B2647 ING (M)

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DEQ-AQD LANSING D.O.

March 26, 2019

MAR 26 2019 JB

DEQ/AQD Lansing District Office
ATTN: Julie Brunner
Constitution Hall
525 W. Allegan, 1 South
P.O. Box 30242
Lansing, MI 48909

DEQ/AQD Enforcement Supervisor
ATTN: Jenine Camilleri
Constitution Hall
525 W. Allegan, 2 South
P.O. Box 30260
Lansing, MI 48909

SUBJECT: REO TOWN PLANT EUNGENGINE
RESPONSE TO NOTICE OF VIOLATION

Dear Mrs. Brunner,

On February 26, 2019, the Lansing Board of Water & Light (LBWL) received a Violation Notice for our REO Town Plant emergency engine, EUNGENGINE, for permit limit exceedances of PM2.5 and PM10 during the December 12-13, 2018 emissions test. The test performed by Mostardi Platt utilized U.S. EPA Method 5/202. The December testing was an average of three 2-hour runs with results indicating an exceedance of 0.03 lbs/hr. This notice was the second Violation Notice after conducting the same emissions test resulting in permit limit exceedances of PM2.5 and PM10 on September 13, 2018. The September testing utilized the same test consultant, methods, and run times, which results indicated an exceedance of 0.05 lbs/hr.

The February 26, 2019 violation notice requested a written response by March 12, 2019; however, a request to extend the response was submitted and received on March 6, 2019. The extension was granted until March 26, 2019.

Attached are appendices to support our response. Appendix A is the formal response which gives a summary of the investigation the Lansing Board of Water and Light completed and proposed next steps to prevent reoccurrence. Appendix B is an article titled "The Impact of Generator Set Underloading" which support the decision for the December retest. Appendix C is the laboratory sample analysis of the Method5 filter and Method 202 condensable particulate matter from the December retest. The

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appended document summarizes the corrective actions that have been taken and proposed next steps to prevent reoccurrence.

We appreciate the opportunity to respond to your concerns. If you have any questions, please contact Nathan Hude at 517-702-6170.

Sincerely,

Lori Myott
Manager, Environmental Services
Lori.Myott@lbwl.com
517-702-6639

cc:

Nathan Hude, BWL
Mark Matus, BWL
Tom Dickinson, BWL
Roberto Hodge, BWL

Appendix A: Reo Town Emergency Engine VN Response

BACKGROUND

EUNGENGINE is a 1300-kilowatt natural gas fired (spark ignition) emergency engine located at REO Town Station. The purpose of EUNGENGINE is to provide emergency lighting and electricity during power outages to REO Station and the adjacent LBWL corporate offices. EUNGENGINE is permitted under Renewable Operating Permit (ROP) MI-ROP-B2647-2018. The engine has an operational restriction of no more than 100 hours per year (no limit for emergency purposes) as required by 40CFR60 Subpart JJJJ and Special Condition III.2 of the ROP; however, it rarely operates. As of the date of this letter, EUNGENGINE has only operated 170 hours since the REO Town Plant commenced commercial operation in July of 2013. These 170 hours all consist of operational checks and stack testing with less than 10 hours of actual emergency use. 170 hours is equivalent to operating 7 days of the 2,068 days the unit has been installed or operating 0.34% of the time since installed in 2013.

Prior to the September 13, 2018 test, EUNGENGINE was operated on a monthly basis for approx. ½ hour to ensure operational readiness and identify unplanned maintenance concerns. Since the September 13, 2018 test, EUNGENGINE has only operated for retest preparation and the retest on December 12-13, 2018. EUNGENGINE has not operated since the December testing.

2018 EMISSIONS TESTING INVESTIGATION

Upon the receipt of the September 13, 2018 test results, it was believed that the failure was stemming from oil penetrating the piston rings due to the engine being operated without or at a low generator load during readiness testing. This information was provided by Caterpillar staff and is documented in the Caterpillar Online Community titled "The Impact of Generator Set Underloading," Appendix A. Thus, in preparation for the December retest, the engine was only operated with the generator in a loaded status and was again tuned by Caterpillar. This operation totaled 8 hours.

The December 12-13, 2018 testing showed that results improved slightly from the September test, but were nonetheless still slightly above the permit limit. The LBWL contracted MVA Scientific Consultants through Mostardi Platt for further analysis of the test filters and condensable materials in an effort to determine what the constituents were and potential source. The Method 5 filters were analyzed using Scanning Electron Microscopy / energy dispersive x-ray spectrometry (SEM/EDS) and the Method 202 back half samples were analyzed using polarized light microscopy (PLM), Fourier transform infrared spectroscopy (FTIR) and /or SEM/EDS for determining elemental composition. The final report for this analysis was received on February 6, 2019 and is included in Appendix B.

The findings of the Method 5 filters include the presence of what is believed to be calcium phosphate, $Ca_3(PO_4)_2$ and iron oxide/hydroxide. The Method 202 back half sample findings using a stereomicroscope identify a solid substance that is orangish/red in color in granular form and fan-like crystals. There is also what appears to be embedded fibers and a clear gypsum crystal in the run 1 impinger set. EDS analysis of the Method 202 back half samples indicates the presence of carbon, nitrogen, oxygen, sodium, aluminum, sulfur, potassium, calcium, magnesium, and iron.

The conclusion of the MVA Scientific Consultants report indicates that "The principal materials found on the filters and in the impinger samples of this sample set are unusual in stack samples and not ordinarily associated with natural gas combustion. They may arise from the environment and enter the stack during times when the emergency generator is dormant and/or reflect degradation of the inner lining of the stack." At this point the BWL began looking at the exhaust stack for signs of metal degradation, foreign materials, and outside influence.

The stack investigation by LBWL staff included disassembly of exhaust ductwork for inspection and use of a borescope camera for viewing inaccessible exhaust ductwork areas. Areas of rust corrosion were identified in certain sections and evidence of moisture influence from the adjacent cooling towers was observed, yet LBWL staff found no distinct evidence or casual agents of the stack testing failures. The results of the investigations all produced inconclusive results.

<u>EMISSIONS TESTING DISCUSSION</u>

Over the course of REO Station's operation, EUNGENGINE has been tested a total of 4 times, of which 3 have been failures. The test results for all tests are as follows:

Table 1: Summary of all stack tests completed on EUNGENGINE.

Test Date	Test Result	Filterable (M5) Emission Rate	Condensable (M202) Emission Rate	Total PM (M5/202) Emission Rate	Total PM Emission Limit	PM Limit Exceedance Amount
7/29/13	Fail	0.05 lbs/hr	0.16 lbs/hr	0.21 lbs/hr	0.13 lbs/hr	0.08 lbs/hr
9/10/13	Pass	0.02 lbs/hr	0.06 lbs/hr	0.09 lbs/hr		na
9/13/18	Fail	0.053 lbs/hr	0.122 lbs/hr	0.18 lbs/hr		0.05 lbs/hr
12/12-13/18	Fail	0.032 lbs/hr	0.126 lbs/hr	0.16 lbs/hr		0.03 lbs/hr

Using the highest "Total PM Emission Rate" of 0.21 lbs/hr from testing and the total hours of operation for EUNGENGINE, total PM emissions from EUNGENGINE equate to 35.7 lbs from the 170 hours of operation since the beginning of operations in July of 2013.

<u>PERMIT LIMIT DISCUSSION</u>

EUNGENGINE permit limits are based on U.S. EPA AP42 Section 3.2 for Natural Gas-fired Reciprocating Engines, Table 3.2-2 for 4-Stroke Lean Burn Engines. The combined emission factor for PM Condensable, and PM10/PM2.5 filterable is 9.99E-03 lbs/MMBtu with an emission factor rating of D. The emission factor range is A-E, with A being the best and most reliable estimated emissions and E being the least reliable.

MI-ROP-B2647-2018 identifies the EUNGENGINE PM10 and PM2.5 limit at 0.13 lbs/hr. As discussed above, the emission factor utilized to calculate the permit limit did not allow for anomalies in testing or with engine operation and was not specific to the engine installed at the plant. Further, the low emission factor rating of D reduces the confidence in the accuracy of this calculation.

CONCLUSION

Extensive analysis and maintenance by Michigan Caterpillar service representatives indicate the engine is operating as designed. With the exception of generator loading during maintenance checks, operations of the engine and its monitoring systems indicate normal parameters. Changes in loading the engine generator for readiness testing have been implemented, yet the engine has not been operated since the December testing. Additional analyses conducted on the filterable and condensable portions were inconclusive but indicate an outside source, prompting the visual investigation of the stack internal conditions. Although evidence of cooling tower moisture was present, no conclusive evidence of outside influence causing additional condensable PM is determinable.

It is the LBWL belief that the permit limits set forth for EUNGENGINE is not reflective of the engine installed at REO Town Plant. Given that three of the four tests conducted resulted in test failures with differences of 0.03 to 0.08 lbs/hour averages, the LBWL is investigating the modeling of EUNGENGINE emissions to determine if the removal or an increase in the PM10/PM2.5 emission limits is allowable. As detailed earlier, the emission factor for the limits in place are poorly rated and the limit is at the lowest possible level based on anticipated emissions. Thus, it places the LBWL at a disadvantage for meeting emissions requirements. At the time of the original permit, operational restrictions at the engine on a daily basis were not considered, as modeling guidance at the time did not allow permit applicants to fully incorporate operational restriction assumptions in modeling analyses. More recent modeling guidance allows some credit for operational restrictions, especially those governing intermittent emergency sources.

Since original permit issuance, the U.S. EPA has issued numerous other changes to modeling guidance and has updated the AERMOD regulatory dispersion model. Improvements including treatment of low wind-speed conditions are anticipated to reduce previously estimated maximum modeled impacts. The LBWL believes updates to the modeling for EUNGENGINE will support increased emission levels based on more recent improvements to the model and guidance. Once the modeling results are available, we look forward to discussing the opportunity to amend our permit limits to obtainable yet environmentally protective emission levels.

Appendix B: Reo Town Emergency Engine VN Response

CAT

BLOG: POWER PERSPECTIVES

The Impact of Generator Set Underloading

by bjabeck 03-16-2015 07:49 AM - edited 03-16-2015 07:52 AM

POWER PERSPECTIVES
ELECTRIC POWER GENERATION BLOG

Brian Jabeck
Market Development and Design Engineer Consultant
Caterpillar Inc.

System health and reliability are critical to backup and prime power solutions for any installation—from mission critical data centers to neighborhood grocery stores. While power systems vary in operation, application and load profile, they're all designed to provide reliable power and maximized efficiency. The generator set is a key piece of the power system that requires special attention for long-term system reliability, availability and uptime. To achieve these, it's important to understand system operation, load profile and required maintenance. This blog will focus on generator set operation in low-load scenarios, and what can result if they are used outside of specific parameters.

