CORROSION ENGINEERING SPECIFICATION FOR INSTALLATION

SPECIFICATION FOR CONCRETE VESSELS DESIGNED TO RECEIVE BRICK OR MEMBRANE AND BRICK LINING

1. VESSEL DESIGN

1.1 The design of the concrete vessel shall be in accordance with and follow completely the best practices of concrete construction as recommended by the American Concrete Institute or the Portland Cement Association. The slab on which the vessel rests shall have sufficient reinforcing and strength to float the vessel without any deflections no matter how unstable the ground may be below the slab. The walls, bottom, and reinforcing shall be designed in sufficient size, thickness, and strength, to hold without any deflection of the walls liquid of specific gravity of 1.7 at a level of not less than 6" from the top of the vessel, except that if the vessel is to empty through a weir or overflow, the level shall be 1" above the level of such weir or overflow.

1.2 *Concrete Vessel Contours* - The design of the sides of rectangular or other straight sided vessels shall conform to one of the following, preference in order given.

1.2.1. All walls shall be bowed outward so that the walls form a continuous curve outward from corner to corner, the distance between opposite walls being greater at the midpoint than at the ends. The amount of bow outward shall be 1% of the length of the longer side and 2% of the length of the shorter side, but in no case less than 1½" or more than 6" out of a straight line, measured at the midpoint. In tanks with near square configuration the percentage should be between 1% and 2%. The curve shall be uniform for the full depth and be the same at the bottom as at the top.*

* Where excessive thermal shock or pressure shack may be anticipated, percentage of the bow should be increased to 4% of any

side. If the designer anticipates excess thermal or pressure shock he is invited to discuss the service conditions with Corrosion Engineering.

1.2.2. All walls shall be smooth and completely flat (except that an outward bow will be acceptable and an inward bow unacceptable), and shall slope outward (batter) with a slope of 7½° to 10° outward from bottom to top so that the lines are essentially straight but the inside dimensions are greater at the top than at the bottom.

1.2.3 All walls shall be dead straight and vertically true and plumb. Any bow or lean inward of any portion of any wall from bottom to top shall be adequate reason to reject the tank until the condition is corrected. An outward bow shall be acceptable providing that it is part of a continuous and uniform curve, and that no part of the wall includes a reverse curve.

2. MEMBRANE SELECTION

2.1 The selection of the membrane to be employed in the lining shall be dependent on the chemical and thermal conditions anticipated and shall be completely liquid tight. If the tank at any time leaks it is, of course, prima face evidence that the membrane is not continuous.

3. BRICK LINING DESIGN

3.1 Selection of the type of brick and type of mortar to be used is dependent on service conditions anticipated. Brick linings are of necessity self-supporting and, therefore, must depend on themselves for stability. The design of the brick lining shall be in accordance with the following guide lines. (Note drawing CED 1026)

3.1.1 In small sump pits and gutters, brick on edge (2¼" or 2½" thick) will be acceptable, provided that the depth of the brickwork is not greater than 2' when the length of the wall is 20' or less, or deeper than 1' if the wall is longer, and further provided that extremes of temperature shock are not anticipated (such as the dumping of boiling liquids on room-temperature brickwork).

3.1.2 In deeper vessels a single course 4" (nominal) lining of "stretcher" courses of brick laid flat is acceptable if the depth does not exceed 6' or the length 30', except that if the walls are bowed as in 1.2.1 above

these limitations are void. Some special exceptions with design modifications may be made, if the vessels are to operate only at ambient temperatures and not subject to thermal shock.

3.1.3 In vessels deeper than 6' or longer than 30' where thermal variations much beyond ambient are to be anticipated which are designed as in 3.1.1 or 3.1.2, two courses, each of a nominal 4" thickness, to a total thickness of 8" or more, are required.

3.1.4 In all cases where the brick lining is to supply thermal protection to the membrane, the required thickness to provide that insulation shall be computed and specified.

3.1.5 Where excessive mechanical abuse is anticipated, the thickness of the brick lining shall be increased accordingly over the minimums indicated in 3.1.1 through 3.1.4.

