bcc C. Paton/G. Fague
1800 D. R. Hansen
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November 1, 1972

Mr. R. N. Soderlind
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Camas, Washington 98607

Dear Mr. Soderlind:

In answer to our telephone conversations and your letter of September 15, 1972, I have the following response to your questions on the biphenyl bulk storage tank and associated equipment.

1. Varec Flame Arrestor, 4"-Fig. 50SG-assure that this model is jacketed or steam traced and insulated to preclude crystal blockage. We use 10 psig steam jacketing and tracing in our plant on a similar device from Protectoseal and have not experienced crystal blockage. Steam tracing, 3/8" copper tubing, is applied to the nozzle supporting the flame arrestor and to the non-jacketed outlet of the device.

2. Concerning heat transfer coefficients: a conservative condensing coefficient for low pressure steam of 1000 Btu/hr. sq. ft.°F is used assuming minimal condensate loading or flooding of steam coils.

   For a steam coil in molten biphenyl, non-agitated, an overall design heat transfer coefficient of 25 to 35 Btu/hr. sq. ft.°F is adequate for a loose or stacked coil such as a pancake or vertical helical type. We use dual vertical helical coils in one large biphenyl storage tank and find them to be very effective. Pancake coils have been used as have external plate coil types to maintain molten products in storage tanks.

Heat transfer coefficients for external plate coils without a heat conducting cement are 50 to 75% of the above internal free connection coils. I prefer the internal coil for insulated bulk storage tanks - better utilization of heat for high melt point products and some natural convection effect to aid heating the biphenyl. Overall heat transfer coefficients for crystalline biphenyl on steam coils is 20 to 25 Btu/hr. sq. ft.°F assuming intimate crystal contact with the heating coil. The initial melt tends to improve surface contact and increase slightly the film coefficient.

3. Electro-wrap, electric heating tapes or strips, are less preferred than steam coils for storage tank heating. Surface temperatures are more difficult to control unless sophisticated and costly equipment is used. Too high a surface temperature >90°C will cause discoloration of biphenyl in storage which is undesirable for some applications. Steam, with pressure regulation, can be simply adjusted to achieve the desired heat input whether melting or maintaining molten biphenyl. The use of internal steam coils, while most effective, may not melt biphenyl at the cooler periphery or at some nozzles on the storage tank. Electrical tracing, of course, can reach these points, but must be more extensive than nine turns of tape you suggest on the 10,000 gallon tank or the twenty turns suggested on the 20,000 gallon tank. Local steam tracers would be more effective in my opinion. The use of electric heating tape on long transfer lines may be more convenient to install than steam tracers. Another objection I have to heating tape is lack of mechanical strength and abrasion resistance. Of course long steam tracers can freeze up, but I prefer the steam tracers.

4. After much deliberation, I agree that the Fisher, Type 252V, high level control is adequate. Some concern was expressed over possibly crystal formation at the fulcrum of the float, thus impairing its operation.. Assure the switch area is properly insulated against heat loss and consider a wrap of tracer on the adaptor nozzle.

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5&9. I calculate heat loss from the ten foot diameter tank at 23,900 Btu/hr. considering 2 inch Urethane insulation, zero°F ambient, 10 mph wind effect and 190°F internal temperature and ignoring bottom heat losses.

For the 12 ft. diameter at above conditions except heat loss on all sides, I calculate 14,200 Btu/hr.

The proposed Electro-wrap at 9.8 and 5.5 KW on the respective tanks seems just adequate to hold tank temperature, but inadequate to melt completely solid tank contents in less than 43 days in the smaller tank and 41 days in the larger tank. Additional heat would be required should melt of crystalline tank contents ever be necessary. Another reason why I favor internal steam coils is that melt out of the core is quick compared to less efficient periphery melt making product more readily available in the event of crystallization of the biphenyl.

6. On Urethane insulation, both preformed sheets and spray-on type, 2" thick, are adequate. Urethane insulations have a 225°F decomposition limit which may be a consideration when used with external heating, especially electric tape. Both types require support clips or rods to hold insulation to the tank surfaces. The preformed sheets allow subsequent maintenance with ease of replacement and the use of Monel bonds provide a more stable installation.

