Recycling and Reuse Technology Transfer Center

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The Recycling Process of Perlite by the University of Northern Iowa Greenhouse

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95-057

Under Graduate Research Paper
Recycling And Reuse Program For The UNI Greenhouse

Presented To

Department of Environmental Programs

University of Northern Iowa

Under Graduate Research

83:299

Jon A. Musgrave

289506

MEMORANDUM

To: Ed Brown

From: Catherine Zeman CZ

Date: May 5, 1995

Re: Jon Musgrave final grade

In my opinion, I find very little to criticize in Jon's paper from a perspective of content. His research has been consistent, and he has always been interested and motivated when we have met. I find his design and plans for this recycling system realistic and well thought out. Unfortunately, he was unable to provide Mr. Camarata with everything he wanted in a recycling system, but this does not distract from the value of the exercise nor from the potential value of the system as designed for Mr. Camarata.

The two points of constructive criticism I do have for the paper are these:

1. English gammer needs to be firmed-up. In particular, I find that Jon needs to refine his use of commas (when a dependent clause starts a sentence) and carefully read his drafts for clarity. I don't believe in this context he should be heavily down graded for this, since it is not the main point in this internship experience; however, he does need to be aware of this and it will "count" in the workplace.

2. I would have liked to see a little more explanation of the cost/benefit ratio to his proposed recycling process. When we met and discussed this issue, Jon noted that his estimate of the staff time needed to go through the recycling process was very conservative and not based on actual observation, so some improvement might be gained in this regard when and if the program is actually implemented. I was glad to see that he noted the improved performance that would come with scaling up the system capacity (within reasonable limits).

Overall, I suggest that Jon receive an A for his internship. If you are interested in making a point of the two previous constructive criticisms, (and the grade point assigned to the student will remain the same) an A- might also be appropriate (might also be considered tough grading).

Introduction

The University of Northern Iowa greenhouse uses many products to grow a variety of needed plants for beautification and research for the University. The greenhouse is currently exploring the possibility of recycling a product named perlite. Currently, after perlite is used once it is given to University of Northern Iowa Plant Services to be used as fill in landscaping projects on the University grounds or discarded to the Cedar Falls landfill.

The product perlite is used by the greenhouse as the medium for which all of their cuttings are started. Perlite serves very well at holding water and providing an aired medium to grow cuttings. A single cutting may be grown in a bed of perlite as long as one week to three months, depending on the species. The greenhouse has found that after perlite is used once it has become contaminated with microbes and bacteria that inhibit the growth of a new cuttings. Until eighteen months ago the perlite was placed into five gallon buckets to await a recycling process after one use. Over time the greenhouse found that their recycling process was time consuming, took up valuable space, and was not cost effective relative to the amount of labor spent.

Ronald Camarata, greenhouse/ preserves manager, specifically asked that a liquid disinfectant be used to kill the microbes and bacteria present with in the perlite. A liquid disinfectant is need because as perlite dries out it begins to become dusty which is a heath risk to greenhouse laborers. Mr. Camarata asked that the recycling process only use five square feet of floor space. Research shows that

five square feet was not a possible figure to meet given the recycling project Mr. Camarata has asked for. Mr. Camarata also asked that the process be kept simple and easily operated by one person. Constant supervision should not be needed for this process. If constant supervision is not needed during the entire operation it allows the operator to continue work on a second project.

By-Product/ Waste Description

Perlite is a volcanic glass having numerous concentric cracks which give rise to perlitic structure. Most perlites have a higher water content than obsidians. Usually they contain 65 to 75 % SiO_2, 10 to 20 % Al_2O_3, 2 to 5 % H_2O, and smaller amounts of soda, potash, and lime. When perlite is heated to it's softening point, it expands to form a light fluffy material similar to pumice. It is found in California, Colorado, New Mexico, Nevada, and Oregon (Thursh, 1968). Perlite is used mainly in construction related projects, filters, and agricultural markets (Bolen, 1990). Specific health concerns and other properties of perlite are stated on it's MSDS (figure 1). A bleach has been selected to be used as a anti microbial agent for the proposed recycling process. If handle with care as would be with any other bleach it should not impose any serious problems. A MSDS for a stock 5.5 % sodium hypochlorite solution, similar to a 5.0 % stock solution of highlex, is shown in figure 2.

