

## XI. APPENDIX III

### MATERIAL SAFETY DATA SHEET

The following items of information which are applicable to a specific product or material shall be provided in the appropriate block of the Material Safety Data Sheet (MSDS).

The product designation is inserted in the block in the upper left corner of the first page to facilitate filing and retrieval. Print in upper case letters as large as possible. It should be printed to read upright with the sheet turned sideways. The product designation is that name or code designation which appears on the label, or by which the product is sold or known by employees. The relative numerical hazard ratings and key statements are those determined by the rules in Chapter V, Part B, of the NIOSH publication, An Identification System for Occupationally Hazardous Materials. The company identification may be printed in the upper right corner if desired.

#### (a) Section I. Product Identification

The manufacturer's name, address, and regular and emergency telephone numbers (including area code) are inserted in the appropriate blocks of Section I. The company listed should be a source of detailed backup information on the hazards of the material(s) covered by the MSDS. The listing of suppliers or wholesale distributors is discouraged. The trade name should be the product designation or common name associated with the material. The synonyms are those commonly used for the product, especially formal chemical nomenclature. Every known chemical designation or

competitor's trade name need not be listed.

(b) Section II. Hazardous Ingredients

The "materials" listed in Section II shall be those substances which are part of the hazardous product covered by the MSDS and individually meet any of the criteria defining a hazardous material. Thus, one component of a multicomponent product might be listed because of its toxicity, another component because of its flammability, while a third component could be included both for its toxicity and its reactivity. Note that an MSDS for a single component product must have the name of the material repeated in this section to avoid giving the impression that there are no hazardous ingredients.

Chemical substances should be listed according to their complete name derived from a recognized system of nomenclature. Where possible, avoid using common names and general class names such as "aromatic amine," "safety solvent," or "aliphatic hydrocarbon" when the specific name is known.

The "%" may be the approximate percentage by weight or volume (indicate basis) which each hazardous ingredient of the mixture bears to the whole mixture. This may be indicated as a range or maximum amount, ie, "10-40% vol" or "10% max wt" to avoid disclosure of trade secrets.

Toxic hazard data shall be stated in terms of concentration, mode of exposure or test, and animal used, eg, "100 ppm LC50-rat," "25 mg/kg LD50-skin-rabbit," "75 ppm LC man," or "permissible exposure from 29 CFR 1910.1000," or, if not available, from other sources of publications such as the American Conference of Governmental Industrial Hygienists or the American National Standards Institute Inc. Flashpoint, shock sensitivity,

or similar descriptive data may be used to indicate flammability, reactivity, or similar hazardous properties of the material.

(c) Section III. Physical Data

The data in Section III should be for the total mixture and should include the boiling point and melting point in degrees Fahrenheit (Celsius in parentheses); vapor pressure, in conventional millimeters of mercury (mmHg); vapor density of gas or vapor (air = 1); solubility in water, in parts/hundred parts of water by weight; specific gravity (water = 1); percent volatiles (indicated if by weight or volume) at 70 degrees Fahrenheit (21.1 degrees Celsius); evaporation rate for liquids or sublimable solids, relative to butyl acetate; and appearance and odor. These data are useful for the control of toxic substances. Boiling point, vapor density, percent volatiles, vapor pressure, and evaporation are useful for designing proper ventilation equipment. This information is also useful for design and deployment of adequate fire and spill containment equipment. The appearance and odor may facilitate identification of substances stored in improperly marked containers, or when spilled.

(d) Section IV. Fire and Explosion Data

Section IV should contain complete fire and explosion data for the product, including flashpoint and autoignition temperature in degrees Fahrenheit (Celsius in parentheses); flammable limits, in percent by volume in air; suitable extinguishing media or materials; special firefighting procedures; and unusual fire and explosion hazard information. If the product presents no fire hazard, insert "NO FIRE HAZARD" on the line labeled "Extinguishing Media."

(e) Section V. Health Hazard Information

The "Health Hazard Data" should be a combined estimate of the hazard of the total product. This can be expressed as a TWA concentration, as a permissible exposure, or by some other indication of an acceptable standard. Other data are acceptable, such as lowest LD50, if multiple components are involved.

Under "Routes of Exposure," comments in each category should reflect the potential hazard from absorption by the route in question. Comments should indicate the severity of the effect and the basis for the statement, if possible. The basis might be animal studies, analogy with similar products, or human experiences. Comments such as "yes" or "possible" are not helpful. Typical comments might be:

Skin Contact--causes delayed burns.

