FINAL
BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)
BACKGROUND DOCUMENT FOR

VANADIUM-CONTAINING WASTES
(P119 AND P120)

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1. INTRODUCTION AND SUMMARY

Pursuant to Section 3004(m) of the Resource Conservation and Recovery Act (RCRA) as enacted by the Hazardous and Solid Waste Amendments (HSWA) of November 8, 1984, the Environmental Protection Agency (EPA) is promulgating treatment standards based on the best demonstrated available technology (BDAT) for vanadium-containing wastes. These wastes are identified in 40 CFR 261.33 as the waste codes P119 and P120. Compliance with today's final treatment standards is a prerequisite for land disposal of these wastes as defined in 40 CFR Part 268.2. The effective date of final treatment standards for P119 and P120 will be August 8, 1990.

This background document presents the Agency's technical support and rationale for developing regulatory standards for these wastes. Sections 2 through 6 present waste-specific information for P119 and P120 wastes. Section 2 presents the number and location of facilities affected by the land disposal restrictions, the waste-generating processes, and waste characterization data. Section 3 discusses the technologies used to treat the wastes (or similar wastes), and Section 4 presents available performance data, including data upon which the treatment standards are based. Section 5 explains EPA's determination of BDAT. Treatment standards for vanadium wastes are determined in Section 6.

The land disposal restrictions program and BDAT methodology are more thoroughly described in two additional documents: Methodology for Developing BDAT Treatment Standards (USEPA 1989a) and Generic Quality Assurance Project Plan for Land Disposal Restrictions Program ("BDAT") (USEPA 1988a). The petition process to be followed in requesting a variance from the treatment standards is discussed in the methodology document.

From a partial analysis of responses to EPA's 1986 National Survey of Hazardous Waste Generators (Generator Survey), the Agency has information indicating that at least seven facilities presently generate P119 and P120 wastes. These facilities generate hazardous wastes that are either nonwastewaters or wastewaters. For the purpose of determining applicable treatment standards, a wastewater is defined by the Agency as a waste containing less than 1 percent (weight basis) total suspended solids* (TSS) and less than 1 percent (weight basis) total organic carbon (TOC). Wastes not meeting this definition must comply with the standards for nonwastewaters.

The characterization and treatment data for vanadium came from a routinely generated wastewater stream. However, the treated stream contains vanadium that is treated in the same way that a P wastewater stream would be treated. EPA believes that this routinely generated waste stream is as difficult or more difficult to treat than P119 and P120. Therefore, the Agency is transferring the performance data from this routinely generated waste stream to P119 and P120.

The treatment standard for P119 and P120 nonwastewaters is stabilization as a method of treatment. Recovery is not precluded as a method of treatment, provided the residuals from the P119 and P120 vanadium recovery process are stabilized. In the event that recovery or stabilization is not appropriate for P119 or P120 (e.g., for a container that does not meet the definition of "empty" in 40 CFR 261.7(b)(3)), a variance from the treatment standard remains as an alternative. The treatment standard for P119 and P120 wastewaters is 28 mg/l. The treatment standards for vanadium are summarized in Table 1-1.

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* The term "total suspended solids" clarifies EPA's previously used terminology of "total solids" and "filterable solids." Specifically, the quantity of total suspended solids is measured by Method 209c (Total Suspended Solids Dried at 103° to 105°C) in Standard Methods for the Examination of Water and Wastewater, 16th Edition (APHA, AWWA, and WPCF 1985).

Table 1-1 BDAT Treatment Standards for P119 and P120 Wastewaters and Nonwastewaters

Regulated constituent	Wastewaters maximum for any 24-hour composite sample Total composition (mg/l)	Nonwastewaters
Vanadium	28	Stabilization as method of treatment

2. INDUSTRIES AFFECTED AND WASTE CHARACTERIZATION

As defined in 40 CFR 261.33, P119 and P120 are the following discarded commercial chemical products, off-specification species, container residues, and spill residues thereof:

P119 - Ammonium vanadate
P120 - Vanadium pentoxide

Section 2.1 describes the industries affected by the land disposal restrictions for P119 and P120 wastes. Section 2.2 summarizes the available waste characterization data for these wastes. Section 2.3 uses the Agency's analyses of the sources of P119 and P120 wastes and waste composition to determine waste treatability groups.

