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## **Question 53: What are your Best Practices used to minimize the time needed to prepare a crude storage tank for safe entry?**

**WEBER** [Marathon Petroleum Corporation (MPC)]

The biggest obstacle, in my mind, to gain entry a crude tank is the accumulated sludge and solids. There are several strategies operators can use to attack that issue. The first strategy is to keep the sludge from accumulating during normal operation. For most MPC refineries, we try to keep our crude tank mixers running as much as possible. Occasionally, we will shut them down to dewater as needed; but for the most part, the mixers are operated continuously. If the tank mixers have been off for some period of time and there is accumulated sludge, caution must be used when turning on the mixers to avoid sending a high concentration of solids to the crude unit. What can be done in this case is to pull the tanks down as low as possible (close to where the tank roof lands), turn on the mixers and then inject the crude/sludge mixture at a low percentage to the crude unit. Typical injection would be about 1 to 5% and then increasing the percentage gradually as allowed by the unit.

The second strategy involves utilizing different methods for reducing/removing accumulated sludge prior to opening. This is accomplished by minimizing the tank bottoms using stripping pumps to pump the sludge either to another tank or to vacuum boxes for oil, water, and solids separation. Following this step, a solvent, such as a lighter crude or light cycle oil from the FCC, is circulated throughout the tank and mixed to dilute the wax or the asphaltenic materials as much as possible. Another method is to heat the tank in order to melt any waxy or asphaltenic material. This was performed successfully at our refineries using external steam heat exchangers, circulating the tank bottoms and solvent, and then heating the mixture up to 150°F. When using this method, the key is to make sure the solvent/sludge mixture is heated evenly from the bottom up. At refineries where this method was used, only a few inches of sludge remained upon entry.

The final strategy I will discuss applies once the tank manways are opened for final decontamination. Water cannons are used to disturb the sludge and liberate any remaining H<sub>2</sub>S (hydrogen sulfide) and hydrocarbon. We use a degassing chemical along with the water cannons. We also inject LCO (light cycle oil) and remove as much liquid as possible before allowing anyone in the tank. We place air movers on the tank manways to remove vapors and achieve a safe atmosphere. For final cleaning after gross decontamination, we continuously monitor the tank atmosphere and require breathing air and appropriate PPE (personal protective equipment) for anyone entering the tank. These precautions are used until the tanks are in a condition for entry to perform inspection and maintenance.

**BI (CARRIE) JIANG** (Forland Petrochemical Technology LLC, an HCpect Company)

I would like to know how you handle high concentration H<sub>2</sub>S (hydrogen sulfur).

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**WEBER** [Marathon Petroleum Corporation (MPC)]

We have used thermal oxidizers with air movers to pull the vapors out of the tank and combust them. The degassing chemicals I mentioned will also help knock the H<sub>2</sub>S into the liquid phase, and then it is pumped out with the remaining water and oil.

**SAMUEL LORDO** (NALCO Champion)

We developed a patented process for tank entry. It is a 21-day process that cleans crude tanks very effectively and deoils the solids so you can minimize sludge production. You also deoil them to the point where you do not have the light hydrocarbon vapors typically associated with the solids. The oil in the sludge is recovered; and actually, in most of the cases when we do the economics, it pays for the cleaning itself. It actually makes a little money for the refinery because you are able to rerun the material that you pull out. We have degassing. As John mentioned, there are degassing chemistries that you follow up with to clean the walls.

**SHRIKANT MADHAV VAIDYA** (Indian Oil Corporation Limited)

I want to know the benchmark time for crude tank major maintenance and inspection turnarounds. Say after 10 years or so, I am giving a crude tank for maintenance and inspection involving total bottom plate replacement. What would be the time required to complete the maintenance and inspection for a tank of, say, 50,000 to 60,000 kiloliters?

**WEBER** [Marathon Petroleum Corporation (MPC)]

That is hard to say. It depends on the size of the tank. I have no idea how much 50,000 kiloliters are, I will be honest with you [laughter]. I am familiar with 500,000-barrel crude tanks. For these tanks, the completion of maintenance and inspection is anywhere from six months to a year. The duration to complete also depends on whether our tank budget will allow us to work six or seven 10-hour days. If there is a high opportunity cost for having the tank out of service, you may want to work more hours or even around the clock. So, six to 12 months is a rough benchmark.

**DENNIS HAYNES** (NALCO Champion)

A correction in the phrasing of the question is that phosphorus-based chemicals are used to passivate process surfaces to minimize corrosion due to naphthenic acids; they do not neutralize the naphthenic acids. Phosphorus-containing compounds have been used for years upstream of many hydrotreating processes without adverse impacts. If greatly overused, there is the possibility that issues may occur, so application protocols and injection system design should be in place to minimize risk with these types of

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chemistries. Process fouling of upstream additives has been reported, and there are sequestration additives that may be used to minimize the number of phosphorus-based additives that would go downstream to hydrotreating processes.

## **JOHN WEBER [Marathon Petroleum Corporation (MPC)]**

Crude tanks that must be taken out of service require removal of flammable and toxic materials before they can be entered for final cleaning and maintenance activities. One of the most time-consuming challenges is the removal of sludge and sediment that accumulate over time while the tank is in service. While each situation and tank configuration are unique, there are several practices used by Marathon Petroleum Corporation (MPC) to minimize the time needed to prepare a tank for entry. These can be divided into three general categories:

1. Minimization of sludge accumulation during normal operation: This is accomplished by keeping the tank mixed by using either mechanical, shell-mounted mixers or jet nozzle-type mixers. Some MPC refineries keep their mixers running at all times, while others shut down to dewater. In some cases, floating suctions have been installed to minimize potential desalter upsets caused by slugs of high solids or water. Where a tank has mixing capabilities that have not been used and sludge has accumulated, the tanks have been mixed offline and then introduced to the crude unit at low (1 to 5) percentages. The tanks are then refilled with crude and the charge percentage increased until the solids are diluted to the desired point.
2. Removal of sludge/wax prior to opening the tank manways: With the tank offline, stripping pumps are typically used to remove as much of the material as can be pumped out of each available nozzle. The material can be pumped to another tank for reprocessing or to vacuum boxes for oil and solids separation and recovery. After the initial pump-out, a solvent material such as FCC light cycle oil can be used to “cut” or dissolve the remaining material by partially filling the tank and then circulating and mixing. One MPC refinery has successfully used a portable heat exchanger to heat the circulating crude/solvent mixture up as high as 150°F to melt any waxy material and help separate oil from solids.
3. Removal of sludge and flammable/toxic vapors after tank manways have been opened: Prior to entry, additional cutter stock is used to dilute and suspend remaining solids and sludge and pump out to vacuum boxes for further processing. Water cannons and degassing chemical are used from the manways to disturb sludge piles and release any trapped gas. Air movers are used, along with thermal oxidizers (as required), to ventilate the tanks, remove flammable/toxic gases, and ensure that the atmosphere is not oxygen deficient. Multi-gas monitors are used with tubing to test the tank atmosphere across the cross-section of the tank.

Careful preplanning and coordination are required among the Operations, Maintenance, Safety, and

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Environmental groups to develop and execute a plan that minimizes downtime while ensuring the safety of everyone involved.

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