First, it is important to understand that generator sets are designed to run with load. This may seem trivial, but loading a generator set properly is essential to availability and a long engine life. Manufacturer service intervals and projected component life are based on operation in load ranges to deliver an ideal mix of product performance, power density and long-term operational life.

Incorrect generator set operation can result in reduced output, component damage, reduced lifecycles, and unscheduled downtime. The ideal operation targets of each generator set will depend on the application and rating.

Underloading Diesel Generator Sets

Generally speaking, standby- and prime-rated diesel generator sets are designed to operate between 50 and 85 percent load, while continuous-rated diesel generator sets optimize between 70 and 100 percent load. Operating diesel generator sets at loads less than 30 percent for extended periods can impact uptime and engine life.

The most prevalent consequence of underloading is exhaust manifold slobber, or wet stacking, which is the black oily liquid that can leak from the exhaust joints when the engine does not reach minimum temperatures and pressures. Visible engine slobber doesn't necessarily indicate a problem, but it signals possible underloading concerns, low ambient temperatures or jacket water temperatures that are too low. Additionally, long periods of light loading can lead to deposit build-up behind the piston rings or inside the cylinders, which can cause power loss, poor performance, accelerated wear and in extreme cases, cylinder liner polishing.

ANNOUNCEMENTS

Help us grow the Caterpillar Community:

Invite a Friend

MEET OUR BLOGGERS

Nick Kelsch (KelscNM)
Gas Application Consultant

Chad Dozier (diesel_dude)
Marketing Application Consultant

Dave Hedrick (hedrdb)
Sr. Engineering Specialist

Robb Holmoka (wattsup)
Product Support Manager

Kevin Benz (oltwodogs)
Product Support Consultant

Paul Newman (cool_hand_luke)
Engineering Project Team Leader

Lou Signorelli (Siggy62)
Systems Engineer

Jennie Tylec (jen-erator)
Market Development Consultant

Steven Baker (bakersj)
Sizing Consultant

RECENT DISCUSSION TOPICS

Re: DVR Parameters
Posted By mikel

SR5 Spare Parts
Posted By daddycool

Appendix B: Reo Town Emergency Engine VN Response

Underloading Gas Generator Sets

Natural gas and biogas generator sets, independent of application and rating, are typically designed for operation between 60 and 100 percent load. Without enough cylinder pressure to maintain oil control at low loads, gas engines can develop ash deposits, a reduced detonation margin and damaged engine components. Similar to diesel generator sets, deposit build-up on valves, spark plugs and behind piston rings can occur—which may cause cylinder liner polishing, power loss, poor performance and accelerated component wear—ultimately increasing the likelihood of higher maintenance costs and downtime.

Managing Low Load

If maintained properly, diesel and gas generator sets can operate at light loads for long periods without harmful effects. After underloading, the generator sets should run at increased load to raise the cylinder pressure and temperature, which will clean the deposits from the combustion chamber. Regular low load operation requires a more aggressive maintenance plan to reduce excessive component wear and may require engine modification.

Engine Load	Time Limit
0 to 30 percent	1/2 hour
31 to 50 percent	2 hours
51 to 100 percent	Continuous[1]
[1]For continuous operation, the manifold air pressure must be greater than the atmospheric pressure.	

Table 1: Time limits for low load operation of natural gas generator sets

Diesel engines should run at a minimum of 30 percent load for about 30 minutes for every four hours of light-load operation, and operators should measure exhaust temperature prior to the turbo for analysis. Natural gas engines are more sensitive to low loads, so there are specific underloading time limits required to maintain optimal performance, see the chart above. After the time limit has expired, the engine should run at a minimum of 70 percent load for at least two hours.

Power system underloading impacts individual components as well as overall performance, so it should not be taken lightly. While the simple solution is to operate generator sets at a load that meets design requirements, the reality is that system needs sometimes change. This makes underloading common in the realm of power generation—especially in standby applications. However, the effects of underloading can be minimized with a thorough operation and maintenance plan to preserve system health and avoid extra costs down the road.

- We'd like to hear from you. Tell us how generator set underloading has impacted your operation.
- What strategies have you implemented to ensure optimal performance at low loads?
- In your experience, how has underloading diesel generator sets differed from natural gas-fired engines?
- What can Caterpillar do to improve system design and help reduce the impact of underloading for your application?

For more information, visit www.catelectricpowerinfo.com or contact your local Cat dealer.

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Comments

by Bamgles2 Options

on 03-19-2015 05:45 AM

By underloading the generator it will affect the service of the generator and electrical system.

Re: what is it like to paintings as a electricity plant operator?
Posted By Ashishgada

Re: Old 3516 emission data?
Posted By EvanSR

LABELS

7x24 Exchange **(1)**
Air flow **(1)**
arc flash **(2)**
BIM **(1)**
Biogas **(2)**
blackout **(1)**
Building Information Modeling **(1)**
circuit breakers **(1)**
contingency plan. emergency response **(1)**
cost per electrical kW **(1)**
Country of Use Facett Added to cat.com **(1)**
Critical Load **(1)**
critical power **(1)**
CSA **(1)**
CT **(1)**

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Stack Sample Analysis

PM10 & PM2.5 Custom Particle Sizing

Particle Shape Analysis

Particulate Matter Identification

Back-Half Catch Residue Identification (M202)

Filter Debris Analysis

Ambient Air Sample Characterization

Condensable Analysis

Litigation Support

Techniques

Light Microscopy

Scanning Electron Microscopy

Transmission Electron Microscopy

Fourier Transform Infrared Spectroscopy

Confocal Raman Microscopy

White Light Interference Microscopy

Energy Dispersive X-ray Spectrometry

Fluorescence Microscopy

Ion Milling & Ultramicrotomy

Accreditations

cGMP Compliant

ISO/IEC 17025
A2LA Certificate #2096.01

FDA Registered

Revised Report of Results: MVA12978

Identification of Material in Stack Samples

Prepared for:

Mostardi Platt
888 Industrial Drive
Elmhurst, IL 60126

EXECUTED BY ELECTRONIC SIGNATURE

Respectfully Submitted by: ______________________

Tim B. Vander Wood, Ph.D.
Executive Director

Supercedes Report Dated 18 January 2019

6 February 2019

Revised Report of Results: MVA12978

Identification of Material in Stack Samples

Introduction

On 3 January 2019 we received three Method 5 filters and three samples of dried residue in glass vials with the request that we identify the components of the particulate on the filters and in the vial residues. The samples were reportedly taken from a natural gas-fired emergency generator that is only intermittently fired. The samples were assigned MVA Scientific Consultants laboratory identification numbers as follows:

Client Identification	MVA Number
Test 1 Filter	AE0002
Test 2 Filter	AE0003
Test 3 Filter	AE0004
Test 1 Water from Imps	AE0005
Test 2 Water from Imps	AE0006
Test 3 Water from Imps	AE0007

The samples were analyzed in our laboratory during the period 7 January through 17 January 2019. This revised report was issued to include observations about possible sources of the materials identified in the sample.

Methods

A portion of each filter was excised, mounted and coated with a thin layer of carbon to provide electrical continuity. The prepared samples were analyzed by scanning electron microscopy/energy dispersive x-ray spectrometry (SEM/EDS) using a JEOL JSM-6490LV scanning electron microscope equipped with a Thermo Scientific Noran System 7 energy dispersive x-ray spectrometer.

The material in the vials was examined visually and with the aid of a stereomicroscope. Portions of the samples were analyzed by polarized light microscopy (PLM), Fourier transform infrared spectroscopy (FTIR) and/or scanning electron microscopy/energy dispersive x-ray spectrometry (SEM/EDS). PLM examination was conducted with an Olympus BHSP polarized light microscope, FTIR was conducted using a SensIR IlluminatIR infrared spectrometer attached to an Olympus BX51 compound microscope, and SEM/EDS was conducted using a JEOL JSM-6490LV scanning electron microscope equipped with a Thermo Scientific Noran System 7 energy dispersive x-ray spectrometer.

Please note that in the enclosed EDS spectra, the presence of a peak labeled with an element symbol indicates the presence of that element in the sample, and the height of the peak can be related to the concentration of the element in the sample.

Results and Discussion

Filter Samples. The types of particles found on the filter samples and their approximate compositions are given in Table 1. The dominant particle types in all three samples are a calcium-phosphorus-oxygen-rich type (probable calcium phosphate, $Ca_3(PO_4)_2$) and iron oxide/hydroxide (possible corrosion products). The putative calcium phosphate particles are often associated with variable amounts of zinc and sulfur. There is a slight tendency for an increasing ratio of calcium phosphate to iron oxide from Test 1 to Test 3. We noted during our analyses that the iron oxide particles are generally larger than the calcium phosphate particles and likely make up a larger percentage of the samples on a mass basis (Table 1 results are on a particle count basis.) Representative images and EDS spectra are shown in Figures 1 through 5.

Calcium phosphate is not expected the flue gas of a natural gas-fired generator and likely originates outside of the combustion process. Calcium phosphate is a common industrial mineral with principal use in fertilizer. Similarly, iron oxide is not an expected combustion product of natural gas. It has been found as a corrosion product in flue gasses resulting from corrosion of the stack itself. Calcium phosphate is sometimes used as a corrosion inhibitor.

Water from Imps Samples. All three samples present as an orange/rust-colored residue in glass vials (Figures 6 through 8). Analysis by PLM indicated that all three samples consist principally (60-80% v/v) of an orange isotropic resinous material with entrained glass and fibers consistent with cellulose making up as much as 20% of the sample (e.g. Figure 9). Crystals consistent with gypsum (e.g. Figure 10) and fan-like arrays of acicular crystals (e.g. Figure 11) are present in all samples and make up as much as 40% of sample "Test 1 Water from Imps."

SEM/EDS analysis of the orange resinous material indicated that it is composed principally of carbon, nitrogen, oxygen, sodium and sulfur (Figures 12 through 14).

A portion of sample "Test 1 Water from Imps" was extracted with hexane and water. No hexane-soluble material was found. The orange residue was readily soluble in water, leaving a clear orange solution. Figures 15 through 22 present the SEM/EDS data obtained from the reprecipitated water-soluble fraction. These results indicate that this fraction is composed of sodium/calcium sulfate/sulfite(?) crystals (Figures 16, 19, 21 and 22) embedded in a matrix composed principally of carbon, nitrogen and oxygen (Figures 18 and 20). Iron is present at low levels and may account for the orange color. Analysis of the insoluble fraction indicates it is composed of a carbon/oxygen phase (with no nitrogen) (Figure 23) and gypsum (Figure 24).