Eye Contact--some pain and transient irritation.

"Emergency and First Aid Procedures" should be written in lay language and should primarily represent first-aid treatment that could be provided by paramedical personnel or individuals trained in first aid.

Information in the "Notes to Physician" section should include any special medical information which would be of assistance to an attending physician including required or recommended replacement and periodic medical examinations, diagnostic procedures, and medical management of overexposed employees.

(f) Section VI. Reactivity Data

The comments in Section VI relate to safe storage and handling of hazardous, unstable substances. It is particularly important to highlight instability or incompatibility to common substances or circumstances, such as water, direct sunlight, steel or copper piping, acids, alkalies, etc. "Hazardous Decomposition Products" shall include those products released under fire conditions. It must also include dangerous products produced by aging, such as peroxides in the case of some ethers. Where applicable, shelf life should also be indicated.

(g) Section VII. Spill or Leak Procedures

Detailed procedures for cleanup and disposal should be listed with emphasis on precautions to be taken to protect employees assigned to cleanup detail. Specific neutralizing chemicals or procedures should be described in detail. Disposal methods should be explicit including proper labeling of containers holding residues and ultimate disposal methods such as "sanitary landfill" or "incineration." Warnings such as "comply with local, state, and federal antipollution ordinances" are proper but not sufficient. Specific procedures shall be identified.

(h) Section VIII. Special Protection Information

Section VIII requires specific information. Statements such as "Yes," "No," or "If necessary" are not informative. Ventilation requirements should be specific as to type and preferred methods. Respirators shall be specified as to type and NIOSH or US Bureau of Mines approval class, ie, "Supplied air," "Organic vapor canister," etc. Protective equipment must be specified as to type and materials of construction.

(i) Section IX. Special Precautions

"Precautionary Statements" shall consist of the label statements selected for use on the container or placard. Additional information on any aspect of safety or health not covered in other sections should be inserted in Section IX. The lower block can contain references to published guides or in-house procedures for handling and storage. Department of Transportation markings and classifications and other freight, handling, or storage requirements and environmental controls can be noted.

(j) Signature and Filing

Finally, the name and address of the responsible person who completed the MSDS and the date of completion are entered. This will facilitate correction of errors and identify a source of additional information.

The MSDS shall be filed in a location readily accessible to employees potentially exposed to the hazardous material. The MSDS can be used as a training aid and basis for discussion during safety meetings and training of new employees. It should assist management by directing attention to the need for specific control engineering, work practices, and protective measures to ensure safe handling and use of the material. It will aid the safety and health staff in planning a safe and healthful work environment and in suggesting appropriate emergency procedures and sources of help in the event of harmful exposure of employees.

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## MATERIAL SAFETY DATA SHEET

| I PRODUCT IDENTIFICATION              |  |   |
|---------------------------------------|--|---|
| MANUFACTURER'S NAME                   | REGULAR TELEPHONE NO.<br>EMERGENCY TELEPHONE NO. |   |
| ADDRESS                               |  |   |
| <b>TRADE NAME</b>                     |  |   |
| <b>SYNONYMS</b>                       |  |   |
| II HAZARDOUS INGREDIENTS              |  |   |
| MATERIAL OR COMPONENT                 | %  | HAZARD DATA                             |
|                                       |  |   |
|                                       |  |   |
|                                       |  |   |
|                                       |  |   |
|                                       |  |   |
|                                       |  |   |
|                                       |  |   |
| III PHYSICAL DATA                     |  |   |
| BOILING POINT 760 MM HG               |  | MELTING POINT                           |
| SPECIFIC GRAVITY (H <sub>2</sub> O=1) |  | VAPOR PRESSURE                          |
| VAPOR DENSITY (AIR=1)                 |  | SOLUBILITY IN H <sub>2</sub> O, % BY WT |
| % VOLATILES BY VOL                    |  | EVAPORATION RATE (BUTYL ACETATE=1)      |
| APPEARANCE AND ODOR                   |  |   |

