Common Equipment Issues and Solutions

I. Reactor Acidification (VFA Accumulation, pH Drop)

Symptoms

• pH < 6.5, VFA > 500 mg/L

• Sudden drop in biogas production, methane < 50%

• Increased COD in effluent, grayish-black color

Causes

• Sudden increase in influent load, overload

• Sudden temperature fluctuations (±5°C)

• Toxic substances (heavy metals, sulfides)

• Nutrient imbalance (C:N:P ≠ 100:5:1)

Solutions

1. Emergency load control: Immediately reduce influent flow by 50% or stop influent

2. Adjust pH: Add sodium bicarbonate (baking soda); do not use NaOH or $Ca(OH)_2$

3. Recirculation dilution: Recirculate aerobic effluent to flush out VFA

4. Replenish microbial inoculum: Add granular sludge or anaerobic digestion sludge

5. Recovery: Once VFA < 300 mg/L and pH > 6.8, increase the load by 10% weekly

II. Sludge Loss (Sludge Leakage, High Effluent SS)

Symptoms

• Turbid effluent, SS > 150 mg/L

• Sludge accumulation in the three-phase separator, thinning of the sludge bed

Causes

• Excessively high upflow velocity (>1.0 m/h)

• Three-phase separator design issues or damage

• Disintegration of granular sludge, poor settling

• Uneven water distribution, short-circuiting

Solutions

1. Reduce flow velocity: Decrease recirculation rate; maintain flow velocity ≤ 0.5–0.8 m/h

2. Intercept and recover: Install a 20-mesh screen at the outlet

3. Promote granulation: Add PAC (50 mg/L) and PAM

4. Maintain the three-phase separator: Adjust weir plates, clear blockages, and repair leaks

5. Optimize water distribution: Clear blockages, switch to multi-point distribution

III. Low Gas Production/Methane Content

Symptoms

• Yield < 0.3 m^3/kg COD

• Methane < 60% (normal range: 65–75%)

• COD removal rate < 70%

Causes

• Acidification/VFA accumulation

• Unstable temperature (fluctuations > ±2°C)

• Gas leaks, pipe blockages

• Low sludge activity/sludge loss

Solutions

1. Address acidification first (as above)

2. Stabilize temperature: Medium temperature 35±2°C, High temperature 55±2°C

3. Inspect and repair leaks: Check water seals, valves, and flanges

4. Supplement nutrients: Add urea and phosphate salts at a C:N:P ratio of 100:5:1

5. Clear blockages: Unclog biogas pipes and water seals

IV. Slow Granular Sludge Growth/Disintegration

Symptoms

• Sludge is predominantly flocculent with poor settling

• Difficulty increasing load; low removal efficiency

Causes

• Insufficient nutrients/trace elements (Fe, Co, Ni)

• Excessively low load; excessive pre-acidification

• Presence of toxic substances; frequent pH fluctuations

• Excessive hydraulic/gas shear

Solutions

1. Nutrient supplementation: C:N:P = 100:5:1; add trace elements

2. Stabilize loading: COD 1000–3000 mg/L during start-up

3. Control shear: Reduce flow velocity; adjust mixing/recirculation

4. Prevent shocks: Remove toxins in pretreatment; control temperature/pH

V. Reactor Scaling/Precipitation

Symptoms

• Clogged distribution pipes/three-phase separators

• Reduced effective volume, increased resistance

Causes

• High calcium and magnesium levels, carbonate/phosphate precipitation

• High sulfide and sulfate levels

• High influent SS, sediment accumulation

Solutions

1. Pretreatment: Softening, dehardening, adding scale inhibitors

2. pH control: Avoid excessively high pH (＜7.5)

