TECHNIQUE TO PERFORM PETROCHEMICAL COMPLEX WIDE

INADVERTENT CHEMICALS MIXING AND REACTIVITY STUDY

Typically, the hazards of inadvertent mixing are studied within the boundaries of individual plants, while ignoring the credible scenarios of cross mixing from Plant A to Plant B within the same Petrochemical Complex.

Building an inadvertent chemical mixing credibility matrix is a good starting point for ensuring hazards are not missed during process hazard analyses (PHAs) and other risk assessments. Chemicals transported using entirely different methods (truck vs. rail) may be excluded from credible mixing scenario related to unloading, but these chemicals are still concerns for drains & sewers. Likewise, chemicals which have unloading connections very far away from each other, may be excluded as well. Hence, a shortlist of chemicals for credible mixing and hazardous reactivity related to "unloading" scenarios may be made for detailed study. Focus should be on obvious mixing and reactivity scenarios.

TYPES

Chemical Type	Transport Methods	Remarks (*PHA of Procedures can address most inadvertent mixing scenarios*)
Water Treatment Additives	Mostly one way container such as 1 Ton-Eurotainer or tankers	Critical for inadvertent mixing study as these are more likely to be missed in PHA
Process Additives-Liquid Catalyst	Mostly one way container such as 1 Ton-Eurotainer or tankers; sometimes rail	Less critical as mixing scenarios covered in PHA of unloading procedures; but mixing study adds more focus
Raw Material, Product, Intermediate	Mostly piping or Rail	Less critical as mixing scenarios covered in PHA of unloading procedures
Lab Chemicals	Small Packing	Not Critical due to less quantity
Solid Chemicals, Catalyst, Desiccants, Filter Media,	Drums or bags	Not critical for inadvertent mixing
Utilities	Mostly piping	Not critical as mixing scenarios covered in continuous-mode (normal mode) PHA

DATA COLLECTION

#	Unit	Name	1	2	3	4	5	6	7	8	9	10
1	A	Chem-A1	1									
2	A	Chem-A2	✓	2								
3	A	Chem-A3	×	×	3							
4	B	Chem-B1	×	×	×	4						
5	B	Chem-B2	✓	✓	×	×	5					
6	B	Chem-B3	×	×	×	×	✓	6				
7	B	Chem-B4	×	×	✓	×	×	×	7			
8	B	Chem-B5	×	×	×	×	×	×	×	8		
9	C	Chem-C1	×	×	✓	×	×	×	×	×	9	
10	C	Chem-C2	✓	×	×	×	×	×	×	×	✓	10

Credible ✓
NOT Credible ×

Inadvertent Mixing Credibility chart

#	Unit	Name	1	2	3	4	5	6	7	8	9	10
1	A	Chem-A1	1									
2	A	Chem-A2	PU	2								
3	A	Chem-A3	×	×	3							
4	B	Chem-B1	×	×	×	4						
5	B	Chem-B2	U	H	×	×	5					
6	B	Chem-B3	×	×	×	×	C	6				
7	B	Chem-B4	×	×	E	×	×	×	7			
8	B	Chem-B5	×	×	×	×	×	×	×	8		
9	C	Chem-C1	×	×	U	×	×	×	×	×	9	
10	C	Chem-C2	H GT	×	×	×	×	×	×	×	GF H	10

C: Cancer causing
E: Explosion
H: Heat
F: Fire
U: Unknown but hazardous
GT: Toxic gas formation
GF: Flammable gas formation
PU: Process upset

Inadvertent Mixing Consequence chart
(Input from Vendors might be required)

BRAINSTORMING AND RISK RANKING

Method What if

Scenarios to RR Top Credible

Team Process engineer
Operation specialist
Process safety engineer
Chemical reactivity SME
Chemical supplier representative

