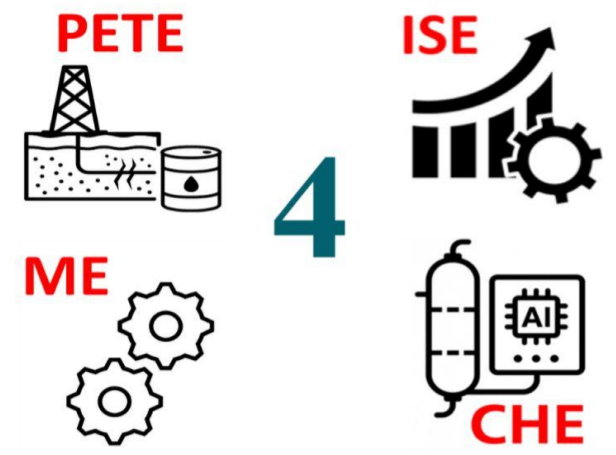


# CLAYDYN: Closed-Loop Drilling Mud Property Control and Mixing System

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## Background

Maintaining drilling mud properties is a critical safety and operational requirement. However, these properties are often monitored and corrected manually, which is slow and highly dependent on operator judgment. This delay can reduce the system's ability to respond to real-time downhole disturbances.

## Solution

CLAYDYN's closed-loop system continuously monitors drilling fluid behavior. It instantly detects density and rheology disturbances, automatically adjusting mixing speeds and precise additive dosing to restore mud properties in under five minutes.

## Constraints and Specifications

<b>CHE</b>	<b>C5</b> <b>Chemical handling:</b> Guarantee safe, SDS-based storage and proper laboratory labeling procedures.
	<b>S1</b> <b>Target density:</b> Maintain the steady fluid density at exactly $\rho = 1.20 \pm 0.01$ g/mL.
	<b>S4</b> <b>System recovery:</b> Return the fluid to all required targets strictly within five minutes.
<b>PETE</b>	<b>C3</b> <b>Mud disturbances:</b> Successfully handle simulated 10% water, 3 wt% NaCl, and drill cuttings.
	<b>S3</b> <b>Target yield:</b> Maintain the fluid yield point strictly at $YP = 20 \pm 2$ lb/100 ft <sup>2</sup> .
	<b>S5</b> <b>Target viscosity:</b> Maintain the fluid plastic viscosity strictly at $PV = 20 \pm 2$ cP.
<b>ME</b>	<b>C2</b> <b>Pump capacity:</b> Exceed 150 mL/min per pump with a strict 10% volume accuracy.
	<b>C4</b> <b>Hardware safety:</b> All mixing components must operate safely under continuous active running conditions.
	<b>C6</b> <b>Lab instruments:</b> Utilize commercial lab sensors for continuous system monitoring and accurate logging.
	<b>S2</b> <b>Solid dosing:</b> Keep the active calcium carbonate dosing rate strictly between (65-85) g/min.
	<b>S6</b> <b>Mixer control:</b> Keep the active impeller mixing speed within the [300, 600] rpm range.
<b>ISE</b>	<b>C1</b> <b>Project budget:</b> Keep the total automated prototype building cost strictly under 5500 SAR.
	<b>S7</b> <b>Data logging:</b> Record the exact impact, actions, and recovery times for all disturbances.
	<b>S8</b> <b>Cost optimization:</b> Minimize total chemical costs while achieving all targets within five minutes.
<b>SHARED</b>	<b>IS1</b> <b>System integration:</b> Cohesively link the automated dosing, mixing, measurement, and logging units.
	<b>IS2</b> <b>Real-time control:</b> Optimize the active setpoints to meet constraints while minimizing costs.
	<b>IS3</b> <b>Process validation:</b> Align all system formulations and responses with standard industrial practices.