3. Regular flushing: Air-water backwashing of distribution pipes

4. Sludge removal: Regular sludge removal to prevent sediment buildup

VI. Foam/Scum

Symptoms

• Excessive foam at the top, blocking gas venting

• Thick scum layer containing sludge

Causes

• Load/temperature fluctuations, CO_2 surge

• High protein/lipid levels, low surface tension

• Sudden increase in gas production, excessive agitation

Solutions

1. Stabilize operation: Daily load variation <10%, temperature variation <±2°C

2. Defoaming: Add vegetable oil/defoamer (small amount)

3. Scum skimming/spraying: Install a scum skimmer, use water spraying to break bubbles

4. Pretreatment: Oil removal, protein removal

VII. Elevated COD in Effluent

Symptoms

• Removal efficiency < 70–80%; high COD in effluent

Causes

• Excessive load, acidification

• Sludge loss/low activity

• Inlet water contains refractory COD

• Short-circuiting, poor mixing

Solutions

1. Reduce load, stabilize pH/T

2. Control sludge loss; replenish sludge

3. Enhance pretreatment: hydrolysis/precipitation

4. Optimize water distribution and recirculation to prevent short-circuiting

VIII. Daily Monitoring Parameters (for Early Warning)

• pH: 6.8–7.2

• VFA: <300 mg/L

• Alkalinity: >1000 mg/L

• Temperature: Stable at ±2°C

• Upflow velocity: 0.5–0.8 m/h

• Biogas: Methane 65–75%

Core failures in Wiggins Wet Gas Holders are concentrated in six major categories: seals, pistons, guide wheels, corrosion, water seals, and leaks. Below are the most common on-site issues and practical solutions:

I. Piston Tilting, Jamming, and Unstable Movement

Symptoms

- Piston misalignment, abnormal noise from guide wheels, and jerky movement

- Significant pressure fluctuations inside the holder and localized friction-induced heat

Causes

- Guide wheel wear, excessive clearance, and lubrication failure

- Uneven tension in the leveling wire ropes, broken wires, and jammed pulleys

- Deformed guide rails, accumulated debris, or installation misalignment

- Uneven piston counterweight distribution or abnormal localized loads

Solutions

1. Guide wheel maintenance: Replace worn guide wheels, adjust clearance to 0.5–1 mm, and regularly apply high-temperature grease

2. Leveling correction: Tighten the leveling steel cables simultaneously to ensure consistent tension; replace cables with broken wires

3. Guide Rail Treatment: Straighten deformed guide rails, remove deposits, and grind down burrs

4. Counterweight Inspection: Verify counterweight blocks; add or adjust weights to ensure the piston is level

5. Slow Test Run: Perform multiple short-stroke lifts to break in the system

II. Sealing Rubber Curtain (Membrane) Wrinkles, Tears, Air Leaks

Symptoms

• Obvious air leakage at the seal, methane concentration alarm

• Wrinkled rubber curtain, localized bulging, or cracking

Causes

• Excessive piston tilt, uneven stress on the rubber curtain

• Aging of the rubber curtain, material degradation, or misalignment during installation

• Excessively fast lifting/lowering, impact, or scratches from foreign objects

• Corrosion of the sealing angle iron, air leakage from welds

Resolution

1. Minor wrinkling: Repeatedly raise and lower the piston; depressurize to allow the rubber curtain to naturally reset

2. Localized damage: Repair with specialized adhesive; apply reinforcement patches

3. Severe tearing: Shut down the system and replace the rubber curtain; realign the piston horizontally before reinstallation

4. Corrosion of angle steel: Use a non-welded clamping device + sealant for online leak sealing

5. Prevention: Limit lifting/lowering speed to ≤0.5 m/min; regularly inspect the condition of the rubber curtain

III. Water Seal Air Leakage and Abnormal Water Levels

Symptoms

• Bubbling, air leakage, or excessive methane levels at the water seal

• Rapid drop in water level in the water tank/water seal, or abnormal overflow

Causes

• Water level too low, water seal 缺水

• Corrosion perforation of the water seal tank, weld seam leakage

• Piston tilt causing water seal misalignment and overflow

• Malfunctioning makeup water valve, blocked piping

Resolution

1. Emergency water replenishment: Refill to normal overflow level, maintain continuous slight overflow

2. Leak detection and repair: Shut down for welding, epoxy repair, or replacement of water seal components

3. Leveling: Adjust the level of the piston and tower section to eliminate flow deviation and overflow

4. Make-up Water System: Inspect and repair the make-up water valve and filter to ensure automatic make-up water supply

IV. Corrosion and Leaks in Cabinet, Piston, and Base Plate

Symptoms

• Gas seepage and pitting/perforation at welds on side panels, base plates, and pistons

• High iron content and excessive rust debris in condensate

Causes

• Corrosion caused by H_2S and CO_2 in gas, as well as acidic condensate

• Aging or damaged anti-corrosion coatings, failure of cathodic protection

• Poor water seal quality, sludge buildup, and anaerobic corrosion

Solutions

1. Minor leaks: Seal online using metal repair compounds or specialized sealants

2. Perforations/major leaks: Shutdown for welding repairs, reinforcement with arc-welded plates, and reapplication of anti-corrosion coating