The UNI greenhouse has three potential reuse/ recycling options for perlite. One, they may return to their previous means of recycling. Two, continue giving the used perlite to UNI Plant Services

to utilize. Three, they may follow the suggestions for reuse discussed in this paper. Perlite's only restriction toward reuse is that it must be kept wet to prevent harmful dust. At this point in the research process there appears to be no other restrictions that may apply to the reuse of perlite.

Reuse/Recycling Options

The UNI greenhouse has three specific options they may choose from in making a decision on the reuse of perlite.

Original Recycling process

The greenhouse may return to recycling the perlite in the same fashion they had been up until eighteen months ago. At this time the greenhouse has decided against using this processes, because it was time consuming, took up valuable space, and was not cost effective relative to the amount of labor spent.

- Steps in Original Recycling Program
    1) Large plant material is removed from the Perlite by hand
    2) Used Perlite is placed into a five gallon bucket for storage
    3) When the five gallon bucket is full, a cup of bleach with water is added to the bucket to sterilize the perlite
    4) After an amount of time (varied between laborer) the bleach is poured out
    5) The Perlite is then washed with water before it is ready to be used again with no side effects

UNI Plant Services

The second option to the greenhouse is to continue giving the used perlite to the UNI Plant Services. Plant Services may then use the perlite as fill in their landscaping projects, or dispose of it in the Cedar Falls landfill. Disposal costs of solid non-toxic waste is currently, $34.00 per ton.

Proposed Recycling Program

The greenhouse's third recycling option is to follow the proposed recycling program presented in this report. This recycling program has it's roots in the original greenhouse recycling program.

- Steps in Proposed Recycling Program
    1) Used perlite from cuttings is placed into a storage bin until the recycling program is needed
    2) Perlite is poured into a 5 gallon per treatment capacity screen sifter, sifter is motor operated allowing for no supervision
    3) Perlite is retrieved in a 10 gallon bucket under sifter stand (no more than 9 gallons)
    4) Sifter screen box is removed and large organic material is brushed out, and disposed
    5) 1% Highlex solution is added to sterilize the perlite
    6) Mixture is allowed to sit for 30 minutes , and churned at T=0 minutes and T= 5 minutes
    7) Highlex solution is poured off
    8) Sterilized perlite is poured onto second screen, and rinsed with water for 10 minutes
    9) Wet perlite is placed into a storage container ready for reuse

This recycling process will require from the greenhouse operation space, funding for construction, and labor. The apparatus will require two screen stands occupying 8 ft^2. Other parts of the apparatus may take close to 3 ft^2 of space. For a total of 11 ft^2. Plans for the apparatus are shown in figure 3 with calculations in figure 4.

Market Analysis

The greenhouse, with it's current situation, is not interested in the possibility of other companies utilizing the used perlite product. Currently the used perlite is put to use by UNI Plant Services as fill when the greenhouse is finished with it. The UNI greenhouse is specifically interested in finding a process to reuse their perlite. If a process is not found that is acceptable the UNI greenhouse will continue to give the used perlite to UNI Plant Services.

Conclusion/ Recommendation

I believe the correct decision has been made by the UNI greenhouse concerning this problem. If an easily operated and cost effective means of recycling perlite is found it should be implemented. The current wage per hour of a greenhouse employee is $5.25. The operation process, cleaning 8 US gallons, will require 25 minutes of hands on operation time, and $2.18 in labor cost. The cost to the greenhouse for the treatment of 4 ft^3 (32 gallons) perlite is $8.72. One 4 ft^3 bag of perlite costs $6.25 to buy from a distributor. Every

two weeks 20 gallons of used perlite is produced therefore requiring only three cycles to clean two weeks of perlite. This report's proposed process does not directly save the UNI greenhouse money. With this recycling program there is the removal of $37.00 per ton in disposal costs to the Cedar Falls landfill paid by UNI Plant Services. With disposal costs there would be an increase in the frequency of disposal. To society this process would decrease their marginal benefit of recycling, because less waste is being disposed into the Cedar Falls landfill. At this point with the limited space that may be devoted to this project it is not possible to make this process cost effective. If an apparatus were created that uses this processes same basic ideas, but recycled a larger load it is predicted that a more cost effective apparatus would result.

