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How Archimetis Operational Reasoning System Detected a Hidden Furnace Failure In Under an Hour

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ABSTRACT

A mid-sized refinery (150K BPD) was experiencing repeated thermal cycles and unit trips on its Gasoline Hydrotreater Reactor Furnace. The plant's DCS and APC indicated the furnace was operating within healthy parameters, masking a serious latent failure. This poster presents how Archimetis's Operational Reasoning System (ORS), a multi-agent system that ingests heterogeneous plant data and reasons over it the way an experienced process engineer would identified the root cause in under an hour. Working with plant engineers, the ORS reviewed several months of operating data alongside event data from the cycles and trips. It detected a 3% gap between theoretical and measured stack O_2, indicating an air-deficient, fuel-rich combustion state inconsistent with the air flow transmitter reading. By cross-referencing combustion stoichiometry, draft pressure, control-valve backpressure trends, and radiant-versus-convective duty shifts, the ORS isolated the cause to a major Air Preheater (APH) leak diverting an estimated 34% of measured airflow before combustion. A subsequent bowtie process safety review confirmed that the leak had compromised the furnace purge cycle and was producing convection-section afterburn creating a credible explosion-during-startup possibility that conventional monitoring had not flagged. The post illustrates three capabilities that distinguish an ORS from conventional APC, anomaly detection, or first-principles models: (1) automated cross-referencing of disparate, weakly-coupled data streams; (2) hypothesis generation and falsification against process physics; and (3) production of engineer-auditable evidence chains. End-to-end diagnosis took approximately one hour versus an estimated week of manual investigation, avoiding ~$200K/day in further downtime and a portion of the turnaround budget. A realized value of $1.5–2M on a single event.