

Background

- Scaling reduces system reliability
- CaCO₃ is the main issue
- Packed-bed enables controlled precipitation

Problem statement

- Scaling → efficiency loss + fouling
- Need controlled removal & retention
- Maintain stable operation

Specification & Constrains

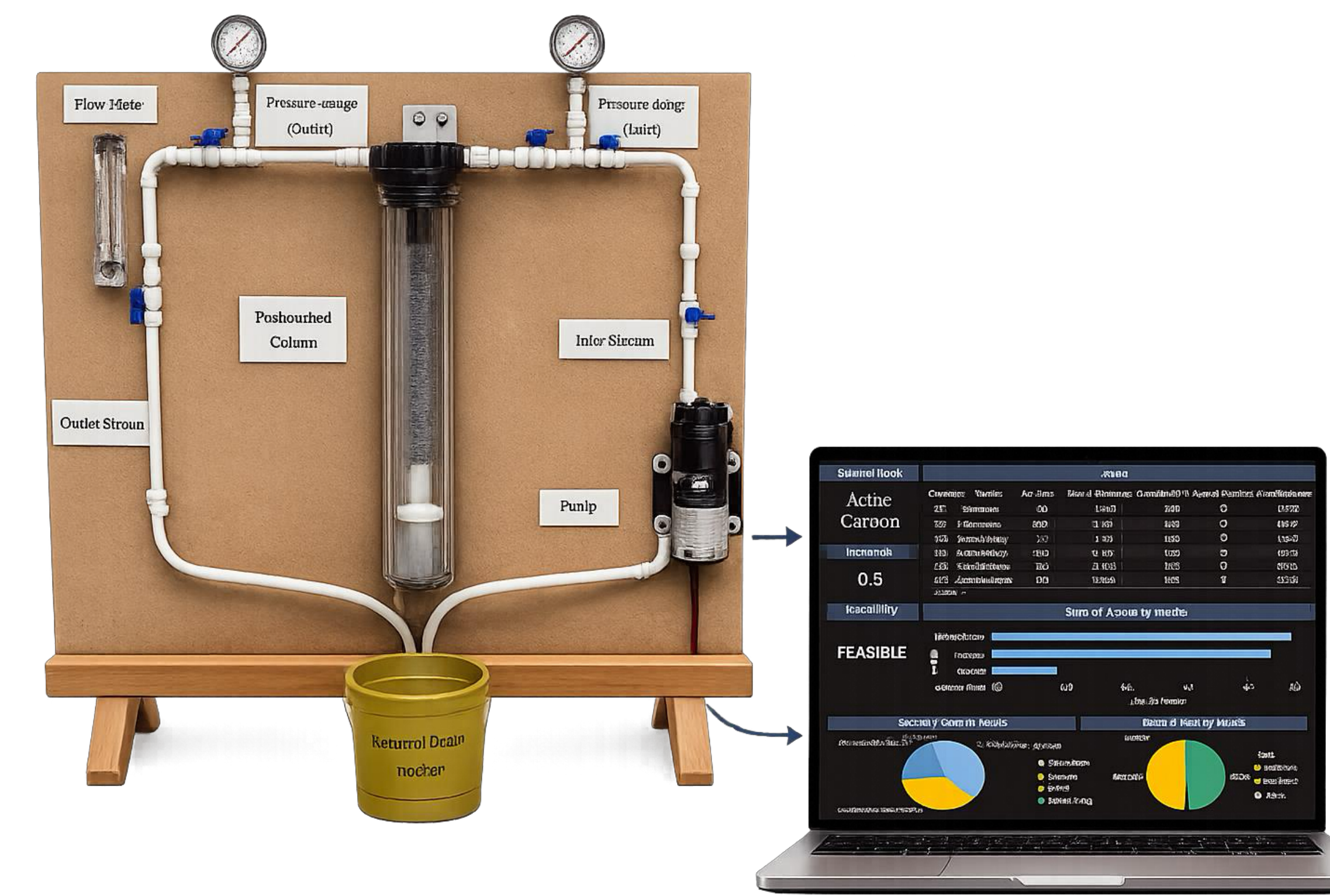
SPECIFICATIONS

- ≥ 0.2 g CaCO₃ per run
- ≥ 70% solids retention in packed media
- Turbulent flow (Re > 4000)
- Velocity: 0.5–2.0 m/s
- Pressure: 5–30 bar
- Dashboard with 3 scenarios (Worst / Base / Optimized)
- Includes success, control, and feasibility analysis