## Prototype Design



Figure 1. CLAYDYN Prototype

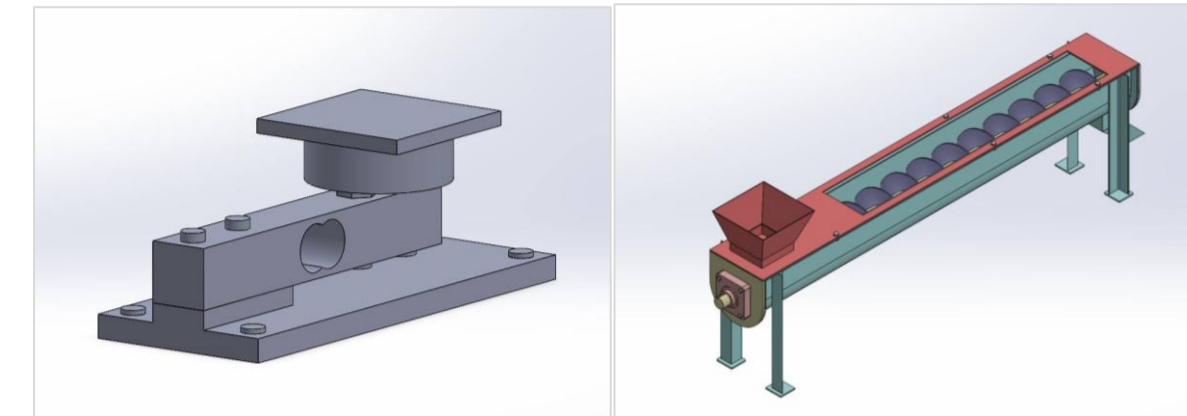


Figure 2. 3D Design of Prototype Components

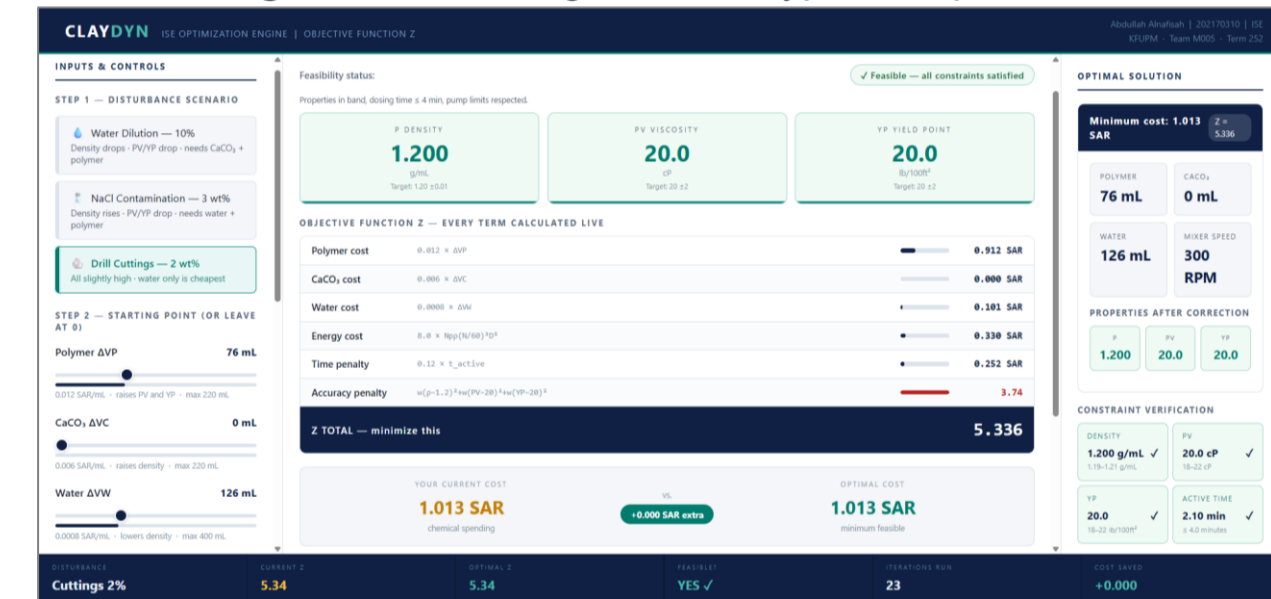