3.1.6 In no case shall a brick thickness less than 2¼" be acceptable in the design of any vessel lining.

4. Expansion Joint and Shear Pads

4.1 Masonry linings require expansion joints to provide for both (a) irreversible growth of all domestically produced shale or fireclay type brick to a maximum of 0.16% of any dimension and (b) expansion and contraction of the masonry under thermal changes. Without considering (b), provision for expansion of up to 0.38" must be made for every 20' of length, and consideration of (b) is in addition to this. Expansion in vessels up to 30' or slightly more can often be provided for by padding of the ends of the vessel with compressible pads. In extreme cases and in large vessels, interlocking expansion joints should be provided. These will be detailed below.

Provision for thermal expansion and contraction shall be in addition to the provision required for brick growth and shall be computed from the anticipated maximum thermal changes, the coefficients of thermal expansion of the materials of construction, and the Delta T of the layer in which the material is employed. Joint must be double the size of the anticipated movement.

Where walls are bowed as in 1.2.1, expansion joints in walls can frequently be omitted. However, where thermal variations exceed 150°F and the vessel walls exceed 50' it is important to compute internal stress build up

under extremes of temperature and irreversible growth to be sure that the internal stresses do not exceed the compressive strength of the brick-mortar combination or the tensile strength of the concrete wall. If stresses are dangerously high, expansion joints should be provided. Expansion joints shall be installed as follows:

4.1.1. End Pads - Preferably by padding the ends of the vessel with sponge rubber or other compressible material selected to meet the anticipated conditions. The full end of the vessel should be padded with the pad adhered to the membrane. The areas that will receive the thrust of the ends of the walls and floors should be padded with firmer padding than the rest of the tank end so that compression at that point will not be translated into internal pressures at the center of the wall. Pad should be thick enough so that a compression of 50% will satisfy the full anticipated movement at that point.

4.1.2 Wall Joints - Where walls are so long that to satisfy expansion requirements the pad must be thicker than 1", additional expansion joints must be built into the walls. These should be not larger than ¼" and there should be a sufficient number of them equally spaced to accommodate all anticipated movement without leaving residual stresses in the brickwork.

4.1.3 Location of Joints Relative to Fixed Points - All fixed points (drains, thermocouple thimbles, pipe, and other penetrations though the tank walls, etc.) must be points of no movement. If this is not so planned, movement of the brick will either shear off outlets, pipe, etc.,or the brick wall will spall, but in all cases, leaks will be created through the lining.

4.1.4 Plain Expansion Joints - In nominal 4" (or single course) linings, straight line expansion joints shall be installed. These run from the top of one wall, down to the tank floor, across the floor, and up the other side to the top in one continuous line. The joint shall be a nominal ¼" wide, run from the face of the brick back to the membrane, and be filled with a compressible material selected for the environment.

4.1.5 Interlocking Expansion Joints - In multi-course linings, the ¼" expansion joint shall be interlocking, that is, follow the brick contours, but in each course following different joints so that no portion is continuous front to back. Between vertical courses, and the

lengthwise joints between the brick in each layer a ⅛" shear pad, such as a unvulcanized sheet rubber shall be installed so that each module of the brick wall can move independently, sliding over its contact brick. As in Section 4.1.4, the joint shall be from membrane to outer brick face and continuous from top of one wall, across bottom to top of opposite wall.

4.1.6 Shear Pads - In large heated tanks a shear pad ⅛" thick (such as unvulcanized rubber) shall also be supplied to separate the capping of the tank from the lining, so that the lining may be free to move without disrupting the capping on the wall top or veneer outside of the tank. However expansion joints to provide for brick growth should still be supplied for cap and veneer, though they need be neither as frequent nor as large as those inside the tank.

4.1.7 Outlet Sleeves and Service Piping - Growth and heat expansion will also take place vertically, and must be provided for where the wall is penetrated by outlets or service piping, or other fixed objects. The principles of the expansion or squeeze joint given above may be employed to prevent the shear of such services. If the calculated movement is not too great the outlet may be sleeved through the masonry with a flexible sleeve such as Teflon to permit this movement without disrupting the membrane.

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5.2 Please contact Corrosion Engineering for specific recommendations at +1-610-833-4000 or fax +1-610-833-3040.