I've attached information of both types of urethane systems for your information. My personal preferance is preformed sheets with metal bonding. Cost tends to be greater, but the insulation system is more stable and serviceable.

7. Rupture discs are an added and sometimes necessary pressure protection on storage tanks. I would suggest a Teflon protected, metal rupture disc or a carbate (graphite) type disc. Either are satisfactory. The nozzle containing the disc should be traced and insulated to prevent accumulation of biphenyl crystals below the disc.

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My calculations for ¼" thick wall, mild steel tanks show a 40 psig rupture disc on the 10 ft. diameter tank and a 30 psig rupture disc on the 12 ft. diameter tank. These values are lower than stated in your letter.

My pressure ratings are based on 70% longitudinal welded joint efficiency and 13750 psi tensile strength on wall metal using ASME formula for pressure vessel shell thickness.

8. All valves and transfer piping runs should be traced and insulated. We prefer single parallel steam tracing, 3/8" diameter copper tube, on 2" diameter transfer piping. On larger lines we use dual parallel tracers. Steam pressure on this tracing is 10 psig. Our pipe runs are relatively short; on long pipe runs electrical tape may be advantageous, precluding possible steam trap freeze up.

The above comments cover questions in your September 15 letter.

In addition, our phone conversations touched other areas that require comment:

-- toxicity and safe handling of biphenyl; data is attached.

-- 3" standpipe in 10'x34' tank; the 3/8" hole used as a vacuum break seems small and could plug with crystals. Perhaps relocation of the hole to the inside bottom of the tee would minimize potential freeze up, yet not contribute to static electric discharge. We use a fill pipe within a stand pipe or subsurface entry as shown in the 12' diameter tank.

-- We have used the pressure diaphragm type liquid level control successfully provided they are located below liquid level.

-- an 18" temperature probe of the filled bulb or thermocouple type in each tank is adequate for controlling molten biphenyl temperature.

-- Durco, type G-11 plug valves with Teflon seats are satisfactory for biphenyl transfer line valving. Assure that these valves are traced and insulated. I do not recommend insulation of the stem or stem packing nut on valves.

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-- The Model LQ34V, steam jacketed Viking transfer pump should have Teflon impregnated asbestos or Union Carbide's Grafoil packing as the shaft seal material.

-- Molten biphenyl tank cars are well insulated and hold temperature for long periods. We have not seen a solid car, but have seen accumulation of about one foot of crystals on the walls of the car. This crystal accumulation will melt down in less than 24 hours with 80 psig steam on the tank car coils.

-- Steam coils in the cars will hold up to 150 psig steam pressure.

-- Molten biphenyl cars are top and bottom unloading. Top unloading is through a dip pipe. We use 30 psig dry plant air or nitrogen pressure to top unload. It may be necessary to melt crystalline material in the car stand pipe with a steam coil bayonet prior to unloading. Air pressure can be used to assure unloading line is clear prior to unloading car. Care should be exercised in melting product in the stand pipe to avoid liquid eruptions from bottom melted biphenyl.

   Cars can also be unloaded top or bottom with positive displacement pumps such as the Viking called out on the material list. Initial air pressure may be required to prime the pump for top unloading. If bottom unloading is desired, I suggest you request a 2" bottom cock on each bulk car to aid in unloading.

   Internal steam coil connections on the cars are either end or center located. We have no standard and some flexibility must be allowed on steam supply connections.

   A caution: the car top platform or unloading area can become very slippery should biphenyl spills occur, particularly when wet with water.

Attached is one copy each of your flow diagram and materials list. I'll retain a copy of each for reference in the event you have questions.

I hope the brief delay in getting this information to you has not been an inconvenience. Please call if you have questions.

Very truly yours,

D. E. Roush
Technical Manager
Process Fluids

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Enclosures
cc Mr. J. P. Blaschka

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