3. Water quality control: Regular water changes, addition of corrosion inhibitors, and drainage to remove sludge

4. Anti-corrosion repair: Rust removal, reapplication of corrosion-resistant coatings, and restoration of cathodic protection

V. Guide Rollers/Pulleys/Wire Rope Failures (Broken Strands, Wear, Jamming)

Symptoms

• Guide wheels not rotating, abnormal noise, wear grooves

• Wire rope broken strands, loose strands, pulley jamming

Causes

• Insufficient lubrication, dust/sludge blockage

• Long-term alternating stress, fatigue, interference with structure

• Improper material selection, corrosion damage

Solutions

1. Lubrication: Regularly apply lithium-based grease to ensure pulleys/guide wheels operate smoothly

2. Replacement: Immediately replace worn guide wheels or wire ropes with over 5% broken strands

3. Interference Adjustment: Relocate pulleys or guide frames to prevent wire rope friction against structural components

4. Corrosion Prevention: Apply anti-corrosion oil to wire ropes and inspect for rust regularly

VI. Abnormal Cabinet Pressure (Excessive/Negative Pressure)

Symptoms

• Pressure exceeds upper limit, safety valve activates

• Negative pressure, abnormal cabinet noise, risk of cabinet collapse

Causes

• Imbalance in inlet/outlet flow, excessive lifting/lowering speed

• Jamming or high sealing resistance causing pressure to spike

• Malfunctioning vent/inlet valves, interlock failure

Resolution

1. Overpressure: Immediately reduce air intake and increase exhaust; manually vent to relieve pressure

2. Negative pressure: Stop exhaust, introduce inert gas/air to restore positive pressure

3. Interlock verification: Inspect pressure transmitters, high/low-pressure interlocks, and vent valves

4. Sticking resolution: Eliminate resistance according to the piston sticking procedure

VII. Condensate/Sludge Accumulation, Poor Drainage

Symptoms

• Water accumulation at the bottom of the piston, thick sludge, and drainage containing debris

• Clogged drain valves, corroded piping

Causes

• Deposits of coal gas condensate, dust, and tar

• Insufficient drainage slope, internal valve leakage, or blocked piping

Solutions

1. Regular forced drainage: Drain and flush at the end of each shift until the water runs clear and free of debris

2. Dredging: Clean sludge from the bottom of the piston during annual shutdown

3. Pipeline Modifications: Optimize slope, install flush fittings, and install anti-clogging valves

VIII. Key Daily Monitoring Points (Early Warning)

• Piston Levelness: ≤5–10 mm/m

• Gas Holder Pressure: Design value ±200 Pa

• Water Seal Level: Normal overflow, no lateral flow

• Sealing: No air leaks; rubber diaphragm free of wrinkles or cracks

• Guide wheels/steel wire ropes: No abnormal noises; no broken wires

The most common issues with Wiggins dry gas holders (rubber diaphragm seals) fall into six major categories: sealing diaphragm, piston tilt, leaks, abnormal pressure, tank volume indication, and corrosion.

I. Damaged, Wrinkled, or Leaking Diaphragm (Most Common)

Causes

• Piston tilting/drifting/rotating, causing the diaphragm to be pulled, squeezed, or rubbed

• Excessively high inlet gas temperature (>70°C), tar/dust/moisture content, aging, corrosion, or embrittlement

• Burrs or sharp edges on T-plates, side plates, or angle irons causing scratches

• Installation stress, thermal expansion/contraction, long-term fatigue

Solution

• Small tears: Shut down the unit → Purge with nitrogen → Sand and clean → Apply specialized rubber adhesive + double-sided canvas patch → Cure for 24 hours

• Large areas/aging: Replace the entire diaphragm

• Prevention: Control inlet air temperature ≤70°C, filter and dry, regularly check piston level, eliminate sharp edges

II. Piston Tilting, Drifting, or Jamming

Causes

• Uneven airflow, sudden changes in flow rate

• Uneven piston counterweight, guide wheel binding, guide rail deformation

• Uneven foundation settlement

• Uneven tension on both sides of the diaphragm

Solutions

• Install tilt/level monitors for real-time monitoring

• Adjust piston counterweights, guide wheel clearances, and guide rail verticality