We were unable to obtain a useful infrared absorption spectrum from the bulk sample or the water-soluble residue. We therefore pyrolyzed a portion of sample "Test 1 Water from Imps" and obtained the absorption spectrum of the pyrolyzate. This spectrum is consistent with a polyacrylic acid or similar compound and is presented in Figure 25.

A polyacrylate is not expected as a significant combustion product of natural gas. Acrylates are commonly used in coatings (e.g., paints) and plastics.

Conclusions

The particulate on the filters is composed of iron oxide consistent with iron corrosion product and a calcium/phosphorus/oxygen compound consistent with calcium phosphate.

The orange material in the vials is consistent with a combination of polyacrylic acid (or similar compound), sodium and calcium sulfate/sulfite(?) salts including gypsum, and an unknown nitrogen-rich compound.

The principal materials found on the filters and in the impinger samples of this sample set are unusual in stack samples and not ordinarily associated with natural gas combustion. They may arise from the environment and enter the stack during times when the emergency generator is dormant and/or reflect degradation of the inner lining of the stack.

Table 1. Approximate Composition of Particulate on Method 5 Filter Samples

Sample	MVA Number	$Ca_3(PO_4)_2$*	FeOx	C-rich	Other
Test 1 Filter	AE0002	40-50%	40-50%	ND	<10%
Test 2 Filter	AE0003	60-70%	30-40%	ND	<5%
Test 3 Filter	AE0004	65-75%	15-25%	<5%	<10%

ND = not detected
*probable calcium phosphate with zinc and sulfur commonly associated

12978AE0002(5)

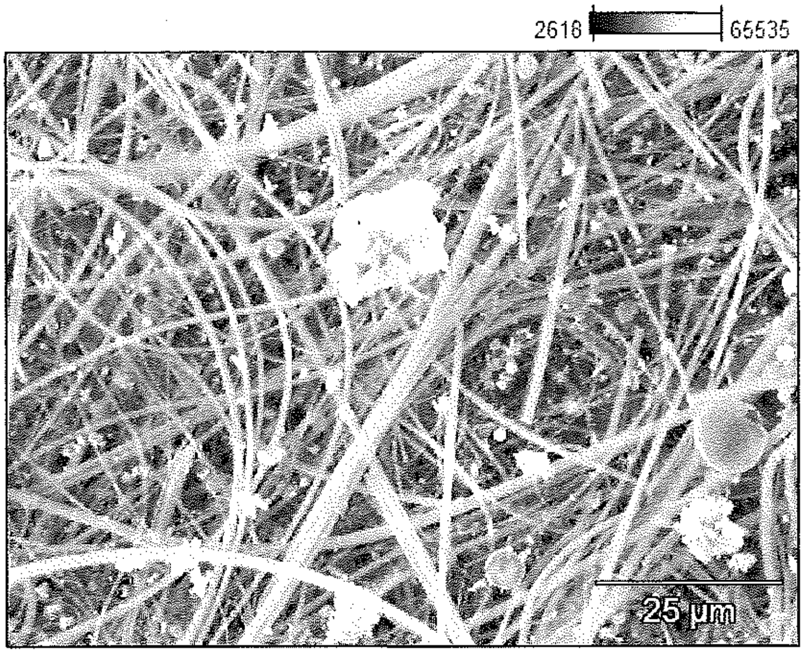


Figure 1. SEM image of particulate on sample "Test 1 Filter." The irregular particles are iron oxide; the more rounded and spherical particles are consistent with calcium phosphate.

12978AE0003(4)

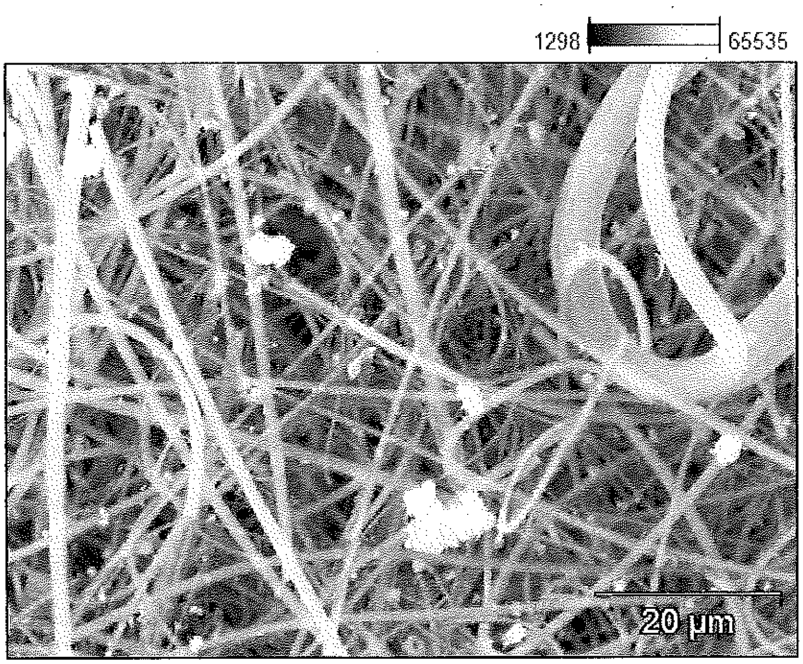


Figure 2. SEM image of particulate on sample "Test 2 Filter."

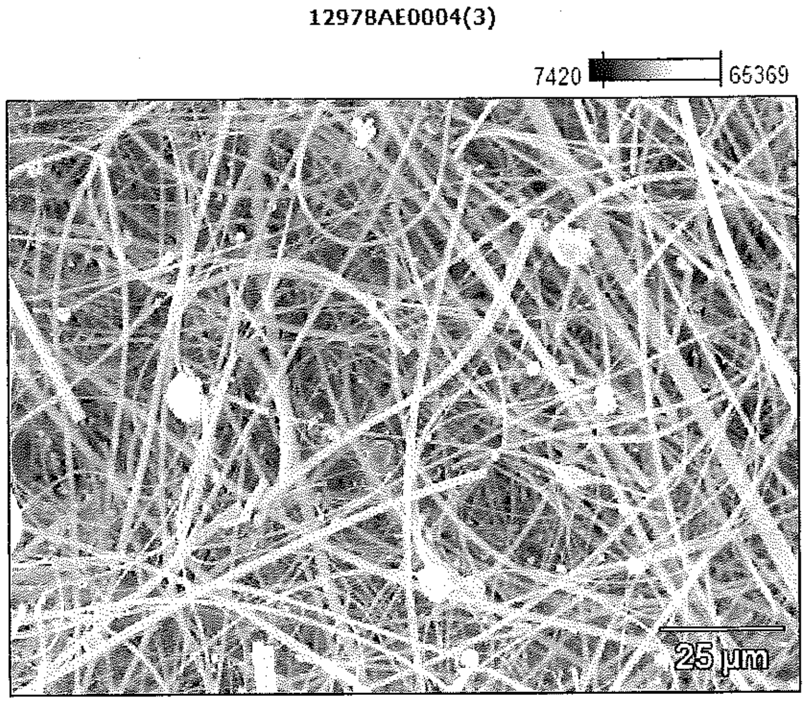


Figure 3. SEM image of particulate on sample "Test 3 Filter."

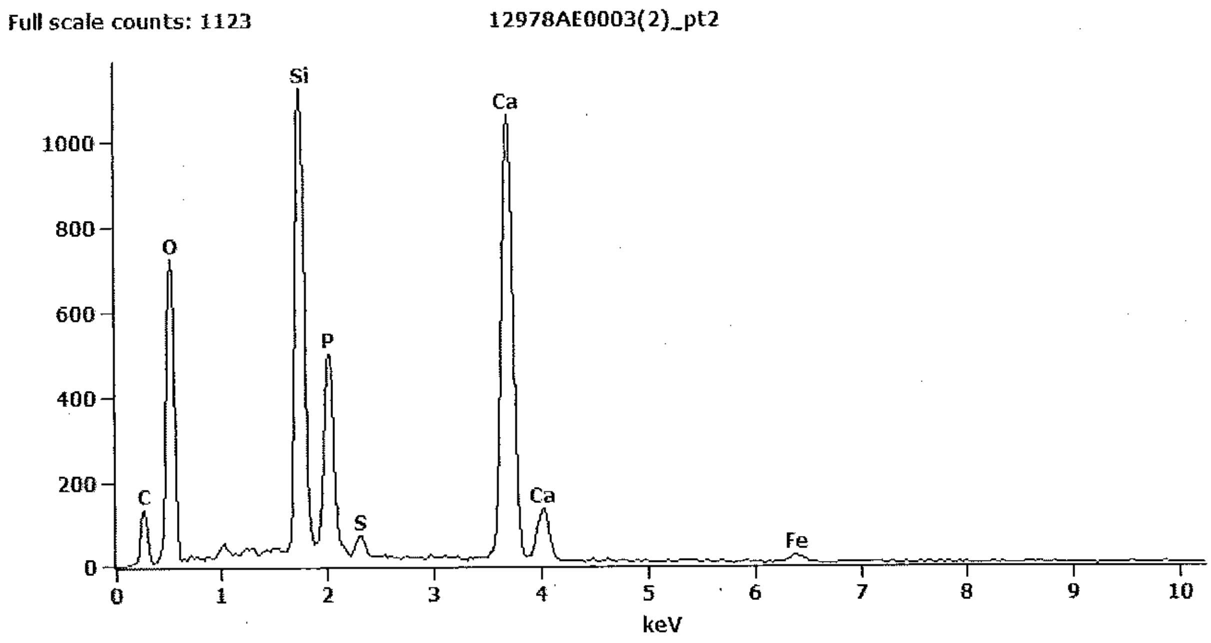


Figure 4. The EDS spectrum obtained from a typical calcium-phosphorus-oxygen-rich particle, probable calcium phosphate. Sample "Test 2 Filter." C = carbon (from applied carbon coating), O = oxygen, Si = silicon (from the quartz filter fibers), P = phosphorus, S = sulfur, Ca = calcium, Fe = iron.

