Arab Academy
for Science , Technology and Maritime Transport

The International Maritime Transport and Logistics Conference

"MARLOG 13"

Towards Smart Green Blue Infrastructure

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EFFICIENT INDUSTRIAL WASTEWATER RECYCLING WITH IoT

Moamen A. Morsi , Yehia M. Youssef and Mohamed K. Hassan

Outlines

1. Introduction
2. Theoretical Background
3. Experimental Methods
4. Results and Discussion
5. Conclusions and Future Work

1. Introduction

Study Aim and Objectives

according to
topics

Problem Definition

Solving global water scarcity problem through essential treatment of diverse wastewaters, including industrial detergent effluents.

Study Aim

Applying the Concept of Quality 4.0 to enhance industrial wastewater for agricultural applications.

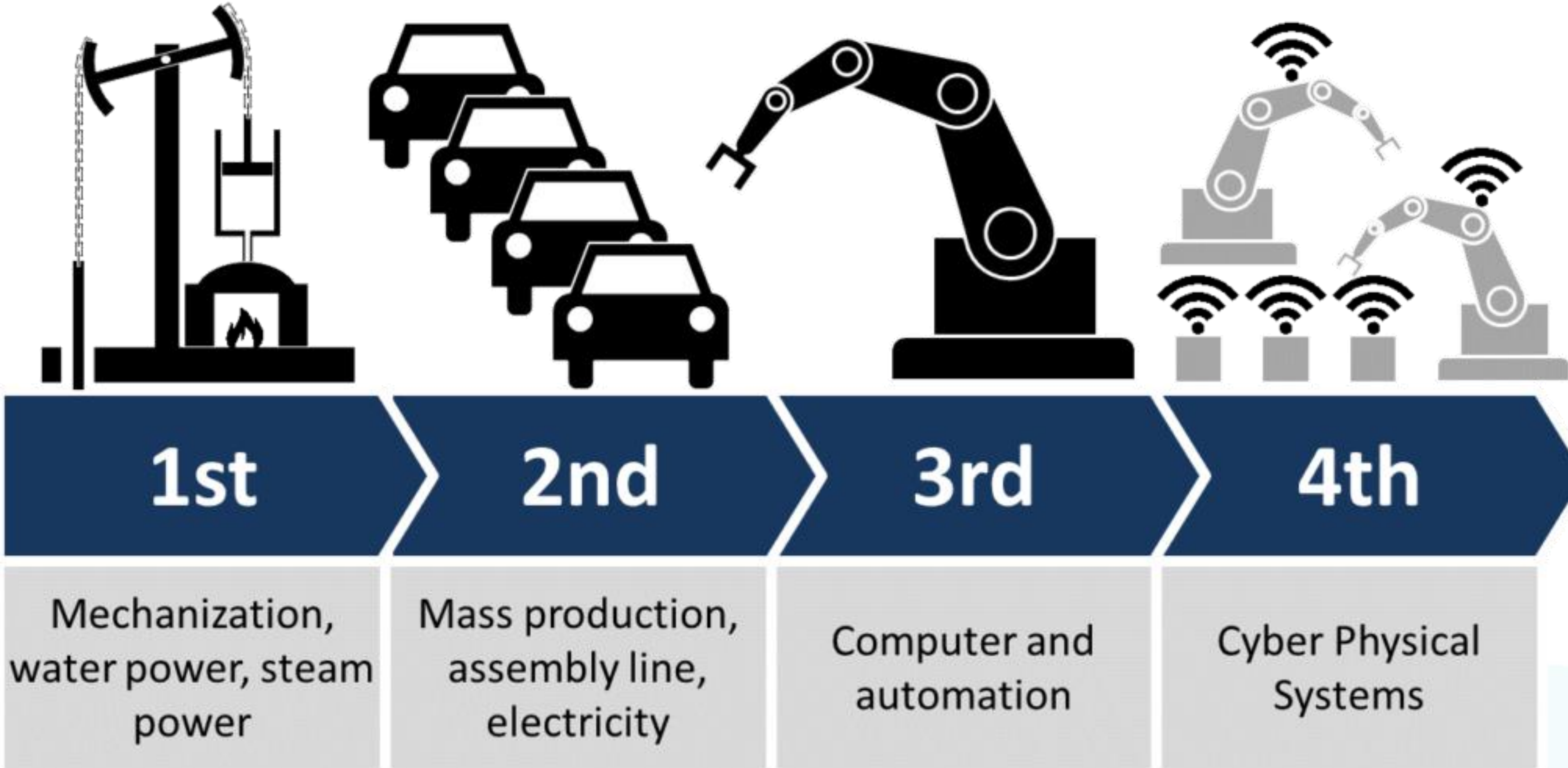
Study Objective

Enhance treated wastewater quality for safe agricultural use, integrating the Concepts of Quality 4.0 and Industry 4.0.

