Materials for Ancillary Equipment

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History Sheet

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Contents

1 Introduction

The Washington Administrative Code, 173-303-640(3)(a), states that the tank system and ancillary equipment shall be compatible with the waste. This report addresses material selection for corrosion protection of WTP ancillary waste containment equipment. External corrosion protection of pipe in direct contact with the soil or water is not addressed in this report.

According to WAC-173-303-040, *Definitions*, "Ancillary equipment" means any device including, but not limited to, such devices as piping, fittings, flanges, valves, and pumps, that is used to distribute, meter, or control the flow of dangerous waste from its point of generation to a storage or treatment tank(s), between dangerous waste storage and treatment tanks to a point of disposal on-site, or to a point of shipment for disposal off-site.

For the purposes of the WTP project, in addition to the definition above, ancillary equipment may also include other in-line components containing dangerous waste such as, breakpots, pulse pots, dampers, drains, overflows, jumpers, joggles, ejectors, strainers, reducers, misters, mixing tees, and certain heat exchangers associated with the piping. The definition as used here does not include gaskets, seals, or other non-metallic consumable components.

2 Applicable Documents

The Washington Administrative Code, WAC-173-303-640, *Tank Systems*.

3 Description

The waste containment piping and ancillary equipment material selection is based on the Corrosion Evaluations performed for vessels, tanks, columns, evaporators, ultrafilters, filtration units, pulse pots, and breakpots. Corrosion Evaluations include reviews of:

- General Corrosion
- Pitting Corrosion
- End Grain Corrosion
- Stress Corrosion Cracking
- Crevice Corrosion
- Corrosion at Welds
- Microbiologically Induced Corrosion (MIC)
- Fatigue/Corrosion Fatigue
- Vapor Phase Corrosion
- Erosion
- Galling
- Fretting/Wear

- Galvanic Corrosion
- Cavitation
- Creep
- Inadvertent Addition of Nitric Acid

3.1 Heat Exchangers

Corrosion Evaluations for process heat exchangers address both the process and cooling sides of the heat exchanger.

In tube heat exchangers the shell has a suitable corrosion allowance based on the shell material, the design life of the heat exchanger, and fluid contained by the shell. The corrosion allowance of the tubes can be zero where provisions have been made to replace the heat exchanger and/or tubes when adding material to the tubes will greatly increase the heat transfer resistance, and the size of the heat exchanger.

3.2 Pumps

Corrosion Evaluations are prepared, as required, for the containment boundaries of the pump. For pumps containing dangerous waste, where more wear can be expected due to higher velocities. Corrosion Evaluations are prepared to ensure that the materials specified are consistent with the expected chemistry, pH, temperature, process conditions, and expected design life. Based on the design life of centrifugal pumps, the less easily replaced volute casing has a larger corrosion allowance than the impeller, which may have to be replaced as the efficiency of the pump decreases.

3.3 Piping

Because of the detailed corrosion analysis done for each vessel and the large number of pipes entering or leaving each vessel, a conservative approach has been used. This approach is to construct ancillary equipment downstream of a source vessel of the same material as the vessel and with the same or greater corrosion allowance. If the service seen in the downstream line warrants a different material or corrosion allowance, approval from the Materials Engineering Technology (MET) group is required.

Some exceptions to this philosophy include offgas lines or liquid pipelines exposed to multiple liquids or piping exposed to the same waste stream as the vessel but for shorter periods of times and at the same or lower temperatures as the vessel. Under these conditions, a less resistant material or lower corrosion allowance may be acceptable with approval from the MET group.

Drain piping that drains to vessels are typically 316L stainless steel. This is based on their limited use and flushing after use.

Exceptions are made for extremely long lines, such as for transfer lines between facilities that will be flushed and, if needed after an acid transfer, flushed with alkaline solutions after each use. Exceptions can also be made if the component is maintainable, or if the transfer pipe is double contained within a suitable outer epoxy coated pipe constructed of a different material. In those cases, the alloy selected may be slightly less corrosion resistant but fully qualified for its use and expected life. If the restrictions given for an exemption cannot be met or the specified alloy is not available, then a more corrosion resistant alloy, as specified on the Corrosion Evaluation for the vessel, may be used. Steam ejectors and steam piping located in some vessels as well as the downstream lines that are subjected to an elevated temperature may need to be fabricated from the more corrosion resistant Hastelloy® C-22.

