COMPREHENSIVE CONTROL STRATEGY FOR MODIFIED STARCH DRYER

Project: AGRANA ROMANIA - Modified Starch Drying Project

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1. PRIMARY CONTROL LOOPS

1.1. MAIN MOISTURE CONTROL LOOP (Cascade Control)

Primary Loop - Moisture Control:

- **Sensor:** MT-101 (Moisture Transmitter, 0-50% range)
- **Controller:** MIC-101 (Moisture Indicating Controller)
- **Setpoint:** 12% moisture (adjustable based on product specification)
- **Output:** Setpoint to secondary temperature loop

Secondary Loop - Temperature Control:

- **Sensor:** TT-103 (Temperature Transmitter at Fan Inlet, 0-200°C)
- **Controller:** TIC-103 (Temperature Indicating Controller)
- **Setpoint:** Received from MIC-101 (typically 60-80°C)
- **Output:** 4-20mA to Steam Control Valve on Zone 3 Heater (TCV-101)

Control Algorithm:

```
IF MT-101 > Setpoint THEN
    Decrease TIC-103 Setpoint (reduce drying temperature)
ELSE IF MT-101 < Setpoint THEN
    Increase TIC-103 Setpoint (increase drying temperature)
ENDIF
```

1.2. FEED RATE CONTROL BASED ON MOISTURE

Control Logic: In normal operation, moisture control is performed by the **1.1. MAIN MOISTURE CONTROL LOOP (Cascade Control)** until the deviation from the setpoint becomes significant or sudden changes occur in the conditions of the input cake to the dryer; at that point, the control of the dryer is assigned to this loop **(1.2. FEED RATE CONTROL BASED ON MOISTURE)** until conditions stabilize.

- **Master:** MT-101 Moisture reading
- **Slave:** VFD-B6200 (Agitated Feed Vessel speed)
- **WT-B6200:** Weight measurement for feed rate calculation

```
Feed Rate Adjustment = f(MT-101, Product Throughput)
IF MT-101 > 15% THEN
    Reduce VFD-B6200 speed by 10%
ELSE IF MT-101 < 9% THEN
    Increase VFD-B6200 speed by 10%
ENDIF
```

1.3. SECONDARY TEMPERATURE CONTROL LOOP

After-Heater Temperature Control:

- **Sensor:** TT-102 (Temperature Transmitter in Dryer Duct, 0-200°C)
- **Controller:** TIC-102 (Temperature Controller)
- **Setpoint:** 170°C (adjustable)
- **Alarms:**
    - TAH-102: High Alarm at 180°C
    - TAL-102: Low Alarm at 150 ((variable based on capacity))
- **Output:** Trim adjustment to main steam valve

Safety Interlock:

```
IF TT-102 > 185°C THEN
```

```
    Close steam valve fully
    Activate emergency stop sequence
ENDIF
```

2. SAFETY INTERLOCKS & ESD SYSTEM

2.1. EXPLOSION PROTECTION SYSTEM

Sensors: XS-101 to XS-106 (Dryer Duct) + XS-F6506 to XS-F6511 (Cyclones) + XS-B6512 (Silo)

```
IF ANY explosion sensor activated THEN
    IMMEDIATE:
    1. Close all steam valves (FT-S101 related)
    2. Stop ID fan (V6515)
    3. Stop the starch cake feed system to the dryer, including screw conveyors M-1 to M-4 and the starch cake blower (H6204).
    4. Activate quench steam suppression system
    5. Isolate system from plant
    6. Alarm to control room
ENDIF
```

2.2. HIGH TEMPERATURE PROTECTION

```
IF TT-101 > 180°C OR TT-102 > 185°C THEN
    Close steam control valve
    Reduce fan speed to 50%
    Alarm: "HIGH TEMPERATURE - PROCESS INTERRUPTED"
ENDIF
```

2.3. PRESSURE SAFETY

```
text
IF PT-102 > 1.5 barg OR PT-103 < -0.5 barg THEN
    Stop ID fan (V6515)
    Open emergency vent
```

```
    Alarm: "PRESSURE DEVIATION - SYSTEM STOPPED"
ENDIF
```

2.4. DOOR SAFETY INTERLOCKS

Sensors: GS-101 to GS-106 (Heater & Duct doors) + GS-B6200 to GS-H6512, GS-H6513 (Equipment access)

```
IF ANY door open during operation, THEN
    Stop relevant equipment section
    Prevent restart until door closed
    Local indication + Control room alarm
ENDIF
```

3. SEQUENCE CONTROL

3.1. STARTUP SEQUENCE

```
PHASE 1: PRE-START CHECKS
    - All doors closed (GS-xxx verification)
    - No active alarms
    - Utilities available (steam, power, air)
    - Safety systems armed

PHASE 2: COLD START
    1. Start exhaust fan V6515 at 20% speed
    2. Open steam valve gradually to reach TT-A102 = 50°C
    3. Start feed system (B6200 → H6202 → H6203 → H6204)
    4. Ramp up fan speed to 50%
    5. Increase temperature to setpoint (TT-102 = 170°C)

PHASE 3: NORMAL OPERATION
    - Engage moisture control loop (MT-101 → TIC-103)
    - Monitor all parameters
    - Ramp to 100% capacity
```

3.2. NORMAL SHUTDOWN SEQUENCE

```
STEP 1: Feed system stop
    - Stop B6200 (feed vessel) after WT-B6200 tend to Zero
    - Stop H6202 (screw conveyor)+Delay Time
    - Stop H6203 (feeder) +Delay Time
    - Stop H6204 (wet blower) +Delay Time
STEP 2: Drying system cooldown
    - Reduce steam valve to 10%
    - Maintain fan at 30% for 10 minutes
    - When TT-103 < 50°C, stop fan

STEP 3: Complete shutdown
    - Close steam valve
    - Isolate system
    - Purge if necessary
```

