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| **STREAM** | **PROCESS**  **PARAMETERS** | **DEVIATIONS** | **POSSIBLE CAUSES** | **CONSEQUENCES** | **ACTION REQUIRED** |
| Feed (ST1)  Reactant (ST2)  Catalyst (ST3)  Catalyst (ST4)  Reactant (ST5) | Flow | High  Low  No | Valve failure/fully open  Valve failure/closed  Flow control failure  Flow control sensor  failure  Operator failure  Plugged pipe  Pipe breakage  Empty storage tank | Possible upset in downstream  Overflow  Increased reaction rate  Downstream process backed-up  Pipe damage  Reaction rate Reduced  No reaction  Pump cavitation | Install HA  Install LA  Install check valve  Regular maintenance and calibration  Operator training  Implementation of absorbing material to avoid leaks to ground  Inspection prior to startup |
| Reactant (ST2)  Catalyst (ST3)  Catalyst (ST4)  Reactant (ST5) | Pressure | Low | Valve failure/fully open  Operator failure  Leak in pipe  Plugged pipe  Pumps fails | Possible upset in downstream  MeOH may partial vaporized  Pipe breakage  Pump damage  Pump cavitation | Check differential pressure across valve during routine  maintenance  Fail-closed mechanism  Inspection prior to startup |
| Feed (ST1)  Reactant (ST2)  Catalyst (ST3)  Catalyst (ST4)  Reactant (ST5) | Temperature | High  Low | Excessive heating  Operator failure  Temperature control  Failure  Temperature sensor  Failure  Not sufficient heating  Cooling occurs | Increase pressure  Pipe melt  CH3OH boil  WCO boil  Pump damage  Reduced pressure  Viscosity increase  WCO solidify upon cooling | Install HA + thermo couples  Operator training  Install throttle  Install LA + thermo couples installed  Regular maintenance |