| IV FIRE AND EXPLOSION DATA              |  |       |                             |  |
|---|--|-------|-----------------------------|--|
| FLASH POINT<br>(TEST METHOD)            |  |       | AUTOIGNITION<br>TEMPERATURE |  |
| FLAMMABLE LIMITS IN AIR, % BY VOL.      |  | LOWER | UPPER                       |  |
| EXTINGUISHING<br>MEDIA                  |  |       |                             |  |
| SPECIAL FIRE<br>FIGHTING<br>PROCEDURES  |  |       |                             |  |
| UNUSUAL FIRE<br>AND EXPLOSION<br>HAZARD |  |       |                             |  |
| V HEALTH HAZARD INFORMATION             |  |       |                             |  |
| HEALTH HAZARD DATA                      |  |       |                             |  |
| ROUTES OF EXPOSURE                      |  |       |                             |  |
| INHALATION                              |  |       |                             |  |
| SKIN CONTACT                            |  |       |                             |  |
| SKIN ABSORPTION                         |  |       |                             |  |
| EYE CONTACT                             |  |       |                             |  |
| INGESTION                               |  |       |                             |  |
| EFFECTS OF OVEREXPOSURE                 |  |       |                             |  |
| ACUTE OVEREXPOSURE                      |  |       |                             |  |
| CHRONIC OVEREXPOSURE                    |  |       |                             |  |
| EMERGENCY AND FIRST AID PROCEDURES      |  |       |                             |  |
| EYES                                    |  |       |                             |  |
| SKIN:                                   |  |       |                             |  |
| INHALATION:                             |  |       |                             |  |
| INGESTION                               |  |       |                             |  |
| NOTES TO PHYSICIAN                      |  |       |                             |  |

| <b>VI REACTIVITY DATA</b>                            |  |
|--|--|
| CONDITIONS CONTRIBUTING TO INSTABILITY               |  |
| INCOMPATIBILITY                                      |  |
| HAZARDOUS DECOMPOSITION PRODUCTS                     |  |
| CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION  |  |
| <b>VII SPILL OR LEAK PROCEDURES</b>                  |  |
| STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED |  |
| NEUTRALIZING CHEMICALS                               |  |
| WASTE DISPOSAL METHOD                                |  |
| <b>VIII SPECIAL PROTECTION INFORMATION</b>           |  |
| VENTILATION REQUIREMENTS                             |  |
| SPECIFIC PERSONAL PROTECTIVE EQUIPMENT               |  |
| RESPIRATORY (SPECIFY IN DETAIL)                      |  |
| EYE  |  |
| GLOVES   |  |
| OTHER CLOTHING AND EQUIPMENT                         |  |

**IX SPECIAL PRECAUTIONS**

PRECAUTIONARY  
STATEMENTS

OTHER HANDLING AND  
STORAGE REQUIREMENTS

PREPARED BY \_\_\_\_\_

ADDRESS: \_\_\_\_\_

DATE \_\_\_\_\_

## XII. APPENDIX IV

### GLOSSARY\*

**ALKYLATING AGENTS** - Agents capable of introducing an alkyl radical into an organic or inorganic molecule by forming a stable carbon covalent bond.

**BASE-PAIRING RULES** - The requirement that adenine must always form a base pair with thymine (or uracil) and guanine with cytosine, in a nucleic acid double helix.

**BASE-PAIR SUBSTITUTION MUTATION** - A change of one base pair for another base pair, eg, A--T to G--C.

**DELETIONS** - Loss of a section of the genetic material from a chromosome. The size of the deleted material can vary from a single nucleotide to sections containing a number of genes.

**DNA (Deoxyribonucleic Acid)** - A polymer of deoxyribonucleotides. The genetic material of all cells.

**FRAMESHIFT MUTATIONS** - Either deletions or additions of one or more but not three or a multiple of three base pairs. In the case of deletion, reading of the codon is shifted forward one base and in the case of addition, the reading is shifted back one base.

MUTAGENS - Physical or chemical agents, such as radiation, heat, and alkylating or deaminating agents, which may increase the frequency of mutation above the observed spontaneous frequency.

MUTATION - An inheritable change in a nucleic acid.

NUCLEOPHILE - An atom or a molecule which can share a pair of electrons with an electropositive center in order to form a covalent bond.

POINT MUTATION - Alteration in DNA affecting one or a very small number of nucleotides. These alterations can be divided into two main subgroups: frameshift mutations and base-pair substitution mutations.

REVERSE (BACK) MUTATION - An inheritable change in a mutant gene that restores the original biologic function and, in some cases, the original nucleotide sequence.

SPONTANEOUS MUTATIONS - Mutations for which there is no "observable" cause.

SUPPRESSOR MUTATION - A mutation that totally or partially restores a function lost by a primary mutation and is located at a genetic site different from the primary mutation.

TRANSLOCATION - The transfer of a section of one chromosome to a nonhomologous chromosome.