• Control piston lifting/lowering speed ≤ 2 m/min; ensure slow and uniform gas inlet/outlet

• If tilt exceeds limits: Stop air intake, slowly vent pressure to level the system

III. Abnormal Cabinet Pressure (Too High/Too Low/Fluctuating)

Causes

• Stuck, malfunctioning, or leaky relief valves

• Faulty pressure transmitters/control valves, zero-point drift

• Diaphragm stuck, wrinkled, or increased resistance

• Blockage or leakage in inlet/outlet valves or piping

Resolution

• Inspect, clean, and lubricate the relief valve, counterweight, and push rod

• Calibrate pressure gauges and replace seals

• Move the piston through its full stroke to smooth out the diaphragm

• Clean piping, repair leaks, and inspect valves

IV. Inaccurate or No Tank Capacity Indication

Causes

• Loose, corroded, or misaligned steel cables

• Seized gears or pulleys; lack of lubrication

• Water ingress into the meter; sensor malfunction

• Zero point or range drift

Solutions

• Tighten steel cables; remove rust and apply lubricant; replace damaged parts

• Apply grease to all moving parts

• Dry the meter head and repair the circuitry

• Recalibrate the tank capacity

V. Leaks Due to Corrosion of Sealing Angle Irons, Side Panels, and Bottom Panels

Causes

• Gas contains H_2S, condensate, or acidic substances

• Damage to welds or anti-corrosion coatings

• Water accumulation at the bottom, poor drainage

Solution

• Corrosion points: Grind and remove rust → Apply anti-corrosion paint/sealant → Use non-welded clamping devices for online sealing

• Drain water and remove contaminants regularly

• Enhance desulfurization and dehydration of incoming gas

VI. Piston Jamming at Top/Bottom

Causes

• Uncontrolled gas flow, interlock failure

• Tank volume/limit switch malfunction

• Operator error

Solutions

• Improve high/low-level alarms and interlocked gas shut-off

• Regularly calibrate limit switches and instruments

• Strictly enforce work permits and supervision protocols

VII. Guide Wheels/Pulleys Seizing or Abnormal Noise

Causes

• Lack of lubrication, rust, or dust buildup causing jamming

• Improper clearance between guide wheels and guide rails

Solutions

• Clean and apply high-temperature grease

• Adjust the clearance and align the guide rails

I. Difficulty Igniting, Unable to Ignite Automatically

Common Causes

1. Carbon buildup on ignition electrodes, moisture, or excessive/insufficient gap

2. Low biogas concentration, insufficient pressure, or unstable gas flow

3. Ignition transformer failure, aging wiring, or poor contact

4. Solenoid valve blockage, water accumulation in gas lines, or blockage by impurities

5. Strong winds or rain blowing directly onto the ignition port

Solutions

1. Clean carbon deposits and rust from the ignition needle, adjust the electrode gap (standard 3–5 mm); replace if damaged

2. Increase biogas inlet pressure; install a pressure-regulating valve upstream; inspect the pipeline network for leaks

3. Inspect the high-voltage ignition coil and control wires; tighten terminal connections; replace aged wiring

4. Disassemble and clean the gas solenoid valve and filter; regularly drain condensate from the piping

5. Install a wind and rain shield; shut down external high-wind facilities during severe weather

II. Incomplete Torch Combustion, Black Smoke, or Yellow Flame

Common Causes

1. Insufficient air supply, malfunctioning combustion air fan, or insufficient damper opening

2. Low methane content in biogas, high impurity levels, or high hydrogen sulfide content

3. Clogged, scaled, or partially burnt combustion head nozzles

4. Biogas overload or excessive instantaneous gas flow

5. Ash buildup in the furnace chamber or debris blocking ventilation channels

Remedial Measures

1. Check the operating status of the combustion air fan, clean the fan filter screen, and adjust the air intake damper to an appropriate opening

2. Optimize the operation of the anaerobic system to increase methane concentration; install desulfurization and dust removal equipment

3. Periodically disassemble and clean the burner nozzles, grind off coke and carbon deposits, and replace damaged combustion components

