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Development of a digital twin for a downstream process in API manufacturing for decision-making and process improvement

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In the field of API production, process control and stability are crucial for ensuring a maximum capacity and most importantly that final API meets the required quality, as any deviation from these targets can have a dire consequence on the patient's life. One promising approach to address these challenges in the production is the use of a digital twin, which is a virtual replica of the physical system that can simulate its behavior and provide insights into its dynamics and operation. In this context, a digital twin for a downstream process that is the recovery process in API production is developed based on a hybrid model that accurately represents the underlying process dynamics. The model can then be used to simulate different scenarios and test the impact of various process parameters on the system's behavior. By doing so, one can gain a deeper understanding of the process operation and identify opportunities to optimize its performance in terms of stability and yield.

Another key advantage of the developed digital twin is its ability to perform "what-if"and "what-is"best analyses, which involved testing hypothetical scenarios to understand how the process might respond under different conditions without performing real tests and without endangering the process. For example, one could simulate the impact of changing the flow rate of a particular stage of the process or the flow profile of the next capture step to see how it affects the overall operation and performance, or to test different process design topologies that aim at increasing the yield.

In summary, by developing digital twin for downstream API production's recovery process, a wealth of opportunities was harnessed as it offered a versatile tool and an informative platform that provided a direct value co-creation by supporting the production in the daily operation either to test "what-if"scenarios or screening different ideas to increase the yield. Hence, the developed model helped in achieving a targeted decision-making and allowed for a systematic approach to improve the process performance.

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