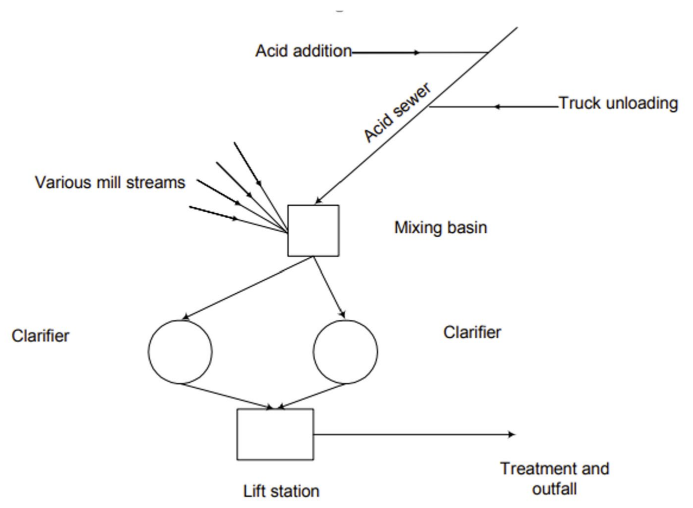
#	Mixing Chemicals	Location	Credibility	Make up Frequency	Causes	Consequences	C	L	R	Safeguards	Recommendations
1	Chem-A1 Chem-C2	Unit C	Credible due to similar mode of transport within same plant and similar transport container (iso tank)	Weekly	Escort mistakenly leads truck to wrong location and connected to tank	Hazardous reaction that may generate heat, splattering or boiling and toxic vapors	Moderate	Likely	High	• SOPs • Operational practices and experience • Labeling • Different nozzles types (Confirm)	1. Improve labeling at both locations. 2. Re-confirm different design of nozzles 3. Consider adding lock and key arrangement for Chem-A1 unloading point

Types of Protection Layers
(beyond administrative controls)

Type	Specifics	RRF	For*	Cost ($K)
Bar Code /Scanner	Bar Code – w/o procedure imbedded; combined with interlocks	3-10	OE/MD	0.1
Bar Code /Scanner	Bar Code – with procedure imbedded; combined with interlocks	3-10	All	0.3
Proof Switches	RFID (radio frequency identification; the reader is hardwired)	100	OE/MD	5
Proof Switches	Proximity Limit Switches (both ends are hardwired)	10-100	OE/MD	0.5
Hardware	Stand-alone valve (spring loaded dead-man valves; for quick draining/venting)	10-100	OE	0.2 to 1
Hardware	Dry disconnects (auto-closing valve on hose end designed to have no leaks on disconnection)	10-100	OE	TBD
Hardware	Automated/interlocked valve (typically to eliminate hose)	100	OE/MD	1 to 10
Hardware	Captive Key	100	OE/MD	0.5 to 1

OE: Open Ended
MD: Misdirected

EXAMPLE CASE



Paper mill sewer system
(CSB Report 20001-1-AL)

Release of H_2S from process sewers resulted in the **deaths of two contractors and injured eight others** (*CSBreport, 2002*). Causes included flaws in the sewer system design, including later connections made to the sewer system which were not properly evaluated as part of the MOC process, as well as several other design, management, and PSM gaps.

Such diagrams and drain / sewer maps should be proactively considered with regards to chemical reactions (weighed against credibility matrices, etc.), especially if scenario of inadvertent mixing could be catastrophic.

CONCLUSIONS

- May reveal hidden risks which may remain undiscovered during PHAs of individual plants
- Building strong Workforce Competency on PSM, including topics such a Reactive Chemicals Management is of paramount importance
- Continuous improvement in training and SOPs is required all the time to avoid chemical unloading incidents
- Emergency response plan and equipment should be reconsidered based on the chemical mixing and reactivity study
- Perform PHA of procedures for loading and unloading to find the scenarios that are unique to these batch operations
- Always adhere to the required PPEs while handling any chemicals, while also ensuring there are sufficient engineering safeguards to prevent releases and mixing
- Outside drivers should not be allowed to do unloading connections, as they may not be fully aware of the nature of inadvertent mixing and hazardous reactivity

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