Figure 1: Material Safety Data Sheet of Perlite

Material Safety Data Sheet

May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY *(As Used on Label and List)*
Perlite Coarse 4 c/f (4193)

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name
Strong-Lite Products Corp.

Address *(Number, Street, City, State, and ZIP Code)*
P. O. Box 8029
Pine Bluff, AR 71611

Emergency Telephone Number
(501)536-3453

Telephone Number for Information
(501)536-3453

Date Prepared
July 20, 1987

Signature of Preparer *(optional)*

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% *(optional)*
Perlite Volcanic Glass		10 mg/M^3 - Total Dust		
Silicate, amphorous Siliceous Mineral				
CAS #73763-70-3				

Section III — Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H_2O = 1)	.04 - .15
Vapor Pressure (mm Hg.)	N/A	Melting Point	N/A
Vapor Density (AIR = 1)	N/A	Evaporation Rate (Butyl Acetate = 1)	N/A

Solubility in Water
0

Appearance and Odor
White Granules - No Odor

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
N/A	N/A	N/A	N/A

Extinguishing Media
N/A

Special Fire Fighting Procedures
Incombustible Mineral

Unusual Fire and Explosion Hazards
None

(Reproduce locally)

OSHA 174, Sept. 1985

Figure 2: Material Safety Data Sheet of Sodium Hypochlorite "Bleach"

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SODIUM HYPOCHLORITE SOLUTION, 5.5%
SODIUM HYPOCHLORITE SOLUTION, 5.5%
SODIUM HYPOCHLORITE SOLUTION, 5.5%

MATERIAL SAFETY DATA SHEET

FISHER SCIENTIFIC
CHEMICAL DIVISION
1 REAGENT LANE
FAIR LAWN NJ 07410
(201) 796-7100

EMERGENCY NUMBER: (201) 796-7100
CHEMTREC ASSISTANCE: (800) 424-9300

SUBSTANCE IDENTIFICATION

CAS-NUMBER 7681-52-9

SUBSTANCE: **SODIUM HYPOCHLORITE SOLUTION, 5.5%**

TRADE NAMES/SYNONYMS:
SO-S-291; ACC40179

CHEMICAL FAMILY:
INORGANIC SALT

MOLECULAR FORMULA: CL-H-O-NA MOL WT: 75.45

CERCLA RATINGS (SCALE 0-3): HEALTH=U FIRE=0 REACTIVITY=0 PERSISTENCE=0
NFPA RATINGS (SCALE 0-4): HEALTH=3 FIRE=0 REACTIVITY=0

COMPONENTS AND CONTAMINANTS

COMPONENT: SODIUM HYPOCHLORITE PERCENT: 5.5

COMPONENT: WATER PERCENT: 94.5

OTHER CONTAMINANTS: NONE

EXPOSURE LIMITS:
NO OCCUPATIONAL EXPOSURE LIMITS ESTABLISHED BY OSHA, ACGIH, OR NIOSH.

PHYSICAL DATA

DESCRIPTION: CLEAR, PALE GREENISH-YELLOW LIQUID WITH AN ODOR OF BLEACH

BOILING POINT: DECOMPOSES MELTING POINT: 32 F (0 C)

SPECIFIC GRAVITY: 1.1 VAPOR PRESSURE: 14 MMHG (WATER)

EVAPORATION RATE: (ETHER = 1) >1 SOLUBILITY IN WATER: SOLUBLE

VAPOR DENSITY: 0.7 (WATER)

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD:
NEGLIGIBLE FIRE HAZARD WHEN EXPOSED TO HEAT OR FLAME.

FLASH POINT: NON-FLAMMABLE

FIREFIGHTING MEDIA:
DRY CHEMICAL, CARBON DIOXIDE, HALON, WATER SPRAY OR STANDARD FOAM (1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR STANDARD FOAM (1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4).

FIREFIGHTING:
MOVE CONTAINERS FROM FIRE AREA IF POSSIBLE. COOL CONTAINERS EXPOSED TO FLAMES WITH WATER FROM SIDE UNTIL WELL AFTER FIRE IS OUT. STAY AWAY FROM STORAGE TANK ENDS (1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4, GUIDE PAGE 60).