Material selection for piping components, such as valves, fittings, and flanges, is consistent with the material selection for piping, and are identified in the piping class sheets. Components are typically constructed of the same (or better) material as the pipe of equal or greater wall thickness. In some cases valve materials are substituted when valves are not available from the manufacturer in the same material as the piping (e.g. 316L substituted for Mo-6% or Mo-6% substituted for C-22). Valves are able to be replaced if needed. Any deviations from the recommended material or corrosion allowance will be reviewed by the Materials Engineering Technology (MET) group and documented in the approved design.

Several high performance materials, erosion and corrosion resistant, are used in the WTP piping systems. These include:

UNS No.	Trade Name	Typical WTP Application
S30403	304L	air, water, reagents, nitric acid, waste, some vent systems
S31603	316L	air, water, dilute nitric acid, waste, vent systems
N08367/N08926	6% Mo	halogenated, acidic waste
N06022	Hastelloy® C-22	halogenated, acidic waste at elevated temperatures
R50400	Ti-2	equipment for canister decontamination using cerium nitrate
N06690	Inconel® 690	high temperature areas such as melter offgas
N06625	Inconel® 625	high temperature areas such as melter offgas

When chemical compatibility is not a question, but erosion is a concern, additional erosion allowances will be specified.

Slurries without glass formers:

Generally the corrosion resistant alloys, i.e. stainless steel, 6% Mo, and C-22, are also resistant to erosion when the slurry velocity is less than 12 feet per second and undissolved solids content is less than or equal to 2 wt %. In this case the erosion allowance is 0.011 inch for a 40 yr allowance.

When the undissolved solids content is greater than 2 wt % but less than or equal to 27.3 wt % the erosion allowance is 0.048 inch for a 40 yr allowance.

When the velocity and/or undissolved solids content is greater or other materials of construction specified, the erosion allowance shall be justified by calculation.

In addition to the required erosion allowance a corrosion allowance of 0.024 inch is used.

Slurries with glass formers:

When slurry velocity is less than 10 feet per second, a 40 yr erosion allowance is 0.125 inch for stainless steel and nickel based alloys, based on the wear tests in piping from sharp silica sand, with a weighted mean average diameter of 21 micron, a solids concentration of 60 wt%, and multiplied by 2 to account for bends and fittings. The expected wear is a synergistic combination of both erosion and corrosion. When velocities are greater than 10 feet per second the erosion allowance, or other materials of construction, shall be justified by calculation.

4 Application of the Information

The lowest acceptable piping materials are shown on Material Selection Guide drawings which depict the materials for major process lines. A piping class that is consistent with the material shown on the Material Selection Guide, the process fluid code, and the solids content of the fluid are shown by the piping class for each pipeline on the Piping and Instrument Diagram (P&ID). As part of the check procedure to ensure that the correct material has been chosen, the P&ID and any subsequent material changes are routed through the MET group as required to ensure that the piping class chosen meets the required material and corrosion allowances.

Changes of materials on the P&IDs and proposed by Construction through field change requests or vendors through supplier deviation disposition requests are evaluated by MET and by Environmental and Nuclear Safety (E&NS) for potential permit impacts in accordance with permit condition III.10.C.9.h. Equivalent or superior material substitutions will be made in accordance with permit condition III.10.C.10. If Washington State Department of Ecology (WDOE) determines that a substitution is not equivalent or superior, the material change is unacceptable, or that the original material or equipment will have to be used, then a permit modification request will be submitted.

5 Summary

1. Ancillary equipment is fabricated from the same material, or better, as the source vessel unless otherwise specified by the MET group, and accepted by WDOE in accordance with permit condition III.10.C.10.
2. The corrosion allowance used for the ancillary equipment is the same as that of the source vessel unless the MET group determines that the service seen in the downstream line warrants a different material, corrosion allowance, or other modification.
3. Any exceptions to previous item 1 or 2 are evaluated by the MET group and may result in additional operating restrictions.
4. As part of the check procedure to ensure that the correct material has been chosen, the P&ID is routed through the MET group as required to ensure that the piping class chosen meets the required material and corrosion allowances.