2.1 Industries Affected

The industries affected by the land disposal restrictions for P119 and P120 are (1) the inorganic chemicals industry, which produces or recovers vanadium pentoxide and ammonium vanadate, and (2) several industries that use vanadium compounds to manufacture metal alloys and to manufacture catalysts used in the production of sulfuric acid, adipic acid, and phthalic anhydride and in vapor-phase organic polymerizations.

2.1.1 Production of Inorganic Vanadium Compounds

According to the U.S. Bureau of Mines, approximately 5,000 tons of vanadium were consumed in 1988. Approximately 90 percent of the vanadium was used in the production of ferrous vanadium alloys. The remaining 10 percent (i.e., 500 tons) was used in the production of ammonium metavanadate, vanadium pentoxide, and other compounds. (U.S. Bureau of Mines 1989). Ammonium metavanadate and vanadium pentoxide are produced from two sources: (1) vanadium pentoxide recovery from ore processing and (2) recovery from spent catalysts. The current manufacturers of vanadium compounds and facilities that recover vanadium from spent materials are shown in Table 2-1. Most vanadium produced in the United States is produced as either vanadium pentoxide or ammonium metavanadate from mined ores or recovery processes. Uranium production facilities and some phosphorus production facilities produce vanadium as a byproduct. Vanadium recovery from spent catalysts or from Stretford solutions also contributes to the production of vanadium compounds.

(1) Recovery from ore processing. Vanadium is recovered domestically as a principal mine product, as a coproduct or byproduct from uranium-vanadium ores, and from ferrophosphorus produced as a byproduct in the production of elemental phosphorus.

The first stage in ore processing is the production of an oxide concentrate. The principal vanadium-bearing ores are usually crushed, ground, screened, and mixed with a sodium salt, e.g., NaCl or Na_2CO_3. This mixture is roasted at about 850°C, and the vanadium oxides are converted to water-soluble sodium metavanadate, $NaVO_3$. The vanadium is extracted by leaching with water. It is then precipitated at a pH of 2 to 3 as sodium hexavanadate, $Na_4V_6O_{17}$, a red cake, by the addition of sulfuric acid. This cake is then fused at 700°C to yield a dense black product that is sold as technical-grade vanadium pentoxide (V_2O_5). This product contains a minimum of 86 percent V_2O_5 by weight and a maximum of 6 to 10 percent Na_2O by weight.

The red cake can be further purified by dissolution of sodium oxide in an aqueous solution of Na_2CO_3. Iron, aluminum, and silicon impurities precipitate from the solution upon pH adjustment. Ammonium metavanadate (NH_4VO_3) then precipitates upon the addition of NH_4Cl. This compound is then calcined to give vanadium pentoxide of greater than 99.8 percent purity. Most of the vanadium pentoxide produced in this manner is converted onsite to the metal for metallurigical purposes.

Table 2-1 Manufacturers and Recoverers of Vanadium Compounds

Manufacturers	Location
Kerr-McGee Corporation	Soda Springs, Idaho
Union Carbide Corporation, UMETCA Minerals Corporation (subsidiary)	Blanding, Utah
Shieldalloy Corporation	Cambridge, Ohio
Strategic Minerals Corporation	Hot Springs, Arkansas
Recovery Facilities	**Location**
Gulf Chemical and Metallurgical	Freeport, Texas
UPE - SOMEX, Ltd.	Bartlesville, Oklahoma
AMAX Metals Recovery	Braithwaite, Louisiana
Dow Chemical	Freeport, Texas
IT Corporation	Benicia, California

Source: USEPA 1986b.

Vanadium and uranium are extracted from carnotite (a uranium ore containing vanadium) by direct leaching of the raw ore with sulfuric acid. An alternative method is roasting the ore followed by successive leaching with H_2O and dilute HCl or H_2SO_4. In some cases, the first leach is with a Na_2CO_3 solution. The uranium and vanadium are then separated from the pregnant liquor by liquid-liquid extraction techniques involving careful control of the oxidation states and pH during extraction and stripping. The product is usually in the form of ammonium metavanadate, which is also mostly converted to the metal onsite for metallurgical applications.

