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International Commission on Irrigation and Drainage (ICID)

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Hydrocyclone Separators for Smart Irrigation Water Security

2nd Indo Global Irrigation Summit
24-25 June 2026, New Delhi India

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Hydrocyclone Separators for Smart Irrigation Water Security

cbs Technologies

Greater Noida, Uttar Pradesh, India

Manufacturer under Make in India initiative
Technology Transfer: ECE, Netherlands | Performance Validated by IIT Delhi

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The Silt Challenge in Indian Irrigation

- India irrigates **68 million hectares** — most fed by sediment-laden rivers
- Himalayan rivers carry **1,000–5,000 ppm** suspended sediment in monsoon and glacial melt
- Result: pump impellers erode in **8–12 months**, seals fail every **4–6 months**
- Scheme downtime: **15–20 days/year**; energy use rises **15–25%** on eroded impellers
- Maintenance burden **exceeds original capital cost** of the installation

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Hydrocyclone Technology — The Solution

How it works:

- Centrifugal force separates solids from water in a single pass
- **No moving parts, no filter media, no extra energy**

CbS system specifications:

- **Make in India** manufacture | Tech transfer from **ECE, Netherlands**
- Cut size: **40 µm at >90% efficiency**
- Capacity: **1 to 3,200 m³/hr** per unit
- **SCADA-compatible** for remote monitoring
- https://www.youtube.com/watch?v=75XPvR0oTDw

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Hydrocyclone Separator — How It Works

Operating Principle — 5 Steps

1. **Entry** Liquid with solids enters tangentially, creating high-speed centrifugal flow
2. **Acceleration** SHI top-inlet accelerates flow for optimal centrifugal action (>100G)
3. **Separation** Centrifugal force moves solids to chamber walls; they drop to collection chamber
4. **Cleaned Liquid** Particle-free water rises through the vortex and exits the top outlet
5. **Solids Removal** Solids are periodically or continuously purged from the collection chamber

Removes 98% of 70µm+ solids — No moving parts — No filter media

Process Flow — Sand Eliminator

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Independent Validation by IIT Delhi

- Tested by **Prof. Raj Kumar Pandey, PhD** — Mechanical Engineering, IIT Delhi
- Ref: **IITD/IRD/CW16791/488405** Certified: **17 March 2026**
- Test standard: **IS 14743:1999** (Bureau of Indian Standards)
- Test medium: SAE J726 coarse dust at multiple concentrations and flow rates

"An efficient single-pass technology for separation of solids/silt/algae from liquid streams."

— Prof. R.K. Pandey, IIT Delhi


INDIAN INSTITUTE OF TECHNOLOGY DELHI
Department of Mechanical Engineering
Raj Kumar Pandey, PhD
Professor
Certificate of Performance of Hydrocyclone Separators
Dr. Raj Kumar Pandey

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IIT Delhi Test Results — Separation Efficiency

Particle Size Range	Separation Efficiency	Pressure Drop	Standard
≥ 70 µm	> 98 %	< 1.0 bar	IS 14743:1999
40 – 70 µm	> 90 %	< 1.0 bar	IS 14743:1999
< 40 µm	> 65 %	< 1.0 bar	IS 14743:1999

Certified by Prof. R.K. Pandey, IIT Delhi — Ref: IITD/IRD/CW16791/488405, 17 March 2026

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Case Study: Dunda Lift Scheme, Uttarakhand

- Location: **Block Dunda, Uttarkashi, Uttarakhand**
- Source: **Bhagirathi River** (glacially-fed)
- Contract: **Agg-20/A.E.I/2024-25** with Executive Engineer, Laghu Dal Khand, Uttarkashi
- Unit: **Mild steel hydrocyclone, 60–125 m³/hr** (nominal 100 m³/hr)
- Installed **downstream of river intake pump** — protects entire network
- Commissioned Feb 2025; certified Dec 2025

Protected pump-house piping & valves
Source-level treatment keeps downstream pumps, valves and gauges silt-free — extending the life of the whole network.

CbS hydrocyclone unit — Bhagirathi intake

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Field Performance — Before vs. After Installation

Performance Parameter	Before	After	Change
Pump impeller replacement interval	8–12 months	> 36 months	~3× longer
Mechanical seal life	4–6 months	> 12 months	~2.5× longer
Valve wear incidents	Frequent	Minimal	Significant
Water quality (visual)	Turbid / silty	Clear	Marked improvement
Maintenance schedule	Monthly	Quarterly	75% reduction
Pump energy consumption	Baseline	−8 to −12%	Energy savings
System downtime (days/year)	15–20	< 5	~75% reduction

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Economic Analysis — Dunda Lift Scheme