2. Theoretical Background

- Industry 4.0
- Quality 4.0
- Use of IoT in Wastewater Treatment
- Smart Wastewater Treatment System

Industry 4.0


1st
2nd
3rd
4th
Mechanization, water power, steam power
Mass production, assembly line, electricity
Computer and automation
Cyber Physical Systems

Industry 4.0


Autonomous Robots
Simulation
System Integration
Internet of Things
Cybersecurity
Cloud Computing
Additive Manufacturing
Augmented Reality
Big Data
INDUSTRY 4.0

Quality 4.0

Quality 1.0 (Prior to 1890)

- Productivity was priority
- Measurement and inspection
- Volume was prior over quality
- No focus on wastes

Quality 2.0 (1890-1940)

- Maximizing productivity
- Minimum acceptance quality level were defined
- Reduction of scrap
- Labour Performance

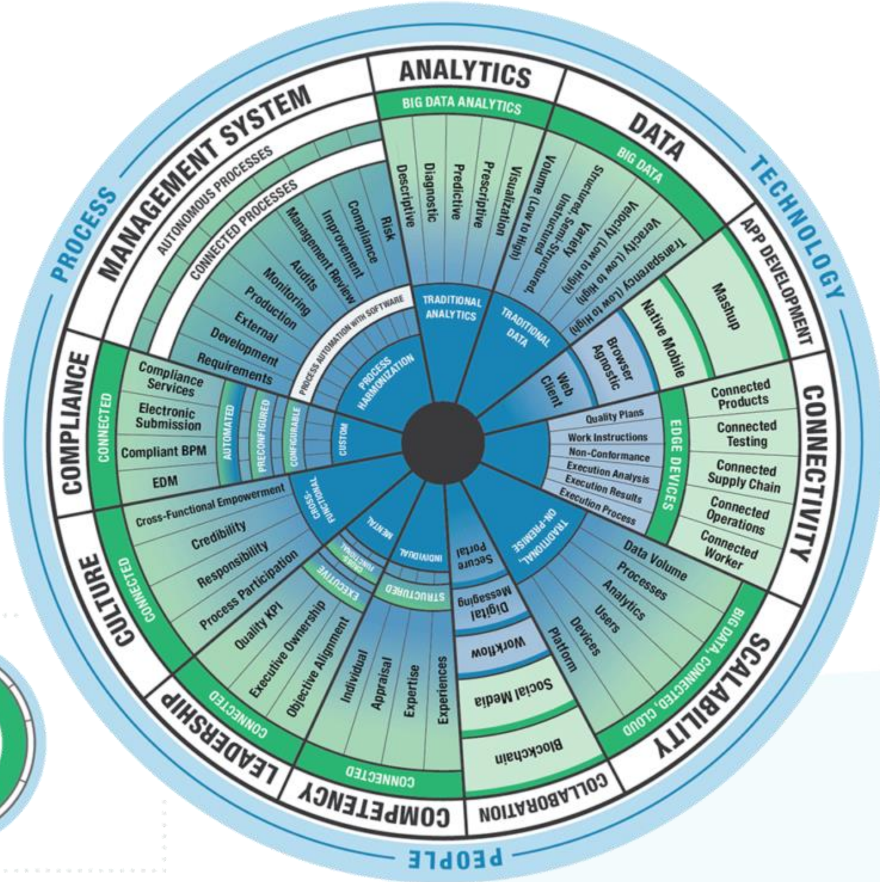
Quality 3.0 (1940-1995)

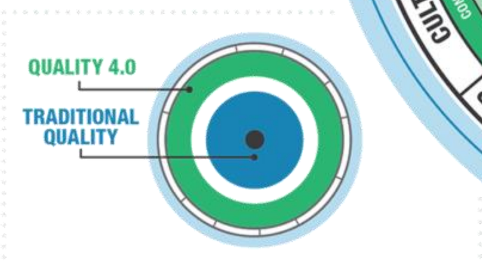
- Customer satisfaction
- Continuous Quality Improvement
- Standardization
- Quality is business need

Quality 4.0 (1995 to Present)

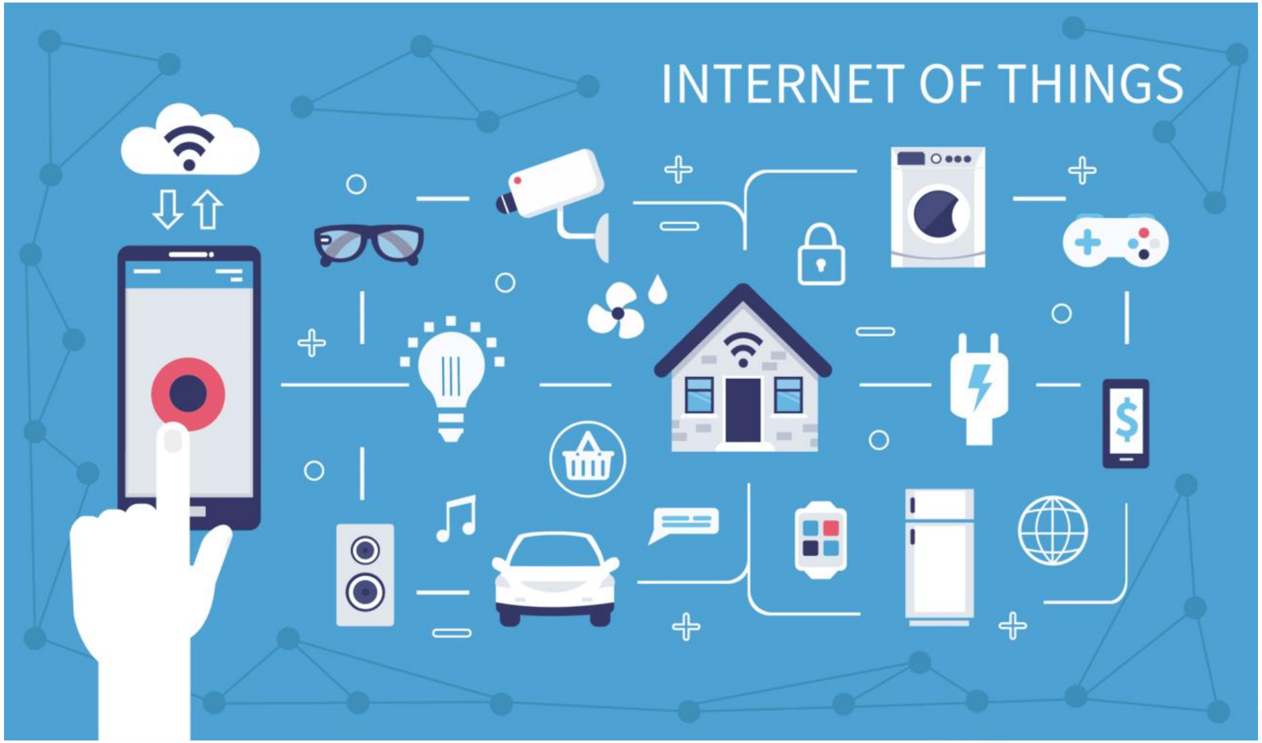
- Digitalization
- Adaptive learning
- Process design is focused
- Optimize quality and productivity
- Cyber-physical interaction

