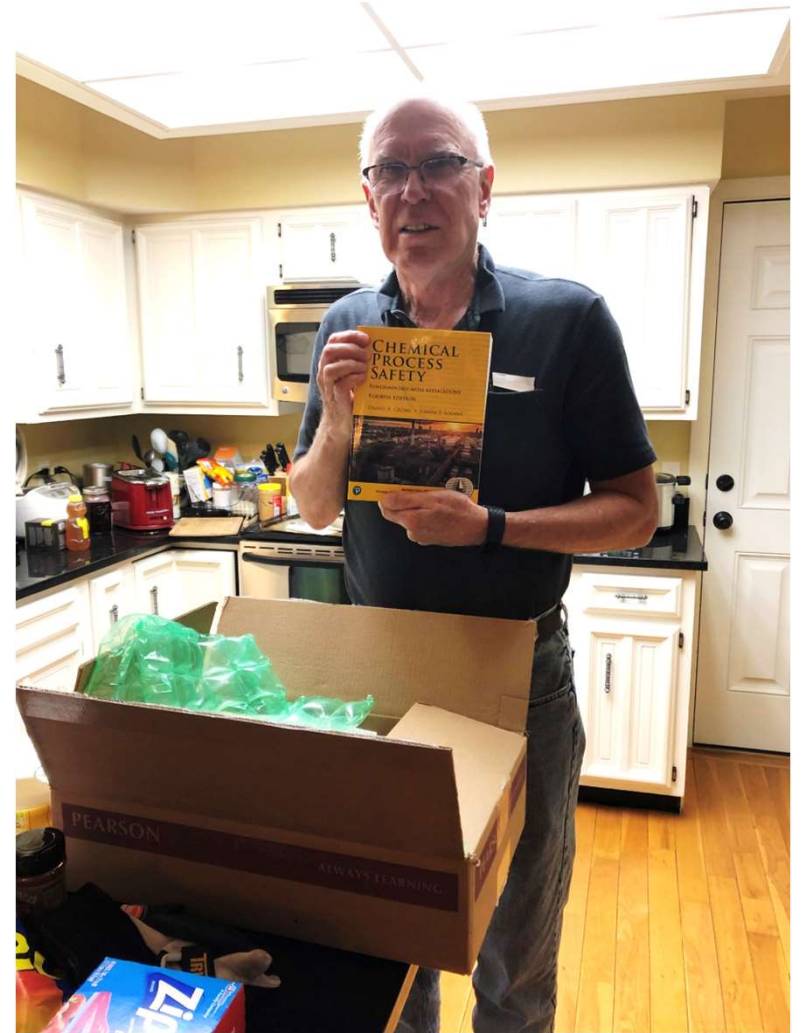


The 5th Edition of *Chemical Process Safety, Fundamentals with Applications*

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Chad Mashuga, Texas A&M
Hunter Flodman, University of Nebraska**



In memory of Joe Louvar, who convinced me that process safety was something I should be involved with!

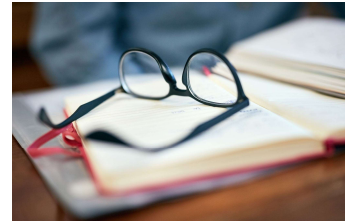
He passed away last December at 88 years of age.



Joe lecturing at a faculty workshop on process safety at BASF.

Textbook Design Constraints

1. Present the content in a progressive style, working from what the student knows to what they don't know. (Prime Directive for Instruction!)
2. Tell a story.
3. Be aligned with current industrial practices.
4. Suitable for use for academic instruction **and** industrial reference.
5. Be fundamentally based showing the derivation of all major equations. **This must be at the same rigorous fundamental level as other courses in chemical engineering.**
6. Versatile for any level class in chemical engineering.
7. Provide lots of references for further study.
8. Contain active content: lots of figures, tables and example problems.
9. Have consistent nomenclature.
10. Contain more content than could be used in a single course, providing the instructor with the flexibility to pick and choose topics.



Death by a thousand paper cuts!

Textbook:

Chemical Process Safety, Fundamentals with Applications.

1st Edition, 1990, 426 pages

Objectives: Develop a workable outline; obtain and develop the technical content; industrially relevant and practical examples and homework problems.

We expected a revolution, which did not occur!