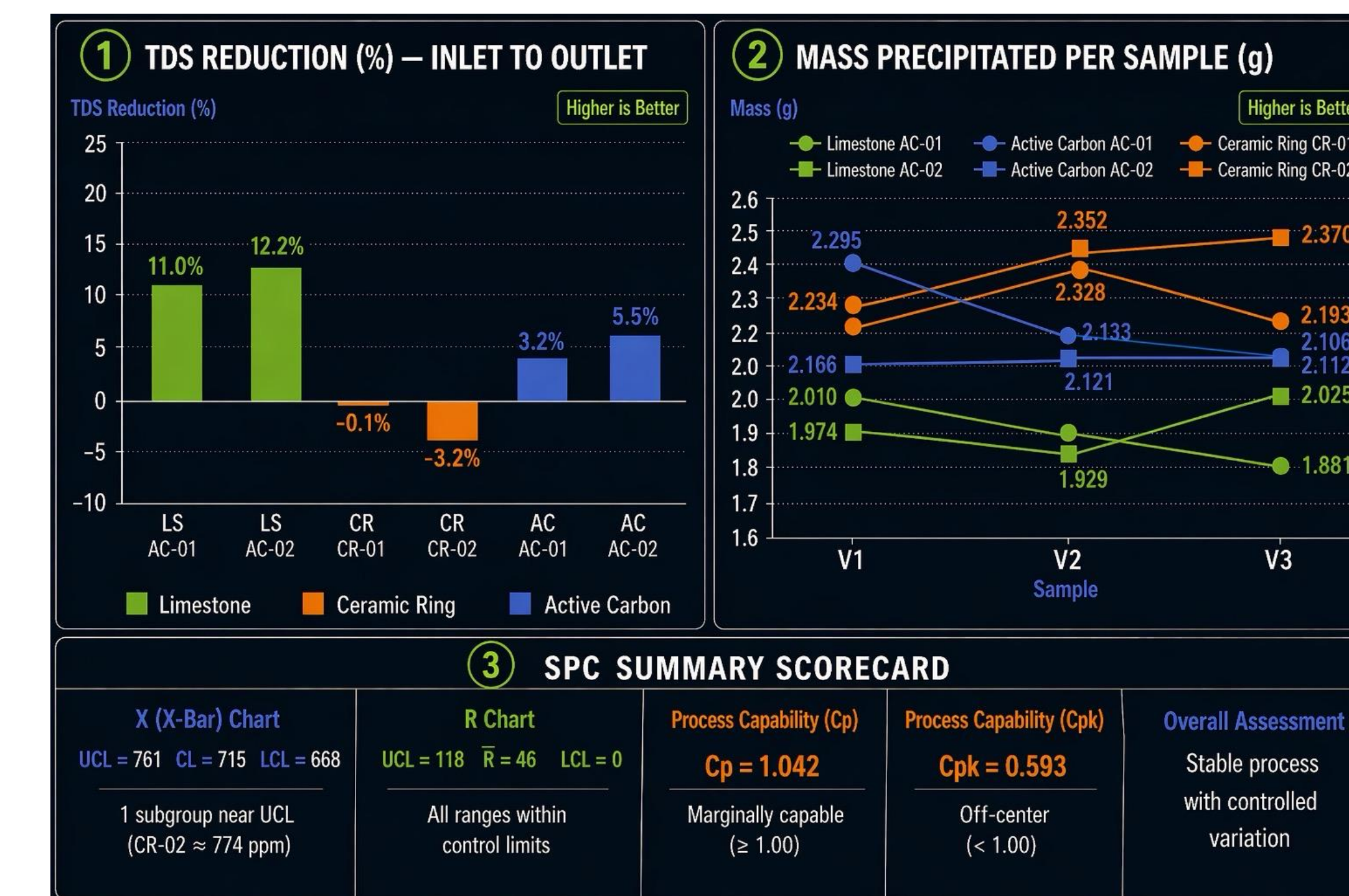
CONSTRAINTS

- Fixed solution volume ≥ 3 L
- Bed height: 15–25 cm
- Control valve to simulate worst-case scaling zone
- System decision generated within ≤ 30 s