4. Regulate the gas flow appropriately; implement staged combustion and phased startup during high-volume operations

5. Perform regular ash removal to ensure unobstructed furnace ventilation

III. Flame Extinction, Backfire, and Unstable Flame

Common Causes

1. Significant fluctuations in biogas pressure, with sudden spikes and drops

2. Excessive air intake or strong backdraft

3. Wear, deformation, or seal failure of the burner head

4. Negative pressure in the piping causing air intake, or air leaks at sealing points

5. Insufficient gas flow, below the minimum stable combustion load for the flare

Solutions

1. Install pressure stabilizers and buffer tanks to stabilize gas supply pressure and prevent sudden fluctuations

2. Reduce the combustion air flow rate and optimize the wind protection structure to prevent backdraft

3. Inspect and replace the burner head and sealing gaskets to ensure structural integrity

4. Conduct a comprehensive inspection of pipe flanges, valves, and joints, and promptly seal any leaks

5. Set a minimum self-sustaining combustion flow rate; when gas flow is low, automatically adjust the frequency or limit the flow to maintain stable combustion

IV. Frequent Flame Extinguishment and Automatic Shutdown

Common Causes

1. Contamination or malfunction of the flame detector (UV/ion probe)

2. Improper control system parameter settings; flameout protection sensitivity is too high

3. Severe moisture in biogas, causing the water seal to block the gas supply

4. Unstable power supply voltage; control cabinet short-circuited due to moisture

5. Piping frozen and blocked in low-temperature environments

Solutions

1. Regularly wipe the flame sensor lenses to remove dust and moisture; periodically calibrate the detectors and replace them if faulty

2. Re-calibrate PLC control parameters; appropriately adjust flameout delay and protection logic

3. Install a steam-water separator and a condensate drain valve upstream, with scheduled automatic drainage

4. Install dehumidification and waterproofing measures in the control cabinet; ensure stable power supply and install a voltage stabilizer

5. Insulate and heat pipelines during winter to prevent freezing and blockages

V. Strong Odor, Excessive Exhaust Emissions, and Foul-Smelling Combustion

Common Causes

1. Incomplete combustion, resulting in direct escape of biogas

2. Untreated hydrogen sulfide; combustion of sulfur-containing gases produces odors

3. Ignition failure without timely gas supply cutoff, resulting in biogas leakage

4. Poor flare sealing or gas leakage through bypasses

Remedial Measures

1. Ensure adequate air supply to prevent oxygen-deficient combustion; maintain a pilot flame during low-load operation

2. Install dry or wet desulfurization equipment to reduce H_2S content

3. Improve interlocks: automatically close the gas inlet valve upon ignition failure and trigger an alarm

4. Inspect the flare body, valves, and bypass piping; seal and repair leaks

VI. Abnormal Equipment Noise, Excessive Vibration, and Unusual Combustion Noise

Common Causes

1. Airflow resonance, unbalanced damper ratios

2. Damaged fan bearings; unbalanced impellers due to dust accumulation

3. Localized flash fires in the burner; airflow pulsations

4. Loose equipment mounting brackets

Remedial Measures

1. Fine-tune the air-to-gas ratio to eliminate combustion resonance

2. Perform regular fan maintenance, apply grease, clean dust from impellers, and replace damaged parts

3. Stabilize inlet pressure to prevent flash fires caused by sudden surges of air

4. Tighten the flare base, supports, and anchor bolts; add vibration-damping mounts

VII. Pipeline Freezing, Blockages, and Winter Operational Failures

Common Causes

1. High moisture content in biogas leading to condensation and freezing at low temperatures

2. Lack of insulation and trace heating on valves and pressure-reducing valves

3. Insufficient drainage, leading to frozen blockages from accumulated water

Solutions

1. Install insulation and electric tracing on main pipelines, valves, and pressure regulators

2. Install a pre-treatment dehydration unit and implement routine manual and automatic drainage

3. Maintain a steady pilot flame throughout the winter to prevent freezing and blockages

VIII. Automatic Control System Failures (Inability to Control Remotely, False Alarms)

Common Causes

1. Damaged sensors or signal line interference

2. Short circuits in components due to moisture or corrosion inside the control cabinet

3. Program malfunctions or lost parameters

Solutions

1. Isolate high- and low-voltage circuits, shield against signal interference, and replace damaged sensors

2. Dehumidify and apply anti-corrosion treatment to the control cabinet; perform regular dust removal

3. Regularly back up control programs; restore factory settings and re-calibrate in case of abnormalities