One plant, Kerr McGee, Soda Springs, Idaho, produces vanadium pentoxide from ferrophosphorous produced using western phosphate ores. The production process is proprietary. The products of this plant are vanadium pentoxide and ammonium metavanadate used for chemical purposes.

(2) Recovery from spent catalyst. Vanadium recovery from spent catalysts is typically accomplished through a process that involves thermal oxidation, leaching, metals precipitation with caustic, and final oxidation and granulation. Spent catalysts typically contain about 5 percent vanadium compounds. (Any P119 and P120 waste containing comparable or higher levels of vanadium is likely to be managed by this technology.)

One process that recovers vanadium from mixed spent catalysts separates the spent catalyst into four products: molybdenum trisulfide, vanadium pentoxide, alumina trihydrate, and nickel-cobalt concentrate. A typical example of this process is described in greater detail in Section 3.1.1(1).

2.1.2 Users of Inorganic Vanadium Compounds

Most vanadium compounds are used in alloying iron and steel to enhance physical properties and in catalyst operations.

(1) Alloying. The most important use of vanadium is as an alloying element in the steel industry, where it is added to produce grain refinement and hardenability in steels. Vanadium is a strong carbide former, which causes carbide particles to form in the steel, thus restricting the movement of grain boundaries during heat treatment. This produces a fine-grained steel that is more resistant to cracking during cooling. In addition, the carbide dispersion confers wear resistance, weldability, and good high-temperature strength. Vanadium steels are used in dies or taps because of their deep-hardening characteristics and for cutting tools because of their wear resistance. They are also used as constructional steel in light and heavy sections; for heavy iron and steel castings; for forged parts, such as shafts and turbine motors; for automobile parts, such as gears and axles; and for springs and ball bearings. Vanadium is an important component of ferrous alloys used in jet aircraft engines and turbine blades, where high-temperature creep resistance is a basic requirement.

(2) Catalysts. Vanadium compounds are used as catalysts in the production of sulfuric acid, adipic acid, and phthalic anhydride and in vapor-phase organic polymerizations. The major producers of adipic acid and phthalic anhydride are presented in Table 2-2.

Ammonium metavanadate wastes may result from off-specification production of the final product. Ammonium metavanadate resulting from "poisoned" catalysts, however, is not considered P119. The producers of ammonium vanadate are capable of reintroducing off-spec material into a calcining operation and eliminating any potential waste.

Table 2-2 Manufacturers of Adipic Acid and Phthalic Anhydride

Major Adipic Acid Producers	Location
DuPont	Orange, Texas
DuPont	Victoria, Texas
Monsanto	Pensacola, Florida
Allied Signal	Hopewell, Virginia
Major Phthalic Anhydride Producers	**Location**
BASF	Kearney, New Jersey
Exxon	Baton Rouge, Louisiana
Koppers Company	Cicero, Illinois
Stephan Company	Millsdale, Illinois
Tenn-USS Chemical	Pasadena, California

Source: SRI 1989.

Generators reported production of very small amounts of P120 waste. The EPA's national survey of Treatment, Storage, Disposal, and Recycling facilities (TSDR) indicates that two facilities land disposed significant quantities of P120 in 1986. Other anticipated generators of vanadium pentoxide (P120) might be oil refineries that perform hydrotreating to remove vanadium pentoxide and other metallic impurities and sell those recovered metals as a product, as opposed to disposing of them as a waste.

2.2 Waste Characterization

From a partial response to the 1986 Generator Survey (USEPA 1986a), the Agency has information on facilities that produce P119 and P120. One is an ore processing facility generating P119 waste, and six facilities generate P120 waste. Data from these seven facilities are for mixtures of wastes containing wastes other than P119 or P120. The vanadium in the waste mixture from the one plant with P119 is in the concentration range of 1 to 10 ppm. The vanadium in the waste mixtures from the six plants with P120 is in the concentration range of 1 to 25 percent.