Quality 4.0


PROCESS
TECHNOLOGY
PEOPLE
MANAGEMENT SYSTEM
AUTONOMOUS PROCESSES
CONNECTED PROCESSES
Risk
Compliance
Improvement
Management Review
Audits
Monitoring
Production
External
Development
Requirements
PROCESS AUTOMATION WITH SOFTWARE
PROCESS HARMONIZATION
ANALYTICS
BIG DATA ANALYTICS
Descriptive
Diagnostic
Predictive
Prescriptive
Visualization
TRADITIONAL ANALYTICS
DATA
BIG DATA
Volume (Low to High)
Structured, Semi-Structured, Unstructured
Variety
Velocity (Low to High)
Veracity (Low to High)
Transparency (Low to High)
TRADITIONAL DATA
APP DEVELOPMENT
Mashup
Native Mobile
Browser Agnostic
Web Client
CONNECTIVITY
EDGE DEVICES
Connected Products
Connected Testing
Connected Supply Chain
Connected Operations
Connected Worker
Quality Plans
Work Instructions
Non-Conformance
Execution Analysis
Execution Results
Execution Process
SCALABILITY
BIG DATA, CONNECTED, CLOUD
Data Volume
Processes
Analytics
Users
Devices
Platform
TRADITIONAL, ON-PREMISE
COLLABORATION
Blockchain
Social Media
Workflow
Digital Messaging
Secure Portal
COMPETENCY
CONNECTED
Experiences
Expertise
Appraisal
Individual
STRUCTURED
INDIVIDUAL
LEADERSHIP
CONNECTED
Objective Alignment
Executive Ownership
Quality KPI
EXECUTIVE
MENTAL
CULTURE
CONNECTED
Process Participation
Responsibility
Credibility
Cross-Functional Empowerment
CROSS-FUNCTIONAL
COMPLIANCE
CONNECTED
Compliance Services
Electronic Submission
Compliant BPM
EDM
AUTOMATED
PRECONFIGURED
CONFIGURABLE
CUSTOM

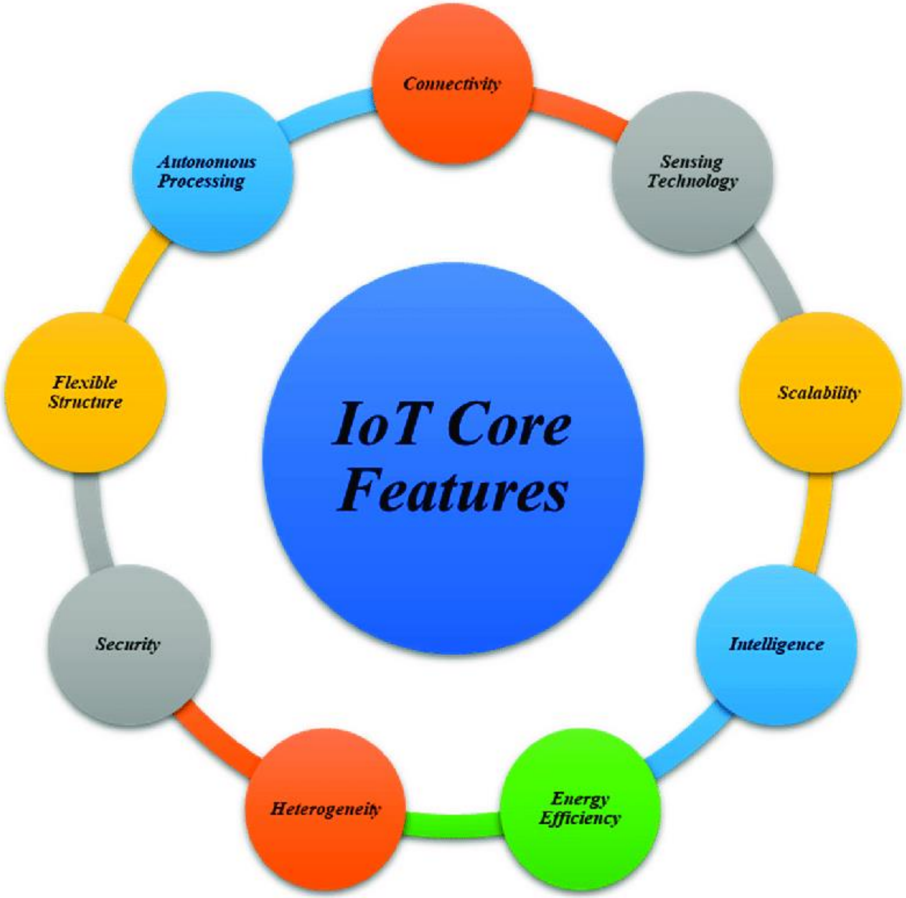

QUALITY 4.0
TRADITIONAL QUALITY

Internet of Things (IoT)