2nd Edition, 2002, 625 pages

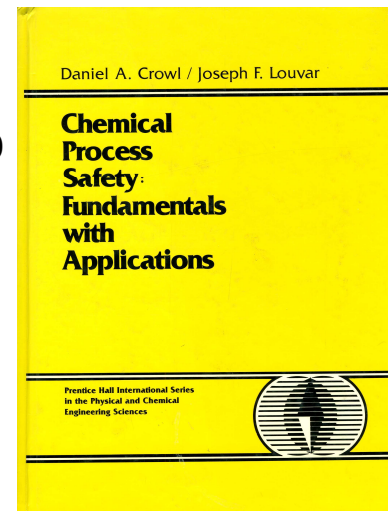
Objectives: Expand content on flammability, including triangle diagrams.

Revisions and additions as required.

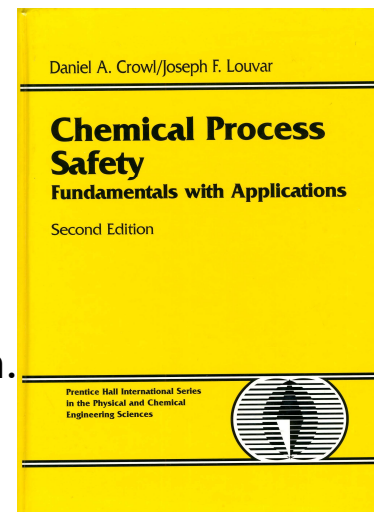
Added additional homework problems.

Retained outline and most content from the 1st Edition.

1990



2002



Textbook:

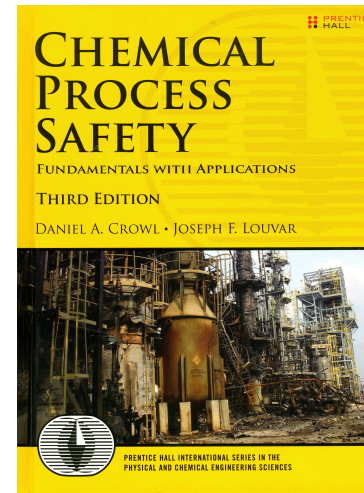
Chemical Process Safety, Fundamentals with Applications.

3rd Edition, 2011, 723 pages

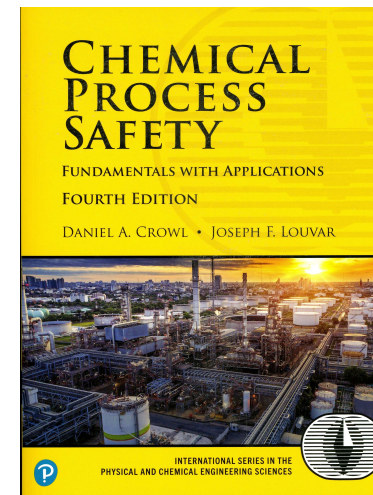
Objectives: Added new chapter on Chemical Reactivity
Revisions and additions as required.
Add additional homework problems.
Retain most of 2nd edition content.

4th Edition, 2019, 628 pages. Paperback!

Objectives: Aggressively updated content to be more aligned
to current industrial practices.
Reduced page count by 100 pages by removing less used content.
Rewrite Chapter 1: Include Risk Matrix, Swiss cheese model with
safeguards, 20 Elements of RBPS, other content.
Specific modest revisions in all chapters.



2011



2019

Overall Objectives for the 5th Edition of *Chemical Process Safety, Fundamentals with Applications.*

1. The technical content from the 4th edition is established.
2. Insure professors have a current, available and relevant teaching tool.
3. Improve instructional / educational format.
4. Bring the content closer to industrial practice.



Threats to all Engineering Textbooks:

1. Illegal knockoffs!
 2. Students not book oriented.
 3. Increased production costs.
 4. Reduced hard cover sales.
- 5th edition will also be published in paper and electronically.
 - Chemical engineering market smaller than other engineering disciplines.

Sustainability and Adaptability of the Textbook

Chemical Process Safety, Fundamentals with Applications

Added three new co-authors to insure the longevity of the textbook:

R&D, Industrial Process Safety and Educational Experience:

Chad Mashuga, Texas A& M



TEXAS A&M
UNIVERSITY

R&D and Educational Experience:

Tracy Carter, Northeastern University



Process and Educational Experience:

Hunter Flodman, University of Nebraska



All three have taught process safety for many years.