Prototype

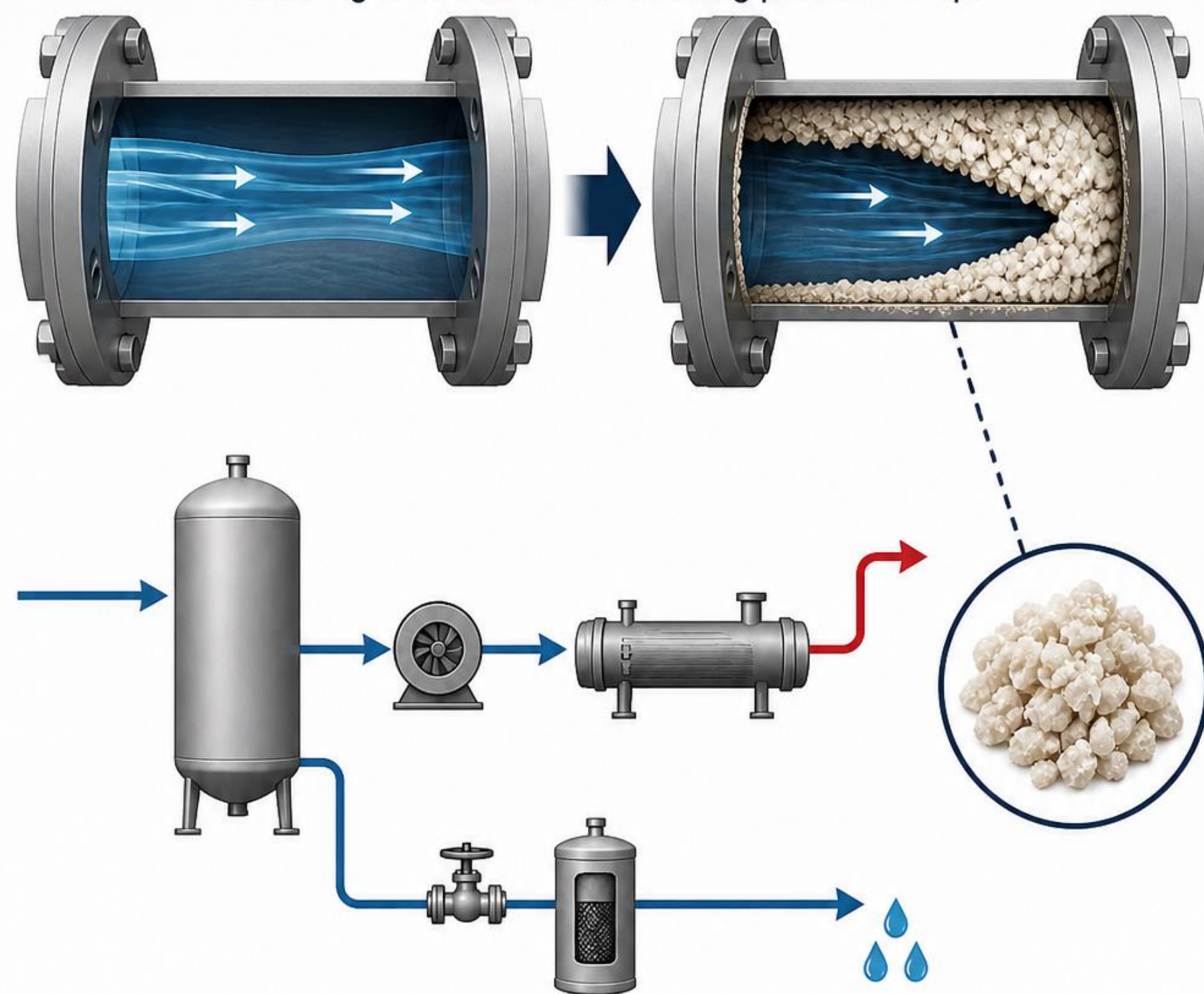


Testing / Validation



THE PROBLEM SCALE FORMATION IN PIPELINES

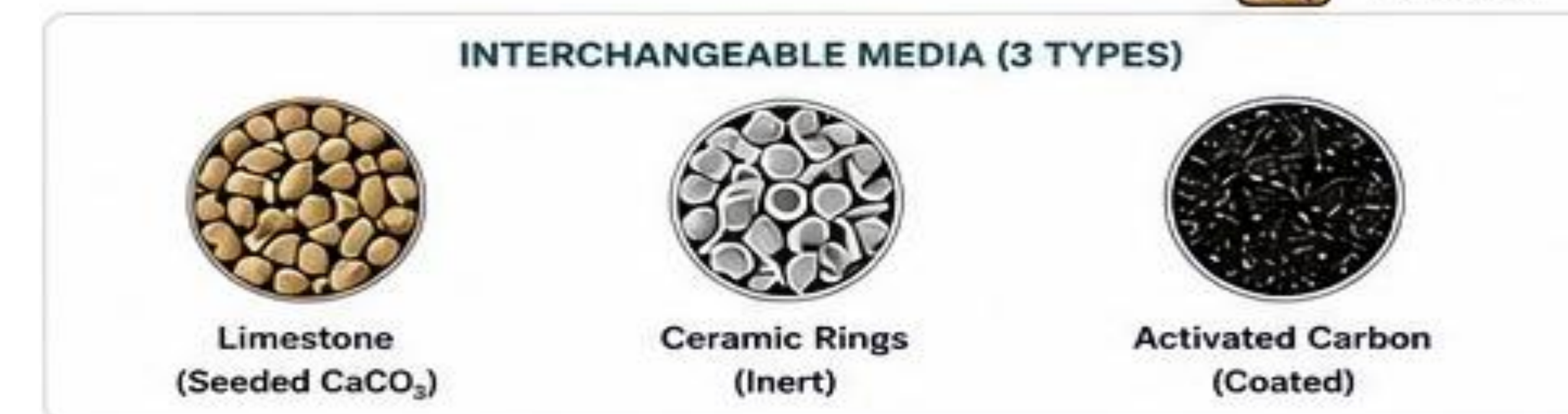
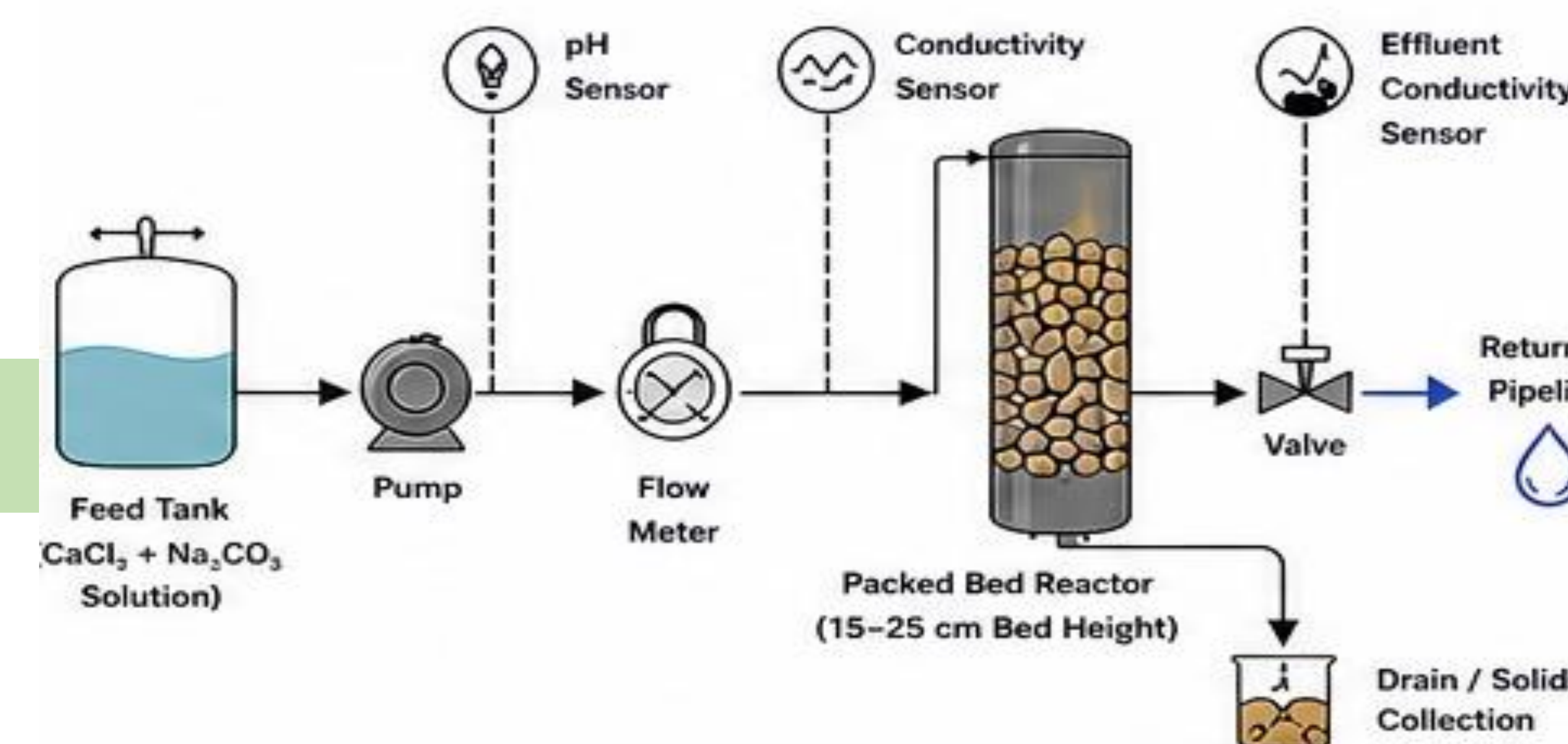
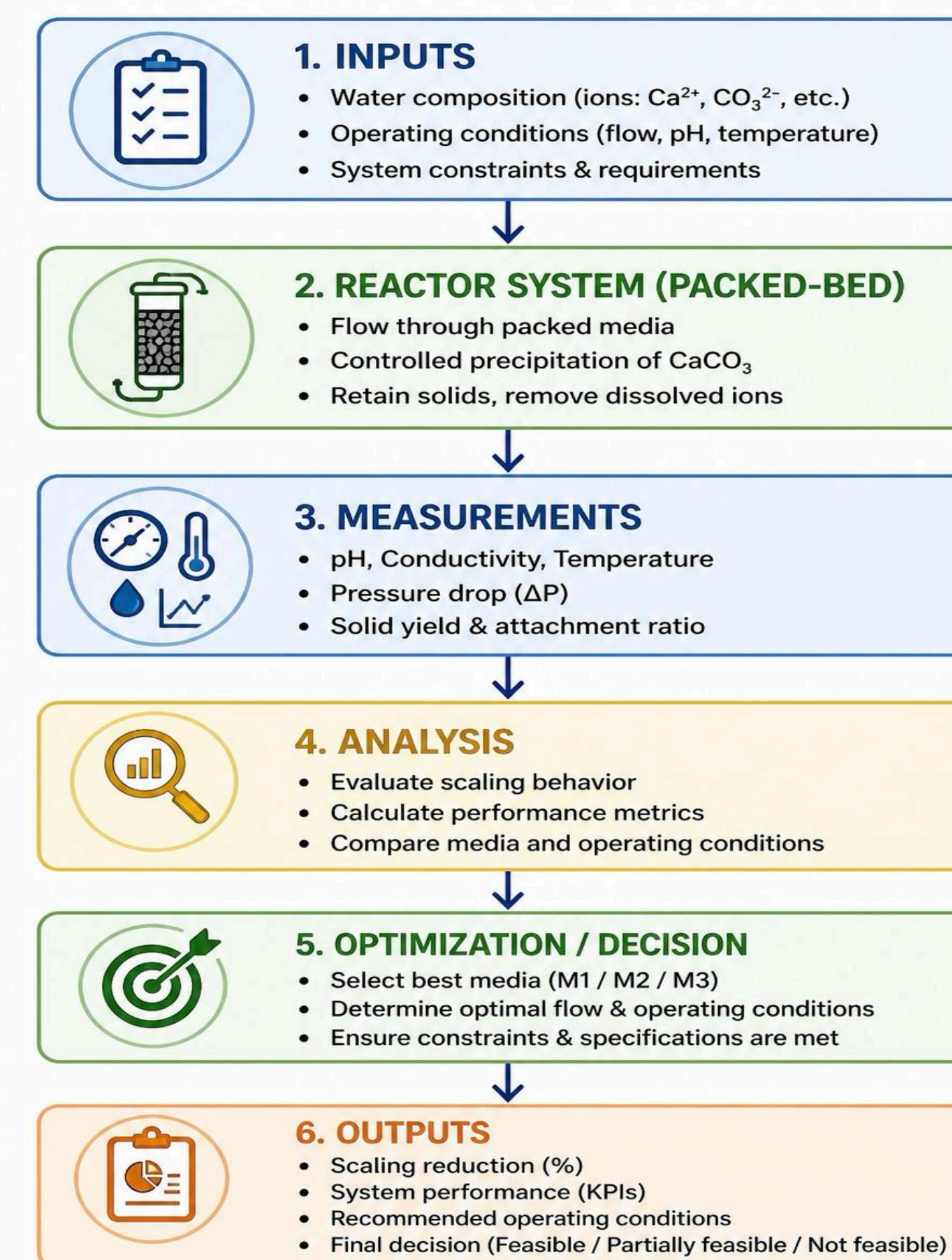
Calcium carbonate (CaCO₃) scale builds up on pipe walls, reducing flow area and increasing pressure drop.



- REDUCES FLOW AREA
- INCREASES PRESSURE DROP
- LEADS TO HIGHER ENERGY CONSUMPTION
- INCREASES MAINTENANCE AND DOWNTIME

UNCONTROLLED SCALING CAUSES HIGHER COST, LOWER EFFICIENCY, AND RELIABILITY ISSUES.

Block Diagram



Conclusion

- Scaling relocated to a controlled reactor
- Media & conditions affect precipitation
- Feasible for scaling management

CONDUCTIVITY & TDS MEASUREMENT



WHAT WE MEASURE

- Conductivity (mS/cm)
- TDS (ppm)
- Temperature (°C)

WHY IT MATTERS

Monitors ion concentration and ensures stable operating conditions during scaling experiments.

BENEFITS

- Real-time monitoring
- Data accuracy
- Process reliability