Cost / Saving Category	Annual Saving (₹)	Notes
Pump impeller replacements avoided (2/yr)	80,000	At ₹40,000 each
Extended mechanical seal life	35,000	4 seals
Reduced maintenance & labour	25,000	10 visits avoided
Energy savings (~10% efficiency gain)	45,000	On energy bill
Pipeline & valve repair reduction	20,000	Conservative
TOTAL ANNUAL SAVINGS	**₹ 2,05,000**	**Dept. verified**
System cost (installed, incl. GST)	**₹ 4,96,780**	**Govt. contract**
SIMPLE PAYBACK PERIOD	**2.4 YEARS**	**–**

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National-Scale Potential

Scaling the proven Dunda outcome across India

15,000	5,000	₹3–4.5K Cr	60–80%
Govt. lift schemes	**Schemes retrofittable**	**Annual savings**	**Lifespan extension**
Currently operating in India	200–2,000 m³/hr range	Projected at full scale	Of retrofitted infrastructure

Investment of ₹ 750–1,250 crore generates 3-4× annual return and extends infrastructure life

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Smart Irrigation Integration & Key Findings

Source-level treatment is the foundation of any smart irrigation system:

- Flow meters, automated valves and drip emitters (2–4 L/hr) all fail when silt enters the network — clog threshold is **9 mm**
- CbS units transmit differential-pressure data to **PLCs / IoT gateways** for predictive maintenance

Key conclusions:

- IIT Delhi certified: **>98% / >90% / >65%** efficiency across particle size ranges
- Dunda field: **~2× pump life, 75% downtime cut, payback in 2.4 years**
- Closes the **farm-scale (≤50 m³/hr) to canal-scale (3,200 m³/hr)** capacity gap

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Integrating AI into Hydrocyclone Systems

From passive centrifugal separation to intelligent, self-optimising water management

Three pillars of AI integration:

- **Predictive Maintenance** — ML models on pressure & flow data predict clogging and wear before failure occurs
- **Real-Time Process Optimisation** — AI auto-adjusts inlet pressure & underflow valves to maximise separation efficiency
- **Intelligent Monitoring & Alerts** — Cloud dashboards with anomaly detection, remote diagnostics, and operator alerts

CbS hydrocyclones are already SCADA-compatible — AI is the logical next layer on existing sensor infrastructure

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AI for Predictive Maintenance & Anomaly Detection

How it works with CbS hydrocyclones:

- Existing **differential-pressure sensors** feed SCADA/PLC gateways every 30 seconds — AI baseline models flag deviations >15% as early-warning alerts
- Machine learning models (LSTM / gradient boosting) trained on **seasonal silt load patterns** (monsoon, glacial melt) predict peak clogging risk 48–72 hours ahead
- Cloud dashboard sends **WhatsApp / SMS / email alerts** to field operators — zero need for on-site inspection to trigger maintenance action

Expected outcome:

- Unplanned downtime cut by a further **30%** beyond the 75% already achieved at Dunda; maintenance cost reduced by an estimated **₹50,000–80,000/yr per scheme**

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AI-Driven Process Optimisation & Water Quality Control

Real-time separation optimisation:

- AI models transmit turbidity, flow rate and inlet pressure in real time — automatically adjusting **underflow valve aperture** to sustain >90% efficiency even as silt concentration spikes
- Reinforcement learning optimises **pump speed vs. cyclone cut size** trade-off — cutting energy use by a further 5–8% over and above existing gains

Digital twin & national data network:

- A **digital twin** of each installation enables simulation of monsoon surge scenarios before they occur, letting operators pre-position resources
- Aggregated data from 5,000+ retrofitted schemes feeds a **national silt intelligence platform** under Jal Shakti Abhiyan — enabling river-basin level water quality management

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AI-Enhanced Benefits — CbS with Intelligence

Projected uplift on top of baseline CbS performance at Dunda — with AI layer

>90%	₹80K/yr	5–8%	<1.8 Yrs
Downtime reduction	**Extra savings per scheme**	**Additional energy saving**	**AI-enhanced payback**
AI predictive alerts vs. reactive maintenance	AI-driven maintenance scheduling	AI optimising pump speed vs. cut size	Down from 2.4 yrs (baseline CbS)

AI integration on existing CbS infrastructure: sensor overlay + cloud software — no hardware redesign required — deployable from Day 1

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Recommendations for Policy & Procurement

- **(a)** Mandate hydrocyclone separation at intake of all new lift schemes from sediment-loaded rivers
- **(b)** Retrofit highest-maintenance schemes in each state as monitored proof-of-concept installations
- **(c)** Include large-capacity hydrocyclones (≥ 100 m³/hr) under PM Krishi Sinchai Yojana subsidy
- **(d)** Require IS 14743:1999 + IIT/NABL certification in all government hydrocyclone tenders
- **(e)** Establish a national programme under Jal Shakti Abhiyan for Himalayan river-intake separation

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Thank You

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