Tracy and Hunter have been the faculty coordinators for CCPS faculty workshops worldwide.

Joe Louvar met via Zoom with new authors prior to his passing and gave his blessing!

Educational Objectives of the 5th Edition

- **A simple process safety framework will help students and practicing engineers understand the entire process safety procedure from day 1.**
- **The framework questions are also aligned with industrial practice.**

The framework questions are:

1. **What are the hazards and how are they characterized?**
 - Chemical and process hazards
2. **How are the hazards eliminated or controlled?**
3. **What can go wrong and how?**
 - Develop scenarios.
4. **What are the consequences?**
5. **What is the likelihood?**
 - Likelihood = f (probability or frequency)
6. **What is the risk and is it acceptable?**



The entire content in the textbook will be organized into sections using the framework question. The number of pages should remain about the same as the 4th edition (628 pages).

Units!

“The US is **inching** its way towards the metric system” ***NOT!***

The 5th volume will continue to support both English and metric units, but with an increasing movement towards metric units.



Most industrial plants in the US continue to use English units, and there does not appear to be any movement by the US towards metric units.

Olde English Units!

1 Stoneweight (st) = 14 pounds

1 Fathom (Fm) = 6 feet

1 Fortnight (FN) = 2 weeks

$$g_c = \frac{mg}{F} = 7.851 \times 10^{12} \frac{\text{stoneweight}_m \text{ fathom}}{\text{stoneweight}_f \text{ fortnight}^2}$$

Units can always be worse!

I'll give you some time to write this down!

The Process Safety Framework can be applied to:



