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Interoffice Communication

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To John Friend, Oklahoma City, Oklahoma

From Walter R. Finch, Ponca City, Oklahoma

Date December 17, 1979

Subject Hydrotest Procedure for PVC Reactors

It has been recommended that the PVC reactors be hydrotested at 90 percent of rupture disc setting when installing a new rupture disc and perhaps thereafter on some set schedule. This is to decrease the chance of a VCM release due to premature rupture disc failure. It has also been recommended that the hydrotest be done with a gas blanket (as opposed to a liquid full system). This is to decrease the chance of a disc reversing but not bursting which could cause the disc to fail at higher than set pressure. Recently a six-inch disc from Oklahoma City reversed and when tested did not fail until 354 psig.

To accomplish these objectives, the following hydrotest procedure is proposed.

1. Fill the reactor about 95 percent full using charge water pumps (143 M Lbs at 140°F).

2. Pressure the reactor to 100 psig with N_2. This will require 3 or 4 standard cylinders.

3. Finish the hydrotest using HPSW per existing procedure. At 30 gpm water flow rate, it will take an additional 10-15 minutes to reach 165 psig which is 90 percent of the lowest rupture disc setting (185 psig).

When using this procedure, all condenser flanges and the top manway must be leak tested with soap.(1) It is suggested that the nitrogen be bubbled through the water when added to help saturate the water. This should minimize the loss in reactor pressure due to diffusion of nitrogen into the water.

Nitrogen is used instead of air to pressurize the reactor. This will prevent an explosive mixture in the vapor space in case of a VCM leak. Plant air could be considered if the reactor had been monitored for VCM while changing out the discs with no indication of any leaks; however, air usage will always involve some hazard.

Calculated large reactor volume is around 2500 cubic feet. Condenser volume is 65 cubic feet and top head volume is 217 cubic feet.

(1) The top manway and condenser bottom flange may be under the water level under some circumstances. They should be checked for water leaks before soaping.

This procedure calls for filling the reactor with water (via the charge pumps) 2/3 of the way into the top head. The remaining vapor space is 135 cubic feet or five percent of total reactor volume.

The time required to pressure the reactor (following 95 percent water fill and nitrogen pressurization) can be calculated using the following equation:

$$P = \frac{nRT}{V-WT}$$

where P = Reactor pressure (psia)
n = Moles of gas in reactor vapor space
T = Vapor temperature (°R)
R = 10.731 (Ft^3-Lb_f/In^2-Mole-°R)
V = Initial vapor volume (Ft^3)
W = HPSW flow rate (Ft^3/Min)
T = Filling Time (Min)

Using this equation, pressurization times for several initial conditions were calculated:

Case	A	B	C
Vapor Temp, (°F)	60	60	60
Initial Vapor Volume (Ft^3)	135	135	135
HPSW Flow Rate (gpm)	30	30	30
Initial Pressure (psig)	0	50	100

Time, (min)	Press, (psig)	Time, (min)	Press, (psig)	Time, (min)	Press, (psig)
0	0	0	50.0	0	100.0
10	6.2	10	77.2	5	119.9
20	21.4	20	144.1	10	148.3
30	117.7	21	156.6	11	155.4
31	165.9	22	171.1	12	163.3

Thus if no nitrogen is added to the system (Case A), the reactor will pressure slowly during HPSW injection for 30 minutes and then suddenly shoot up. This combination of long pressurization time and sudden pressure increase will likely lead to operation error. Pressurizing to 100 psig with N_2 before HPSW injection, shortens pressurization time to a more practical twelve minutes and reduces the rate of pressure increase at the end to 8 psi/minute and is therefore recommended.

The reactor can be filled into the top manway with the top manway open, thus insuring a constant fill amount. Alternately, the charge water counter can be used. The system response for a ± 2 percent error in charge water meter calibration has been calculated.

Case	A	B	C
Vapor Temp, (°F)	60	60	60
HPSW Flow Rate (gpm)	30	30	30
Initial Pressure (psia)	100	100	100
Meter Error (%)	-2	0	+2
Initial Vapor Volume (Ft^3)	182	135	88

Time, (min)	Press, (psig)	Time, (min)	Press, (psig)	Time, (min)	Press, (psig)
0	100.0	0	100.0	0	100.0
5	114.2	5	119.9	5	133.7
10	132.3	10	148.3	6	143.0
15	156.4	11	155.4	7	153.5
16	162.2	12	163.3	8	165.5

Thus at ± 2 percent error in charge water addition, pressurization time will vary from 8 to 16 minutes and pressurization rate from 6 to 12 psi/minute.

Finally, nitrogen requirement to pressure 135 cubic feet to 100 psig is 2.42 moles or 918 SCF. Another 300 SCF may be required to saturate the water. Total nitrogen requirement is 900-1200 SCF or 3-4 standard cylinders.

Following hydrotest, the reactor should be depressured before starting to drain water to the sewer. Otherwise, the water flow rate would likely overload the sewer. The reactor atmospheric vent can be used to vent nitrogen although this needs to be checked for both water carryover and noise. If operations find during the field check that the reactor vent is not appropriate, alternate vent methods can be examined. Reactor drain rates following venting will be same as existing.

If you have any comments or questions on the suggested procedure, please call me.

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