EXTINGUISH USING AGENTS INDICATED; DO NOT USE WATER DIRECTLY ON MATERIAL. IF LARGE AMOUNTS OF COMBUSTIBLE MATERIALS ARE INVOLVED, USE WATER SPRAY OR FOG IN FLOODING AMOUNTS. USE WATER SPRAY TO ABSORB CORROSIVE VAPORS. COOL CONTAINERS WITH FLOODING AMOUNTS OF WATER FROM AS FAR A DISTANCE AS POSSIBLE. AVOID BREATHING CORROSIVE VAPORS; KEEP UPWIND.

TRANSPORTATION DATA

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DEPARTMENT OF TRANSPORTATION HAZARD CLASSIFICATION 49CFR172.101:
ORM-B

DEPARTMENT OF TRANSPORTATION LABELING REQUIREMENTS 49CFR172.101 AND SUBPART E:
NONE

DEPARTMENT OF TRANSPORTATION PACKAGING REQUIREMENTS: 49CFR173.510
EXCEPTIONS: 49CFR173.505

TOXICITY

SODIUM HYPOCHLORITE:
IRRITATION DATA: 10 MG EYE-RABBIT MODERATE.
TOXICITY DATA: 1 GM/KG ORAL-WOMAN TDLO; MUTAGENIC DATA (RTECS).
CARCINOGEN STATUS: NONE.
LOCAL EFFECTS: CORROSIVE- INHALATION, SKIN, EYE, INGESTION.
ACUTE TOXICITY LEVEL: INSUFFICIENT DATA.
TARGET EFFECTS: SENSITIZER- SKIN.

HEALTH EFFECTS AND FIRST AID

INHALATION:
SODIUM HYPOCHLORITE:
CORROSIVE.
ACUTE EXPOSURE- DEPENDING ON CONCENTRATION, FUMES MAY CAUSE SLIGHT TO SEVERE IRRITATION OF THE RESPIRATORY TRACT. HIGH CONCENTATIONS MAY CAUSE SORE THROAT, COUGHING, DYSPNEA, AND DELAYED PULMONARY EDEMA, POSSIBLY SEVERE.
CHRONIC EXPOSURE- RARELY CASES OF ASTHMA HAVE OCCURRED FROM EXPOSURE TO PUBLIC WATER SUPPLIES CONTAINING CHLORINE.

FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, GIVE ARTIFICIAL RESPIRATION. MAINTAIN AIRWAY AND BLOOD PRESSURE AND ADMINISTER OXYGEN IF AVAILABLE. KEEP AFFECTED PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. ADMINISTRATION OF OXYGEN SHOULD BE PERFORMED BY QUALIFIED PERSONNEL. GET MEDICAL ATTENTION IMMEDIATELY.

SKIN CONTACT:
SODIUM HYPOCHLORITE:
CORROSIVE/SENSITIZER.
ACUTE EXPOSURE- CONTACT WITH DILUTE SOLUTIONS MAY BE IRRITATING. HOWEVER, MORE CONCENTRATED SOLUTIONS MAY BLEACH THE SKIN AND CAUSE PAIN, BLISTERING WITH ECZEMA, AND POSSIBLY BURNS. SENSITIZATION DERMATITIS MAY OCCUR IN PREVIOUSLY EXPOSED PERSONS.
CHRONIC EXPOSURE- DEPENDING ON CONCENTRATION AND DURATION, SYMPTOMS MAY BE AS THOSE OF ACUTE EXPOSURE. SENSITIZATION DERMATITIS MAY OCCUR IN SUSCEPTIBLE INDIVIDUALS.