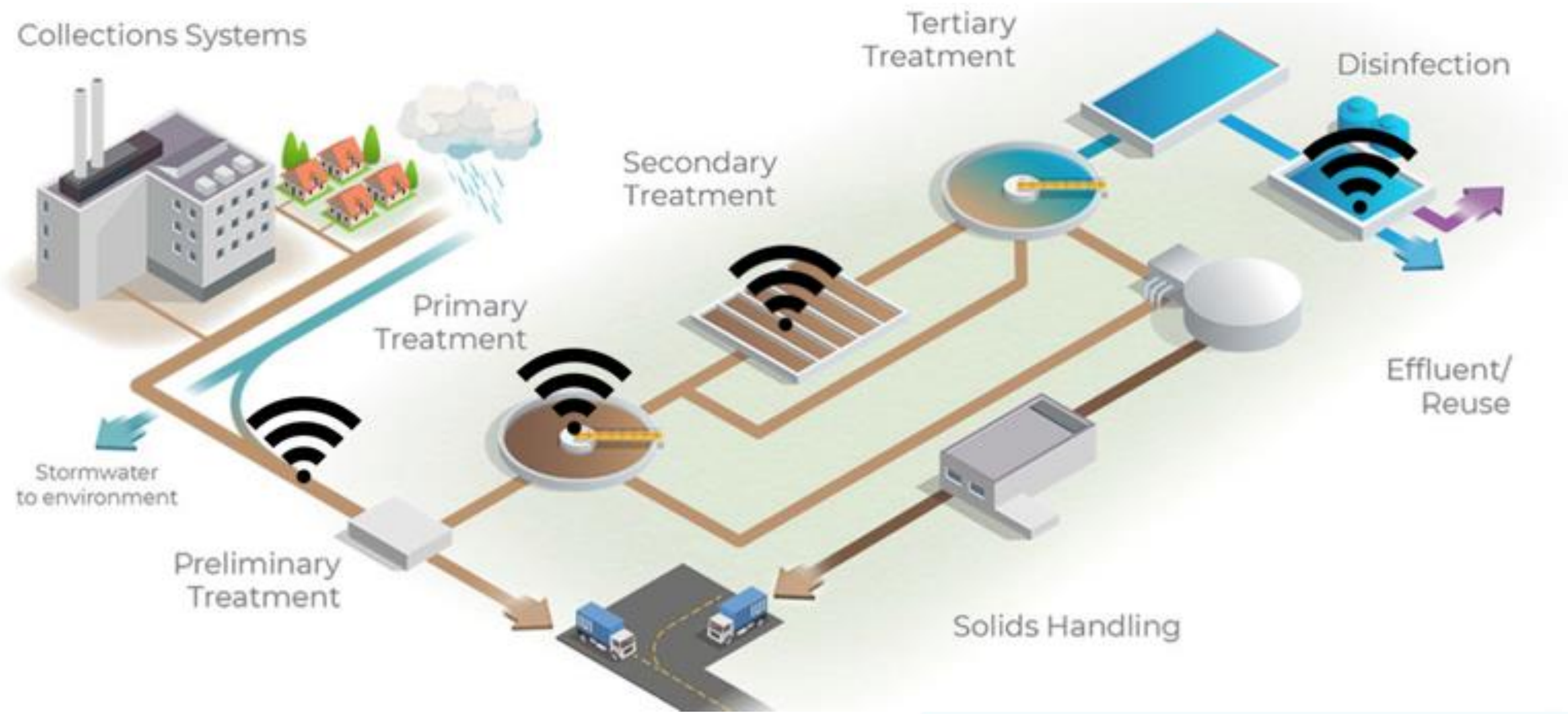


Internet of Things (IoT) is a network of interconnected devices that can communicate and share data over the internet.

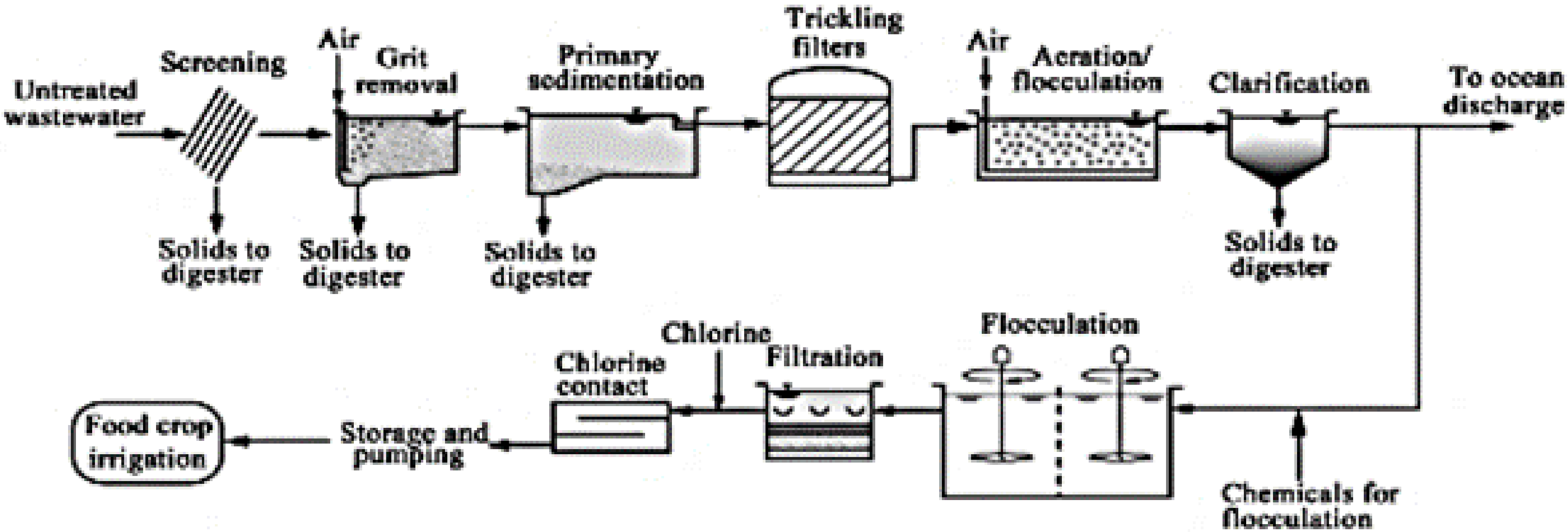
Internet of Things (IoT)



