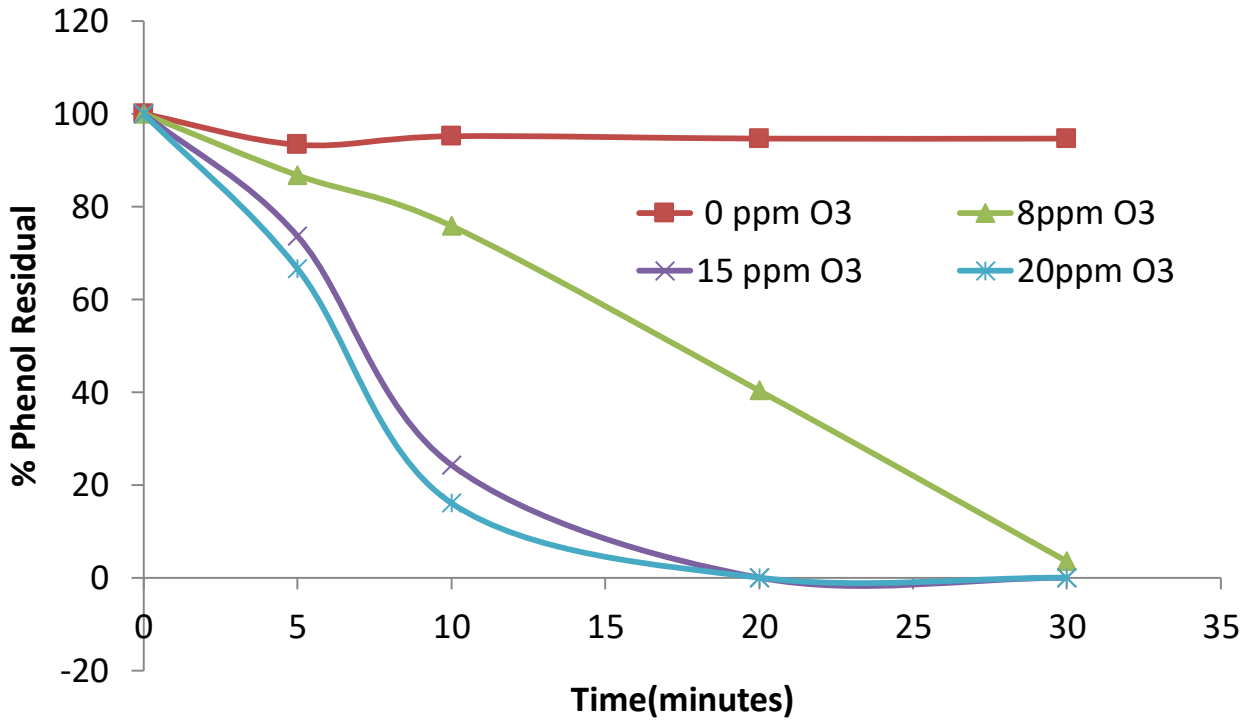
Effect of Treatment Time

We varied time while keeping other conditions (100mg of 1% Ce-POFA , 100ppm of phenol). Result showed that optimum time for phenol removal under this condition is 20 minutes.