From the two generators that reported data for P120 that is not mixed with other wastes, the two sets of data indicate vanadium present at 50 to 75 percent for one facility and at greater than 90 percent at the other facility.

2.3 Determination of Waste Treatability Groups

Ammonium vanadate and vanadium pentoxide are classified as "P" wastes (P119 and P120, respectively). A U or P waste is, in essence, a nonroutine discharge of the particular component, i.e., a discharge that was not planned. A generator or a user of the constituent in question can generate the U and P waste only by accidentally spilling a commercially available material containing the constituent or by disposing of the commercially available material because it is off-specification for its intended use. A routine process waste from a production process or from a routine wastewater treatment process is not a U or P waste, regardless of the constituents it contains (unless the wastewater treatment system discharge is contaminated with a U or P waste, in which case the entire wastewater discharge becomes the U or P waste by the mixture rule). The only exception to this rule is containers that held the commercial product with the constituent of concern and were not cleaned properly. (Proper cleaning is defined in 40 CFR 261.7.)

Any of the processes that recover vanadium run the risk of generating a P waste because the recovered vanadium product may in fact be off-specification and require disposal. Also, the recovered product may be spilled by the generator or user or spilled en route. The drums may be disposed of, and if not properly cleaned they would also be a P waste. Routinely generated waste streams that contain ammonium vanadate or vanadium pentoxide are not P wastes.

EPA has determined that P119 and P120 can be generated as either wastewaters or nonwastewaters. The Agency is establishing these two treatability groups to account for the physical forms these wastes may take. The Agency believes that most P119 and P120 wastes will be generated as nonwastewaters; however, wastewater forms may be generated through such occurences as incidental spills of solution grade products or spills mixing with other aqueous liquids.

Residues from the treatment of P119 and P120 are also P119 and P120 by the "derived from" rule, unless formerly delisted.

3. APPLICABLE AND DEMONSTRATED TREATMENT TECHNOLOGIES

In this section, the treatment technologies that are applicable to P119 and P120 wastes are identified. The Agency determination of which, if any, of the applicable technologies can be considered demonstrated for the purpose of establishing BDAT is also presented in this section.

To be "applicable," a technology must be theoretically usable to treat the waste in question or to treat a waste that is similar in terms of the parameters that affect treatment selection. (For detailed descriptions of the applicable technologies, see EPA's Treatment Technology Background Document (USEPA 1989b).)

To be "demonstrated," the technology must be in full-scale operation for the treatment of the waste in question or a similar waste. Technologies available only at pilot- and bench-scale operations are not considered when demonstrated technologies are identified.

3.1 Applicable Treatment Technologies

3.1.1 Applicable Technologies for Nonwastewaters

EPA has identified recovery and stabilization as applicable treatment technologies for nonwastewater forms of P119 and P120 wastes. These technologies are discussed below.

(1) Recovery. Vanadium recovery is sometimes accomplished through a process that involves thermal oxidation, leaching, metals precipitation with caustic, and final oxidation and granulation. Spent catalysts typically contain over 5 percent vanadium compounds. Similarly, any P119 and P120 waste containing comparable or higher levels of vanadium should be manageable by this technology.

The CRI-MET process is currently employed at the AMAX Metals Recovery facility in Braithwaite, Louisiana, and is considered typical for the industry. This process uses a two-stage leach process: one stage for the solubilization of vanadium and molybdenum, and the other for the solubilization of alumina. The process separates the spent catalyst into four products: molybdenum trisulfide, vanadium pentoxide, alumina trihydrate, and nickel-cobalt concentrate.

The spent catalyst is fed to a ball mill, along with caustic soda (NaOH). There it is finely ground and partially leached. The slurry is then pumped to the first-stage leach autoclave, where it is oxidized at high temperature and pressure. The sulfur is converted to sulfate, the hydrocarbons are mostly destroyed, and the molybdenum and vanadium are dissolved. The solution is then filtered and fed to the vanadium recovery process. The solids, along with recycle caustic, make up the feed for the second-stage alumina leach autoclave, which operates exactly as the first stage.