Smart water treatment system



Industrial Wastewater Treatment (Overview)



Case Study Applied to a Detergent Manufacturing Facility

Detergent Manufacturing Process

Detergent manufacturing combines solid and liquid ingredients, mixed, dehydrated, and filtered to create powdered detergent.

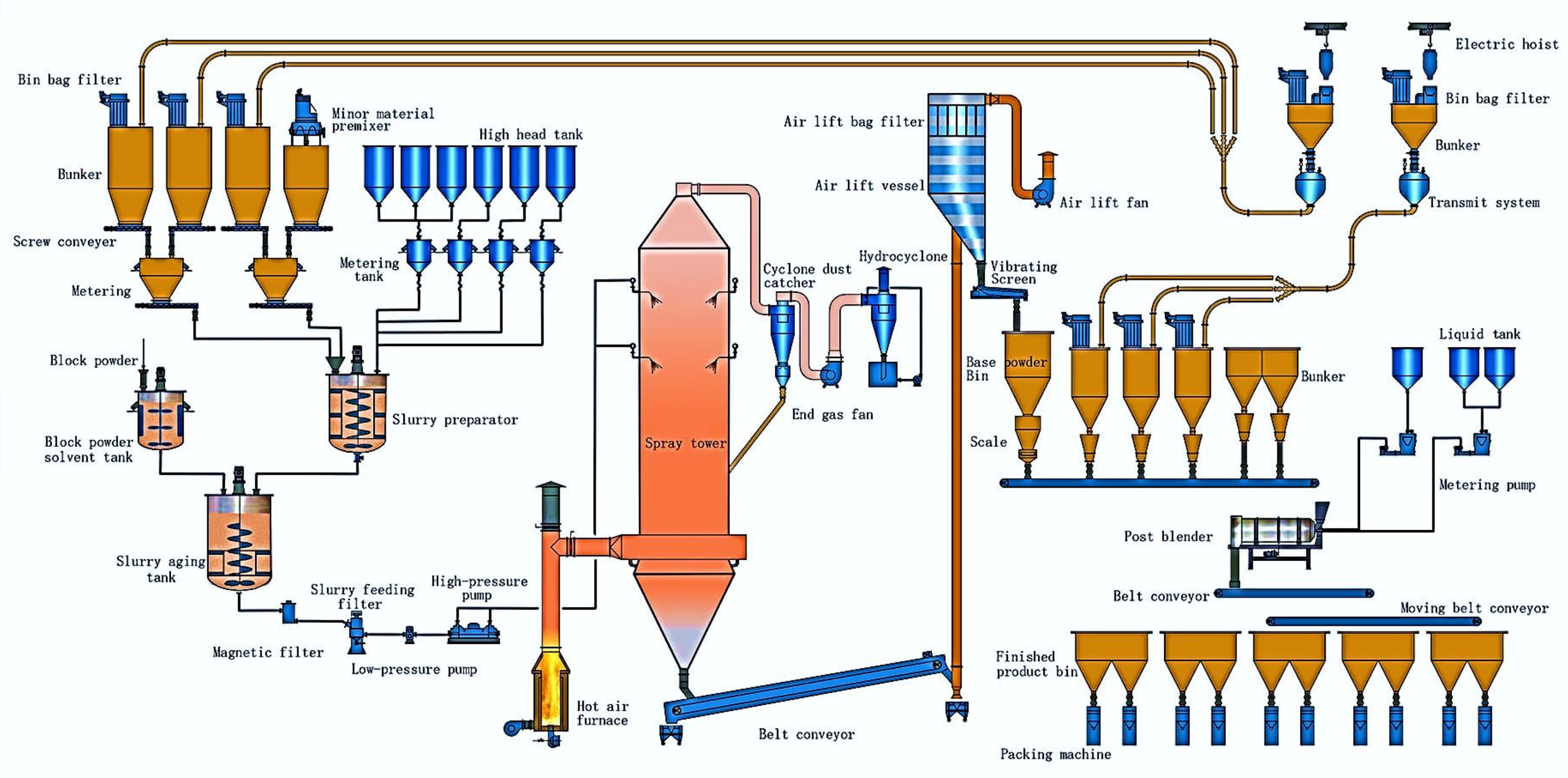
Solid Ingredients

- Soda ash
- Sodium tripolyphosphate
- Sodium perborate
- Carboxymethyl cellulose (CMC)

Liquid Ingredients

- Oils
- Water
- Sulfonic acid
- Oxygenated water
- Fragrances

Detergent Manufacturing Process



Detergents Manufacturing Process Wastewater Treatment

Detergent manufacturing wastewater, containing contaminants that is needed to be treated.