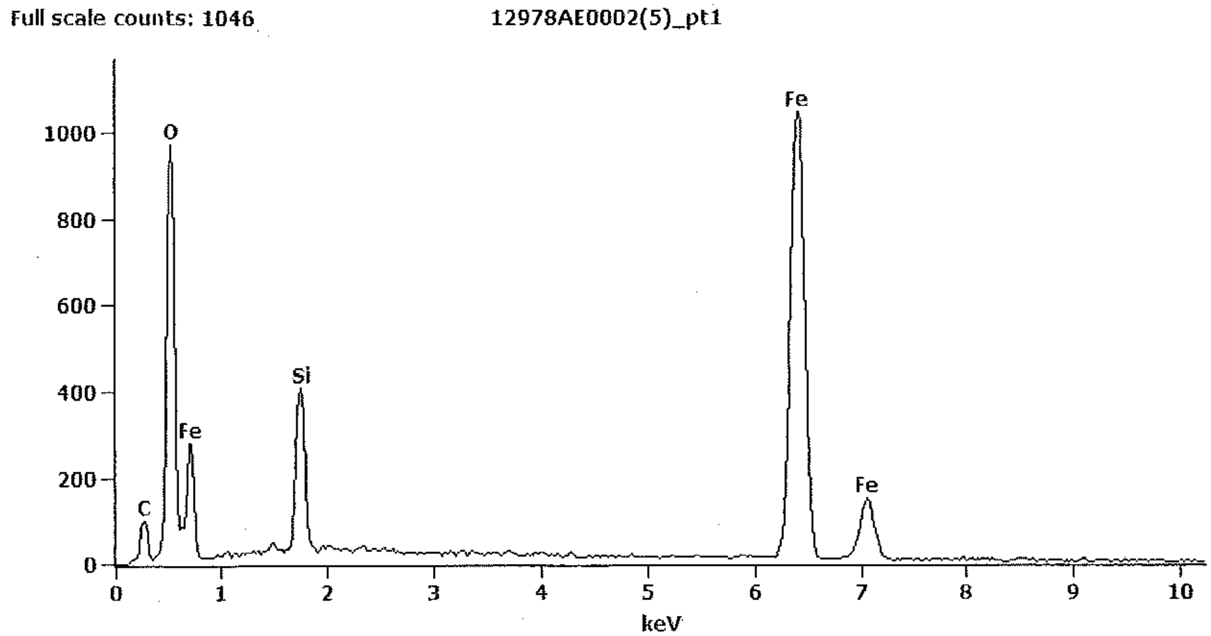


Figure 5. The EDS spectrum obtained from a representative iron oxide particle. Sample "Test 1 Filter."

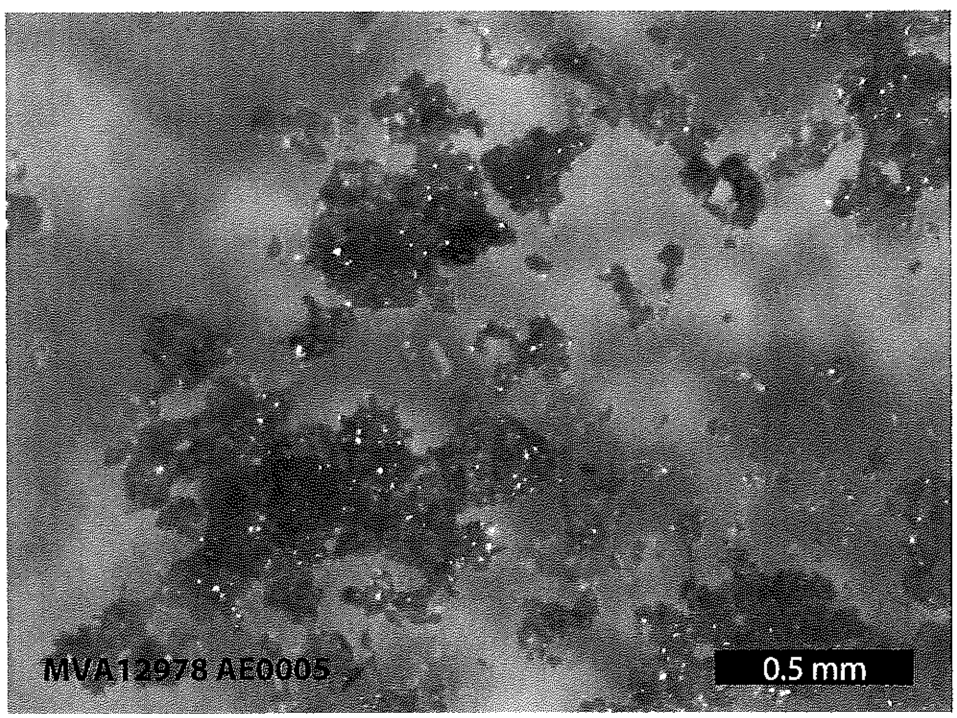


Figure 6. Stereomicroscope image of a portion of the residue from sample "Test 1 Water from Imps."

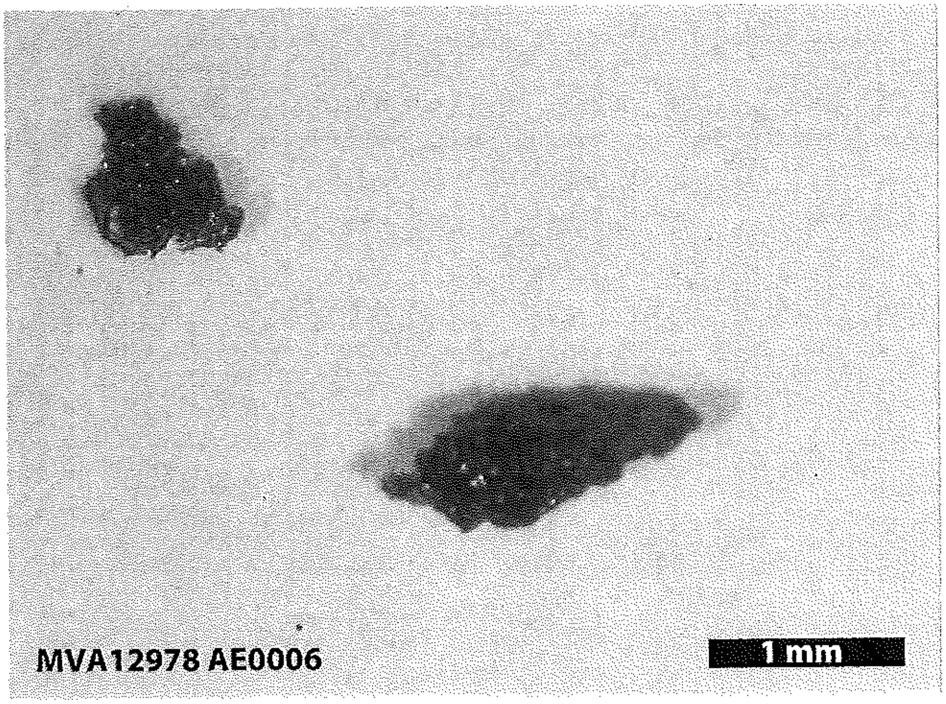


Figure 7. Stereomicroscope image of a portion of the residue from sample "Test 2 Water from Imps."

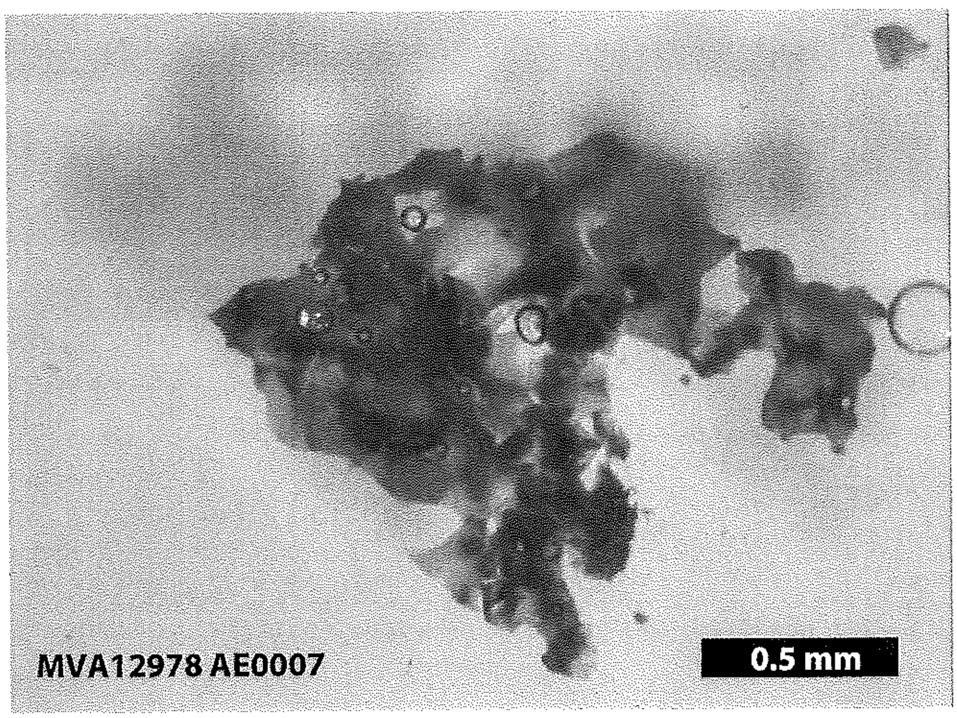


Figure 8. Stereomicroscope image of a portion of the residue from sample "Test 3 Water from Imps."

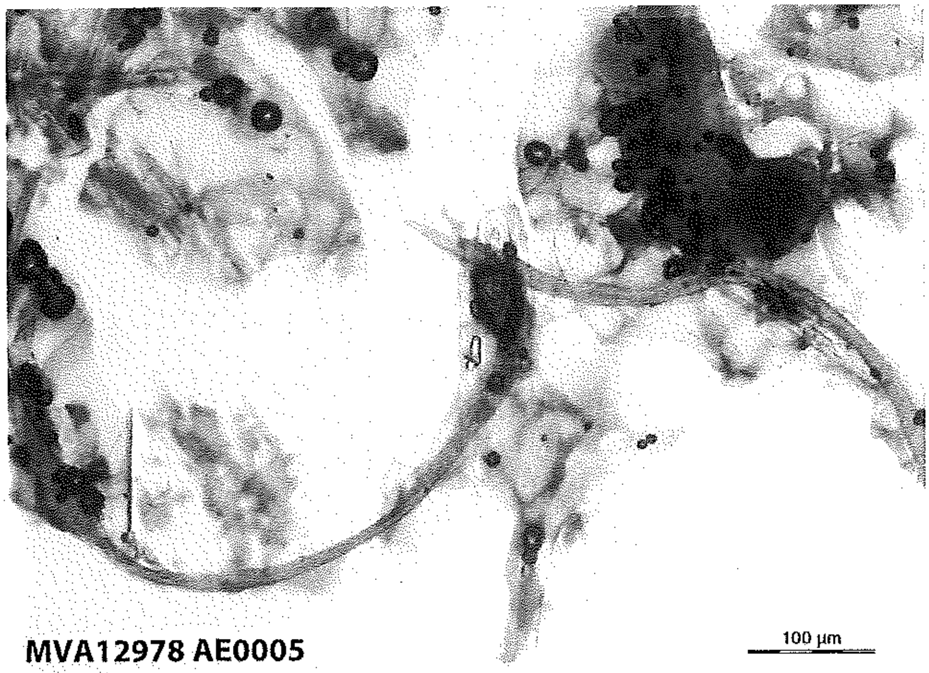


Figure 9. Embedded fibers consistent with cellulose in sample "Test 1 Water from Imps."

