Total Solvent Plant Safety

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ABSTRACT

Plant design should consider and avoid deficiencies in the critical areas of conveying, condensing, vessel design, separation sump, etc. Ask your process engineering company or manufacturer hard questions. Review your design criteria with operating personnel, get their input. Critical safety devices can provide a minute-by-minute surveillance of crucial areas; those parts of the process that can generate the potential dangerous problems. Supervisor and operator training needs constant review. Be sure the operator thoroughly understands the process, including the reasons for and the functioning of the instrumentation and automation provided. Define limits of authority, control potential hazards by using a permit system, investigate all unsafe incidents, and make a careful analysis that will result in proper corrective action. Good management makes safe plants.

Anyone can contribute positively or negatively to a successful total solvent plant safety program. Ten basic contributors to solvent plant safety are:

Physical plant: (a) Process design, (b) equipment design, (c) critical vessel design, (d) instrumentation/automation, and (e) critical safety devices.

Plant operation: (a) Critical task instruction/training, (b) defined authority and responsibility, (c) permitted work (system), (d) incident investigation, and (e) safety management evaluation.

I have deliberately left out fire protection systems and portable extinguishers. In my opinion they are essential to the protection of the solvent plant, but only after a crisis exists. Before the crisis, one must diligently practice good safety management which is involved in each of the ten basics above.

Solvent plants are built for continuous operation. Emergency downtime results in process upset and is a potential cause of unsafe conditions. Emergency stops are inevitable, from very frequent during the inauguration of the plant to very infrequent as the bottlenecks are corrected and operators are trained. By avoiding design weaknesses in key areas, lengthy stops and unsafe situations can be avoided.

Critical design considerations include:

Conveying: Chain conveyors, screw feed conveyors, and screw discharge conveyors.

Condensing: Surface, and water temperature and volume.

Vent system: Physical size, duct size, and pressure drop.

Desolventizer: Horsepower and reducer size, and design strength.

Solvent water separator: Adequate volume separation, amply sized hexane overflow, and phase monitor.

Waste water boiler: Design, and temperature monitor.

Separation sump (containment basin): Design, size, and level monitor.

In my experience, conveying (transport equipment) is the greatest cause of emergency downtime. Undersized and underpowered conveying, while in itself not a safety hazard, provokes other situations that can be.

Condensing, particularly the main condensers off the desolventizer and distillation, can absorb considerable heat without exaggerated system upsets resulting from dramatic increases in miscella flow rate or flake load to the desolventizer, provided they are designed properly. (Rule of thumb sizing I will leave to the manufacturers.) Overpressure within the system caused by hexane vapor and/or steam within the vent system due to rapid plant start up, or drastic flow rate changes, or physical blockage in the vent system or shortage of water can result in unsafe conditions. Amply designed condensing, venting and ducting will permit modest system upset. Ask your process design people what criteria have been used in your individual case.

Vent systems designed to recover, to the greatest extent possible, final traces of hexane can introduce system backpressure when absorber and duct sizes are marginally sized. This condition often requires supplementary equipment to induce vapor flow (e.g., fans or ejectors).

The desolventizer should be able to start under normal load. Underdesigned shafts, sweeps, reducer and motor can result in manually cleaning the desolventizer and exposing personnel to hexane vapor in the event of emergency stops. Or, the operators will run the desolventizer lower than prudent to facilitate the start up and risk producing underdesolventized meal.

Solvent water separator operation is simple and automatic once the basic design has been proven effective. Process manufacturers normally supply their own particular system. However, consideration should be given to providing ample time for decanting and a method to avoid internal or vent system pressures from pushing the water level seal out. The consequence is liquid hexane leaving with the water. Also, the hexane overflow return to storage should be designed to handle the maximum output of the hexane pump(s) from storage.

Waste water boilers are designed to clean up the water leaving the solvent plant by removing and recovering the last traces of hexane. It should be designed like a stripper and provided with temperature monitoring to ensure that the temperature of the existing water is well above the boiling point of hexane.

Recently, separation sump or containment basin design has been the focus of much attention. Size recommendations are one and one-half times the largest volume of hexane or miscella contained within the solvent plant. Suggested designs are at least two compartments with some empty reserve capacity for decanting the lighter phases, oily hexane or miscella. The prime consideration for any design should be to provide adequate time for light phases and water to separate in case of emergency spills and to contain these light phases in the safe area on the owner's property.

Extractors vary so greatly in design that it is important to discuss safety as well as efficiency considerations with the manufacturer, particularly when it is a first purchase. Important safety considerations would be facility to drain, clean and purge (air/steam), as well as recommended or installed safety devices such as limit switches, clutches or level indicators. Consider high liquid level overflows. If the extractor should break down under load, how can it be safely emptied and repaired? Are critical parts accessible?