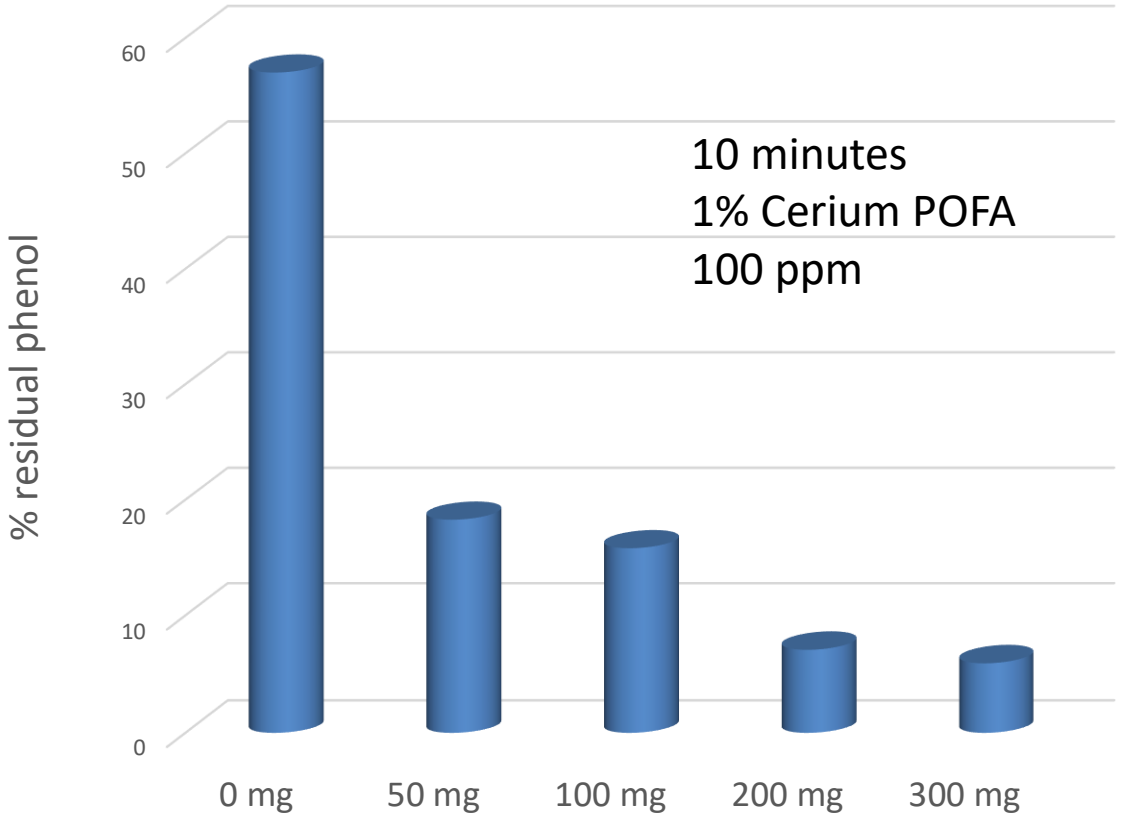
Results and Discussion

Effects of varying Ozone Conc. with Constant Optimal catalyst:

- 0 ppm showed insignificant removal
- 8 ppm gave average removal
- 15 ppm (level 2) and 20 ppm (max) produced almost same efficiency.
- 15 ppm (level 2) is recommended since it requires less energy and produces similar optimal effect as max level



Results and Discussion



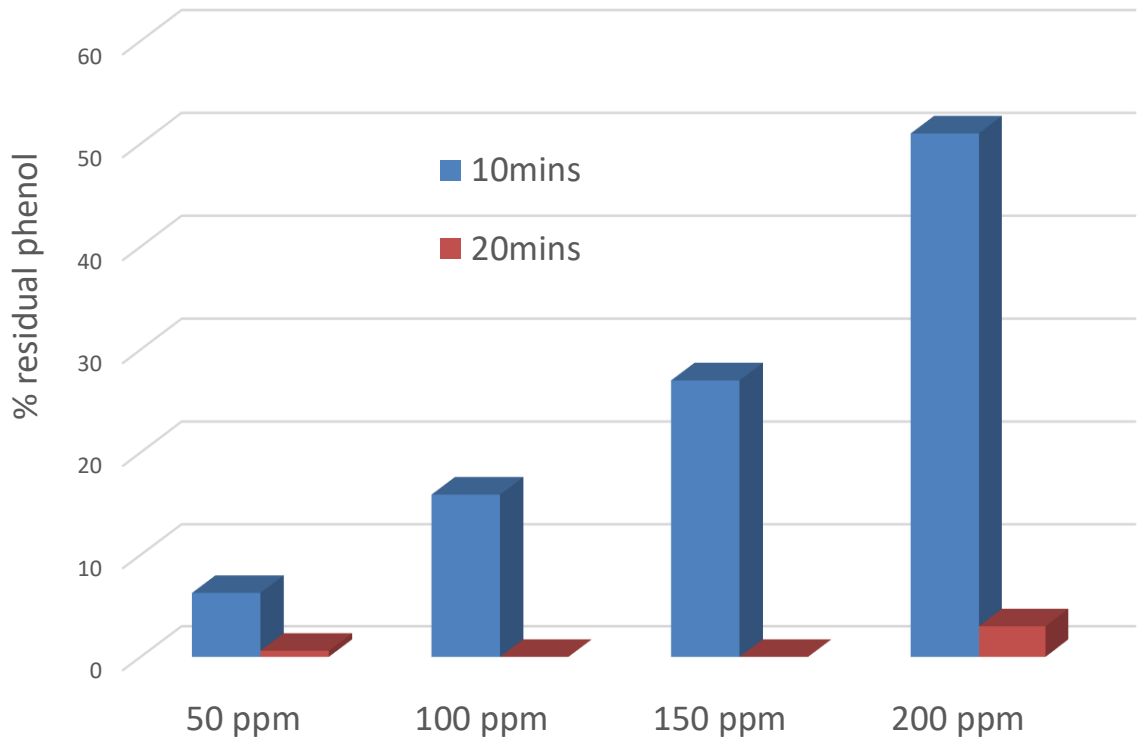
Effect Of Catalyst Dosage

- **Regardless of dose used, almost 100% removed after 20 minutes**
- **For 300mg and 200mg dosages, almost everything was removed within 10minute**
- **Considering Cost and Performance, between 50mg to 100mg is optimum**