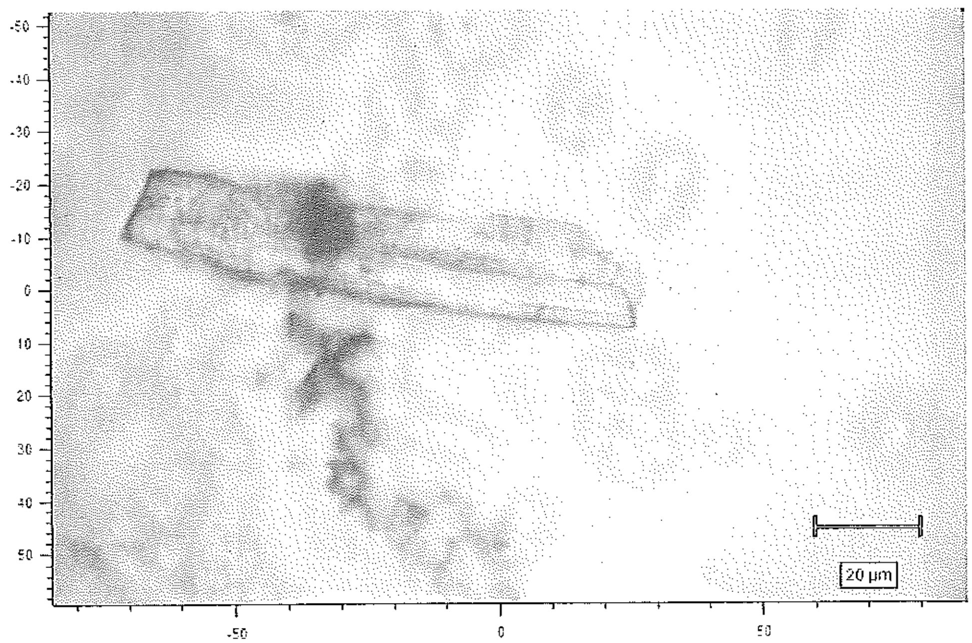


Figure 10. Gypsum crystal isolated from sample "Test 1 Water from Imps."

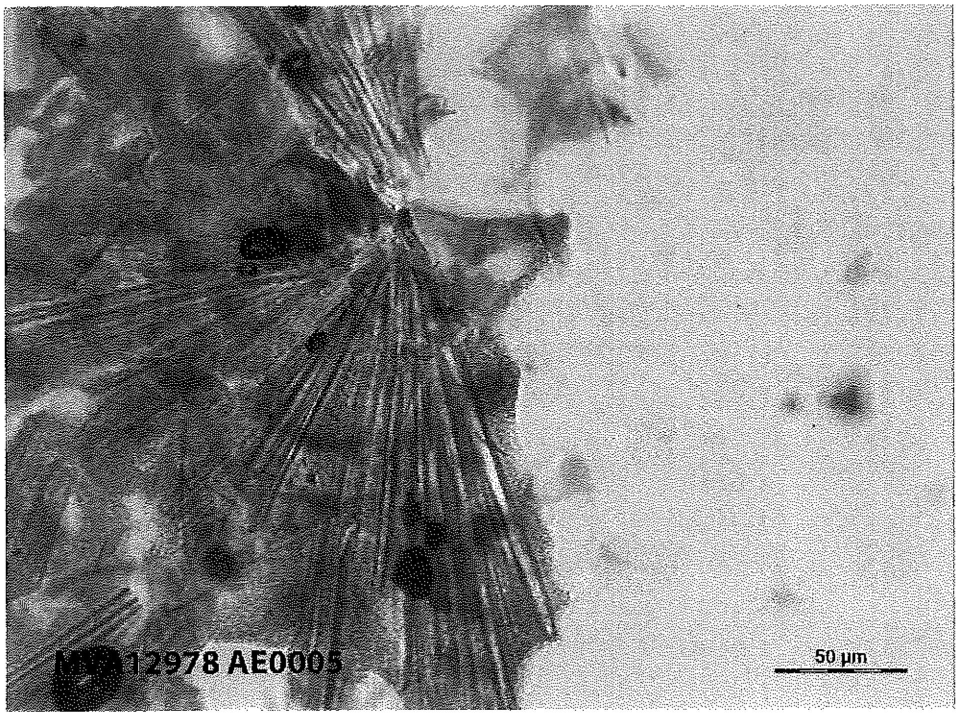


Figure 11. Fan-like acicular crystals in sample "Test 1 Water from Imps."

12978AE0005(1)

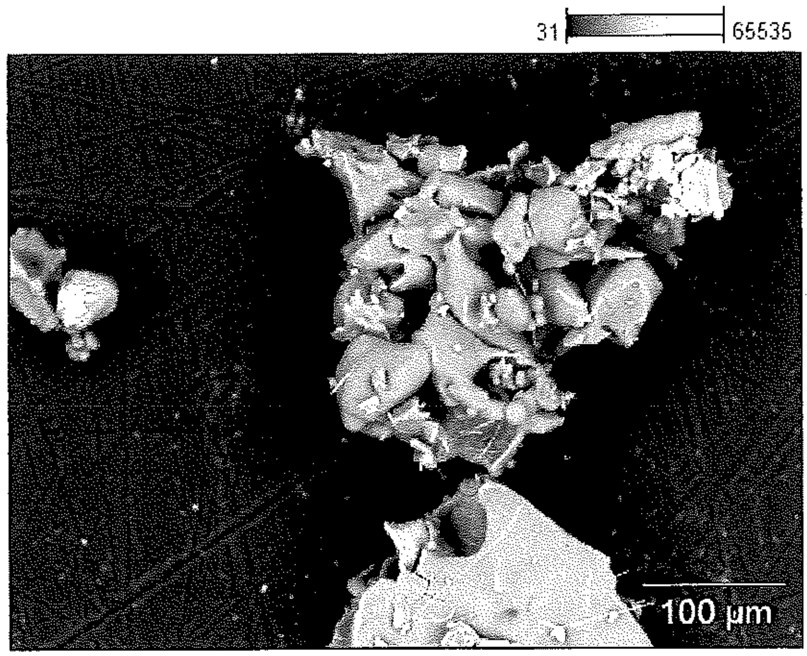
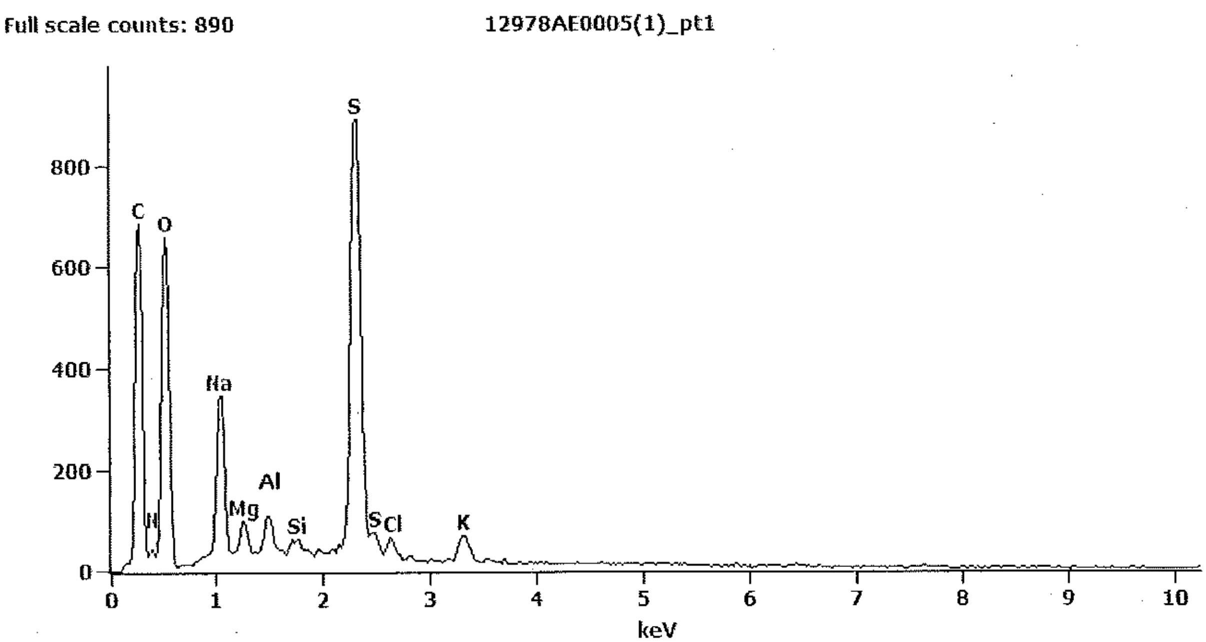


Figure 12. SEM image (above) and EDS spectrum (below) of a portion of the orange resinous material from sample "Test 1 Water from Imps." C = carbon, N = nitrogen, O = oxygen, Na = sodium, Mg = magnesium, Al = aluminum, Si = silicon, S = sulfur, Cl = chlorine, K = potassium.



