

SF2 Systems for Intelligent Resin Type Classification in Extruder Systems

99.5% precision in identifying resin types
using only existing machine sensors.



33+
Undisclosed Sensors
concurrently recorded



36,000+
Extrusion Records
analyzed



75%
Threshold
for overlap matching



99.5%
Precision
identifying resin types

THE CHALLENGE – Delayed Detection of Resin Transitions Increases Waste

A polymer manufacturer sought to improve resin transition detection in extrusion, as current monitoring systems proved inadequate::

- **Manual Sampling** → resin identification requires manual lab tests, causing costly delays.
- **Transition Waste** → gradual, multi-hour changeovers make it difficult to pinpoint when a new resin has fully displaced the previous, resulting in tons of material waste.
- **Reactive Quality Control** → marginal specification changes between resin variants make reliable discrimination difficult.
- **Sensor Drift** → fixed models struggle with drift & changing operational conditions.

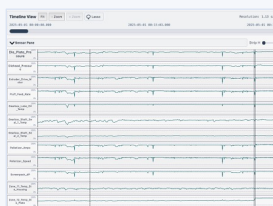
Extrusion processes continuously shift over time, making stable classification difficult for conventional statistical models

“ The challenge is not simply identifying the material – it is understanding the machine's unique response to it.”

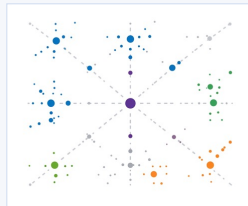
THE SF2 SOLUTION – Decoding the Language of Complex Processes

SF2 converts typically already existing sensor streams into a unique digital fingerprint – a “FacelD” for machines – capturing the total operational state of the extrusion process at a given moment. By doing so, SF2 learns a distinctive process signature for each resin.

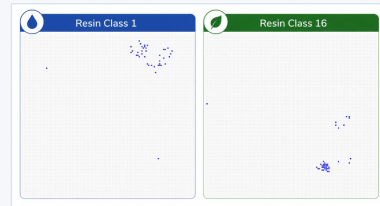
Extruder Sensor Streams



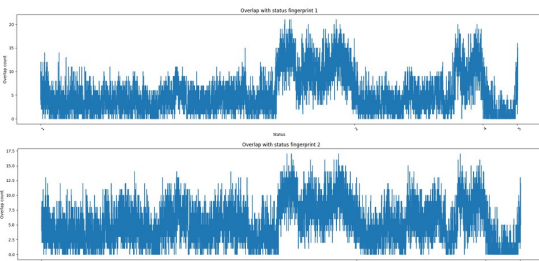
SF2 Sensor Fusion



Resin Class Fingerprints



THE RESULT – Real-Time Quality Monitoring & Waste Reduction



Overlap Line Plot: Confirming Material Identity

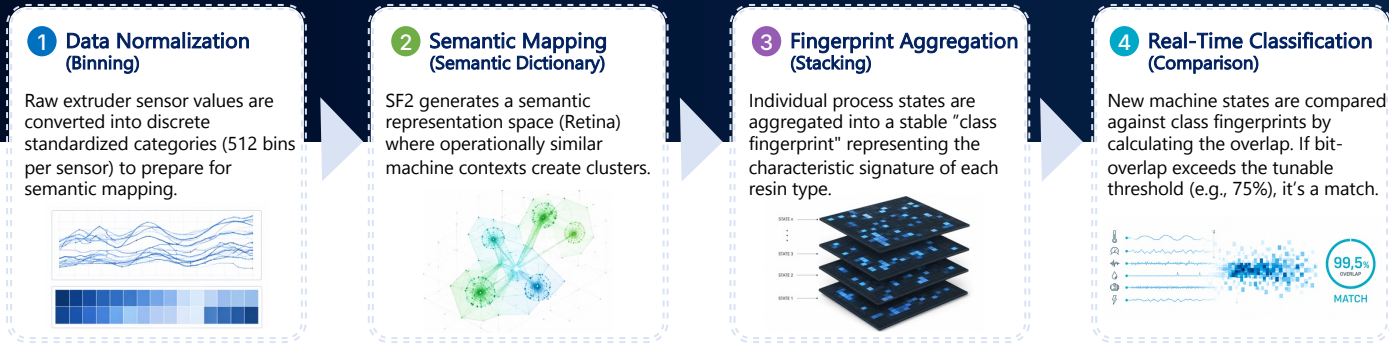
Proof of Performance

- ✓ **99.5% Precision:** Reliable classification for well-sampled resins types.
- ✓ **High Separability:** Sensor signatures captured for distinct resin mixtures.
- ✓ **Hidden Insights:** Identified same resin types with minor variants.
- ✓ **No system or data science knowledge required**

Overlap plots compare each resin fingerprint against every status record in the timeline, with distinctive “spikes” where strong matches occur. High spikes indicate highly similar signatures, while low baseline regions show separation from other resin classes, making it easy to identify overlapping materials or distinct resin behaviors.

SF2 enables extrusion systems to become intelligent, self-interpreting industrial production lines.

HOW SF2 WORKS



By aggregating concurrent sensor fingerprints into a single digital snapshot, SF2 uses semantic mapping to maintain stability against raw sensor shifts, ensuring the extruder's operational context remains interpretable even during sensor drift.

Why Semantic System Understanding Outperforms Statistical AI

SF2 (Deterministic)

- ✓ Accurate state-based monitoring & prediction
- ✓ Detects gradual shifts as they occur
- ✓ No labelled data required
- ✓ Explainable and reproducible
- ✓ Real-time, low compute
- ✓ 100% data sovereignty
- ✓ 100% edge-capable / offline – real-time on any device

Model-Centric AI (Probabilistic)

- ✗ Uncertain approximations
- ✗ Detects failures only after thresholds are crossed
- ✗ Requires large labeled datasets
- ✗ Black-box behavior
- ✗ High compute & high-latency processing
- ✗ Mostly cloud-dependent (data & security risk)
- ✗ Not edge-ready

MEASUREABLE BUSINESS IMPACT



Automated Quality Control
Eliminate manual sampling



Reduced Transition Waste
Detect transitions and off-spec production in real-time



Less Downtime
Avoid costly failures before they occur



Faster Time-to-Value
Deploy in days, not months



Edge-Ready
Deploy locally, secure & transparent

SF2 converts elusive operational behavior into consolidated semantic representations, enabling engineers to understand how materials influence system state in real time. This allows them to identify when product specifications are met and to optimize the capacity utilization of the production line(s). As a result, system behavior remains interpretable even under changing operating conditions. All analysis is performed at the edge and does not require prior knowledge of the physical system or sensor types.

CONCLUSION

SF2 turns noisy extruder sensor streams into a unified live representation of material composition. In this study, resin types were classified with up to 99.5% precision, providing a foundation for real-time quality monitoring and anomaly detection without the need for complex AI models.

Learn more at www.SF2systems.com

FUTURE POTENTIAL – Any machine with sensors can become operationally interpretable