EYE CONTACT:
SODIUM HYPOCHLORITE:
CORROSIVE.
ACUTE EXPOSURE- MAY CAUSE REDNESS, PAIN, AND BLURRED VISION. SOLUTION OF 5% SPLASHED IN HUMAN EYES HAVE CAUSED A BURNING SENSATION AND LATER ONLY SLIGHT SUPERFICIAL DISTURBANCE OF THE CORNEAL EPITHELIUM WHICH CLEARED COMPLETELY IN THE NEXT DAY OR TWO WITHOUT SPECIAL TREATMENT. HOWEVER, ONE ANIMAL STUDY REPORTS A 5% SOLUTION CAUSING ONLY MODERATE IRRITATION WITH CLEARING WITHIN 7 DAYS. A HIGHER CONCENTRATION OF 15% TESTED ON RABBIT EYES CAUSED IMMEDIATE SEVERE PAIN, HEMORRHAGES, RAPID ONSET OF GROUND-GLASS APPEARANCE OF THE CORNEAL EPITHELIUM, MODERATE BLUISH EDEMA OF THE WHOLE CORNEA, CHEMOSIS AND DISCHARGE FOR SEVERAL DAYS. SUCH EYES HAVE SOMETIMES HEALED IN 2-3 WEEKS WITH SLIGHT OR NO RESIDUAL CORNEAL DAMAGE BUT THEY HAD NEOVASCULARIZATION OF THE CONJUNCTIVA AND DISTORTION OF THE NICTITATING MEMBRANE BY SCARRING.
CHRONIC EXPOSURE- DEPENDING ON CONCENTRATION AND DURATION OF EXPOSURE, SYMPTOMS MAY BE AS THOSE OF ACUTE EXPOSURE.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (AT LEAST 15-20 MINUTES). CONTINUE IRRIGATING WITH NORMAL SALINE UNTIL THE PH HAS RETURNED TO NORMAL (30-60 MINUTES). COVER WITH STERILE BANDAGES. GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION:
SODIUM HYPOCHLORITE:
CORROSIVE.
ACUTE EXPOSURE- INGESTION MAY CAUSE CORROSION OF THE MUCOUS MEMBRANES, BURNING OF THE MOUTH, BLISTERING IN THE THROAT, STOMATITIS, AND EDEMA, POSSIBLY SEVERE, OF THE PHARNYX AND LARYNX. ABDOMINAL SPASM, NAUSEA, VOMITING, COLITIS, HYPOTENSION, CIRCULATORY COLLAPSE, DELERIUM AND COMA ARE POSSIBLE. LATENT ESOPHAGEAL STENOSIS MAY OCCUR. PERFORATION OF THE ESOPHAGUS AND STOMACH HAVE OCCURRED RARELY. WHEN THE CONCENTRATION IS ABOVE 15%, AS LITTLE AS 1 OZ. MAY BE LETHAL.
CHRONIC EXPOSURE- NO DATA AVAILABLE.

FIRST AID- IF CONSCIOUS, GIVE MILK, MELTED ICE CREAM, OR BEATEN EGGS TO DILUTE AND DECOMPOSE THE CHEMICAL. DO NOT USE EMESIS OR GASTRIC LAVAGE OR ACID ANTIDOTES. ANTACIDS SUCH AS MILK OR MAGNESIA OR ALUMINUM HYDROXIDE

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GEL ARE ALSO USEDFUL. MAINTAIN AIRWAY, RESPIRATION, AND BLOOD PRESSURE. GET MEDICAL ATTENTION IMMEDIATELY. (DREISBACH, HANDBOOK OF POISONING, 11TH. ED.) AVOID USE OF SODIUM BICARBONATE.

ANTIDOTE:
THE FOLLOWING ANTIDOTE HAS BEEN RECOMMENDED, HOWEVER, THE DECISION AS TO WHETHER THE SEVERITY OF POISONING REQUIRES ADMINISTRATION OF ANY ANTIDOTE AND ACTUAL DOSE REQUIRED SHOULD BE MADE BY QUALIFIED MEDICAL PERSONNEL.

HYPOCHLORITE POISONING:
IF AVAILABLE, A FEW OUNCES OF 1% SODIUM THIOSULFATE SOLUTION MAY BE INGESTED AND LEFT IN THE ALIMENTARY TRACT. (GOSSELIN, CLINICAL TOXICOLOGY OF COMMERCIAL PRODUCTS, 5TH ED.)

REACTIVITY

REACTIVITY:
STABLE UNDER NORMAL TEMPERATURES AND PRESSURES.