Appendix C: Reo Town Emergency Engine VN Response

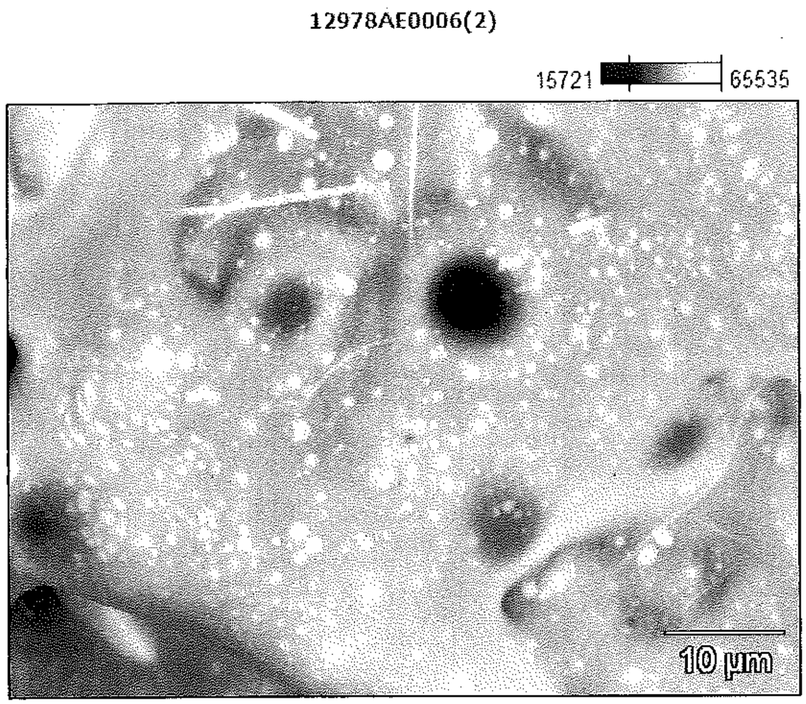
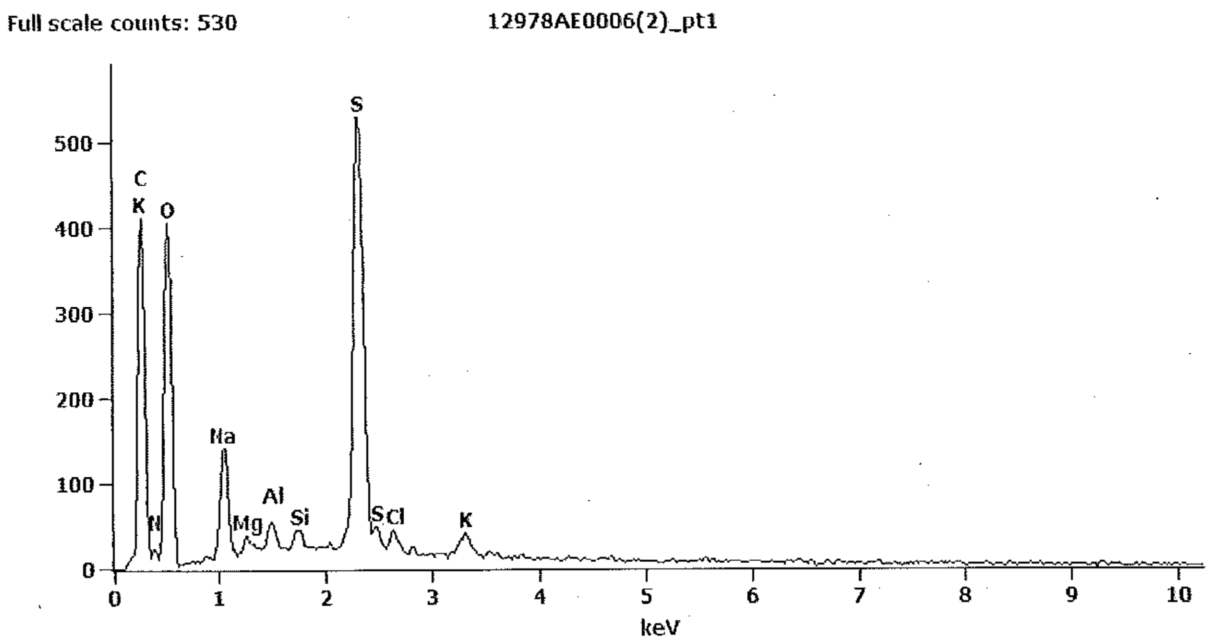


Figure 13. SEM image (above) and EDS spectrum (below) of a portion of the orange resinous material from sample "Test 2 Water from Imps."



12978AE0007(1)

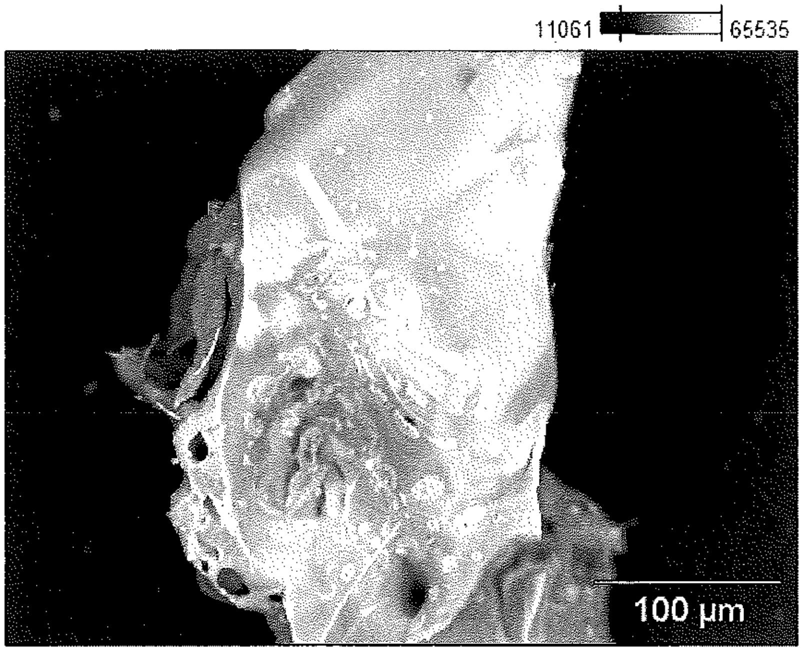
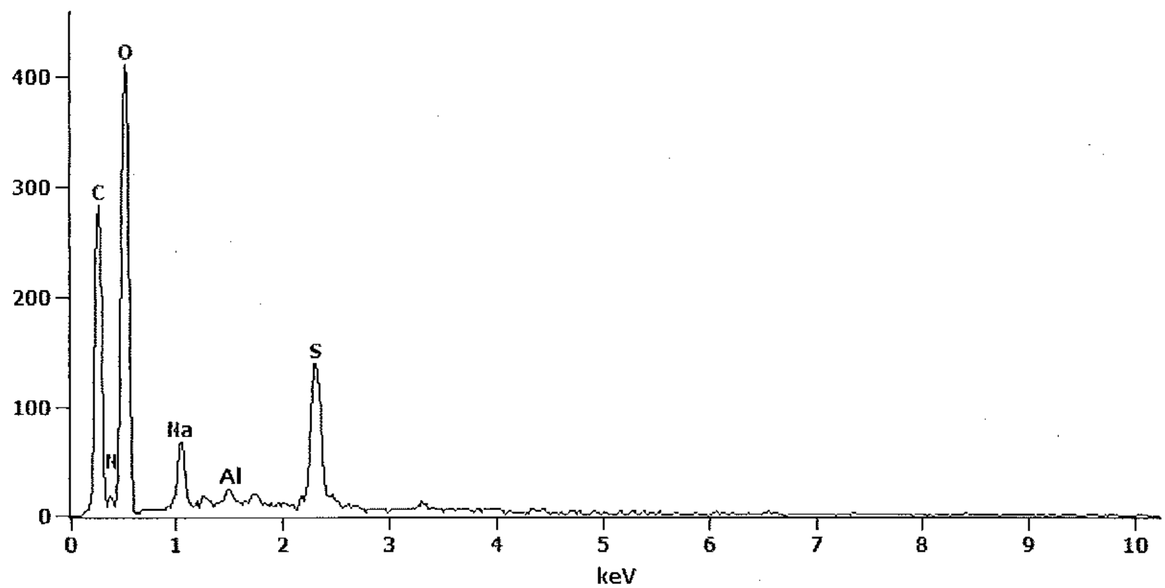


Figure 14. SEM image (above) and EDS spectrum (below) of a portion of the orange resinous material from sample "Test 3 Water from Imps."

Full scale counts: 410 12978AE0007(1)_pt1



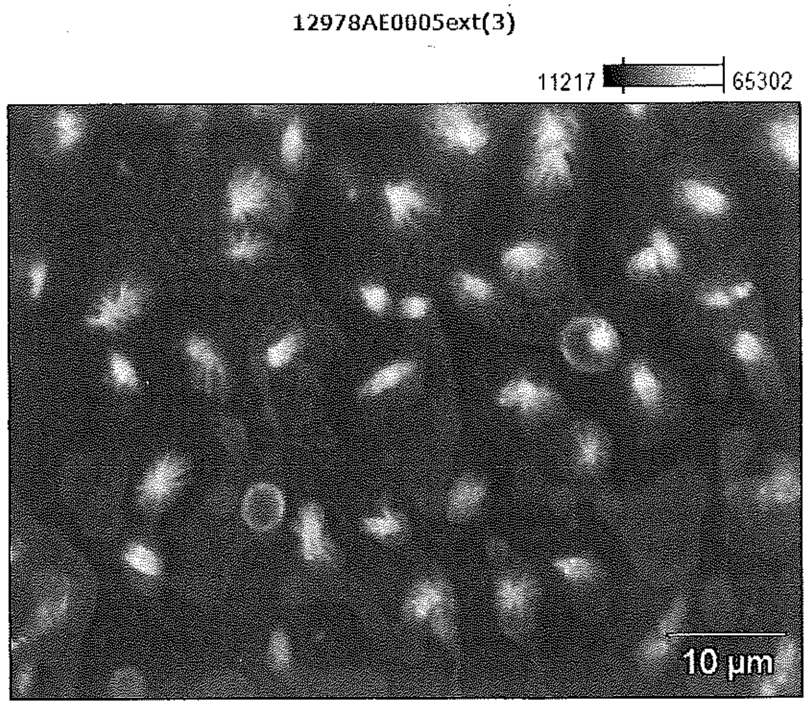


Figure 15. SEM image of a portion of the water-soluble fraction of sample "Test 1 Water from Imps."

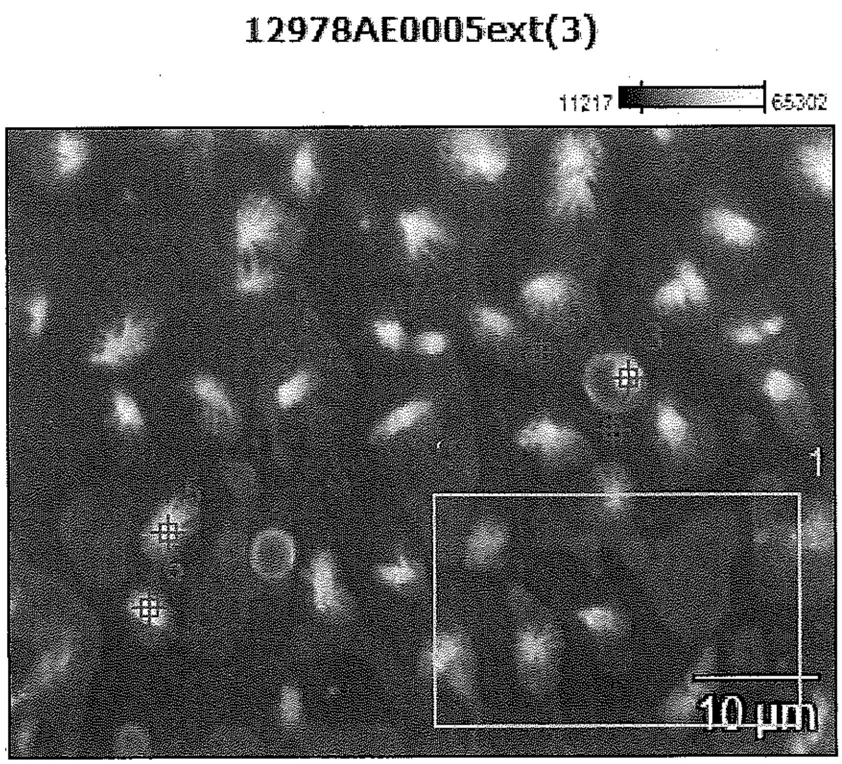


Figure 16. The same field of view shown in Figure 15, with the locations of individual EDS analyses indicated.