Figure 3. Optimization Model

## Testing and Validation

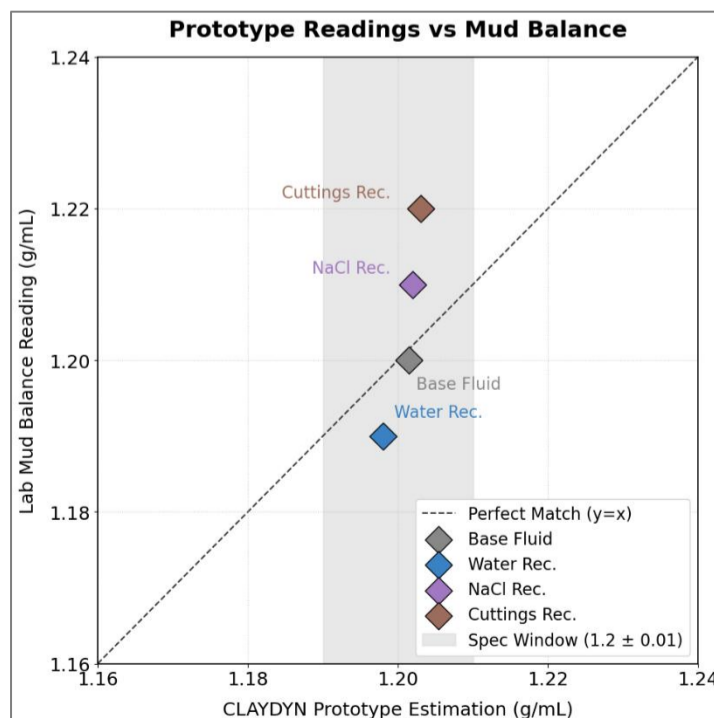


Figure 4. Density Readings (Post-Recovery)