Results and Discussion

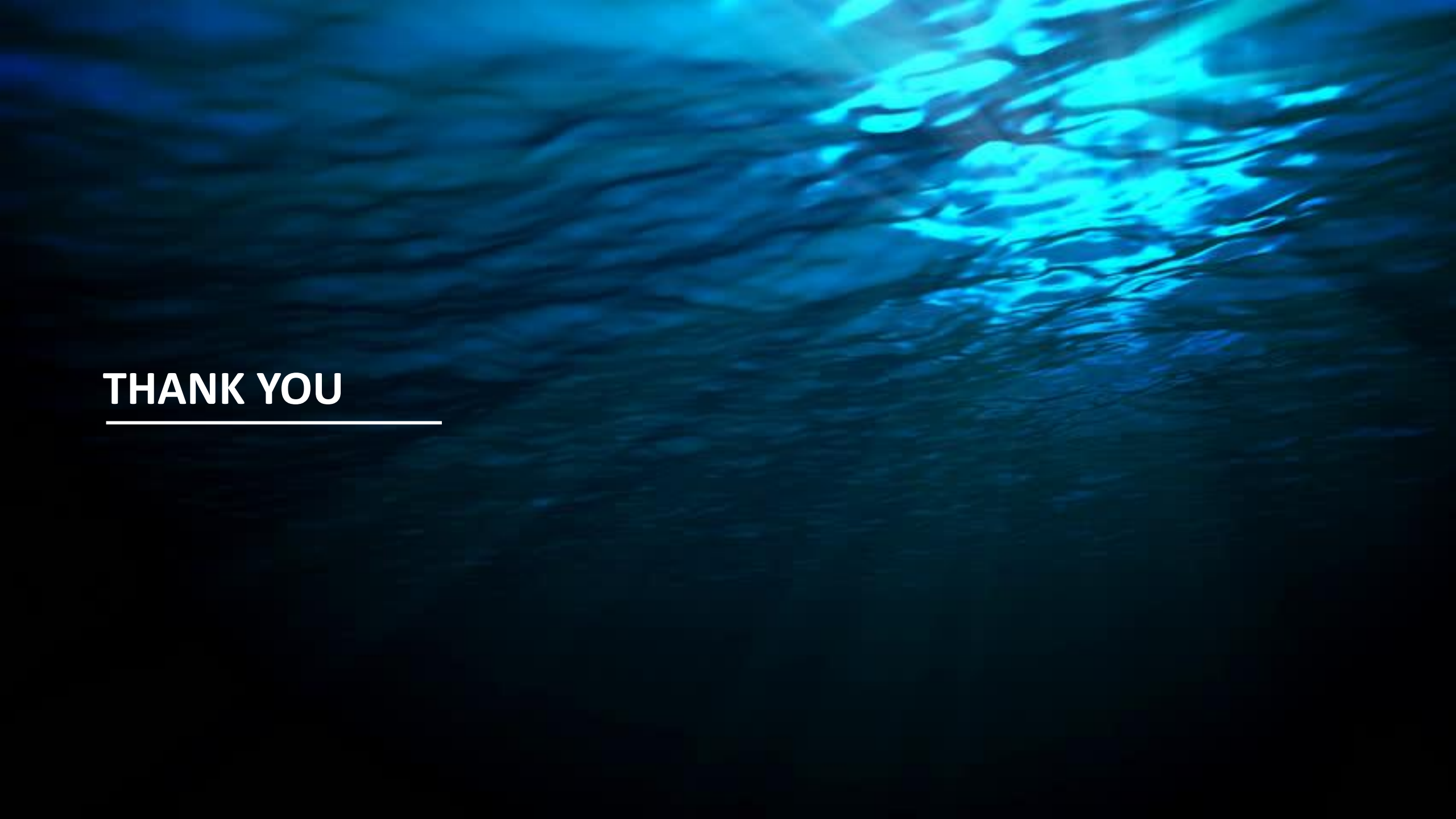
Effects of Initial Phenol Concentration

After varying initial phenol concentration, we realized the capacity of our catalyst can go beyond 100pm. Although additional 10 minutes may be required for the removal.



Conclusion

- In this research, we synthesized a cerium-based POFA as catalyst and optimized its conditions for treatment of phenol-polluted water.
- Addition of the catalyst to ozonation works and that optimal conditions are 100mg 1% Ce-POFA can remove 100ppm of phenol within 10 minutes
- This is exciting as the materials used to produce the catalyst is proven to be cheap and almost free, hence we have a material that is cheap, well efficient, as well as highly environmentally friendly to use as catalyst in phenol removal with ozone


THANK YOU