3.3. EMERGENCY SHUTDOWN SEQUENCE

```
TRIGGERS:
    - ESD button pressed
    - Explosion detected (XS-xxx)
    - Fire alarm
    - Power failure
    - Critical parameter deviation

ACTIONS:
    IMMEDIATE (0-2 seconds):
    1. Close all steam valves
    2. Stop all rotating equipment
    3. Activate suppression if needed

    FOLLOW-UP (2-30 seconds):
    4. Purge system with inert gas
    5. Isolate from plant
    6. Full system alarm
```

3.4. OPERATIONAL MODES

AUTO MODE:
- All control loops active
- Automatic startup/shutdown
- Recipe-based operation

MANUAL MODE:
- Operator control of individual devices
- Override capability
- For maintenance/troubleshooting

RECIPE MODE:
- Product-specific parameters
- Automatic adjustment for different starch types
- Historical data logging

4. MONITORING & DATA ACQUISITION

4.1. CRITICAL PARAMETERS MONITORING

TEMPERATURES (All TT-xxx):
- TT-S101: Steam header (0-220°C)
- TT-101: Dryer inlet (0-200°C)
- TT-102: Dryer process (0-200°C)
- TT-103: Fan inlet (0-200°C)
- TT-C101-C104: Condensate temperatures

PRESSURES (All PT-xxx & PG-xxx):
- PT-S101: Steam pressure (0-16 barg)
- PT-102/103: Process pressures (0-2 barg)
- Trend analysis for filter clogging detection

FLOW:
- FT-S101: Steam flow (0-xxx kg/hr)
- FT-C101: Condensate flow

```
MOISTURE:
    - MT-101: Product moisture (0-50%)
```

4.2. EQUIPMENT STATUS MONITORING

```
MOTOR STATUS:
    - V6515: Fan status, speed, vibration (VT-V6515)
    - Temperature monitoring: TT-V6515A/B (motor), TT-V6515C/D (bearings)

ROTATING EQUIPMENT:
    - Speed sensors ST-M1 to ST-M7
    - Vibration monitoring for predictive maintenance

LEVEL MONITORING:
    - LSH-B6506 to LSH-B6512: Hopper/silo high level
    - LSL-B6512: Silo low level
    - LT-B6515: Condensate tank level
```

4.3. ALARM MANAGEMENT

Priority 1 (Critical - Red):

- Explosion sensor activation
- Temperature > 185°C
- Motor failure
- Safety system fault

Priority 2 (High - Orange):

- Temperature deviation > 10°C
- Pressure deviation > 20%
- Moisture out of spec
- Level alarms

Priority 3 (Medium - Yellow):

- Equipment warning
- Maintenance due
- Efficiency drop

5. ADDITIONAL CONTROL STRATEGIES

5.1. ENERGY OPTIMIZATION

```
text
IF Condensate temperature (TT-C104) < 85°C THEN
    Adjust steam trap operation
    Optimize heat recovery
ENDIF

Fan speed optimization based on:
    - Pressure drop across system (PT-102 to PT-103)
    - Product moisture content
    - Energy consumption
```

5.2. PRODUCT QUALITY ASSURANCE

```
text
Continuous monitoring:
    - Moisture consistency (MT-101 trend)
    - Temperature profile (TT-101, TT-102, TT-103)
    - Residence time calculation
    - Product throughput rate
```

5.3. PREVENTIVE MAINTENANCE TRIGGERS

```
text
Vibration monitoring (VT-V6515):
    IF > 4.5 mm/s THEN Warning
    IF > 7.0 mm/s THEN Alarm + Schedule maintenance

Bearing temperature (TT-V6515C/D):
```

```
    IF > 85°C THEN Investigate
    IF > 95°C THEN Schedule maintenance
```

6. CONTROL SYSTEM ARCHITECTURE

6.1. HARDWARE CONFIGURATION

```
PLC System:
    - Redundant processors
    - Distributed I/O stations
    - Safety PLC for ESD functions

Field Devices:
    - 4-20mA analog signals (majority)
    - Digital inputs for status/interlocks
    - Profibus/Profinet for smart devices

Human-Machine Interface:
    - Redundant operator stations
    - Engineering workstation
    - Mobile access for maintenance
```

6.2. COMMUNICATION PROTOCOLS

```
- MODBUS TCP/IP for PLC to DCS
- PROFINET for field devices
- OPC UA for data historian
- Wireless for mobile devices
```

7. IMPLEMENTATION PRIORITY

PHASE 1 (Immediate - Safety):

1. ESD system implementation

2. Temperature safety interlocks
3. Door safety interlocks

PHASE 2 (Short-term - Basic Control):

1. Moisture-temperature cascade control
2. Basic sequence control
3. Critical parameter monitoring

PHASE 3 (Medium-term - Optimization):

1. Advanced control algorithms
2. Energy optimization
3. Predictive maintenance

PHASE 4 (Long-term - Integration):

1. Full plant integration
2. Advanced analytics
3. Remote monitoring

8. KEY PERFORMANCE INDICATORS

```
text
1. Product Moisture Consistency: ±0.5%
2. Energy Consumption: ≤0.608 ton steam/ton product
3. System Availability: >98%
4. Safety Incident Rate: 0
5. Maintenance Cost: <2% of CAPEX annually
```

This comprehensive control strategy ensures safe, efficient, and reliable operation of your modified starch drying system while meeting all your specified requirements and incorporating industry best practices.