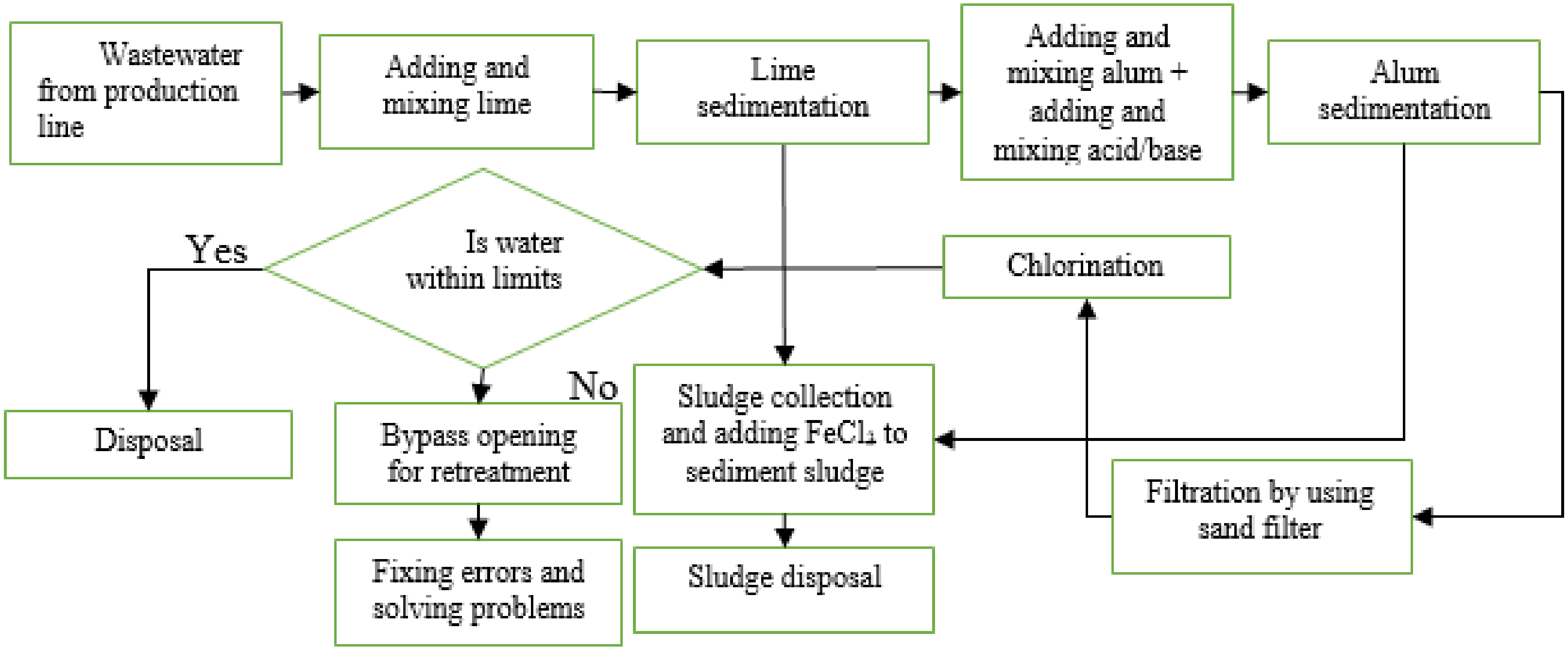
Pollutant	Treatment
Suspended Solids	• Plain Sedimentation • Chemically Enhanced Sedimentation • Filtration
Dissolved Solids (Inorganic)	• Sedimentation • Filtration
Unacceptable Acidity or Alkalinity	• pH Adjustment
Organic Contaminates	• Disinfection