TRANSDUCTION - Transfer of a portion of one gene to another gene by movement of DNA.

TRANSITION MUTATION - The replacement of a purine by a different purine or a pyrimidine by a different pyrimidine in a nucleic acid sequence.

TRANSVERSION MUTATION - The replacement of a purine by a pyrimidine or of a pyrimidine by a purine.

WILD-TYPE GENE - The form of gene (allele) commonly found in nature.

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\*Adapted from references 68 and 69

## XIII. TABLES AND FIGURES

TABLE XIII-1

## PHYSICAL PROPERTIES OF EPICHLOROHYDRIN

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|  |  |
|--|--|
| Molecular formula                            | C3H5OCl  |
| Formula weight                               | 92.5   |
| Boiling point                                | 116.4 C  |
| Melting point (freezing point)               | -58.1 C  |
| Vapor pressure                               | 5 mmHg at 5.6 C<br>20 mmHg at 29 C<br>400 mmHg at 97.4 C                           |
| Specific gravity (20/4 C)                    | 1.1839   |
| Solubility                                   | 6.48% in water; soluble<br>in acetone, benzene,<br>ether, heptane, and<br>methanol |
| Flashpoint (open cup)                        | 93 F   |
| Saturation concentration<br>(in air at 25 C) | 22,390 ppm   |
| Lower explosive limit                        | 3.8%   |
| Upper explosive limit                        | 21.0%  |
| Autoignition temperature                     | 416 C  |
| Conversion factors<br>(760 mmHg and 25 C)    | 1 ppm = 3.78 mg/cu m<br>1 mg/cu m = 0.26 ppm                                       |

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Derived from references 2,4, and 5

TABLE XIII-2

INDICES OF INTOXICATION IN RATS SUBJECTED TO ONE 4-HOUR  
 INHALATION EXPOSURE TO EPICHLOROHYDRIN AT VARIOUS CONCENTRATIONS

| Dose<br>(mg/l) | Day* | Body Temp<br>(C) | O <sub>2</sub> Con-<br>sumption<br>(ml/hr) | Liver<br>Weight Co-<br>efficient | BSP Test | Urine<br>Volume<br>(ml) | Specific<br>Gravity of<br>Urine | Chloride<br>Content<br>in Urine<br>(mg/day) |
|----------------|------|------------------|--|----------------------------------|----------|-------------------------|---------------------------------|---|
| 0.35           | 0    | 33.4±0.34        | 235±23.3                                   | 4.26±0.18                        | 8.6±0.30 | -                       | -                               | -   |
|                | 1    | 36.8±0.13        | 244±20.3                                   | -                                | 0.1      | 4.4±0.56                | 1.023±0.006                     | 8.3±1.91                                    |
| 0.02           | 0    | 35.5±0.36        | 275±11.7                                   | 4.00±0.18                        | 2.5±1.30 | -                       | -                               | -   |
|                | 1    | 36.7±0.20        | 281±16.7                                   | -                                | 3.8±0.20 | 4.0±0.54                | 1.016±0.002                     | 5.5±0.54                                    |
| 0.007          | 0    | 36.2±0.15        | 331±19.4                                   | 4.11±0.26                        | 1.4±0.40 | -                       | -                               | -   |
|                | 1    | 37.1±0.10        | 318± 4.8                                   | -                                | 2.8±0.20 | 4.9±0.65                | 1.009±0.002                     | 7.1±1.15                                    |
| Control        | 0    | 36.6±0.11        | 426±14.6                                   | 3.31±0.17                        | 0.1      | -                       | -                               | -   |
|                | 1    | 36.9±0.09        | 410±15.4                                   | -                                | 0.1      | 2.6±0.72                | 1.030±0.007                     | 3.6±0.90                                    |

\*Observation made immediately after exposure (Day 0) or after 1 day (Day 1)