Personal safety



Academic and
industrial lab safety



Pilot plants



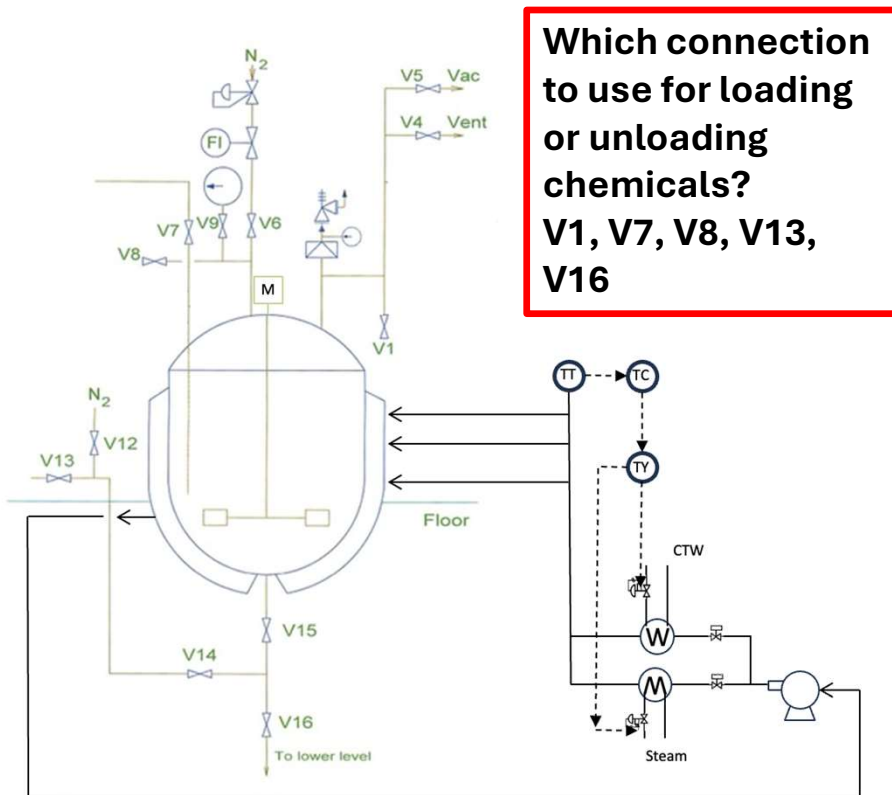
Industrial
processes



Anywhere that
hazards exist

**This will provide the students with an important life skill
that can be used professionally and personally!**

100 gal (378 L) Pilot Plant Multi-purpose Vessel



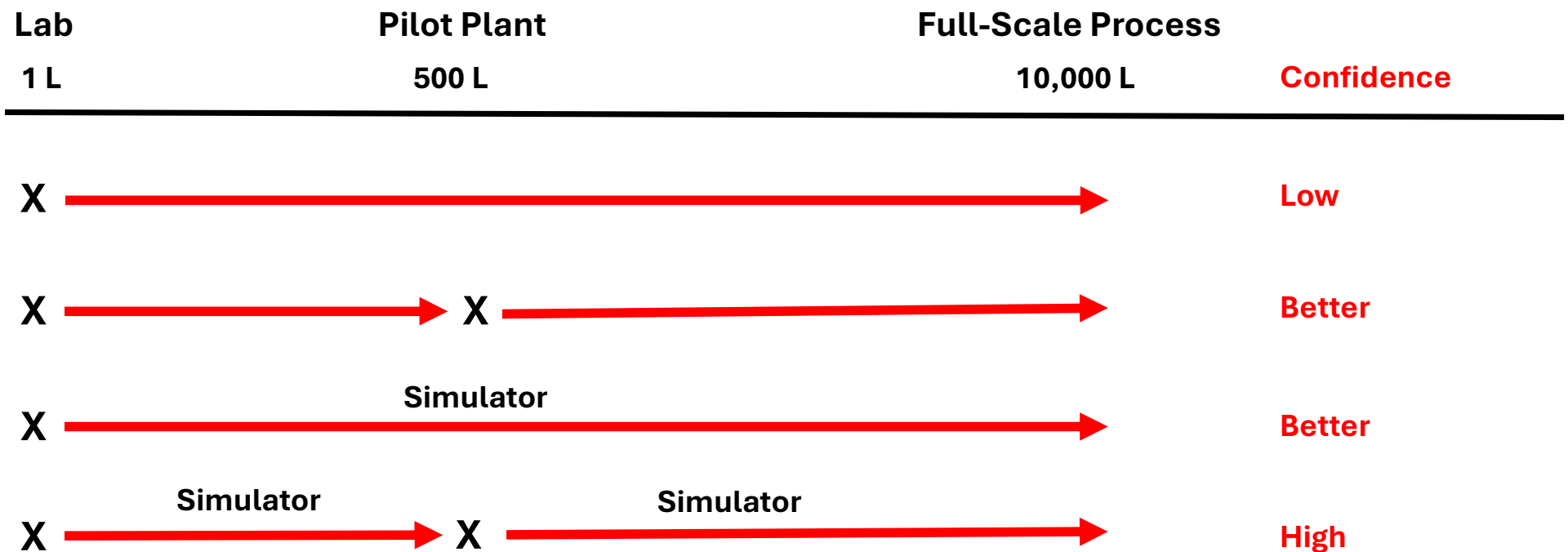
Not actual process we will use!

- Can be used for a wide variety of applications, including chemical, bio, and food.
- Used throughout the book for examples and homework to demonstrate application of the framework questions to a real process.
- Provides a realistic process experience for the students, but not as complex as a full-scale process.
- **Very detailed process specifications provided in appendix.**
- A full chapter on overview of the process.

Example: Making hand sanitizer



Why does industry need pilot plants? Heat and mass transfer processes do not scale linearly!



The pilot plant helps calibrate the simulator prior to full scale-up!

Why does industry use pilot plants?

1. Identify and troubleshoot any problems with the scale-up to a larger process, including mixing, heat and mass transfer, chemical and biochemical reactivity, to name a few.
2. Develop more detailed documentation on the operation, process control and maintenance of the larger process.
3. Identify opportunities to improve the process.
4. Verify compatibility of materials of construction with the chemicals in the process.
5. Calibrate process simulation of the larger process.
6. Preliminary training of operators and maintenance workers for the process.
7. Confirm product yield and production rates.
8. Confirm required purity levels of raw materials and products.
9. Develop a more detailed maintenance schedule for equipment.
10. Establish operator, maintenance, management and other staffing levels.
11. Confirm waste generation levels and disposal methods.
12. Confirm utility requirements, including cooling water, steam, electricity, nitrogen and others.
13. Confirm storage requirements for feedstocks, final products, intermediates and wastes.
14. Confirm process economics for the full-scale process, including cash flows for raw materials, products, utilities, waste disposal, etc.
15. Diagnose problems with an existing full-scale process or evaluate suggested improvements to the full-scale process.