INCOMPATIBILITIES:
SODIUM HYPOCHLORITE
SELF-REACTIVE: THE ANHYDROUS FORM OBTAINED FROM THE PENTAHYDRATE IS UNSTABLE AND WILL DECOMPOSE VIOLENTLY WITH HEAT OR FRICTION.
METHANOL: EXPLOSIVE REACTION.
ACIDIFIED BENZYL CYANIDE: EXPLOSIVE REACTION.
CELULOSE: VIOLENT REACTION.
ORGANIC AND COMBUSTIBLE MATERIAL: VIOLENT REACTION.
ACIDS: VIOLENT REACTION.
REDUCING AGENTS: VIOLENT REACTION.
NITROGEN COMPOUNDS: FORM N-CHLORO COMPOUNDS WHICH ARE EXPLOSIVE.
PRIMARY AMINES: FORM CHLOROAMINES WHICH ARE EXPLOSIVE.
AZIRIDINE: FORMS N-CHLORO COMPOUND WHICH IS EXPLOSIVE.
ETHYLENEIMINE: FORMS 1-CHLOROETHYLENEIMINE WHICH IS EXPLOSIVE.
AMMONIUM ACETATE: RAPID DECOMPOSITION.
AMMONIUM CARBONATE: RAPID DECOMPOSITION.
AMMONIUM NITRATE: RAPID DECOMPOSITION.
AMMONIUM OXALATE: RAPID DECOMPOSITION.
AMMONIUM PHOSPHATE: RAPID DECOMPOSITION.
OXALIC ACID: INTENSE REACTION.
ALUMINUM, ZINC, MOST METALS: CORROSIVE ACTION.

DECOMPOSITION:
THERMAL DECOMPOSITION, OR CONTACT WITH ACID, EVOLVES CORROSIVE CHLORINE GAS. SLOW DECOMPOSITION EVOLVES OXYGEN WHICH ACCELERATES THE FLAMMABILITY OF COMBUSTIBLE MATERIAL.

POLYMERIZATION:
HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

****

CONDITIONS TO AVOID

MAY BURN BUT DOES NOT IGNITE READILY. FLAMMABLE, POISONOUS GASES MAY ACCUMULATE IN TANKS AND HOPPER CARS. MAY IGNITE COMBUSTIBLES (WOOD, PAPER, OIL, ETC.).

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SPILL AND LEAK PROCEDURES

OCCUPATIONAL SPILL:
DO NOT TOUCH SPILLED MATERIAL. STOP LEAK IF YOU CAN DO IT WITHOUT RISK. FOR SMALL SPILLS, TAKE UP WITH SAND OR OTHER ABSORBENT MATERIAL AND PLACE INTO CONTAINERS FOR LATER DISPOSAL. FOR SMALL DRY SPILLS, WITH CLEAN SHOVEL PLACE MATERIAL INTO CLEAN, DRY CONTAINER AND COVER. MOVE CONTAINERS FROM SPILL AREA. FOR LARGER SPILLS, DIKE FAR AHEAD OF SPILL FOR LATER DISPOSAL. KEEP UNNECESSARY PEOPLE AWAY. ISOLATE HAZARD AREA AND DENY ENTRY.

PROTECTIVE EQUIPMENT

VENTILATION:
PROVIDE LOCAL EXHAUST OR GENERAL DILUTION VENTILATION SYSTEM.

RESPIRATOR:
HIGH LEVELS- SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE, HELMET, OR HOOD. SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE.

FIREFIGHTING- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE (IMPERVIOUS) CLOTHING AND EQUIPMENT TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH THIS SUBSTANCE.

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

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EYE PROTECTION:
EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES TO PREVENT EYE CONTACT WITH THIS SUBSTANCE.

EMERGENCY EYE WASH: WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES MAY BE EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHOULD PROVIDE AN EYE WASH FOUNTAIN WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