Adapted from reference 32

TABLE XIII-3

EVALUATION OF URINE  
OF EPICHLOROHYDRIN-EXPOSED PERSONNEL FOR MUTAGENIC ACTIVITY

| Subject | 8-hr TWA<br>Exposure<br>(ppm) | Revertants (Treated)/Revertants (Control.) |       |       |       |       |
|---------|-------------------------------|--|-------|-------|-------|-------|
|         |                               | S typhimurium Strain                       |       |       |       |       |
|         |                               | 1535                                       | 1537  | 1538  | 100   | 98    |
| PW1     | 0.8                           | 1.11                                       | 0.88  | 1.69  | 1.91  | 1.78  |
| CBS     | 1.2                           | 0.96                                       | 1.11  | 0.69  | 1.21  | 1.73  |
| TWW     | 1.2 (A)                       | 1.27                                       | 0.93  | 1.72  | 0.87  | 0.83  |
|         | 1.2 (B)                       | 1.20                                       | 0.87  | 1.56  | 1.00  | 0.58  |
| JJM     | 1.5                           | 0.93                                       | 1.00  | 1.25  | 1.54  | 1.23  |
| CBS     | 1.7 (A)                       | 1.00                                       | 0.95  | 0.57  | 0.93  | 1.62  |
|         | 2.6 (B)                       | 0.80                                       | 0.84  | 0.66  | 0.93  | 1.31  |
| PW1     | 3.2 (A)                       | 1.16                                       | 0.67  | 1.22  | 2.00  | 1.62  |
|         | 3.2 (B)                       | 1.30                                       | 0.58  | 1.69  | 1.79  | 1.46  |
| H       | 3.5                           | 0.87                                       | 1.00  | 1.13  | 0.87  | 1.00  |
| DDL     | 3.6                           | 0.62                                       | 0.63  | 0.60  | 0.91  | 1.00  |
| PW1     | 4.0                           | 1.03                                       | 0.67  | 1.41  | 1.61  | 1.38  |
| SJ*     | exceeds<br>25**               | 2.48                                       | 0.24  | 1.12  | 0.99  | -     |
| GV*     | exceeds<br>25**               | 2.64                                       | 0.53  | 1.12  | 1.13  | -     |
|         | Average                       | 1.24                                       | 0.78  | 1.17  | 1.26  | 1.21  |
|         | SD                            | ±0.59                                      | ±0.24 | ±0.42 | ±0.42 | ±0.49 |

TABLE XIII-3 (CONTINUED)

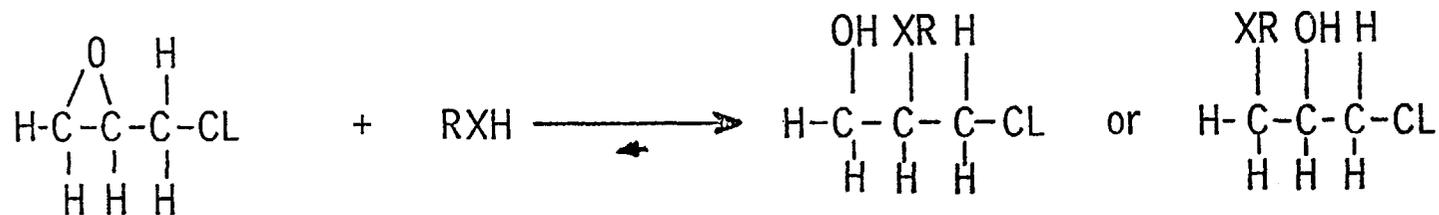
EVALUATION OF URINE OF  
EPICHLOROHYDRIN EXPOSED PERSONNEL FOR MUTAGENIC ACTIVITY

| Subject | 8-hr TWA<br>Exposure<br>(ppm) | Revertants (Treated)/Revertants (Control) |       |       |       |       |
|---------|-------------------------------|---|-------|-------|-------|-------|
|         |                               | S typhimurium Strain                      |       |       |       |       |
|         |                               | 1535                                      | 1537  | 1538  | 100   | 98    |
| WR      | Control                       | 1.24                                      | 0.54  | 0.88  | 1.00  | 1.08  |
| RWV     | "                             | 0.86                                      | 1.04  | 1.19  | 1.58  | 1.00  |
| SRR     | "                             | 0.89                                      | 0.13  | 0.94  | 1.70  | 0.76  |
| LAS     | "                             | 1.08                                      | 0.42  | 1.22  | 2.21  | 1.03  |
| L       | "                             | 0.78                                      | 0.63  | 0.98  | 0.57  | 0.89  |
|         | Average                       | 0.97                                      | 0.55  | 1.04  | 1.41  | 0.95  |
|         | SD                            | ±0.19                                     | ±0.33 | ±0.15 | ±0.64 | ±0.13 |

\*Acute exposure

\*\*Average area monitoring results during 105 min

From DJ Kilian (written communication, April 1976)



where X = an electronegative element such as oxygen  
nitrogen, or sulfur

where R = an alkyl or aryl or other organic group.