Vanadium recovery from the first-stage leach solution follows molybdenum precipitation. The vanadium is precipitated with caustic. It is then washed, centrifuged, dried, oxidized, and granulated. Recovery processes usually recover the vanadium in its pentoxide state. End use may dictate further refinement of the initially produced or recovered vanadium compound.

The process does not generate a solid waste. (All nonwastewater residuals from this process are recyclable.) The wastewaters are typically processed through a wastewater treatment system before discharge under NPDES permit.

Pretreatment in tanks is not precluded before recovery. Such practices as dissolution, chemical precipitation, cation exchange, or resin adsorption may render the waste more amenable to recovery. The Agency does not wish to limit the types of recovery that could potentially be used to treat these wastes, nor does it wish to prohibit pretreatment in tanks prior to recovery.

(2) Stabilization technologies. Stabilization is identified as an applicable technology for treatment of nonwastewaters containing most BDAT list metals. Stabilization technologies involve mixing the waste with lime/fly ash mixtures, cement, concrete mixtures, or other formulations, both proprietary and nonproprietary. Water is then added, and the mixture sets into a solid mass in which the leachability of the metals is reduced compared to that in the untreated waste. Stabilization technologies are discussed in detail in the Treatment Technology Background Document (USEPA 1989b).

3.1.2 Applicable Technologies for Wastewaters

EPA has identified a proprietary wastewater treatment process, which is Confidential Business Information (CBI), and chemical precipitation as technologies applicable to wastewater forms of P119 and P120 wastes. These technologies are discussed below.

(1) Solvent Extraction. Solvent extraction is commonly used for organics, but can also be used to extract a few inorganics such as vanadate salts. The basic principle of operation in solvent extraction is that constituents are removed by mixing the waste with a solvent that will preferentially dissolve the constituents of concern from the waste. The waste and the solvent must be immiscible so that after mixing, the two immiscible phases can physically separate by gravity. In theory, the maximum degree of separation that can be achieved is provided by the

selectivity value, which is the ratio of equilibrium concentration of the constituents in the solvent to the equilibrium concentration of the constituent in the waste. The solvent extraction process can be either batch or continuous.

In the simplest extraction systems, three chemical components are mixed: (1) the solute, or the constituents in the waste stream to be extracted; (2) the nonsolute portion of the waste stream; and (3) the solvent. The solvent and the waste stream are mixed to allow mass transfer of the constituent(s) (the solute) from the waste stream to the solvent. Separation of the solvent phase and the waste stream phase occurs under quiescent conditions, relying on the density differences between the two phases.

The solvent solution containing the extracted constituents is called the extract. The extracted waste stream with the constituents removed is called the raffinate. The extract can be either the heavy (more dense) phase or the light (less dense) phase. Overall process operational details can be found in the Treatment Technology Background Document (USEPA 1989b).

(2) Chemical precipitation Chemical precipitation is a treatment technology applicable to wastewaters containing a wide range of dissolved metals. This technology removes these metals from solution in the form of insoluble solid precipitates. The solids formed are then separated from the wastewater by settling, clarification, and/or polishing filtration.

The basic principle of operation of chemical precipitation is that metals in wastewater are removed by the addition of a precipitating agent that converts the soluble metals to insoluble precipitates. These precipitates are settled, clarified, and/or filtered out of solution, leaving a lower concentration of metals in the wastewater. The principal precipitation agents used to convert soluble metal compounds to less soluble forms include lime ($Ca(OH)_2$), caustic (NaOH), sodium sulfide (Na_2S), and, to a lesser extent, soda ash (Na_2CO_3), phosphate (PO_4^{-3}), and ferrous sulfide (FeS). A common precipitating agent used for removal of vanadium from wastewaters is ferric sulfate, which is added with pH adjustment. When ferric sulfate is used as treatment, the vanadium is removed from the wastewaters as ferric metavanadate, which is relatively insoluble and remains in the filter cake. Chemical precipitation is discussed in detail in the Treatment Technology Background Document (USEPA 1989b).

3.2 Demonstrated Treatment Technologies

3.2.1 Demonstrated Technologies for Nonwastewaters

EPA believes that recovery is a demonstrated treatment technology for P119 and P120 because information is available indicating that spent catalysts containing vanadium compounds with greater than 5 percent vanadium can be recovered using this process.