Many others!

100 Gallon (378 L) Pilot Plant Multi-purpose Vessel

The students will be given more details on this than shown here.

Entire process is in a pilot plant area with:

- Fire alarm pull stations.
- An explosion proof (XP) area classification
- Ventilation (5 or 10 air changes per hour) plus elephant trunks.
- Flammable vapor detectors and alarm.
- **Standard utilities: compressed air, nitrogen, water (deionized), electrical, vacuum, etc.**
- **Standard supporting equipment: drums, weigh scales, buckets, grounding clamps, fork-lift, etc.**
- **Standard PPE: safety glasses, goggles, aprons, gloves, hard hats, moon suits, others.**
- Steel toed shoes required due to drum lifting.
- Fire extinguishers, small and large.
- Drain catch vessel with isolation.
- Portable hydraulic pumps for loading and unloading.
- Others....

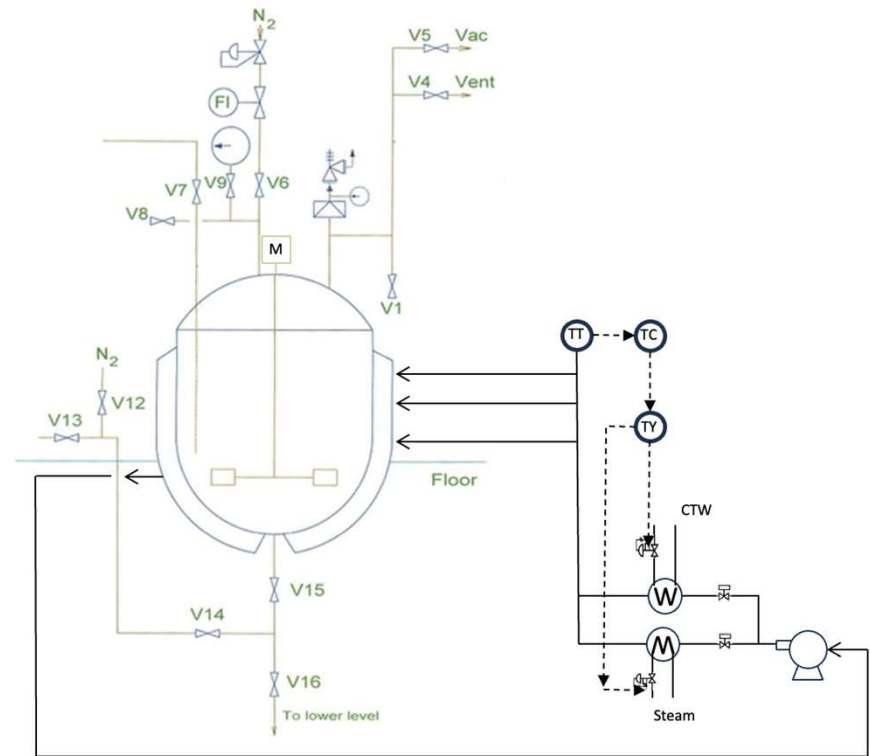
For each activity the students will need to assess how these features and equipment inform safe operations.

100 Gallon (378 L) Pilot Plant Multi-purpose Vessel

Multi-purpose vessel is in a process development area with other equipment and operations. Entire area has personal protective equipment (PPE) and operational requirements (XP rated area!)