AUTHORIZED - FISHER SCIENTIFIC, INC.
CREATION DATE: 07/22/85 REVISION DATE: 10/13/89

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Figure 3: Apparatus

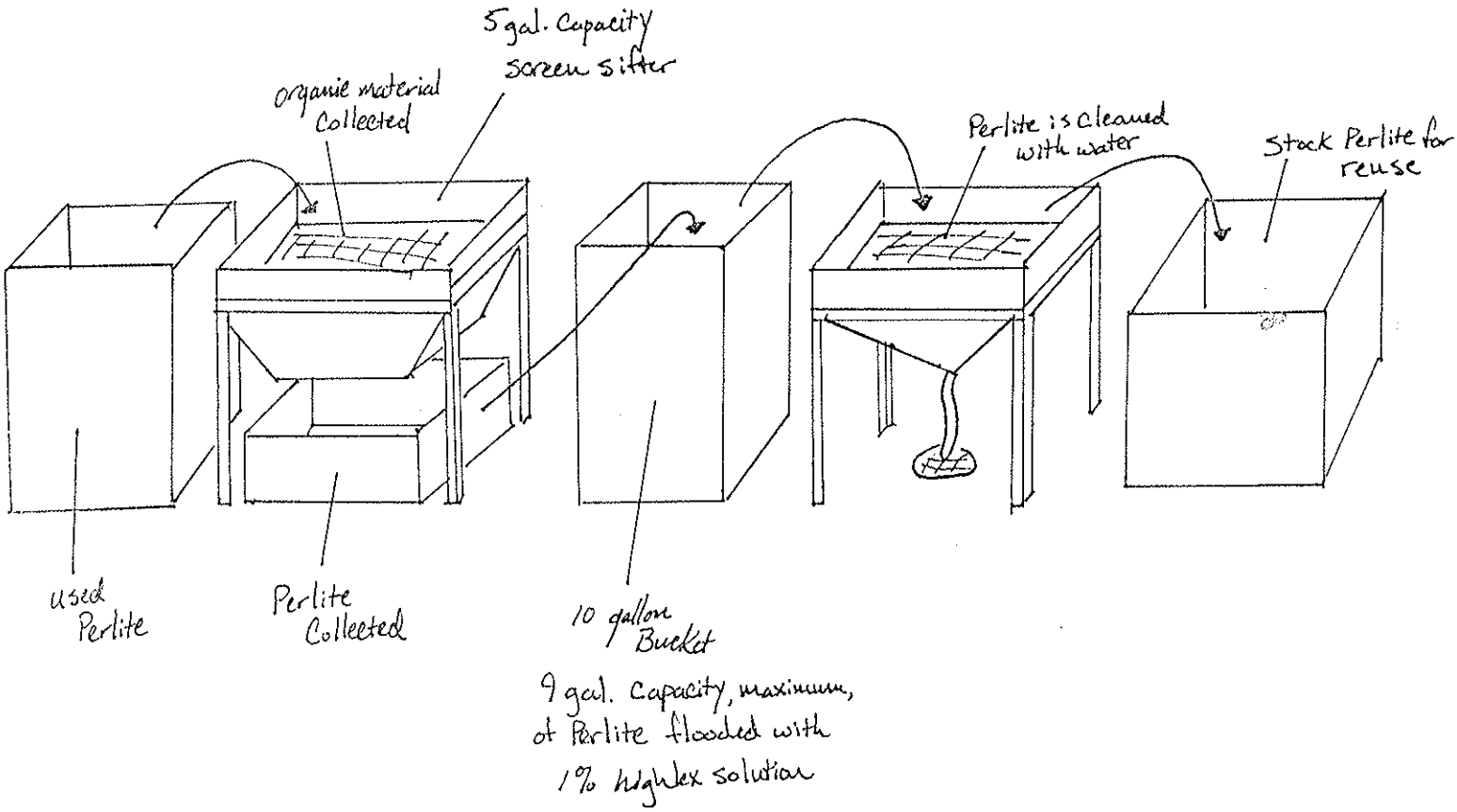

Figure 4: Calculations

Dimensions of Sifter Box 1 & 2

- 5 gal. = 1.1552×10^3 in^3
- 24 in. x 16 in. x 3 in. = 1.1552×10^3 $in.^3$
- length-24 in.; width-16 in.; height-6 in.
- Weight of recycled perlite in box-16.4 pounds

Highlex solution

- Stock: 5.0%, working 1%
- $C_1V_1 = C_2V_2$
- 2.96 L H_2O + 0.74 L 5.0% highlex = 3.7 L 1.0% sol. highlex
- 0.8 gal H_2O = 0.2 gal of 5.0% highlex = 1 gal of 1.0% sol. highlex

Recommendations For Construction and Operation

- During my research I was unable to locate manufacture that carried 3/8 inch screening for sifter box #1. In my experiments 3/8 inch screening appears to be the best choice of screen.
- Aluminum rods beneath the screen are needed to support the 16.4 pounds of perlite in both boxes.
- Both sifter stands should be constructed so that the sifter box may lifted out an cleaned.
- Motor attached to the sifter stand #1 will be supplied by Mr. Camarata.

Bibliography

Bolen, Wallace P. (1990) *Minerals Yearbook Volume 1 Metals and Minerals.* US Department on the Interior, Bureau of Mines

Thruch, Paul W. (1968) *A Dictionary of Mining, Mineral, and Related Terms.* US Department of the Interior, Bureau of Mines