EPA also believes that P119 and P120 nonwastewaters can be stabilized since these wastes are inorganic compounds. Stabilization has been used on a commercial basis to treat many wastes containing BDAT list metals in an inorganic waste matrix.

3.2.2 Demonstrated Technologies for Wastewaters

Solvent extraction is a demonstrated technology because it is used on a commercial basis to remove vanadium from wastewater. Confidential data are available on solvent extraction of vanadium from wastewaters from a commercial plant specializing in the recovery of vanadium. (See Figure 3-1). Chemical precipitation is also a demonstrated technology for vanadium wastewaters because it was used to treat leachate extracted from nonwastewaters.

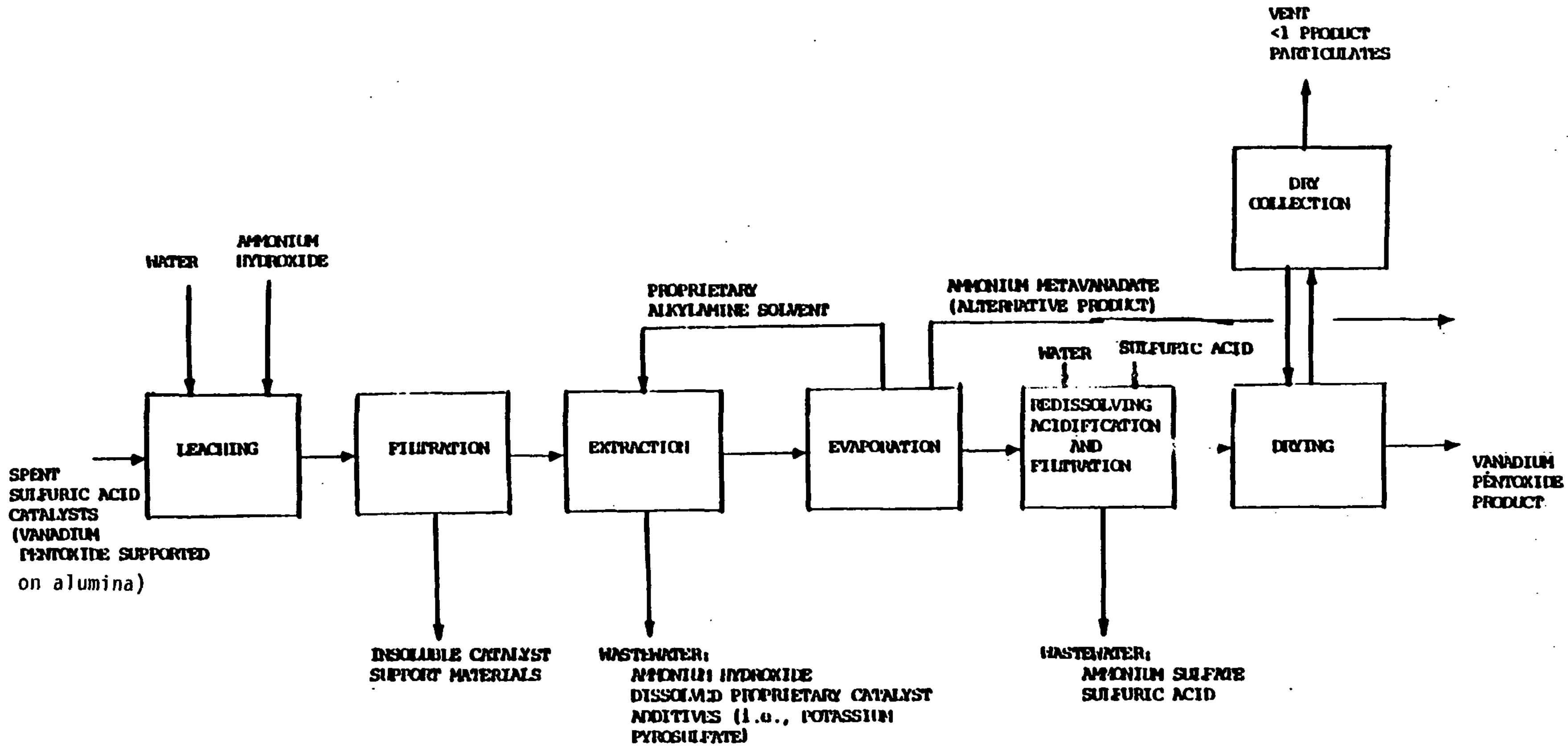

Figure 3-1 Vanadium Pentoxide and Ammonium Metavanadate Manufacture from Spent Sulfuric Acid Catalysts.