Critical safety devices, in my estimation, are similar to but serve a different purpose than the same devices for balance, will alert operators when certain critical conditions of temperature, pressure or flow are being exceeded. This is process safety. Critical safety devices should be designed to help the operator monitor critical parts of the process or specific equipment and alert operating management when normal conditions or levels are not within the safe and acceptable control range, including shutting down the plant.

Examples of these would be to monitor hexane content of ambient air on the solvent plant floor and the volatility of vapors in the separation sump area or leaving the desolventizer; to monitor temperatures of exit water from the waste water evaporator or meal from the desolventizer; to monitor critical hexane or water levels in the solvent water separator or separation sump (containment basin); to assure that designed water seals are, in fact, in place; to monitor speed of legs and belts; and to monitor, with pressure switches, adequate process steam and cooling water. All of this leads to obvious and absolute need for thorough and ongoing operator training.

How do operators learn to run the plant and distinguish between the correct procedures and the wrong procedures? So often operators are taught by other operators and I submit that each time this happens, something is left unsaid or untold unless specific operating instructions are provided, specific tasks are identified and written, and management reviews these procedures at least annually and incorporates changes and improvements in the procedure.

For those operators who buy turnkey plants, the engineering company or manufacturer is obliged to provide the start up and training. But training is not only learning which buttons to push and valves to turn, it is why you do it and when, as well as an understanding of what happens when you do. It is understanding what the manometers, thermometers, pressure switches, flow switches, limit switches, rotometers, etc., are telling you or the operator.

Training operators to run the solvent plant safely for maximum production and efficiency or to keep it running after a successful start up requires that management issue specific instructions to operating personnel. Management reacts when meal is off standard, solvent loss is high or energy consumption is up. And there are probably specific instructions issued or policies envoked. More frequently than management would care to admit, there are unwanted incidents which occur in the solvent plant while running, starting up, or during a shutdown for which no safe procedure or action plan has been developed. The lack of a defined policy of authority and responsibility as concerns safety is a failure of management.

Total solvent plant safety is not achieved until unplanned and unwanted incidents that can jeopardize the security of the plant and personnel are dealt with by: defining authority and responsibility; controlling potentially hazardous work (permit program); thorough analysis of unsafe incidents; and safety management evaluation and corrective action.

Management must define the limits of authority for supervisors and operators in any emergency situation. Which of these are emergency situations: opening the instrumentation or automation. Instrumentation is designed to assist the operator to keep his process in balance and produce quality products as efficiently as possible. A side benefit is that instrumentation, by keeping the process in desolventizer to unplug; opening the extractor to clean a sight glass; cleaning out the wet flake conveyor; operating the plant with high vent pressure; operating the plant with low temperature tail water from the waste water stripper; or operating the desolventizer with low deck levels?

In my opinion, these are all emergency situations. Management must first identify unsafe conditions, then establish acceptable limits of safe conduct for all operating personnel. For example, stipulate who has the authority to open vessels containing hexane or hexane vapor. Then communicate these limits of authority to supervisors and operators. Some decisions should be made by top operating management (in some cases the owner), and some by the supervisor, but limits of responsibility and authority must be clearly defined.

The permit *system* provides the control required to assure management that employees do not overstep their authority when confronted with potentially hazardous situations that could jeopardize property and the lives of personnel. This system of control does not strip authority from supervision—rather, it places the decision-making responsibility at the proper level. Top management becomes involved with the problem and is a part of the decision making.

Permits are used in daily operations and are designed to communicate to management that unusual work is being performed and who is responsible. It assures management that the task will be performed in the safest manner because of the step-by-step checklist and the signed authorization required.

Permits are issued for but not limited to: vessel entry, bin tank entry, opening equipment containing hexane (liquid or vapor), purging vessels, and cutting and welding.

Thorough incident investigation, whether it involves personal injury or property loss, can be an important tool and an aid to preventing recurring incidents. Management and supervision too often look for the obvious answer when accidents occur, e.g., the operator was careless, he did not use the right procedure or he was in a hurry. Maybe the real reason for the unsafe act or situation was that he was not properly instructed, he was placed in a situation where the right procedure would have been to stop the plant, but he did not have the authority or he hurried because the control valves were very inconveniently located, requiring several trips up and down stairs.

Management must approach solvent plant safety in the same way as they approach decision-making in other areas of the business. Make sure the person in the plant making the decisions is authorized and qualified to make them. Take corrective action immediately to resolve problems or conditions revealed by the incident investigation. If operators do not know, they must be instructed. Make a list of the critical tasks the operator must perform and write simple step-by-step proper task procedures. Use them for training. Define the limits of the operators and supervisors beyond which they must call for advice, guidance and/or permission to proceed. Plant breakdowns or emergency stops that could develop into a major crisis require this type of discipline.