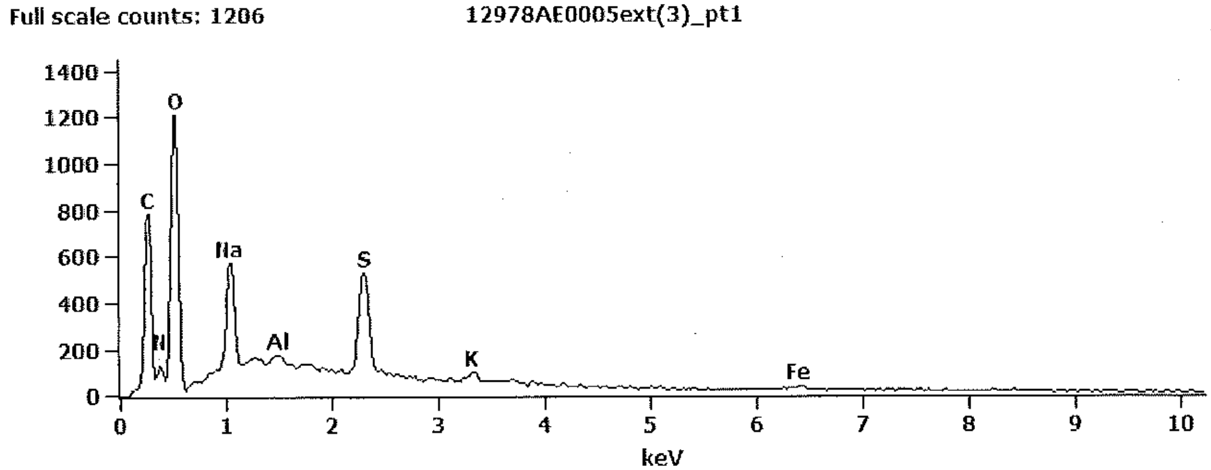


Figure 17. The EDS spectrum obtained from location 1 in Figure 16.

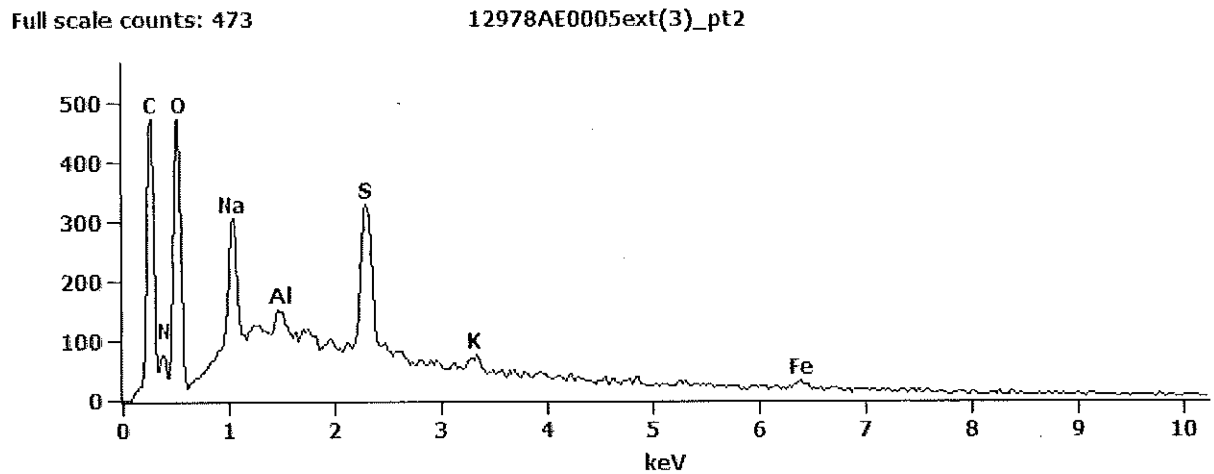


Figure 18. The EDS spectrum obtained from location 2 in Figure 16.

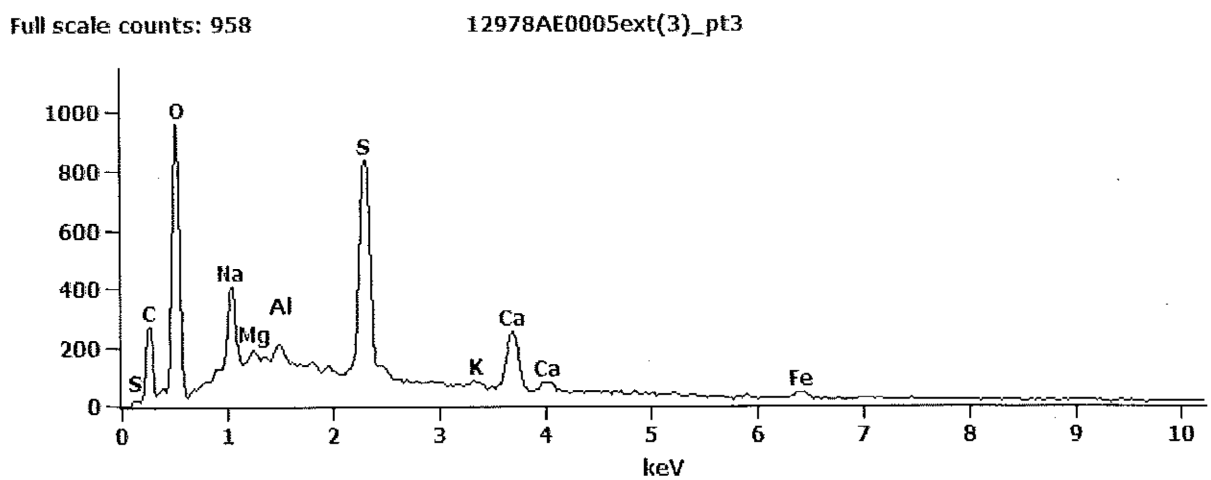


Figure 19. The EDS spectrum obtained from location 3 in Figure 16.

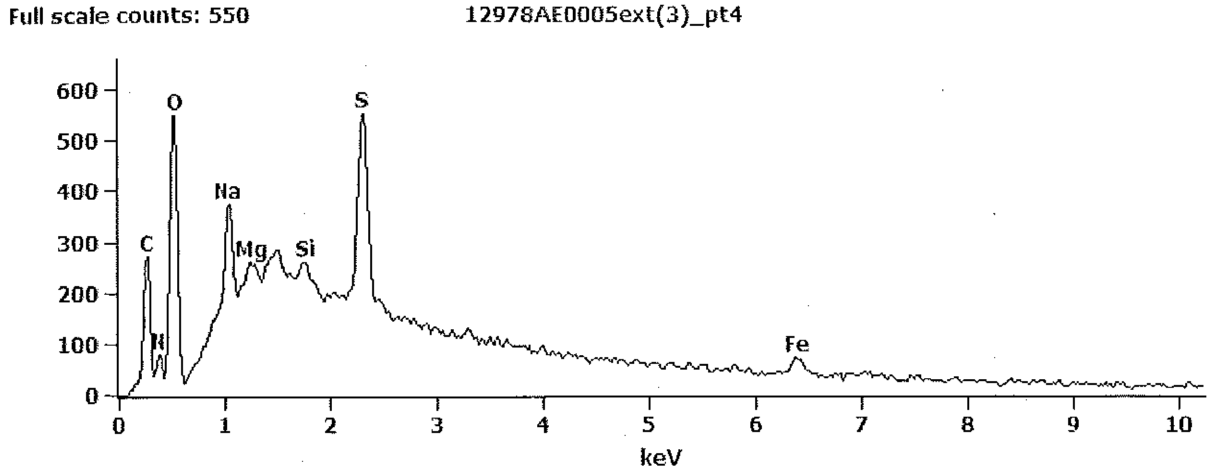


Figure 20. The EDS spectrum obtained from location 4 in Figure 16.

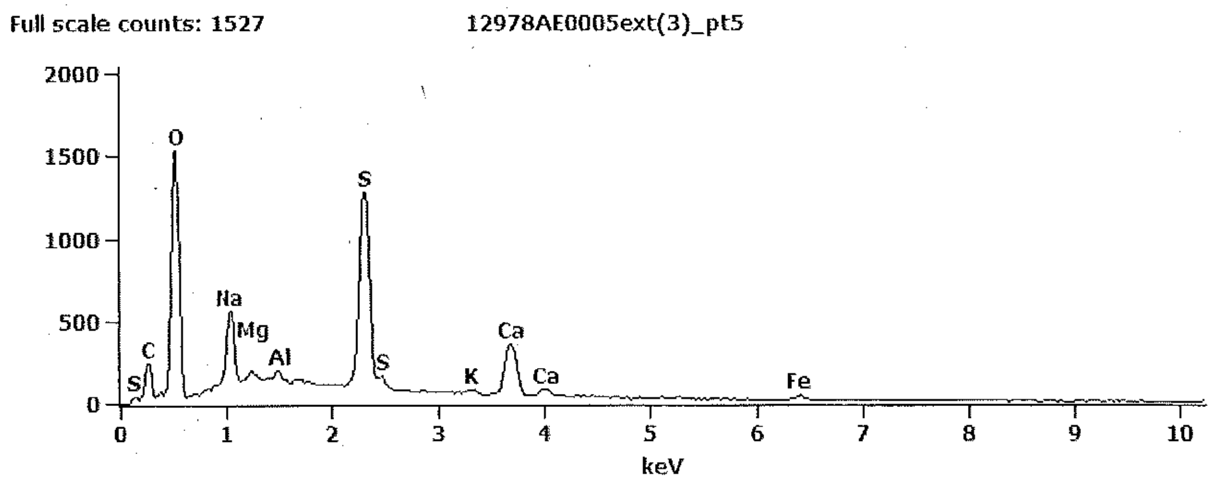


Figure 21. The EDS spectrum obtained from location 5 in Figure 16.