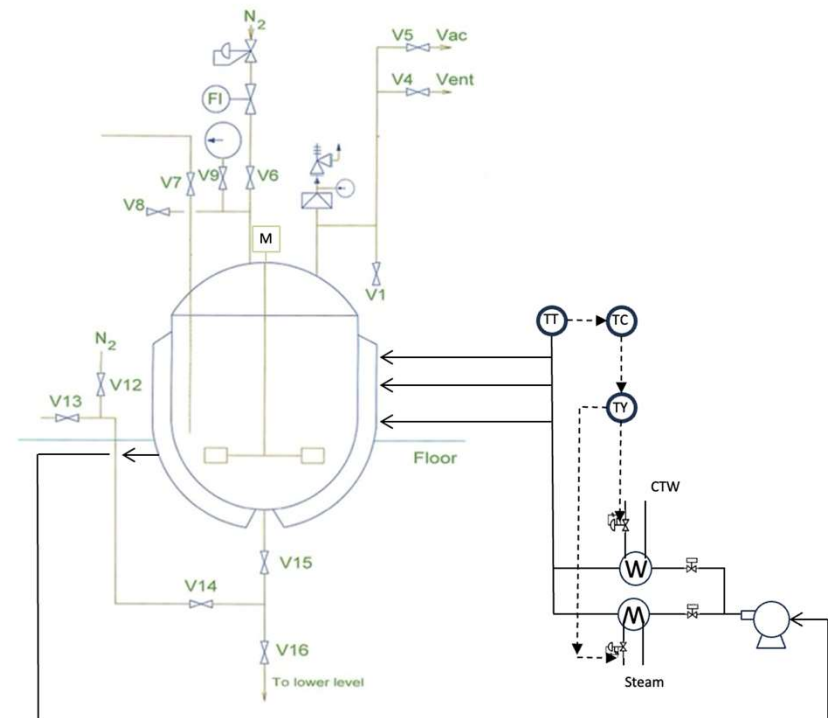
Simple activity: Charge 50 gallons of water into the multi-purpose vessel.

All Framework questions must first be completed prior to developing an operating procedure.



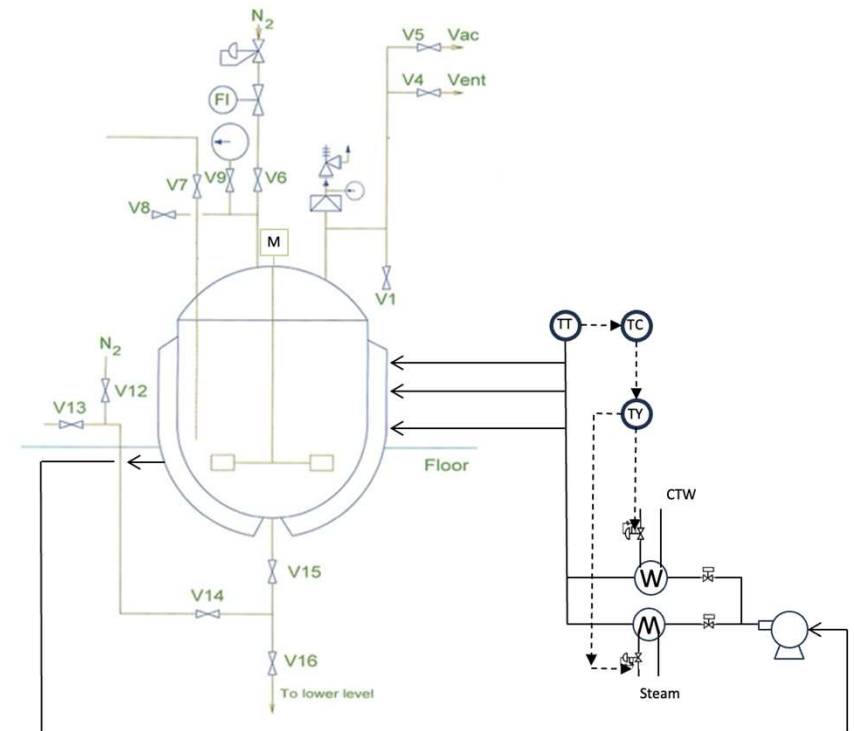
100 Gallon (378 L) Pilot Plant Multi-purpose Vessel

1. Determine PPE required due to area rating and operations.
2. Place empty drum on weigh scale. (Use forklift)
3. Attach grounding / bonding clamp to drum/vessel and grounding rod into water in drum (XP rated area)
4. Add water to drum using water supply hose until more than 30 gallons by weight.
5. Attach hose to line with V7 and place other end into water in drum.
6. Calculate weight of 30 gallons of water – subtract from current drum / water weight. This is the target scale weight.
7. Vacuum charge water into vessel until weigh scale trips at target weight.
8. Close valves, disconnect hose, disconnect bonding and grounding, empty drum.
9. Cleanup.



Summary

1. The 5th edition will retain most of the technical content of the 4th edition.
2. The content will be re-organized using the framework questions.
3. The multi-purpose pilot-scale vessel will bring the student experience much closer to actual process operations.
4. 5th edition manuscript is due to publisher on August 31, 2025. Will take up to a year to publish.



Questions?

Comments?