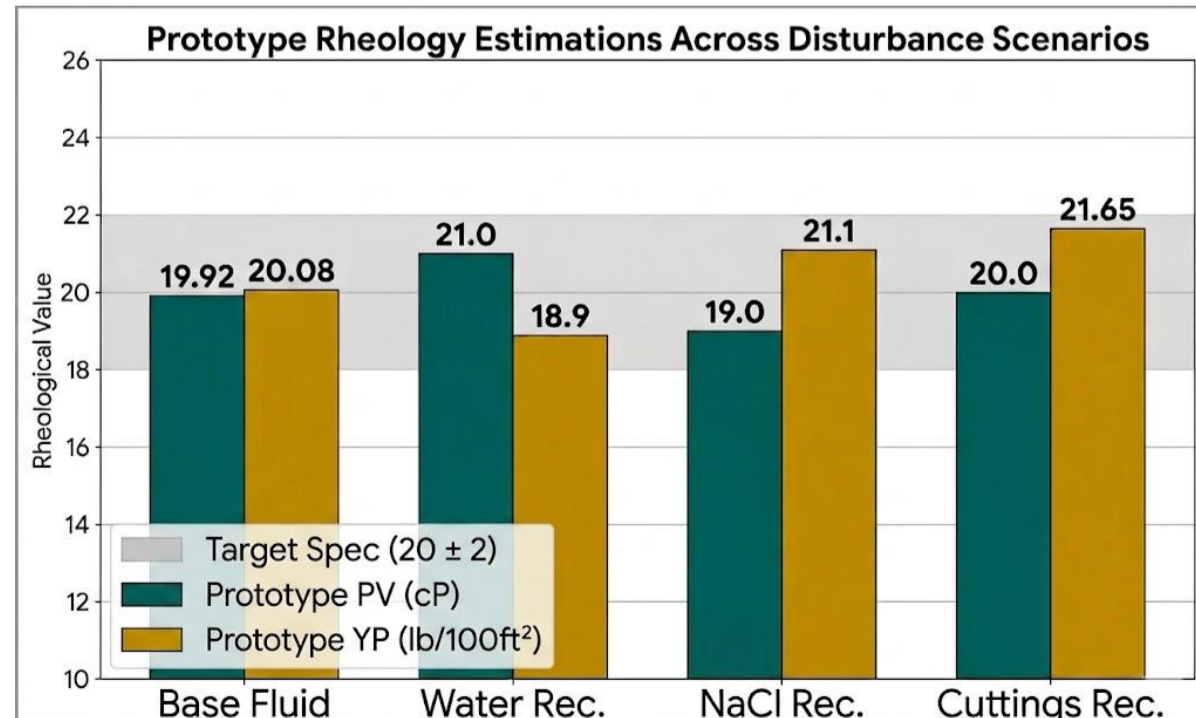


Figure 5. PV/YP Readings (Post-Recovery)

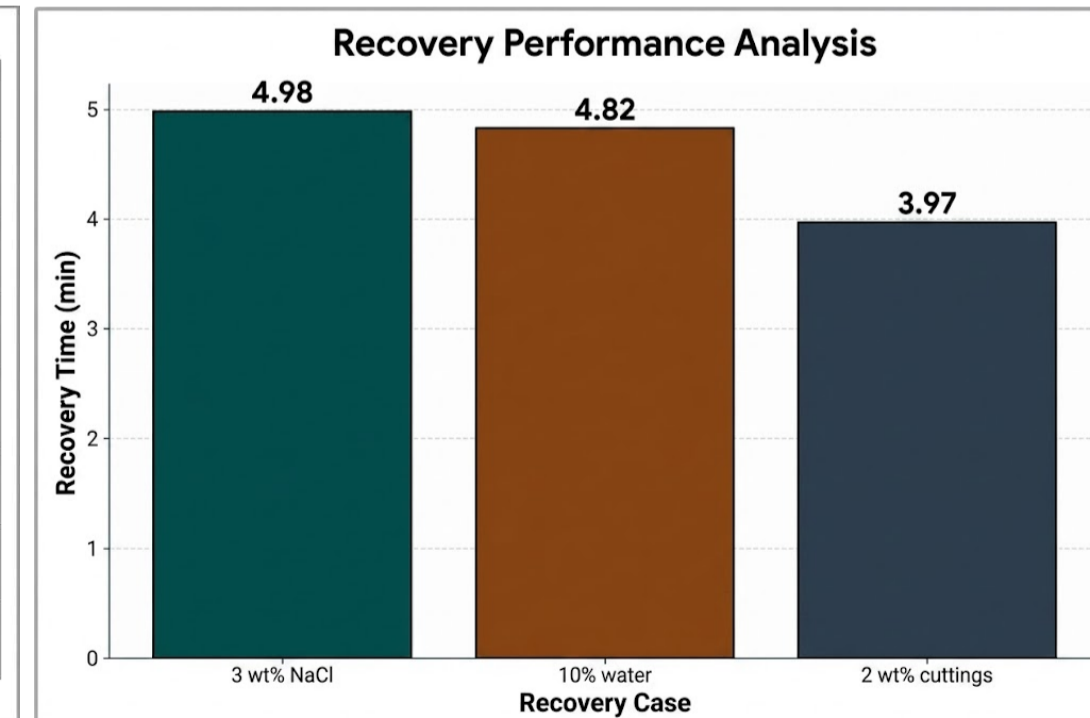


Figure 6. Optimized Recovery Time

## Conclusion

CLAYDYN successfully replaces manual mud testing with an automated system. By instantly detecting and treating disturbances:

- 10% Fresh Water
- 3 wt% NaCl
- 2 wt% Cuttings

The prototype autonomously restored:

- Density (1.20 g/mL)
  - Rheology (PV/YP = 20)
- in under 5 minutes.