3. Experimental Methods

according to
topics

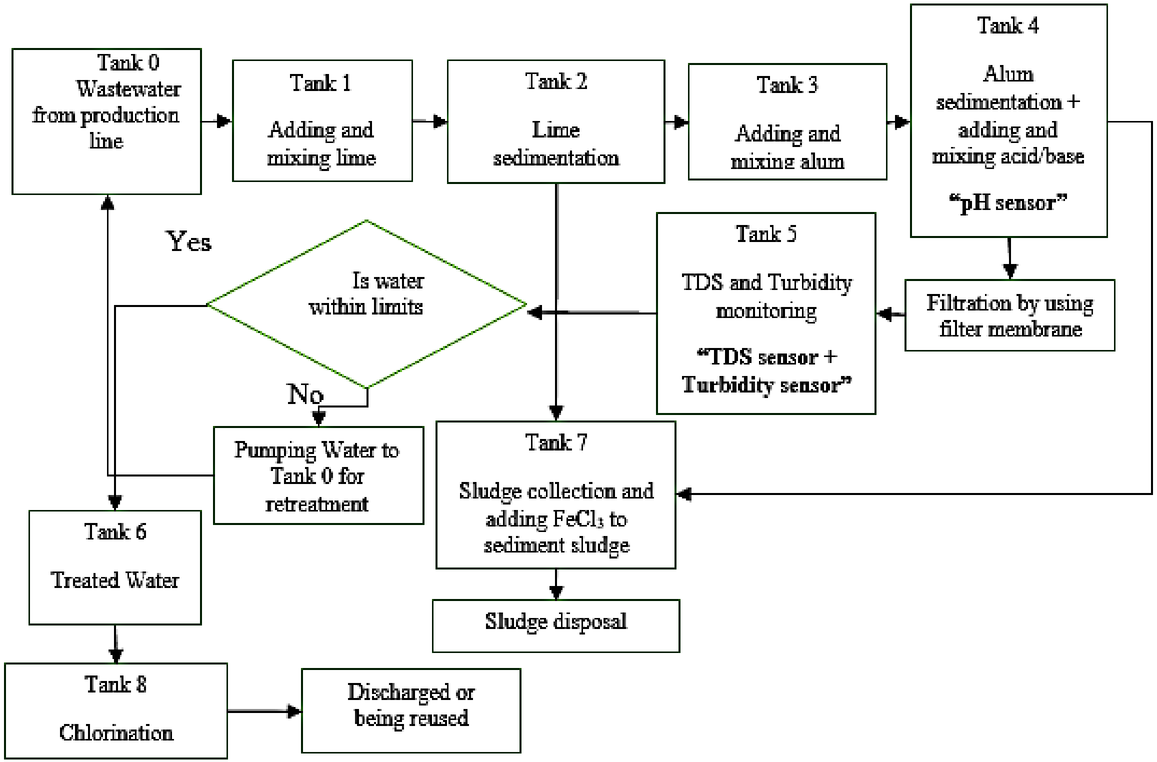
Traditional Wastewater Treatment

Manual or semi-automated water treatment processes with limited real-time monitoring, relying on periodic human intervention.



Smart Wastewater Treatment System (Pilot Model)

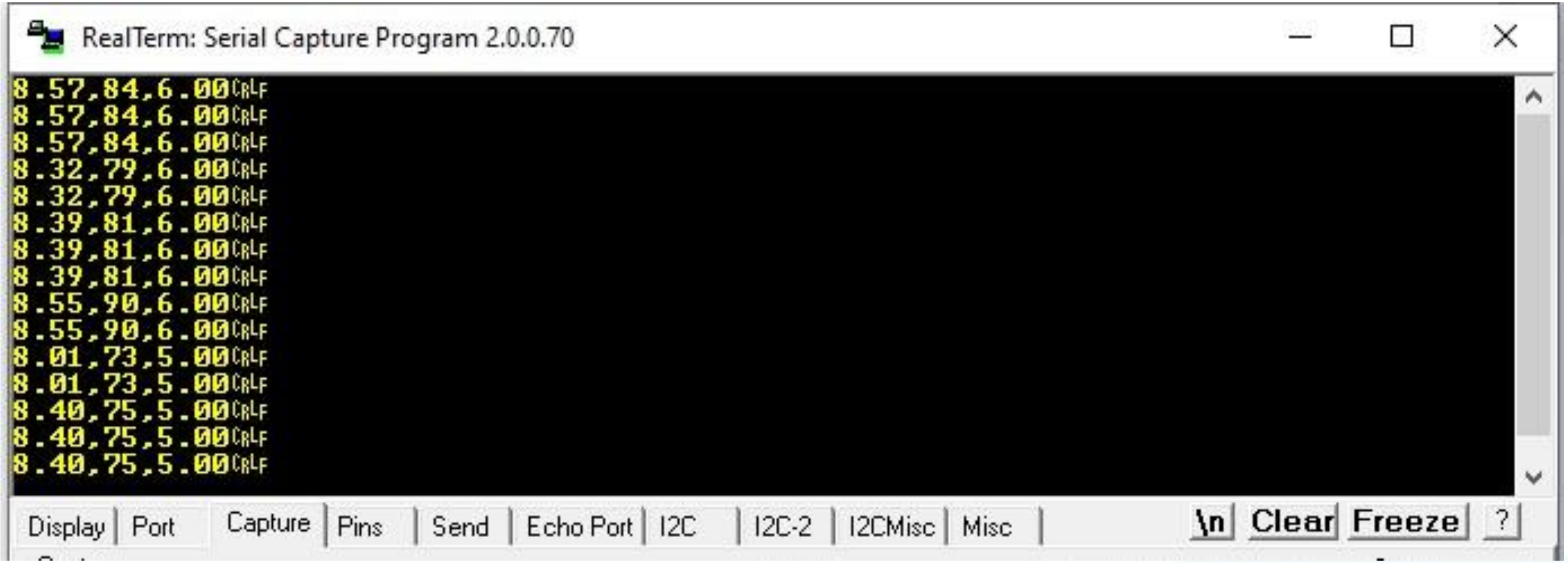
A wastewater treatment system that incorporates smart technology such as sensors, automation, and data analysis to optimize treatment processes.



Smart Wastewater Treatment System (Pilot Model)

```
void stageThreeFunc() {
  if (phValue == 0 || phValue > 14) {
  } else {
    if (phValue < PH_MIN) {
      pumpControl(acidPumb, OFF);
      pumpControl(basePumb, ON);
    } else if (phValue > PH_MAX) {
      pumpControl(acidPumb, ON);
      pumpControl(basePumb, OFF);
    } else {
      pumpControl(acidPumb, OFF);
      pumpControl(basePumb, OFF);
    }
  }
}
```

Smart Wastewater Treatment System (Pilot Model)