By the law of mass action, the rate of reaction of epichlorohydrin with a nucleophile is given by : .

$$\frac{d [\text{CH}_2 \text{OCHCH}_2 \text{CL}]}{dt} = k [\text{CH}_2 \text{OCHCH}_2 \text{CL}] [\text{RXH}]$$

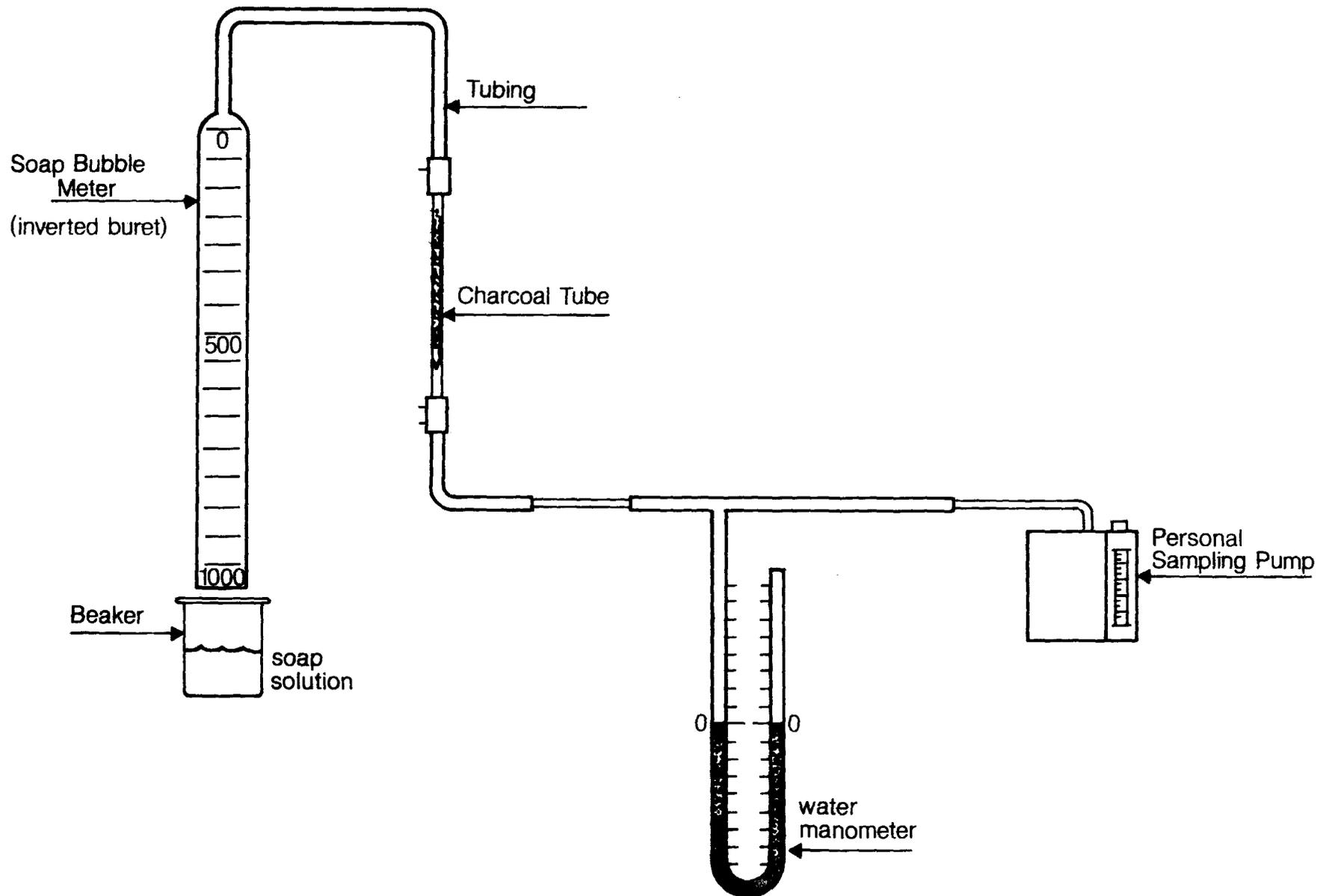
where k = a rate constant

REACTION OF EPICHLOROHYDRIN

Figure XIII-1

FIGURE XIII-2

CALIBRATION SETUP FOR PERSONAL SAMPLING PUMP WITH CHARCOAL TUBE



DEPARTMENT OF  
HEALTH, EDUCATION, AND WELFARE  
PUBLIC HEALTH SERVICE  
CENTER FOR DISEASE CONTROL  
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH  
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