Source: Versar 1980.

4. PERFORMANCE DATA

This section presents relevant data available to EPA on the performance of demonstrated technologies in treating listed wastes containing vanadium compounds in concentrations similar to the concentrations expected to be found in P119 and P120 wastes. These data are used elsewhere in this document for determining which technologies represent BDAT (Section 5) and for developing treatment standards (Section 6). Eligible data, in addition to full-scale demonstration data, may include data developed at research facilities or obtained through other applications at less than full-scale operation, as long as the technology is demonstrated in full-scale operation for a similar waste or wastes as defined in Section 3.

Performance data, to the extent that they are available to EPA, include the untreated and treated waste concentrations for a given constituent, the values of operating parameters that were measured at the time the waste was being treated, the values of relevant design parameters for the treatment technology, and data on waste characteristics that affect performance of the treatment technology.

Where data are not available on the treatment of the specific wastes of concern, the Agency may elect to transfer data on the treatment of a similar waste or wastes, using a demonstrated technology. To transfer data from another waste category, EPA must find that the wastes covered by this background document are no more difficult to treat (based on the waste characteristics that affect performance of the demonstrated treatment technology) than the treated wastes from which performance data are being transferred.

4.1 Performance Data for Nonwastewaters

The Agency does not have performance data on the recovery technologies for the treatment of P119 and P120.

The Agency has performance data for treatment of vanadium-containing nonwastewaters using stabilization, as shown in Table 4-1. The data presented are performance data developed from stabilization of K048 and K051 waste. However, the concentration of vanadium in the untreated K048 and K051 waste was in the 690 to 910 ppm range, well below the expected vanadium concentration levels for P119 and P120. It follows that the level of treatment achieved for the K048 or K051 vanadium concentrations may not be achieved for P119 and P120 wastes containing higher concentrations of vanadium. These data were not used to calculate a concentration-based treatment standard for P119 or P120.

4.2 Performance Data for Wastewaters

Wastewater treatment data that were received from the Chemical Manufacturers Association (CMA) for a commercial vanadium recovery plant. The data have been analyzed for the development of concentration-based treatment standards for P119 and P120 wastewaters. The data are confidential and are thus not presented in this document.

Table 4-1 Treatment Performance Data Collected by EPA for K048 and K051
Plant 1 - Stabilization of Incinerator Ash

	Untreated waste		Treated waste: TCLP extracts of stabilized fluidized bed incinerator ash								
			Cement binder			Kiln dust binder			Lime and fly ash binder		
	Total composition (mg/kg)	TCLP (mg/l)	Run 1 mg/l (ppm)	Run 2 mg/l (ppm)	Run 3 mg/l (ppm)	Run 1 mg/l (ppm)	Run 2 mg/l (ppm)	Run 3 mg/l (ppm)	Run 1 mg/l (ppm)	Run 2 mg/l (ppm)	Run 3 mg/l (ppm)
167. Vanadium	695-910	2.5-3.6	1.4	1.21	1.29	1.53	1.64	1.56	0.148	0.149	0.156
Design and operating parameters											
Binder-to-waste ratio			0.2	0.2	0.2	0.2	0.2	0.2	NA	NA	NA
Lime-to-waste ratio			NA	NA	NA	NA	NA	NA	0.2	0.2	0.2
Fly ash-to-waste ratio			NA	NA	NA	NA	NA	NA	0.2	0.2	0.2
Water-to-waste ratio			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Ambient temprature (°C)			23	23	23	19.0	19.5	20	19	19	19
Mixture pH			11.6	11.5	11.5	12.1	12.1	12.1	12.0	12.1	12.1
Cure time (days)			28	28	28	28	28	28	28	28	28
Unconfined compression strength (lb/in^2)			943.5	921.6	1270	222.8	267.7	241.0	565.8	512.6	578.8

NA = Not applicable.