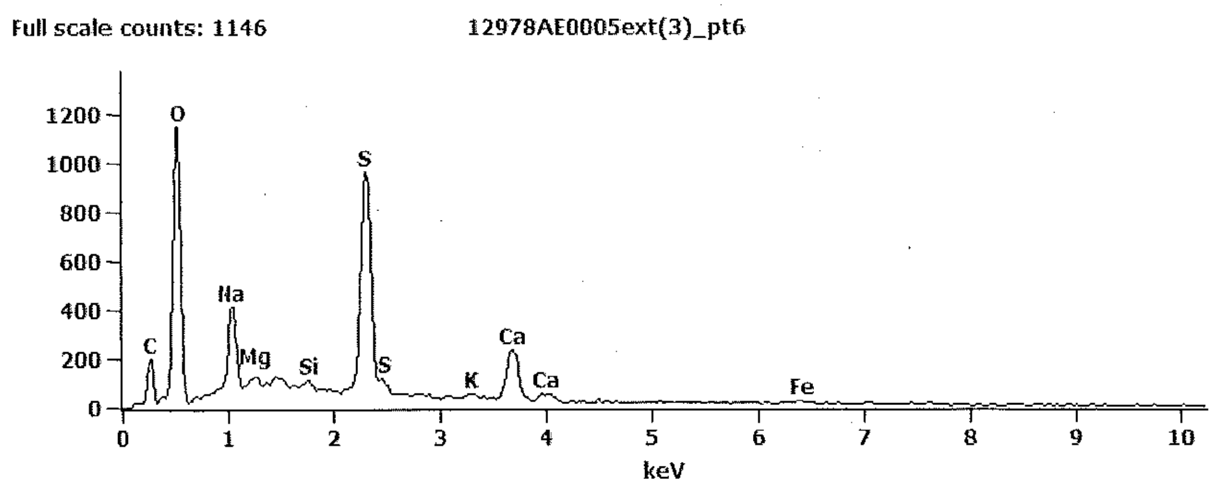


Figure 22. The EDS spectrum obtained from location 6 in Figure 16.

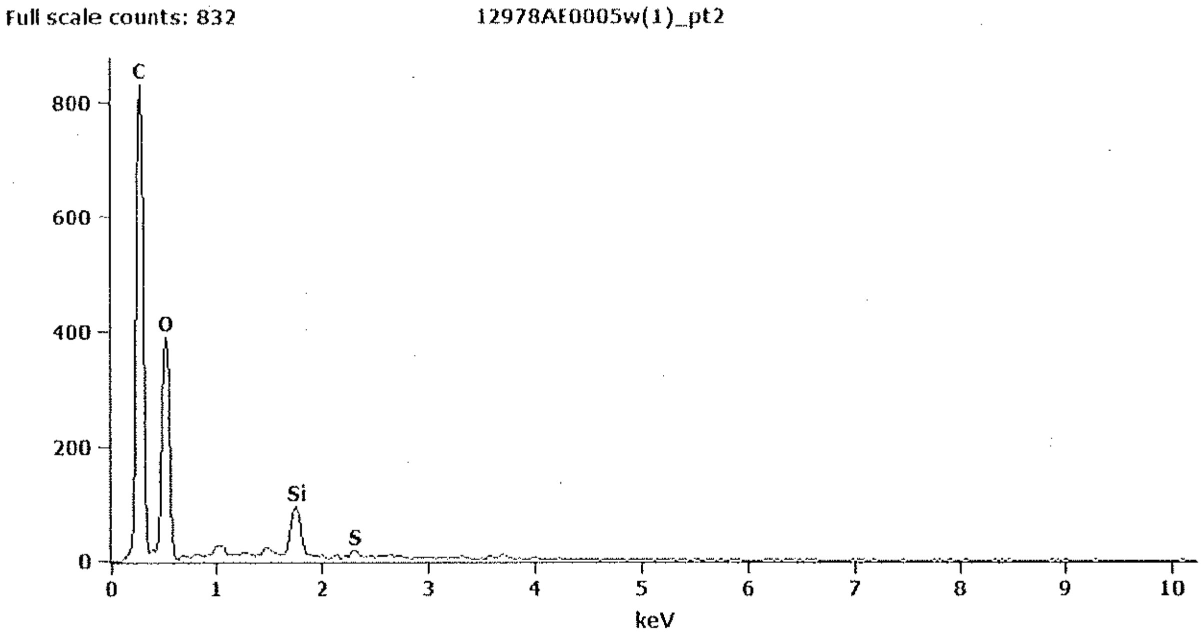


Figure 23. EDS spectrum obtained from the water-insoluble residue of sample "Test 1 Water from Imps."

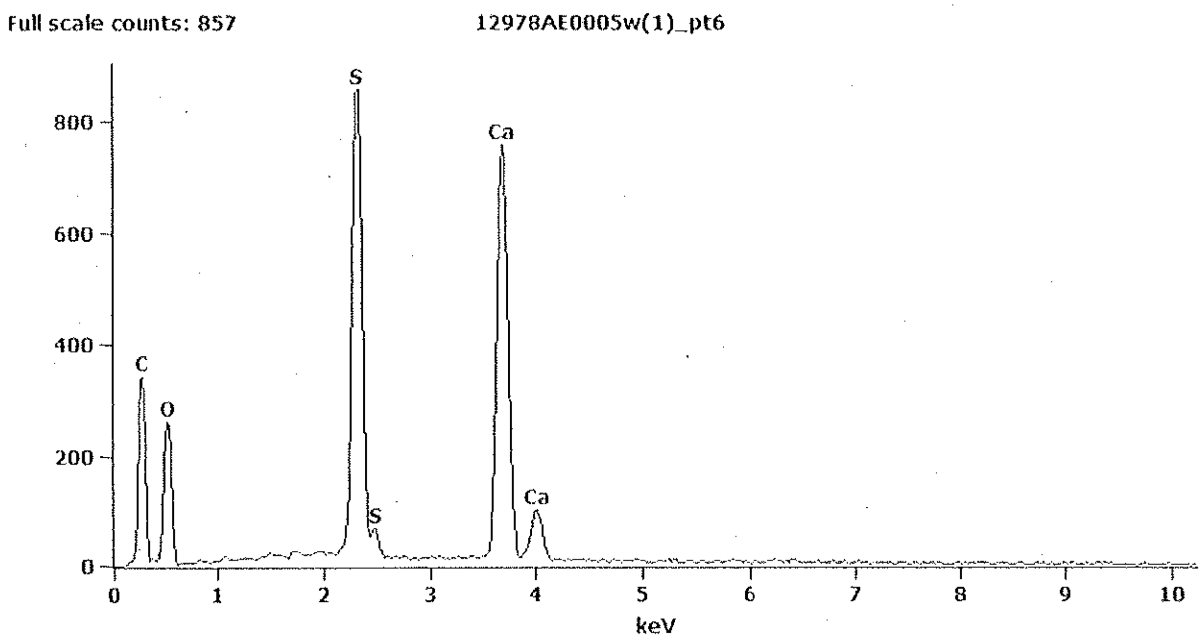


Figure 24. EDS spectrum obtained from gypsum in the water-insoluble residue of sample "Test 1 Water from Imps."

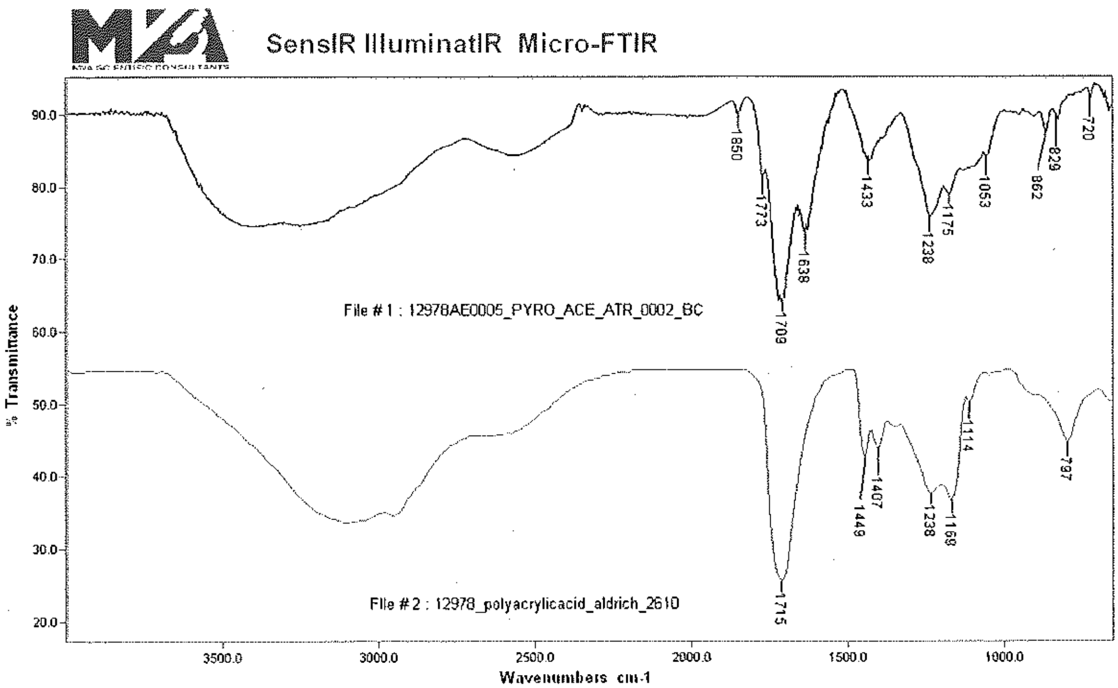


Figure 25. The infrared absorption spectrum obtained from the pyrolyzate of sample "Test 1 Water from Imps" (upper trace) shown with a reference spectrum for polyacrylic acid.

 1/29/18

mostardi platt

Chain-of-Custody Form

Project Number: M184504-02	Date Results Required:
Client: Lansing Board of Water and Light	TAT Required:
Plant/Test Location: Emergency Generator	Project Supervisor: SLB
PO#:	

Sample Number	Sample Date	Sample Point Identification	# of Conts	Sub Lab	Analysis Required	Volume, mls
001	12/12/18	Test 1 Filter AE0002	1	MVA	SEM/EDS	
002	12/12/18	Test 2 Filter AE0003	1	MVA	SEM/EDS	
003	12/12/18	Test 3 Filter AE0004	1	MVA	SEM/EDS	
004	12/12/18	Test 1 Water from Imps AE0005	1	MVA	EDS	
005	12/12/18	Test 2 Water from Imps AE0006	1	MVA	EDS	
006	12/12/18	Test 3 Water from Imps AE0007	1	MVA	EDS	
007						
008						
009						
010						
011						
012						
013						
014						
015						
016						
017						
018						
019						
020						

Delivered to Lab by: Date/Time:	Received by: Date/Time:	Processed by: Date/Time:
12/31/18	1/3/19 11:05	

Laboratory Notes: