

Cannabis Processing Equipment

A practical guide to cannabis processing equipment, covering the reader intent, the relationship to cannabis processing equipment, key evaluation criteria, common risks, and the information the intended project audience should confirm before taking the next step.



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In the rapidly evolving landscape of botanical extraction, cannabis processing equipment has transitioned from artisanal setups to sophisticated, industrial-scale production lines. To maintain consistency, safety, and throughput, these systems rely heavily on precise automation and instrumentation. Among the most critical components in any extraction or distillation facility are level measurement instruments. These sensors ensure that solvents are managed safely, extract yields are monitored accurately, and storage tanks are optimized for space and safety.

For engineers and facility managers, selecting the right instrumentation is a fundamental step in designing a high-performance facility. For a comprehensive overview of available industrial sensors and technical specifications, you may visit the [Main Page](#) to review product options and application support.

The Role of Level Measurement in Cannabis Processing

Cannabis processing involves several stages where liquid management is paramount. Whether it is the storage of bulk solvents like ethanol, the pressurized handling of hydrocarbons like butane and propane, or the collection of refined crude oil and distillates, knowing the exact volume of material is essential for both operational efficiency and regulatory compliance.

Level sensors in cannabis processing equipment serve three primary functions:

1. **Process Control:** Maintaining steady-state conditions in evaporation and distillation columns by ensuring consistent feed rates.
2. **Inventory Management:** Tracking the usage of expensive solvents and the accumulation of high-value extracts.
3. **Safety and Overfill Protection:** Preventing hazardous spills of flammable solvents and protecting pumps from running dry, which can lead to mechanical failure or ignition risks in volatile environments.

Core Measurement Principles for Extraction and Distillation

Before selecting a sensor, it is important to understand the physics behind the various measurement technologies used in modern cannabis processing equipment.

Radar Level Measurement (Non-Contact)

Radar sensors emit high-frequency microwave pulses that reflect off the surface of the liquid. The time-of-flight between emission and reception is used to calculate the distance.

Advantages: Radar is largely unaffected by changes in pressure, temperature, or the presence of vapors. This makes it ideal for CO₂ extraction vessels or solvent recovery tanks where vapors are prevalent.

Frequency Matters: High-frequency radar (e.g., 80 GHz) provides a narrow beam angle, which is useful in small processing tanks with internal agitators or heating coils.

Ultrasonic Level Measurement

Ultrasonic sensors use sound waves rather than microwaves. The sensor measures the time it takes for a sound pulse to hit the liquid surface and return.

Advantages: These are cost-effective and easy to install for non-pressurized water-based applications or simple storage tanks.

Limitations: Ultrasonic waves can be distorted by heavy vapors, foam, or vacuum conditions, which are common in ethanol extraction and rotary evaporation.

| Hydrostatic Pressure Measurement

This principle involves placing a pressure transmitter at the bottom of a tank. The sensor measures the pressure exerted by the liquid column above it, which is directly proportional to the liquid's height and density.

Application: Excellent for large-scale outdoor solvent storage tanks where the liquid density remains relatively constant.

| Magnetic Level Gauges

These utilize a float containing a magnet that moves with the liquid level inside a bypass chamber. An external indicator or electronic transmitter tracks the float's position.

Advantages: Provides a clear visual reference for operators while simultaneously sending a 4-20mA signal to a control system. They are highly reliable for high-pressure hydrocarbon storage.

| Selecting Sensors for Specific Cannabis Processing Equipment

The choice of instrumentation depends heavily on the specific stage of the extraction process. Cannabis processing equipment is often categorized by the solvent used and the final product desired.

| 1. Ethanol Extraction Systems

In large-scale ethanol extraction, biomass is soaked in chilled ethanol (often at temperatures as low as -40°C to -80°C).

Instrumentation Needs: Level sensors must be able to withstand cryogenic temperatures. Radar sensors with specialized antennas are preferred here because they do not have moving parts that could freeze or fail in extreme cold.

Material Compatibility: All wetted parts must be 316L stainless steel or PTFE to ensure they do not leach contaminants into the food-grade or pharmaceutical-grade extract.

| 2. CO2 Extraction (Supercritical)

CO2 extraction operates at very high pressures, often exceeding 70 bar (1,015 psi).

Instrumentation Needs: Sensors must be rated for high-pressure environments. Non-contact radar is frequently used through high-pressure sight glasses or specialized process connections to monitor the separation of oil from the CO2 stream.

| 3. Solvent Recovery and Distillation

Following extraction, the solvent must be removed from the oil. This occurs in falling film evaporators or rotary evaporators, often under vacuum.

Instrumentation Needs: Because vacuum conditions change the speed of sound, ultrasonic sensors are generally avoided. Radar or guided wave radar (GWR) is preferred as it is immune to vacuum. Additionally, the sensor must be able to handle the high viscosity of the concentrated cannabis oil as it accumulates.

| Technical Comparison Table: Level Technologies

The following table provides a practical engineering reference for comparing different technologies used in cannabis processing equipment.

Technology	Accuracy	Ideal Application	Limitations	Metric Range (Approx.)
80GHz Radar	±1 mm	Distillation, Solvent Recovery	High cost relative to others	Up to 30 meters
Ultrasonic	±0.25%	Water treatment, simple tanks	Vapors, Vacuum, Foam	0.25 to 15 meters
Hydrostatic	±0.1%	Large storage tanks	Sensitive to density changes	0 to 200 meters
Guided Wave Radar	±2 mm	Small tanks with foam	Contact-based (probe)	Up to 6 meters
Magnetic Gauge	±5 mm	High-pressure hydrocarbons	Mechanical float can stick	0.3 to 6 meters

| Installation Considerations and Best Practices

Proper installation is as critical as selecting the right technology. When integrating level sensors into cannabis processing equipment, engineers should follow these guidelines:

1. **Dead Zones (Blocking Distance):** Every sensor has a minimum distance it cannot measure (the "dead zone"). Ensure the sensor is mounted high enough that the maximum liquid level does not enter this zone. For radar, this is typically 50 mm to 200 mm (approx. 2 to 8 inches).
2. **Nozzle Geometry:** For non-contact sensors, the mounting nozzle should be short and wide enough to prevent signal interference from the nozzle walls.
3. **Agitator Interference:** Many cannabis mixing tanks contain agitators. Sensors should be positioned away from the path of the blades. Modern radar sensors often include "false signal suppression" software to ignore reflections from fixed internal tank structures.

4. **Sanitary Standards:** Since cannabis products are intended for human consumption, equipment must often meet 3-A or EHEDG sanitary standards. This requires tri-clamp fittings and polished surfaces ($Ra < 0.8 \mu m$) to prevent bacterial growth and facilitate Clean-in-Place (CIP) cycles.

5. **Hazardous Area Certification:** Much of the cannabis processing environment is classified as Class I, Division 1 or 2 due to the presence of flammable solvents. Sensors must be intrinsically safe (Ex ia) or explosion-proof (Ex d).

| Limitations and Environmental Challenges

While modern instrumentation is highly advanced, certain environmental factors in a cannabis facility can pose challenges:

Foaming: During the evaporation of ethanol, foaming can occur. This can absorb ultrasonic signals and cause false readings in non-contact radar. In these cases, Guided Wave Radar (GWR) is often the better choice as the probe guides the signal through the foam to the liquid surface.

Build-up: Cannabis oil is extremely sticky. Over time, resin can build up on the sensor face or probe. Non-contact radar is less susceptible to this than contact-based methods, but periodic cleaning is still necessary to maintain accuracy.

Dielectric Constant: Radar relies on the dielectric constant (Dk) of the liquid. While ethanol has a high Dk (~ 24), some hydrocarbons have very low Dk values (~ 1.5 to 2.0). Low Dk liquids reflect weaker signals, requiring more sensitive radar units or the use of a stilling well to concentrate the signal.

| Frequently Asked Questions (FAQ)

Q: Can I use the same level sensor for ethanol and butane?

A: Not necessarily. While the sensor technology (like radar) might be the same, the pressure ratings and seal materials differ significantly. Butane requires high-pressure ratings and specific elastomers (like Viton or Kalrez) that are compatible with hydrocarbons, whereas ethanol requires compatibility with alcohols.

Q: How often should level sensors in cannabis processing equipment be calibrated?

A: For inventory and regulatory compliance, annual calibration is standard. However, for critical safety overfill protection, semi-annual functional testing (bump tests) is recommended.

Q: Are ultrasonic sensors suitable for vacuum distillation?

A: No. Ultrasonic sensors require air or gas to transmit sound waves. In a vacuum, there is no medium for the sound to travel through, rendering the sensor inoperable. Radar is the preferred choice for vacuum applications.

Q: What is the benefit of a 4-20mA HART output?

A: This allows the sensor to communicate not just the level, but also diagnostic information. It enables remote configuration and troubleshooting, which is vital in automated cannabis processing facilities.

| Conclusion

The integration of high-quality level measurement into cannabis processing equipment is no longer optional for businesses aiming for industrial scale. By understanding the principles of radar, ultrasonic, and hydrostatic measurement, and by accounting for the unique chemical and physical properties of cannabis extracts and solvents, operators can ensure a safer, more efficient production environment. Whether you are managing a single extraction vessel or a massive tank farm, the right instrumentation is the backbone of process control and profitability.