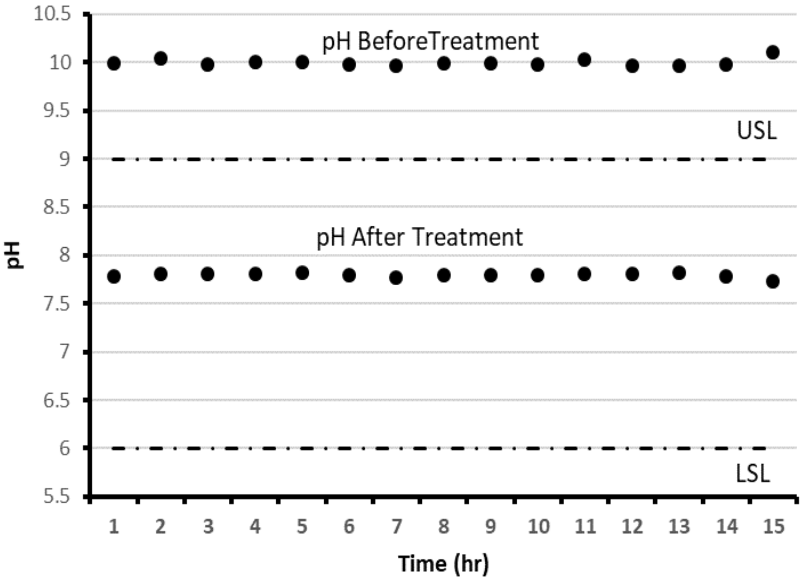
Traditional vs. Smart Wastewater Treatment Systems

Aspect	Traditional Wastewater Treatment System	Smart Wastewater Treatment System
Level of Automation	Manual or semi-automated	Incorporates smart technology
Real-time Monitoring	Limited	Enabled
Control	Periodic human intervention	Real-time control
Efficiency	Lower	Enhanced
Environmental Sustainability	Compliance-focused	Promotes sustainability
Operational Costs	Higher	Potential reduction
Initial Investment	Lower	Higher due to smart technology
Technical Expertise Requirements	Standard	Advanced
Data Security Concerns	N/A	Present

4. Results and Discussion

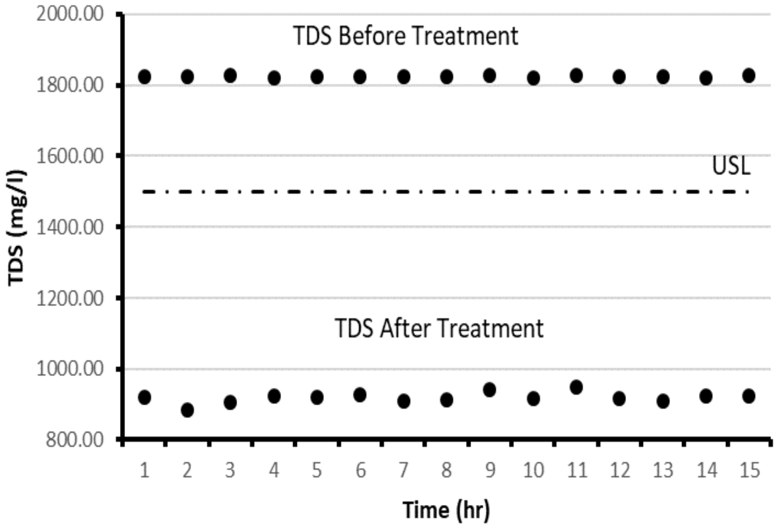
pH Control

- Basic components in wastewater rise pH parameter levels.
- Smart pH sensor enables real-time monitoring and control.
- pH adjustment control pH parameter



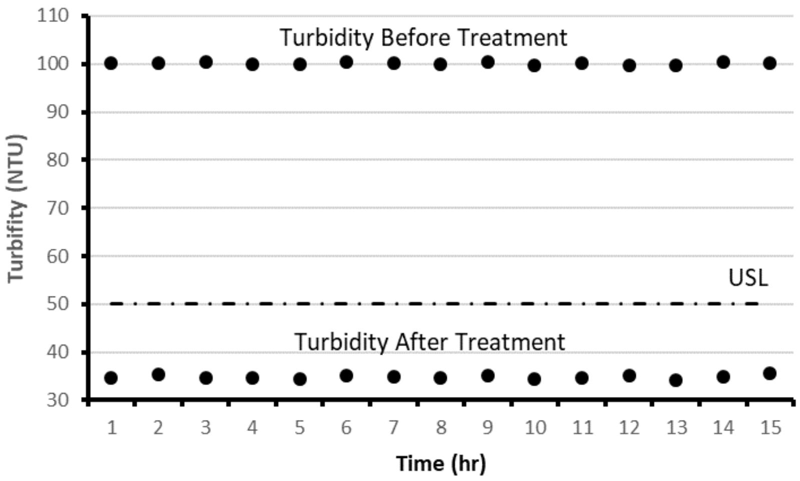
Total Dissolved Solids (TDS) Control

- The high TDS levels indicating pollution.
- Filtration and chemicals control TDS.
- Real-time monitoring ensures proper treatment.



Turbidity Control

- High turbidity signals pollution.
- Filtration and chemicals control turbidity.
- Sensors ensure treatment success.



Improvement Percentages in Water Quality Parameters

Point of comparison	Improvement Post-Treatment
pH	22.02%
TDS	49.61%
Turbidity	65.17%
Labor	83.33%
Chemical Costs	55.84%

5. Conclusions and Future Work

Conclusions

- Smart wastewater treatment system improved water quality parameters.
- Quality 4.0 integration enhanced efficiency, reduced cost of treatment, and ensured compliance with environmental regulations.
- Smart wastewater treatment offers a sustainable solution for industrial wastewater management.

Future Work

The following are possible suggestions for future work:

- **Scaling-up the system for wider industrial applications.**
- **Refine sensor technology for better monitoring and control of different water quality parameters .**
- **Explore more uses for treated wastewater in various applications.**

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Thank You