Source: USEPA 1988.

5. DETERMINATION OF BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)

This section presents the Agency's rationale for determining best demonstrated available technology (BDAT) for P119 and P120 nonwastewaters and wastewaters.

The Agency examines all available performance data on technologies that are identified as demonstrated to determine (using statistical techniques) whether one or more of the technologies perform significantly better than the others. The technology that performs best on a particular waste or waste treatability group is then evaluated to determine whether it is "available." To be available, the technology must (1) be commercially available to any generator and (2) provide "substantial" treatment of the waste, as determined through evaluation of accuracy-adjusted data. In determining whether treatment is substantial, EPA may consider data on the performance of the treatment on a waste similar to the one in question, provided that the similar waste is at least as difficult to treat. If the best technology is found to be not available, then the next best technology is evaluated, and so on.

The most desirable waste management technology is one that results in no residual streams, or in a residual stream with no hazardous properties. EPA has identified demonstrated recovery technologies for vanadium spent catalysts that could be used for treatment of P119 and P120 nonwastewaters. However, since the Agency does not have sufficient performance data on the recovery technologies for the treatment of P119 and P120, stabilization is considered best for nonwastewaters. Recovery is not precluded as a method of treatment, provided the residuals from the recovery process are stabilized.

EPA has identified solvent extraction as a demonstrated technology for wastewaters containing some BDAT list metals. Solvent extraction is the only technology for which the Agency has reliable treatment data for vanadium-containing wastewaters. Solvent extraction can be used to extract vanadate salts, and the process is now being used in a commercial plant; thus, this technology is available and represents BDAT for P119 and P120 wastewaters.

For P119 and P120 wastewaters, EPA has identified a proprietary, wastewater treatment process as demonstrated to remove vanadium from these wastewaters. As discussed in Section 4, the treatment data for this proprietary process is confidential. This proprietary process is commercially available, i.e., it can be licensed; therefore, it is an "available" process. Since it is "best," "demonstrated," and "available," it has been selected as BDAT.

6. CALCULATION OF BDAT TREATMENT STANDARDS

In this section, treatment standards are developed for the BDAT technologies based on the appropriate performance data presented in Section 4.

6.1 BDAT Treatment Standards for Nonwastewaters

The Agency is promulgating a treatment standard expressed as "Stabilization as a method of treatment" (see Table 6-1). Using data in Table 4-1 as a basis, the Agency believes that P119 and P120 nonwastewaters can be stabilized. Those data show that nonwastewaters up to 910 mg/kg concentration and 2.5 to 3.6 mg/l TCLP were stabilized to between 0.15 and 1.6 mg/l in TCLP leachate. Therefore, the Agency is promulgating stabilization as a treatment method for nonwastewaters. The Agency is not setting a numerical standard for P119 and P120 nonwastewaters because the only data available are from one source of vanadium-containing waste. Since U and P wastes are likely to be of varied matrices and the Agency has data for only one of the waste matrices, the Agency believes that it has insufficient data to support a numerical standard. If sufficient additional stabilization data become available, EPA will consider a numerical standard.

In the event that stabilization is not appropriate for P119 or P120, a variance from the treatment standard remains an alternative.

6.2 BDAT Treatment Standards for Wastewaters

The treatment standard for P119 and P120 wastewaters was calculated from wastewater treatment data from a commercial vanadium recovery plant using a proprietary CBI vanadium recovery process. Based on these treatment data (confidential), the Agency is proposing a treatment standard of 28 mg/l vanadium for P119 and P120 wastewaters (see

Table 6-1). The details of this calculation are CBI, including accuracy adjustment of the treatment data and calculation of the variability factor, and are thus not included in this document.

Table 6-1 BDAT Treatment Standards for P119 and P120
Wastewaters and Nonwastewaters

Regulated constituent	Wastewaters maximum for any 24-hour composite sample Total composition (mg/l)	Nonwastewater
Vanadium	28	Stabilization as method of treatment

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